UFC 3-240-01
1 November 2012
Change 2, 1 January 2019

UNIFIED FACILITIES CRITERIA (UFC)

WASTEWATER COLLECTION

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UNIFIED FACILITIES CRITERIA (UFC)

WASTEWATER COLLECTION

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER CENTER

Record of Changes (changes are indicated by **1**\ ... /**1**/)

Change No.	**Date**	**Location**
1	1 Nov. 2014	1. Coordinated language in paragraph 5-2 to align with 10 State Standards. 2. Updated references in paragraphs 2-2.1.3, 3-4.1.1 and Appendix A. 3. Editorial changes in Table 4-2 and paragraphs 1-2, 1-3.2, 5-1.4, 5-8 and Appendix A..
2	1 Jan. 2019	1. Updated references in various paragraphs, Appendix A and Appendix B. 2. Updated WEF MOP FD-5 to ASCE MOP 60 a joint publication. 3. Revised paragraphs 2-1.1, 2-4.1, 2-4.2, 2-5,3-2.3, 3-3,3-4, 4-1, and 5-1.1. 4. Revised Appendix B paragraph numbering.

This UFC supersedes: UFC 3-240-04A, UFC 3-240-06A, UFC 3-240-07FA and UFC 3-240-08FA, all dated 16 January 2004.

FOREWORD

The Unified Facilities Criteria (UFC) system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD (AT&L) Memorandum dated 29 May 2002. UFC will be used for all DoD projects and work for other customers where appropriate. All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the more stringent of the UFC, the SOFA, the HNFA, and the BIA, as applicable.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Center for Engineering and the Environment (AFCEE) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: Criteria Change Request. The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site http://dod.wbdg.org/.

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

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UNIFIED FACILITIES CRITERIA (UFC)
NEW REVISION SUMMARY SHEET

Title: UFC 3-240-01, *Wastewater Collection*

Superseding: UFC 3-240-04A, 3-240-06A, 3-240-07FA, and UFC 3-240-08FA.

Description: This new UFC 3-240-01 consolidates into one Tri-Service document the civil engineering criteria applicable to wastewater collection that were formerly in the superseded documents. This UFC – through succinct reference to industry and government standards, codes and references – makes possible the replacement and/or consolidation of numerous criteria documents.

The complete list of wastewater engineering documents referenced in this UFC can be found in Appendices A and B.

Reasons for Document:

- The new UFC updates the guidance and requirements for wastewater collection contained in several existing engineering documents and efficiently consolidates them into a single UFC.

- The superseded UFC documents included requirements that were not consistent with industry standards or utilized different industry standards.

Impact:

This unification effort will result in the more effective use of DoD funds in the following ways:

- By significantly improving the design process for DoD projects and facilities, through a more efficient application of facilities criteria and enabling more efficient maintenance of facilities criteria.

- The consolidation of the UFC 3-240-01 will positively impact the project costs incurred, as a result of the following direct benefits:

    - Reduction in the number of civil references used for military construction provides more clear and efficient guidance for the design and construction of DoD facilities.

    - Improved clarity and convenience results in reduced time required for execution of project designs.

    - Reduction in ambiguity and the need for interpretation reduces the potential for design and construction conflicts.

    - The reduction in the number of documents and the use of industry standards improves the ease of updating and revising this reference document as better information becomes available.

Non Unified Issues: No major unification issues.

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TABLES

CHAPTER 1 INTRODUCTION

1-1 PURPOSE AND SCOPE.

This Unified Facilities Criteria (UFC) provides requirements for typical wastewater collection systems for the Department of Defense (DoD). These minimum technical requirements are based on UFC 1-200-01. Where other statutory or regulatory requirements are referenced in the contract, the more stringent requirement must be met.

1-2 APPLICABILITY.

This UFC applies to service elements and contractors involved in the planning, design and construction of DoD facilities worldwide. It is applicable to all methods of project delivery and levels of construction, but is not applicable to public-private ventures (PPV).

All design and construction outside of the United States and United States territories is governed by international agreements, such as the Status of Forces Agreements (SOFA), Host Nation-Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA), and country-specific Final Environmental Governing Standards (FGS) or \2\ DoD 4715.05-G *Overseas Environmental Baseline Guidance Document* (OEBGD) /2/. The OEBGD applies when there are no FGSs in place. Therefore, in foreign countries this UFC will be used for DoD projects to the extent that it is allowed by and does not conflict with the applicable international agreements and the applicable FGS or OEBGD.

1-3 OTHER CRITERIA.

1-3.1 General Building Requirements.

UFC 1-200-01, "General Building Requirements", provides applicability of model building codes and government-unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, sustainability, and safety. Use this UFC in addition to UFC 1-200-01 and the UFCs and government criteria referenced therein.

1-3.2 Safety.

All DoD facilities must comply with \1\DODI 6055.1/1/ and applicable Occupational Safety and Health Administration (OSHA) safety and health standards.

1-3.3 Antiterrorism and Security.

Use and consider installation wastewater vulnerability assessments if available.

1-4 REFERENCES.

Appendix A contains the list of references used in this document. The publication date of the code or standard is not included in this document. In general, the latest available issuance of the reference is used.

1-5 BEST PRACTICES.

Appendix B identifies background information and practices for accomplishing certain wastewater collection system design and engineering services. The Designer of Record (DoR) is expected to review and interpret this guidance as it conforms to criteria and contract requirements, and apply the information according to the needs of the project. If a Best Practices document has guidelines or requirements that differ from the Unified Facilities Guide Specifications (UFGS) or UFC, the UFGS and the UFC must prevail. If a Best Practices document has guidelines or requirements that are not discussed in the Unified Facilities Guide specification (UFGS) or UFC, the DoR must submit a list of the guidelines or requirements being used for the project with sufficient documentation to the Government Project Manager for review and approval prior to completing design.

CHAPTER 2 GENERAL DESIGN REQUIREMENTS

2-1 DESIGN.

2-1.1 Design Criteria.

Design wastewater collection systems to meet the wastewater regulations and requirements of applicable federal, state and local government agencies or overseas equivalent.

Design the wastewater collection system in accordance with the following criteria precedence:

1. State sewerage regulations;

2. Utility provider's requirements;

3. *Recommended Standards for Wastewater Facilities*, latest edition, Policies for the Review and Approval of Plans and Specifications for Wastewater Collection and Treatment Facilities, A Report of the Wastewater committee of the Great Lakes – Upper Mississippi River Board of State Public Health and Environmental Managers (known hereafter as the "Ten State Standards").

Exceptions or additions to the above criteria are noted herein. Refer to the applicable Manuals of Practice prepared by the Water Environment Federation (WEF) for additional design criteria not indicated above, as applicable to the project.

\2\ /2/

Gravity systems are preferred and must be provided wherever possible. Use pump stations only where specifically identified in the project scope of work or upon written approval, prior to design, from the Government.

Combined sewers must not be permitted.

2-1.2 Design Approval.

The Designer of Record must identify and obtain all permits required by federal, state, and local regulatory agencies or overseas equivalent. The Civil Engineering Designer of Record must be a Professional Civil Engineer experienced and licensed; licensure in the location of the project may be required to obtain permits and approvals. In CONUS locations the Government will review for acceptability plans for new sanitary sewer systems, extensions to new areas, or rehabilitation/replacement of existing sanitary sewer systems. In OCONUS locations with Host nation agreements, follow design approval procedure as directed in project scope and by Government Project Manager. In OCONUS locations without Host nation agreements, the Government will review and approve plans for new sanitary sewer systems, extensions to new areas, or rehabilitation/replacement of existing sanitary sewer systems.

2-1.3 Planning for Non-War Emergencies.

Refer to Best Practices document, AWWA M19, *Emergency Planning for Water Utility Management*, for non-war emergencies such as earthquakes, hurricanes, tornadoes, floods and vandalism.

2-2 EXISTING CONDITIONS.

2-2.1 Field Investigation.

2-2.1.1 Existing and Proposed Service Areas.

Utilize installation's existing utility maps and proposed planning documents to develop existing and proposed service areas for present and future (minimum 5 year) conditions.

2-2.1.2 Topographic Survey.

Provide a topographic survey of project area including locations of existing utilities in accordance with UFC 3-201-01.

2-2.1.3 Geotechnical Site Investigation – Soil Corrosivity.

\2\ Require geotechnical for soil corrosivity, when existing operating records, visual observations, inspections or testing indicate a need for corrosion control. Provide an evaluation of existing soils at the proposed depths and locations of piping in accordance with AWWA M27, Chapter titled *Evaluating the Potential for Corrosion*. Use WEF MOP 8, Chapter 8, *Materials of Construction and Corrosion Control* for guidance and provide recommendations on materials and corrosion protection systems. /2/

2-2.1.4 Environmental Considerations.

Contact the Installation's Environmental Reviewer prior to design and evaluate site for environmental concerns and known contamination. Notify Government Project Manager of known environmental contamination to ensure adequate funding in current project.

2-3 WASTEWATER SOURCES AND FLOWS.

Refer to UFC 3-240-02 for definition and calculation of average daily flow, average hourly flow and peak flow.

2-4 TYPES OF COLLECTION SYSTEMS.

2-4.1 Gravity Sewer.

Design gravity sanitary sewer systems in accordance with \2\ paragraph 2-1.1 and ASCE MOP 60. /2/

2-4.2 Alternative Sewer Systems.

These alternatives require Government approval prior to use. Alternative sewer systems include pressure sewers with grinder pumps and septic tank effluent; vacuum sewers; effluent gravity sewers using small diameter pipes carrying septic tank effluent. Design alternative sewer systems in accordance with \2\ paragraph 2-1.1 and WEF MOP FD-12 /2/.

2-5 PUMP STATION SYSTEMS.

Design pump station systems in accordance with \2\ paragraph 2-1.1 and WEF MOP FD-4. Use Best Practices document, *Pumping Station Design* for design guidance. /2/

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CHAPTER 3 GRAVITY SEWER SYSTEMS

3-1 HYDRAULICS.

3-1.1 Minimum Velocity.

Sewers must be designed to provide a minimum velocity of 2.5 feet per second (0.76 m/s) at peak flow.

3-1.2 Minimum Pipe Size.

3-1.2.1 Design.

Design trunk and interceptor sewers to flow at depths not exceeding 90 percent of full depth; laterals and main sewers, 80 percent; and building connections, 70 percent.

3-1.2.2 Building Connection.

Minimum size of a building connection must comply with local plumbing code. If no local plumbing code, minimum size of a building connection must be 4-inch (100 mm) in diameter.

3-1.3 Alignment.

Exception to *Ten State Standards*: Curvilinear alignment of sewers larger than 24 inches (600 mm) will not be allowed.

3-1.4 Hydraulic Profile.

Provide hydraulic profiles for larger sewers, 24-inch (600 mm) diameter and above, constructed in runs of less than 100 feet (30.5 m) and with a number of control sections where nonuniform flow can occur. Provide hydraulic profiles for process and plant piping at wastewater treatment facilities.

3-1.5 Critical Flow.

Gravity sewers are ordinarily designed to maintain subcritical flow conditions. However, in instances where supercritical flow conditions occur, design downstream pipe conditions to not induce a hydraulic jump or other flow disturbance. Consult Government Civil Reviewer.

3-2 LAYOUT AND APPURTENANCES.

3-2.1 Minimum Cover.

Minimum cover over sewer pipes must be 2 feet (0.61 m); greater than frost penetration according to UFC 3-310-01; or sufficient to support imposed dead and live loads for the pipe materials used; whichever is more stringent.

3-2.2 Layout.

Watertight manhole covers or watertight manhole inverts must be used when the manhole rim elevation is below the 100 year flood elevation according to UFC 3-201-01.

3-2.3 Pretreatment.

\2\ Use UFC 3-240-02 for pretreatment of nondomestic wastewater sources. /2/

3-2.4 Building Connections.

For service connections 4 inches (100 mm) and 6 inches (150 mm) in diameter, where a change in slope and/or direction occurs, the manhole may be replaced by a cleanout, provided that the length of service line downstream of the cleanout is not longer than 100 feet (30.5 m). Combining sewer laterals from multiple buildings will not be allowed. Each building must have its own lateral to the sewer main.

3-3 STRUCTURAL DESIGN.

Structural design for gravity sanitary sewer systems must be in accordance with \2\ UFC 1-200-01, ASCE MOP 60 /2/ and pipe manufacturer's recommendations. Structural design of gravity sanitary sewer piping installed in areas subject to earthquakes must provide appropriate seismic protection.

3-3.1 Supporting Strength of Sewers.

3-3.1.1 Rigid Conduit.

For piping not tested and rated by the three-edge bearing test (TEBT) method, other strength criteria must be applied as follows. Reinforced concrete pipe strength must be based on D-loads at the 0.01 inches (0.25 mm) crack load and/or ultimate load; use Best Practices document, *Concrete Pipe Design Manual* for guidance. For ductile iron pipe, AWWA C150/ANSI A21.50 must be used to calculate the required pipe thickness classification in relation to field loadings. Use Best Practices document, AWWA's Manual M41, *Ductile-Iron Pipe and Fittings* for guidance. The strength of cast iron soil pipe, normally used for cleanouts only, must be evaluated; use Best Practices document, *Cast Iron Soil Pipe and Fittings Handbook* published by the Cast Iron Soil Pipe Institute (CISPI) for guidance.

3-3.1.2 Flexible Conduit.

For PVC design parameters not indicated in criteria in paragraph 2-1.1 entitled "*Design Criteria*". Use Best Practices document, *Handbook of PVC Pipe: Design and Construction* for guidance. For PVC force mains, use applicable portions of Best Practices document, AWWA's Manual M23, *PVC Pipe – Design and Installation*.

3-3.2 Unsatisfactory Soil Conditions.

Information on subsurface conditions must be obtained prior to design to determine, but not be limited to, appropriate construction method in order to achieve a suitable pipe bedding.

3-4 MATERIAL SELECTION.

\2\ Approach selection of construction materials for wastewater systems in accordance with the recommendations of WEF MOP 8, Chapter 8, Materials of Construction and Corrosion Control.

Types of corrosion, including soil corrosion, are addressed in ASCE MOP 60, Chapter 4, Corrosion Processes and Controls in Municipal Wastewater Collection Systems and WEF MOP 8, Chapter 8, Materials of Construction and Corrosion Control /2/.

3-4.1 Domestic Wastewater.

3-4.1.1 External Corrosion.

For corrosive soils, select piping materials and/or a positive corrosion protection system to protect from corrosion. Use Best Practices document AWWA Manual M27, \1*External Corrosion Control for Infrastructure Sustainability*/1/; however, explicit approval by the Government is required prior to providing a cathodic protection system on a buried pipeline.

3-4.1.2 Hydrogen Sulfide and Other Internally Corrosive Conditions.

Provide piping materials and/or a positive corrosion protection system to resist corrosion for intended life span when high hydrogen sulfide concentrations are expected. Explicit approval by the Government is required prior to providing a cathodic protection system on a buried pipeline.

3-5 DEPRESSED SEWERS/INVERTED SIPHONS.

Depressed sewers must withstand internal pressures greater than atmospheric; pipe materials required must be rated for force mains.

3-6 SANITARY STRUCTURES.

3-6.1 Manholes.

3-6.1.1 Frames and Covers.

Frames and covers must be sufficient to withstand impact from wheel loads where subject to vehicular or airfield traffic.

3-6.1.2 Depth.

For manholes over 12 feet (3.7 m) in depth, provide one vertical wall with a fixed side-rail ladder.

3-7 EVALUATION AND REHABILITATION OF EXISTING SEWER SYSTEMS.

Evaluate and rehabilitate existing sanitary sewer systems in accordance with the latest edition of \2\ WEF MOP FD-6. /2/

3-8 TRENCHLESS TECHNOLOGY.

Obtain approval prior to design from the Government for use of trenchless technology on projects where beneficial to the Government. Utilize trenchless technology in accordance with the guidelines of the latest edition of Best Practices document, \2\ WEF *Trenchless Technology and Asset Management* /2/.

3-9 PIER AND WHARF COLLECTION SYSTEMS.

Provide wastewater collection, treatment and transmission systems for piers, wharfs, and drydock facilities in accordance with UFC 4-150-02.

CHAPTER 4 OIL/WATER SEPARATORS

4-1 GENERAL.

\2\ Use UFC 3-460-01 for the design of fuel facilities. Wastewater sources with conventional pollutants, such as oil or grease, from facilities such as:

- Vehicle wash racks
- Aircraft washing
- Vehicle maintenance

must have a Spill Prevention, Countermeasures and Control (SPCC) plan. The SPCC plan must identify the pollution prevention measures used, such as spill containment or spill treatment. When spill treatment is used, direct the wastewater flow through an oil/water separator prior to connecting to a domestic wastewater sewer flowing to a domestic wastewater treatment system. Evaluate the need for oil/water separator installation by following specific Base/Installation environmental requirements. Do not install a new oil/water separator unless all other alternatives have been evaluated and an oil/water separator is approved by the Installation's Environmental Reviewer. /2/If the Civil Engineering Designer of Record designs around a particular manufacturer's oil/water separator, at least three different manufacturers must be specified in the construction documents.

4-2 OIL/WATER SEPARATORS.

4-2.1 Regulatory Compliance.

Comply with latest regulations for wastewater discharges from federal, state and local regulatory authorities.

4-2.2 Related Impacts on Collection/Treatment Systems.

Oil/water separators are needed to prevent accumulation of oil and grease in wastewater collection piping, causing flow obstructions. Also, oil/water separators are needed to prevent accumulation of oil and grease in treatment facility sludge, resulting in hazardous substance disposal requirements.

4-3 DESIGN OF OIL/WATER SEPARATORS.

Provide materials or a coating system which will protect the separator from the oil-in-water mixture, atmosphere, and in-situ soil conditions. Provide an oil/water separator of steel, precast concrete, cast-in-place concrete, or fiberglass. Units constructed below ground must have secondary containment and must protrude above the ground surface a minimum of 8 inches (200 mm) to prevent stormwater intrusion. The Government may require below ground units to be installed with a liner and leak detection system. The Government may also require steel tanks have cathodic protection.

4-3.1 Wastewater Characteristics.

If possible, analyze the wastewater to be treated by an oil/water separator for total oil and grease using conventional methods listed by EPA Standard Methods or American Society for Testing and Materials (ASTM) standards. Include free, emulsified, and dissolved oil fractions determined by an approved API method. Include total suspended solids (TSS), volatile suspended solids (VSS), and settable solids in the analysis. Include, at the minimum design temperature, specific gravities of the oil and water phases and the absolute viscosity of the water.

4-3.2 Establishing the Design Flow.

Base design flow on the maximum flow rate to be treated, including the addition of any future oily wastewaters. In determining peak flow rates, variations between shifts and daily and seasonal variations must be considered. Flow rates must be measured where the wastewater generating process already exists, or accurately estimated where it does not.

Where useful, establish production-based wastewater generation rates for projecting future flows. For example, the maximum flow expected from an aircraft washing facility may be estimated from the expected washwater per aircraft multiplied by the maximum number of aircraft to be washed in a given period. If unit wastewater generation rates from another facility are used, differing conditions must be accounted for, such as differences in the type and size of aircraft and washing procedures.

Consider diverting stormwater runoff to a separate drain during rainfall periods. Storm water inflow must be eliminated to the maximum extent practical for all separators discharging to the sanitary sewer or to waters of the United States. Oil/water separators must be designed to adequately handle anticipated maximum oily waste loads.

4-3.3 Design Criteria.

Design the oil/water separator to be readily accessible for maintenance and inspection. The separator must be an “open type unit” with removable grates or covers for easy access for maintenance. Covers must be easily removable by no more than two workers. Consider cover removal exposing a minimum of 50% of wet surface area. Enclosed separators with small manways must not be installed, except for the protection of health and safety; approval by the Government Project Manager is required prior to design completion. Mechanical components must be kept to a minimum.

An oil/water separator must conform to the applicable guidelines of archived API 421, Design and Operation of Oil-Water Separators. Use Best Practices Document, SFIM-AEC-EQ-CR-200010, Multiservice Oil/Water Separator Guidance Document, for planning, operations and maintenance of oil/water separators.

4-3.1.1 Gravity Oil/Water Separators.

Conform to Table 4-1 for design of gravity oil/water separators. For continuous wastewater sources, provide a bypass channel or unit.

Table 4-1 Gravity Oil/Water Separators – General Design Information

Category of Oil Removed	> 150 microns
Maximum Horizontal Velocity	2 to 3 ft/min (0.010 to 0.015 m/s) or equal to 15 times the rise rate of the oil droplets, whichever is smaller
Depth of Flow in Separator	Minimum: 3 to 4 ft (0.91 to 1.2 m) Maximum: 8 ft (2.4 m)
Width of Separator	Minimum: 6 ft (1.8 m) Maximum: 20 ft (6.1 m)
Length-to-width Ratio	Between the limits 3:1 to 5:1
Depth-to-width Ratio	Typically between the limits 0.3:1 to 0.5:1 Maximum: 1:1
Surface Loading Rates	Between the limits 60 to 1,000 gpd/ft^2 (2.83 x 10^{-5} m^3/s/m^2 to 4.72 x 10^{-4} m^3/s/m^2)
Detention Time at Design Flow	Common: 45 minutes to 2 hours High: 8 hours
Average Effluent Oil Concentration	Meet permit limit conditions

4-3.1.2 Parallel Plate Oil/Water Separators.

If parallel plate separators are required, they must be designed with cross flow parallel plates. Parallel plates will increase the surface area of the separator providing additional removal of oil; however, they must be cleaned regularly to function properly. Conform to Table 4-2 for design of parallel plate oil/water separators.

Table 4-2 Parallel Plate Oil/Water Separators – General Design Information

Category of Oil Removed	>20 microns
General Design	See Table 4-1
Design Capacity	Two to three times that of an equivalently sized conventional gravity separator
Spacing \1\Between/1/ the Plates	Minimum spacing between inclined plates is 0.75 inch (19 mm) General spacing range: 0.75 to 1.50 inches (19 to 38 mm)
Angle of Inclining Plates	45 to 60 degrees from horizontal
Surface Loading Rate	0.33 gal/min/ft^2 (2.24 x 10^{-4} m^3/s/m^2) of plate area
Plate Cleaning Interval	A minimum interval of every 6 months is appropriate
Average Effluent Oil Concentration	Meet permit limit conditions

4-3.4 Design Criteria for Pumped Influent.

Pumping of oily wastewater to the separator must be avoided. Where site conditions require pumping, only progressive cavity pumps or other low shear pumps must be used. Centrifugal pumps must not be used.

The separator inlet must include a distribution header designed to reduce turbulence.

Manufacturers typically indicate catalog flow ratings of their oil/water separators based upon the influent flowing by gravity with no pumps upstream of the separator. Current manufacturer's research indicates that low rpm, low shear pumps may be used upstream only if the flow capacity of the oil/water separator is de-rated in order to achieve the effluent quality standards required. If pumped influent cannot be avoided, the Civil Engineering Designer of Record must provide the Government documentation from manufacturers that the proposed oil/water separator has been sized sufficiently to meet effluent standards under anticipated pump flow rates.

CHAPTER 5 WASTEWATER PUMP STATIONS

5-1 PUMP STATION.

5-1.1 Site Selection.

Pumping facilities must not be constructed beneath buildings, streets, roadways, railroads, aircraft aprons or runways, or other major surface structures.

Medium and large pump stations must not be located closer than 500 feet (152 m) to buildings or other occupied facilities, unless adequate measures are provided for odor and gas control. \2\ Small wastewater pump stations are defined as having peak flow rates less than 500 gpm (31.5 L/s); medium wastewater pump stations are defined as having peak flow rates of 500 gpm (31.5 L/s) to 3200 gpm (202 L/s); and large pump wastewater pump stations are defined as having peak flow rates greater than 3200 gpm (202 L/s) /2/.

The location of pump stations must consider availability of utilities such as electric power, potable water, fire protection, gas, steam, and telephone service.

5-1.2 Pump Station Depth.

Set the high water level in the wet well below the lowest incoming invert of the sewer and minimize fall of wastewater releasing hydrogen sulfide.

5-1.3 Architectural.

The architectural exterior must be compatible with the existing surrounding or future planned buildings.

5-1.4 Access.

Pump stations must have adequate access for personnel and equipment maintenance and replacement. Access points must be lockable and meet Base Security requirements.

All pump stations must be readily accessible from an \1\all-weather/1/ road. For stations that are not enclosed, access must be provided for direct maintenance from a truck equipped with hoist attachments. For enclosed stations, provisions must be included in the structure to facilitate access for repair, and to provide a means for removal and loading of equipment onto a truck.

5-2 PUMPS AND MOTORS.

Pumps are selected to meet flow, pressure and efficiency requirements. The number and capacity of pumps provided must be sufficient to discharge the \1\ design average flow, design maximum day flow and design peak hourly /1/ flow rates.

5-2.1 Pump Construction.

When operating in wastewater containing substantial quantities of grit, impellers made of bronze, cast steel or stainless steel will be required. Enclosed impellers must be specified for wastewater pumps required to pass solids. Pump casings of the volute type must be used for pumping raw untreated wastes and wastewaters containing solids.

5-2.2 Pump Motors.

Pump location must determine type of motor enclosure. For dry pit pump installations above the 100 year flood elevation, motor enclosures are normally open, drip proof type. Pumps installed outdoors, or in dirty or corrosive environments, must require totally enclosed motors. Submersible pumps must have motor enclosures that are watertight. Motors installed outdoors must have temperature ratings adjusted to suit ambient operating conditions. For pumps designed to operate on an intermittent basis, space heaters must be provided in motor housings to prevent condensation. Motors installed in wet wells must be explosion proof. Motor starters must be designed for limiting the inrush current where shocks or disruptions to the electrical supply are likely to occur as a result of pump start-up.

5-2.2.1 Motor Horsepower.

Select the pump motor horsepower such that it will accommodate any variation in flow and head along the entire design impeller curve without motor overload or failure.

5-2.2.2 Emergency Power.

Provide for emergency power operation, such as a dedicated standby emergency generator or a portable generator, in conformance with applicable regulatory and utility provider requirements.

5-2.2.3 Speed Control System.

The simplest system which allows pumps to accomplish the required hydraulic effects must be chosen for design. Factors to be considered in selecting a system include cost, efficiency, reliability, structural requirements, ease of operation and degree of maintenance necessary. The last two items are critical at military installations where adequate personnel cannot always be provided. In general, variable speed control devices are more expensive, less efficient, and require a higher degree of maintenance than constant speed controls. However, in some instances, variable speed pumping is the best approach. Consideration for variable speed pumps will be coordinated and conducted in close coordination with the facility utility provider.

5-2.3 Redundancy.

Pumping capacity must be adequate to discharge the peak flow with the largest pump out of service.

Consult with the Government's Civil Reviewer for exceptions to this redundancy requirement, such as a wastewater pump station serving extremely low flows, i.e. a remote gate house.

5-3 HYDRAULICS.

5-3.1 Force Main.

5-3.1.1 Minimum Diameter.

Minimum diameters to be used are 1 ¼-inch (32 mm) for force mains at grinder pump installations; and 4-inch (100 mm) for force mains serving small nonclog submersible pump stations and pneumatic ejectors. Final force main sizing for a particular project must be based on hydraulic calculations considering velocity, friction loss, power requirements, etc.

5-3.1.2 Hazen-Williams Roughness/Friction Coefficient.

Values lower than 80 will not be allowed unless verified by flow and pressure tests; if verified, consider replacement.

5-3.1.3 Maximum Flow Velocity.

Velocities above 5 feet per second (fps) (1.52 m/s) must be avoided because of high friction losses. Where excess head is available, limit velocities to 10 fps (3.04 m/s).

At velocities above 5 feet per second (1.5 m/s), particularly in PVC pipe, the design must address surge pressures and conditions.

5-3.2 Pump Selection.

Pumps must be selected so that the total required capacity of the pump installation can be delivered with the minimum level in the wet well and maximum friction in the discharge line. Pump efficiency must be at a maximum at average operating conditions.

All operating conditions must be evaluated including, but must not be limited to, multiple pump operation within the subject force main, simultaneous pump station operation for common force main situations, as well as the possibility for gravity flow conditions in force main segments with extreme negative slopes that may not flow full. Pump operation must also be evaluated with wet well levels both at "pump off" and "lag pump on" to ensure that the pump selection works in the full range and does not extend off the manufacturer's recommended performance curve at either condition.

5-3.3 Cavitation.

Confirm net positive suction head available is greater than the manufacturer's net positive suction head required at all anticipated operating conditions.

5-3.4 Surge Analysis and Control.

Utilization of computer programs for water hammer analysis of large pump stations is required.

5-3.5 Thrust Restraint.

Provide calculations for restrained joints. Use Best Practices document, DIPRA's *Thrust Restraint Design for Ductile Iron Pipe* for guidance.

5-4 LAYOUT.

5-4.1 Minimum Cover.

Minimum cover over the force mains must be 2 feet (0.61 m); greater than frost penetration according to UFC 3-310-01, sufficient to support structural loads; or greater than depth required to install valve riser; whichever is more stringent.

5-4.2 Layout.

Consider the space required to remove bolts from thrust harnesses of sleeve couplings and to slide couplings off joints. In the dry well or structure, provide a minimum clearance of 4 feet (1.2 m) between adjacent pump casings, and a minimum of 3 feet (1.0 m) from each outboard pump to the closest wall. A 7 feet (2.1 m) minimum clearance between floor and overhead piping will be maintained where practicable.

Wet wells for all stations must have no length, width or diameter smaller than 4 feet (1.2 m).

Avoid split level floors.

5-4.3 Safety.

In pump stations where the possibility exists for toxic, explosive, or otherwise hazardous atmospheres, proper design for personnel safety must be included. Wastewater pumping stations are classified as light hazard, industrial type occupancies.

5-5 PUMP CONTROLS.

5-5.1 Selection of Control Points.

A minimum of 6 inches (150 mm) will be required between pump control points used to start and stop successive pumps, or to change pump speeds.

5-5.2 Controls.

Alarms must be provided to signal high liquid levels in the wet well, pump failure, or a malfunctioning speed control system. Provide alarms required to satisfy pump manufacturer's warranty. Consider a low level alarm below the "pump off" level; consider an emergency, low level pump cutoff below the low level alarm.

5-5.3 Remote Monitoring.

Provide for remote monitoring, such as telemetry, in conformance with applicable regulatory and utility provider requirements. Remote monitoring systems must meet the Installation's IT security requirements and standards.

5-6 VALVES AND APPURTENANCES.

5-6.1 Blowoff Valves.

Normally blowoff valves are required only on long depressed sections of force main, or where an accumulation of solids is likely to occur. Install blowoff connections in manholes or valves structures with adequate drainage and protect against freezing.

5-6.2 Pressure Gages.

For dry pit/wet pit pump stations, provide pressure gages on discharge piping directly downstream of the pump.

5-7 MATERIAL SELECTION.

5-7.1 Force Mains.

\2\ Select piping materials and protective coating system to protect materials from corrosion. For highly corrosive soils, provide a protective coating system for highly corrosive soils or a cathodic protection system in accordance with UFC 3-570-01. /2/

5-7.2 Wet Wells.

For packaged pump stations, provide wet wells of precast concrete or fiberglass construction with adequate flotation protection measures assuming groundwater elevation at the ground surfaces.

5-8 UPGRADES TO EXISTING PUMP STATIONS.

Existing pump stations may be upgraded where a complete hydraulic analysis shows that the \1\upgraded/1/ pump station can operate at the proposed capacity in conformance with the jurisdictional requirements for a new pump station of equal capacity. The hydraulic analysis must include \1\effects/1/ on the existing force main to its point of discharge, and if networked, the effects on all other pump stations connected to the system. This analysis is required whenever additional flow is added to a pump station, even if physical changes to the station are not proposed.

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APPENDIX A REFERENCES

GOVERNMENT PUBLICATIONS

UNIFIED FACILITIES CRITERIA (UFC), DEPARTMENT OF DEFENSE (DoD) http://dod.wbdg.org/

UFC 1-200-01, \2\ *DoD Building Code (General Building Requirements)* /2/

UFC 3-201-01, *Civil Engineering* \1\ /1/

UFC 3-240-02, *Domestic Wastewater Treatment*

UFC 3-310-01, *Structural Load Data*

\2\ UFC 3-460-01 Design: Petroleum Fuel Facilities

UFC 3-570-01, *Cathodic Protection* /2/

UFC 4-010-01, \2\ *DoD Minimum Antiterrorism Standards for Buildings* /2/

UFC 4-020-01, *DoD Security Engineering Facilities Planning* \1*Manual*/1/

UFC 4-150-02, *Dockside Utilities for Ship Service*

\2\ DEPARTMENT OF DEFENSE
https://www.esd.whs.mil/DD/

DEPARTMENT OF DEFENSE MANUALS
DoD 4715.05-G, *Overseas Environmental Baseline Guidance Document*

DEPARTMENT OF DEFENSE INSTRUCTIONS (DoDIs)
DODI 6055.1, *DoD Safety and Occupational Health (SOH) Program* /2/

NON-GOVERNMENT PUBLICATIONS

\2\AMERICAN SOCIETY OF CIVIL ENGINEERS

1801 Alexander Bell Drive, Reston, VA 20191-4400

https://ascelibrary.org/

ASCE MOP 60, *Gravity Sanitary Sewer Design and Construction*, a joint publication with WEF (WEF MOP FD-5)/2/

AMERICAN PETROLEUM INSTITUTE (API), 1220 L STREET, NW, WASHINGTON, DC 20005

API 421, *Design and Operation of Oil-Water Separators*

AMERICAN WATER WORKS ASSOCIATION, 6666 W. QUINCY AVENUE, DENVER, CO 80235

AWWA C150/ANSI A21.50, *American National Standard for the Thickness Design of Ductile Iron Pipe*

AWWA Manual M27, \1*External Corrosion Control for Infrastructure Sustainability*/1/

GREAT LAKES – UPPER MISSISSIPPI RIVER BOARD OF STATE PUBLIC HEALTH AND ENVIRONMENTAL MANAGERS

Recommended Standards for Wastewater Facilities, latest edition

WATER ENVIRONMENT FEDERATION, 601 WYTHE STREET, ALEXANDRIA, VA 22314-1994

WEF MOP FD-4, *Design of Wastewater and Stormwater Pumping Stations*

WEF MOP FD-6, *Existing Sewer Evaluation and Rehabilitation*

WEF MOP FD-12, *Alternative Sewer Systems*

APPENDIX B BEST PRACTICES

This appendix identifies background information and practices for accomplishing certain wastewater design and engineering services. The Civil Engineering Designer of Record (DoR) is expected to review and interpret this guidance and apply the information according to the needs of the project. If a Best Practices document has guidelines or requirements that differ from the UFGS or Unified Facilities Criteria, the UFGS and the UFC must prevail. If a Best Practices document has guidelines or requirements that are not discussed in the Unified Facilities Guide specification (UFGS) or UC, the DoR must submit a list of the guidelines or requirements being used for the project with sufficient documentation to the Government Project Manager for review and approval prior to completing design.

B-1 WHOLE BUILDING DESIGN GUIDE

The Whole Building Design Guide provides additional information and discussion on practice and facility design, including a holistic approach to integrated design of facilities.

The WBDG provides access to all Construction Criteria Base (CCB) criteria, standards and codes for the DoD Military Departments, National Aeronautics and Space Administration (NASA), and others. These include, Unified Facilities Criteria (UFC), Unified Facilities Guide Specifications (UFGS), Performance Technical Specifications (PTS), design manuals, and specifications. For approved Government employees, it also provides access to non-government standards.

B-2 WASTEWATER ENGINEERING RELATED GUIDANCE

GOVERNMENT PUBLICATIONS

DEPARTMENT OF DEFENSE (DoD)
http://www.wbdg.org/ccb/browse_cat.php?o=29&c=76

SFIM-AEC-EQ-CR-200010, *Multiservice Oil/Water Separator Guidance Document*

NON-GOVERNMENT PUBLICATIONS

AMERICAN WATER WORKS ASSOCIATION, 6666 W. QUINCY AVENUE, DENVER, CO 80235

AWWA Manual M19, *Emergency Planning for Water Utility Management*

AWWA Manual M23, *PVC Pipe – Design and Installation*

AWWA Manual M41, *Ductile Iron Pipe and Fittings*

AMERICAN CONCRETE PIPE ASSOCIATION, 8320 OLD COURTHOUSE ROAD, VIENNA, VA 22180

Concrete Pipe Design Manual, latest edition

BUTTERWORTH-HEINEMANN, 30 CORPORATE DRIVE, SUITE 400, BURLINGTON, MA 01803

Pumping Station Design, edited by Garr M. Jones with Robert L. Sanks, George Tchobanoglous and Bayard Bosserman, latest edition

CAST IRON SOIL PIPE INSTITUTE (CISPI), 1064 DELAWARE AVENUE, SE, ATLANTA 30316

Cast Iron Soil Pipe and Fittings Handbook, latest edition.

DUCTILE IRON PIPE RESEARCH ASSOCIATION, 245 RIVERCHASE PARKWAY EAST, SUITE O, BIRMINGHAM, AL 35244-1856

Thrust Restraint Design for Ductile Iron Pipe, latest edition.

UNI-BELL PVC PIPE ASSOCIATION, 2655 VILLA CREEK DRIVE, SUITE 155, DALLAS, TX 75234

Handbook of PVC Pipe: Design and Construction, latest edition

\2\ WATER ENVIRONMENT FEDERATION, 601 WYTHE STREET, ALEXANDRIA, VA 22314-1994

WEF MOP 8, *Design of Water Resource Recovery Facilities*

Trenchless Technology and Asset Management /2/

B-3 ADDITIONAL BEST PRACTICES

B-3.1 Types of Collection Systems.

Generally a gravity sewer system will be justified until its cost exceeds the cost of a pumped system by 10 percent. Consider future demand and whether the gravity sewer will serve as an intermediate connection within wastewater collection system. When it is not readily apparent which design solution will be more economical, conduct a life cycle cost analysis.

B-4 OIL/WATER SEPARATORS.

B-4.1 Typical Military Applications.

The prevailing type of oil/water separator installed on military installations is the parallel plate oil/water separator.

B-4.2 Other Considerations.

Consider the following during design:

- Using detergents to clean up work areas increases emulsification and inhibits gravity oil/water separation. Use of high-pressure water also causes emulsification but is generally less detrimental to oil/water separation than the use of detergents.
- Consider use of dry absorbents to minimize the amount of oil reaching sewers. Dry absorbents may be collected and disposed of with solid waste materials. If possible, replace wet process with dry processes, and plug floor drains.
- Implementation of point source controls may eliminate or reduce the wastewater volume and contaminant concentrations. For example, used oils may be segregated for disposal or reuse rather than allowing them to enter the wastewater stream. Implementing point source controls may also be more economical than providing a wastewater treatment system. Point source control techniques include process change or modification, material recovery, material substitution, wastewater segregation, and water reuse/recycling.
- Implement best management practices in the stormwater pollution prevention plan which will minimize or eliminate the need for oil/water separators in most instances.
- Minimize the formation of oil emulsions and segregate emulsions for special treatment whenever possible. Emulsions are usually complex, and bench or pilot plant testing is generally necessary to determine an effective method for emulsion breaking.
- Investigate current process operating practices to determine if good housekeeping practices are employed and if changes can be made to reduce waste materials or use of excess water. In many cases, proper attention to control of operations can greatly reduce the amount of soluble oil requiring treatment. Minimizing leaks, avoiding spills, using drip trays, employing spill containment techniques, and discarding oil only when it is no longer serviceable must be part of any oily waste control program. Oil/water separators are not to be used for spill containment.

B-4.3 Treatment Technology.

Lack of proper maintenance is one of the biggest causes of oil/water separator failure. Design for ease of maintenance so as to promote adequate periodic maintenance.

B-4.3.1 Gravity Separation.

Typical API separators are open top, limited to effluent discharge rates of 50 gpm (3.15 L/s), and based upon the removal of free oil globules larger than 150 microns. If a separator is needed to remove 20 micron oil droplets, the required surface area of the conventional API gravity oil/water separator is prohibitively large. Therefore, parallel plate separators are typically used to meet current effluent standards.

B-4.3.2 Parallel Plate Separators.

Oil is removed by passing the wastewater at laminar velocity through the pack of closely spaced, parallel plates, which are constructed at various inclines ranging from 45 to 60 degrees.

Suspended solids settle to the bottom and are collected in a sludge well. From the well, sludge is pumped or withdrawn by gravity to waste. If sludge transfer is by gravity displacement, an automatic valve is usually provided.

The plates may be made of oleophilic (oil attracting) material to promote coalescence of oil droplets. For this reason, the units are sometimes referred to as coalescing plate separators. Coalescing plates are usually recommended only for light oil loadings when a higher level of oil removal is required, the wastewater stream contains minimal solids concentrations, and the facility is committed to the additional maintenance procedures required to keep the coalescing pack free of debris.

The plates may also be constructed in a corrugated configuration with alternate troughs and ridges, such as in the corrugated plate interceptor (CPI).

B-4.3.3 Air Flotation Separators.

In the air flotation process, separation of both oil and solid particles is brought about by introducing fine air bubbles into the liquid waste stream. The bubbles attach to the particular matter and oil droplets, and the buoyant force of the air bubbles causes both particles and small oil droplets to rise to the surface. The oil/solids/air bubble mixture forms a froth layer at the surface which is skimmed away. The Design Engineer of Record must document adequate justification for the additional maintenance requirements before selecting an air-flotation unit for oil/water separation.

B-4.4 Treatment of Emulsified Oil.

B-4.4.1 Destabilization.

Treatment of oil emulsions is usually directed toward destabilizing the dispersed oil droplets, causing them to coalesce and form free oil. The process typically consists of rapidly mixing coagulant chemicals with the wastewater, followed by gentle mixing (flocculation). The agglomerated oil droplets may then be removed by gravity or flotation.

B-4.4.2 Chemical Processes.

Some manufacturers require emulsified oils to be chemically pretreated before entering the separator. Alternative chemical emulsion breaking processes include either the addition of acid (acid cracking), iron or aluminum salts (coagulation), or chemical emulsion breakers. Different products may need to be evaluated through bench scale tests to determine which product is most effect in a particular application.

B-4.4.3 Mechanical Impingement and Filtration Processes.

Other methods for removing emulsified oil include mechanical impingement devices and filtration. A mechanical impingement device includes coalescing filters. Pressure filters may also be used but rarely on military installations.

B-4.5 Treatment of Dissolved Oil.

Treatment of dissolved oil is also not normally practiced at military installations. Dissolved oil that might be present is expected to be removed by the biological treatment processes employed by the wastewater treatment plant downstream.

B-4.6 Oil/Sludge Removal and Disposal.

Reliable oil removal is critical from the surface of the separation chamber for both commercially available units and custom-designed separators. In the past one of the methods used involved suction removal by military installation personnel using equipment commonly referred to as a “vacuum” or “vac-all” truck, normally used for cleaning catch basins.

Oils and oily sludges removed from the oil/water separator may be disposed of by reuse/recovery, incineration, sale by the DLA Disposition Service, waste hauler, landfill, and land disposal. Evaluate final disposal options with oil/water separation methods and environmental requirements to establish the most cost-effective total system. The sludge may require regulation as a hazardous waste if levels of pollutants exceed Resource Conservation and Recovery Act (RCRA) or state hazardous waste levels. Further, a leaking oil/water separator containing a hazardous waste can result in a designation as a solid waste management unit (SWMU) and be subject to corrective actions under RCRA regulations.

B-5 WASTEWATER PUMP STATIONS.

B-5.1 Pumps and Motors.

B-5.1.1 Pump Motor Speed.

For a 60 cycle, alternating current power supply, the maximum synchronous motor speed allowed for wastewater pumps for medium and large pump stations is recommended at 1200 rpm.