UFC 3-240-01
1 May 2020

UNIFIED FACILITIES CRITERIA (UFC)

WASTEWATER COLLECTION AND TREATMENT

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UNIFIED FACILITIES CRITERIA (UFC)

WASTEWATER COLLECTION AND TREATMENT

Indicate the preparing activity beside the Service responsible for preparing the document.

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

This UFC supersedes UFC 3-240-01 dated November 2012, UFC 3-240-02 dated November 2012 and UFC 4-832-01N dated 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 most 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 Civil Engineering Center (AFCEC) 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 may be sent to the respective DoD working group by submitting a Criteria Change Request (CCR) via the Internet site 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://www.wbdg.org/ffc/dod.

Refer to UFC 1-200-01, *DoD Building Code (General Building Requirements)*, for implementation of new issuances on projects.

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UNIFIED FACILITIES CRITERIA (UFC)
REVISION SUMMARY SHEET

Document: UFC 3-240-01 *Wastewater Collection and Treatment*

Superseding: UFC 3-240-01 dated 1 November 2012, with Change 1 dated 1 November 2014, UFC 3-240-02 dated 1 November 2012 with Change 2 dated 1 January 2019, and UFC 4-832-01N dated 16 January 2004.

Description: This revised UFC consolidates criteria for domestic wastewater collection, domestic wastewater treatment, industrial wastewater collection and industrial wastewater treatment into one UFC. The use of industry standards and federal codes aided in the consolidation of these criteria documents. This revision updates technical requirements, industry standards, and maximizes uniformity among Tri-Service requirements. Appendix C contains a complete list of referenced wastewater requirements and Appendix B contains a complete list of referenced best practices.

Reasons for Document:

- This revised UFC updates wastewater collection and treatment criteria that was previously contained in multiple criteria documents and efficiently consolidates them into a single UFC.
- Establishes technical requirements by maximizing the use of industry standards to meet DOD requirements.
- Reorganizes the content to align with industry standards.
- Coordinates criteria requirements in other core and specialty UFC criteria documents.

Impact:

- This revision will have minimal impacts on design cost.

Unification Issues:

- FC 1-300-09N is referenced for Navy design procedures.

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CHAPTER 1 INTRODUCTION

1-1 BACKGROUND.

People have used different terminology to describe wastewater treatment facilities for many years. Today people use terms such as sewage treatment plant, wastewater treatment plant, wastewater treatment facility, or publicly owned treatment works to describe domestic wastewater treatment facilities. *Recommended Standards for Wastewater Facilities* uses the terms wastewater facilities or wastewater treatment facilities. The EPA generally uses the terms municipal wastewater treatment facilities and wastewater treatment facilities. In recent years, Water Environment Federation (WEF) started using the term water resource recovery facilities (WRRF) to describe domestic wastewater treatment facilities since the wastewater industry is becoming more focused on resource recovery. These terms apply only to domestic wastewater treatment. This terminology should not be used interchangeably with industrial wastewater treatment facilities.

1-2 PURPOSE AND SCOPE.

This Unified Facilities Criteria (UFC) provides requirements for domestic wastewater collection, domestic wastewater treatment, industrial wastewater collection and industrial wastewater treatment for the Department of Defense (DoD).

1-3 APPLICABILITY.

This UFC applies to service elements and contractors involved in the planning, design, and construction of permanent DoD facilities worldwide. It is applicable to all methods of project delivery and levels of construction. The contingency operation wastewater flows are applicable to facilities supporting military operations.

1-4 GENERAL BUILDING REQUIREMENTS.

Comply with UFC 1-200-01, *DoD Building Code*. UFC 1-200-01 provides applicability of model building codes and government unique criteria for typical design disciplines and building systems, as well as for accessibility, antiterrorism, security, high performance and sustainability requirements, and safety. Use this UFC in addition to UFC 1-200-01 and the UFCs and government criteria referenced herein.

1-5 CYBERSECURITY.

All control systems (including systems separate from an energy management control system) must be planned, designed, acquired, executed, and maintained in accordance with UFC 4-010-06, and as required by individual Service Implementation Policy.

1-6 NON-GOVERNMENT STANDARD MODIFICATIONS.

UFC 3-240-01 modifies Recommended Standards for Wastewater Facilities (known hereafter as the “10 States Standards”) for domestic wastewater collection treatment. Chapters 3 modifies Chapters 10, 20 and 30 of the 10 State Standards. Chapters 4 through 11 modify chapters 40 through 110 of the 10 States Standards. The 10 State Standards section modifications are one of four actions, according to the following legend:

[Addition] – Add new section, including new section number, not shown in 10 States Standards.

[Deletion] – Delete referenced 10 States Standards section.

[Replacement] – Delete referenced 10 States Standards section or noted portion and replace it with the narrative shown.

[Supplement] – Add narrative shown as a supplement to the narrative shown in the referenced section of 10 States Standards.

1-7 COMMENTARY.

Limited commentary has been added to the chapters. Section designations for such commentary are preceded by a “[C]” and the commentary narrative is highlighted with light gray.

1-8 GLOSSARY.

APPENDIX B contains acronyms, abbreviations, and terms.

1-9 REFERENCES.

APPENDIX C contains a list of references used in this document. The publication date of the code or standard is not included in this document. Unless otherwise specified, the most recent edition of the referenced publication applies.

1-10 BEST PRACTICES.

Appendix A provides guidance for accomplishing engineering services related to wastewater collection and treatment systems. 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 prevail. If a best practices document has guidelines or requirements that are not discussed in the UFGS or UFC, the DoR must submit a list of the guidelines or requirements being used for the project with sufficient documentation to the Authority Having Jurisdiction (AHJ) for review and approval before beginning design.

CHAPTER 2 PLANNING AND DESIGN

2-1 SAFETY.

Comply with DODINST 6055.01 and applicable Occupational Safety and Health Administration (OSHA) safety and health standards.

2-2 PLANNING.

Use UFC 3-201-01 for planning topics such as wetlands and flood hazard areas. Use the Installation's existing utility maps and planning documents to develop population estimates and plans for new service areas. Use WEF MOP 8, Chapter 2, *Principles of Integrated Design* for additional planning guidance.

2-2.1 Domestic Wastewater Collection.

In addition to population estimates, account for flow from industrial pretreatment, and ship to shore sources. Permits may be required for domestic wastewater collection systems.

2-2.2 Domestic Wastewater Treatment.

Plan the domestic wastewater treatment facility for current population and future population growth, minimum 5 years, using the Installation's master development plan. Account for seasonal fluctuations, low flow, peak flow, existing combined sewer flows, flow from industrial pretreatment, flow from ship to shore sources, receiving waterbody quality and discharge requirements. Plan for future expansion of new treatment components. Provide space for future expansion in the layout of new treatment components and processes. A life-cycle cost analysis should be conducted to account for future capacity issues, capital investment, operation and maintenance, and constructability. Applicable construction and operating permits are required for the treatment of domestic wastewater.

2-2.2.1 Pilot Testing.

Pilot testing should be performed as part of the planning effort because of the time required to perform tests. Evaluate the need for pilot testing using the 10 State Standards. Pilot testing can be used to verify performance predictions or determine the effectiveness of unit treatment processes needed for the design of a domestic wastewater treatment facility.

2-2.3 Industrial Wastewater Systems.

Plan the industrial wastewater treatment facility for the largest current and future peak flow, minimum 5 years, using the Installation's master development plan. Industrial wastewater may be discharged directly to a receiving waterbody when industrial wastewater effluent meets or exceeds receiving waterbody discharge requirements or indirectly to a domestic wastewater treatment facility when the industrial wastewater effluent meets or exceeds pretreatment requirements. Applicable construction and operating permits are required for the treatment or pretreatment of industrial wastewater. Refer to Figure 2-1 for an illustration of planning considerations. Use WEF MOP FD-3, Section 1, *Planning and Managing Industrial Wastewater Pretreatment Processes*.

Figure 2-1 Planning Considerations

Industrial Waste Characterization

- Identify industrial wastewater sources
- Identify types of pollutants
- Identify pollutant loads and flows
- Identify any variation in loads or flows
- Identify any existing treatment processes

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Regulatory Requirements and Treatment Criteria

- Define treatment objectives
- Identify discharge options, direct or indirect
- Identify categorical standards
- Identify permit requirements

2-2.3.1 Pilot Testing.

Pilot testing should be performed as part of the planning effort because of the time required to perform pilot testing. Pilot testing can be used to verify performance predictions or determine the effectiveness of unit treatment processes needed for design of industrial wastewater treatment facilities. Conduct pilot testing on the wastewater stream requiring treatment, when available, or on an equivalent wastewater stream.

2-2.4 Solids Management.

Use WEF MOP 8, Chapter 18 through 25 for guidance on solids or biosolids management.

Use *Solids Process Design and Management,* Chapter 2, *Considerations of Planning of Biosolids Management Projects,* for guidance on developing a biosolids management plan.

2-2.5 Planning For Non-War Emergencies.

Use *Emergency Planning, Response, and Recovery* for guidance when planning for non-war emergencies such as, earthquakes, hurricanes, tornadoes, and floods.

2-3 EXISTING CONDITIONS.

Use UFC 3-201-01 for preliminary site analysis, and evaluation of existing conditions such as geotechnical site investigation, environmental considerations, surveying, and topographic surveying.

2-3.1 Existing Sewers.

Use WEF MOP FD-6 for guidance when evaluating and rehabilitating existing sewers.

2-3.2 Modifications to Existing Wastewater Treatment Facilities.

Evaluate the effect of modifications on each individual wastewater treatment processes and notify the AHJ of any undersized treatment process or required upgrades to accommodate the modifications.

2-4 DESIGN.

Use UFC 3-201-01 for topics such as site development, grading, and storm drainage systems.

2-4.1 Design Criteria.

2-4.1.1 Within the United States.

For Installations located in the United States and its territories and possessions the wastewater system must comply with the following criteria precedence:

1. EPA or State as applicable and local regulations for the project location;
2. Utility provider’s requirements;
3. Criteria indicated in this UFC;
4. UFC 01-200-02 for energy and sustainability; and
5. Appendix A for design guidance.

2-4.1.2 Foreign Countries.

For Installations located outside of the United States and its territories and possessions, the wastewater system must comply with the following criteria precedence:

1. The Foreword of this UFC (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));
2. Final Governing Standards (FGS);
3. DoD 4715.05-G, Overseas Environmental Baseline Guidance Document (OEBGD);
4. Utility provider's requirements;
5. Criteria indicated in this UFC;
6. UFC 01-200-02 for energy and sustainability; and
7. Appendix A for design guidance.

DoD 4715.05-G, Overseas Environmental Baseline Guidance Document (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.

2-4.2 Design Approval.

The DoR must identify, assist, and provide, as applicable, all permits, approvals, and fees required for the design and construction of the new project from federal, state and local regulatory authorities or overseas equivalent. The DoR must be a Professional Engineer experienced and licensed. Licensure in the location of the project may be required to obtain permits and approvals. For new or rehabilitated sanitary sewer systems or facilities such as service extensions, domestic wastewater treatment, or industrial wastewater treatment, coordinate with the applicable primacy agency to determine permitting requirements. Consult with the Government Project Manager to determine the appropriate signatories for permit applications.

2-4.2.1 Within the United States.

In the United States and its territories and possessions, the Government will review permits for acceptability.

2-4.2.2 Foreign Countries.

In locations outside of the United States and its territories and possessions with host nation agreements, follow permit approval procedure as directed in project scope and by the Government Project Manager.

In locations outside of the United States and its territories and possessions without host nation agreements, the Government will review and approve plans for compliance.

2-5 FEDERAL DISCHARGE REQUIREMENTS.

In the United States and its territories and possessions, the EPA implements the Clean Water Act and regulates quality standards for surface waters. The Clean Water Act provides Federal regulations for the discharge of pollutants into the waters of the United States. The National Pollutant Discharge Elimination System (NPDES) 40 CFR 122 and the National Pretreatment Program 40 CFR 403.6 provide specific discharge standards and requirements for pollutants based on industry, pollutant, available technology and type of source. The EPA may delegate this authority to individual states territories or possessions.

2-6 CORROSION CONTROL.

Use AWWA M27, WEF MOP 8, Chapter 8, *Materials of Construction and Corrosion Control* and ASCE MOP 60, Chapter 4, *Corrosion Processes and Controls in Municipal Wastewater Collection Systems* for guidance on corrosion control.

2-6.1 Hydrogen Sulfide and Other Internally Corrosive Conditions.

In areas where high hydrogen sulfide concentrations, such as piping in wet wells or manholes, provide corrosion resistant materials, coatings or linings.

2-6.2 Materials Selection.

Approach selection of construction materials for corrosion control systems in accordance with the recommendations of WEF MOP 8, Chapter 8, Materials of Construction and Corrosion Control and AWWA M27. Corrosion control systems, such as, coatings, linings, polyethylene encasement or cathodic protection may be used to protect materials from corrosion. Explicit approval by the AHJ is required prior to providing a cathodic protection system on a buried pipeline. Use UFC 3-570-01 for the design of cathodic protection systems.

2-7 SECURITY.

Security must be an integral part of wastewater resource recovery system design. Planners, engineers, and security and antiterrorism personnel must determine site specific protective measures for wastewater systems. Use UFC 4-020-01 to establish protective measures. The engineering risk analysis, conducted as part of UFC 4-020-

01, should be consistent with the terrorism risk analysis conducted by installation security or antiterrorism staff.

2-8 OPERATION AND MAINTENANCE.

Provide a design that:

- Minimizes operation and maintenance requirements, including additional training, higher level of operator certifications ,or equipment that is not provided by the project. The AHJ must approve any operating equipment that is not provided by the project and required to maintain continuous operation of the wastewater treatment facility;
- Minimizes the number of operators required to operate the wastewater treatment facility. For new wastewater treatment facilities, the number of operators and level of training or operator certification required to operate the wastewater treatment facility must be approved by the AHJ. For existing wastewater treatment facilities, any increases to the number of operators, level of training, or operator certification required to operate the wastewater treatment facility must be approved by the AHJ. Give special consideration to minimizing operation and maintenance requirements in remote locations, including the limited availability of qualified operators available, technical support, and training opportunities;
- Includes operator training required to operate the wastewater treatment facility;
- Provides more than one piece of equipment, tank, or piping and isolation valves required to maintain continuous operation. Size equipment, tanks, and piping to maintain continuous operation with one piece of equipment or tank out of service.
- Provides space for the repair and removal of equipment without requiring the removal of equipment or pipe not in need of repair or replacement;
- Provides access, walkways, and space that complies with the applicable OSHA general industry and construction standards for operations, maintenance, and inspections;
- Provides tanks with isolation valves and drains to facilitate cleaning, inspection, and maintenance; and
- Provides drains with means of draining and containing pollutants that cannot be released to the environment.

2-8.2 Operation and Maintenance Manuals.

Prepare and furnish a site-specific operation and maintenance manual for wastewater pump stations and wastewater treatment systems, domestic or industrial. Operation and maintenance manual must include operating and maintenance procedures for the type of equipment specified or approved during construction, including any changes made during construction.

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CHAPTER 3 – 10 STATES STANDARDS CHAPTERS 10, 20, AND 30

3-1 MODIFICATIONS TO CHAPTER 10 ENGINEERING REPORTS AND FACILITY PLANS.

For Navy: Use Chapter 10 except as modified by FC 1-300-09N.

3-1.1 SECTION 11 ENGINEERING REPORT OR FACILITY PLAN.

11.23 Population Projection and Planning Period [Replacement].

Use Chapter 2 to determine the minimum project planning period. Phased construction of wastewater facilities should be considered in rapid growth areas. Sewers and other facilities should be designed for the applicable Installation and project planning period.

11.23.1 Design Population [Addition].

Determine design population by the resident and nonresident populations. The effects of factors such as birth rates, death rates, and immigration are not applicable to military installations. The present and future populations may be obtained from the Installation's planning documents. Facilities that are not occupied and are included in the Installations current demotion plan should not be considered when determining resident and nonresident populations.

11.23.1.1 Resident Population [Addition].

Determine the resident population on full occupancy of all housing and quarters served. When the actual family population is unknown, the population of family housing units is typically estimated to be 3.6 residents per unit. Consider the number of National Guard, ROTC, reserve personnel, boarding schools, guesthouses, and any satellite functions such as service to a local community or other Federal agencies when estimating resident populations.

11.23.1.2 Non-resident Population [Addition].

Determine the non-resident population on full occupancy of all non-residential facilities. Consider the number of civil service personnel, contractor personnel, and daytime students when estimating non-resident populations.

11.242 Hydraulic Capacity for Wastewater Facilities to Serve Existing Collection Systems [Supplement].

When actual flow data is not available, use paragraph 11.243.

11.243 Hydraulic Capacity for Wastewater Facilities to Serve New Collection Systems [Replacement].

Hydraulic capacity for wastewater collection systems and wastewater facilities serving new collection systems.

a. Use Table 3-1 plus wastewater flow from industrial plants and major institutional and commercial facilities to compute the average daily flow unless water use data or other justification upon which to better estimate flow is provided.

b. When designing wastewater collection systems serving areas with wastewater generated by nonresidents or other short term uses, compute the average hourly flow rate based on the actual time period of waste generation.

c. Use the values in Table 3-1 and the peaking factors in Table 3-2 to compute peak flows. These peaking factors cover normal infiltration for wastewater collection systems built with modern construction techniques, refer to Chapter 30.

Table 3-1 Domestic Wastewater Allowances [1]

Permanent			
Type of Installation or Building	**Per Unit**	**gal/unit/day (L/unit/d)**	**Flow duration, Hours**
Single Family Housing [2,]	Per unit	300 (1136)	24
Multifamily Housing [2]	Per Unit	250 (946)	24
Type of Installation or Building	**Per Person**	**gal/cap/day (L/cap/d)**	**Flow duration, hours**
Military Installations	Per Person	100 (379)	24
Nonresident Personnel and Civilian Employees	Per Person	30 (114)	8
Military Training Camps	Per Person	50 (189)	24
BOQ and BEQ	Per Person	70 (265)	24
Barracks	Per Person	50 (189)	24
Temporary Host Nation Facilities			
Military Installations	Per Person	35 (132)	24
BOQ and BEQ	Per Person	20 (76)	24
Barracks	Per Person	15 (57)	24

1. Allowances do not include industrial or process wastes.
2. For the purpose of calculating populations in family housing areas, each housing unit is typically estimated to be 3.6 residents per unit.

Table 3-2 Minimum Peak Flow Factors

Population	**Peak Factor**
Greater than 500,000	2.5
Between 100,000 and 500,000	3.0
Less than 100,000	4.0

[C] 11.243 Hydraulic Capacity for Wastewater Facilities to Serve New Collection Systems [Replacement].

Peaking factors for military facilities are higher than most peaking factors to accommodate small populations, small service areas and unexpected operational changes.

d. Peak wastewater flow determined by total drainage fixture units may be used in lieu of estimated per capita peak flows if total drainage fixture unit flow is determined to be higher. Use UFC 3-420-01 and ASCE MOP 60 Chapter 3, titled *Quantity of Wastewater* to compute peak flow using total drainage fixture units.

[C] 11.243 Hydraulic Capacity for Wastewater Facilities to Serve New Collection Systems [Replacement].

Using total drainage fixture units to determine peak flow is not typically used by civil engineers to design wastewater collection systems. Using total drainage fixture units for facilities in which a large number of people may assemble in one place may be beneficial.

e. When actual flow data is not available and the condition of existing wastewater collection systems is unfavorable, an additional allowance for infiltration and inflow should be made.

f. When a new collection system serves existing facilities, evaluate the potential for infiltration and inflow from existing service lines or non-wastewater connections. Make an additional allowance for infiltration and inflow when infiltration and inflow from existing service lines is expected. Non-wastewater flows should be disconnect and rerouted or demolished.

11.244 Combined Sewer Interceptors [Replacement].

In addition to the above requirements, interceptors for existing combined sewers must have capacity to receive a sufficient quantity of combined wastewater for transport to treatment facilities to ensure attainment of the appropriate water quality standards.

11.244.1 Combined Sewers [Addition].

New combined sewers are not allowed. When an existing combined sewer is rehabilitated the stormwater interceptor should be separated from the wastewater collection system. Where stormwater interceptors are not separated from the wastewater collection system, rehabilitation of existing combined sewers may be approved when applicable regulations and permits allow rehabilitation of existing combined sewers.

11.245 Ship Chemical Holding Tank Discharges [Addition].

Use UFC 4-150-02 or contact the Government Project Manager for ship wastewater discharge capacities. Domestic wastewater discharges from ships have varying discharge capacities and high rates of flow.

11.246 Arctic Locations [Addition].

Wastewater systems in arctic locations practice water conservation. Water consumption is typically low, and infiltration is nil. If actual water consumption data are not available, base average daily wastewater flow for arctic locations on 80% of the flow determined for similar uses.

11.25 Organic Capacity [Supplement].

Pretreat normal laundry wastes when laundry flow exceeds 25% of the average daily wastewater flow.

11.250 Ship Chemical Holding Tank Discharges [Addition].

Ship wastewater discharges are more concentrated than typical domestic wastewater and may contain high concentrations of sodium from seawater use.

3-2 MODIFICATIONS TO CHAPTER 20 – ENGINEERING PLANS AND SPECIFICATIONS.

For Navy: Use Chapter 20 except as modified by FC 1-300-09N.

3-3 MODIFICATIONS TO CHAPTER 30 – DESIGN OF SEWERS.

3-3.1 SECTION 31 APPROVAL OF SEWERS [Supplement].

Use a gravity collection system unless justification is provided to and approved by the AHJ. A gravity sewer system is typically justified until the cost of the gravity system exceeds the cost of a pumped system by more than 10 percent.

31.1 Sewers for Collection of Ship Wastewater [Addition].

Use UFC 4-152-01 and UFC 4-150-02 for the design of piers, wharfs, and drydock wastewater collection facilities.

3-3.2 SECTION 33 DETAILS OF DESIGN AND CONSTRUCTION [SUPPLEMENT].

Design structural components of gravity sanitary sewer systems in accordance with UFC 1-200-01, ASCE MOP 60 Chapter 9, and the pipe manufacturers recommendations. Provide appropriate seismic protection in areas subject to earthquakes. Use EPA 810-B-18-001 for seismic design guidance.

33.1.1 Building Connection [Addition].

Use UFC 3-420-01 to size building sewers and for minimum building sewer diameter.

33.2 Depth [Supplement].

Minimum cover over sewer pipes must be the most stringent of the following requirements:

- 2 ft (0.61 m);
- 3 ft (0.91 m) for plastic pipe subject to traffic loading;
- greater than frost penetration according to UFC 3-301-01; or
- sufficient to support imposed dead and live loads for the pipe materials and pipe bedding used.

Evaluate temporary conditions during construction and final conditions. Provide calculations for minimum cover.

33.41 Recommended Minimum Slopes [Replacement].

Design and construct sewers with a diameter of 42 inches (1050 mm) or less to give minimum cleansing velocities, when flowing full, of not less than 2.0 feet per second (0.6 m/s), based on Manning's formula using an "n" value of 0.013. Minimum slopes for sewers with a diameter of 42 inches (1050 mm) or less are indicated in Table 3-3. Best Practice: For sewer with a diameter of 42 inches or less, design sewers to provide a minimum velocity of 2.5 ft/sec (0.76 m/s), when flowing full.

Design and construct sewers with a diameter of 48 inches (1200 mm) or larger to give mean velocities, when flowing full, of not less than 3.0 feet per second (0.9 m/s), based on Manning’s formula using an “n” value of 0.013.

33.42 Minimum Flow Depths [Replacement].

The minimum depth of flow is typically 0.5 d for the design average flow, where d is the sewer diameter. Where justification is provided to and approved by the AHJ the minimum depth of flow may be reduce to 0.3 d.

Table 3-3 Minimum Slopes

Nominal Sewer Size	Minimum Slope in Feet Per 100 Feet (m/100 m)
8 inch (200 mm)	0.40
10 inch (250 mm)	0.28
12 inch (300 mm)	0.22
15 inch (375 mm)	0.15
18 inch (450 mm)	0.12
21 inch (525 mm)	0.10
24 inch (600 mm)	0.08
27 inch (675 mm)	0.067
30 inch (750 mm)	0.058
33 inch (825 mm)	0.052
36 inch (900 mm)	0.046
39 inch (975 mm)	0.041
42 inch (1050 mm)	0.037

33.43 Minimization of Solids Deposition [Replacement].

Select the pipe diameter and slope to minimize settling problems. Do not use oversized sewers to justify flatter slopes.

33.45 High Velocity Protection [Supplement].

Design gravity sewers to maintain subcritical flow conditions. Where steep slopes are unavoidable, use drop manholes to prevent supercritical flow conditions. Design downstream pipes to prevent hydraulic jumps and other flow disturbances.

33.47 Maximum Flow Depths [Addition].

Design sewer mains to carry the peak flow at a flow depth of no more than 0.9 d, where d is the sewer diameter.

33.5 Alignment [Replacement].

Use straight alignments between manholes.

Curvilinear alignment of sewers is not allowed.

33.7.1 Trenchless Technology [Addition].

Before beginning trenchless pipe design, obtain approval from the AHJ. Use UFC 3-230-01 for fusible pipe design.

3-3.3 SECTION 34 MANHOLES.

34.1 Location [Replacement].

Install manholes at the end of each line; all changes in grade, size, or alignment; at all intersections; at distances not greater than 400 ft (120 m) for sewers that are 15 inches (375 (mm) or less, and at 500 ft (150 m) for sewers that are 18 inches (450 mm) to 30 inches (750 mm). Distances of up to 600 ft (185 m) may be approved in cases where adequate modern cleaning equipment for such spacing is provided. Greater spacing may be permitted in larger sewers when approved by the AHJ.

34.1.1 Building Connections [Addition].

UFC 3-420-01 provides requirements for building sewers. These requirements include items such as making connections, changes in direction, location of cleanouts and for building connections larger than 8 in. (200 mm), and manhole location.

34.6 Watertightness [Supplement].

Watertight manhole frames and covers must be used when the manhole rim elevation is in the 100 year flood plain.

34.10 Frames and Covers [Addition].

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

34.11 Ladders [Addition].

For manholes over 12 ft (3.7 m) in depth, provide one vertical wall with a fixed side-rail ladder. Use ASCE MOP 60 for guidance on steps.

3-3.4 SECTION 35 INVERTED SIPHONS [SUPPLEMENT].

Depressed sewers must withstand internal pressures greater than atmospheric. Use pipe materials rated for force mains. Use inverted siphons only if no other option can be used.

3-3.5 SECTION 38 PROTECTION OF WATER SUPPLIES.

38.3 Relation to Water Mains [Replacement].

Use UFC 3-230-01 for horizontal and vertical separation distances from contaminated sources and wastewater sewer crossings.

38.31 Horizontal and Vertical Separation [Delete].

38.32 Crossings [Delete].

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CHAPTER 4 – MODIFICATIONS TO CHAPTER 40 WASTEWATER PUMPING STATIONS

4-1 SECTION 41 GENERAL [SUPPLEMENT].

Use pumping stations only where specifically identified in the project scope of work or upon written approval from the AHJ. Obtain written approval before beginning design.

41.1 Flooding [Supplement].

Use UFC 3-201-01 for flood design.

41.2 Accessibility and Security [Replacement].

Provide pumping stations with adequate access for personnel and equipment maintenance and replacement. Access points must be lockable and meet Installation security requirements.

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

41.4 Safety [Supplement].

Design the pump station to protect maintenance personnel from toxic, explosive, or otherwise hazardous atmospheres.

41.5 Site Selection [Addition].

Pumping facilities must not be constructed beneath buildings, streets, roadways, railroads, aircraft aprons or runways, or other major surface structures. Consider availability of utilities such as electric power, potable water, fire protection, gas, steam, and telephone service.

Maintain a minimum setback to buildings and other occupied facilities of 500 ft (152 m) for medium and large pumping stations, unless adequate measures are provided for odor and gas control. Small wastewater pumping stations are defined as having peak flows less than 500 gpm (31.5 L/s); medium wastewater pumping stations are defined as having peak flowrates of 500 gpm (31.5 L/s) to 3200 gpm (202 L/s); and large wastewater pumping stations are defined as having peak flows greater than 3200 gpm (202 L/s).

41.6 Architectural [Addition].

Design pump station buildings to be architecturally compatible with the surrounding buildings in accordance with the Installations Appearance Plan.

41.7 Upgrades to Existing Pumping Stations [Addition].

Existing pumping stations may be upgraded where a complete hydraulic analysis shows that the upgraded pumping station can operate at the proposed capacity in conformance with the jurisdictional requirements for a new pumping station of equal capacity. The hydraulic analysis must include effects on the existing force main to its point of discharge and, if networked, the effects on all other pumping 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.

4-2 SECTION 42 DESIGN.

42.22 Equipment Removal [Supplement].

Provide 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 ft (1.2 m) between adjacent pump casings and a minimum of 3 ft (1.0 m) from each outboard pump to the closest wall. Maintain a 7 ft (2.1 m) minimum clearance between floor and overhead piping, where practicable.

42.3 Pumps [Supplement].

Evaluate the system characteristics and determine the requirements for the pumping systems, such as flow rates, system head-capacity curves, pump station location, area served and force main velocities when selecting pumps. To determine system requirements, develop a system head-capacity curve which includes minimum, average and peak flow rates for the design condition and, if applicable, any interim conditions. Select a minimum of three different pump manufactures or pump models capable of:

- Discharging the peak flow for the system with one pump out of service and simultaneous pump operation;
- Operating for the full range of wet well levels;
- Discharging to either a gravity sanitary sewer or force main as applicable; and
- Operating in the manufacturer’s recommended performance curve and maximizing pump efficiency for the design average and peak flow conditions.

Use WEF MOP FD-4 for guidance when developing system head-capacity curves and selecting pumps.

42.31 Multiple Units [Supplement].

A single pump may be used for a wastewater pumping stations serving extremely low flows, such as a remote gate house, when justification is provided to and approved by the AHJ.

42.35.1 Pump Motors [Addition].

Select a pump motor enclosure suitable for the pump location. Provide totally enclosed fan-cooled motors for dry well pump installations. Ensure submersible pumps have watertight motor enclosures. Ensure temperature ratings of motors installed outdoors are adjusted to suit ambient operating conditions. To prevent condensation in dry wells, provide heat for pump motors designed to operate on an intermittent basis. Use motors rated for hazardous locations. Use motor starter technology for large motors to limit inrush current and mitigate electrical transients on electrical supply.

42.35.2 Motor Horsepower [Addition].

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.

42.38 Pumping Rates [Supplement].

Use a computer program for water hammer analysis of large pump stations.

42.39 Cavitation [Addition].

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

42.4.1 Adjustable Speed Drives [Addition].

Select the simplest system that allows pumps to accomplish the required hydraulic effects. Evaluate cost, efficiency, reliability, structural requirements, ease of operation, and degree of maintenance necessary. Operation and maintenance are critical at military installations where adequate personnel cannot always be provided. Coordinate with the electrical DoR when using adjustable speed drives for variable speed pump operation. In general, adjustable speed drives are more expensive, less efficient, and require a higher degree of maintenance than across-the-line full voltage motor starters. However, in some instances, adjustable speed drives may be the best approach.

42.4.2. Selection of Control Points [Addition].

Provide a minimum of 6 in. (150 mm) between pump control points used to start and stop successive pumps or to change pump speeds.

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

42.62 Size [Supplement].

The minimum length, width, or diameter is 4 ft (1.2 m).

42.65 Pressure Gauges [Addition].

Provide pressure gages on discharge piping directly downstream of the pump in dry well pumping stations.

4-3 SECTION 46 ALARM SYSTEMS [SUPPLEMENT].

Provide alarms such as low level and high temperature when required by pump manufacturer to maintain the pump manufacturer's warranty.

Remote monitoring systems must meet the requirements in UFC 4-010-06. Use UFC 4-010-06 for cybersecurity Risk Management Framework (RMF).

4-4 SECTION 49 FORCE MAINS.

49.1 Velocity and Diameter [Replacement].

For grinder pumps use a minimum 1¼ in. (32 mm) diameter. For small non-clog submersible pumps and pneumatic ejectors use a minimum 4 in. (100 mm) diameter. Size force mains based on hydraulic calculations considering factors such as velocity, friction loss, and power requirements.

Flow velocities should range from 2 to 5 feet per second (0.6 to 1.5 meters per second) for the design flow. The maximum velocity depends on new and existing piping materials and appurtenances. Ensure that the maximum pressure of the piping materials and appurtenances exceeds the maximum pressure of the system, including the potential for surge pressure.

49.2 Air and Vacuum Release Valves [Supplement].

Use AWWA M51 for guidance on air and vacuum release valves.

49.4.1 Rigid Conduit [Addition].

For ductile iron force mains, use AWWA C150/ANSI A21.50 to calculate the required pressure class or special thickness class.

49.4.2 Flexible Conduit [Addition].

For PVC force mains use AWWA M23 and applicable AWWA and ASTM standards.

49.61 Friction Coefficient [Supplement].

Hazen-Williams Roughness: values lower than 80 are not allowed unless verified by flow and pressure tests; if verified, consider replacement.

49.10 Cover [Supplement].

Minimum cover over force mains must be the most stringent of the following requirements:

- 2 ft (0.61 m);
- 3 ft (0.91 m) for plastic pipe subject to traffic loading;
- greater than frost penetration according to UFC 3-301-01;
- greater than the depth required to install valve riser; or
- sufficient to support imposed dead and live loads for the pipe materials and pipe bedding used.

Evaluate temporary conditions during construction and final conditions. Provide calculations for minimum cover.

49.11 Thrust Restraint [Addition].

Use DIPRA for thrust restraint design procedures. Provide calculations for restrained joints using a minimum safety factor of 1.5. Use the geotechnical investigation report and consult with the Geotechnical Engineer to determine soil bearing capacity.

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CHAPTER 5 – MODIFICATIONS TO CHAPTER 50 WASTEWATER TREATMENT FACILITIES

5-1 SECTION 51 PLANT LOCATION.

51.2 Flood Protection [Supplement].

Use UFC 3-201-01 for flood design and the minimum design flood elevation for flood design class 2. Provide wet proofing or dry proofing when station hatches are below the design flood elevation. Extend venting above the design flood elevation.

51.3 Location [Addition].

Maintain a minimum distance of 1,000 ft (305 m) between drinking water source and any wastewater treatment system.

For wastewater treatment facilities with a treatment capacity of 50,000 gpd (189 m^3/d) or less, maintain a minimum separation distance of 500 ft (152 m) from living quarters, working areas, and public use areas, when this minimum distance will not result in unacceptable noise or odor levels. Larger facilities, and wastewater treatment ponds regardless of size, must be more than one-quarter mile from living quarters, working areas, and public use areas.

51.3.1 Arctic and Cold Locations Outside the United States [Addition].

Exceptions to the 500 ft (152 m) restriction in paragraph 51.3 can be made for cold climate module complexes where the treatment system is a part of the module complex. Do not locate wastewater treatment equipment within the same module as living quarters.

5-2 SECTION 53 DESIGN.

53.1 Type of Treatment [Supplement].

The DoR must examine each unit operation in the proposed treatment system for potential problems caused by remote locations, limited availability of construction materials, available labor, time required for construction, cost of construction and operation and maintenance cost.

53.1.1 Arctic and Cold Locations Outside the United States [Addition].

For wastewater treatment unit operations in cold and arctic climates, the DoR must examine each unit operation in the proposed treatment system for potential problems caused by extreme cold, wind and snow, thermal stress on structures, frost heaving, and permafrost.

53.1.2 Tropic and Semiarid Locations Outside the United States [Addition].

For wastewater treatment unit operations in the tropics, the DoR must examine each unit operation in the proposed treatment system for potential problems caused by high temperature, torrential tropical rain, and variations in local wastewater characteristics.

53.2 Required Engineering Data for New Process and Application Evaluation [Supplement].

Provide three acceptable products when using a packaged wastewater treatment plant, equipment or component for approval. When approved by the AHJ, two acceptable products may be allowed. When only one suitable product is available, the DoR must submit a justification and authorization to the Government for approval. When a justification and authorization is approved by the Government Contracting Officer, one acceptable product will be allowed. Add the Government-approved product to the project specification.

53.2.1 Special Conditions for New Equipment Evaluation [Addition].

New equipment or components must be pre-approved for the proposed application and project conditions in the state or host nation where the project is located or approved by the applicable regulatory agencies. If the host nation does not maintain a pre-approved wastewater treatment equipment, equipment that is pre-approved for similar applications and project conditions by another state or host nation may be used when approved by the applicable regulatory authorities. Provide documentation indicating the location and conditions of the pre-approval and describe how the proposed application is similar to the project application.

5-3 SECTION 55 PLANT OUTFALLS.

55.1 Discharge Impact Control [Supplement].

A special study may be needed when effluent is discharged into a bay or similar area. Use ASCE MOP 60 for outfall studies and design guidance.

55.2 Protection and Maintenance [Supplement].

Anchor or pile support all sections of outfall pipelines subject to movement from the high water level to prevent movement.

Evaluate the low-water depth above the outfall pipe, ship and boat traffic, and use of anchors. Provide buoys, marking, or other means of warning as required.

55.4 Sizing and Capacity [Addition].

Design the minimum size of the outfall for peak hourly flow at the maximum anticipated stage of the receiving water. If the receiving water is tidal, evaluate both high and low conditions and tidal flow directions. If a diffuser is installed, use mixing models to select the port sizes and spacing. Ensure that port sizes are 2 in. (50 mm) in diameter or greater to avoid clogging by scaling or barnacles.

55.5 Outfall Depth [Addition].

Outfalls are typically a minimum of 8 ft (2.4 m) deep to provide mixing opportunity. Evaluate extending existing outfalls to deeper water. Factors for extending existing outfalls may include conditions such as, shallow water, shallow outfall depth, or permit compliance.

5-4 SECTION 57 SAFETY [SUPPLEMENT].

Ensure adequate safety by providing the following, as applicable:

- Continuous toxic gas monitors with alarms.
- Facility designs that eliminate the need to reach beyond safe limits.
- Facility designs that minimize the need for manual lifting.
- Directive, hazard-warning, and instructional signs, where appropriate.
- Equip pump and other equipment that handles corrosive solutions with spray or splash guards to protect the personnel working in the area.

57.2 Hazardous Chemical Handling [Supplement].

Include the following in a chemical handling area, as applicable:

- Easily accessible, clearly marked, well-lighted unloading stations.
- Guard posts to protect equipment and storage tanks from vehicle damage.
- A roofed platform or dock for unloading containerized chemicals.
- Mechanical devices to aid unloading and transporting chemicals to storage areas.
- Separate receiving and storage areas for chemicals that react violently when mixed together.
- Unique pipe configuration and valving for each chemical storage tank on-site to prevent the wrong chemical from being loaded into a tank.
- Dust control equipment for dry bulk and bagged chemicals.
- Protection of concrete against corrosive chemicals.
- Washdown and cleanup facilities for all chemical handling areas and separate drainage systems for noncompatible chemicals.
- A bulk tank level control system with a high-level alarm audible at the truck unloading station.

57.29 Eyewash Fountains and Safety Showers [Supplement].

Comply with the latest edition of ANSI Z358.1 for emergency eyewashes and shower equipment.

57.4 Chemical Storage [Addition].

Determine compatibility of all chemicals stored and store incompatible chemicals separately. Label all chemical storage areas. Follow the chemical manufacturer's recommendations regarding material compatibility and selection of system components in direct chemical contact. Include the following in a chemical storage areas, as applicable:

- Storage for peak demands.
- Light switches and ventilation controls located outside of the chemical storage rooms or areas.
- Automatic controls to actuate forced ventilation and lighting when chemical storage rooms are occupied.
- Protect exposed materials from the corrosive effects of stored chemicals.

57.4.1 Storage for Dry or Containerized Chemicals [Addition].

Provide the following:

- Dry rooms to store materials in original containers on boards or pallets.
- Adequate room to maneuver hand trucks, pallet jacks, or forklifts.
- Storage for dry chemicals at feed hopper inlet level or a platform capable of supporting a pallet of containers at the feed hopper inlet level.
- Signage indicating the safe load limits for floors, platforms and shelving.

57.4.2 Storage for Liquid Chemicals [Addition].

Provide the following:

- Containment of store volume plus a safety margin.
- Isolated containment for incompatible materials such as strong acids and strong bases.
- Capacity to hold the contents of one standard tank truck plus a sufficient reserve supply between shipments.
- Fire-rated storage facilities for flammable liquids.
- Freeze protection for exposed piping, valves, and bulk tanks.

5-5 SECTION 58 LABORATORY [SUPPLEMENT].

Do not locate administrative and laboratory buildings close to or downwind from primary treatment tanks, sludge drying beds ,or similar treatment processes that may cause unfavorable conditions.

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CHAPTER 6 MODIFICATIONS TO CHAPTER 60 SCREENING, GRIT REMOVAL, AND FLOW EQUALIZATION

Use 10 State Standards Chapter 60.

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CHAPTER 7 MODIFICATIONS TO CHAPTER 70 SETTLING

Use 10 State Standards Chapter 70.

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CHAPTER 8 MODIFICATIONS TO CHAPTER 80 SLUDGE PROCESSING, STORAGE, AND DISPOSAL

8-1 SECTION 81 GENERAL. [ADDITION].

Comply with 40 CFR 501 and 40 CFR 503.

81.1 Domestic Wastewater and Septage [Addition].

For the disposal of sewage sludge generated during the treatment of domestic sewerage in a treatment works comply with:

40 CFR 258 for the disposal of sludge in a solid waste landfill; or

40 CFR 503 for land application, incineration, surface disposal and any other sludge use or disposal that may be regulated by 40 CFR 503. Refer to 40 CFR 503.6 for exclusions.

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CHAPTER 9 MODIFICATIONS TO CHAPTER 90 BIOLOGICAL TREATMENT

Use 10 State Standards Chapter 90.

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CHAPTER 10 MODIFICATIONS TO CHAPTER 100 DISINFECTION

10-1 SECTION 102 CHLORINE DISINFECTION.

102.1 Type [Supplement].

Do not use chlorine gas for disinfection in small treatment systems.

[C] 102.1 Type [Supplement].

Chlorine gas introduces additional safety concerns for both operators and others in close proximity. Operation of chlorine gas disinfection systems typically requires additional operator training.

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CHAPTER 11 MODIFICATIONS TO CHAPTER 110 SUPPLEMENTAL TREATMENT PROCESSES

Use 10 State Standards Chapter 110.

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CHAPTER 12 SMALL TREATMENT SYSTEMS

12-1 GENERAL.

Small treatment systems are defined as treatment systems and components with 10,000 or fewer people or an average wastewater flow of less than 1 mgd (3,785 m^3/d). Small treatment systems using conventional processes must comply with the 10 State Standards as modified by this UFC. Small treatment systems using innovative approaches to wastewater treatment may be allowed when approved by the AHJ. Use paragraph 53.2 for required engineering data and process evaluation for innovative approaches that do not conform to the 10 State Standards as modified by this UFC.

12-2 PACKAGED TREATMENT PLANT.

Packaged treatment plants are typically used for small treatment systems associated with military operations in remote locations. These systems combine processes such as aeration, settling, and solids treatment in a multi-compartment unit or units. Typical types of treatment include extended aeration (activated sludge), rotating biological contactors (RBC), and sequencing batch reactors (SBR). Various processes within the packaged treatment system may include proprietary components. The DoR is responsible for specifying performance requirements, construction quality control, testing and verification, providing operation and maintenance procedures, equipment startup and operator training. WEF MOP OM-7 provides operation and maintenance guidance for extended aeration systems.

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CHAPTER 13 ON-SITE WASTEWATER TREATMENT AND DISPOSAL

13-1 GENERAL.

When a project is not served by a wastewater collection system, provide an on-site wastewater disposal system capable of handling the wastewater generated. Typical military applications include facilities such as remote training locations and remote entry control facilities. Use the IPSDC for on-site treatment systems.

13-2 ALTERNATIVE SEWER SYSTEMS.

Provide gravity collection systems when possible. Use the IPSDC for the design of alternative sewer systems.

13-3 HOLDING TANKS.

Holding tanks may be used when connecting to an approved wastewater collection system and constructing an on-site treatment system is not feasible. When a holding tank is used, the Installation must be able to demonstrate the means for regularly disposing of the sewage. Holding tank must be large enough to store peak flows for the Installation's disposal interval.

13-4 NONLIQUID SATURATED TREATMENT SYSTEMS.

Nonliquid saturated treatment systems, such as waterless toilets, may be used for composting human waste. Do not use a nonliquid saturated treatment system when a facility has a water supply source such as a potable water distribution system or potable well. Do not use non-potable water for handwashing or human consumption. Provide handwashing by waterless bacteriological hand cleaner and disposable hand towels or pre-moistened hand towels. Use the IPSDC for nonliquid saturated treatment systems.

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CHAPTER 14 INDUSTRIAL WASTEWATER COLLECTION AND TREATMENT

14-1 INDUSTRIAL AND OILY WASTE CONTROL SYSTEMS.

This chapter provides design requirements for the collection and treatment of industrial and oily wastewater control systems. These requirements are intended to serve as a general guide to assist the DoR in determining all applicable requirements and include items such as permits, effluent discharge limits, and disposal of solids. The DoR must take into account new regulations, widely accepted practices and proven treatment technologies. More stringent state requirements may be applicable when the EPA has delegated their permitting authority to an approved state program or when the project is located outside of the jurisdiction of U.S. laws. The criteria provided does not eliminate, change or modify any statutory or regulatory requirement.

Collect and hold all fire suppression system discharge for offsite disposal. Do not collect fire suppression system discharge in domestic or industrial wastewater collection systems, combine with other industrial wastes, or provide industrial wastewater treatment for fire suppression system discharge. Use UFC 3-600-01 and UFC 4-211-01 for fire suppression system discharge collection and containment requirements.

14-2 SPILL PREVENTION, CONTROL, AND COUNTERMEASURE PLANS.

Use UFC 3-460-01 for spill prevention, control and countermeasures plan requirements associated with petroleum fuel facilities. 40 CFR 112.1 establishes the general applicability of the spill prevention, control and countermeasure rule. 40 CFR 112.1(d)(6) exempts wastewater treatment facilities or portions thereof that are used exclusively for wastewater treatment. This exemption does not apply to wastewater treatment devices such as oil water separators that are used to provide secondary containment under 40 CFR 112.8(c)(2) for oil storage containers. The exemption also does not apply to containers that are used to store recovered oil in an oily waste treatment process or facility. Refer to EPA 550-B-13-002 for additional guidance.

14-3 INDUSTRIAL DISCHARGE LIMITS.

Industrial wastewater may discharge wastewater either directly or indirectly. Indirect discharge is typically the most cost effective approach to treating industrial wastewater. For indirect discharge, effluent discharge limits are determined by pretreatment regulations and POTW requirements. For indirect discharge, the DoR must comply with pretreatment regulations, requirements set by the POTW and control mechanisms in the POTW's NPDES permit. For direct discharge, effluent discharge limits are determined by direct discharge regulations and NPDES permits. For direct discharge, the DoR must obtain and comply with direct discharge regulations and the terms of the NPDES permit. EPA 833-R-12-001A provides industrial user permitting guidance.

14-4 GENERAL PRETREATMENT REGULATIONS FOR EXISTING AND NEW SOURCES OF POLLUTION (40 CFR 403).

The National Pretreatment Program, 40 CFR Part 403, provides the regulatory basis to require nondomestic dischargers to comply with pretreatment standards to ensure compliance with the Clean Water Act (CWA). The National Pretreatment Program controls toxic, conventional, and non-conventional pollutants from nondomestic sources that discharge into publically owned treatment works (POTW). EPA 833-B-11-001 provides federal pretreatment requirements and guidance.

14-4.1 Industrial Discharges.

Industrial discharges can fall into several different categories. Understanding and applying the requirements for industrial discharges is essential to understanding industrial wastewater treatment requirements and correctly applying responsibilities. 40 CFR 403.3 contains a complete list of definitions.

14-4.2 Industrial User (40 CFR 403.3(j)).

The National Pretreatment Program requires indirect discharges to obtain permits or other control mechanisms to discharge wastewater to the POTW. The permit may specify the effluent quality that necessitates that an industrial user pretreat or otherwise control pollutants in its wastewater before discharging it to a POTW.

14-4.3 Categorical Industrial User.

An industrial user subject to national categorical pretreatment standards.

14-4.4 Non-Significant Categorical Industrial User (40 CFR 403.3(v)(2)).

In general, non-significant industrial users never discharge more than 100 gallons per day of total categorical wastewater and some additional conditions apply including never discharging any untreated concentrated waste. Refer to 40 CFR 403.3(v)(2) for a definition and additional conditions.

14-4.5 Significant Industrial User (40 CFR 403.3(v)).

In general, significant industrial users are subject to categorical pretreatment standards and any other industrial user that discharges:

- An average of 25,000 gallons per day or more of process wastewater to the POTW,
- Contributes a process waste stream which makes up 5 percent or more of the average dry weather hydraulic or organic capacity of the POTW, or
- Is designated as such by the Control Authority on the basis that the industrial user has a reasonable potential for adversely affecting the

POTW's operation or for violating any Pretreatment Standard or requirement (in accordance with 40 CFR 403.8(f)(6)).

14-4.6 Middle-Tier Categorical Industrial User (40 CFR 403.12(e)(3)(i)-(iii)).

A classification that a POTW, in the case of a POTW with an approved pretreatment program, or the Approval Authority, in the case of a POTW without an approved pretreatment program may apply to certain industrial users if their discharge of categorical wastewater does not exceed certain conditions. Refer to 40 CFR 403.12(e)(3)(i)-(iii). In terms of discharge, the industrial user does not discharge more than 5,000 gallons per day.

14-4.7 National Pretreatment Standards: Prohibited Discharges (40 CFR 403.5).

40 CFR 403.5 identifies prohibited discharges for national pretreatment standards.

1. General prohibitions: 40 CFR 403.5(a)(1);
2. Specific prohibitions: 40 CFR 403.5(b);
3. When specific limits must be developed by POTW: 40 CFR 403.5(c);
4. Local limits: 40 CFR 403.5(d);
5. EPA enforcement actions under section 309(f) of the Clean Water Act: 40 CFR 403.5(e).

14-4.8 National Pretreatment Standards: Categorical standards (40 CFR 403.6).

Pretreatment standards are implemented through the National Pretreatment Program. Discharges from indirect dischargers are regulated through categorical standards. Existing and new categorical standards for specific industrial subcategories are included in 40 CFR 405 through 40 CFR 471.

14-5 DIRECT DISCHARGE (40 CFR 122).

A direct discharge is the discharge of any pollutant into waters of the United States from any point source. Refer to 40 CFR 122.1 for a complete list of regulatory requirements. Refer to 40 CFR 122.2 for a complete list of definitions. Unless covered by an exclusion, the NPDES Permit Program requires point source pollutant discharges to waters of the United States to obtain an NPDES permit. Refer to 40 CFR 122.3 for exclusions. For point sources that introduce pollutants through direct discharge, the EPA has promulgated effluent guidelines through the NPDES Permit Program and at the same time as pretreatment standards. Direct discharges are required to comply with the same categorical pretreatment standards as indirect discharges using effluent limitation guidelines established in the categorical pretreatment standards. Direct discharge usually requires extensive wastewater treatment to reduce pollutants and achieve effluent requirements. Refer to EPA 833-K-10-001 for direct discharge guidance.

14-6 INDIRECT DISCHARGE.

Once pretreatment effluent requirements have been met, industrial wastewater may be combined with domestic wastewater in the domestic wastewater collection system and conveyed to a POTW. Indirect discharge to a receiving water body occurs after the wastewater has passed through a POTW.

14-7 CONVENTIONAL POLLUTANTS (40 CFR 401.16).

Five conventional pollutants are defined in 40 CFR 401.16. Conventional pollutants are expected to be present in domestic wastewater. They are:

- Biochemical oxygen demand (BOD);
- Total suspended solids (TSS);
- Fecal coliform;
- pH;
- Oil and grease (O&G).

14-8 INDUSTRIAL POLLUTANTS.

Industrial wastewater may contain toxic or non-conventional pollutants in addition to conventional pollutants. POTW are not design to treat most toxic or non-conventional pollutants. When a POTW has the capability to remove toxic pollutants from industrial wastewater the pollutants can end up in the POTW's sludge.

14-8.1 Toxic Pollutants (40 CFR 401.15).

40 CFR 401.15 provides a complete list of toxic pollutants. The list currently contains 65 toxic pollutants.

14-8.2 Priority Pollutants (40 CFR 423).

40 CFR 423, Appendix A to Part 423 - 126, provides a complete list of Priority Pollutants. The Priority Pollutants are a set of chemical pollutants that EPA regulates and for which EPA has published analytical test methods. The Priority Pollutant list is more practical than the list of toxic pollutants for testing and for regulation. Priority pollutants are described by their individual chemical names. In contrast, the list of toxic pollutants contains open-ended groups of pollutants. For example, chlorinated benzenes contain hundreds of compounds and there is no test for the group as a whole. The Clean Water Act, 33 USC 1317(a)(1), references the Toxic Pollutant List.

14-8.3 Nonconventional Pollutants.

Nonconventional pollutants are any pollutant not specified as a toxic pollutant or conventional pollutant. Nonconventional pollutants include parameters such as chlorine, ammonia, nitrogen, phosphorus, chemical oxygen demand (COD), and whole effluent toxicity (WET).

14-9 INDUSTRIAL WASTEWATER SURVEYS.

Identify all industrial wastewater sources and flows through field investigation and existing records to extent possible. The composition of industrials pollutants and flows can be variable and depend on the type and operation of the facility.

14-9.1 Physical Characteristics.

Use existing records to identify the physical characteristics of the industrial wastewater collection system. Determine the extent of available records such as existing maps or drawing files. Field verified all existing records to verify accuracy. Compile records and carefully review to see if they accurately represent the existing wastewater collection system.

14-9.2 Waste Stream Characteristics.

Being able to identify all pollutants and their concentrations is an important part of the industrial wastewater survey. North American Industry Classification System and Standard Industrial Classification codes may be helpful when determining the appropriate industrial category. Use existing records such as prior sampling results to identify pollutants and pollutant concentrations. If existing records are not available or are not sufficient to identify pollutant concentrations a field monitoring program should be established to verify and update existing records.

14-9.3 Waste Stream Flows.

Use existing records to identify waste stream flows to the extent possible. Most Installations meter water usage from water treatment facilities. Metered data may be used to perform a water balance evaluation. Add water obtained directly from other sources, such as wells.

14-10 PRELIMINARY DESIGN.

14-10.1 Facility Industrial Wastewater Survey.

Use WEF MOP FD-3, Chapter 4 *Industrial Wastewater Survey and Characterization* for industrial wastewater survey and waste stream characterization. The DoR must identify the physical characteristics, composition of industrials pollutants, flow characteristics for the facility type, and planned operation procedures.

14-10.1.1 Physical Characteristics.

If existing sewer maps are not available, they must be prepared. Show how the facility's industrial waste stream will connect to the existing industrial or domestic wastewater collection system and how the new connection will affect any existing industrial or domestic wastewater flows. Prepare a comprehensive schematic flow diagram of the facility's wastewater systems.

14-10.1.2 Waste Stream Characteristics.

For existing facilities, when existing records are not available or sufficient to identify pollutant concentrations identify wastewater characteristics through field investigation. Identify wastewater sources using typical industrial waste survey techniques such as identifying sources, establishing a sampling plan and dye tracer testing. Refer to EPA 833-K-10-001 for additional guidance.

14-10.1.3 Waste Stream Flows.

When existing flow records are not available, use actual measurement to establish flow rates or estimate flows from equipment ratings, process analysis, or other reliable methods. Identify variations in peak flow such as modes of occurrence (continuous or intermittent) and period of discharge. Correlate flowrates with process production rates and concentration variations.

14-11 DESIGN.

14-11.1 Process Changes.

Evaluate process changes that reduce waste stream volume, pollutant concentration, or treatment processes before proceeding on any industrial waste collection and treatment project. Process changes may include:

- Segregating or combining industrial waste streams based on waste stream characteristics;
- Changing cleanup operations from wet to zero discharge or dry methods;
- Product recovery;
- Using wastewater from one process as a source of water for another process (when the quality of the effluent from the first source meets or exceeds the required water quality of the following processes); or
- Recycling all or a portion of wastewaters.

Use WEF MOP FD-3, Chapter 7 *Management Strategies for Pollution Prevention and Minimization* for additional minimization practices.

14-11.1.1 Waste Stream Minimization.

Investigate waste stream minimization techniques to eliminate or reduce wastewater volume and pollutant concentrations. Reducing wastewater volume may be more economical than providing wastewater treatment. Evaluate process changes such as reducing waste stream volume, segregating waste streams, recycling treated effluent, and product recovery. Some pollutants have discharge limitations that require a zero discharge system. Segregate all industrial and domestic waste streams. Segregate stormwater drainage from all waste streams.

14-11.1.2 Separating Waste Stream Sources.

Isolate waste streams requiring different treatment processes, when pretreatment reduces downstream treatment requirements, containing recoverable materials, or with non-compatible or hazardous pollutants. The additional cost of source separation is typically offset by reducing treatment processes and operational cost.

14-11.1.3 Combining Waste Stream Sources.

Evaluate combining separate waste flows that are compatible for co-treatment, such as neutralization by combining acid and alkaline flows. Consider combining compatible waste streams when waste stream combination reduces the cost of treatment processes. Prohibit combining industrial and domestic wastewater.

14-11.2 Establishing the Design Flow.

Base design flow on the maximum flowrate to be treated, including any future expansions for the project planning period. Evaluate seasonal, daily and shift variations in determining peak flowrates. Where appropriate, establish production-based generation rates for projecting future flows. If unit wastewater generation rates from another facility are used, account for differences, including size, type of facility, and differences in operating procedures.

14-11.2.1 Peak Flows.

Design industrial wastewater collection systems for the peak industrial flow, as determined for the industrial process or activity involved. Peak hourly flows may be higher during a specific 8-hour shift during the day or for a specific day at single shift shops.

14-11.3 Industrial Wastewater Collection.

Collect industrial wastes in a manner that avoids unsafe conditions to personnel, equipment, and facilities. Select pipe materials, pumps, and appurtenances that are rated for the characteristics of the industrial waste stream. During the materials selection process, obtain and follow manufactures' recommendations. Obtain approval from the AHJ for any exceptions to manufactures' recommendations. Some waste streams may contain pollutants that can damage materials such as oily waste, solvents, high temperature, and unusual pH ranges. Some pipe materials are not rated for high-temperature waste streams. Use piping rated for the high-temperature of the wastewater being collected to prevent detrimental effects on the wastewater collection system. Use Chapters 2, 3, and 4 for the design of gravity sewer systems.

14-11.4 Industrial Wastewater Treatment.

Most POTW are not designed to treat industrial wastes that may contain toxic or non-conventional pollutants. Where pollution prevention techniques such as reducing or recycling industrial waste are not sufficient to reduce pollutants such as primary or toxic pollutants to the required regulatory levels, provide pretreatment for industrial wastewater sources in accordance with 40 CFR 403 or provide a separate industrial wastewater collection and treatment system. Document the industrial wastewater sources and the treatment or pretreatment strategies used for compliance.

Industrial wastewater treatment may include removal of fat, oil, and grease; organic or inorganic constituents; and pH control. Use Chapters 2 and 5 - 11 for the design of industrial wastewater treatment systems. Use WEF MOP FD-3 for industrial wastewater treatment and pretreatment guidance. Select industrial wastewater treatment processes based on the characteristics of the pollutants, the full range of industrial wastewater flows, permitted discharge limits, technical ability of personnel operating the industrial wastewater treatment facility, cost of construction, and operation and maintenance costs. Identify adverse effects from upstream treatment processes on subsequent treatment steps and methods of mitigating the adverse effects. For projects with wastewater flows from industrial sources, include evidence of adequate treatment or pretreatment strategies for review and approval by Installation EV staff and the AHJ.

14-11.4.1 Treatability.

Length and configuration of the collection system, liquid transport velocities, pumping, and associated appurtenances can significantly influence wastewater characteristics. Use WEF MOP FD-3 Chapter 5 *Wastewater Treatability Assessments* for treatability assessment guidance.

14-11.4.2 Pretreatment.

Use Chapter 2 and WEF MOP FD-3, Section 2, for design of pretreatment processes.

Identify daily and process-related variations in wastewater characteristics related to current and future production operations to develop control strategies. Evaluate combining separate waste flows that are compatible for co-treatment, such as neutralization by combining acid and alkaline flows.

14-11.5 Flow and Load Equalization.

Evaluate equalization on a large scale for compatible wastes received at a treatment facility, or on a smaller scale for specific process batch discharges. Processes with short duration and high flow and loading rates can adversely impact collection and treatment systems, evaluate at-the-source equalization to minimize hydraulic and pollutant load surges.

Evaluate the relative cost of constructing and implementing effective flow equalization, and the anticipated cost savings of reducing the size of downstream treatment processes. Determination of the need for flow equalization is based on the potential effects of peak hourly flow on pretreatment, industrial treatment facility, or POTW operating parameters such as flow rate, pH, BOD, COD, ammonia, toxicity, and variations in peak flow.

14-11.5.1 Basin Sizing.

Use peak flows for equalization, and as the basis for sizing treatment facilities.

The three basic types of equalization processes are alternating flow diversion, intermittent equalization, and completely mixed equalization. Completely mixed combined flow equalization is most common. Determine the minimum volume of a completely mixed combined flow equalization basin using the below formula.

$$V = (\Sigma f_i) T_e k$$

Where

V = equalization volume (m^3);

f_i = individual flowrates (m3/min);

T_e = equalization time (hours); and

k = conversion factor for units (min/hour)

For additional information and sizing information on alternating flow diversion or intermittent equalization processes and sizing using a cumulative flow curve, use WEF MOP FD-3, Chapter 8 *Flow and Load Equalization.*

14-11.5.2 Basin Construction.

Evaluate the need for liners based on frequency of basin use and solids deposition and clean-out. If required, provide a protective liner compatible with wastewater characteristics. Earth embankment lagoons are not allowed unless permitted by local regulatory agencies.

14-11.5.3 Mixing Conditions.

For biodegradable wastes provide minimum airflow rate of 4 ft^3/min/1000 gal (0.5 L/m^3 s) of basin volume to keep solids in suspension. Consult manufacturers as to circulation capacity of aeration or mixing equipment for manufacturer specific basin configuration.

14-11.6 Solids Removal.

Provide for removal of deposited solids from the basin, by either draining and cleaning during off-peak hours or by cleaning without draining. This can be through manways installed in steel tanks, depressed floor pits for solids accumulation and pumping, or by sloped floors in basins to collection pits.

14-11.6.1 Solids Separation and Handling.

Use WEF MOP FD-3 Chapter 9 *Solids Separation and Handling*. Remove suspended solids from industrial wastewater prior to discharge to a POTW. Concentrations greater than 500 mg/L can overload POTW systems and clog sewer lines and pumping station wet wells, and, if biodegradable, cause odors.

Classify solids by size and removal technique:

- Large solids – solids greater than 1 inch (25 mm)
- Grit – suspended matter that settles more rapidly than organic matter
- Settleable solids – particles with diameters between 1 µm and 25 mm that settle out of wastewater during a standard Imhoff cone test and may be organic or inorganic.
- Colloids – particles between 0.001 and 1 µm and may be organic or inorganic. Colloids are typically removed with chemical coagulation and flocculation.

14-11.6.2 Removal Methods.

Select methods based on the initial concentration of solids in the wastewater, the final concentration needed, and particle size and characteristics. For wastewater streams with TSS less than 1% (10,000 mg/L) the typical methods used include straining, gravity separation, and filtration. Use WEF MOP FD-3 Chapter 9, *Solids Separation and Handling*, and Chapters 6 and 7 of this UFC.

14-11.6.3 Solids Handling and Processing.

Industrial solids processing, particularly for industrial biological sludges, may be more difficult to dewater than domestic sludge. Solids conditioning, thickening, dewatering, and disposal are discussed in Chapter 8.

14-11.6.4 Disposal of Industrial Sludge.

Coordinate with Installation EV staff and industrial wastewater treatment operators to determine the optimal treatment strategy and waste disposal methods. All sludges resulting from industrial wastewater treatment processes must be evaluated as a potentially hazardous waste in accordance with 40 CFR 261; specifically 40 CFR 261.2 and 261.3. Treatment strategies, disposal methods and applicable exemptions or exclusions will be based on the results of that regulatory evaluation and must be approved by Installation EV staff and the AHJ.

14-11.7 pH Control.

Use WEF MOP FD-3 Chapter 11 *pH Control.* Adjust pH of wastewater if required prior to direct or indirect discharge. For direct discharge the effluent pH required is typically between 6 – 9 to protect receiving waters. POTW requirements will vary based on treatment processes, but typically will require 5.5 – 10 to protect collection systems and prevent process upset, and 6.5 – 8 if the POTW uses biological pretreatment processes.

Evaluate possible adverse chemical reactions due to acidity of wastewater such as reactions with cyanide and sulfides.

14-11.7.1 Acidity And Alkalinity.

Determine the wastewater's total acidity or alkalinity by performing a titration. Use the titration curve and flow variability to define reagent, dose, and process control characteristics.

Select neutralizing agents based on cost, reaction time, solids production, safety, maximum and minimum pH in overtreatment, ease of chemical handling, and availability. Solids produced during neutralization may require removal and processing.

14-11.8 Removal of Inorganic Constituents.

Refer to WEF MOP FD-3 Chapter 12 *Removal of Inorganic Constituents.* Inorganic constituents found in industrial wastewater include heavy metals, cyanide, sulfides, and nutrients (primarily nitrogen and phosphorus). Control heavy metals and other inorganic compounds present in some industrial wastes to avoid upset or pass-through problems to the POTW.

14-11.8.1 Treatment Strategies and Processes.

Inorganic pollutants may require treatment in individual rather than combined streams due to the variety of compounds and sources. Common treatment techniques include neutralization – precipitation, chemical reduction, oxidation, stripping, ion exchange, adsorption, membrane filtration, electrodialysis, and evaporation.

14-11.9 Removal of Organic Constituents.

Use WEF MOP FD-3 Chapter 12 *Removal of Organic Constituents.*

14-11.9.1 Biological Treatment Processes.

Use biological treatment processes for waste streams with a significant biodegradable fraction or to destroy hazardous organics by converting to more benign forms. Consider carbon source and nutrient and growth factors in design.

Conventional biological treatment systems can remove some organic compounds via biodegradation, volatilization (stripping) from aeration, and adsorption onto sludge, while others pass through. Actual removal performance depends on the operating characteristics (sludge age, mixed liquor suspended solids) of the treatment facility, the method of oxygenation, and the amount and nature of other compounds present in the wastewater.

14-11.9.2 Organic Treatment Approaches.

Evaluate reaction kinetics, bacterial growth and pollution removal rates, and process control parameters. One or more treatment technologies may be required to meet effluent limits. Treatment technologies include: activated sludge; sequencing batch reactors; facultative ponds; aerobic, anaerobic and combination ponds; fixed film technologies; trickling filters; and submerged media attached growth reactors.

Remove nitrogen via physical – chemical means or biological processes. If wastewater contains organic nitrogen, convert to ammonia by deamination followed by nitrification. Remove phosphorus by precipitation or biological processes.

CHAPTER 15 OILY WASTE TREATMENT

15-1 OILY WASTE SOURCES.

Oily waste originates in numerous locations on board ships and throughout shore facilities, including equipment washracks, vehicle maintenance, fueling and petroleum, oil and lubricant sources, metal products and machinery, floor drains, shipboard oily wastewater, and stormwater runoff. Design oil-water separators to handle anticipated maximum oily waste loads.

15-1.1 Oily Waste Characteristics.

The types and concentrations of pollutants in oily wastes will depend on the source of the oily wastewater and the source of the pollutants. Identify the source of the oily wastewater and the source of the pollutants to determine the appropriate treatment process. Oil, grease, and total suspended solids are the typically primary conventional pollutants found in oily waste. Oils may be present in the form of free, dispersed, emulsified, or dissolved oil. Other types of pollutants may include pollutants such as fuel, heavy metals, or solvents. Pollutants may be present individually or in combination with other pollutants.

15-1.2 Oily Waste Waste Oil.

Oily wastes and waste oils are byproducts of operating ocean-going vessels. Oily bilgewater is the mixture of water, oily fluids, lubricants and grease, cleaning fluids, and other wastes that accumulate in the lowest part of a vessel from a variety of sources including engines (and other parts of the propulsion system), piping, and other mechanical and operational sources found throughout the machinery spaces of a vessel. This type of oily waste is commonly referred to as oily waste waste oil (OWWO). Refer to Chapter 16 for additional OWWO criteria.

15-1.3 Sampling.

When the specific pollutant or combination of pollutants is unknown, develop a sampling plan for the type of activities performed at the facility. Analyze oily wastewater using approved EPA methods. The EPA publishes laboratory analytical methods, or test procedures that are used by industries and municipalities to analyze the chemical, physical ,and biological components of wastewater and other environmental samples that are required by the Clean Water Act. Most of these methods are published in 40 CFR 136. An American Society for Testing and Materials (ASTM) standard using an approved EPA method may be used. The completed analysis must identify the amounts of free, dispersed, emulsified, and dissolved oil fractions present. When pollutants other than only conventional pollutants may be present additional sampling and analysis will need to be included in the sampling plan. The additional sampling and analysis may include an analysis of volatile suspended solids (VSS) to determine the full range pollutants present. Refer to *Standard Methods for the Examination of Water and Wastewater* for guidance on sampling and analysis.

Sampling for facilities such as vehicle wash facilities will typically be limited to temperature, pH, total suspended solids and total oil and grease. Use grab samples to analyze for pH and total oil and grease. Use composite samples to analyze for total suspended solids. For composite samples, collect five grab samples evenly spaced over an 8-hour period or if the discharge is less than 8 hours, evenly spaced for the duration of the discharge.

15-2 IDENTIFICATION OF FLOWS.

Estimate the peak flow rate of the oily wastewater requiring treatment, including the addition of any future oily wastewaters. When determining peak flow rates, evaluate flow variations between shifts, daily operations and seasonal flow variations. Estimate peak flows by monitoring and measuring existing flows during peak operating periods for existing flows or by estimating peak flow based on the estimated peak flow of the water used at the facility for new flows. For example, the peak flow from a new aircraft washing facility may be estimated from the water used per aircraft multiplied by the maximum number of aircraft to be washed in a given period. Peak flow rates from a similar facility may be used when differing conditions are evaluated and accounted for, such as differences in the pressure of the water supplied, vehicle type and washing procedures.

15-3 OILY WASTE OIL COLLECTION.

Do not mix high flashpoint oil with low flashpoint oil, or halogenated solvents with non-halogenated oil. Evaluate segregation of oily wastewater streams based on the characteristics of the wastewater and the source of pollutants. Segregate oily wastewater and solvents at their source when possible. Do not mix oily wastewater with industrial wastewater such as wastewater containing metals and phenols.

Minimize the formation of chemical and physical emulsified oils. Avoid using emulsifying agents such as detergents and creating turbulent flow, such as pumping oily waste. Segregate oily wastewater containing emulsified oil from oily wastewater without emulsions when possible.

15-3.1 Waste Stream Minimization.

In addition to the waste stream minimization requirements indicated in Chapter 14, facilities such as washracks should be covered to prevent rainfall events from increasing the volume of oily waste requiring treatment. When cover is not provided, provide a waste collection system capable of segregating oily wastewater flows from stormwater runoff during periods when oily wastewater flows are not being generated.

15-3.2 Pumps.

Avoid pumping oily wastewater to a gravity or enhanced-gravity oil water separator. If pumping is required, use positive displacement pumps to prevent the formation of physical emulsions. When oily wastewater is pumped, an enhanced oil water separator should be used.

Manufacturers typically indicate peak influent flow capacity using gravity flow with no pumps upstream of the separator. When positive displacement pumps are used, de-rate the flow capacity of the oil water separator to account for non-quiescent conditions. When oily wastewater is pumped, the DoR must provide documentation from the specified manufacturers indicating the proposed oil water separator has been de-rated for the anticipated pump flowrates and is sized to meet effluent standards.

15-4 OILY WASTE TREATMENT.

Design the oily waste treatment system for the peak flow at the minimum expected operating temperature. Use the minimum operating temperature to determine the properties of the oil water mixture, such as density and absolute viscosity.

15-4.1 Oil Water Separators.

Use UFC 3-240-03 to evaluate the need for new or existing oil water separators. Coordinate with the Installation EV staff for direct discharge permitting requirements or POTW approval.

Design grit chambers and gravity separators located below grade for traffic loads. Use H-20 traffic loading as the minimum design load. When a gravity oil water separator is open to the atmosphere, the wall of the separator must extend a minimum of 6 in (150 mm) above the surrounding ground surface. Separators that are not designed for traffic loads must extend a minimum of 6 in (150 mm) above the surrounding ground surface.

15-4.1.1 Gravity Separators.

Separators that are open to the atmosphere may require removable grates or covers to prevent people from accidentally falling into the separator. Design grates or covers to be removable by no more than two people.

15-4.2 Conventional Pollutants.

Oily wastewater with pollutants limited to conventional pollutants typically includes facilities such as vehicle wash racks, aircraft washing, and vehicle maintenance facilities. When only conventional pollutants are present, gravity oil water separators are typically the most efficient type of treatment for free oil and in some cases, dispersed oil.

15-4.3 Emulsified Oils.

Gravity separators are not capable of removing emulsified oils without providing additional treatment processes. Do not use gravity separators as a single unit process for emulsified oil removal. Bench or pilot plant testing should be performed to determine an effective emulsion breaking method. An effective treatment process for emulsified oil treatment may include gravity separation to remove free oil followed by dissolved air flotation (DAF).

15-4.4 Dissolved Oils.

Treatment technologies for the treatment and direct discharge of dissolved oils are typically not performed on military installations. Dissolved oil may be removed through biological treatment processes employed by the downstream wastewater treatment plant or POTW.

15-4.5 Industrial Pollutants.

Oily wastewater containing pollutants other than conventional pollutants will typically require more than one treatment process. A single treatment process or commercial device is not typically capable of removing non-conventional pollutants and oil. Especially when oil is in the form of dispersed, emulsified or dissolved oil. A series of treatment processes or units is typically required to achieve the desired effluent quality. The treatment processes or devices provided must be able to meet the direct discharge or POTW discharge limits.

15-4.6 Pretreatment Techniques.

Provide pretreatment as close to the source as possible to help avoid emulsification. If flow is highly variable, flow equalization may be required to maintain quiescent conditions and ensure efficiency of the separator.

15-4.6.1 Grit Removal.

Provide a separate grit removal basin when the total suspended solids exceed 200 mg\l. Use a minimum detention time of 5 minutes for gravity separation. A grit removal basins will also assist with flow equalization.

15-4.6.1.1 Maintenance.

Provide access for inspection and a truck with suction equipment to remove grit.

15-4.7 Gravity Separation.

Use gravity separation for the removal of free oil and settleable solids. Gravity separation of dispersed oil is typically more difficult and may require using parallel plate coalescing media to meet discharge requirements.

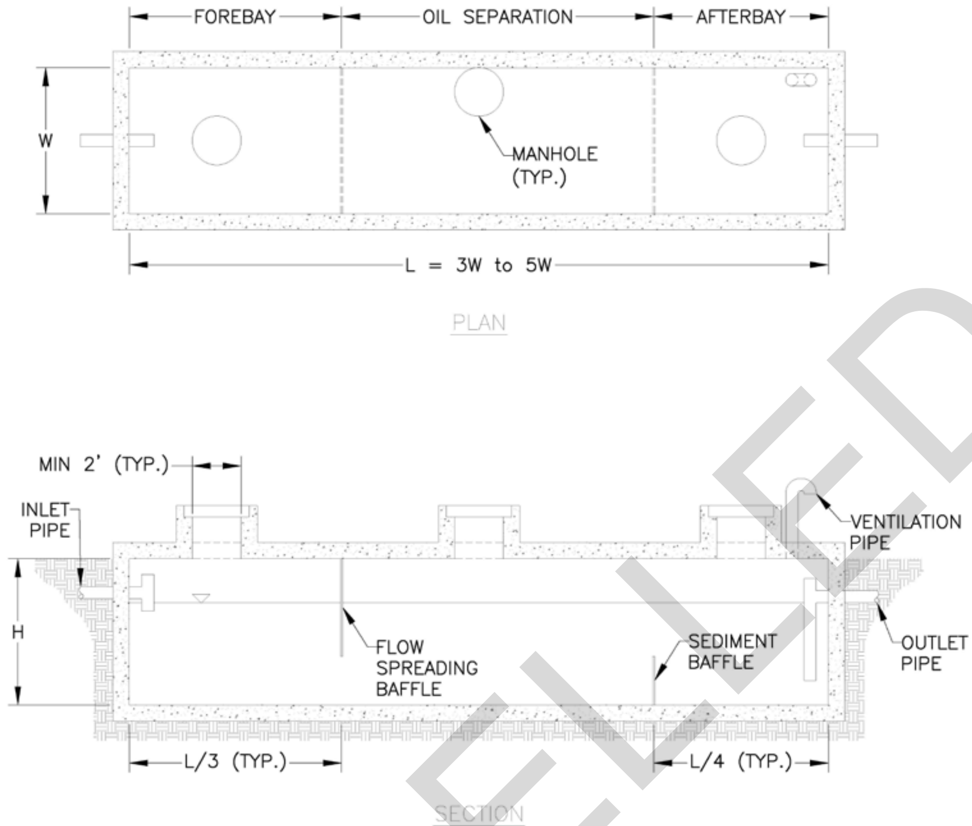

Figure 15-1 Gravity Oil Water Separator

15-4.7.2 Gravity Separator Sizing.

Use the following procedure to size a gravity oil water separator using the smallest oil droplet size to be removed:

1. Use stokes law to compute the rate of rise, V_t.

$V_t = [(g)(\rho_w - \rho_o)(d^2)] / [(18*\mu_w)]$

Where:
V_t = rise rate of the oil droplet (cm/s or ft/sec)
g = acceleration due to gravity (cm/s² or ft/s²)
ρ_w = density of water at the design temperature (g/cm³ or lbm/ft³)
ρ_o = density of oil at the design temperature (g/cm³ or lbm/ft³)
d = oil droplet diameter (cm or ft)
μ_w = absolute viscosity of the water at the minimum expected operating temperature (g/cm-s or lbm/ft-s)

2. Compute mean horizontal velocity, V_h or use a maximum value of 3 ft/min (0.91 m' min). Best practice; use a maximum value of 1 to 2 ft/min (0.3 to 0.61 m/min)

$V_h = 15 * V_t$

Where:
V_h = mean horizontal velocity (m/min or ft/min)
V_t = rise rate of the oil droplet (m/min or ft/min)

3. Compute the minimum vertical cross sectional area, Av.

$A_v = Q_{peak} / V_h$

Where:
A_v = minimum vertical cross sectional area (m^2 or ft^2)
Q_{peak} = peak flow rate (m^3/min or ft^3/min)
V_h = mean horizontal velocity (m/min or ft/min)

4. Select the depth, d. Use a minimum depth of 3 ft (0.9 m). Best practice; use a maximum depth of 8 ft (2.4 m). Additional depth may be required when mechanical sludge removal equipment is included.
5. Select the width, w. Best practice; use a minimum width of 6 ft and maximum width of 20 ft (6.1 m).
6. Compute the number of separators or separator channels, n.

$n = Av / w * d$

Where:
n = number of separators or separator channels
A_v = minimum vertical cross sectional area (ft^2 or $m^{2)}$
w = width of the separator (m or ft)
d = depth of the separator (m or ft)

7. Compute the depth to width ratio, d/w. Minimum depth to width ratio = 0.3 and maximum depth to width ratio = 0.5. If the depth to width ratio obtained is not in the acceptable range, repeat calculations until depth to width ratio is in the acceptable range.
8. Select the length, L. The minimum length should be 3 to 5 times the width. Best practice; use a minimum length equal to five times the width.
9. Compute the overflow rate, Vo.

$V_o = Q_{peak} / L*w$

Where:
V_o = overflow rate (m/min or ft/min)
Q_{peak} = peak flow rate (m^3/min or ft^3/min)
L = length of the separator (m of ft)
W = width of the separator (m or ft)

10. Verify that the oil droplet's rate of rise, Vt, equals or exceeds the over flow rate, Vo. When the oil droplet's rate of rise does not equal or exceed the overflow rate, repeat calculations until oil droplet's rate of rise equals or exceeds the over flow rate. When repeating calculations, try increasing the length of the separator first.

11. Select an appropriate freeboard based on fluctuations in peak flow and rainfall if the separator is not covered and has an open top. Use a minimum freeboard of 6 in (150 mm).

Removing oil with a droplet size smaller than 150 microns will significantly increase the size of the oil water separator. For example, an oil droplet size of 150 microns will rise nine times faster than a 50 micron oil droplet.

15-4.8 Enhanced Gravity Separation.

Coalescing media assists with gravity separation of oil droplets smaller than 150 microns. The coalescing media increases the surface area of the gravity separator and allows for efficient removal of oil droplets. Enhanced gravity separation can typically be used to treat oil droplets as small as 60 microns. Some more efficient enhanced separators may be able to treat oil droplets as small as 30 to 40 microns but successful removal will depend on many variables. When enhanced gravity separation is used to meet direct discharge limits, additional tertiary treatment may still be required to meet discharge limits indicated in the NPDES permit, especially for the removal of oil droplets in the 20 to 60 micron range. Discharges to a POTW typically do not require an enhanced gravity separator.

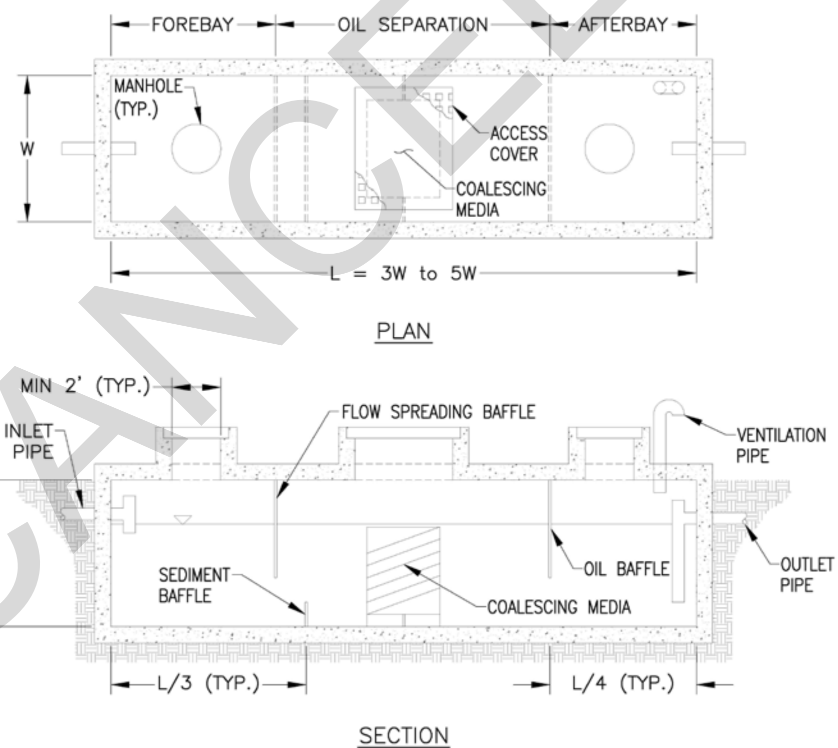

Figure 15-2 Enhanced Gravity Oil Water Separator

15-4.8.1 Enhanced Gravity Separator Sizing.

In general, the design of enhanced oil water separators is similar to gravity oil water separators with two general exceptions:

1. The surface area of the coalescing media reduces the surface area required for gravity oil water separator design.
2. The enhanced oil water separator can operate efficiently at higher horizontal velocities.

Most manufacturers have empirically derived design data that they use for enhanced oil water separator design. In these cases, the manufacturer is the best source of design data. For 60 micron oil droplets, the required horizontal surface area of parallel plates can be computed using the following equation:

$A_h = Q_{peak}/V_t = Q_{peak}$ / (.00386) * $((S_w - S_o)/(\mu_w))$

Where:
A_h = horizontal surface area of the plates (ft^2)
V_t = rise rate of the oil droplet (ft/min)
Q_{peak} = design flowrate (ft^3/min)
S_w = specific gravity of water at the design temperature
S_o = specific gravity of oil at the design temperature
μ_w = absolute viscosity of the water (poise)

Laminar flow through the coalescing media is required. Verify the Reynolds Number for flow through the coalescing media is less than 500.

15-4.9 Other Types of Treatment.

The degree of treatment required will be determined by the type of discharge, indirect or direct. For direct discharges, treatment requirements will also be identified in the NPDES permit. For indirect discharges, the POTW may identify additional treatment requirements. Sludge disposal requirements will be determined by the level of treatment provided and the characteristics of the sludge. Refer to WEF MOP FD-3 Chapter 10 *Removal of Fats, Oil and Grease,* for oily waste treatment guidance. Bench or pilot plant testing should be performed to determine the effectiveness of the treatment system.

15-4.10 Inspection and Maintenance.

Design oil water separators to be readily accessible for inspection by one person. Design each oil water separator bay or compartment to be readily accessible for inspection, maintenance and cleaning. Provide access for a truck with equipment capable of removing grit, oil or sludge from each oil water separator bay or compartment.

15-4.10.1 Enhanced Gravity Separators.

Enhanced gravity separators with coalescing media require a higher level of maintenance then gravity separators. Provide enhanced gravity separators with access for inspection and removal of the coalescing media units or packs. The coalescing media units or packs must capable of being removed as complete units or packs. Do not use coalescing media that requires disassembly in the separator prior to removal.

15-4.11 Redundancy.

Provide a minimum of two treatment units or channels when continuous operation is required. Two treatment units or channels will allow one channel to be taken out of service without bypassing the separator. The most cost effective design minimizes the number of treatment units or channels.

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CHAPTER 16 OILY WASTE AND WASTE OIL COLLECTION AND TREATMENT.

16-1 SOURCES.

Most ships have oil water separators, waste oil tanks (WOT), oily waste holding tanks (OWHT), and oily waste transfer pumps (OWTP). A brief description of oily waste equipment is presented below:

1. OWHT can usually contain the oily waste generated in one-half day by a ship in auxiliary mode. It holds at least 1,000 gallons.
2. WOT can usually contain the oily waste separated during a 60-day mission.
3. OWTP is normally a segregated electric driven pump that pumps bilge water to the OWHT and waste oil or oily waste to shore facilities. Some older ships use rotary vane pumps, but the newer ones use sliding shoe pumps. Pumps discharge at least 10 psi at the lowest weather deck of the ship. These pumps normally have capacity of off-loading the OWHT in approximately 1- 2 hours. On aircraft carriers, the off-loading time may take up to 4 hours.

16-2 SHIP DISCHARGE VALUES.

Use UFC 4-150-02 or contact the Government Project Manager for ship oily waste discharge capacities.

16-3 SITE LAYOUT.

Use UFC 4-152-01 for the design of oily waste and waste oil (OWWO) collection systems serving piers, wharfs, and drydocks. Design the oily waste collection system to segregate oily and non-oily wastewater sources, minimize oil-water separator hydraulic loading, minimize emulsification, and maximize oil and grease concentration.

Include the following concepts when laying out a pier collection pipeline:

a. Ships of same class type often berth together.
b. Install valves at head of each pier to allow for isolation in case of pier pipeline damage.
c. Allow for minimum slope toward free discharge to prevent liquid stagnation and freezing.
d. Evaluate need for freeze protection.
e. Use a minimum fluid velocity that will prevent settling of suspended solids and minimize emulsification of oils.
f. Provide cleanouts at junctions, directional changes, end of pipe run and every 400 ft (122 m).

g. Provide single wall piping unless double-walled pipe or secondary containment is required by local regulations. Check local regulatory agencies for requirements.

h. Provide thrust support for OWWO pipeline. Use Chapter 4 for thrust restraint requirements.

i. Provide pipe supports or hangers spaced at intervals suitable for supporting the OWWO pipeline. Use MSS SP-58-2018 or pipe manufacturer's requirements, whichever are more stringent.

j. Use materials and coatings capable of withstanding marine environment conditions.

16-4 IDENTIFICATION OF FLOWS.

Ship bilge daily flow varies with the class of ship, shipboard operations, and condition of the ship's mechanical equipment. The three measures of oily waste discharge flow are average (Q_{ave}), peak (Q_{peak}), and additional oily waste discharge from compensating fuel tanks (Q_{comp}). These flows are used in various combinations (depending on facility size) to estimate the total daily oily waste flow (Q_{daily}) from a pier. Q_{comp} is determined based on the fueling capability of the facility. If no fuel capability exists on the pier, then this quantity is zero. Fuel capability may be in the form of piping, trucks or barges. If fueling capability exists, then this quantity is equal to the maximum fueling rate for one day. Q_{daily} is used to estimate ship utility discharges and shoreside oily waste treatment plant capacity, operating costs, and operating schedule. The size of the pier facility depends on the historical usage rates and pier berthing plan. Use UFC 4-150-02 or contact the Government Project Manager for ship oily waste discharge capacities. Use the following subparagraphs to estimate flows.

16-4.1 Facility Daily Flow.

Determine the number and classes of ships present during maximum holiday berthing and average daily berthing. Determine if the activity is a "small" or "large" facility. Determine the number and classes of ships present during maximum holiday berthing and average daily berthing. Compute Q_{daily} for small facilities. Compute Q_{daily} and $Q_{maximum}$ for large facilities.

16-4.1.1 Small Facilities.

Use the following equation for pier facilities with fewer than 15 vessels:

$$Q_{daily} = Q_{comp} + \sum_{n=1}^{N} Q_{peak}$$

Where:

Q_{daily} = design daily flow for facility in gpd (L/day)
Q_{comp} = maximum fueling flow per day from shore to ships in gpd (L/day)
N = number of ships at piers during maximum holiday berthing or special peacetime exercise
Q_{peak} = peak daily flow from each ship in gpd (L/day)

16-4.1.2 Large Facilities.

Use the following equation for pier facilities with 15 or more vessels:

$$Q_{daily} = Q_{comp} + \left(1.33 * \sum_{n=1}^{M} Q_{average}\right)$$

Where:

Q_{daily} = design daily flow for facility in gpd (L/day)
Q_{comp} = maximum fueling flow per day from shore to ships in gpd (L/day)
M = number of ships at piers during maximum holiday berthing or special peacetime exercise
$Q_{average}$ = average daily flow from each ship in gpd (L/day)

16-4.1.3 Maximum Daily Flow.

Use the following equation to determine maximum daily flow ($Q_{maximum}$) using the maximum number of ships berthed during special exercises or holiday operations:

$$Q_{maximum} = Q_{comp} + \sum_{n=1}^{N} Q_{average}$$

Where:

$Q_{maximum}$ = maximum daily flow during holiday berthing in gpd (L/day)
Q_{comp} = maximum fueling flow per day from shore to ships in gpd (L/day)
N = number of ships at piers during maximum holiday berthing or special exercises
$Q_{average}$ = average daily flow from each ship in gpd (L/day)

16-4.2 Design Flow For Pier Oily Waste.

Use the following equation to determine size of main and laterals, and pump station capacity:

$$Q_{main} = 0.31 \sum_{i=1}^{S} (n_i)\,(q_i)$$

Where:

Q_{main} = design daily flow in gpd (L/day)
S = maximum number of ships at piers, use ship mix that produces largest daily flow including holiday berthing
q_i = discharge rate from each OWTP (assume one pump per riser) in gpd (L/day)
n_i = total number of OWTP connected to the main, lateral or pump station

16-5 GRAVITY FLOW COLLECTION SYSTEM.

Compute the diameter of mains and laterals using Q_{main} as shown in the following subparagraph. Use a minimum design velocity of 2 fps (0.6 m/s) during discharge operations for collection mains. Use a minimum design velocity of 5 fps (1.5 m/s) during discharge operations for collection mains. The design velocity should be in the range of 5 to 7 fps (1.5 to 2.1 m/s).Compute maximum design velocity to prevent scour. Use pipe manufacturer data to compute scour velocity. The minimum slope must be capable of maintaining a full flow velocity of 2 fps (0.6 m/s) using manning's formula and a manning's n value 0.013.

Use a minimum 6 inch (150 mm) pressure main with a minimum 4 inch (100 mm) pressure laterals to main. Facilities berthing only submarines or MSO ships may use 3 inch (75 mm) lateral. Space laterals and pier riser at 150 feet (46 m). This relatively close spacing facilitates flexible berthing configurations, mission change and flexibility. Hose riser assemblies are not needed at the end of piers unless specifically required by the activity. Use dual hose receivers to provide capability for nesting ships. Nesting may occur during major exercises, holidays and during periods when nearby berths are down because of damage or repair. Provide containment according to 33 CFR 154.530.

16-5.1 Design Flow For Pier Oily Waste.

Use the following equation to determine size of main and laterals, and pump station capacity:

$$Q_{main} = 0.31 \sum_{i=1}^{S} (n_i)\,(q_i)$$

Where:

Q_{main} = design daily flow in gpd (L/day)
S = maximum number of ships at piers, use ship mix that produces largest daily flow including holiday berthing
q_i = discharge rate from each OWTP (assume one pump per riser) in gpd (L/day)
n_i = total number of OWTP connected to the main, lateral or pump station

16-5.1.1 Head Loss.

Since the ship's OWTP feeds the gravity collection system, head loss must be evaluated. Compute head loss at each main and lateral intersection and verify the discharge pressure from each ship's OWTP exceeds the estimated head loss at each main and lateral intersection. Determine deck riser elevation, ship discharge pressure and berthing plan, including nesting, for each ship class berthed at pier. If a ship's discharge pressure does not exceed the computed head loss, additional computations must be performed. Typically head loss can be reduced by increasing the main diameter first and then increasing lateral diameter if head loss still needs to be reduced. Evaluate the gravity collection system characteristics that contribute to head loss such as length of main, length of lateral, elevation of pier riser assembly, elevation of ship's deck riser, hose length and fittings. Evaluate maximum hose length for nested ship berthing.

16-6 PRESSURIZED PIER COLLECTION SYSTEM.

Only use pumps when gravity collection systems are not hydraulically feasible. Slope pressurized systems to prevent fluid stagnation, freezing, and for cleaning purposes. The minimum slope should be capable of maintaining a full flow velocity of 2 fps (0.6 m/s) using meanings formula and a manning's n value 0.013. Design requirements for pump systems:

a. Locate pumps as close to oily wastewater source as possible to maximize detention time between pumping and treatment and minimize impact of mechanical emulsification. Equalization tanks may be used as an alternative approach. If equalization is employed, avoid detention times that would likely result in odor and gas production. Use vapor controls as required by applicable environmental regulations.

b. Use reciprocating positive displacement or screw pumps to transfer oily wastewater to treatment unit or equalization facility. Maximize size of wet well and select a number of pumps and an operating schedule to minimize surge effect of pump off-on cycle times. Consider adjustable speed drives on transfer pumps.

c. If rotary displacement or centrifugal pump is used, design for low speed (≤900 rpm) to minimize mechanical emulsification.

d. Maximize size of wet well and select the number of pumps and an operating schedule to minimize surge effect of pump off-on cycle on downstream oil-water separators.

e. Consider the use of a pump control valve and a surge tank with control orifice to throttle discharge to oil water separator. Consider adjustable speed drives on transfer pumps.

16-7 PUMP STATIONS.

Design pump stations to handle the cumulative Q_{main} for piers served assuming that individual pier main flows occur simultaneously. Design requirements for pump stations:

a. Provide a protective wet well liner or protective coating capable of resisting oil, grease, and saltwater.

b. Provide continuous ventilation with complete air changeover every 2 minutes.

c. Provide basket or bar type inlet screens on a pump inlet which can be removed and cleaned from the ground surface without requiring confined space entry.

d. Determine pump capacity and operating cycle for peak flows. Use positive displacement pumps with pressure relief valve, rather than centrifugal pumps, to reduce mechanical formation of emulsion at oily waste treatment plants. Pumps should pass solids having a diameter 0.125 inches (3 mm).

e. Provide controls suitable for Class I, Division 1, Group D safety classification. Use float or sonic type mechanisms, not air bubblers, for pump control and alarm. Provide discharge pump control valve to minimize surge effect on equalization basins at oily waste treatment plants (not applicable for positive displacement pumps). Provide an alarm system for overflow or power failure. Provide manual override of pump controls but not of low level alarms.

f. Provide an accumulating flow meter, elapsed time meter for pumps, pump suction and discharge pressure gages with oil-filled diaphragm, and cutoff valves to monitor station activity.

16-8 OILY WASTE TREATMENT.

OWWO may contain free, dispersed, emulsified ,or dissolved oil. Gravity type oil water separators can typically provide complete treatment for free oil. A single treatment process or commercial device will not typically remove emulsified and dissolved oils in oil water mixtures. A series of treatment process units is typically required to remove emulsified and dissolved oils. The degree of treatment required will be determined by the type of discharge, indirect or direct. For direct discharges, treatment requirements will also be identified in the NPDES permit. For indirect discharges, the POTW may identify additional treatment requirements. Sludge disposal requirements will be determined by the level of treatment provided and the characteristics of the sludge. Refer to EPA 800-R-11-007 for OWWO guidance.

Design oily waste treatment systems to operate on a 40-hour workweek with emergency response for alarms outside of normal work hours unless the activity, state or local have extended operational requirements. Treatment systems should be sized for the following flows.

16-8.1 Equalization.

Use an equalization basin to equalize peak flows and store oily wastewater flows prior to oil-water separation. Equalization systems can be concrete or steel tanks. Equalization systems should be covered or under a roof in a rainy climate or where wildlife is present.

16-8.2 Primary Treatment.

Primary treatment is required. The extent to which receiving waters or treatment works are impacted by effluent determines whether additional treatment is required.

16-8.2.1 Gravity Separation.

Bench testing should be performed to determine time required for optimum gravity separation. During treatment, free oil floats to the surface. Skimmers may be used to collect and remove oils on the surface. Settleable solids, also referred to as sludge, sink to the bottom and can scraped into a hopper for withdrawal, additional treatment or disposal. Provide multiple LET to allow for continuous (fill and drawoff) operation of the facility.

16-8.2.2 Load Equalization Tank.

A load equalization tank (LET) is a batch operated, gravity oil-water separator. Oily wastes are discharged to the LET for a predetermined collection period. Wastes are settled, the oil skimmed off to storage, and sludge withdrawn for further processing and disposal. Clarified water is passed on for additional treatment or discharge. Batch treatment in a LET is recommended for treatment of OWWO. When a treatment method other than a LET is used, the alternate treatment method must be able to meet or exceed all LET requirements.

16-8.2.2.1 Load Equalization Tank Sizing.

Method 1: Use actual flow data to the extent possible.

Method 2: Estimate the type and number of berthed ships discharging to the pierside collection system including the number of ship waste oily barges and discharge frequency. Use historical records to the extent possible.

Method 3: Use Q_{daily}, $Q_{maximum}$, and Q_{peak} established for design of pierside collection systems.

16-8.2.2.2 Load Equalization Tank Design.

LET design requires multiple tanks for normal operation of the gravity separation process. At larger Installations subject to periodic surges in ship berthing, the capability to process sudden, abnormally high oily waste flows may warrant extra reserve capacity. At smaller Installations where available land area imposes layout restrictions, a minimum of three reduced volume LET may be necessary to provide operating flexibility for normal peak flow occurrences and for tank cleaning downtime. When oily waste generated from shore facilities will be treated in addition to OWWO additional LET may be required. Oily waste generated from shore facilities will typically have different oily waste characteristics and need to be segregated from OWWO for treatment. Each tank should have a minimum capacity equal to the average flow for 7 days. Determine the total number of tanks required using the maximum flow with one tank out of service. Longer LET operating periods or large volume upstream receiving tanks should not be used since they promote anaerobic conditions and hydrogen sulfide gas production. Hydrogen sulfide gas will corrode metal and concrete, cause odor problems, and create potential health hazards when hydrogen sulfide concentration exceeds 10 ppm. Design requirements for LET:

a. To the extent possible, use aboveground LET to facilitate gravity flow to downstream processes or the discharge point.
b. Provide mechanical oil skimming equipment.
c. Provide a separate oil containment tank for the oily waste collected from the surface of the LET.
d. Provide a sludge hopper on the inlet side of the LET to facilitate sludge removal.
e. Slope LET to facilitate the transport of settled solids to the sludge hopper.
f. Provide mechanical sludge collection for sludge removal and processing.
g. Provide mechanical efficiency and simplicity appropriate for the characteristics of the OWWO and sludge being treated.
h. Identify sampling requirements and provide sample taps or ports to facilitate sampling. Locate sample taps or ports in locations that are easily accessible or provide additional access to sampling taps or ports.

i. Provide multiple potable or non-potable water supply discharge points to facilitate tank cleaning, foam control, and general housekeeping. Space water supply discharge points to facilitate cleaning all LET for all possible operational procedures. Do not exceed 100 feet of tank length between water supply discharge points. Provide backflow prevention when potable water supply is used.

16-8.2.2.3 Circular Tanks.

At smaller Installations, where LET of less than 15,000 gallons (56,781 liters) are required, circular steel LET may be more cost effective than a rectangular concrete LET. Evaluate local availability and cost of materials. A circular tank may allow for more efficient use of available ground for system layouts on smaller parcels of land.

16-8.3 Secondary Treatment.

Secondary treatment may be required for direct discharges or discharges to a POTW. Dissolved air flotation (DAF) is recommended for secondary treatment. A DAF unit will remove significant amounts of residual OWWO and emulsified oils. Typical effluent discharges from a DAF unit may be as low as 10 to 15 mg/L. It may be necessary to add coagulating and emulsion breaking chemicals to the DAF influent to optimize removal of contaminants. Bench testing should be performed to size the secondary treatment system and determine optimum coagulant dose.

16-8.4 Tertiary Treatment.

To provide consistent direct discharge quality effluent, tertiary treatment may be required for direct discharge depending on permit requirements. The recommended process is multimedia filtration with relatively fine graded media followed by carbon adsorption. In certain situations, primarily where flows are higher and space limitations prevent installation of a sufficient number or size of multimedia filters, coalescing filtration units may be considered. Coalescing filters are mechanically complex, but they perform reliably if operated and maintained properly.

16-8.5 Redundancy.

Provide redundancy for OWWO treatment. It is important to avoid the loss of a key unit operation during maintenance, scheduled or unscheduled, for any piece of equipment. Provide redundancy for individual processes such as downstream polishing treatment units, transfer pumping equipment, and effluent monitoring instrumentation required for continuous operation.

16-8.6 Discharge to Publicly Owned Treatment Works.

For free oil removal, effluent discharge requirements may be achieved by batch treatment gravity separation processes. The oily waste is discharged into a short-term storage or separation tank referred to as a load equalization tank (LET). The typical effluent from a LET contains less than 50 ppm of oil and grease. Discharges to a POTW must be coordinated with and approved by the POTW.

16-8.7 Direct Discharge.

Effluent discharge requirements for direct discharge are more stringent. Additional treatment is required to remove oils, such as free oil or emulsified oil, remaining after LET treatment. An NPDES permit would be required. Sulfide control and metals removal may also be necessary to meet effluent discharge requirements.

16-8.8 Emulsified Oil Treatment.

Unlike free oils, simple gravity settling is not effective for emulsified oils. Minimize the formation of chemical and physical oil emulsions. Avoid excessive turbulence such as pumping or turbulent flow and the use of detergents or emulsifying agents. Emulsions are usually complex, and bench or pilot plant testing is generally necessary to determine an effective method for emulsion breaking. Segregate emulsions or provide additional treatment for their removal from the waste stream. Use WEF MOP FD-3, Chapter 10 for emulsified oil treatment.

16-8.9 Hydrogen Sulfide Formation.

The presence of sulfides in oily wastewater is primarily due to biological reaction involving anaerobic bacteria that use hydrocarbons as their energy source and convert sulfates to sulfides. The pH of wastewater affects the distribution of sulfide species. If low pH oily wastewater is exposed to the atmosphere, hydrogen sulfide gas is released causing severe odors and corrosion problems. At alkaline pH, the sulfide species do not escape to the atmosphere. Exposure to small concentrations of hydrogen sulfide in the air is also a health hazard as it can affect the respiratory system.

The time gap between the generation and treatment and disposal of oily wastewater is a major factor for sulfide formation. During this time, oxygen is rapidly depleted causing a decrease in the ORP which favors the activity of sulfate reducing bacteria. This time should be kept at a minimum to limit sulfide production.

16-8.9.1 Control Techniques.

The principal physical and chemical methods for sulfite control at oily waste treatment plants include chemical oxidation, chemical precipitation, and wastewater aeration. Other techniques such as biological processes or adsorption have limited application due to cost and operational requirements of these processes.

16-8.10 Dissolved Metals Removal.

Oily wastewater may contain significant amounts of dissolved metals. The removal of dissolved metals may be necessary to meet comply with POTW requirements or direct discharge permit requirements. Metals such as iron, zinc, lead, copper, and nickel may be reduced to low levels by chemical precipitation.

16-8.10.1 Dissolved Metals Removal.

The removal of dissolved metals can typically be accomplished by raising the pH of the wastewater above 8 by using additives such as lime or sodium hydroxide. Most metals form highly insoluble precipitates at higher pH levels. The minimum solubility of different metals occur at different pH values. Therefore, a laboratory investigation is essential to determine the optimum pH level for removal of dissolved metals. For plants using sulfide control by chemical precipitation, additional treatment for metals removal may not be necessary. As alkaline solution is added for sulfide control, it will affect metals precipitation and metals will be co-precipitated as hydroxides and sulfides. The metal precipitates may be separated from wastewater in the oil-water separation equipment, such as DAF. For improved removal of these precipitates, addition of polyelectrolytes may be necessary. The laboratory investigation should be conducted to select the type and amount of polyelectrolyte for simultaneous suspended solids (metals precipitates) and emulsified oil removal from wastewater.

16-8.11 Sludge Disposal.

The characteristics of oily sludge are specific to the oily waste treatment facility and treatment process. Sludge may have toxic or hazardous characteristics. Evaluate the characteristics of the sludge to determine the appropriate method of disposal.

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APPENDIX A BEST PRACTICES

Appendix A provides design guidance.

A-1 WHOLE BUILDING DESIGN GUIDE.

The [Whole Building Design Guide](#) (WBDG) provides access to DoD criteria such as Unified Facilities Criteria (UFC), Unified Facilities Guide Specifications (UFGS), and for approved Government employees, access to non-government standards.

A-2 MATERIALS.

A-2.1 Rigid Conduit.

For concrete pipe use *Concrete Pipe Design Manual* for guidance. For ductile iron pipe use AWWA M41 for guidance. For cast iron soil pipe use *Cast Iron Soil Pipe and Fittings Handbook* for guidance.

A-2.2 Flexible Conduit.

For PVC pipe use the *Handbook of PVC Pipe Design and Construction* for guidance.

A-3 TRENCHLESS TECHNOLOGY.

Trenchless Technology Pipeline and Utility Design, Construction and Renewal and WEF MOP FD-6 provide guidance on trenchless renewal technology.

A-4 DOMESTIC WASTEWATER FLOWS.

Per capita rates should be determined using actual wastewater flow and load data, water usage rates or average daily per capita wastewater estimates for the specific facility type. For some facility types, it may be appropriate to use data from a similar facility type. When a similar facility type is used, differences in water conservation practices should be evaluated.

WEF MOP 8, Chapter 2, *Principals of Integrated Design* provides typical flowrates for commercial and institutional sources. Do not use these typical waste loading values for temporary host nation facilities.

A-4.1 Average Hourly Flow.

Example 1: 1,000 residents at 100 gal/cap/day (379 L/cap/day) will generate 100,000 gallons/day (379 m^3/day) in 24 hours for an average hourly flow rate of 4,167 gal/h (15.77 m^3/h).

Example 2: 1,000 nonresidents at 30 gal/cap/day (114 L/cap/day) will generate 30,000 gallons/day (114 m^3/day) in 8 hours for an average hourly flow rate of 3,750 gal/h (14.2 m^3/h). Note that the average daily flow is 30,000 gal/day (114 m^3/day), but the wastewater system must be designed to carry the 30,000 gallons (114 m3) in 8 hours not 24 hours.

A-5 WASTEWATER COLLECTION.

A-5.1 Pump Stations.

WEF FD-4 provides guidance for the design of wastewater pump stations.

A-5.2 Thrust Restraint for Force Mains.

Online thrust restraint calculators can assist in performing thrust restraint calculations. See EBAA IRON Restraint Length Calculator located at http://rcp.ebaa.com/ or DIPRA located at https://www.dipra.org/ductile-iron-pipe-resources/calculators/thrust-restraint-of-ductile-iron-pipe. Consider the bearing surface of the fitting when designing thrust blocks. Compact fittings reduce the bearing surface of the thrust block.

A-6 WASTEWATER TREATMENT FACILITIES.

A-6.1 Health and Safety.

WEF MOP 1 provides comprehensive guidance for health and safety at wastewater treatment facilities.

A-6.2 Security.

Water and Wastewater Systems Sector-Specific Plan, and Emergency Planning, Response and Recovery provide guidance for the protection of wastewater treatment facilities.

A-6.3 Operator Considerations.

Meetings with the wastewater treatment operator should held prior to development of the 35 percent design submittal. Operators can provide valuable input about problems with existing processes or operational lessons learned. Consider the experience and level of operator training when designing wastewater treatment systems.

A-6.4 Plant Location.

WEF MOP 8, Chapter 3, provides guidance for site selection.

A-6.4.1 Separation Distances.

Greater separation distances between occupied areas and the wastewater treatment facilities may be required to eliminate odors. Consider using greater separation distances when occupied areas are located on the leeward side of the wastewater treatment facilities, in areas subject to prolonged or frequent air stagnation, fog, or mist cover, at a lower elevations than the treatment works, or with surface and groundwater flow from the wastewater treatment facilities toward the occupied area.

A-6.5 Special Consideration for the Tropics and Semiarid Locations Outside of the United States.

Consider that brackish water may be used for washing, cooling, or cleaning; if it is allowed to enter the waste stream, the increased salinity will lower biological process efficiencies. Also, high dissolved solids concentrations have an effect on the treatment process efficiency. If gray water is separated from the waste stream and recycled or used directly for irrigation, washing, or cooling, wastewater flow will be low and much more concentrated. Loss of water by evaporation and from pipelines into the ground may further decrease flow to the POTW.

A-6.5.1 High-Temperature Parameters.

A major design parameter will be water temperature. Use of rooftop rain storage, cistern water, brackish water, and the ambient conditions will result in a very warm wastewater. The engineer should expect high salt content, including sulfate, chloride, phosphate, borate, and nitrate ions, and both alkali and alkaline earth cations. Oxygen levels will be very low and chalcogenides as well as dissolved hydrogen sulfide should be anticipated. The most dramatic effect of high temperature will be on biochemical reaction rates.

A-6.5.2 Unit Operations in the Tropics.

Although activated sludge, trickling filter, or rotating biological filter processes may be used in hot climates, strong sunlight and adequate space will make the use of wastewater treatment ponds advantageous. Temperature and sunlight intensity will control algal growth, which will be intense. The most useful type of pond will be the facultative pond. Pond retention time may be over 30 days; depth is typically between 5 and 10 ft (1.5 and 3.0 m).

For trickling filters and rotating biological disc filters, filter media volumes decrease proportional to temperature increases. Sludges dry much more rapidly in hot climates; but, in the humid tropics, covers may be required. Odor problems have been common in the sludges produced in hot climates, indicating that aerobic digestion or aerobic composting are potentially useful. Investigate anaerobic digestion and gas production because a hot climate encourages microbiological fermentation reactions.

A-6.6 Special Consideration for Cold and Arctic Locations Outside the United States.

Extreme low temperature is common: as low as -75° F (-59° C) in interior locations in northern Canada; below -100° F (-73° C) in Antarctica; and a month or more of subzero air temperature in the Arctic. Water, sewer, electric utilities, and steam lines are typically run in utilidors above ground to conserve their heat, allow for easy access, and conserve materials. Utilidors are kept insulated from the ground because the permafrost can be alternately melted and frozen if trenches are used.

A-6.6.1 Wind Protection.

Wind in the arctic zone produces a great heat loss problem, which is reflected in wind chill factors. Snow and wind loads on structures require careful consideration. Precipitation in northern climates is typically quite low, but the snow produces drifts and can cause severe problems in transportation and operation if the engineer fails to consider wind. Rotating biological equipment and other covered equipment should be well insulated, and designed to withstand thermal extremes, buffeting wind loads and wet spring snow.

A-6.6.2 Conservation Practices.

Because wastewater is transported above the ground surface or in well-insulated, well-constructed tunnels, fresh water use is almost the same as wastewater return. Design conditions can be expected to be about 300 ppm (300 mg/L) for BOD, BOD_5 at 60 to 80 gpd/cap (2.63 x 10-6 to 3.51 s 10-6 to 0.30 m^3/cap·s). Wastewater will typically be delivered to the facility at approximately 50° F (10° C).

A-6.6.3 Processes.

Chemical and biological processes are negatively affected by extreme cold. Chemical reaction rates are generally slower at low temperatures, and chemical solubilities are reduced. All chemical reactions, especially those involving partially soluble salts, should be recalculated to reflect the low solubility of chemicals in cold water. Each flocculent or deflocculant, each polymer, and each detergent or other organic chemical used should be tested for unanticipated interaction brought about by low temperatures.

The rates of biological reactions are also reduced greatly, which affects the sizing of biological treatment processes. The biological processes that have been used most successfully in cold climates include wastewater treatment ponds, either facultative or aerated; activated sludge with long solids retention times; and attached growth systems. Design biological processes such as lagoons and ponds to withstand the effect of ice and use submerged aeration systems. Attached growth systems such as trickling filters and RBCs should not be used unless they are adequately enclosed and protected from the cold. Suspended growth systems with short solids retention times such as conventional activated sludge should be avoided.

A-6.6.4 Modifications for Viscosity and Dissolved Oxygen Variations.

All operations where operation is viscosity dependent should be corrected for increased viscosity. This includes sedimentation tanks, filters, and wastewater treatment ponds. All processes that involve oxygen transfer will be aided by the increased solubility of oxygen at low temperatures; but, to overcome the deleterious effect of increased viscosity, more mixing may be required. An absorption process such as oxygen bubble-water transfer is enhanced by the lower temperature, but the lower viscosity reduces the rate of contact so that, overall, neither oxygen transfer nor absorption change in rate.

A-6.6.5 Insulation of Appurtenances.

Trash racks, bar screens, grit chambers, unit process tanks, biological reactors, aerators, gates, walkways, and instrumental sensing devices should be enclosed, covered, heated, insulated, redesigned to withstand icing and snowpack, or a combination.

A-6.7 Preliminary Treatment.

WEF MOP 8, Chapter 9, *Preliminary Treatment,* provides guidance for the design of preliminary treatment systems.

A-6.8 Primary Treatment.

WEF MOP 8, Chapter 10 *Primary Treatment,* provides guidance for the design of preliminary treatment systems.

A-6.9 Settling.

A-6.9.1 Primary Settling.

Table A-1 Best Practices for Primary Settling

Best Practices for Primary Settling					
Rectangular Tank	Minimum Length	Maximum Length	Minimum Width	Maximum Width	Maximum Depth
	50 ft (15 m)	300 ft (90 m)	10 ft (3 m)	80 ft (24m)	16 ft (4.9 m)
Circular Tank	Minimum Diameter	Maximum Diameter			Maximum Depth
	10 ft (3 m)	200 ft (60 m)			16 ft (4.9 m)
Best Practices for Secondary Settling					
Rectangular Tank	Minimum Length	Maximum Length	Minimum Width	Maximum Width	Maximum Depth
	100 ft (30 m)	200 ft (60 m)	20 ft (6 m)	33 ft (10m)	16 ft (4.9 m)
Circular Tank	Minimum Diameter	Maximum Diameter			Maximum Depth
	30 ft (9 m)	140 ft (43 m)			16 ft (4.9 m)

A-6.9.2 Surface Overflow Rates.

Table A-2 Surface Overflow Rates

Best Practices for Surface Overflow Rates				
	Design Average Flow		Design Peak Hourly Flow	
Primary Settling				
Tanks not receiving waste activated sludge	Minimum	Maximum	Minimum	Maximum
	800 gpd/ft^2 (33 m^3/m^2 d)	1000 gpd/ft^2 (41 m^3/m^2 d)	1000 gpd/ft^2 (41 m^3/m^2 d)	1500 gpd/ft^2 (61 m^3/m^2 d)
Tanks receiving waste activated sludge	550 gpd/ft^2 (22 m^3/m^2 d)	700 gpd/ft^2 (29 m^3/m^2 d)	800 gpd/ft^2 (33 m^3/m^2 d)	1200 gpd/ft^2 (49 m^3/m^2 d)

A-6.10 Biological Treatment.

A-6.10.1 Biofilms.

WEF MOP 8, Chapter 11 *Biofilm Reactor Technology and Design,* provides design guidance for biofilms and biofilm reactor systems.

A-6.10.2 Activated Sludge.

WEF MOP 8, Chapter 12: Suspended-Growth Treatment Processes, provides design guidance for aerobic activated sludge.

A-6.10.2.1 Solids Loading Rate.

The average solids loading rate is typically between 20 – 30 lb/d/ft^2 (98 – 146 kg/m2 d) and the peak solids loading rate is typically between 40 – 50 lb/d/ft^2 (195 – 244 kg/m2 d).

A-6.10.3 Integrated Biological Treatment

WEF MOP 8, Chapter 13: *Integrated Biological Treatment,* provides design guidance for fixed-biofilm treatment in series with suspended-growth treatment.

A-6.11 Support Systems for Wastewater Treatment Operations.

WEF MOP 8, Chapter 7 provide guidance on designing wastewater support systems such as instrumentation and control, chemical storage and chemical feed systems.

A-6.12 Advanced Wastewater Treatment.

WEF MOP 8 Chapter 14 *Physical and Chemical Processes for Advanced Wastewater Treatment* provides guidance for the design of advanced treatment systems. Advanced treatment systems include secondary effluent filtration, activated carbon adsorption, chemical treatment, membrane processes, air stripping, ammonia removal by breakpoint chlorination, and effluent reoxygenation.

A-6.13 Disinfection.

WEF MOP 8, Chapter 17 *Disinfection* provides guidance on disinfection design. Disinfection guidance includes chlorine disinfection, dichlorination, ultraviolet disinfection, ozone disinfection, and other disinfection methods.

A-7 SOLIDS PROCESS DESIGN AND MANAGEMENT.

Solids Process Design and Management provides guidance for processing sludge for disposal and sludge to biosolids.

A-8 NATURAL SYSTEMS.

WEF MOP 8, Chapter 16: *Natural Systems* and WEF MOP FD-16 provide design guidance for natural systems. Natural systems include infiltration, stabilization ponds, aquatic plants, and constructed wetlands.

A-8.1 Facultative Ponds.

A facultative pond is easy to maintain and has stable to flow and load variations. The facultative pond has low capital and operating costs. Organic loadings are generally much higher in summer than in winter. A facultative pond is applicable in climates where evaporative losses exceed the average annual rainfall. One disadvantage to facultative ponds is that they will require a larger amount of large land area to maintain area BOD_5 loadings in a suitable range.

A-8.2 Algae Control.

Algae present in pond effluent represents one of the most serious performance problems associated with facultative ponds. Refer to WEF MOP FD-16, Chapter 7, Section 22, for algae control.

A-8.3 Aerated Ponds.

The main advantage of aerated ponds compared with facultative lagoons is that they require less land area.

A-8.4 Aerobic Ponds.

Aerobic ponds, also referred to as high-rate aerobic ponds are not typically used and are typically limited to warm, sunny climates. The chief advantage of the high-rate aerobic pond is that it produces a stable effluent with low land and energy requirements and short detention times. Operation is more complex than for a facultative pond. Without an algae removal step d, the effluent will contain high suspended solids. Short detention times also mean that very little coliform die-off will result. Because of their shallow depths, these ponds need to paved or lined to prevent weed growth.

A-9 ON-SITE TREATMENT SYSTEMS.

A-9.1 Alternative Sewer Systems.

WEF MOP FD-12 provides design guidance for alternative sewer systems. Alternative sewer systems include pressure sewers systems, vacuum sewer systems, and effluent sewers.

A-10 BIOASSAY OF WASTEWATER.

Observed toxicity of effluent may be measured using bioassay procedures to determine the possible effects on the ecosystem of the receiving stream. Industrial process wastewater installations may contain toxic compounds that exhibit none of the generic pollutant parameters or cannot be disclosed for security reasons. Regulatory agencies may require bioassay monitoring of these effluents.

A-10.1 Standard Bioassay Procedures.

A bioassay measures the concentration of pollutant at which a designated percentage of selected test organisms exhibits an observable adverse effect. These require extensive equipment, time, and test procedures and do not provide a rapid assessment of effluent toxicity. The percentage is typically 50%, and the adverse effect is typically death or immobility. Concentrations (percent by volume) are expressed as LC50 for median lethal concentration and EC50 for median effective concentration.

- Test organisms—Effluent tests should be conducted with a sensitive species that is indigenous to the receiving water. The test organisms do not have to be taken from the receiving water. Refer to EPA 600/4-90-027F for a complete list of acceptable test organisms and temperatures.
- Methodology—refer to EPA 600/4-90-027F and S*tandard Methods for the Examination of Water and Wastewater* for a complete description of required test equipment, laboratory and test procedures, sampling and analytical procedures, procedures for data gathering and reporting, and methods for data reduction and analysis to determine LC50 or EC50.

Regulatory bioassay requirements and LC50 or EC50 are typically based on 48- or 96-hour tests using fish or invertebrates (e.g., minnows or Daphnia, respectively).

A-10.2 Rapid Bioassay Procedures.

In lieu of standard procedures investigate the use of rapid bioassay procedures (RBPs). RBPs are useful tools in effluent monitoring, providing inexpensive yet reliable toxicity data quickly. Check with state or local regulatory agency for approval of RBPs before developing a test program.

A-11 INDUSTRIAL WASTEWATER TREATMENT

A-11.1 Biological Systems.

Control toxic substances such as heavy metals and certain organic compounds present in some industrial wastes to avoid upset or pass-through of biological systems. Use WEF MOP FD-3 Chapter 5 Wastewater Treatability Assessments to examine the degree and methods of removal of pollutants, including organic pollutants. Conventional biological treatment systems can remove some organic compounds via biodegradation, volatilization (stripping) from aeration, and adsorption onto sludge, while others pass through. Actual removal performance depends on the operating characteristics (sludge age, mixed liquor suspended solids) of the treatment facility, the method of oxygenation, and the amount and nature of other compounds present in the wastewater. Refer to WEF MOP FD-3 Chapter 6 *Industrial Wastewater Characteristics and Approach* to Wastewater Management for appropriate treatment options.

A-11.2 Nutrients.

Evaluate nutrient levels for separate and combined industrial waste treatment systems. Maintain minimum amounts of nutrients required for efficient biological treatment. Normal proportions needed for active microbiological growth are typically about 1 lb (0.45 kg) of phosphorus (as P) and 5 lb (2.25 kg) of nitrogen (as N) for each 100 lb (45 kg) of BOD removed (requirements are somewhat lower for lightly loaded systems). Evaluate mixing industrial wastes with domestic wastewater to avoid the need for supplemental nutrients as wastewater contains excess amounts. Mixing domestic wastewater with industrial waste may also affect disinfection requirements and increase disposal of waste solids from treatment because of human waste components in the solids.

A-11.3 Source Separation.

Examples of industrial wastewater to be separated are precipitation treatment of copper and lead (incompatible because optimum pH of precipitation of each metal is not equal) and acid reduction of hexavalent chrome in the presence of cyanide (hazardous because it produces toxic hydrogen cyanide gas).

A-12 OIL-WATER SEPARATORS.

Gravity oil-water separators and enhanced gravity separators with coalescing media should not be used to treat emulsified or dissolved oil.

A-12.1 Types of Oily Waste.

Oil is one of the most common types and highly visible forms of water pollution. Even small quantities it can cause harm to the aquatic environment.

A-12.1.1 Free Oil.

Oil droplets with a diameter of 150 microns and larger.

A-12.1.2 Dispersed Oil.

Oil droplets with a diameter of 150 microns and larger.

A-12.1.3 Mechanically Emulsified Oil.

Oil droplets with a diameter of 150 microns and larger.

A-12.1.4 Chemically Emulsified Oil.

Oil droplets with a diameter of 150 microns and larger.

A-12.1.5 Dissolved Oil.

An oil-water mixture with oil in soluble form.

A-12.2 Field Investigation.

When possible, investigate existing operations and evaluate:

- Making process changes to reduce the amount of oily waste generated.
- Using spill prevention, control, and countermeasures such as minimizing leaks, avoiding spills, and using drip trays and dry absorbents to minimize the oily waste.
- The potential for toxic and hazardous materials in the waste stream.

A-12.3 Oily Waste Treatment.

The level of required treatment for oily wastewater depends on the method of discharge, POTW or direct discharge.

A-12.3.1 Discharge to POTW.

Effluent discharge limits to a POTW can range from 25 to 50 mg/l of oil and grease on the low end or as high as 100 mg/l to 200 mg/l of oil and grease for more efficient treatment works. Coordinate with the operator of the POTW to see what level of oily waste effluent they will be able to accept. Typical effluent quality requirements can be achieved by gravity oil-water separators.

A-12.3.2 Discharge to Navigable Water.

Effluent discharge limits for direct discharge depend on the water quality of the receiving water. Average oily waste effluent discharge limits typically range from 5 to 15 ppm (5 to 15 mg/l). Peak oily waste effluent discharge limits may be as high as 30 ppm (30 mg/l). Applicable permits, such as an NPDES permit, will need to obtained for direct discharges. As part of the permitting process, effluent limits for other types of contaminates such as pH and total suspended solids may also be required. Total suspended solids discharge limits are typically around 60 mg/l and pH discharge limits are typically a minimum of 6.0 to a maximum of 9.0.

Oily waste streams containing hazardous materials, metals, or other wastes with discharge should not be discharged to navigable waters without providing additional treatment.

A-12.4 Emulsions.

Minimize the formation of oil emulsions. Segregate emulsified oil for special treatment wherever possible.

A-12.4.1 Chemical Emulsions.

Using detergents increases emulsification and inhibits gravity oil-water separation.

A-12.4.2 Physical Emulsions.

Use of high-pressure water or centrifugal pumps cause emulsification of the oily waste. Physical emulsions are generally less detrimental to oil-water separation than the use of detergents.

A-12.5 Grit Removal.

Grit removal should be provided prior to entering the oil-water separator compartment for the removal of total suspended solids. When the suspended solids are minimal, the grit chamber may be included as the first oil-water separator compartment. For wastewaters with a high suspended solids concentration the design should include a separate grit chamber. A detention time of 5 minutes at the maximum rate of flow may be used to size the grit chamber. Settleable solids sink to the bottom of the chamber and will need to be removed and disposed of. Allow space for accumulated grit between for the expected grit removal maintenance cycle. Access should be provided for a truck with suction equipment to periodically remove grit.

A-12.6 Gravity Separators.

Gravity separators are used for the removal of free oil and in some cases dispersed oil. In gravity oil-water separators free oil floats to the surface where it can be separated from the clean effluent. Typical effluent depends on the flow rate through the oil-water separator and typically contains less than 50 ppm of oil and grease. Dispersed oil can be more difficult to remove as the micron size decreases. When removing dispersed oil the size of a gravity oil-water separator will need to need to be increased to improve the quality of the effluent. Using gravity separators to remove dispersed oil will typically require an oil-water separator that may be prohibitively large. Access should be provided for a truck with suction equipment to periodically remove the oil. Some gravity oil water separators are covered with steel grating that can be easily removed to provide access to the entire oil separation compartment.

A-12.7 Parallel Plate Separators.

Parallel plate coalescing media can enhance the performance of gravity separators and can typically remove the lower ranges of dispersed oil where gravity oil-water separators are ineffective or prohibitively large. The lower range of oil removal is typically in the range of 30 to 40 microns. Oil is removed by passing the wastewater at laminar velocity through the parallel plate coalescing media. Parallel plate coalescing media is inclined to aid in the removal of oil. Inclines typically range from 45 to 60 degrees. 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 typically recommended where the facility is committed to the additional maintenance procedures required to periodically remove and clean the parallel plate coalescing media. Access should be provided for removing the parallel plate coalescing media unit without the need for entering the oil-water separator or disassembling the parallel plate coalescing media unit.

Some manufactures are starting to provide additional post-separation treatment capable of removing oil not typically removed by parallel plate separators. These additional treatment processes should be evaluated based on compliance with discharge limits, maintenance requirements and the cost associated with purchasing material required for maintenance.

A-12.8 Maintenance.

Lack of proper maintenance is one of the biggest causes of oil-water separator failure. Design oil-water separators with accessible chambers for monitoring and maintenance.

A-12.9 Emulsified Oil Treatment.

Emulsions are typically complex, and bench or pilot facility testing is generally necessary to determine an effective method for emulsion breaking. Common emulsion-breaking (demulsification) methods are a combination of physical and chemical processes. The most common approach to removing emulsified oils from wastewater is by the use of chemicals. Chemicals commonly used include alum, ferrous sulfate, ferric sulfate, ferric chloride, sodium hydroxide, sulfuric acid, lime, and polymers. The effectiveness of various chemicals in breaking emulsions can be determined by laboratory testing. Refer to *Standard Methods for the Examination of Water and Wastewater* (Method 5520 Oil and Grease and Method 2540 Solids) for the testing procedure.

A-12.9.1 Destabilization.

Treatment of oil emulsions is typically directed toward destabilizing the dispersed oil droplets, causing them to coalesce and form free oil. A typical process 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.

A-12.10 Oil and Oily 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. Oil may be removed by suction or vacuum equipment. This equipment is sometimes referred to as a vacuum or truck and may also be used for cleaning catch basins.

Oils and oily sludges removed from the oil-water separator may be disposed of by sale by the Defense Logistics Agency, Disposition Service. Evaluate final disposal options with oil-water separation methods such as landfill, incineration or land disposal and associated environmental requirements to establish the most cost-effective total system. The sludge may require regulation as a toxic or hazardous waste if levels of pollutants exceed Resource Conservation and Recovery Act or state hazardous waste levels.

A-13 LOAD EQUALIZATION TANK SIZING.

Table A-3 Load Equalization Tanks

Sizing Guidance - 7 Day Capacity		
Let Volume	0.1 to 0.5 Mgal (379 to 1,893 m^3)	1.0 to 1.5 Mgal (3,785 to 5678 m^3)
Length to Width Ratio	3:1	5:1
Depth	10 ft (3.05 m)	20 ft (6.1 m)
Freeboard	1.5 ft (0.5 m)	1.5 ft (0.5 m)

A-14 BEST PRACTICE REFERENCES.

GOVERNMENT PUBLICATIONS:

Environmental Protection Agency:

EPA 550-B-13-002, *SPCC Guidance for Regional Inspectors*

EPA 600/4-90-027F, *Methods For Measuring The Acute Toxicity Of Effluents And Receiving Waters To Freshwater And Marine Organisms*

EPA 800-R-11-007, Oily Bilgewater Separators

EPA 810-B-18-001 *Earthquake Resilience Guide for Water and Wastewater Utilities*

EPA 833-B-11-001, *Introduction to the National Pretreatment Program*

EPA 833-K-10-001, *NPDES Permit Writers' Manual*

EPA 833-R-12-001A, *Industrial User Permitting Guidance Manual*

Department of Homeland Security:

Water and Wastewater Systems Sector-Specific Plan

NON-GOVERNMENT PUBLICATIONS:

AMERICAN PUBLIC HEALTH ASSOCIATION

https://www.apha.org/

Standard Methods for the Examination of Water and Wastewater, a joint publication with APHA, AWWA and WEF

AMERICAN WATER WORKS ASSOCIATION

AWWA M23, *PVC Pipe – Design and Installation*

AWWA M27, *External Corrosion for Infrastructure Sustainability*

AWWA M41, *Ductile Iron Pipe and Fittings*

AWWA M51, *Air Valves: Air Release, Air/Vacuum, And Combination*

AMERICAN CONCRETE PIPE ASSOCIATION

Concrete Pipe Design Manual

CAST IRON SOIL PIPE INSTITUTE

Cast Iron Soil Pipe and Fittings Handbook

Najafi, Mohammad, Ph. D, P.E.

Trenchless Technology Pipeline and Utility Design, Construction and Renewal

WATER ENVIRONMENT FEDERATION

Solids Process Design and Management, 2012

Emergency Planning, Response, and Recovery, 2013

WEF MOP 1, *Safety, Health, and Security in Wastewater Systems*

WEF MOP 8, *Design of Water Resource Recovery Facilities,* a joint publication with ASCE (ASCE Manuals and Reports on Engineering Practice No. 76), Sixth Edition

WEF MOP FD-4, *Design of Wastewater and Stormwater Pumping Stations, 1993*

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

WEF MOP FD-12, *Alternative Sewer Systems*

WEF MOP FD-16, Natural Systems for Wastewater Treatment, 3rd Edition

WEF MOP OM-7, *Operation of Extended Aeration Package Plants*

UNI-BELL PVC PIPE ASSOCIATION

INDUSTRIAL PRESS

Handbook of PVC Pipe Design and Construction, 5th Edition

APPENDIX B GLOSSARY

B-1 ACRONYMS.

AFCEC	Air Force Civil Engineering Center
AHJ	Authority Having Jurisdiction
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BEQ	Bachelor Enlisted Quarters
BIA	Bilateral Infrastructure Agreements
BOD	Biochemical Oxygen Demand
BOQ	Bachelor Officer Quarters
COD	Chemical Oxygen Demand
DAF	Dissolved Air Flotation
DoD	Department of Defense
DoR	Designer of Record
FGS	Final Governing Standards
HQUSACE	Headquarters, U.S. Army Corps of Engineers
HNFA	Host Nation Funded Construction Agreements
IPSDC	International Private Sewage Disposal Code
LET	Load Equalization Tank
NAVFAC	Naval Facilities Engineering Command
NPDES	National Pollution Discharge Elimination System
MOP	Manual of Practice
OEBGD	Overseas Environmental Baseline Guidance Document
OSHA	Occupational Safety and Health Administration
OWHT	Oily Waste Holding Tanks

OWTP	Oily Waste Transfer Pumps
OWWO	Oily waste and Waste Oil
O&G	Oil and Grease
POTW	Public Owned Treatment Works
RBC	Rotating Biological Contactors
RBP	Rapid Bioassay Procedures
RMF	Risk Management Framework
SBR	Sequencing Batch Reactor
SOFA	Status of Forces Agreements
TSS	Total Suspended Solids
UFC	Unified Facilities Criteria
UFGS	Unified Facilities Guide Specifications
U.S.	United States
VSS	Volatile Suspended Solids
WEF	Water Environment Federation
WET	Whole Effluent Toxicity
WOT	Waste Oil Tanks
WRRF	Water Resource and Recovery Facility

APPENDIX C REFERENCES

GOVERNMENT PUBLICATIONS:

CODE OF FEDERAL REGULATIONS

33 CFR 154.530 - *Small discharge containment*

40 CFR Subchapter N – *Effluent Guidelines and Standards*

40 CFR 112 - *Oil Pollution Prevention*

40 CFR 122 - *EPA Administered Permit Programs: The National Pollutant Discharge Elimination System*

40 CFR 136 – *Guidelines for Establishing Test Procedures for the Analysis of Pollutants*

40 CFR 257 - *Criteria for Classification of Solid Waste Disposal Facilities and Practices*

40 CFR 261 – *Identification and Listing of Hazardous Waste*

40 CFR 401.15 – *Toxic pollutants*

40 CFR 401.16 - *Conventional pollutants*

40 CFR 403 – *General Pretreatment Regulations for Existing and New Sources of Pollution*

40 CFR 423, Appendix A to Part 423 - 126 – *Priority Pollutants*

DEPARTMENT OF DEFENSE

DoD 4715.05-G, *Overseas Environmental Baseline Guidance Document*

DODINST 6055.01, *DoD Safety and Occupational Health (SOH) Program*

UNIFIED FACILITIES CRITERIA

http://dod.wbdg.org/

UFC 1-200-01*, DoD Building Code*

UFC 1-200-02, *High Performance and Sustainable Building Requirements*

FC 1-300-09N, *Navy and Marine Corp Design Procedures*

UFC 3-201-01, *Civil Engineering*

UFC 3-230-01, *Water Storage and Distribution*

UFC 3-240-03, *Operation and Maintenance (O&M): Wastewater Treatment*

UFC 3-301-01, *Structural Engineering*

UFC 3-420-01, *Plumbing Systems*

UFC 3-460-01, *Petroleum Fuel Facilities*

UFC 3-570-01, *Cathodic Protection*

UFC 3-600-01, *Fire Protection Engineering for Facilities*

UFC 4-010-06, *Cybersecurity of Facility Related Control Systems*

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

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

UFC 4-152-01, *Design: Piers And Wharves*

UFC 4-211-01, *Aircraft Maintenance Hangars*

NON-GOVERNMENT PUBLICATIONS:

AMERICAN SOCIETY OF CIVIL ENGINEERS

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

AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI Z358.1, *Standard for Emergency Eyewash and Shower Stations*

AMERICAN WATER WORKS ASSOCIATION

AWWA C150/ANSI A21.50, *Thickness Design of Ductile Iron Pipe*

DUCTILE IRON PIPE RESEARCH ASSOCIATION

DIPRA, *Thrust Restraint Design for Ductile Iron Pipe*, latest edition

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

10 State Standards, *Recommended Standards for Wastewater Facilities*, 2014

INTERNATIONAL CODE COUNCIL

IPSDC, *International Private Sewage Disposal Code*, (same version as International Plumbing Code as required by UFC 3-420-01)

Manufacturers Standardization Society of the Valve and Fittings Industry, Inc., 127 Park Street, NE, Vienna, Virginia 22180-4602

MSS SP-58-2018, Pipe Hangers and Supports, Materials, Design, Manufacture, Selection, Application, and Installation

WATER ENVIRONMENT FEDERATION

WEF MOP FD-3, *Industrial Wastewater Management, Treatment, and Disposal, third edition*