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Multiservice Oil/Water Separator Guidance Document

"Providing guidance to optimize oil/water separator operations and investments."

Developed by the DoD Clean Water Act Services Steering Committee

June 11, 1999

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14. ABSTRACT
In accomplishing its primary mission, the Department of Defense (DoD) generates oily wastewaters. Historically, oil/water separators have treated these wastewaters. In recent years, it has become obvious that many of the DoD separators are either, not required, or are not adequately treating the wastewater. Both of these situations utilize much-needed funds without significant environmental improvement.

The expenditure of funds without comparable benefits mandates that a change in philosophy be implemented. The revised DoD philosophy is to close all unnecessary separators, upgrade existing or install new systems as necessary to ensure regulatory compliance, and adequately operate and maintain existing systems.

This guidance document will provide the installation with the necessary tools to evaluate the regulatory compliance of the discharges; determine if a separator is necessary; and make appropriate decisions concerning the need to install, upgrade or replace a separator.

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Multiservice Oil/Water Separator Guidance Manual

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U.S. Army Environmental Center
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CHAPTER 1
INTRODUCTION

> This document is designed so that the user can go directly to appropriate chapters for relevant information without having to read the entire document.

In accomplishing its primary mission, the Department of Defense (DoD) generates oily wastewaters. Historically, oil/water separators have treated these wastewaters. In recent years, it has become obvious that many of the DoD separators are either, not required, or are not adequately treating the wastewater. Both of these situations utilize much-needed funds without significant environmental improvement. This approach has continued to the point that the military funding level for oil/water separator related actions has exceeded several hundred million dollars.

The expenditure of funds without comparable benefits mandates that a change in philosophy be implemented. The revised DoD philosophy is to close all unnecessary separators, upgrade existing or install new systems as necessary to ensure regulatory compliance, and adequately operate and maintain existing systems.

The primary causes for unnecessary or inadequate separators are:

- failure to institute aggressive pollution prevention at the oily wastewater source;
- a general misunderstanding of wastewater characteristics, permit/regulatory requirements, and the appropriate type of separator to treat a specific wastewater;
- inadequate operation and maintenance; and
- failure to reevaluate the source following a change in mission.

This guidance document will provide the installation with the necessary tools to evaluate the regulatory compliance of the discharges; determine if a separator is necessary; and make appropriate decisions concerning the need to install, upgrade or replace a separator. The document chapters are described below:

Chapter 2 - Regulations Governing Oil/Water Separators
This chapter focuses on federal, state and local environmental statutes and regulations that have the potential to impact the construction, operation, maintenance, or discharge of an oil/water separator.

Chapter 3 - Conducting an Oil/Water Separator Inventory
Procedures to develop an oil/water separator inventory are discussed. If the procedures are followed, the installation should have adequate information to begin making decisions concerning the existing separators, including potential problem areas, excess treatment capacity, maintenance requirements, and their upgrade/replacement/removal needs.

Chapter 4 - Oil/Water Separator Compliance Evaluation
A method is provided to determine the oil/water separator effectiveness. The quality of the raw and treated wastewater is discussed. Upon completion of the compliance evaluation, adequate information will be available to determine if the existing discharge requires treatment.

Chapter 5 - Oil/Water Separator Management Plan Guidance
The intent of the oil/water separator management plan is to provide the installation a guide to control and manage the oil/water separator systems. A format by which the installation may compile the generated information is provided.

Chapter 6 - Oily Wastewater Sources and Pollution Prevention Opportunities and Best Management Practices at the Shop Level
Chapter 6 describes the most common military sources of oily wastewater and runoff. The descriptions include the industrial operation, particular contaminants associated with the operation, and relevant pollution prevention activities.

Chapter 7 - What You Should Know Before Installing, Upgrading, or Replacing an Oil/Water Separator
This chapter discusses the methodology to evaluate existing or proposed oil/water separator needs. Emphasis is placed on the elimination of unnecessary systems and the consolidation of those wastewater sources that require separator treatment. Oil/water separator decision and design flow diagrams are provided.

Chapter 8 - Principles of Oil/Water Separation
Oil contained in wastewater may take multiple forms, which will affect separator design considerations. This chapter defines the various categories of oil that can be found in the wastewaters generated by the military and the design basis utilized to separate/remove the respective oil categories.

Chapter 9 - Types of Oil/water Separator Systems and Applications
Selection of the appropriate treatment process for oily wastewater is dependent on the oil category. Chapter 9 describes the various types of separators and the categories of oil removed by the respective systems. Relative costs and advantages/disadvantages of each system are provided.

Chapter 10 - Shop Level Cleaning Activities - Detergents/Cleaners and Solvents
The activities at military installations require that materials and equipment be cleaned periodically in concert with scheduled maintenance. The types of cleaning compounds and cleaning methods are described along with their impacts on separator operations. A cleaning process evaluation flow diagram is provided.

Chapter 11 - Operation, Maintenance, and Inspection Guidance
Information is provided to help the installation establish and conduct an operation and maintenance program. Details are provided for gravity oil/water separators concerning

grounds maintenance; oil and solids monitoring, removal and disposal/reuse; and major component maintenance/inspection guidance.

Chapter 12 - Closure of Oil/Water Separators
This chapter provides general guidance on the closure of oil/water separators. Only "clean closure" is addressed. Information on closure procedures, permitting, and documentation is provided.

Chapter 13 - Grease Traps
General information is provided on sources of grease; pollution prevention; and grease trap design, operation, maintenance, and closure.

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CHAPTER 2
REGULATIONS GOVERNING OIL/WATER SEPARATORS

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CHAPTER 2
REGULATIONS GOVERNING OIL/WATER SEPARATORS

It is imperative that the installation contact state and local governments concerning their approach to the laws and regulations discussed below, before any actions are undertaken.

NOTE: Contact with state or local regulators should be coordinated through the installation environmental office.

2.1 FEDERAL, STATE, AND LOCAL REGULATIONS

This section focuses on federal, state and local environmental statutes and regulations that have the potential to impact the construction, operation, maintenance, or discharge of an oil/water separator. Federal legislation that are of primary interest include the Clean Water Act (CWA), the Oil Pollution Act (OPA), the Federal Facility Compliance Act (FFCA), the Resource Conservation and Recovery Act (RCRA), the Safe Drinking Water Act (SDWA) and the Solid Waste Disposal Act (SWDA).

Table 2-1 lists various activities or conditions associated with oil/water separators and potentially relevant rules/regulations. Permits are addressed in **Section 3.1.13**.

Table 2-1 - Oil/Water Separators and Associated Regulations

ACTIVITY OR CONDITION	DESCRIPTION OF POTENTIALLY APPLICABLE RULES/REGULATIONS
Underground Oil/Water Separator	State - RCRA - UST requirements (potential, based on State interpretation).
Treated Wastewater Discharge to:	
• *POTW*	Federal - CWA - Pretreatment requirements; Local - Sewer Use Ordinance/permits.
• *FOTW*	Federal - CWA - Pretreatment or effluent requirements, and FFCA (SWDA) - Sewer use exclusion; Local - FOTW requirements.
• *Waters of the U.S.*	Federal - CWA - NPDES or storm water (if runoff, only) permit; or State - CWA - SPDES permit; or State and Federal permits for non-delegated states.
• *Drainfield, leachfield, dry well*	Federal/State - SDWA - UIC permit and wellhead protection; and State/Local - Other applicable permits. NOTE: Any discharges to the groundwater by separators should be eliminated.
• *Land application or unlined, non-discharging pond*	State/local permit(s).
"Used Oil" Holding Tanks	
• *Underground*	Federal/State - RCRA - UST requirements (potential, based on State UST regulation interpretation).
• *Aboveground*	Federal/State - CWA - Spill Prevention Control and Countermeasure (SPCC) Plan modification (potential).
"Used Oil"	

• *Hazardous Fuel (> 1,000 ppm, total halogens)*	Federal - RCRA and some "Used Oil" requirements.
• *Energy Recovery -"Used oil"* *"on-specification"* *"off-specification"*	 Federal - "Used Oil" - exempted from most regulations; Federal - "Used Oil" regulations.
• *Not used for energy recovery*	Federal - "Used Oil" regulations.
• *Dust suppressant*	Federal - "Used Oil" - prohibited, except when the activity takes place in a state listed in 40 CFR 279.82. NOTE: "Used oil" as a dust suppressant is prohibited.
Solids (Hazardous)	Federal - RCRA.
Solids (Non-hazardous) Disposal to:	
• *Landfill*	Federal - SWDA - Non-hazardous, non-PCB, and non-liquid; State/Local - Additional restrictions (potential) including total petroleum hydrocarbon limitations.
• *Land Application*	Federal - SWDA - Solids quality and site operational controls; State/Local - permits and other requirements.
Leaking Oil/Water Separator	Federal - SDWA - (potential UIC, Class V well); State/Local - Handled by State programs dealing with oil management and/or groundwater quality protection.
• *Installation does not have a RCRA part B permit*	Federal - The leaking separator is not considered a Solid Waste Management Unit (SWMU).
• *Installation has a RCRA part B permit*	Federal - The leaking separator may be considered a SWMU, following evaluation by EPA or delegated State.

Each of the major acts that may impact an oil/water separator system are discussed below:

2.1.1 Clean Water Act

The CWA may regulate an oil/water separator system under the following conditions:

- the discharge of treated industrial wastewater to a publicly owned treatment works (POTW), federally owned treatment works (FOTW), or waters of the United States (including storm sewers);
- the discharge of treated runoff to waters of the United States; or
- an aboveground "used oil" holding tank.

The main focus of the CWA related to oil/water separators deals with the discharge of treated industrial wastewater. If the separator discharges to waters of the U.S., the discharge will be issued an individual National/State Pollutant Discharge Elimination System (NPDES/SPDES) permit or a specific outfall number under a broader NPDES/SPDES permit. The discharge could be regulated by a permit issued by EPA, the State, or both (if the state has not been delegated the NPDES program). The discharge of treated runoff may be controlled by a storm water permit.

If the separator discharges to a POTW, EPA's general pretreatment regulations, categorical industry pretreatment regulations, and/or a local sewer use ordinance (developed by the POTW) may govern the discharge. The CWA contains specific provisions (General Pretreatment Regulations - Section 403.5(b)) that may be applicable to oily discharges to domestic wastewater systems. These provisions prohibit the discharge of pollutants that:

- cause interference or pass through a treatment works; (This includes petroleum oil, non-biodegradable cutting oil, or products of mineral oil origin, in concentrations that will cause interference or pass through; or that will cause the receiving treatment works to exceed effluent limitations.)
- create a fire or explosive hazard in the sewerage system; or
- result in the presence of toxic gases, vapors, or fumes within the sewerage system that may cause acute worker health and safety problems.

Discharges to an FOTW may be regulated by EPA's categorical industry effluent limitations or under conditions listed within the FOTW's NPDES permit. FOTW pretreatment programs could be affected by the Federal Facility Compliance Act **(Section 2.1.4)**.

Federal, state, and some local regulations have established standards for the discharge of wastewaters containing oily residues. These standards vary from finite quantities stated in milligrams per liter (mg/L) or pounds per day to qualitative standards requiring that the wastewater have no visible sheen. Although these standards, and the analytical methodology on which they are based, differ, their intent is clear: to control the discharge of oil residues into the environment. The effluent parameters that may be regulated for an oil/water separator include, but are not limited to: oil and grease (or total petroleum hydrocarbons), total suspended solids, and pH.

The effluent quality requirements for discharge to waters of the U.S. are listed in the NPDES/SPDES permit. Effluent quality requirements for discharge to POTWs are determined by local and municipal authorities and, therefore, may vary. A range of typical effluent quality requirements encountered (actual state or local limits may vary), are as follows (DoD, 1988):

	Discharge to	
Parameter	Waters of the U.S.	POTW/FOTW
Oil and Grease, mg/L	10	50 - 100
Total Suspended Solids, mg/L	15	100 - 500
pH, S.U.	6 - 9	6 - 9

Discharges from separators treating only runoff as a best management practice may only have general maintenance requirements.

"Used oil" aboveground holding tanks serving a separator may be regulated by SPCC requirements. If the installation has an existing SPCC plan, any new aboveground tanks must be incorporated into the plan. If the installation is not currently required to have an SPCC plan, the applicability of the SPCC requirements will be dependent upon the tank's storage capacity and proximity to waters of the United States.

Table 2-2 - Oil/Water Separators and the Clean Water Act

SECT.	DESCRIPTION OF CLEAN WATER ACT SECTION (AF, 1994)	REGULATIONS
301	Prohibits the discharge of pollutants into the waters of the United States.	
303	**Water Quality Standards** and Implementation Plans, requires the development of water quality standards to protect bodies of water.	40 CFR 130 and 131.
306	**Categorical Effluent Limits**. National Standards of Performance, requires effluent and pretreatment standards for specific categories of industries.	40 CFR 405 through 471
307	**Toxic and Pretreatment Effluent Standards**, requires limits on toxic pollutants.	40 CFR 129 and 403
311	**Oil Pollution Prevention** establishes requirements for preventing discharge of oil and other hazardous substances and requires certain actions following spills. The implementing regulations require the development of Spill Prevention Control and Countermeasure Plans; establish actions required in the event of a spill; designate hazardous substances; specify reportable quantities; and provide reporting procedures.	40 CFR 110, 112, 116, and 117
313	**Federal Facilities Pollution Control** requires Federal facilities to comply with all Federal, state, interstate and local water pollution requirements in the same manner as nongovernmental entities. The President may issue regulations exempting equipment or other property of the Armed Forces that is uniquely military in nature.	
402	**National Pollutant Discharge Elimination System** requires permits to discharge point source wastewater and some storm waters. NPDES storm water permits require preparation of and compliance with the Storm Water Pollution Prevention Plan.	40 CFR 122, 125, and 402
307, 204, 208, 301, 304, and 309	**Pretreatment Standards**. Some pollutant discharges interfere with the operation of Publicly Owned Treatment Works. These standards prohibit the discharge of certain pollutants and require the pretreatment to remove other pollutants.	40 CFR 403
	Oil Pollution Act of 1990 amended the CWA to expand oil spill prevention activities, improve preparedness and response capabilities, and ensure that companies are responsible for damages from spills.	40 CFR 110 and 112
	Federal Facility Compliance Act did not amend the CWA, but this 1992 amendment of Subtitle C of the Solid Waste Disposal Act, conditionally excludes the discharge of certain wastes to FOTWs from the definition of solid waste (sewer use exclusion).	None

2.1.2 Oil Pollution Act of 1990

The CWA prohibits spills, leaks or other discharges of oil or hazardous substances into waters of the United States in quantities that may be harmful. The Oil Pollution Act of 1990 amended the CWA to expand oil spill prevention activities, improve preparedness and response capabilities, and ensure that companies are responsible for damages from spills (CNO, 1996).

The OPA establishes liability for removal costs and damages for those parties responsible for a vessel or facility from which oil is discharged, or which poses the substantial threat of discharge of oil, into or upon waters of the U.S. or adjoining shorelines or the exclusive economic zone. Regulations implementing portions of the OPA which could affect oil/water separators include 40 CFR Part 110, "Discharge of Oil," and Part 112, "Oil Pollution Prevention." Part 112 establishes requirements for the preparation and implementation of Spill Prevention Control and Countermeasure plans (AF, 1996).

> The SPCC plan should be amended when oil/water separators with aboveground "used oil" holding tanks are constructed.

2.1.3 Safe Drinking Water Act

The SDWA requires EPA to set national primary drinking water regulations and provides for the direct control of underground injection of fluids that could potentially affect groundwater supplies. The SDWA implementing regulations are contained in 40 CFR 141-149.

2.1.3.1 Underground Injection Control

Part C of the SDWA regulates underground injection. Regulated operations could include injection wells, infiltration basins, and common septic systems serving multiple housing units or large remote buildings. States usually assume the predominant role in executing groundwater protection programs. The EPA has direct responsibility only if a State chooses not to participate in the underground injection control program.

There are several definitions in the Underground Injection Control (UIC) regulations that may relate to an oil/water separator. An injection well is a “bored, drilled, or driven shaft or a dug hole, whose depth is greater than the largest surface area dimension” into which “fluids” are being injected. The concept that the depth is greater than the width is very significant and should always be considered when dealing with applicability of the regulations.

> USTs, underground piping, etc. are not considered injection wells.

The second definition in the regulations deals with the Class of the “injection well.” The five classifications of injection wells are contained in 40 CFR 146.5. Any releases of treated or untreated wastewater from the oil/water separator, that would be conveyed to the groundwater via a “well” would fall under a Class V well category.

Table 2-3 - Classification of Injection Wells

CLASSIFICATION	GENERAL DESCRIPTION
I	Wells used to inject hazardous, industrial, or municipal waste below the lower most formation containing, within 0.25 mile, an underground source of drinking water.
II	Wells which inject fluids associated with oil or natural gas production.
III	Wells which inject for extraction of minerals.
IV	Wells used to inject hazardous or radioactive waste into or above a formation containing, within 0.25 mile, an underground source of drinking water.
V	Wells not included in classes I - IV.

Examples of potential Class V injection well scenarios associated with oil/water separators were posed to EPA and several states. It should be noted that regulations and their interpretations may vary from state-to-state. The examples and conclusions are listed below:

- Oil/water separator effluent to a drainfield, leachfield, or dry well;
  (Class V injection well)
- Oil/water separator effluent to an unlined pond, if the pond is not deeper than it is wide;
  (Not an injection well)
- Leaking oil/water separator.
  (*Class V injection well.* EPA Region III stated that regulatory interpretations are not clear cut and final decisions rely on how quickly the owner corrects the problem after it was discovered.)

The UIC regulations (40 CFR 144-147) are generic in nature. EPA is in the process of proposing amendments to these regulations. The proposed amendments will require States having an approved program to adopt regulations at least as stringent as those promulgated by EPA.

Installations should review their current situations related to oil/water separators and, if necessary, obtain permits under the Federal UIC Program (40 CFR 144) and/or applicable state programs for subsurface wastewater discharges.

> Any discharges to the groundwater by separators via a drainfield, leachfield or dry well, should be eliminated.

2.1.3.2 Wellhead Protection Program

Oil/water separators may be impacted by Section 1428 of the SDWA, "State Programs to Establish Wellhead Protection Areas." As is inferred in the title, wellhead protection is a state, not federal, program. Each state is charged with the development of a program to protect wellhead areas from contaminants that may have an adverse effect on human health. The separator would be impacted only if it is within a State that has implemented an approved wellhead protection program and is physically located within a delineated protection area.

Table 2-4 - Oil/Water Separators and the Safe Drinking Water Act

DESCRIPTION OF RELEVANT SAFE DRINKING WATER ACT SECTIONS	REGULATIONS
Federal Underground Injection Control Program	40 CFR 144 - 147
Injection Well Criteria	40 CFR 146
Wellhead Protection (Section 1428 of the SDWA)	None (State specific)

2.1.4 Federal Facility Compliance Act

Section 108 of the Federal Facility Compliance Act amended Subtitle C of the Solid Waste Disposal Act and conditionally excluded the discharge of certain wastes to FOTWs from the definition of solid waste (sewer use exclusion). This exclusion, in essence, relieves the FOTW industrial users from managing these certain wastes as hazardous. This exclusion is based on the affected discharge maintaining compliance with existing or proposed relevant pretreatment standards.

Certain regulatory and statutory requirements are inferred or directly applicable to these discharges. The requirements directly listed in the FFCA are that the FOTW be owned and operated by the Federal government, primarily treat domestic sewage, and have a discharge permit (National or State Pollutant Discharge Elimination System) issued under section 402 of the CWA. The exclusion applies to liquid wastes introduced into an FOTW if one of the following four conditions are met:

1. such solid or dissolved material is subject to a pretreatment standard under section 307 of the Federal Water Pollution Control Act, and the source is in compliance with such standard;

2. for a solid or dissolved material for which a pretreatment standard has not been promulgated pursuant to section 307 of the Federal Water Pollution Control Act, the Administrator has promulgated a schedule for establishing such a pretreatment standard which would be applicable to such solid or dissolved material not later than 7 years after the date of enactment of this section, such standard is promulgated on or before the date established in the schedule, and after the effective date of such standard the source is in compliance with such standard;

3. such solid or dissolved material is not covered by paragraph (1) or (2) and is not prohibited from land disposal under subsections (d), (e), (f), or (g) of section 3004 because such material has been treated in accordance with section 3004(m); or

4. not withstanding paragraphs (1), (2), or (3), such solid or dissolved material is generated by a household or person which generates less than 100 kilograms of hazardous waste per month unless such solid or dissolved material would otherwise be acutely hazardous waste and

> subject to standards, regulations, or other requirements under this Act notwithstanding the quantity generated.

EPA has developed no implementing regulations for the FFCA. The interpretation and applicability of the FFCA to military operations have therefore not been clearly defined. It should also be noted that the 7-year period for the development of pretreatment standards, listed in paragraph 2 above, has expired.

2.1.5 Solid Waste Disposal Act

The SWDA, other than its RCRA provisions, regulates the disposal of solids from oil/water separators. The operating criteria (40 CFR 258.20) for municipal landfills contain restrictions on materials that may be placed in the landfill including regulated hazardous waste, polychlorinated biphenyl (PCB) waste (40 CFR 761), and “free liquids” (40 CFR 258.28).

> A PCB waste, according to federal regulations, is a substance that has a dry-weight PCB concentration greater than 50 mg/kg. State and local concentrations may be lower.

If the solids from the oil/water separator are to be land applied, the material and operational practices must comply with “Criteria for Classification of Solid Waste Disposal Facilities and Practices” (40 CFR 257).

2.1.6 Resource Conservation and Recovery Act

RCRA, Subtitle C, "Hazardous Waste Management," establishes the requirements to regulate and control the generation, treatment, storage, transportation, and disposal of solid and hazardous wastes. RCRA also establishes requirements to regulate underground storage tanks containing certain substances, including oil and hazardous wastes.

> RCRA can have serious impacts on oil/water separators.

If the influent wastewater, "used oil," or solids is hazardous, the following may apply:

- Oil/water separators may constitute hazardous waste treatment which requires a RCRA Treatment, Storage or Disposal Facility (TSDF) permit (DA USACE, 1994);
- Oil holding may be prohibited under RCRA unless the military installation is permitted under RCRA as a TSDF (DA USACE, 1994); and
- A leaking oil/water separator may result in designation as a solid waste management unit **(Section 2.1.6.2)** (DoD, 1997e).

The following question was posed to EPA, Headquarters and Region III, and two States, Virginia and Maryland:

> If the solids are found to be a characteristic hazardous waste and a facility adds a material to the oil/water separator to eliminate the characteristic, is this considered treatment and therefore requires a Part B permit?

The general consensus was that if the facility does not currently have a Part B, is not a TSDF, and has a discharge permit issued under the CWA, this action would not be considered treatment.

EPA Region III added that if a facility did have a Part B, the action could be considered treatment. One state considered the action as treatment, while the second did not. (See **Section 11.5.5.2**)

The Missouri Department of Natural Resources was contacted by ProAct (Air Force) concerning the “treatment” of separator solids, and stated if the material is added to solids that (Lehman, 1996):

- contain listed hazardous wastes, the procedure would be considered treatment and would require a permit; or
- contain a characteristic hazardous waste (toxicity, ignitability, corrosivity, and reactivity), and the process results in the solids no longer being characteristically hazardous, the procedure would not need to be permitted.

2.1.6.1 Underground Storage Tanks

Federal Underground Storage Tank (UST) regulations (40 CFR 280) exempt some underground oil/water separators from being defined as a UST. This exemption applies to separators (treatment tanks) that are regulated under Section 402 (NPDES) or 307(b) (pretreatment) of the CWA. The exemption may not apply to separate "used oil" holding **(Section 9.2.3.3)** tanks. Non-exempt "used oil" tanks may be required to meet specific design standards.

The states apply varying interpretations of the UST regulations to the oil/water separator and any associated "used oil" tank. Underground oil/water separators and/or their holding tanks may be regulated USTs due to the oil contained in the holding reservoirs or tanks. This can impose stringent controls, management and reporting requirements under Title 40 CFR Part 280, "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)," and includes physical requirements such as double walls or linings, leak detection devices, and monitoring wells.

> Some states do not regulate "used oil" holding tanks if the capacity is less than 110 gallons or if it contains a *de minimis* amount of product, less than 1 inch, at any time.
> It is important to check with your state regulators concerning this issue.
>
> Installations should also consult their DoD Regional Environmental Coordinator (REC) for advice on separator UST compliance. The REC can provide policy guidance, lessons learned, and regional regulatory perspectives.

2.1.6.2 Solid Waste Management Unit

A leaking oil/water separator containing hazardous wastes may be designated a solid waste management unit (SWMU) and be subject to corrective actions under RCRA regulations found in Title 40 CFR 264.90 (Subpart F, "Releases from Solid Waste Management Units"). SWMU corrective actions generate numerous investigative and potential cleanup requirements, not to mention possible notices of violation (NOV) (AF, 1996).

Two states and EPA, Headquarters and Region III, were contacted concerning the SWMU issue. Both states indicated that the release would be handled as an oil management or groundwater quality issue, not as a SWMU. EPA stated that a facility cannot have a SWMU unless it has a Part B permit. If the installation has a Part B permit for the treatment, storage, and disposal of hazardous waste then the separator ***could*** be considered a SWMU. The unit would then be subject to investigation by the issuing authority and a determination would be made at that time.

2.1.6.3 "Used Oil"

The oil removed by a separator is considered "used oil." Under current EPA regulations "used oil" falls into one of three categories: on- and off-specification "used oil," and hazardous waste fuel **(Figure 11-1)**.

Hazardous Waste Fuel

If the "used oil" contains more than 1,000 ppm total halogens, EPA considers the oil a hazardous waste. This oil is subject to all hazardous waste regulations, including the burning of hazardous waste as fuel.

> It is important to note that "used oil" is typically considered hazardous if it contains over 1,000 ppm total halogens (40 CFR 279.11).
>
> State and local requirements may be more stringent and include additional regulated parameters.

"Used Oil"

If the oil contains less than 1,000 ppm total halogens, the oil is regulated under 40 CFR 279 (Standards for Managing Used Oil). Further clarification concerning the status of the "used oil" (on- or off-specification) is determined based on additional analysis **(Section 11.4.3.2)**.

On-Specification "used oil" must meet all allowable levels based on the analytical results. If on-specification "used oil" is to be burned for energy recovery, it can be exempted from many of the requirements contained in 40 CFR 279. If on-specification "used oil" is reused or disposed of (not used for energy recovery), it must meet all requirements of 40 CFR 279.

Off-specification "used oil" must meet all requirements of 40 CFR 279 no matter how the material is to be used (energy recovery, reuse, or disposal).

> "Used oil" as a dust suppressant is prohibited by DoD.

2.1.6.4   Solids

The solids from an oil/water separator may be hazardous if it exhibits a characteristic of ignitability, corrosivity, reactivity, and/or toxicity (40 CFR 261.20-261.24). Determining the toxicity characteristic involves testing the solids by the Toxicity Characteristic Leachate Procedure (TCLP) for metals (40 CFR 261 Appendix II), pesticides and solvents. Furthermore these solids may be hazardous if they are listed (F, K, P, U) according to 40 CFR 261.30-261.33, or if they are a mixture containing listed waste (DA USACE, 1994).

Table 2-5 - Oil/Water Separators and the Solid Waste Disposal Act

DESCRIPTION OF SOLID WASTE DISPOSAL ACT SECTIONS	REGULATIONS
Criteria for Classification of Solid Waste Disposal Facilities and Practices (land application)	40 CFR 257
Municipal Landfill Operating Criteria	40 CFR 258.20
PCB Waste	40 CFR 761
Resource Conservation and Recovery Act (RCRA)	40 CFR 260 - 268
Characteristic Hazardous Waste	40 CFR 261.20-261.24
Listed Hazardous Waste	40 CFR 261.30-261.33
Releases from Solid Waste Management Units	40 CFR 264.90
Standards for Managing Used Oil	40 CFR 279
Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)	40 CFR 280
Federal Facility Compliance Act amended Subtitle C of the Solid Waste Disposal Act, which conditionally excludes the discharge of certain wastes to FOTWs from the definition of solid waste (sewer use exclusion).	None

2.1.7 Air Pollution Requirements

No federal regulations currently exist that require oil/water separators to be covered or have off-gas treatment for volatile organic compounds (See **Section 2.1.10.6** concerning state/local regulations) (DA USACE, 1994).

2.1.8 Pollution Prevention Act

The Pollution Prevention Act of 1990 (PPA) makes pollution prevention the national policy of the United States. The goals of the PPA are that "pollution should be prevented or reduced whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible; and disposal or release into the environment should be employed only as a last resort." In other words, source reduction is the preferred choice, where source reduction is defined as reducing the amount of a pollutant that enters a waste stream or that is otherwise released into the environment prior to out-of-process recycling, treatment, or disposal (DoD, 1998).

2.1.9 Occupational Safety and Health Administration
OSHA Standards for Process Safety Management of Highly Hazardous Chemicals, 29 CFR 1910.119, implements requirements for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. The standard provides guidance on implementation of required programs in the event of accidental release, and requires that adequate information be gathered for highly hazardous chemicals and that appropriate process safety management programs are in place (DoD, 1998). One of the primary impacts of OSHA on the operation of oil/water separators would be associated with confined space entry (29 CFR 1910.146) for cleaning the equipment.

2.1.10 State and Local Requirements
Not only do the state and local regulators have the option of applying standards more stringent than the Federal requirements, they may also have regulatory interpretations of existing requirements substantially different than EPA.

> It is imperative that the installation contact state and local governments concerning their approach to the laws and regulations discussed above, before any actions are undertaken.

2.1.10.1 Publicly and Federally Owned Treatment Works
Many POTW/FOTW sewer use ordinances prohibit the discharge of oil and grease in concentrations that could: cause the material to accumulate in collection system piping and obstruct flow; adversely affect or pass-through the treatment system; or accumulate in the solids of treatment works. Wastewaters may be required to meet pollutant limits based on EPA general or categorical pretreatment standards or limits assigned by the POTW/FOTW. The POTW/FOTW may or may not require monitoring of the indirect discharge.

2.1.10.2 Landfills
Under most circumstances the solids removed from the separator **(Section 11.5.6.2)** will be disposed of in a landfill. The state may have additional requirements on materials placed in a landfill that are not contained in the federal regulations. For example, some states will limit the total petroleum hydrocarbon concentration of soils that are placed in a municipal landfill. The landfill may also have additional requirements above and beyond that of the state.

2.1.10.3 Land Application of Wastewater or Solids
Many states will have a separate permitting program for land application systems, which could include solids and/or wastewater disposal. This would apply to most methods involving land treatment, other than landfilling. There may also be county restrictions such as buffer zones and site zoning.

2.1.10.4 Wellhead Protection Program
Although established by the EPA, the wellhead protection program is to be implemented by the individual states **(Section 2.1.3.2)**. The location of a separator may not be allowed within a given distance of a wellhead.

2.1.10.5 Oil/Water Separator Closure
State and/or local regulations may govern the closure of an oil/water separator **(Chapter 12)**. The non-federal regulations could include ambient monitoring, cleaning, closure, and reporting

requirements.   Some states may consider separators underground storage tanks and establish closure requirements, accordingly.

If the facility's SPCC Plan manages the oil/water separator as part of a spill or oil control site, the Plan should be amended to reflect the closure.

2.1.10.6 Air Pollution Controls

Some state and local air quality agencies have rules that might require vapor tight covers equipped with closed vent systems that direct vapors to an air pollution control device. For example, the South Coast Air Quality Management District (SCAQMD) requires oil/water separators to have covers at oil production fields, refineries, chemical plants and industrial facilities handling petroleum liquids. A closed vent system with air treatment (e.g., a carbon column) is required if volatile organic carbon emissions exceed 500 ppm. Jet fuel or gasoline might violate this criteria but diesel fuel would not be of concern (DA USACE, 1994).

The installation should contact the state and local air quality boards to determine the applicable regulations for covers and vapor treatment systems, particularly related to dissolved air flotation systems.

2.1.11 Installation Plans

Activities associated with oil/water separators may impact plans developed by the installation. Typical plans that may require modification include SPCC, Pollution Prevention, and Storm Water Pollution Prevention Plans.

2.2 DOD DIRECTIVES AND EXECUTIVE ORDERS

Table 2-6 - Oil/Water Separators and DoD Directives and Executive Orders

DOD DIRECTIVES	DESCRIPTION
4120.14	30 August 1977, Environmental Pollution Prevention, Control and Abatement (NOTAL) (CNO, 1994).
5100.50	Protection and Enhancement of Environmental Quality, May 24, 1973, with Changes 1 and 2, directs the military to comply with the spirit and the letter of Federal environmental laws, executive orders, and regulations (AF, 1994).
EXECUTIVE ORDER	
12088	Federal Compliance with Pollution Control Standards, requires the military to: Take all necessary actions to prevent, control, and abate environmental pollution at all installations. Comply with applicable Federal environmental regulations and correct noncompliance (AF, 1994).

2.3 MILITARY GUIDANCE, POLICY, INSTRUCTIONS AND DIRECTIVES

Table 2-7 - Oil/Water Separators and Service Guidance/Policy/Instructions

GUIDANCE/POLICY/ INSTRUCTIONS/ DIRECTIVES	DESCRIPTION
AIR FORCE	
AFI 32-7041	"Water Quality Compliance," 13 May 1994, implements AFPD 32-70. The document provides details of the Air Force Water Quality Compliance Program (AF, 1998). **2.10. Oil/Water Separators.** Normal operation and maintenance activities, such as aircraft refueling operations, must not release fuel, oil, grease, and other contaminants. Use adequately sized oil/water separators to remove incidental releases of residual fuel, oil, grease, and other oily wastewater. Obtain a discharge permit for an oil/water separator when discharge to a wastewater treatment plant is not possible.
AFPD 32-70	Environmental Quality
AFI 32-7006	Environmental Program in Foreign Countries, for water quality compliance requirements at installations outside the United States and its territories.
ARMY	
Army Regulation (AR) 200-1	Environmental Protection and Enhancement (Chapter 2). AR 200-1, par. 2-4.a (2) requires that all Army installations comply with pretreatment regulations applicable to POTWs, and par. 2-4.c states that substantive pretreatment requirements applicable to POTWs will be applied to wastewaters treated by an FOTW.
NAVY/MARINES	
OPNA VINST 5090.1B- Chapters 7 and 9	“Clean Water Ashore” - This chapter identifies requirements and responsibilities for the control and prevention of surface and groundwater pollution at Navy shore facilities within the United States, Commonwealth of Puerto Rico, Canal Zone, Virgin Islands, Commonwealth of the Northern Marianas Islands, Guam, America Samoa, and the Trust Territory of the Pacific Islands. Information on Navy activities in foreign countries is provided in Chapter 18. Chapter 9 identifies requirements and responsibilities applicable to the prevention of oil pollution and the collection, reclamation, and disposal of oily wastes and oils ashore.
MCO P5090.2A- Chapter 20	“Water Quality Management” - This chapter establishes Marine Corps policy and responsibilities for compliance with Federal water pollution control requirements. The chapter specifies that direct discharges from oil/water separators must be permitted, monitored, and reported under the NPDES program. It also requires industrial discharges to POTWs and FOTWs to meet all applicable general and categorical pretreatment standards.

MILITARY HANDBOOKS AND OTHER GUIDANCE DOCUMENTS	
Air Force, December 1996	*PRO-ACT Fact Sheet Oil/Water Separators*
Army, November 1997	*Public Works Technical Bulletin No. 200-1-05, Oil/Water Separator Selection, Installation, And Maintenance: Lessons Learned*
U. S. Army Corps of Engineers, August 1994	*Engineering Technical Letter (ETL) No. 1110-3-466, Selection And Design Of Oil/Water Separators At Army Facilities*
Department of Defense, September 1988	*Military Handbook No. 1005/9. Industrial And Oily Wastewater Control. NAVFAC DM-5.9*.
Department of Defense, June 1997	*Military Handbook No. 1022, Department of Defense Military Handbook, Petroleum Fuel Facilities.*
Department of Defense, October 1997	*Military Handbook No. 1005/16, Wastewater Treatment Design Augmenting Handbook.*
Department of Defense, October 1997	*Military Handbook No.1138, Wastewater Treatment System Operations and Maintenance Augmenting Handbook.*
Department of Defense, October 1998	*Military Handbook No. 1005/17, Nondomestic Wastewater Control and Pretreatment Design Criteria*.

2.4 MILITARY ENVIRONMENTAL HOTLINES

The military has established various service and DoD hotlines and information sources to assist the installations with carrying out their environmental programs. These hot lines and information sources are listed in **Table 2-8**.

Table 2-8 - Military Environmental Hotlines and Information Sources

ORGANIZATION	PHONE NUMBER	WEB ADDRESS
PRO-ACT (Department of the Air Force)	(800) 233-4356 DSN 240-4214	http://www.afcee.brooks.af.mil/pro_acthome.htm
Army Environmental Center Hotline (Department of the Army)	(800) 872-3845 DSN 584-3845	http://aec-www.apgea.army.mil:8080/prod/index.htm
Regional Environmental Coordinator (Department of Defense)		
Region I (Navy, Groton, CT)	(860) 694-3976	
Region II (Air Force, Atlanta, GA)	(404) 562-4200	
Region III (Navy, Norfolk, VA)	(757) 444-3009	
Region IV (Army, Atlanta, GA)	(404) 347-1570 DSN 367-4241 or -4243	
Region V (Army, Aberdeen Proving Ground, MD)	(410) 436-2427 DSN 584-2427	
Region VI (Air Force, Dallas, TX)	(214) 767-4650	
Region VII (Army, Kansas City, MO)	(816) 983-3548	
Region VIII (Army, Commerce City, CO)	(303) 289-0260 DSN 749-2260	
Region IX (Navy, San Diego, CA)	(619) 532-4534	
Region X (Air Force, San Francisco, CA)	(415) 977-8849/ 8888	

CHAPTER 3
CONDUCTING AN OIL/WATER SEPARATOR INVENTORY

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CHAPTER 3
CONDUCTING AN OIL/WATER SEPARATOR INVENTORY

This chapter provides procedures to establish an oil/water separator inventory. If the procedures are followed, the installation should have adequate information to begin making decisions concerning separators, including potential problem areas, excess treatment capacity, maintenance requirements, and their upgrade/replacement/removal needs. Information that an installation should obtain to begin controlling/evaluating existing separators, includes the number and type of separators, appurtenant equipment, and contributing sources.

3.1 OIL/WATER SEPARATOR INVENTORY SHEET

The first section of this chapter will be devoted to providing guidance related to filling out the "Oil/Water Separator Inventory Sheet" **(Worksheet 3-1)**. This information will be placed in other worksheets or computer-based spreadsheets to further define the separator condition.

To help you complete **Worksheet 3-1**, the various items listed on the worksheet are listed and discussed in order, below. For example, item (1) on the worksheet is discussed in section 3.1.1 of this chapter, item (2) is discussed in section 3.1.2, etc.

3.1.1 Oil/Water Separator ID

Each oil/water separator should be assigned its own unique number. This number will allow the installation to track the separator, without confusing one nearby system with another.

3.1.2 Status

The status is used to denote one of three conditions concerning the separator: active, inactive (may be used again), or abandoned (not to be used again).

3.1.3 Physical Description and Location

The "physical description and location" of the separator provides a verbal and pictorial description of the physical appearance and location of the system, along with distances from known structures, roadways, buildings, etc. If a system is located within a building, it should be noted under the description. It is highly recommended that the location of at least one entrance manhole (for underground separators) be located by a global positioning system (GPS) instrument. A site sketch should be made of the separator location denoting distances and landmarks, and attached to the worksheet. The separator location could be incorporated into the installation's global information system (GIS).

3.1.4 Oil/Water Separator Type

The types of oil/water separators are described in **Chapter 9**. The inventory sheet lists only the major types of separators, with space provided for non-listed systems. Before the worksheet is filled out, be sure that field personnel are able to identify the various systems. The manufacturer, if appropriate, and the construction date should be included. The systems on the worksheet and the sections of this document containing their descriptions are:

	Type of Oil/Water Separator		Section in Guidance Manual
(1)	Gravity Oil/Water Separator		9.3
(2)	Oil Interceptor		9.3.3.2
(3)	Coalescing Standard Gravity		9.4
	(a)	Parallel Plate	9.4.1
	(b)	Corrugated Plate	9.4.2
	(c)	Tube	9.5.1
(4)	Dissolved Air Flotation		9.6
(5)	Other		

3.1.5 Elevation of Separator

The elevation of the separator describes where the treatment system is relative to ground level. For use in this document, the following definitions are provided:

Aboveground: An aboveground system is constructed such that no part of the treatment system tank is below the surface of the ground. This does not include system piping or "used oil" holding tanks.

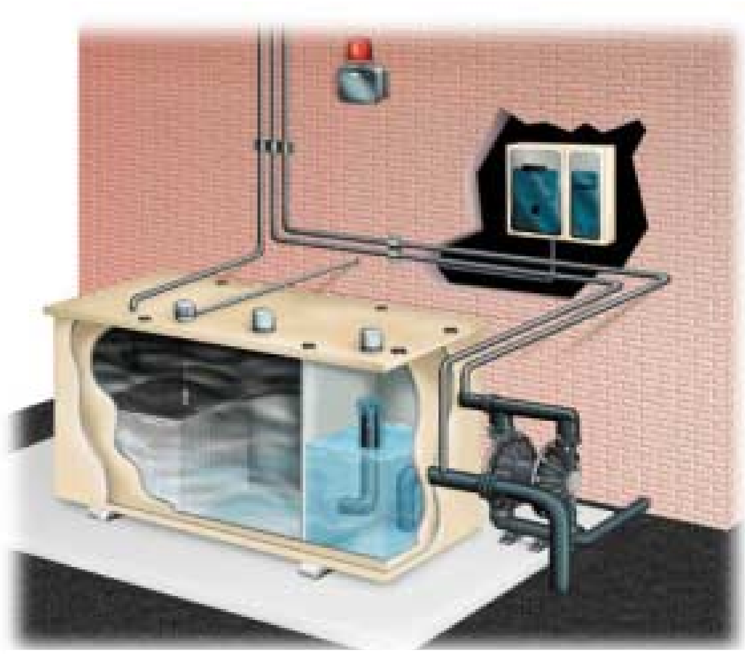


Figure 3-1 Aboveground Oil/Water Separator (Hoover, Undated)

Underground: An underground system is constructed such that the top of the treatment tank is no higher than 8 inches above the ground surface (standard design to prevent flooding).

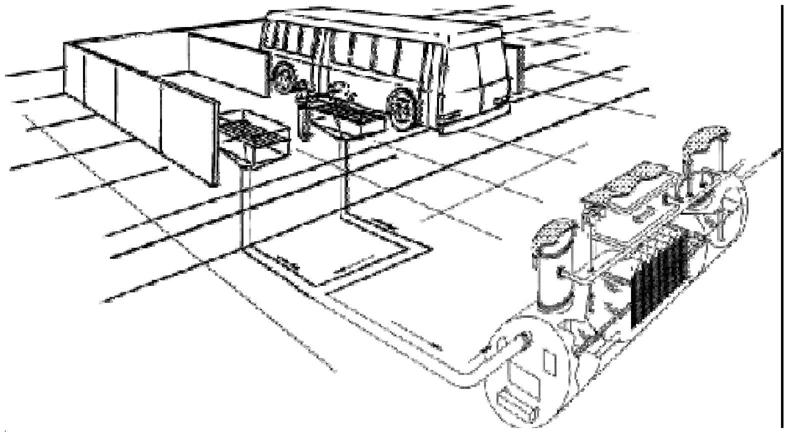


Figure 3-2 Underground Oil/Water Separator (Anchorage, Undated)

In-ground: Any system, that is neither totally aboveground nor underground as defined above, is an in-ground system.

3.1.6 Configuration

The configuration of the separator describes the overall shape of the structure. The various separator shapes are: rectangular, square, circular, and cylindrical. Configuration will also address secondary containment systems associated with the separator.

Secondary Containment: If a separator has a separate structure surrounding the treatment system to contain overflows and leaks, this separate structure is secondary containment. Containment can range from earthen berms to a concrete vault to a double-walled tank.

3.1.7 Construction Material

The construction material section refers to the materials used to construct the separator treatment tanks only. The primary construction materials include reinforced concrete (RC), steel, and fiberglass reinforced plastic (FRP).

3.1.8 Accessibility

The accessibility of a treatment system involves two considerations: the ability to get the necessary maintenance equipment to the separator and the ability to actually maintain the separator.

3.1.8.1 Maintenance Accessibility

Maintenance accessibility is based on whether “vac trucks” or other large maintenance equipment can be easily transported to the separator. If the area around the separator is paved or the separator is adjacent to a paved or gravel road, the site is considered accessible to heavy equipment.

The accessibility of coalescer inserts for removal and cleaning is included under maintenance accessibility.

3.1.8.2 Personnel Accessibility

Separator inspection and maintenance relies on the ability of an individual to have access to the system. The influent structure may have screens to be cleaned, and solids or collected oil to be removed. The main or separation chamber will require inspection for, and removal of, solids and accumulated oil, and may require the removal and cleaning of coalescing devices such as parallel plates. The effluent structure may require general cleaning, discharge sampling, and visual confirmation of no petroleum sheen on the discharge.

The above activities require accessibility. If the separator is configured such that maintenance and inspections may be accomplished with minimal effort (raise a grate), the area is considered "easily accessible." If the separator is configured such that certain portions of structure cannot be accessed, that portion of the separator is considered "not accessible." Areas of the system that do not fit either the "easily" or "not accessible" categories are considered "accessible."

3.1.9 "Used Oil" Holding

"Used oil" holding may take place over a range of configurations including:

No Holding: This is typical of a standard gravity oil/water separator. The separated oil is contained on the surface of the separation chamber by the underflow effluent weir. This configuration does not require an oil-skimming device.

Integral Holding: For the purpose of this document, integral holding is defined as holding that is fully contained within the overall structure of the separator.

Separate Holding: If the separator has oil holding, which is not integral, the holding system will be: "Underground Holding Tank;" "Aboveground Holding Tank;" or "Drum."

Skimmer Type: If the separator has separate or integral "used oil" holding, the oil skimmer type (**Section 9.2.2**) should be listed.

3.1.10 High Water Bypasses and Overflows

"Bypasses" are wastewater diversions at or near the influent structure of the separator. "Overflows" are wastewater diversions at or near the effluent structure of the separator.
Any discharge to the environment, including bypasses and overflows, must have regulatory approvals.

Older separators were constructed such that excessive flow (primarily due to runoff) would be diverted away from the treatment system (bypassed). The bypass may consist of a discharge pipe located within the influent structure or in a manhole prior to the separator. Other separators were constructed such that the system would overflow after the separation chamber to a different discharge point during high flows. As the point of overflow is after the separation chamber, this type of discharge does not “bypass” the system. Bypasses/overflows would divert industrial wastewater and storm water to a storm sewer or nearby ditch or stream.

These discharges may require an NPDES/SPDES permit. It should be noted if there are alarms (audio/visual) associated with the bypass/overflow.

3.1.11 Influent Wastewater Handling/Treatment

This section provides information concerning wastewater treatment/holding prior to entering the separator or at the entrance to the separator.

Equalized: An equalization tank or pond prior to a separator will damp out flow variation and allow the system to operate more efficiently.

Pumped: The type of pump should be noted.

Solids removal before separator: External Solids Removal (grit chamber, sedimentation basin, etc.) - External solids removal will prevent, or delay, the loss of wastewater detention time in the separator due to solids deposition and will decrease separator maintenance requirements. If grit, sand and other abrasives are removed, wear and tear on pumps within the system will be reduced.

Screened: The removal of trash and floatable debris from the influent wastewater will yield a cleaner used oil layer in the separator and prevent operational problems with oil skimming devices.

3.1.12 Effluent Discharge

Oil/water separators are generally flow-through systems, which means that the treated wastewater eventually leaves the separator. Where the effluent discharges will govern many of the regulatory requirements placed on the system **(Table 2-1 and Sections 2.1.1 and 2.1.10.1)**. Listed below are the various discharge locations:

Sanitary sewer: A sanitary sewer may carry storm water and/or industrial wastewater, but its primary function is to carry sewage. The sanitary sewer will discharge to either a privately (private corporation) owned treatment works, publicly (municipality or sewer authority) owned treatment works (POTW), or to a federally owned treatment works (FOTW).

Storm sewer or waters of the U.S.: Separators that treat wastewater from washracks and other activities may discharge through a permitted outfall to a storm sewer, ditch, stream, or other surface waters.

Industrial sewer: The main function of an industrial sewer is to convey industrial wastewater to an industrial wastewater treatment or pretreatment system. These sewers will generally not contain sewage or storm water.

Drainfield, leachfield, dry well: This category represents sub-surface discharges which may be regulated by an underground injection control (UIC) program.

Land application or evaporation/percolation pond: This category represents those discharges that would normally be regulated by state programs other than UIC or NPDES permits.

Recycling: The treated wastewater is returned back to the industrial activity for reuse. It may also be treated by other systems before being reused. The wastewater will eventually be wasted from the system.

3.1.13 Permits Controlling the Discharge

The permits that may be applied to the discharge from oil/water separators are listed in **Table 2-1**. The discharge may be regulated by more than one permit. Each permit or outfall should be listed on the worksheet. Listed below are the permits and sections of the guidance document where each type of permit/requirement is discussed:

Type of Permit/Requirement	***Section in Guidance Manual***
NPDES/SPDES	2.1.1
POTW Pretreatment	2.1.1, 2.1.10.1
FOTW Pretreatment	2.1.1, 2.1.4, 2.1.10.1
Sewer Use Ordinance	2.1.10.1
UIC	2.1.3.1
State or Local	2.1.10
Storm Water	2.1.1
None	

A sewer use ordinance may not specifically list the discharge from a particular separator, but may state that any discharge to the sewer system shall not exceed a certain pollutant concentration, 200 mg/L of oil & grease, for example. This discharge would be controlled by the ordinance, and would have to be in compliance with the listed concentration limits.

An example of a discharge that may not be controlled by a permit or municipal ordinance, is a non-categorical maintenance shop that discharges to an industrial sewer serving an on-site industrial wastewater treatment system. If the industrial treatment system does not have any restrictions placed on internal discharges to the industrial sewer, there would be no petroleum-based limits on the separator.

3.1.14 Discharge Limitations

Once the permit(s) controlling the discharge has been identified, the associated requirements should be listed. This information will be compared to the current raw and treated wastewater quality **(Chapter 4)**.

The type of effluent limits placed on separators can range from “no limits” to “no visible sheen,” to concentration values (mg/L), to production-based mass limits (pounds or kg/day). The effluent parameters which may be regulated include, but are not limited to, flow, oil and grease (or total petroleum hydrocarbons), total suspended solids, and pH.

Discharges from separators treating only runoff as a best management practice may only have general maintenance requirements. If there are no numeric limits in the permit, check “none.” If there are specific maintenance or inspection requirements, describe under “other.”

3.1.15 Flow Information

The information listed in this part of the form will be used to calculate “maximum operational flow” to the separator **(Worksheet 3-3)**. All potential sources of water/wastewater contributing to the separator should be listed.

3.1.15.1 Storm Water Contribution

If the separator receives runoff, the storm water impact must be taken into account. The first required information is the surface area of the site contributing runoff to the separator. The contributing surface area is sloped toward the drains and grates that discharge to the separator and the roofs that drain to the separator system. (Roof drains should be disconnected from separator systems.) The overall surface area contributing to the separator should be divided into two groups: paved or roofed surface area, and unpaved area.

The second major piece of information is the design storm event that will be used. The NPDES permit program requires that a treatment system be capable of operating during a 25-year, 24-hour rain event. The return frequency of a storm event to establish slug (short-term) loadings to a treatment system has not been established in the regulations. Some states have guidance for this slug loading based on a 2-year, 1-hour storm. The DoD established a 5-year, 1-hour design storm for oil/water separators (DoD, 1997g). It is suggested that the runoff volume be estimated at 50% of the incident rainfall on unpaved areas and 90% of the incident rainfall on paved and roofed areas.

> The rain event impacts on the separator should be based on the contribution from a 5-year, 1-hour storm, unless state or local requirements are more stringent.

3.1.15.2 Industrial Discharges to the Separator

Industrial flows are divided into production- and time-based flows. The activity listed in the table should contain a short description of the flow source (floor washing, cooling water, aircraft washing, etc.).

<u>Production-Based Flow</u>

Production-based flows are calculated using a flow/unit, e.g., 50 gallons to wash one vehicle, multiplied by the number of units/day (20 vehicles/day). This yields a total flow for the day (gallons/activity) of 1,000 gallons. The activity description should include the number of units. To equate this flow back to a maximum operation flow (gpm), divide the total flow by the amount of time (minutes) the activity is actually conducted/day. Another means of calculating maximum operational flow from certain activities (such as a washrack) is to list the number of hose bibs that are used at any one time under current operations, and their respective flow capacities (gallons/minute). Add the listed flows in gallons/minute to obtain the maximum operational flow from this activity.

<u>Time-Based Flow</u>
Time-based flows are calculated by multiplying the slug flow (gallons/minute) by the time (minutes/day) that the activity is conducted. A typical time-based flow is cooling water that would be utilized at a given gallons/minute.

The variables contained in **Worksheet 3-1** are listed below:

Activity: A description of the activity that generates the wastewater discharged to the separator. If there is, or will be, a discharge from the operation, it should be listed on the worksheet. This should include details such as the number and type of vehicles washed.

Time: List how long the activity is typically conducted. For example, if the activity is "external washing of 30 M-1 tanks," list the amount of time it takes to wash all 30 tanks. The units should be noted (minutes, hours, and days) on each line.

Frequency: This term describes how often the activity takes place. For example, if you wash "30 M-1 tanks," twice a week, you should input 2/week under "frequency."

Gallons/Activity: This should be filled in for "production-based" activities and list the number of gallons used over the entire operation.

Gallons/Minute: This value should be listed or calculated for all activities. For "production-based" activities divide the "Gallons/Activity" number by the "Time" in minutes.

3.1.15.3 Controlling Flow
After the runoff and industrial contributions to the separator have been established, several other issues have to be resolved to determine the maximum controlling flow. If the industrial activity can take place during a rain event, the controlling flow will be the sum of the industrial and storm water discharges. If the industrial activity does not contribute wastewater during a storm event (some exterior washracks), then the maximum controlling flow is the higher of the two established flows (storm water or industrial wastewater).

3.1.16 Separator Dimensions
Separator dimensions are used to evaluate potential short-circuiting and to calculate the detention times under various flow scenarios. It is suggested that all dimensions be listed as "feet" and measurements taken inside the tank.

The shape of the separator includes: rectangular, circular, and cylindrical. If the separator is square, mark "rectangular" and list the same values for length and width. A circular separator is wider (diameter) than it is deep. A cylindrical separator is longer than it is wide (diameter). The cylindrical separator also allows a description as to how the system is placed in the ground. Horizontal placement means that the cylinder is laying flat (resembling the configuration of a wide sewer pipe). Vertical placement means that the separator is setting on its end.

The dimensions under the appropriate shape, described above, should be filled in. This should be fairly straightforward. It should be noted that the depth (not "operational depth (no solids)") of the tank is measured from the top or lip of the tank to the bottom. Listed below is a separate definition of "operational depth (no solids)" which considers the depth of the liquid in the tank.

Baffles or weirs may divide separator chambers. Each chamber serves a unique purpose **(Chapter 9)**. The influent and effluent portions of the tank are not generally used to provide wastewater treatment and therefore should be eliminated from detention time calculations. The size of these chambers should be measured. The various dimensions (usually associated with a gravity system) are defined below **(Figure 3-3)**:

Length: The entire interior length of the separator. **[Worksheet 3-1, (16)(a)]**

Width: The interior width of the separator. **[Worksheet 3-1, (16)(b)]**

Depth of tank: The distance from the top of the tank to the bottom of the tank. **[Worksheet 3-1, (16)(c)]**

Length of influent chamber: The distance between the influent wall of the separator and the center (top view) of the first underflow weir. **[Worksheet 3-1, (16)(d)]**

Length of main chamber: (The main chamber is also referred to as the separation chamber.) The distance between the centers of the first and the second underflow weirs. **[Worksheet 3-1, (16)(e)]**

Length of effluent chamber: The distance from the center of the second underflow weir and the effluent wall. **[Worksheet 3-1, (16)(f)]**

Operational depth (no solids): The depth from the top of the liquid in the main chamber to the bottom of the tank under normal operation. This depth assumes that there are no collected solids in the separation chamber. **[Worksheet 3-1, (16)(g)]**

Depth to influent pipe: The distance from the top or lip of the tank to the bottom (invert) of the influent pipe. **[Worksheet 3-1, (16)(h)]**

Depth to effluent pipe: The distance from the top or lip of the tank to the bottom (invert) of the effluent pipe. **[Worksheet 3-1, (16)(i)]**

3.2 Evaluating the Physical Characteristics of the Gravity Separator

The physical separator characteristics are those features that will not change regardless of the contributing flows. **Worksheet 3-2** provides the format for calculating volumes, and design ratios (length-to-width and depth-to-width). **Worksheet 3-5** identifies potential deficiencies that may lead to wastewater short-circuiting, which could affect overall treatment.

These physical characteristics reflect the potential of short-circuiting or scouring of the system due to its geometric configuration or depth. The results of the evaluation are listed on **Worksheet 3-5, D**. The critical data to review are under fully loaded, solids holding conditions.

> For the purpose of this guidance document, if operational depth, and depth-to-width and the length-to-width ratio requirements are met under-fully loaded conditions, there are no significant physical problems with the gravity separator.

3.3 Evaluating the Hydraulic Characteristics of the Separator

The hydraulic characteristics developed in **Worksheets 3-3 and 3-4** provide information on wastewater detention times under the controlling flow regime. These worksheets also provide a method for establishing allowable solids holding capacity in the separator.

> As oil/water separators that treat only storm water may have a design detention time other than 45 minutes, this type of separator should not be evaluated using typical hydraulic guidelines.

The hydraulic characteristics reflect the potential of inadequate removal of free oil (detention time) or scouring of the system. The hydraulic characteristic of import is detention time. The results of the evaluation are listed on **Worksheet 3-5, D**. The critical data to review are under fully-loaded conditions with maximum solids holding.

> For the purpose of this guidance document, if under maximum operational (controlling) flow conditions, a detention time of 45 minutes is met in the separation chamber with solids holding, there are no significant hydraulic problems with the gravity separator.

3.3.1 Calculate Maximum Operational Flow Based on Current Use

Worksheet 3-3 calculates the maximum operational flow that may be anticipated at an oil/water separator. The separator is evaluated using the controlling flow (industrial wastewater and/or storm water contributions). Industrial flows are divided into production- and time-based flows.

3.3.1.1 Maximum Operational Flow - Industrial

This flow will establish peak momentary industrial hydraulic loading to the separator. To calculate the maximum operational flow, summarize all industrial activities that can take place at the same time (not just on the same day, but at the same moment).

3.3.1.2 Storm Water Runoff Contribution

If the separator receives runoff, surface area (paved and unpaved) of the site contributing to the separator is required. For ease in calculating anticipated runoff, the area should be listed in square feet on **Worksheet 3-3**. The rain event used to calculate maximum operational flow is the 5-year, 1-hour storm.

> It is suggested that runoff volume be estimated at 90% and 50% of the incident rainfall for paved and unpaved areas, respectively.

The design rain events vary based on geographic location. Rain event information may be obtained from your local or state regulators.

> **NOTE**: Contact with state or local regulators should be coordinated through the installation environmental office.

3.3.1.3 Controlling Flow - Industrial Wastewater and/or Storm Water

From the flow information previously developed, hydraulic loadings to the separator can be compared to standard criteria and guidelines for gravity systems. The controlling flow information will be used to evaluate the liquid detention time under slug loading conditions. The necessary calculations are discussed in **Section 3.3.2** and listed in **Worksheet 3-4**.

> If the industrial activity is not conducted during rain events (such as vehicle washing), the maximum operational flow (industrial) and the storm water contribution should be compared and the highest value used in the calculations.

3.3.2 Calculate Hydraulic Conditions of the Separator

Worksheet 3-3 calculated the controlling flow that could be expected at the separator. **Worksheet 3-4** applies this flow to the physical limitations of the separator and establishes detention time and allowable solids holding information.

> All calculations assume that the discharge line from the separator is capable of adequately handling the wastewater/runoff flows without causing a system back-up.

Some separators are hydraulically over-loaded and therefore have no available solids holding capacity. If a separator is in this condition, pollution prevention measures **(Chapter 6)** should be explored to reduce total or peak flows. If the influent flow cannot be reduced, the treatment system should be evaluated for removal, upgrade, or replacement **(Chapter 7)**. In the interim, solids holding in the separator should be allowed, to prevent undue maintenance of the system.

> Until the hydraulically overloaded separator is modified, as necessary, solids accumulation will be allowed up to 10% of the separator operational volume.

3.3.3 Excess Wastewater Hydraulic Capacity

The evaluation of excess capacity is based on the available capacity in the separation chamber when solids holding is 25% of the operational volume and the detention time in the separation chamber is greater than 45 minutes **(Section 11.5.2)**. This value is listed on **Worksheet 3-5, D** or calculated in the electronic (Excel®) spreadsheet **(Worksheet 3-6)** and listed under "Additional Hydraulic Capacity." This value is the maximum operational flow (gallons/minute) that may be added to the system to maintain the 45-minute detention time criteria in the separation chamber.

If there is excess capacity, and the existing system is meeting the effluent/pretreatment limitations, the listed excess flow may be diverted to the separator from off-site, if economically feasible.

3.4 Potential Gravity Oil/Water Separator Deficiencies

Worksheet 3-5 provides a format to summarize the information developed in the other four worksheets and compare the generated data against standardized criteria. Tables are provided in the worksheet to determine potential problem areas associated with the separator and the contributing industrial/storm water flows. Once this form is completed, the installation will be able to answer the following:

- Is the separator too narrow or wide?
- Is the separator too shallow or deep?
- Is the separator too short or long?
- What is the allowable solids holding in the separator?
- Is the separator hydraulically overloaded?
- Does the separator have excess hydraulic capacity?

3.5 Electronically Evaluating the Potential Separator Deficiencies

The installation has two options for evaluating existing separators. Either complete **Worksheets 3-1 through 3-5** (14 pages) or complete **Worksheets 3-1 and 3-3** (part) and fill in 12 variables in an Excel® spreadsheet, **Worksheet 3-6**. (The disk was provided with the guidance manual.) The electronic version is quicker, easier, and more consistent than using hand calculations.

The required information to complete the spreadsheet includes separator dimensions, industrial flows, the area contributing runoff to the separator, and the rainfall expected during a 5-year, 1-hour rain event. The following variables are contained in the spreadsheet along with the Worksheet references:

- Separator ID **[Worksheet 3-1, (1)]**
- Paved Area Contributing Storm Water Runoff **[Worksheet 3-1, (15)(a)]**
- Unpaved Area Contributing Storm Water Runoff **[Worksheet 3-1, (15)(b)]**
- 5-year, 1-hour Rain Event **[Worksheet 3-3, (24)(a)]**
- Maximum Operational Industrial Flow **[Worksheet 3-3, (23)]**
- Does the Activity Operate During Rain Events **[Worksheet 3-3, (27)]**
- Overall Length of Separator **[Worksheet 3-1, (16)(a)]**
- Width of Separator **[Worksheet 3-1, (16)(b)]**
- Overall Depth of Separator **[Worksheet 3-1, (16)(c)]**
- Length of Separation Chamber **[Worksheet 3-1, (16)(e)]**
- Operational Depth (no solids) **[Worksheet 3-1, (16)(g)]**
- Solids Storage as a Percent of Operational Volume (between 0.10 and 0.25)

Once these variables are input, the spreadsheet will update "Initial Calculated Information…" including the table entitled "Calculated Solids Holding Based on Detention Time." This table evaluates detention times (45 minutes) in the separation chamber. It calculates solids holding capacity based on hydraulic capacity available in the separator under fully-loaded flow conditions, and assigns a percent value of the total operational volume of the separator.

- If the calculated percent value is negative, the separator is hydraulically overloaded.
- If the calculated percent value is < 10% or is negative, place a value of 10% in the blank provided in the spreadsheet under "Insert Solids Storage…"
- If the calculated percent value is >25%, place a value of 25% in the blank provided in the spreadsheet under "Insert Solids Storage…"

The installation does not have to use the calculated percents generated in the table if a trial-and-error approach to setting the appropriate solids holding is preferable.

Insert the percent value in the blank as a decimal. For example, to input 10%, use 0.10.

After the percent is placed in the blank, the table entitled "Summary Review" will be updated. It will compare the calculated information to standard criteria and automatically alert the user to potential physical and hydraulic problems associated with the separator. The spreadsheet will show "OK," in the last two columns for those criteria which are satisfied by the existing separator dimensions and hydraulic loading.

The spreadsheet will also calculate and list the value of any excess hydraulic capacity in the separator, in gallons per minute. This will provide information concerning whether additional wastewaters may potentially be diverted to the gravity system without adversely affecting the overall wastewater detention time. Rather than utilizing the excess hydraulic capacity, the installation may increase the volume of solids holding (up to 25%).

This spreadsheet can be used for cursory evaluations of modifications to existing conditions. For example, if areas of the site contributing runoff were to be eliminated, adjustments could be made to the inputs (area contributing storm water runoff) and an evaluation of how the detention time would be affected by eliminating the runoff. An example of a completed spreadsheet is presented in **Worksheet 3-6**.

3.6 SUMMARIZING INVENTORY DATA

Once all relevant information has been collected and evaluated, installation summaries should be developed. This should be done at the separator level and at the installation level.

The separator summary should contain at a minimum: **Worksheets 3-1 and 3-5** (or a print out of the Excel® spreadsheet, **Worksheet 3-6**).

The installation level information could be placed on a form such as contained in **Table 3-2**. **Table 3-1** provides a list of abbreviations that could be used to fill out information on the form.

3.7 SUMMARY OF PROCEDURES TO CONDUCT AN OIL/WATER SEPARATOR INVENTORY

To complete an oil/water separator inventory, the following actions should be undertaken:

(1) Determine the location of all separators and potential contributing buildings/activities.
(2) Conduct separator site inspection and interviews with individuals knowledgeable of contributing sources.
(3) Fill out **Worksheet 3-1** and **Worksheet 3-3** (Tables 1 and 2) in the field.

At this point, the installation can conduct the separator evaluation using the worksheets in this chapter, or complete the evaluation using the Excel® spreadsheet.

Using the worksheets:

(4) Complete **Worksheet 3-2**, which calculates the physical characteristics of the gravity separator.
(5) Complete **Worksheet 3-3** (Table 3, etc.), which will yield the maximum operational (controlling) flow information
(6) Complete **Worksheet 3-4**, which calculates: hydraulic conditions in the gravity or coalescing gravity separator; allowable solids holding; and excess hydraulic capacity.
(7) Complete **Worksheet 3-5**, which compares the results from all worksheets against standard criteria or rules-of-thumb for gravity separators and provides comments on any potential problems.
(8) Generate an individual separator status for the inventory, by establishing a file for the separator containing, at least, a copy of **Worksheets 3-1 and 3-5**.
(9) Place the individual separator information on the installation inventory, by adding the separator information to **Table 3-2**, using the suggested abbreviations contained in **Table 3-1**.

Using the Excel® spreadsheet:

(4) Input information (12 variables) into the spreadsheet.
(5) Generate an individual separator status for the inventory, by establishing a file for the separator containing, at least, a copy of **Worksheet 3-1** and the spreadsheet, **Worksheet 3-6**.
(6) Place the individual separator information on the installation inventory, by adding the separator information to **Table 3-2**, using the suggested abbreviations contained in **Table 3-1**.

The information generated by following these procedures will allow the installation to determine:

- The number and type of separators;
- Appurtenant equipment associated with each separator;
- Permit/discharge information;

(for gravity/enhanced gravity systems)

- Separators containing excess capacity;
- Separators that may have potential problems and the potential causes of those problems; and
- Separators that may need upgrading or replacement.

Table 3-1 Suggested Abbreviations to be Used for Table 3-2.

Status
- A - Active
- I - Inactive
- Ab - Abandoned

Configuration
- R - Rectangular
- C - Cylindrical
- Ci - Circular
- S - Square

Accessibility - Maintenance
- Y - Yes
- N - No

Oil Holding
- N - No Holding
- I - Integral
- U - Underground Holding Tank
- A - Aboveground Holding Tank
- D - Drum

Influent Systems
- E - Equalized
- P - Pumped
- S - Solids Removal
- Sc - Screening

Permit
- NP - NPDES/SPDES
- P - POTW Pretreatment/Local
- F - FOTW Pretreatment
- SU - Sewer Use Ordinance
- U - UIC
- St - State
- N - None

Depth, Operational
- O - OK
- D - Too Deep
- S - Too Shallow

Depth-to-Width
- O - OK
- D - Too Deep
- S - Too Shallow

Surface Loading
- O - OK
- U - Underloaded
- Ov - Overloaded

Elevation
- A - Aboveground
- U - Underground
- I - In-ground
- S - Secondary Containment

Material (Construction)
- RC - Reinforced Concrete
- S - Steel
- FG - Fiberglass Reinforced Plastic
- O - Other

Accessibility - Separator
- E - Easily Accessible
- A - Accessible
- N - Not Accessible

Bypass/Overflow
- N - No bypass or overflow
- BP - Bypass, permitted
- OP - Overflow, permitted
- B - Bypass, not permitted
- O - Overflow, not permitted

Discharge
- SP - Sanitary Sewer to POTW
- SF - Sanitary Sewer to FOTW
- SS - Storm Sewer or Navigable Waters
- I - Industrial Sewer
- D - Drainfield, Leachfield
- R - Recycle
- L - Land Application

Storm Water
- Y - Storm Water to Separator
- N - No Storm Water Contribution

Width
- O - OK
- N - Too Narrow
- W - Too Wide

Length-to-Width
- O - OK
- L - Too Long
- S - Too Short

Detention Time
- O - OK
- S - Time is short
- L - Long detention time

Table 3-2 - SUMMARY OF EXISTING SEPARATORS

Separator ID	Date Evaluated	Type	Status	Placement	Configuration	Material	Accessibility Equipment	Accessibility Separator	Oil Storage	Bypass	Influent Systems	Discharge	Permit	Storm Water	Depth Operational	Width	Depth-to-Width	Length-to-Width	Surface Loading	Detention Time	Horizontal Velocity

WORKSHEET 3 - 1

OIL/WATER SEPARATOR INVENTORY SHEET

(Page 1 of 2)

Building(s) and/or Area(s) Served:________________________ **(1)** Separator ID: ____________

Date: _____________ **(2)** Status: ( ) Active, ( ) Inactive ( ) Abandoned

(3) Location: *(Attach sketch)*____

____

____

____

(4) Type of Separator: ( ) Standard Gravity (API) ( ) Coalescing Standard Gravity
( ) Oil Interceptor
( ) Parallel Plates
( ) Corrugated Plates
( ) Tubes
( ) Dissolved Air Flotation ( ) Other ______________________________
Manufacturer: ______________________ Date Installed: ___________________________

(5) Elevation of Separator: ( ) Aboveground ( ) Underground ( ) In-ground (partially)

(6) Configuration: ( ) Rectangular ( ) Circular ( ) Cylindrical ( ) Square
( ) Secondary Containment

(7) Construction Material: ( ) Reinforced Concrete ( ) Steel ( ) Fiberglass Reinforced Plastic
( ) Other ___________ ( ) Cathodic Protection

(8) Accessibility: Paved or gravel road to separator: ( ) Yes ( ) No
Top of tank is: ( ) Open ( ) Closed w/manholes ( ) Bolted
( ) w/grates or fence
Influent structure: ( ) Easily accessible ( ) Accessible ( ) Not Accessible
Main chamber: ( ) Easily accessible ( ) Accessible ( ) Not Accessible
Effluent structure: ( ) Easily accessible ( ) Accessible ( ) Not Accessible
Coalescer Device: ( ) Easily accessible ( ) Accessible ( ) Not Accessible

(9) Used Oil Holding: ( ) No holding ( ) Integral ( ) UST ( ) AST ( ) Drum
Holding capacity: ____________ gallons Skimmer Type: _________________

(10) High Water ( ) Bypass or ( ) Overflow: Is the bypass/overflow permitted? ( ) Yes ( ) No ( ) N/A
Alarm ( ) Yes ( ) No ( ) N/A

(11) Influent Wastewater: Equalized ( ) No ( ) Yes
Pumped ( ) No ( ) Yes, type: ________________
Solids removal before separator ( ) No ( ) Yes
Screen/Trash Rack ( ) No ( ) Yes

(12) Effluent Discharges to: ( ) Sanitary sewer to: ( ) POTW or ( ) FOTW
( ) Storm sewer or waters of the U.S.
( ) Industrial sewer to __________________ treatment system
( ) Drainfield, leachfield, dry well
( ) Land application or evaporation/percolation pond
( ) Recycle

WORKSHEET 3 - 1

OIL/WATER SEPARATOR INVENTORY SHEET

(Page 2 of 2)

(13) Permit Controlling the Discharge:
( ) NPDES/SPDES (Permit No ________________)
( ) Storm Water Permit (Permit No ________________)
( ) POTW Pretreatment (Permit No ________________)
( ) FOTW Pretreatment (_______________________)
( ) Sewer Use Ordinance (POTW__________________)
( ) UIC Permit (Permit No ________________)
( ) State or Local Permit (Permit No ________________)
( ) None

(14) Discharge Limitations:
( ) None
( ) Effluent Limits
( ) pH, S. U. = ________ to __________
( ) total suspended solids, mg/L = _______, (avg) _______, (max)
( ) oil & grease or ( ) total petroleum hydrocarbons
mg/L = _______, (avg) _______, (max)
( ) other ______________________________
( ) Monitoring Frequency: _________________

==

(15) FLOW INFORMATION

Runoff Contribution: ( ) None ( ) Yes, Paved Area = ____________ ft^2 **(a)** or ____________ acres
Unpaved Area = ____________ ft^2 **(b)** or ____________ acres
Can the industrial activity operate during a rain event? _______ (yes or no)

Industrial Discharges to Separator:

Activity	Time	Frequency	Gallons/Activity or	Gallons/min.

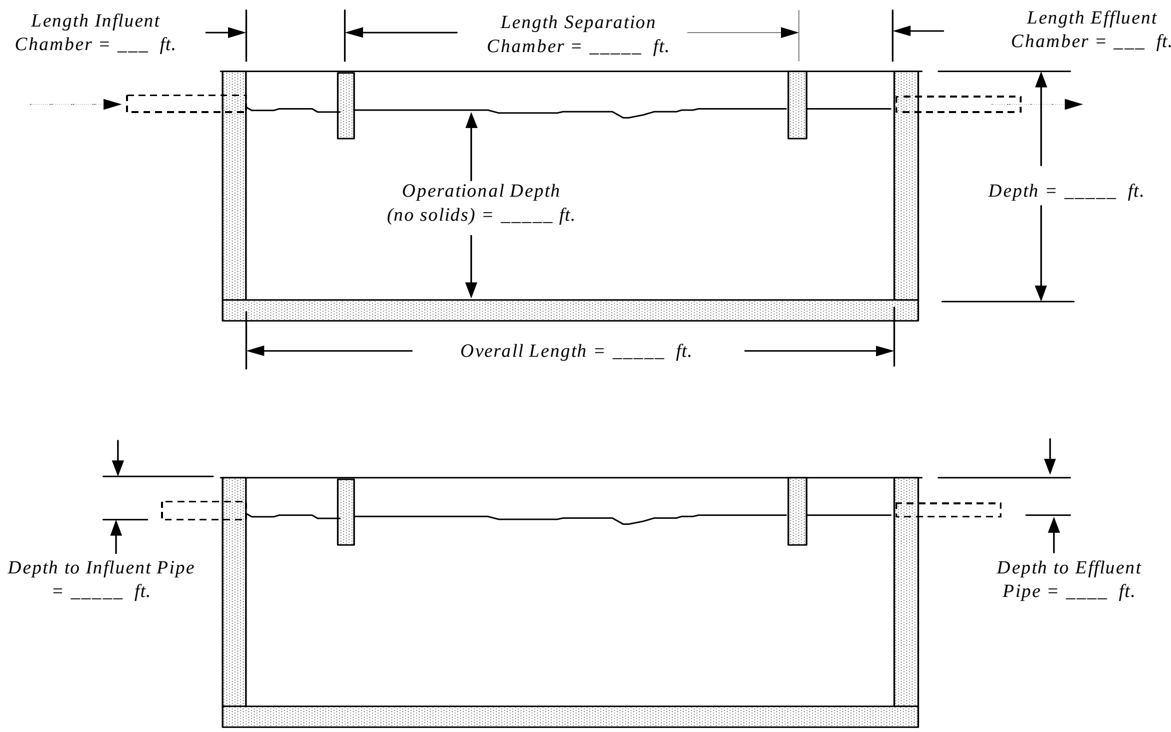
==

(16) SEPARATOR DIMENSIONS (NOTE: All dimensions are interior and reported in feet.)

( ) Rectangular or Square **(See Figure 3-3)**
Length: __________**(a)** Width: ________**(b)** Depth (from top of tank): _______**(c)**
( ) Circular
Diameter:_________ Depth (from top of tank): _________
( ) Cylindrical (Placed: ( ) horizontal ( ) vertical)
Length: __________ Diameter: ________

(See Figure 3-3)
Length of influent chamber: ________ ft. **(d)**
Length of separation chamber: ________ ft. **(e)**
Length of effluent chamber: ________ ft. **(f)**
Operational depth (no solids) from bottom of the tank to the liquid surface in the main chamber: ________ ft. **(g)**
Depth to influent pipe: ________ ft. **(h)**
Depth to effluent pipe: ________ ft. **(i)**

Figure 3-3
Field Measurement Locations
(All measurements are in feet.)



Side View or Cross-Section of Standard Gravity Separator

SUMMARY:	***Information No. Worksheet 3-1***
Overall Length = _____ ft.	*(16)(a)*
Width (internal) = _____ ft.	*(16)(b)*
Depth = ft.	*(16)(c)*
Length Influent Chamber = _____ ft.	*(16)(d)*
Length Separation Chamber = ft.	*(16)(e)*
Length Effluent Chamber = ft.	*(16)(f)*
Operational Depth (no solids) = ft.	*(16)(g)*
Depth to Influent Pipe = _____ ft.	*(16)(h)*
Depth to Effluent Pipe = _____ ft.	*(16)(i)*

WORKSHEET 3 - 2

EVALUATING PHYSICAL CHARACTERISTICS OF GRAVITY SEPARATOR

(Page 1 of 1)

Separator ID: ________________ Date of Evaluation: _____________

Tank Dimensions from Inventory Sheet - Rectangular Tank [**Worksheet 3-1, (16) (a - g)**].

==

A. Total Operational Volume Calculations

Total Separator Volume:

(17) V = **(16)(a)**__________ x **(16)(b)** ___________ x **(16)(g)** _________ = ____________ ft^3 **(17)**
(length of separator) (width of tank) (operational depth, no solids) (volume)

Convert Volume from Cubic Feet to Gallons

(18) V = **(17)** ___________ x 7.48 = __________ gallons **(18)**
(volume, ft^3) (volume, gallons)

B. Separation Chamber Operational Volume Calculations

Separation chamber volume:

(19) V = **(16)(e)**__________ x **(16)(b)** ___________ x **(16)(g)** _________ = ____________ ft^3 **(19)**
(length of main chamber) (width of tank) (operational depth, no solids) (volume)

Convert Volume from Cubic Feet to Gallons

(20) V = **(19)** ___________ x 7.48 = __________ gallons **(20)**
(volume, ft^3) (volume, gallons)

C. Length-to-Width Ratio

(16)(e) ___________________ / **(16)(b)** _______________ = _______________ **(21)**
(length of separation chamber) (width of tank) (length-to-width ratio)

D. Depth-to-Width Ratio (no solids)

(16)(g) ___________________ / **(16)(b)** _______________ = _______________ **(22)**
(operational depth, no solids) (width of tank) (depth-to-width ratio)

WORKSHEET 3 - 3

CALCULATE MAXIMUM OPERATIONAL FLOW BASED ON CURRENT USE

(Page 1 of 4)

Separator ID: _____________ Date of Review: _______________

This worksheet allows the installation to calculate maximum flow rate that may be anticipated at an oil/water separator. The separator will be evaluated using the controlling flow (industrial wastewater and/or storm water contributions).

Industrial flows are divided into production- and time-based flows. Do not list the same activity in both production- and time-based flow tables.

A. Production-Based Flow [Sections 3.1.15.2 and 3.3.1.1]:

Table 1 - Production Based Flows

ACTIVITY DESCRIPTION	NUMBER OF UNITS/DAY (MAXIMUM)	GALLONS / UNIT	TIME/DAY (MINUTES)	TOTAL FLOW (GALLONS/DAY)	GALLONS /MINUTE

B. Time-Based Flow [Sections 3.1.15.2 and 3.3.1.1]:

Table 2 - Time Based Flows

ACTIVITY DESCRIPTION			TIME/DAY (MINUTES)	TOTAL FLOW (GALLONS/DAY)	GALLONS /MINUTE

WORKSHEET 3 - 3

CALCULATE MAXIMUM FLOW RATE BASED ON CURRENT USE

Separator ID: ____________ Date of Review: ______________

C. Maximum Operational Flow - Industrial

This flow will establish peak momentary hydraulic loading to the separator. To calculate the maximum operational flow, list all activities (from production- and time-based flow Tables 1 and 2, above) that can take place at the same time (not just on the same day, but at the same moment) and insert the flow for each activity as gallons per minute.

Table 3 - Maximum Operational Flow Evaluation

ACTIVITY DESCRIPTION					GALLONS /MINUTE

(23) Total: ________

Total the gallons/minute from all slug flows in table 3 and insert the value on line **(23)** above and list as maximum operational flow:

(23) Maximum Operational Flow - Industrial = __________ gallons/minute

Separator ID: ______________ Date of Review: ________________

D. Storm Water Runoff Contribution

If the separator receives runoff, the storm water impact must be taken into account when evaluating the flows contributed to the separator. For ease in calculating anticipated runoff, the surface area of the site contributing to the separator should be listed in square feet.

(24) 5-year, 1-hour rain event: ___________ **(a)** inches = __________ feet **(b)**

(25) Equivalent Drainage Area

= [**(15)(a)**______________ ft^2 x 0.9] + [**(15)(b)**_______________ ft^2 x 0.5]
(paved area) (coefficient) (unpaved area) (coefficient)

= _______________ ft^2 **(25)**

(26) Storm Water Loading (Maximum Operational)

= **(25)**_________________ ft^2 x **(24)(b)**____________ ft./hr = __________ ft^3/hr
(equivalent drainage area) (5-yr, 1-hr) (runoff volume)

=_____________ ft^3/hr x 7.48 = ________ gallons/hour
(runoff volume) (gal/ft^3)

= (_________ gallons/hour) / (60 minutes/hour)

= ________________ gallons/minute **(26)**
(maximum operational storm water)

Separator ID: _____________ Date of Review: _______________

E. Controlling Flow - Industrial and/or Storm Water

If a system receives storm water, certain evaluations are necessary to determine which contributing flow scenario (industrial only, storm water only, or industrial and storm water) will apply the maximum realistic hydraulic loading to the separator.

The first question to be resolved is, can the industrial operation contribute wastewater to the separator during a rain event. For example, will a wash rack be operational during a rain event. If the wash rack is not operational, the rain event flow must be compared to the industrial contribution and the higher value used in evaluating the separator. If the wash rack can operate during a rain event, the combined industrial and storm water contribution must be used to evaluate the separator.

(27) Does the industrial activity contributing wastewater to the separator operate during rain events? ( ) Yes, ***Go to (29)*** ( ) No, ***Go to (28)***

(28) Compare the Storm Water Loading (Maximum Operational) to the Maximum Operational Flow - Industrial.

Storm Water Loading (Maximum Operational) = __________ gallons/minute **(26)**
(maximum operational storm water)

Maximum Operational Flow - Industrial = __________ gallons/minute **(23)**
(maximum operational flow - industrial)

Controlling Flow = the larger flow **(23)** or **(26)**, _________ gallons/minute **(28)**

Go to (30) and place the value of (28) on line (30).

(29) Add the flows (gallons/minute) listed on lines **(23)** and **(26)** of this worksheet.

= **(23)**_______________ + **(26)**________________ = ___________ gallons/minute **(29)**
(maximum industrial) (maximum storm water) (maximum operational flow)

Controlling Flow = _________ gallons/minute **(29)**

Go to (30) and place the value of (29) on line (30).

(30) **Controlling Flow** = _________ gallons/minute **(30)**

WORKSHEET 3 - 4

EVALUATING CURRENT CAPACITY OF GRAVITY OIL/WATER SEPARATOR

(Page 1 of 3)

Separator ID: ________________ Date of Evaluation: _____________

From Inventory Sheet (Rectangular Tank):

==

A. Detention Times (Assuming No Solids Holding Capacity)

(31) Calculate controlling flow detention time in separation chamber

(20) _____________ gallons / **(30)** _____________ gpm = _________ minutes **(31)**
(separation chamber volume) (controlling flow) (detention time)

B. Allowable Solids Holding

If the detention time calculated in **(31)** above is less than 45 minutes, then the maximum allowable solids holding capacity is 10% of the operational volume. Every effort should be made to keep the solids layer significantly below the 10% volume.

(32) If **(31)** is less than 45 minutes, go to **(36)**:

(33) If value **(31)** is greater than 45 minutes, calculate solids holding capacity for separation chamber:

[**(31)** _________ minutes - 45 minutes] x **(30)** _________ gpm = ______ gal **(33)**
(detention time) (controlling flow) (solids holding)

(34) Calculate percent solids holding:

[**(33)** __________ gallons / **(20)** __________ gallons] x 100 = _______ % **(34)**
(solids holding in sep chamber) (separator chamber volume) (percent solids holding)

(35) Compare the calculated % solids holding to DoD guidance:

- If **(34)** is less than 10%, go to **(36)**.
- If **(34)** is greater than 25%, go to **(37)**.
- If **(34)** is equal to or between 10% to 25%, place the value of **(33)** on line **(38)**, and the value of **(34)** on line **(39)**, then go to line **(40)**.

WORKSHEET 3 - 4

EVALUATING CURRENT CAPACITY OF GRAVITY OIL/WATER SEPARATOR

Separator ID: ________________ Date of Evaluation: _____________

(36) Calculate solids holding capacity for hydraulically overloaded system:

(20) __________ gallons x 0.10 = ______________ gallons **(36)**
(separation chamber volume) (min 10% volume) (solids holding in separator)

- Place value **(36)** on line **(38)**, and
- Place "10%" in space **(39),** then go to line **(40).**

(37) Calculate solids holding capacity for hydraulically under-loaded system:

(20) __________ gallons x 0.25 = ______________ gallons **(37)**
(separation chamber volume) (max 25% volume) (solids holding in separator)

- Place value **(37)** on line **(38)**, and
- Place "25%" in space **(39),** then go to line **(40).**

(38) Allowable solids storage volume: ________ gallons **(38)**, value from **(33), (36),** or **(37)**

(39) Allowable % solids holding: ______%, 10%, 25%, or value from **(34)**

C. Allowable Solids Thickness

(40) Calculate thickness of solids layer

[**(39)** __________ % / 100] x **(16)(g)** ___________ ft = _________ ft **(40)**
(percent solids holding) (operational depth, no solids) (allowable solids thickness)

D. Adjusting Operational Volume to Reflect Solids Holding

(41) Calculate solids holding volume

[**(39)** __________ % / 100] x **(20)** ___________ gal = _________ gal **(41)**
(percent solids holding) (separation chamber vol) (solids holding volume)

(42) Calculate adjusted operational volume to reflect solids holding

(20) __________ gal - **(41)** ___________ gal = _________ gal **(42)**
(separation chamber volume) (solids holding vol) (adjusted operational volume)

WORKSHEET 3 - 4

EVALUATING CURRENT CAPACITY OF GRAVITY OIL/WATER SEPARATOR

Separator ID: ________________ Date of Evaluation: _____________

E. Separation Chamber Detention Time with Solids Holding

(43) Calculate Detention Time with Solids Holding

(42) ________ gallons / **(30)** ______ gallons/minute = ______ minutes **(43)**
(adjusted operational volume) (controlling flow) (detention time)

F. Adjusting Operation Depth to Reflect Solids Holding

(44) Calculate adjusted operational depth

(16)(g) __________ feet - **(40)** ______________feet = ___________ feet **(44)**
(operational depth, no solids) (allowable solids thickness) (adjusted operational depth)

G. Adjusting Depth-to-Width Ratio to Reflect Solids Holding

(45) Calculate adjusted depth-to-width ratio

(44) __________ feet / **(16)(b)** ______________feet = ___________ **(45)**
(adjusted operational depth) (width) (adjusted depth-to-width)

H. Excess Hydraulic Capacity

(Applies to any gravity/enhanced gravity system with a calculated solids holding capacity **(34)** greater than 25%. If **(34)** is equal to or less than 25%, do not calculate **(46) - (48)**, mark **(49)**.)

(46) Treatment Volume at 25% Solids Holding = 0.75 x **(20)** ______ gallons = ______ gal **(46)**
(sep chamber volume) (treatment volume)

(47) Calculate Excess Volume

(46) ________ gallons - [**(30)** _______ gallons/minute x 45 min] = _______ gallons **(47)**
(treatment volume) (controlling flow) (excess volume)

(48) Calculate Excess Capacity

(47) _______ gallons / 45 minutes = __________ gallons/minute **(48)**
(excess volume) (excess capacity)

(49) ( ) No excess hydraulic capacity.

WORKSHEET 3 - 5

SUMMARY OF GRAVITY OIL/WATER SEPARATOR CONDITIONS

(Page 1 of 3)

Separator ID: ________________ Date of Evaluation: _____________

===

A. PHYSICAL CHARACTERISTICS:

Worksheet 3-1

Surface Area Contributing Runoff: Paved = **(15)(a)** _____________ ft^2
Unpaved = **(15)(b)** _____________ ft^2

Dimensions:

Length: **(16)(a)** _____________ ft
Width: **(16)(b)** _____________ ft

Criteria: (Width) Between 6 to 20 feet

Depth: **(16)(c)** _____________ ft
Length of influent chamber: **(16)(d)** _____________ ft
Length of main chamber: **(16)(e)** _____________ ft
Length of effluent chamber: **(16)(f)** _____________ ft
Operational Depth (no solids): **(16)(g)** _____________ ft

Criteria: Between 3 to 8 feet, not including solids [Critical: **(44)**, below]

Worksheet 3-2

Total Separator Operational Volume (no solids): **(18)** _____________ gallons
Separation Chamber Operational Volume (no solids): **(20)** _____________ gallons
Length-to-Width Ratio: **(21)** _____________
Depth-to-Width Ratio: **(22)** _____________ (no solids)

Criteria: Between 3 and 5

Criteria: Between 0.3 and 0.5

Evaluation of Physical Characteristics Summary (Check Appropriate Blanks):

(16)(b) Width
( ) at least 6 feet wide but not wider than 20 feet, WIDTH OF SEPARATOR IS OK
( ) less than 6 feet, COULD BE PROBLEMS WITH SOLIDS REMOVAL EQUIP.
( ) greater than 20 feet, PROBLEMS WITH SOLIDS REMOVAL, SHORT-CIRCUITING

(16)(g) Operational Depth (no solids)
( ) between 3 to 8 feet, OPERATIONAL DEPTH IS OK
( ) less than 3 feet, SEPARATOR MAY BE PRONE TO SCOURING
( ) greater than 8 feet, OIL MAY NOT TOTALLY SEPARATE, TOO DEEP

(21) Length-to-Width Ratio
( ) between 3 and 5, LENGTH-TO-WIDTH RATIO IS OK
( ) less than 3, TOO SHORT, MAY BE PRONE TO SHORT-CIRCUIT
( ) greater than 5, TOO LONG, POTENTIAL MAINT./CLOGGING PROBLEMS

(22) Depth-to-Width Ratio (no solids)
( ) between 0.3 to 0.5, DEPTH-TO-WIDTH RATIO IS OK
( ) less than 0.3, MAY BE TOO SHALLOW, SCOURING POTENTIAL
( ) greater than 0.5, MAY BE TOO DEEP, SHORT-CIRCUITING, SEPARATION PROBL

WORKSHEET 3 - 5

SUMMARY OF GRAVITY OIL/WATER SEPARATOR CONDITIONS

Separator ID: ________________ Date of Evaluation: _____________

==

B. FLOW CHARACTERISTICS

Worksheet 3-3

Maximum Operational Flow - Industrial: **(23)** _____________ gallons/minute
5-year, 1-hour rain event: **(24)(b)** ___________ ft
Maximum Operational Flow - Storm Water: **(26)** _____________ gallons/minute
Controlling Flow: **(30)** _____________ gallons/minute

==

C. CURRENT CAPACITY

Worksheet 3-4

Detention Times :

Criteria: 45 to 120 minutes, typical
[Critical review below for **(43)**]

Controlling Flow in Separation Chamber (no solids holding): **(31)** _____________ minutes

Allowable Percent Solids Holding: (10% - 25%)
(39) _____________ %

Separation Chamber Detention Time with Solids Holding:

Controlling Flow: **(43)** _____________ minutes — Criteria: 45 to 120 minutes, typical

Adjusted Operational Depth: **(44)** _____________ feet — Criteria: Between 3 to 8 feet

Adjusted Depth-to-Width Ratio: **(45)** _____________ — Criteria: Between 0.3 and 0.5

Evaluation of Current Capacity Summary (Check Appropriate Blanks):

(43) Separator Detention Time (Control Flow)
( ) greater than 45 minutes, DETENTION TIME APPEARS ADEQUATE
( ) less than 45 minutes, DETENTION TIME APPEARS INADEQUATE
( ) much greater than 8 hours, POTENTIAL FOR SEPTIC CONDITIONS

(44) Adjusted Operational Depth
( ) between 3 to 8 feet, OPERATIONAL DEPTH IS OK
( ) less than 3 feet, SEPARATOR MAY BE PRONE TO SCOURING
( ) greater than 8 feet, OIL MAY NOT TOTALLY SEPARATE, TOO DEEP

(45) Adjusted Depth-to-Width Ratio
( ) between 0.3 to 0.5, DEPTH-TO-WIDTH RATIO IS OK
( ) less than 0.3, MAY BE TOO SHALLOW, SCOURING POTENTIAL
( ) greater than 0.5, MAY BE TOO DEEP, SHORT-CIRCUITING, SEPARATION PROBL

WORKSHEET 3 - 5

SUMMARY OF GRAVITY OIL/WATER SEPARATOR CONDITIONS

Separator ID: ________________ Date of Evaluation: _____________

==

D. SUMMARY OF SEPARATOR PROBLEMS/CONDITIONS:

Separator Characteristics	**Meets Criteria (Insert OK, if meets)**	**Problem Description (If does not meet criteria)**
Width **(16)(b)**		
Length-to-Width Ratio **(21)**		
Depth-to-Width Ratio		
No Solids **(22)**		
W/Solids **(44)**		
Detention Time		
Control Flow **(43)**		
Operational Depth, Adjusted **(44)**		

Excess Hydraulic Capacity: ( ) ____________ gallons/minute **(48),** or
( ) No excess hydraulic capacity. **(49)**

Worksheet 3-6

Oil/Water Separator Capacity

Solids Capacity Based on Detention Time

Date of Review: 3/22/99

INPUT INFORMATION

Separator I.D.: AS - 15
[Worksheet 3-1, (1)]

Storm Water Contribution

Area Contributing Storm Water Runoff:	Surface Area, sq. ft	Runoff Coeff.	
Paved Area	250	0.90	**[Worksheet 3-1, (15)(a)]**
Unpaved Area	400	0.50	**[Worksheet 3-1, (15)(b)]**

5-year, 1-hour Storm: 2 inches **[Worksheet 3-3, (24)(a)]**

Industrial Wastewater Contribution

Maximum Operational Flow: 15 gallons/minute **[Worksheet 3-3, (23)]**

Can the industrial activity operate during a rain event?

Rectangular Separator Dimensions (NOTE: All dimensions are internal)

Overall Length:	12	feet	**[Worksheet 3-1, (16)(a)]**
Width:	8	feet	**[Worksheet 3-1, (16)(b)]**
Overall Depth:	7	feet (from top of tank to bottom of tank)	**[Worksheet 3-1, (16)(c)]**
Length - Separation Chamber:	10	feet	**[Worksheet 3-1, (16)(e)]**
Operational Depth (no solids):	6	feet (from the liquid surface to the bottom of tank)	**[Worksheet 3-1, (16)(g)]**

INITIAL CALCULATED INFORMATION TO ESTIMATE SOLIDS STORAGE

Equivalent Drainage Area: 425 sq. ft.

Storm Water Flows to Separator:

5-year, 1-hour Storm 8.8 gallons/minute (average) 530 gallons/day

Tank Evaluation - No Solids Storage

Operational Volume: 4,308 gallons (total tank)
3,590 gallons (separation chamber)

Controlling Flow: 15.0 gallons/minute

	minutes	hours	Controlling Source
Detention Time in Separation Chamber:	239	4.0	*Industrial Wastewater*

Calculated Solids Storage Based On Detention Time

NOTE: Negative values should not be used.

Detention Time, min.	Location	Solids Volume, gallons	% Operat. Volume
45	Separation Chamber	2,915	81.2%

Worksheet 3-6

INSERT SOLIDS STORAGE AS A PERCENT OF OPERATIONAL VOLUME

(1) The % storage calculated above, or a trial-and-error solution, may be inserted.
(2) If the % value in the above table is < 10% or negative, use 10% for the input value below.
(3) If the % value in the above table is positive and greater than 25%, use 25% for the input below.

Assumed % of separator for solids storage: 25.0% (insert value as a decimal)

Summary Review	***Separation Chamber***	***Entire Tank***	***Units***	***Criteria***	***Evaluate Minimum***	***Evaluate Maximum***
Width		8	feet	6 - 20	OK	OK
Length-to-Width Ratio	1.25			3 - 5	Too short, potential short-circuiting	OK
Operational Depth, Adj	4.5		feet	3 - 8	OK	OK
Operational Vol., Adj.	2,693	3,231	gallons			
Depth-to-Width Ratio						
No Solids	0.75			0.3 - 0.5	OK	May be too deep
W/Solids	0.56			0.3 - 0.5	OK	May be too deep
Detention Time					*(Sep Chamber)*	*(Entire Tank)*
Control Fl, No Solids	239	287	minutes	45	OK	OK
Control Flow, Solids	180	215	minutes	45	OK	OK
Solids Information:						
Storage		25.0%				
Volume	898	1,077	gallons			
Thickness		1.5	feet			

Excess Hydraulic Capacity

(Assumes the input % solids storage and 45 minute detention in separation chamber)

The separator will hydraulically handle an additional **36.0** gallons/minute.

CHAPTER 4
OIL/WATER SEPARATOR COMPLIANCE EVALUATION

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CHAPTER 4
OIL/WATER SEPARATOR COMPLIANCE EVALUATION

In this chapter, the determination of the oil/water separator effectiveness will be discussed. The physical and hydraulic characteristics (including excess capacity) of the separator are addressed in **Chapter 3**. The quality of the raw and treated wastewater is discussed. The majority of this chapter is applicable to standard gravity oil/water separators. Upon completion of the compliance evaluation and a review of **Worksheet 3-5 or 3-6**, the installation will be able to answer the following questions:

- Is the separator physically configured to operate properly?
- Is the system hydraulically overloaded?
- Is the existing separator hydraulically capable of treating additional wastewater sources?
- Does the raw wastewater require treatment?
- If wastewater treatment is required, is the current separator producing a satisfactory effluent?

In bottom-line terms, the installation will know if the gravity separator is adequate, or requires closure, upgrading, or replacement.

4.1 WASTEWATER OR OIL/WATER SEPARATOR COMPLIANCE EVALUATION

After all relevant pollution prevention measures have been implemented and there is a potential for oily wastewater to enter a conveyance system, the wastewater should undergo a permit/ordinance compliance evaluation.

> A compliance evaluation should be conducted on all existing oil/water separators and all discharges being evaluated for future treatment by an oil/water separator.

4.2 PARAMETERS TO BE MONITORED

The parameters to be monitored during a oil/water separator compliance evaluation are only those addressed by the discharge permit/ordinance. To determine the relevant parameters, review the permit/ordinance and list all parameters, even those that do not have specific numerical limits but require monitoring. The permit/ordinance may specify a particular analytical method for each parameter. Be sure that the listed analytical methods are used.

4.2.1 Oil Concentration

There are two generic parameters used for measuring the oil content in wastewater: total petroleum hydrocarbons (TPH) and oil & grease. Oil & grease is the parameter associated with categorical effluent/pretreatment limitations contained in the CFRs. TPH is beginning to be utilized in some NPDES permits governing petroleum-contaminated discharges.

4.2.1.1 Total Petroleum Hydrocarbons

It should be noted that there are several available methods (418.1, 8015 and 1664) for analyzing total petroleum hydrocarbons (TPH). States may restrict the analysis to one particular method.

The various methods are listed in **Table 4-1**.

> If there are no state restrictions on TPH analysis methods, the installation should closely review the applicability of a particular method to their situation and wastewater. In general, the more accurate method is 8015.

4.2.1.2 Oil & Grease

Oil & grease does not measure an absolute quantity of a specific substance. According to Standard Methods (17^{th} Edition), the analyses are suitable for measuring biological lipids and mineral hydrocarbons. "Grease" includes fats, oils, waxes and other related constituents found in wastewater. Other extractable substances measured by oil & grease include mineral oils, such as kerosene and lubricating oil. This analysis has been the historical standard used by EPA for evaluating discharges from certain categorical industries.

The various analytical methods are listed in **Table 4-1**.

Table 4-1 Analytical Methods and Descriptions

PARAMETER (METHOD)	DESCRIPTION
Total Petroleum Hydrocarbons	
EPA SW-846, Method 418.1	Infrared (IR) measures the carbon hydrogen energy (stretch).
EPA SW-846, Modified Method 8015	This method is based on the EPA reference methods SW-846 Method 8015 and the California LUFT (Leaking Underground Fuel Tank) method for fuels analysis. This method provides gas chromatographic analysis of certain non-halogenated volatile and semivolatile organic compounds including petroleum fuels. The results may be provided as: • gas range organics (Method 8015A, C-3 to C-10). And • diesel range organics (aviation gasoline, jet fuels (JP Series) and crude oil) (Method 8015B, C-10 to C-28).
EPA Method 1664	See oil & grease below.
Oil & Grease EPA Method 413.1 - Gravimetric Separation Standard Methods 5520B - Partition - Gravimetric	This method is designed to measure non-volatile hydrocarbons.
EPA Method 413.2 - Infrared Spectrophotometry Standard Methods 5520C - Partition - Infrared	This method is designed for samples that might contain volatile hydrocarbons. This is also the method of choice for low levels (<10 mg/L) of oil & grease.
EPA Method 1664: N-Hexane Extractable Material (HEM) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM) by Extraction and Gravimetry (Oil & Grease and Total Petroleum Hydrocarbons, Respectively)	This method was published in the report of the same title, EPA-821-B-94-004, dated January 1995, and was developed to replace the Freon-based method (413.1 and 413.2) for oil & grease, and to provide a method for TPH analysis.
Total Suspended Solids	
EPA Method 160.2 Standard Methods 2540 D	Total suspended solids are the non-dissolved portion, retained on a filter, of total solids.

4.2.2 Solids

Although gravity separators are primarily designed to remove free oil, they also remove solids. To determine the compliance status of the discharge with permit/ordinance requirements, the wastewater should be analyzed for total suspended solids.

4.2.3 pH

The pH of the wastewater will affect oil removal efficiency. If the wastewater is alkaline (pH above 9.0), some oils may become more soluble (DA USACE, 1994). Most NPDES permits have pH requirements within the general limits of 6.0 to 9.0. Other NPDES permits may have pH ranges from 5.5 to 8.5. The pH limitations contained in sewer use ordinances may range from 5.0 to 10.0. The pH of the wastewater must be measured immediately after sample collection in the field.

4.2.4 Other Discharge Limitations

Other parameters (not listed above) may be included in the permit governing the discharge from the oil/water separator. As stated in other sections, the separator doesn't treat (biodegrade or remove) most contaminants. It is suggested that any parameters contained in the permit be analyzed to determine if additional treatment, other than oil/water separation, may be required to ensure permit compliance.

4.3 SAMPLING INFORMATION

Listed below is some general sampling information:

- The sample type (grab or composite) for each parameter that is listed in the permit/ordinance should be used. If the sample type is not listed, collect only grab samples.

  > If composite samples are required for some parameters, the composite should be flow-proportioned.

- The influent (raw) sample should be collected at the closest upstream manhole above the separator. (If there is not an available upstream manhole, sample the separator in the influent chamber, but do not collect any separated free product in the sample bottle.)

- The time of sample collection is critical for an adequate evaluation of the wastewater. Peak oil & grease (O&G) and total suspended solids (TSS) contaminant loadings from a washrack to the separator vary across the washing cycle. It is suggested that influent samples be collected when the wastewater appears to be high in suspended solids.

- If there is not an existing separator, the wastewater under evaluation should be sampled at the most downstream manhole before it mixes with other wastewaters or sewage.

- The effluent sample should be collected at the discharge point of the separator or at the closest downstream manhole before the separator discharge mixes with other wastewaters. If neither of the above locations is available, collect the sample from the effluent chamber of the separator.

- The time an effluent sample is collected should be based on detention time. If the detention time in the separator is 2 hours and the influent sample was collected at 9:00 a.m., then the effluent sample should be collected at 11:00 a.m.

4.4 COMPLIANCE EVALUATION

All regulated parameters should be analyzed to evaluate wastewater compliance with the permit/ordinance, but only the petroleum-based parameters should be used to determine if a separator is necessary.

The primary function of an oil/water separator is to reduce the concentration of petroleum-based materials in the wastewater to acceptable levels. Therefore, only petroleum-based limitations (oil & grease, or TPH) should be used to determine if a separator is warranted. Solids loadings can be handled by grit chambers/traps without constructing an oil/water separator and should not be evaluated concerning the compliance of a separator discharge. (Once it is decided that a separator is required, solids loadings are critical for separator design.)

The petroleum-based limitations placed on the discharge by federal, state, and/or local permits/ordinances should be compared to the wastewater characteristics, raw (untreated) and treated. The results of the compliance evaluation will yield one of the results contained in **Table 4-2**.

The comments in **Table 4-2 only** apply to petroleum-based parameters (oil & grease or total petroleum hydrocarbons). If the wastewater violates other regulated parameters, wastewater treatment systems other than oil/water separators may be advisable or required.

Table 4-2 - Available Treatment Requirements Based on Compliance Evaluation

Raw Wastewater	Treated Wastewater	Required Action
In Compliance (Discharge to sanitary/industrial sewer)	N/A	Treatment of the wastewater is not necessary. (If you have an existing separator, you should consider closing the system.) It is very important that if you decide that the raw wastewater is in compliance, that there is not a potential of future non-compliance before a separator is closed.
In Compliance (Discharge to storm sewer or navigable waters)	N/A	Treatment of the wastewater may not be necessary. Check with regulating agency prior to deciding to remove existing system or not to install a proposed system.
Non-Compliance	N/A	Review and modify the pollution prevention activities and retest, if appropriate. If non-compliance is confirmed, the wastewater will require treatment by an existing or proposed separator.
	In Compliance	The existing separator is functioning properly and no further evaluation is required.
	Non-Compliance	The existing separator is not functioning properly. The available options are: review and modify the pollution prevention activities and retest, upgrade the existing separator, or provide adequate treatment of the wastewater by new or other existing equipment.

It is suggested that the compliance evaluation be conducted once under worst case conditions with a second analysis for verification, if necessary, before decisions are made to close, replace, or upgrade an existing system.

The impacts of the comparison are listed in **Table 4-2**. If the sample results indicate that the discharge cannot maintain compliance with permit/ordinance limitations, the current pollution prevention (P2) program should be reviewed **(Section 6.9)**. Modifications to the P2 program should be made to better control releases.

If the optimum P2 program cannot prevent non-compliance with petroleum-based limitations, the existing wastewater discharge and/or the oil/water separator system should undergo a design study.

4.5 COMPLIANCE EVALUATION SUMMARY

The information generated as part of the compliance evaluation and physical information concerning the system **(Worksheet 3-5 or 3-6)** can be displayed on **Worksheet 4-1**. The completion of this form will give the installation the necessary information to determine if a separator or wastewater stream should be closely considered for design review.

WORKSHEET 4 - 1

GRAVITY OIL/WATER SEPARATOR COMPLIANCE EVALUATION

Separator ID: ________________ Date of Evaluation: _____________
Installation: ________________

==

A. Physical Characteristics (Evaluation results may also be found on **Worksheet 3-6**.)

Width: **(Worksheet 3-5, D)**	( ) Acceptable ( ) Problems: ____________________________
Operational Depth: **(Worksheet 3-5, D)**	( ) Acceptable ( ) Problems: ____________________________
Length-to-width Ratio: **(Worksheet 3-5, D)**	( ) Acceptable ( ) Problems: ____________________________
Depth-to-width Ratio: **(Worksheet 3-5, D)**	( ) Acceptable ( ) Problems: ____________________________

B. Hydraulic Characteristics (Evaluation results may also be found on **Worksheet 3-6**.)

Detention Time: **(Worksheet 3-5, D)**	( ) Acceptable ( ) Problems: ____________________________

C. Excess Capacity (Evaluation results may also be found on **Worksheet 3-6**.)

(Worksheet 3-5, D) ________________ gallons/minute

D. Compliance Evaluation - Wastewater Analysis

Permit/Ordinance Parameter	Unit	Min/Max	Influent Value	Effluent Value
______________	_______	__________	________	________
______________	_______	__________	________	________
______________	_______	__________	________	________
______________	_______	__________	________	________
______________	_______	__________	________	________
______________	_______	__________	________	________
______________	_______	__________	________	________

Was the petroleum-based limit exceeded in the influent:	( ) no a separator may not be required ( ) yes a separator is required
Was the petroleum-based limit exceeded in the effluent:	( ) no current separator is adequate ( ) yes current separator is not adequate
Was any other permit limit exceeded in the effluent:	( ) no no additional treatment system ( ) yes need additional treatment system

CHAPTER 5
OIL/WATER SEPARATOR MANAGEMENT PLAN GUIDANCE

CHAPTER 5
OIL/WATER SEPARATOR MANAGEMENT PLAN GUIDANCE

The intent of the oil/water separator management plan is to provide the installation a guide to control and manage the oil/water separator systems. This chapter provides a format by which the installation may compile the generated information. An example table of contents for a management plan developed for Moody Air Force Base is contained in **Appendix C**. The suggested content of various chapters within a management plan is discussed below. The sections contained in this chapter do not exactly match the example provided, but the same information is provided to the installation under either format.

5.1 EXECUTIVE SUMMARY

The Executive Summary should provide concise information established in the management plan including relevant regulations, design information, operation/maintenance/inspection guidance, number and type of separators, monitoring program, pollution prevention, tracking, and recommendations concerning optimizing, upgrading, replacing, or closing existing separators.

5.2 INTRODUCTION

The Introduction chapter should provide general information concerning the management plan, such as background, purpose and scope, plan organization and installation description.

5.3 REGULATORY REQUIREMENTS

Regulatory Requirements should address all requirements placed on the separator system(s) by local, state, and federal agencies; specific military branch policy/guidance; Department of Defense policy/guidance; Executive Orders; and installation policy/procedures. These regulations/policies could affect operation & maintenance, wastewater discharges, used oil holding/reuse/disposal, solids reuse/disposal, air emissions, and potential releases to the soil or groundwater. The various federal, state, and local regulations affecting separators are discussed in **Chapter 2**.

5.4 OIL/WATER SEPARATOR OVERVIEW

The overview chapter is a relatively general chapter that discusses the various categories of oil-in-water, and the types of separators within the installation and their design basis/criteria. The categories of oil-in-water and general design equations are contained in **Chapter 8**. Descriptions and design information for specific types of separators are addressed in **Chapter 9**.

5.5 OIL/WATER SEPARATOR INVENTORY

The separator inventory is one of the more important chapters in the management plan. This chapter will contain the number and types of separators; relevant permits; a description of appurtenant equipment; sources contributing to the separators; an evaluation of the physical/hydraulic characteristics of the separators; and the availability of excess hydraulic capacity. The methodology for conducting a separator inventory is provided in **Chapter 3**.

5.6 OIL/WATER SEPARATOR - OPERATION, MAINTENANCE, INSPECTION

This chapter describes the operation, maintenance and inspection requirements for each type of separator based on manufacturers' recommendations and existing policy/guidance. This section should also address solids and used oil removal methodologies and reuse/disposal. Operation, maintenance and inspection schedules should be incorporated along with any standardized forms utilized. Operation, maintenance, and inspection information are available from the manufacturer and generally described for gravity/coalescing gravity systems in **Chapter 11**.

5.7 MONITORING PROGRAM

The monitoring program should address all monitoring required to operate/maintain the systems; and ensure compliance with the associated permits and residual disposal/reuse options. The program should describe sampling procedures and frequencies, analytical methods, sample preservation/handling, equipment decontamination procedures, QA/QC requirements, reporting requirements, and target concentrations to maintain compliance. General sampling/analytical information for "used oil" and solids are contained in **Chapter 11**. Some discharge monitoring information is contained in **Chapter 4**.

5.8 POLLUTION PREVENTION

Pollution prevention opportunities for each of the particular functional activities should be addressed and relevant checklists incorporated. Information concerning industrial sources and pollution prevention opportunities are contained in **Chapter 6**.

5.9 TRACKING SYSTEM

Information on the separators and appurtenant equipment; schedules associated with operation, maintenance, inspections, and monitoring; and maintaining the results of all associated programs should be incorporated into a system where the status of any particular separator may be determined as needed. This chapter should also describe the actual tracking system.

5.10 OIL/WATER SEPARATOR EVALUATIONS AND RECOMMENDATIONS

This chapter should summarize the condition of each separator as determined during the inventory and also evaluate the individual compliance status of the raw and treated wastewater. The type of information in this chapter should address the fundamental issues concerning whether the raw wastewater requires treatment, the existing separator is adequately treating the wastewater, and does the separator require replacement/modification/upgrade/closure. Wastewater sampling methodology and analytical results should be provided to justify any conclusions reached. Final recommendations should include whether a design study is necessary to fully characterize the wastewater to ascertain the type and capacity of separator required to appropriately treat the discharge.

Total costs associated with implementing the recommendations may not be attainable until the type and size of replacement separators are established.

The methods of evaluating existing separators are contained in **Chapters 3, 4 and 7**.

CHAPTER 6
OILY WASTEWATER SOURCES AND POLLUTION PREVENTION OPPORTUNITIES AND BEST MANAGEMENT PRACTICES AT THE SHOP LEVEL

List of Tables

CHAPTER 6
OILY WASTEWATER SOURCES AND POLLUTION PREVENTION OPPORTUNITIES AND BEST MANAGEMENT PRACTICES AT THE SHOP LEVEL

This chapter describes the most common military sources of oily wastewater and runoff. The descriptions include the industrial operation, particular contaminants associated with the operation, and relevant pollution prevention activities.

> Oily wastewater may require treatment by an oil/water separator.

Oil/water separators have been installed to treat oily wastewater and/or contaminated runoff from equipment/vehicle maintenance shops; washracks; Petroleum, Oil and Lubricants (POL) transfer, use and storage areas; shipboard activities; and other shops, areas, or activities where POL contaminants may enter sanitary or storm sewers.

> The deliberate release of hazardous materials or wastes to oil/water separators is strictly prohibited (DA, 1997a).

The types and concentrations of contaminants in oily wastewaters from different sources will vary greatly. The type of contaminants in oily wastewater may be one or more of the following (DoD, 1988b):

- various oils (free, dispersed, emulsified, and dissolved) such as hydraulic, turbine, lubricating, cutting, and motor;
- fuels;
- cleaning/emulsifying agents (detergents, solvents);
- antifreeze, coolants, brake fluid;
- oily sludge; and
- particulate matter (floatable and settleable) such as sand, soil, gravel, paint skins, vegetation, light sticks, and various other materials such as ammunition, ammunition casings, bolts, beverage cans and other items common to military equipment and activities (DA USACE, 1994).

6.1 SOURCE OF WASTE STREAMS

Flows to oil/water separators can be classified into two general types of waste streams (interior and exterior) for military applications (DA USACE, 1994).

6.1.1 Interior Waste Streams

Interior waste streams consist of industrial wastewater, or washdown drainage, and usually does not contain sewage or storm water. Typical contaminants might include petroleum, oil and lubricants (POLs), and grit flushed down floor drains during equipment maintenance and washing activities. The flows are relatively small compared to exterior sources that may be impacted by storm water runoff. Interior flows generated in a hangar used for aircraft washing may be large volume.

6.1.2 Exterior Waste Streams

Exterior waste streams are composed of storm water flows that may or may not include non-storm water sources (e.g. motor pool parking with wash facility). The industrial waste stream would be generated by outside maintenance activities (washdown). Wastewater constituents consist of runoff and a variety of POLs, grit and debris.

6.2 Equipment Washracks

In order to maintain mission readiness, military units must periodically wash their vehicles/equipment. Washing is conducted in a designated area called a washrack.

> Some of the pollutants in typical washing wastewater are: detergents, solids, acid brighteners, oil, salt, water softeners, grease, and metals (EPA, 1997).

6.2.1 Administrative Vehicles

Automatic car washes are equipped with high-pressure spigots dispensing soap solutions, usually containing a degreasing agent, rinsewater, and waxes, and with rotating brushes and buffers. Self-service car washes may be covered or outdoor paved areas (CCAR, 1996).

6.2.2 Tactical Vehicles

Major installations require maintenance and repair of large numbers of tactical vehicles. An important element of vehicle maintenance (both ground and air) is interior and exterior cleaning. The exterior of a vehicle must be clean for inspection, locating leaks or damaged parts, and equipment repairs.

Higher volumes of sediment should be expected from washing field vehicles. The type of soil within the installation will also impact sediment volume, that is, clays will yield more solids per vehicle washing than sand. During wet weather, a tracked vehicle may carry over 2,000 pounds of mud back from the training area (DA USACE, 1994).

The Central Vehicle Wash Facility (CVWF) was developed by the Army in the 1970's for exterior cleaning of tactical vehicles. A CVWF consists of various structures for washing tactical vehicles and a recycling wastewater treatment system.

> Vehicle exterior washing produces high wastewater volume and sediment loading.

6.2.3 Aircraft - Rotary-wing

The military has unique rotary-wing aircraft, specifically designed and manufactured for combat use. These aircraft have a special chemical agent resistant coating (CARC) paint on the exterior surfaces which is porous and difficult to clean. The bucket-and-brush method is the most commonly used cleaning procedure for these aircraft (DA USACE, 1994).

> The cleaning products used in combination with grease, oil, carbon, paint, and other materials washed from aircraft surfaces and mechanical components produce an extremely complex waste stream which may make pretreatment difficult.

6.2.4 Aircraft - Fixed-wing

Waste streams produced from maintenance and cleaning of military fixed-wing aircraft can differ greatly from that of rotary-wing. Due to the type of flying, fixed-wing aircraft generally do not get as dirty as rotary-wing aircraft. In addition, they rarely have CARC paint on exterior surfaces (DA USACE, 1994).

Equipment is usually cleaned with detergents, corrosion inhibitors, and other cleaning compounds by brushing and high-pressure water rinses to remove oil, dirt, and salt spray. There are also rinse areas located adjacent to runways (rinse racks) that remove salt as aircraft land. This rinse water may require treatment to remove oil and grease (DoD, 1988b).

6.2.5 Aircraft Engine and Compressor Cleaning

This group includes washing jet, turboprop, or helicopter engines, internal combustion engines, and engine components on a washrack. Generally, engine washing takes place in an engine maintenance facility where engines may be removed, disassembled, and reinstalled; however, these washracks may be located outdoors. A carbon-removing compound is sometimes used in the washing process. Typical wastewater contaminants generated by the steam cleaning operation include fuel, oils, lubricants, detergents, and heavy metals (DoD, 1998).

The compressors associated with jet engines require periodic cleaning, primarily due to buildup in the system from gunfire smoke. The compressor is cleaned using a hand brush with a liquid detergent. The operation generates approximately 30 to 40 gallons. The resultant wastewater should be evaluated for hazardous waste characteristics (Nault, 1998).

6.3 VEHICLE MAINTENANCE

The most common sources of wastewater requiring pretreatment or treatment for oil or grease separation are associated with vehicle maintenance activities. Within a typical motor pool or aircraft hangar, there are numerous areas, which produce wastewater requiring treatment.

Wastewater from these sources will commonly have an intermittent flow; contain grease, oil and other floating or floatable liquids; floating debris; settleable solids including soil; mechanical components of vehicles; and other materials having a specific gravity greater than that of the wastewater. Cleaning aids such as detergents, solvents, and fuels, may be present.

Even with CVWF, it is common for many installations to allow individual battalion and other motor pools to retain exterior washing facilities. These are frequently used for both maintenance and "final or cosmetic cleaning" (DA USACE, 1994).

Maintenance on tracked-vehicles includes washing and lubricating fluid (POL) changes. Typically, the engine pack is pulled, fluids are occasionally transferred, and the hull, engine, transmission, and other mechanical components are washed prior to servicing.

Common types of vehicle maintenance operations include drainage and replacement of lubricants, coolants, and brake fluids; radiator and brake maintenance; incidental mechanical repairs; and application of paints and coatings (CCAR, 1996).

Table 6-1 - Examples of Sources Associated with Vehicle and Aircraft Maintenance

SOURCES	**DESCRIPTION** (CCAR, 1996)
Parts Cleaning & Degreasing	Cleaning and degreasing of equipment/vehicle parts and steam cleaning of engines are regularly performed as part of maintenance and repair activities.
Radiator Repair	Radiator repair shops clean, flush, and repair radiators. Radiators are drained of coolant and cleaned in tanks of highly alkaline solution (pH above 12), which may contain zinc chloride, and then rinsed with water either in a dip tank or by flushing with a hose. Radiators are pressure tested in a water tank. After testing and drying, radiators may be spray painted.
Autobody Repair & Refinishing	Paint and body shops repair and paint vehicles. Old paint may be removed by stripping and sanding. New paints may be applied with hand-held sprayers.
Corrosion Control	Corrosion control shops may remove dirt from the undercarriage of vehicles and aircraft using pressure hoses. Vehicles may also be pretreated with rust removers containing strong acids or alkalis prior to spraying on corrosion control solutions. Solvents such as kerosene or mineral spirits may be used to clean spray equipment and to remove corrosion control compounds from painted surfaces of the vehicle.
Aircraft Machine and Paint Operations	Aircraft machine and paint shop wastes include many types of lubricating and cutting oils, hydraulic fluids, paints, paint strippers, solvents, degreasers, washdown waters, and plating wastes (DoD, 1988b).
Aircraft Engine Test Cells	Two separate wastewater streams are generated during each test. First, in the engine area, a waste stream is generated due to floor washing, which contains lubricating oil, along with some fuel. The discharge of this water is intermittent and the oil/grease concentration varies. A second wastewater stream comes from the burn room where the exhaust is quenched with cooling water during afterburner testing (Chirkis, 1997).

6.4 FUELING AND POL

6.4.1 Fueling Areas and Tank/Drum Cleaning

Waste streams from fueling areas may include spills associated with fuel transfer operations, dirt and water from the surrounding hardstand. Personnel may clean and flush fuel containers (bladders) in this area. Purging and cleaning of fuel transport equipment is a major source of

POL wastewaters at many installations. These activities may result in large quantities of fuel and water entering the wastewater system. Final rinse of raw material drums may also be conducted at fueling areas.

> Use dry absorbents to pick up fuel and POL. Dispose of the sorbent as solid waste. Check flash point of the spent material for possible hazardous waste characteristics (DoD, 1988b).

6.4.2 POL Storage

POL storage wastewater results from spills, leaking containers, and storm water intrusion **(Table 6-4)**.

6.4.3 Tank Farm Operations

There are two major sources of POL contaminated liquids associated with tank farm operations: water within secondary containment systems and tank bottoms. Secondary containment systems are designed to collect leakage/spillage of petroleum related materials from tank farm operations. The containment system also collects incident rainfall, which must be occasionally removed. Tank bottoms are the water that collects within the petroleum storage tanks that must be removed. Material transfer areas may also contribute contaminated runoff and incidental spillage.

6.5 METAL PRODUCTS AND MACHINERY

Metal parts or end products are repaired or remanufactured at certain military facilities. Drawing, extruding, die-casting, or otherwise forming metal products involves the use of cutting or cooling oils. Usually these oils are emulsified, which makes oil/water separation more difficult to treat. Typically the separation must be preceded by a polymer and/or other chemical addition to float the oil so that it can be removed. The type of oil and how the oil is removed from the metal product will determine the pretreatment chemistry required (EPA, 1993).

> In some operations (e.g., cold rolling), material substitution may be of use, particularly using graphite-based lubricants, which can usually be recycled. In other cases (e.g., engine manifold manufacture), aqueous cleaners that act as surfactants can be applied to the metal product as a first step in the separation process (TNRCC, 1996).

6.6 FLOOR DRAINS

> Unless necessary, due to health and safety considerations, all floor drains should be permanently closed to prevent the release of compounds that cannot be treated by the separator.

Historically, discharges from floor drains in an indoor maintenance bay or hangar would typically result from either wet cleaning of the floor, wet maintenance cleaning of mechanical areas on vehicles, or spills. Floor drains receive wastes containing detergents, sediments, and road salts; leaked or spilled fuels, oils, and solvents; particulate paint wastes with heavy metals; and drips and spills from corrosion control operations. Spill residuals, along with "oil-sorb" (both new and used) and dirt, may enter drains when the floors are cleaned (CCAR, 1996).

6.7 SHIPBOARD OILY WASTEWATER

Oily waste originates in bilges, oily waste holding tanks for collecting lubricating oils and water contaminated fuels, and ballast water on board ships and throughout shore facilities. The largest oily wastewater (by volume) source is shipboard (DoD, 1988b).

Bilge wastes are normally the primary contributor, both in volume and contaminant concentration, to an oily waste treatment system. Wastewater collected in the bilges of ships normally contains about 1 percent oil and grease, heavy metals and organic contaminants **(Table 6-2)**. Treatment or pretreatment of bilge water prior to discharge is necessary.

To improve stability under various operating conditions, vessels of the Armed Forces have the capability to transfer (ballast) water into and out of dedicated tanks. For a description of the types of ballast water, see **Table 6-3**. Ballast water discharged from ships and barges contains lower contaminant levels but is at higher volumes than bilge water (DoD, 1988b).

> Oily wastewater and ballast water from ships contain high concentrations of dissolved solids, which may cause process upsets, corrosion, and scale formation.

Table 6-2 - Potential Bilge Contaminants (Tompkins, Undated)

CONTAMINANT TYPE	CONTAMINANT DESCRIPTION
Acidic Mixture (pH = 1.9)	Rust remover
Basic Mixture (pH = 9.4)	Ammonia, di- and tri-sodium phosphate
Saline Conditions	Seawater
Detergents	Antibacterial cleaner, hard water stain cleaner, soap scum remover.
Foam	Aqueous Film Forming Foam (AFFF)
Petroleum Hydrocarbons	Kerosene, mineral spirits, synthetic lube oil, used motor oil
Oxidizers	Bleach
Paints	Enamel spray paint, oil-based paint, paint primer, zinc chromate primer
Solvents (insoluble)	Paint thinner, methyl chloride
Solvents (soluble)	Diethylene glycol, isopropyl alcohol
Treatment Preps	Scale cleaner

Table 6-3 - Type of Ballast Water (EPA & DN, 1998)

TYPE OF BALLAST WATER	DESCRIPTION
Clean Ballast (Non-POL Replacement Ballast Water)	The ballast water is placed in tanks dedicated for ballast water only. This mode of operation is used by most surface vessels of the Armed Forces.
Dirty Ballast	Dirty ballast is seawater pumped into tanks that normally contain fuel. Prior to taking on seawater, the fuel is transferred to another tank.
Compensated Fuel Ballast	Fuel is continuously replaced with seawater in a system of tanks as fuel is consumed. During refueling, fuel displaces the seawater, which is discharged.

6.8 STORM WATER RUNOFF

Storm water runoff becomes contaminated as it flows across parking lots, fuel storage and transfer areas, storage areas containing raw materials and finished products, and outdoor lubrication racks. Where feasible, segregate potentially contaminated runoff from uncontaminated runoff to minimize the volume of water requiring treatment. Suspended solids in runoff must be minimized to maximize effectiveness of the oil removal system.

Table 6-4 - Examples of Activities or Areas Associated with Oily Runoff

ACTIVITY OR AREA	DESCRIPTION (DA USACE, 1994)
Hardstand Drainage (Paved Areas)	Drainage from the hardstand will occur during area "wash down," from vehicle washing, spillage or leakage of oil or cleaning agents, and during a storm event. Cans placed under vehicles to capture oil leaks are often left exposed to rainfall: • The oil and water mixture that results is frequently emptied into an oil/water separator. • If unchecked for an extended period, drip cans may overflow and mix with hardstand drainage.
POL Storage	Waste oil and anti-freeze, normally stored in 55-gallon drums, are the two most common substances found in POL storage areas. Often, these waste drums are stored without adequate rainfall protection. Storm water can then intrude and overflow the drums, resulting in the mixture entering the drainage system.
Grease Racks	Grease racks allow vehicles to be elevated for inspection and maintenance purposes. Maintenance performed typically involves radiator repairs, lubrication and oil changes. These processes may result in spilled anti-freeze and oil. Storm water will also contribute to the waste stream, as most elevated grease racks are uncovered.
Waste and Raw Material Storage	The uncontrolled storage of various waste and raw materials such that the materials may come in contact with incident rainfall and/or runoff could generate runoff requiring treatment.

6.9 POLLUTION PREVENTION OPPORTUNITIES AND BEST MANAGEMENT PRACTICES

The primary concept of pollution prevention is that the easiest way to address/treat pollution is to prevent it from occurring in the first place. Significant efforts have been undertaken by both the public and private sectors to develop general and specific steps to remove or reduce the generation of wastes from various operations.

Pollution prevention in this manual primarily focuses on: the elimination of unnecessary operations; reduction of POLs and spilled materials to storm, sanitary and industrial systems; and the elimination, to the degree practicable, of contaminants that adversely impact, or cannot be treated by, an oil/water separator.

General Pollution Prevention Questions Applicable to Any Discharge:

1 Is the operation generating the discharge necessary for the mission?
2 Can the operation be combined with a similar nearby operation?
3 Can the wet operation be converted to a dry system?
4 Can the generated discharge be combined with similar wastewaters and treated by an existing treatment system?
5 Can the wastewater volume be reduced?

The best method of pollution prevention is to totally eliminate the process generating the waste. To accomplish this, a careful evaluation is required to determine if the entire process or any of its component parts are necessary to meet the assigned mission. Other general approaches to pollution prevention include:

- limiting the generated byproducts (for example, converting a discharging process to a dry or recycle system);
- consolidating similar processes (move the process to a new location where a similar process is being conducted); or
- consolidating similar wastewater streams (combine several sources of similar characteristics to be treated by one rather than several separators).

> Prior to implementing any process change or material substitution be sure that technical orders are not violated (EPA, Undated). Do not implement any process change that conflicts with existing technical orders and other service technical directives.

Table 6-5 contains a list of various sources, activities, and conveyances that could contribute to an oil/water separator along with a list of pollution prevention opportunities and best management practices. (Additional information on pollution prevention may be obtained from Enviroene Search located at http://es.inel.gov/cgi-bin/search.pl?alldb=on.) The site-specific, pollution prevention plans developed by each installation should also be reviewed and implemented, as appropriate.

Table 6-5 - Pollution Prevention Opportunities and Best Management Practices for Various Sources, Activities, and Conveyances Contributing to an Oil/Water Separator

SOURCE, ACTIVITY, OR CONVEYANCE	POLLUTION PREVENTION OPPORTUNITY AND BEST MANAGEMENT PRACTICES
General Wastewater Pollution Prevention	• If the operation is not necessary to the mission, it should be eliminated. • If the operation is necessary to the mission: Can it be converted from a wet to a dry process? Can the operation be conducted at another location where a similar operation is being used? Can the generated wastewater be diverted to a nearby treatment system? Can the wastewater volume or contaminant loading be reduced?
Detergent Use (Chapter 10)	• If possible, the use of detergents in operations that discharge wastewater to oil/water separators should be avoided. • If detergents are necessary (Gedlinske, 1997): Use detergents that are good cleaners but poor emulsifiers. Use no higher concentration of cleaner than is necessary to get the parts/equipment clean.
Floor Drains	• Unless required by health and safety considerations, floor drains should be plugged. • Sweep floors to remove dirt before cleaning (EPA, 1994a). • Floors should <u>not</u> be cleaned by flushing with water; use a wet-dry vacuum or mop and dispose of cleaning wastes properly (CCAR, 1996). • If the floor drain must remain open, the drain should only be used for final rinsing of the floor after any oils or other spill materials are cleaned up with dry materials (DoD, 1997f).
Floors	• Seal service bay concrete floors with an impervious material to facilitate cleanup without using solvents (CCAR, 1996). • Areas where vehicles are stored or repaired should have an impermeable surface and provisions for containment of vehicle leaks.
Spill Clean-up	• Use pans, trays, or wringable pads for capturing and retrieving liquids instead of granular sorbents (EPA, 1994a). • If dry sorbents must be used, pick up and remove used sorbent immediately. Dry absorbents may be collected and disposed of with solid waste materials, after appropriate characterization.
Storm Water from Exterior Industrial Operations: • Washracks • Material/Waste Storage • Vehicle Storage	• Locate operation inside or eliminate, if unnecessary. • Provide trench drains, curbing, or grading to isolate and minimize the surface area contributing to the separator. • Cover/roof the operation/source area. • In general, flow equalization upstream of a separator is beneficial where the separator would otherwise experience slug loads.

Corrosion Control	• Use high-pressure washing as an alternative to solvents. • Do not undercoat vehicles with used solvent or solvent sludge. • Solvent drippage from cleaning surfaces prior to corrosion protection or undercoating must be collected in a holding tank and disposed of properly (CCAR, 1996).
Equipment Washing	• If the washrack is located outside, review Storm Water from Exterior Industrial Operations. • Every effort should be made to schedule and use the central vehicle wash facility (CVWF) for all cleaning of vehicle exteriors. Prohibiting vehicle exterior washing in the motor pools can eliminate one entire wastewater stream. • Aromatic and chlorinated hydrocarbon solvents should be eliminated from vehicle washing.
General Maintenance & Repair	• Use drip pans to minimize leaks and spills onto the floor. • In engine rebuilding, engine bakeout and ball peening may be a suitable substitute for engine boilout (CCAR, 1996).
Leaking Vehicles	• Use drip pans, isolated from floor drains or other possible pathways to the environment.
Oil Emulsion Control (Chapter 10)	• Using detergents to clean up work areas increases emulsification and inhibits gravity oil/water separation. • In aqueous parts cleaning, use detergents that are good cleaners but poor emulsifiers to improve grease and oil removal at the separator (Gedlinske, 1997). • Use no higher concentration of cleaner in aqueous cleaning than is necessary to get the parts clean. This will also help to keep emulsification to a minimum (Gedlinske, 1997). • Where possible use only hot water for the precleaning and subsequent cleaning steps (CCAR, 1996). • Keep pH at acceptable levels. Monitor pH to minimize emulsification of oils in the aqueous cleaning process (Gedlinske, 1997). • Use of high-pressure water causes emulsification but is generally less detrimental to oil/water separation than the use of detergents (DoD, 1997e). • The formation of oil emulsions should be minimized and emulsions should be segregated for special treatment whenever possible.
Parts Cleaning & Degreasing	• Area should be isolated, preferably located within a containment area, and the floor should be sealed with a suitable impermeable material. • Reduce material loss by removing parts slowly, allowing the part to drain thoroughly over the tank. • Spent aqueous and other non-hazardous solutions may become hazardous after use due to elevated concentrations of heavy metals or toxic organic substances (CCAR, 1996).
Painting	• Painting should be done in a separate, secure area with no floor drains. • Water curtains in paint booths must recirculate the water used. There should be no discharges.

Radiator Repair Shops	Radiator repair shops can use a three-step system: a boil-out tank (no discharge) for cleaning; a dragout (no discharge) from which rinsewater is decanted into the boil-out tank; and a recycling system for rinsing and pressure testing (CCAR, 1996).
Scrap Metal & Other Lubricated Parts	• Scrap metal parts, or other parts that were in contact with lubricant, must be stored in enclosed containers indoors or in areas secured from storm water accumulation. • Dumpsters containing scrap metal should (CCAR, 1996): have drain plug in place and be covered, and be located on a concrete pad with a separate collection catch basin, which is pumped out periodically.
Solvent Use (Chapter 10)	• Solvents should not be discharged to an oil/water separator. • Reduce or eliminate solvents by using one or more methods below, as appropriate: Precleaning parts with a squeegee, rag, wire brush, or hot water High-pressure water washing; Hot water washing; Steam cleaning; or Substitute aqueous or alkaline cleaners, particularly for non-aluminum parts (CCAR, 1996).
Storage - Material and Waste	• Regularly inspect material and waste storage areas for spills and leaks. • Use secondary containment for storage areas. • Store material and wastes indoors or in covered areas.

CHAPTER 7
WHAT YOU SHOULD KNOW BEFORE INSTALLING, UPGRADING, OR REPLACING AN OIL/WATER SEPARATOR

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CHAPTER 7
WHAT YOU SHOULD KNOW BEFORE INSTALLING, UPGRADING, OR REPLACING AN OIL/WATER SEPARATOR

The objective statement of the Department of Defense, Clean Water Act Services Steering Committee, Policy and Guidance for Oil/Water Separators Workgroup is:

"Provide policy and guidance to optimize oil/water separator operations and investments."

In fulfillment of the objective statement, this chapter discusses the methodology by which the installation should evaluate existing or proposed oil/water separator needs. Emphasis will be placed on the elimination of unnecessary systems and the consolidation of those wastewater sources that require oil removal.

> Minimization of the number of separators is encouraged by:
> - eliminating unneeded separators;
> - diverting flows to existing under-loaded systems; and
> - combining flows from various operations into a single separator.
>
> Fewer oil/water separators to operate and maintain may improve the overall installation separator program.

7.1 IS AN OIL/WATER SEPARATOR NECESSARY?

The ultimate management solution is to eliminate the need for an oil/water separator and remove it from service (AF, 1996). Numerous oil/water separators exist at military installations, some of which are not needed or are not accomplishing their intended purpose (Hudson, 1998a). Misapplications and inadequate performance have resulted from poor design, improper selection of pre-manufactured units, failure to adequately understand the character of wastewaters being treated or pretreated, and lack of proper maintenance (DoD, 1997e).

> The need for an oil/water separator should be carefully evaluated before undertaking its design.
>
> If an oil/water separator is not necessary to meet environmental requirements, it should be removed to eliminate the associated liabilities.

Figure 7-1 presents a flow diagram for determining whether a separator is needed. To assist you in following the chart, a brief explanation of each decision area is discussed below:

Figure 7-1
OIL/WATER SEPARATOR DECISION - FLOW DIAGRAM

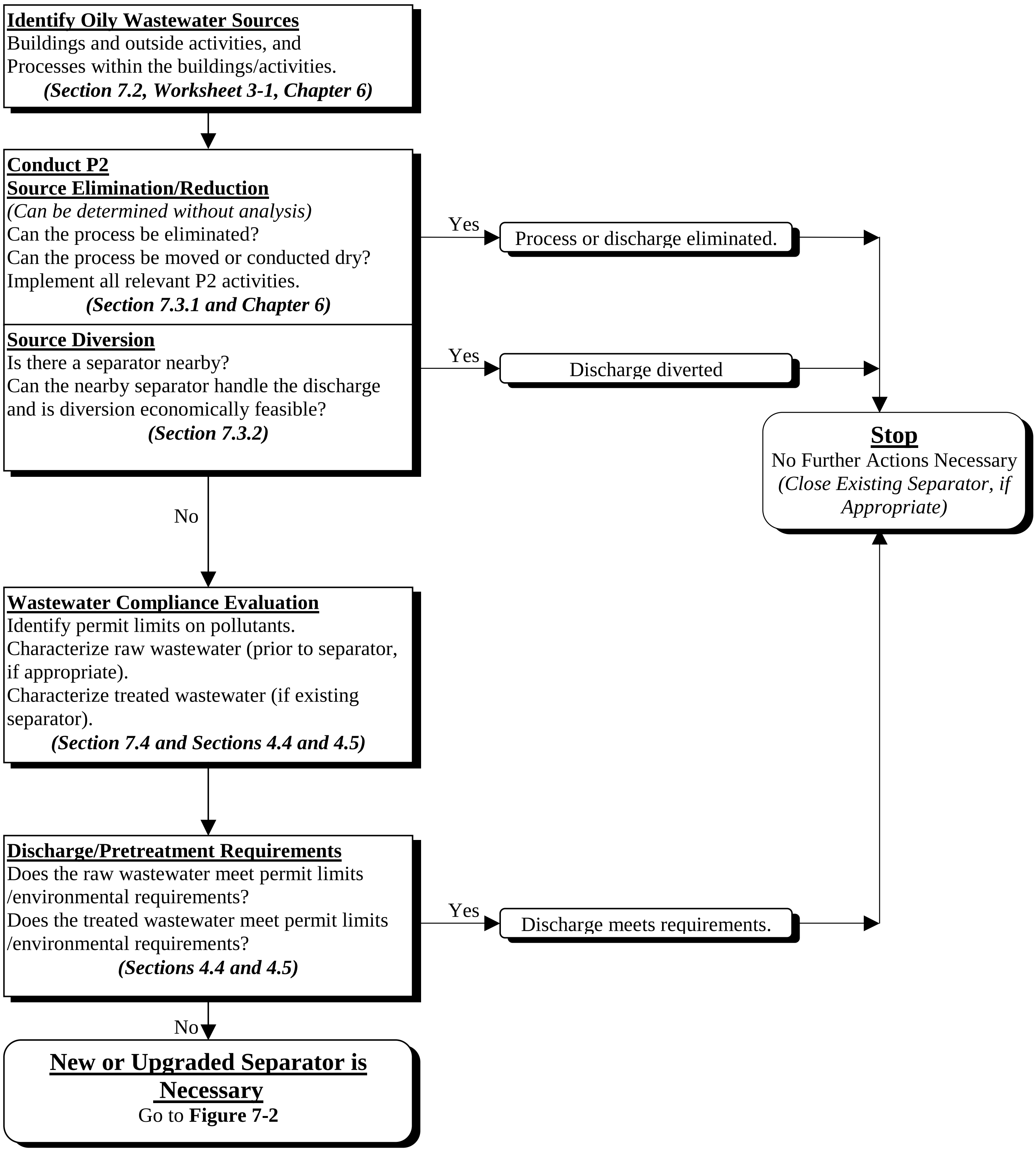
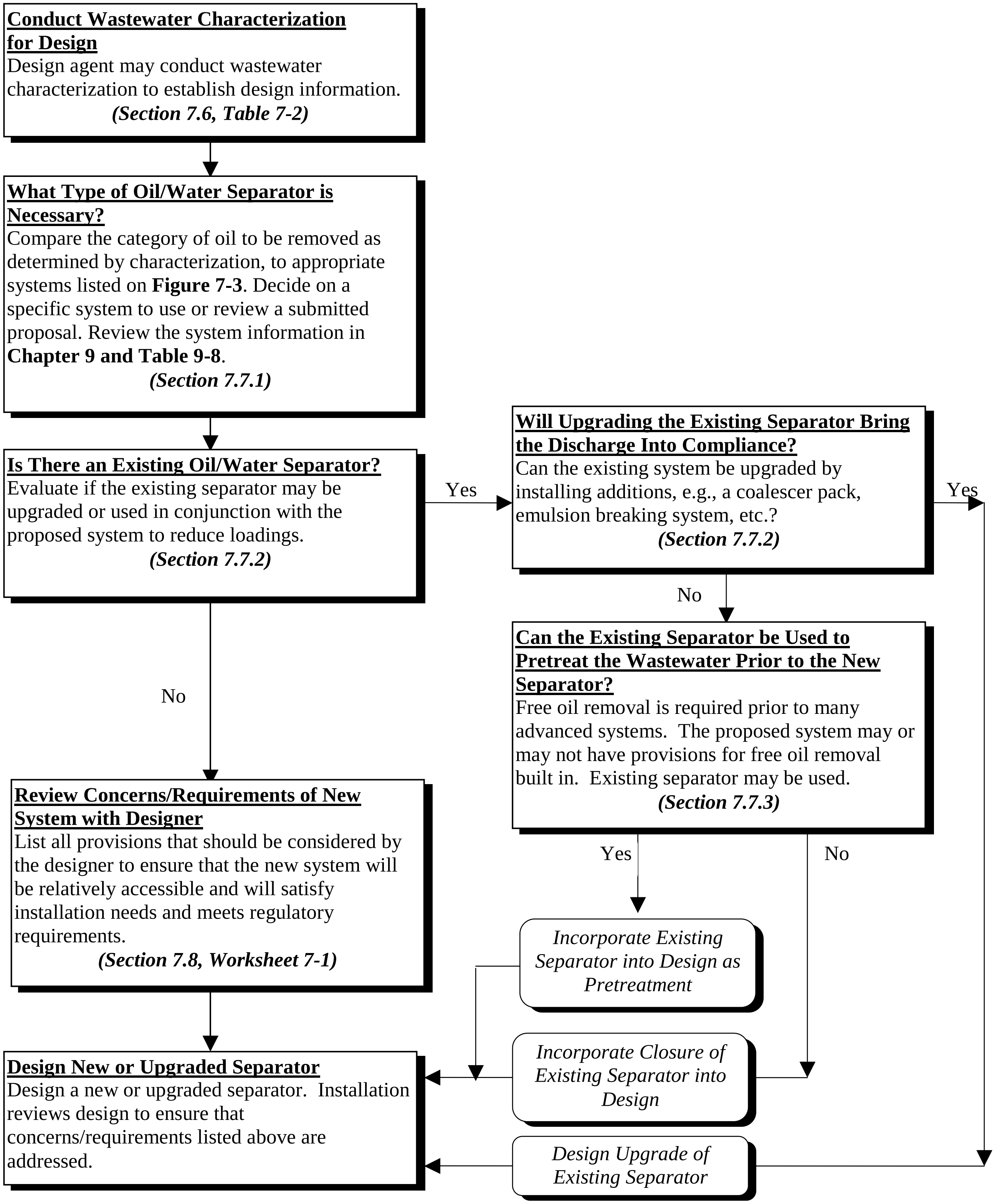


Figure 7-2
OIL/WATER SEPARATOR DESIGN - FLOW DIAGRAM



7.2 IDENTIFY OILY WASTEWATER SOURCES

Those areas/activities contributing to the existing or proposed separator should be clearly established. The type of information **(Chapters 3 and 6)** that should be obtained include, but not limited to:

- Contributing surface area that is exposed to rainfall;
- A description of each operation that will contribute to the separator including wastewater flows and the conditions that would generate those flows, types of chemicals/materials that are used in each operation, expected wastewater characteristics, clean-up procedures required at the end of the operation, frequency and duration of each operation, and a summary of operations that can take place at any one particular time;
- Interior/exterior raw material storage and handling practices; and
- Facility maintenance required within the source area/buildings (such as floor washing).

7.3 CONDUCT POLLUTION PREVENTION

7.3.1 Source Elimination/Reduction

Once the wastewater sources have been identified, each process should be evaluated against the specific pollution prevention guidance for those activities contained in **Chapter 6**. The general pollution prevention guidance listed in **Table 7-1**, below should also be evaluated.

Table 7-1 - General Pollution Prevention Guidance

SOURCES OR CONDITIONS	POLLUTION PREVENTION OPPORTUNITY (DoD, 1997e)
Process Necessity	If the process is not necessary, eliminate it.
Wet Processes	If possible, convert to dry process.
Storm Water Pollution Prevention Plan	Should implement best management practices that will minimize or eliminate the need for oil/water separators to treat runoff in most instances.
Point Source Controls	• May eliminate or reduce the wastewater volume and contaminant concentrations. Point source control techniques include process change or modification, material recovery, material substitution, wastewater segregation, and water reuse. • If a process does not generate oily wastewater, remove it from the separator.
Good Housekeeping Practices	Minimizing leaks and contamination, avoiding spills, using drip trays and pans, employing spill containment techniques, and discarding oil only when it is no longer serviceable (DoD, 1997f).
Floor Drains	Should be plugged, if practicable, and is not required due to health and safety concerns.

Dry Absorbents	Should be considered to minimize the amount of oils reaching installation sewers. Evaluate the flash point of spent absorbent for possible hazardous waste designation under RCRA guidelines (DoD 1997f).
Oil Emulsions	• Formation of emulsions should be minimized. • Emulsions should be segregated for special treatment wherever possible. • Using detergents to clean up work areas increases emulsification and inhibits gravity oil/water separation. Use of high-pressure water also causes emulsification but is generally less detrimental to oil/water separation than the use of detergents.
Divert/Consolidate Discharge	Consider: • Changing the point of discharge to a location that may have less stringent requirements and to protect sensitive environmental areas • Diverting the wastewater to an existing or more effective oily wastewater treatment system, and • Consolidating similar wastewaters to minimize the number of treatment systems.

7.3.2 Source Diversion/Consolidation

The next step would be to determine if there are existing separator systems in the immediate area that are under-loaded and could adequately treat the wastewater under evaluation. If so, conduct a cost comparison to determine if it would be economical to divert the waste stream to the nearby system, when compared to the cost of installing and maintaining a new system.

If there are no nearby systems, determine if there are any nearby sources that could be economically combined with the wastewater under evaluation to a single proposed separator.

7.4 WASTEWATER COMPLIANCE EVALUATION

After all relevant pollution prevention **(Chapter 6)** measures have been implemented and there is still a potential for oily wastewater to enter a conveyance system, the wastewater should undergo a permit/ordinance compliance evaluation. The details concerning the evaluation and various interpretations of the results are presented in **Sections 4.4 and 4.5**. This evaluation should be completed prior to any activities related to installing, replacing, or upgrading an oil/water separator.

7.5 WHY DOESN'T MY CURRENT SEPARATOR WORK?

If a separator treats the discharge under review, and the discharge does not meet the permit/ordinance requirements, the reason(s) why the separator does not work must be determined. The elimination of the problem(s) affecting the existing separator may make separator replacement unnecessary, or improve the efficiency of the replacement system. For example, the category of oil removed by a parallel plate coalescing system is very similar to that removed by a standard gravity separator; and chances are, if the gravity system doesn't adequately treat the wastewater, the coalescing system won't do a significantly better job.

If the current system is not working properly, the following should be evaluated:

- Is the physical configuration of the separator affecting treatment? **(Worksheet 3-5 or 3-6)**
- Is the system hydraulically overloaded? **(Worksheet 3-5 or 3-6)**
- Is the separator undergoing appropriate maintenance and removal of residual materials (oil and solids)? **(Chapter 11)**
- Is the operation or building maintenance emulsifying the oil? (Detergents, solvents, high-pressure hot-water systems, excessive agitation, etc.) **(Chapter 10)**
- Does the wastewater conveyance system (pumping) emulsify the oil?
- Is the oil in the wastewater capable of being removed? (Specific gravity near that of the wastewater, >0.95; is the oil, water-soluble?)
- Are the wastewater characteristics (alkaline, pH > 9) causing oil emulsification?

After the above issues are resolved, the problem(s) with the existing discharge can be isolated to:

- separator/conveyance system deficiencies (hydraulic or configuration);
- separator maintenance;
- contributing processes/material holding;
- building maintenance; and
- storm water.

Once the problem source(s) is identified, determine if something can be done to eliminate or mitigate the problem. If the problem cannot be adequately addressed such that appropriate treatment of the wastewater is attained with the existing system, an upgraded or new separator may be warranted.

7.6 WASTEWATER CHARACTERIZATION FOR OIL/WATER SEPARATOR DESIGN

The specifics of the oily wastewater problem should be carefully studied to determine if a separator is required, and if so, what type. Typical characteristics that should be determined include the design flow, total oil concentration, the category of oil (free, emulsified, or dissolved), and solids information. Other wastewater characteristics may indicate potential emulsification or septicity problems. The various parameters of concern are below and summarized in **Table 7-2**.

> It should be noted that wastewater monitoring is required to assist in the design of any separator, but excessive information may cost more than a simple separator system.

There are multiple approaches to wastewater characterization studies.

A separator design characterization study requires a different approach than a compliance evaluation. It is suggested that the separator designer, also conduct the wastewater characterization. The primary reason is that if the newly installed separator does not function as required, the designer may state that the installation supplied inadequate wastewater characteristics.

Listed below are wastewater characteristics that may be required to complete a design characterization study. Not all parameters listed below are necessarily required.

7.6.1 Flow

The activities producing a wastewater requiring some form of pretreatment will normally be discontinuous. Minimum flow rates will frequently be at or near zero. Peak flow rates can be encountered for several hours, and will normally be the flow rate of interest for design purposes. It is common for pretreatment devices to receive low flows for several days, possibly weeks, while military units are deployed for training or other purposes (DA USACE, 1994).

> The longer the residence time of the waste stream in the oil/water separator, the more efficient it will be at separating oil to a point (AF, 1996). It should also be noted that extended detention times may be detrimental, in that, septic conditions may develop.

The design flow should be based on the maximum flow rate to be treated, including the addition of any anticipated/concurrent oily wastewaters and storm water runoff. In determining peak flow rates, daily-, seasonal-, and shift-variations should be considered. Flow rates should be measured where the process already exists, or accurately estimated where it does not (DoD, 1997e).

> Unless flow equalization is provided upstream of the separator, the design flow should be based on the maximum flow rate attributable to current and future oil-contaminated process wastewaters and storm water runoff (API, 1990).

7.6.1.1 Production-based Flows

In some cases, establishing production-based wastewater discharge rates may be useful for projecting future flows. For example, the maximum flow expected from an aircraft washing facility may be estimated using the expected washwater gallons per aircraft multiplied by the maximum number of aircraft to be washed in a given period. If unit wastewater generation rates from another facility are used, differing conditions should be accounted for, such as differences in the type and size of aircraft and washing procedures (DoD, 1997e).

7.6.1.2 Time-based Flows

Time-based flows are calculated by multiplying the flow (gallons per minute) that the activity discharges, by the time (minutes/day) that the activity is conducted. A typical time-based flow is cooling water.

7.6.1.3 Runoff Contribution

If the separator receives runoff, the storm water impact must be taken into account when evaluating the flows contributed to the separator. The first required information is the surface area (paved and unpaved) of the site contributing runoff to the separator. This surface area is sloped toward the drains and grates that serve the separator and the surface area of roofs that drain to the separator system. (Runoff contributing to a proposed separator should be eliminated to the maximum degree practicable.)

> Where high flows of short duration are to be handled, an alternative to constructing a larger separator is to separate extraneous flows from the system. In general, flow equalization upstream of a separator is beneficial where the separator would otherwise experience slug loads (DoD, 1997e).

The second major piece of information used to evaluate runoff contribution is the design storm event. A short-duration, high-intensity rain event is needed to evaluate hydraulic slug loading of the separator. The rain event used to calculate slug loading has not been established in the regulations. The DoD has established an oil/water separator design storm as a 5-year, 1-hour event (DoD, 1997g).

7.6.2 Oil Concentration

There are two generic parameters used to measure the oil content in wastewater: total petroleum hydrocarbons (TPH) and oil & grease. Oil & grease is the method associated with categorical effluent limitations contained in CFRs. TPH is beginning to be utilized in some NPDES permits. For a discussion on TPH and oil & grease, including analytical methods, see **Section 4.2.1**. Some states have established monitoring programs using other organic compound groups, such as polyaromatic hydrocarbons (PAH), rather than TPH or oil & grease.

7.6.3 Oil Category

Gravity separators remove only free oil and, may remove some mechanically emulsified oil. To determine the concentration of free oil, analyze an influent sample for oil concentration **(Section 4.2.1)**, conduct a “Determination of Susceptibility of Separation” on the sample **(Section 8.2.1.3)**, and analyze the separated water phase for oil concentration. The concentration of free oil is the difference between influent (total oil) concentration and the water phase (emulsified and dissolved oil) concentration (API, 1990).

If the concentration of emulsified and dissolved oil is greater than the limitations contained in the permit/ordinance controlling the discharge, a gravity or coalescing gravity system may not adequately treat the wastewater. The source of the emulsion should be determined and eliminated, if practicable.

7.6.4 Solids

Although gravity separators are primarily designed to remove free oil, they also remove solids. Therefore, the solids content of the wastewater is important in overall system design. Analyses could include total suspended solids (TSS) and settleable solids. These analyses will help determine the amount and frequency of settled materials that will need to be removed from the bottom of the separator and the advisability of providing grit or other solids removal systems upstream of the separator.

> Solids loadings can be handled by grit chambers/traps without constructing an oil/water separator and should not be evaluated concerning the need for separator installation. (Solids loadings are critical for separator design, once it is decided that a separator is required.)

7.6.4.1 Total Suspended Solids

Total suspended solids are the non-dissolved portion, retained on a filter, of total solids. Standard Methods 2540 D (EPA Method 160.2).

7.6.4.2 Settleable Solids

Settleable solids is the term applied to material settling out of suspension within a defined period. This test provides an indication of the amount of settled materials that will have to be removed from the separator. Standard Methods 2540 F.a (EPA Method 160.5).

7.6.5 Temperature (minimum)

Wastewater temperature has a major impact on the efficiency of the separator. Temperature affects oil viscosity. The lower the oil viscosity (higher temperature), the faster the rise velocity of the oil. For example, oil droplets in 40°F water will rise at half the rate that the droplets would rise in 90°F water, other conditions being constant (Storehouse, Undated). The lower the temperature the more difficult separation will be, therefore, the lowest temperatures should be used in sizing the separator (DA USACE, 1994).

> In cold climates, the use of insulation or a heating system may be justified.

Information concerning wastewater temperature, and relevant density and viscosity data are available from various references. The lowest wastewater temperature can be estimated from (DA USACE, 1994):

- the ambient air temperatures experienced during washing operations;
- the water source such as potable water mains;
- high-pressure, hot-water cleaning machines; or
- the ambient ground temperature several feet below grade (where separators may be located).

> In general, a conservative value within the 4.5 - 15.5 °C (40-60 °F) range should be used unless actual testing indicates differently (DA USACE, 1994).

7.6.6 pH

The pH of the wastewater will affect oil removal efficiency. If the wastewater is alkaline (pH above 9.0), some oils may become more soluble (DA USACE, 1994).

7.6.7 Wastewater Oil-fraction Specific Gravity (at minimum design temperature)

The greater the difference in specific gravity between the oil and water, the more efficient separation will be. For example, #2 fuel oil has a specific gravity of 0.85 and #6 fuel oil has a specific gravity of 0.95. This means that #2 will rise three times faster than #6 fuel oil in water (Storehouse, Undated). The specific gravity of oil to be removed should be determined using published data for the heaviest oil expected in the wastewater (DA USACE, 1994).

The greater the difference in specific gravity between the oil and water, the more efficient separation will be (DA USACE, 1994).
In general, the specific gravity of the oil fraction will range from 0.82 to 0.95. Frequently, a specific gravity greater than 0.90 will be appropriate for design (DA USACE, 1994).

7.6.8 Salinity

Salinity is an indication of the dissolved salt content of the wastewater. One indicator measurement method of salinity is conductivity, which measures the ability of an aqueous solution to carry an electric current. Increased salinity (seawater) increases the specific gravity and absolute viscosity of the water.

7.6.9 Potential Septicity Measurements

Extended periods of zero or low flow to the separator can create septicity problems (DA USACE, 1994). This is especially true for applications generating material that is susceptible to biodegradation. It is common for military pretreatment devices to receive low flows for several days or possibly weeks.

> Those parameters that can be used to evaluate potential septicity problems include: volatile suspended solids (VSS), biochemical oxygen demand (BOD), and chemical oxygen demand (COD).

7.6.10 Emulsifying Agents

Detergents, soaps, and cleaners are designed to remove oily grime from dirty weapon systems, vehicles, or other components and can adversely affect oil/water separator operation. These agents are designed to increase solvency of oily grime in water. Hence, the oil droplets take longer to separate from water reducing removal efficiency. Overzealous use of detergents can degrade efficiency by completely emulsifying oil in the wastewater stream, thus allowing it to pass through the oil/water separator unaffected (**Section 9.9** and **Chapter 10**) (AF, 1996).

One analytical method that measures the presence of some detergents (surfactants) is methylene blue active substances (MBAS). MBAS indicates the degree of anionic surfactants in the wastewater.

Chemical analysis of the wastewater is not always required. A review of current or proposed activities contributing to the separator should provide adequate information concerning the use of emulsifying agents. The use of emulsifying agents should be avoided to the degree practicable.

> Type and amount of detergents present in the wastewater and potential changes in future detergent use should be considered during design (DoD, 1997e).

7.6.11 Discharge Limitations

Other parameters (not listed above) may be included in the permit governing the discharge from the oil/water separator. As stated in other sections of this document, the separator doesn't treat (biodegrade or remove) most contaminants. It is suggested that any parameters contained in the permit be analyzed to determine if additional treatment may be required to ensure permit compliance.

7.6.12 Other Characteristics

Other wastewater characteristics that should be established for minimum temperature for separator design are wastewater specific gravity and absolute (dynamic) viscosity (DoD, 1997e).

Table 7-2 - Summary Information on Design Wastewater Characteristics

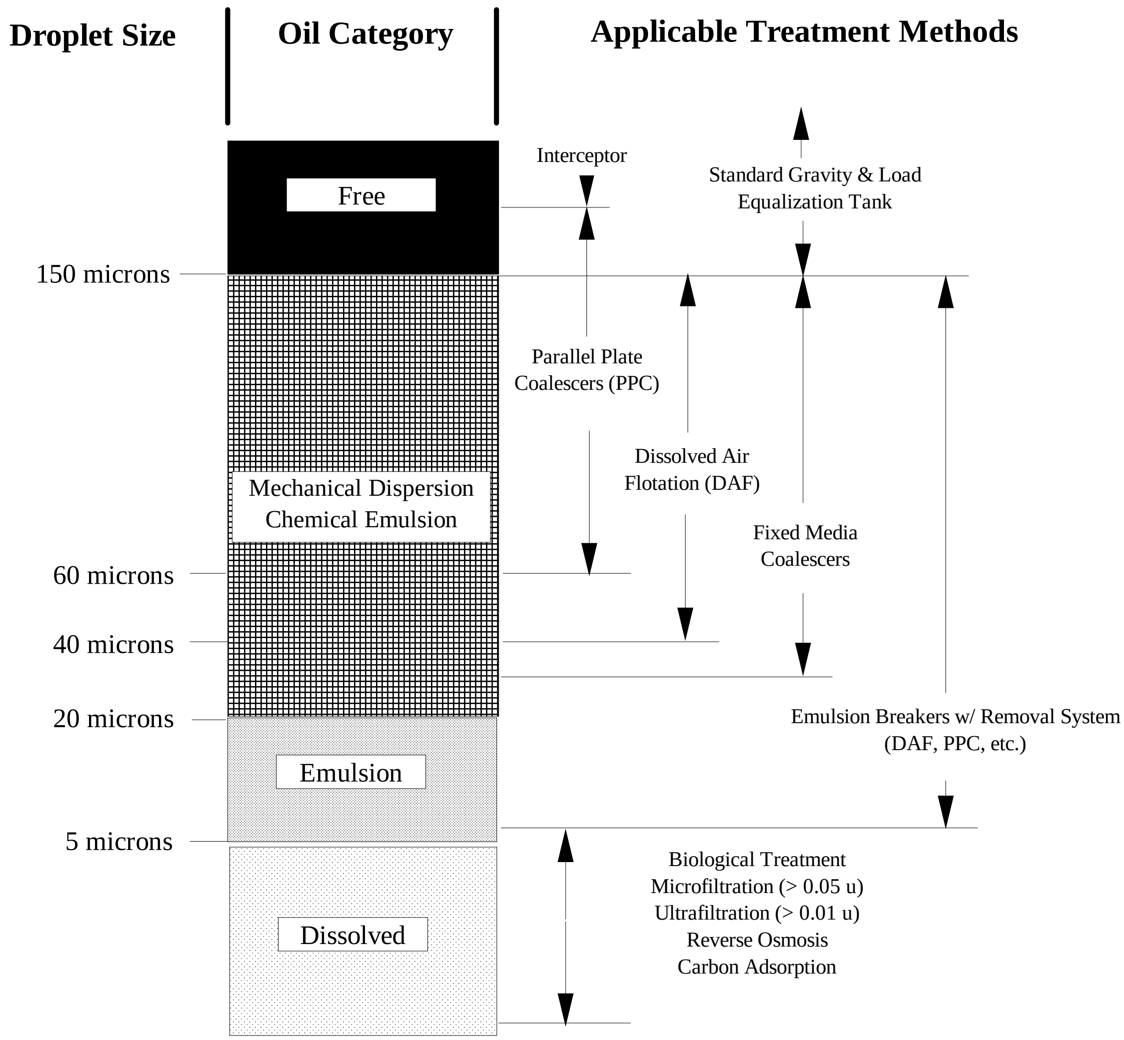
CONTAMINANT/CHARACTERISTIC	VALUE OR DESCRIPTION
Oil Concentration	There are two parameters used for measuring the oil content in wastewater: total petroleum hydrocarbons (TPH) and oil & grease.
Oil Category	(Free, emulsified, dissolved) Conduct a "Determination of Susceptibility to Oil Separation."
Solids	Analyses could include total suspended solids (TSS) and settleable solids.
Temperature	In general, a conservative value within the 4.5 - 15.5 ^{O}C (40-60 ^{O}F) range should be used unless actual testing indicates differently.
pH	If the wastewater is alkaline (pH above 9.0), some oils may become more soluble.
Wastewater Oil-fraction Specific Gravity	The greater the difference in specific gravity between the oil and water, the more efficient separation will be. In general, the specific gravity of the oil fraction will range from 0.82 to 0.95. Frequently, a specific gravity greater than 0.90 will be appropriate for design.
Salinity	Increased salinity increases the specific gravity and absolute viscosity of the water.
Potential Septicity Measurements	Volatile suspended solids (VSS), biochemical oxygen demand (BOD), and chemical oxygen demand (COD) can be used to evaluate potential septicity problems.
Emulsifying Agents	One analytical method that measures the presence of some detergents (surfactants) is methylene blue active substances (MBAS). MBAS indicates the degree of anionic surfactants in the wastewater.

7.7 PRELIMINARY DESIGN

7.7.1 What Type of Oil/Water Separator Is Necessary?

The oil category (free, emulsified, or dissolved) will establish the type(s) of separator system(s) required **(Figure 7-3)**. **Table 9-8** should be reviewed concerning the pro's and con's of each system and the applicability of the system to the particular wastewater. The other measured characteristics (flow and solids) will determine the size of the separator and the preliminary treatment required.

Figure 7-3 - Oil Category and Appropriate Oil Separation/Removal Systems



THE PARAGRAPH BELOW CONTAINS A VERY SIGNIFICANT CONCEPT THAT MUST BE UNDERSTOOD TO ENSURE THAT THE PROPER OIL REMOVAL SYSTEM(S) IS CHOSEN.

In reviewing **Figure 7-3**, the arrows denoting the oil category range that can be removed by a given treatment method should be closely reviewed. For example, dissolved oil is readily treatable by a biological system. If you look at the oil range that can be treated by biological systems, it is almost entirely in the dissolved oil range. This means that all other categories of oil must be removed before the wastewater is subjected to biological treatment. As a matter of fact free oil can be toxic to a biological system. Therefore, if you intend to use a biological system, additional “pretreatment” system(s) will be required to remove any free, and the majority of emulsified, oil.

> The more advanced systems should at least be proceeded by a bulk or free oil removal step, either as a separate system or built into the polishing unit.

It may be necessary to design a system for a specific separation problem. In such cases, the available off-the-shelf components can be added together in series to meet the requirements of the specific situation. For example, a separation system may consist of gravity separation, emulsion breaking, flocculation-assisted air flotation, prefiltration, and filter-coalescence (Cheremisinoff, 1995).

The second major consideration related to the type of separator, is the expected solids loading. All separator systems are sensitive to solids. The solids problem increases with the complexity of the system and degree of oil removal required. If solids can be removed from the wastewater before it enters the separator, the loading is no longer a major consideration.

7.7.2 Will Upgrading the Influent Systems or Existing Separator Address the Non-Compliance?

> Before any approach is taken toward upgrading an existing system, the reason why the existing system is not operating properly should be determined **(Section 7.5)** (API, 1990).

Occasionally, gravity type oil/water separators do not remove enough oil to meet regulatory requirements. In these cases, coalescing devices may be needed to enhance separation. Coalescing (binding together) the smaller oil droplets makes them larger and more buoyant, causing them to rise faster. Many coalescing oil/water separators use parallel plates or inclined tubes to reduce the distance the oil droplets have to rise to be removed from the flow; thereby, increasing the separation efficiency of a typical gravity type separator (AF, 1996). One company states that the installation of its coalescing tube pack in a standard gravity separator will double the flow capacity or enhance the droplet removal performance down to 20 microns with an effluent concentration of 10 mg/L.

> Most of the “performance or capacity enhancing” options for existing separation chambers have severe operation and maintenance implications for the user (DA USACE, 1994).
>
> Without mechanical sludge-removal equipment, parallel plate retrofitting may not be practical, since manual sludge removal can require raising the plate pack at regular intervals (API, 1990).

The use of any type of coalescing device will complicate operation and maintenance of the separator. The devices tend to foul and become blocked with debris and suspended particles attached to the oil. The device/media should be removable and capable of being cleaned or replaced as required.

7.7.3 Is the Existing Separator Required to "Pretreat" Wastewater Before the New Separator?

In reviewing **Figure 7-3**, you will note that certain systems, such as fixed-media coalescers, require that the wastewater be "pretreated" (free oil removal) to ensure proper operation of the system. If you have an existing gravity separator and need to install a fixed-media coalescer, using the existing system to remove free oil from the wastewater prior to entering the new system should be considered. If the new system comes with a preliminary free oil separation chamber, the existing separator would not be necessary and could be closed **(Chapter 12)**.

If an existing system is to be used for "pretreatment," the separator should undergo an evaluation to ensure that it is properly sized, is structurally and operationally sound, and is not leaking.

7.8 DESIGN CONSIDERATIONS

This section is presented to allow installations installing or modifying an oil/water separator a quick review to ensure that the proposed system will meet their needs and provide relative ease of maintenance operations. It is assumed that:

- Pollution prevention has been implemented at the source;
- The wastewater has been characterized, including flows;
- Based on the wastewater characteristics and regulatory requirements an oil/water separator is necessary;
- The discharge could not be adequately treated by a nearby existing system;
- There is no nearby oily wastewater discharge that should be considered in the design of this system; and
- You know the general type of oil/water separator that is necessary to treat the wastewater.

> In many cases, a properly sized and maintained gravity oil/water separator will be sufficient to pretreat military wastewaters discharging to publicly, privately, or federally owned treatment works.

Listed below is a discussion of the various treatment system considerations, which could affect the performance or maintenance of the separator.

7.8.1 Pretreatment of the Influent Wastewater

Pretreatment of the influent wastewater should be implemented to prevent the proposed oil/water separation system from being overwhelmed by solids or oil content. (Hydraulic overloads are addressed under equalization.) As the treatment system removing the oil becomes more advanced, the sensitivity of the system to high strength wastes becomes more acute. Listed below are various pretreatment/wastewater-handling approaches.

7.8.1.1 Wastewater Conveyance System

The use of closed underground piping should be kept to a minimum. The preferred method of transport is open channel flow, left uncovered, if possible (DA USACE, 1994).

7.8.1.2 Pumping Influent Wastewater

Pumping of wastewater should be avoided, if possible, to prevent mechanical emulsification. If pumping is required, low-shear, positive-displacement pumps should be used to prevent shear of the fluid. Hydraulic surges should be minimized by using variable speed pumps. Only the following types of pumps should be used: pneumatic ejectors, screw pumps, plunger pumps and progressing-cavity pumps (DA USACE, 1994).

> Centrifugal pumps should not be used due to the high turbulence generated and the likelihood that physical emulsification of oil will result (DA USACE, 1994).

Any systems containing pumps should be proceeded by sand/grit removal to prevent extraordinary wear on the pumps.

7.8.1.3 Wastewater Equalization

In general, flow equalization upstream of a separator is beneficial where the system would otherwise experience highly variable or slug loads (DoD, 1997e). The holding (surge) tank or basin would equalize and store oily wastewater prior to separation. The surge tank could provide a consistent gravity feed through an upstream control orifice. Holding facilities can be concrete or steel tanks or lined ponds. These systems may accumulate oil and solids.

7.8.1.4 External Solids Removal (grit chamber, sedimentation basin, etc.)

External solids removal is highly suggested for all oil/water separator systems as it will protect existing pumps, and prevent, or delay, the loss of wastewater detention time in the separator due to solids deposition and will decrease separator maintenance requirements. External removal of solids is not as critical to standard gravity systems as it is to all other separators.

Higher volumes of sediment should be expected from exterior washing of field vehicles compared to the volume collected from normal shop operations. When evaluating field vehicle washing, the type of soil within the installation should be considered, that is, clays will yield more solids per vehicle washing than sand.

7.8.1.5 Screening Devices and Trash Racks

The removal of trash and floatable debris from the influent wastewater will yield a cleaner "used oil" layer in the separator and prevent operational problems with oil skimming devices.

API suggests trash racks or bar screens be placed upstream of the separator to remove sticks, rags, stones and other debris that would interfere with the operation of the separator. The trash rack consists of a series of inclined (45 to 75 degrees from horizontal) bars spaced on 1- to 2-inch centers. A perforated pan draining into the separator could be provided to receive debris collected from the bars (API, 1990). The preferred USACE design is a removable inlet trash screen with an approximate 3/4 to 1-1/2 inch mesh opening (DA USACE, 1994). It is suggested that the trash screen/rack be placed upstream of the separator.

7.8.1.6 Bulk (free oil) Removal

Gravity oil/water systems (standard and LETs) allow the removal of easily separated free oil before the wastewater enters a more advanced oil removal system (parallel plates, dissolved air flotation, etc.). This will reduce the maintenance requirements on the downstream system and potentially reduce chemical feed and mechanical requirements.

> If the oil is present in quantities greater than roughly 1% (10,000 mg/L), gravity separation or similar methods should be used to achieve bulk separation (Cheremisinoff, 1995).

Every effort should be made to treat the waste in its most concentrated form and to prevent contamination with particulates and chemical emulsifiers (Cheremisinoff, 1995).

7.8.1.7 Storm Water

Storm water contributions may flood or otherwise hydraulically overload the separator. To protect in-ground or underground units against flooding from surface runoff, locate the top of the tank a minimum of 8-inches abovegrade (DoD, 1988b).

> Storm water contributions to an oil/water separator should be eliminated, if possible, or minimized.

7.8.1.8 Flow Diversion Devices

> Comments contained in this section apply to industrial oil/water separators and not to those separators that treat only storm water runoff.

The use of valved diversion boxes, multi-level weirs, flow diversion channels, and orifice plates within separators is discouraged. Diversion valves operated by installation personnel are not recommended. Proper operating procedures cannot be ensured, and discharges of oily water to the environment may result. Likewise, without proper maintenance, weirs and orifice plates can become fouled with debris and thus become ineffective. Clogging of orifice plates by debris is the rule rather than the exception at most separators (DA USACE, 1994).

7.8.2 Accessibility

Paved or gravel areas for heavy equipment to gain access to oil/water separators is essential for servicing and maintenance of the system (DA USACE, 1994).

Separator units should be provided with generous access openings to allow for easy visual inspection and probing for solids levels, maintenance, and periodic removal of accumulated solids and oil products. Access covers should be easily removable (DA USACE, 1994).

> Aboveground units are generally easier to access for maintenance and inspection than an underground unit (DoD, 1997e).

Accessibility is essential for removing and maintaining many of the performance enhancing configurations such as parallel plates, tubes, coalescing filters, and other devices inserted into the separation chamber. These devices will require frequent cleaning. Cleaning in place requires taking significant health and safety risks, providing proper support equipment, and many other difficulties.

An open type unit with removable grates, covers, or guardrail in order to minimize safety problems and improve accessibility is encouraged. The rail should be designed with a removable section for access during cleaning operations and the grates should be able to be lifted by a single individual (DA USACE, 1994).

Open tankage for oil/water separators is recommended if not prohibited by air quality standards or weather conditions (DA USACE, 1994).

> Due to accessibility problems the following types of systems are discouraged at most locations:
> - below grade, completely covered or enclosed separators with only manways for access (DA USACE, 1994), and
> - buried cylindrical separators (almost impossible to maintain) (DoD, 1997e).

Confined space entry problems related to operation and maintenance of the separator should be eliminated or minimized.

7.8.3 Parallel Treatment Trains and Redundancy

If wastewater flows are discontinuous, are of small volume, or adequate off-line holding tank capacity is provided, a single separator may be used. For sources that continuously discharge oily wastewater to a separator, parallel treatment trains should be considered to provide continuity of operation during individual unit repair, cleaning, or inspection (DoD, 1988b).

For more advanced (polishing) systems that discharge to waters of the U.S., it may be necessary to provide duplicate units for 100% redundancy to ensure that oil concentration limits are consistently met (DoD, 1988b).

7.8.4 Aboveground Separators

The functional design of aboveground gravity separator is similar to an underground gravity system, consisting of a solids settling chamber, oil separation chamber with coalescing baffles, tube or other devices which assist separation of smaller oil droplets. Some systems are recommended to be installed aboveground or partially buried (DoD, 1988b).

Supplemental heating and/or insulation may be justified for separators in cold regions. Freezing concerns are important for aboveground separators and exposed piping (DA USACE, 1994).

The positive aspects of an aboveground unit are (AF, 1996):
- less expensive to install than a comparable underground unit;
- easier access for maintenance and inspection (DoD, 1997e); and
- facilitates leak detection.

The negative aspects of an aboveground unit are (AF, 1996):
- the wastewater has to be pumped into the separator. The increased turbulence caused by pumping hinders the oil separation process in a simple gravity-type separator system;

- may not be suitable for cold climates; and
- may be unsightly, depending on the location.

7.8.5 Underground or In-Ground Separators

Requirements for the prevention and/or detection of releases from an underground oil/water separator system to groundwater are becoming a significant issue. In some states, such as Illinois, concrete tanks used to store or collect petroleum products are required to have a liner, or some other surface treatment designed to eliminate oil leakage through porous concrete surfaces (DA USACE, 1994).

It is becoming more common to place pre-manufactured separators in vaults to ensure a secondary containment and leak detection system. The vaults may present problems with confined space entry, maintenance access, explosive atmospheres, and groundwater that must be considered. The top of below-grade vaults should be open to the atmosphere and provided with aluminum grated covers, and with galvanized steel or aluminum railing around the perimeter of the tank.

Steel tank separators should be protected against corrosion by either: a fiberglass reinforced plastic coating system, or a STI-P3 corrosion control system (DA USACE, 1994).

The positive aspects of an underground unit are:
- the wastewater generally is not pumped into the separator;
- more suitable to cold climates than an aboveground unit; and
- may be located such they are not readily visible.

The negative aspects of an underground unit are:
- more expensive to install than a comparable aboveground unit;
- potential access problems for maintenance, inspection, and monitoring (AF, 1996);
- potential confined space entry issues (DA USACE, 1994);
- may be regulated as an underground storage tank, depending on the State interpretation of RCRA regulations (AF, 1996);
- may require protection from flooding (DoD, 1988b);
- tank corrosion is an issue; and
- some states and the Air Force recommend that underground systems be installed with a liner and leak-detection system (DoD, 1997e).

7.8.6 Water Supply

Parallel-plate separators may require frequent cleaning. Removal for cleaning with high-pressure cleaning equipment is the procedure of choice. If cleaning in-place is used, a hose connection should be provided (DoD, 1997e).

A water supply should also be provided for Load Equalization Tanks **(Section 9.3.3.1)** for cleaning, foam control, and general housekeeping. Potable quality is not essential (DoD, 1988b).

7.8.7 Vapor Loss Control

In some states it may be necessary to control vapor losses from a separator. Using a fixed- or floating-roof cover can control these losses. Because there is a vapor space under a fixed-roof, the potential for explosion hazard needs to be considered. Floating-roof covers rest directly on the liquid surface so vapor concerns are eliminated, but they may interfere with mechanical sludge-removal devices (API, 1990).

The requirement for cover and venting is a site-specific concern. Local fire officials at different installations have sometimes required compliance with National Fire Protection Association Standard 30 for venting of the oil/water separator and waste oil holding tanks due to a potential flammable atmosphere. Some local regulations in California require treatment of air emissions from separators (SCAQMD Rule 464, **Section 2.1.10.6**). If a cover is absolutely necessary, it should be completely removable (DA USACE, 1994).

7.8.8 Performance Guarantees

Require performance testing before the user accepts the separator. The contract specifications for prefabricated units shall require minimum performance guarantees based on influent characteristics stated in the specifications (DA USACE, 1994). Construction and manufacturer warranties should be stipulated in the construction contract, and received by the Contracting Officer prior to project closeout.

Specify unit performance to include oil removal efficiency and effluent oil concentration at expected unit operating conditions (DoD, 1988b).

> There are several types of warrantees associated with the separator system: including corrosion (30 years for steel); and accessories and treatment equipment (1 year).

7.8.9 Operation and Maintenance Manual

Require an operations and maintenance manual for each separator application (DA USACE, 1994). The manual should be stipulated in the construction contract, and received by the Contracting Officer prior to project closeout.

Require that the manufacturer provide training, on-site support and troubleshooting assistance, and a user's manual that is easy to understand and assists in daily, weekly, and monthly maintenance record keeping (Engbert, 1997).

WORKSHEET 7-1

REVIEW WORKSHEET FOR NEW SYSTEMS

This worksheet provides a quick review to make sure the final system addresses concerns that will be important once the system is installed.

(1) Influent Wastewater ( ) Open wastewater channel (w/grates) to separator is recommended
( ) No pumping of influent, if possible (centrifugal pumps are not recommended)
( ) Exterior grit/solids removal is recommended, particularly for systems with pumps
( ) Equalization is recommended for variable flows
( ) Screening to remove floatable solids is recommended
( ) Gravity separation of free oil prior to coalescing or advanced separator is recommended
( ) Storm water contributions should be eliminated
( ) The use of storm water valved diversion boxes, multi-level weirs, flow diversion channels, and orifice plates within separators is discouraged

(2) Accessibility ( ) Is separator accessible by vac truck and other heavy equipment via a paved or gravel road
( ) Are all chambers of the separator easily accessible for inspection and maintenance
( ) Are coalescing gravity (parallel/corrugated plates) devices easily removable for cleaning
( ) Buried cylindrical tanks may be maintenance problems and are not recommended
( ) Access to separator only by manholes (particularly bolted manholes) may lead to maintenance problems
( ) Top of the separator should be open to the atmosphere w/easily removable grates (check local air pollution regulations)
( ) If handrails are used, sections should be easily removable for access
( ) Confined space entry problems should be eliminated or minimized

(3) Parallel Systems ( ) Dual systems for continuous discharges are suggested for ease of maintenance, repair, etc.

(4) Aboveground Separator ( ) Cold climate - may require heating or insulation
( ) Influent pumping should be avoided (particularly centrifugal pumps)

(5) Underground or In-ground Separator
( ) Leak detection/vaults may be required
( ) Steel tank
  ( ) fiberglass reinforced plastic coating system, or
  ( ) corrosion control system

(6) "Used Oil" Holding ( ) Integral to system is recommended
( ) If aboveground, may impact SPCC plan
( ) If underground, may be UST

(7) Water Supply ( ) Is a water supply (non-potable) required to maintain the system

(8) Vapor Loss Control ( ) Is vapor loss control necessary

(9) Performance Guarantee ( ) Should specify oil removal efficiency and effluent oil concentration at design operating conditions

(10) Operation and Maintenance Manual ( ) Provided as part of project

CHAPTER 8
PRINCIPLES OF OIL/WATER SEPARATION

Page

CHAPTER 8
PRINCIPLES OF OIL/WATER SEPARATION

For purposes of this manual, an oil/water separator is any process, tank, or equipment that is used to separate/remove oil from wastewater. Oil contained in wastewater may take multiple forms, which will affect separator design. This chapter will define the various categories of oil that can be found in wastewaters generated by the military and the design basis utilized to separate/remove the respective oil categories.

8.1 CATEGORIES OF PETROLEUM, OIL, AND LUBRICANTS IN WASTEWATER

> For the purposes of this manual, petroleum, oil, and lubricants (POL) will be grouped into one generic term, "oil."

Oily wastewaters are generated in the industrial and maintenance areas of military installations from such activities as aircraft and vehicle maintenance and washing. The oils present in these wastewaters could include gasoline, jet fuel, diesel fuel, and lubricants. The oils are typically classified into three major categories: free, emulsified (mechanically and chemically), and dissolved. Oily wastewaters may include any or all of these categories.

Selection of the appropriate treatment process for oily wastewater is dependent on the oil category(s). No single treatment process or commercial device will remove all the various categories of oil. A series of treatment process units may be necessary to achieve the desired effluent quality.

> In many cases, a properly sized and maintained gravity oil/water separator will be sufficient to pretreat military wastewaters discharging to publicly, privately, or federally owned treatment works.

8.1.1 Free Oil

Free oil consists of droplets large enough to rise as a result of buoyant forces and form an oil layer on top of the water, when given a short quiescent separation period. Theoretically, oil droplets as small as about 20 microns can be classified as free oil (DoD, 1997e). Oil droplets should be approximately 150 microns or greater to be effectively removed in a conventional gravity separation chamber. (See **Section 8.2.1.3** for information concerning API's method of determining free oil removal.)

> There is no totally accurate test to characterize the oil droplet size distribution in the wastewater.

Free oil is primarily removed from wastewater by gravity or coalescing separation systems **(Sections 9.3 and 9.4)**. The removal efficiency of air flotation separators for free oil is similar to that of gravity separators (DoD, 1997e), but at a greater cost.

8.1.2 Emulsified Oil
Emulsified oil can be formed due to mechanical and chemical forces. Mechanically emulsified oil is easier to separate from wastewater. In this document, mechanically emulsified oil will be described as a dispersion, to prevent confusion between the two types of emulsions. Both types of emulsified oil are discussed below.

8.1.2.1 Mechanical Emulsions (Dispersions)
Free oil can be mechanically emulsified through excessive agitation and turbulence, due to high velocities or pumping. Mechanical dispersions are distributions of fine oil droplets ranging in size from microns to fractions of a millimeter and having stability due to electrical charges and other forces but not due to the presence of surface-active materials (Cheremisinoff, 1995).

Information concerning dispersed oil:
- Mechanical emulsification caused by agitation in washing is normally less of a problem for gravity separation than chemically stable emulsions (DA USACE, 1994).
- Larger holding basins, elevated temperatures and contact coalescence may effectively remove emulsified (dispersed) oil (Acurex, 1997).
- Flotation devices tend to be more effective than standard gravity devices in removing dispersed oil, since the buoyancy differential is increased by the attachment of small air bubbles to the slow-rising oil droplets (Cheremisinoff, 1995). Air flotation units can remove dispersed oil droplets in the 40 to 150 micron range (DoD, 1997e).
- Pressure filters may be used to remove dilute concentrations of mechanically emulsified oil, usually as a polishing step downstream of gravity or flotation units (DoD, 1997e).
- Coalescer filtration, often consisting of cartridges, removes dispersed and some emulsified oil to below 10 mg/L (DoD, 1988b).

8.1.2.2 Chemically Stabilized Emulsions
Emulsified oil exists as smaller droplets approximately 1 to 20 microns (to 100 microns (Acurex, 1997)), which are stable in water and incapable of rising to form a separate oil layer without additional chemical treatment (DoD, 1997e). Chemically stabilized emulsions are distributions of oil droplets similar to mechanical dispersions but which have additional stability due to chemical interactions typically caused by surface-active agents present at the oil/water interface (Cheremisinoff, 1995). Emulsification is usually due to the presence of detergents or other cleaning agents.

Information concerning emulsified oil:
- To limit chemical emulsification, wastes containing surface-active agents (typically used to wash down oil-coated equipment) should not be mixed with other oil-laden wastes.
- Formation of oil emulsions should be minimized as much as possible.
- Emulsions are usually complex, and bench or pilot plant testing is necessary to determine an effective method for emulsion breaking.
- Gravity oil/water separator performance will be dramatically reduced when wastewater contains chemically emulsified oils. Emulsified oil cannot be removed by gravity separation unless it can first be converted to free oil by breaking the emulsion.

- A dissolved air-flotation (DAF) unit will remove significant amounts of free and some emulsified oil and grease. The addition of coagulants, with or without organic polyelectrolytes, to break the emulsion may further enhance the effectiveness of the air flotation process in removing emulsified oil (DoD, 1988b).
- Emulsion-breaking methods are generally a combination of physical and chemical processes **(Section 9.9).**

8.1.3 Dissolved Oil

Dissolved oil consists of two types: either dissolved in a chemical sense (soluble in water) or dispersed in such fine droplets (often less than 5 microns) that removal by normal physical means (i.e., filtration, coalescence, or gravity settling) is impossible.

The treatment of dissolved oils and other types of chemically stabilized emulsions that cannot be destabilized by chemical addition may be treated by carbon adsorption, various membrane systems, and biological treatment with acclimated microorganisms.

8.2 BASIS OF SEPARATION AND REMOVAL OF OIL FROM WASTEWATER

The theories utilized to remove oil from a wastewater stream are exclusive to the particular oil category (free, dispersed, emulsified, and dissolved) being acted upon. Most of the oil separation/removal activities conducted by the military involve free, dispersed, and emulsified oils.

8.2.1 Free and Dispersed Oil Separation/Removal

The primary theory associated with the separation/removal of free oil from a wastewater stream is Stokes Law. This law has been used by API (American Petroleum Institute) and most gravity and coalescing system manufacturers as a basis for theoretical computations regarding the separation of free oil from water. Stokes Law can also be used to evaluate treatment systems handling mechanically emulsified (dispersed) oil.

8.2.1.1 Stokes Law

Equation 8-1 below is a simplified version of Stokes Law, and can be found in standard hydraulics textbooks. The equation predicts the terminal velocity of material suspended in liquid and having a density less than, or greater than, that of the liquid. The velocity at which suspended material rises or settles can be used as a basis for predicting the size and dimensions of the removal chamber (DA USACE, 1994).

$$V_p = \frac{54.48\,({}_{p} - {}_{w})d_p^2}{\mu} \qquad \textbf{Equation 8-1}$$

where:
V_p = velocity of particle (cm/sec),
μ = absolute viscosity (poise),
${}_p$ = density of particle (g/cc),
${}_w$ = density of water (g/cc), and
d_p = diameter of particle (cm).

API has simplified the above equation for an oil droplet of 150 microns:

$$V_t = \frac{0.0241}{\mu} (S_W - S_O) \qquad \textbf{Equation 8-2}$$

where:
Vt = rise rate of oil droplet (150 microns) in wastewater, in feet per minute,
μ = absolute viscosity of wastewater at the design temperature, (poise),
S_W = specific gravity of wastewater at design temperature, and
S_O = specific gravity of oil in wastewater at design temperature.

> The influences of certain factors on the terminal velocity of particles suspended in wastewater treated by a gravity separator are that velocity increases as (DA USACE, 1994):
> - the diameter of particles (oil droplet) increases;
> - temperature increases; and
> - the difference in specific gravity increases.

The effectiveness of a gravity separator depends on proper hydraulic design and the period of wastewater detention for a given rise velocity. Longer retention times generally increase separation efficiency. Liquid detention must be sufficient to permit oil droplets rising at a given velocity to come to the fluid boundary where they can be removed by skimming.

> The design particle size for a standard gravity system is 150 microns, where systems utilizing coalescing plates will generally use a design particle size of 60 microns.

Some states have established design standards for gravity separators. For example, Washington State requires storm water separators be designed based on the following conditions (Rust, 1997):

V_t = terminal rise or settling velocity = 0.033 ft/minute
d_p = diameter of oil droplet = 60 microns
T = temperature of wastewater = 50^o F

8.2.1.2 Surface Loading Rate (Hazen Formula)

Regarding the separation zone or flow-through volume within a gravity separator, there are two factors commonly considered in design: (1) surface loading rate, and (2) detention time at the appropriate peak flow rate. Many manufacturers and API relate the surface loading rate to the terminal rise velocity of oil droplets. This does have theoretical merit if the droplet size and distribution within a wastewater are known. However, this is rarely the case with military wastewaters (DA USACE, 1994).

As in the case of conventional clarification equipment, which is sized on the basis of a solids settling velocity, the rise velocity, expressed in feet per minute, can be translated into a design overflow rate, expressed in gallons per day per square foot. The overflow rate term is useful in calculating the surface area required for a given clarification problem (Cheremisinoff, 1995).

A common form of the equation relating surface area to terminal velocity is (DA USACE, 1994):

$$A_S = K_t [Q_m/V_t] \qquad \textbf{Equation 8-3}$$

where:
A_S = surface area of the separator, or horizontal projected area of parallel plates,
K_t = a dimensionless factor describing turbulence and short circuiting (values range from 1.2 to 2.0) (Other sources use a range of 1.2 to 1.75 for traditional baffle separators, and 1 for coalescing filter systems) (Rust, 1997)
Q_m = maximum relative flow rate
V_t = terminal rise or settling velocity

This equation has limited application other than as a mathematical tool to understand the process. The limiting factor is the inability to accurately determine the terminal velocity, which is critical to achieving a desired performance level.

8.2.1.3 Determination of Susceptibility of Separation

The use of the "diameter of particle (d_p)" has caused some disagreements among design groups concerning the validity of using **Equation 8-1**. The reason for the disagreement is that there is no totally accurate test to characterize the oil droplet size distribution in the wastewater. In lieu of droplet size, API has developed a bench-scale test to determine the ability of a standard gravity system to separate free oil from wastewater, "Determination of Susceptibility of Separation" (API, 1990). This method determines the feasibility of removing free oil from a wastewater using a separator designed in accordance with Stokes Law (150-micron particle diameter). It should be noted that the results of this test would show a more complete separation than can be obtained in a full-scale separator during the same time period.

8.2.1.4 Parameters That Affect Separator Design and Free Oil Removal

The design of gravity oil/water separators is affected by certain wastewater characteristics. The following parameters should be considered in the design of conventional gravity separators (free oil separation/removal) (DoD, 1997e):

- design flow;
- minimum wastewater temperature;
- wastewater specific gravity;
- wastewater absolute (dynamic) viscosity;
- wastewater oil-fraction specific gravity;
- minimum droplet size to be removed, usually 150 microns;
- type and amount of detergents present in the wastewater and potential changes in future detergent use;
- the quantity of solids to be removed and handled; and
- the effluent or pretreatment limits to be met.

Details concerning the various parameters are provided in **Sections 4.2 and 7.6**. Specific design criteria for standard gravity separators are contained in **Section 9.3** and **Table 9-2**.

8.2.2 Emulsified Oil Separation/Removal

The primary approach to addressing emulsified oil is breaking the forces that are causing the emulsion, thereby converting the emulsified oil to free oil, where Stokes Law may be used in the design of the free oil separation/removal. Chemical methods of breaking the emulsions include balancing or reversing surface tension, neutralizing electrical charges and precipitating emulsifying agents. For a more complete discussion on treating chemically emulsified oils see **Section 9.9**.

8.2.3 Dissolved Oil Removal

Dissolved oil may be addressed by multiple approaches. These can range from biological degradation, to sorption and membrane systems. These systems are addressed in **Sections 9.10 through 9.12**.

CHAPTER 9
TYPES OF OIL/WATER SEPARATOR SYSTEMS AND APPLICATIONS

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CHAPTER 9
TYPES OF OIL/WATER SEPARATOR SYSTEMS AND APPLICATIONS

Selection of the appropriate treatment process for oily waste is dependent on the oil category. Under proper quiescent conditions, free oil can be removed by gravity separation. Emulsified oil cannot be removed by gravity separation unless it can first be converted to free oil by breaking the emulsion. Emulsified oil may be removed by air flotation, although the emulsion may also have to first be broken for this process to be effective. Removal of soluble (dissolved) oil generally requires biological treatment or adsorption onto a solid phase sorbent such as activated carbon.

9.1 WHAT A GRAVITY OR PARALLEL PLATE OIL/WATER SEPARATOR WILL NOT REMOVE

> If the liquid contains anything other than water, dirt, and a very small amount of oil, it should not be discharged to a gravity or coalescing oil/water separator.

Pollutants, such as solvents, phenols, dissolved metals, and other toxic or hazardous contaminants, are not effectively removed by oil/water separation technology and may require additional source control or pretreatment. A gravity oil/water separator is designed to remove free oil and suspended solids. Gravity oil/water separators will not remove:

- chemically emulsified or dissolved oil;
- soaps, detergents, aqueous cleaners;
- high concentrations of oil such as a spill;
- dissolved inorganic compounds such as heavy metals (may be hazardous waste), nutrients, etc.;
- dissolved organic compounds such as solvents and light fuels (may be a hazardous waste);
- oxygen demanding substances;
- aqueous film forming foam (AFFF); and
- water soluble materials, such as anti-freeze.

It should be noted that separators do not neutralize acids or bases.

9.2 DEVICES COMMON TO GRAVITY AND PARALLEL PLATE SEPARATORS

Certain features are common to most gravity and coalescing oil/water separators. These features include influent chamber, oil skimmer, "used oil" holding, solids holding, and an effluent chamber. Each of these devices is described below.

9.2.1 Influent Chamber

Wastewater enters the separator through the influent chamber. Influent and effluent chambers are normally located on opposite ends of the separator. The primary functions of the influent chamber are to minimize wastewater turbulence (energy dissipation) and prevent short circuiting by distributing the flow equally across the separator. Past designs have utilized orifice control in shear gates, knife gate valves and small pipe diameter inlets as methods of limiting hydraulic overload of the oil/water separator.

This chamber should generate laminar flow and provide quiescent conditions for downstream free oil separation. A secondary function of this chamber is to retain free oil that separated from the wastewater prior to reaching the separator.

Different influent baffle (flow controlling structure) configurations include:

- Two baffle configuration (DoD, 1997e): The upper baffle extends above the water level and three quarters of the way to the tank bottom and prevents the floating oil and scum from entering the main chamber. The lower baffle extends from the bottom and directs the wastewater to the top of the main chamber and prevents short-circuiting. The bottom baffle retains settled solids in the front part of the separator to reduce main chamber cleaning requirements.

- Slotted baffle configuration (DoD, 1997f): The slotted baffle distributes the influent evenly throughout the depth of the separator. A vertical-slot baffle consists of upright members spaced across the channel inlet so that the open areas between members are at least ½ inch wide and larger than bar screen openings (API, 1990).

9.2.2 Oil-Skimming Devices

An oil-skimming device may be provided at the end of the separation chamber. The purpose of the skimmer is to remove the separated oil from the main chamber to a "used oil" holding reservoir. Manual and automatic skimming devices are available. The contained oil may be removed by pumping, or activating a rotary drum or slotted pipe that allows the surface material to drain to a drum or holding tank. Descriptions and diagrams of various skimmers are contained in **Table 9-1** and **Figure 9-1**.

> Reliable oil removal from the surface of the separation chamber is a frequent problem with both commercially available units and specially designed separators. The removal of excess water to the oil holding tank may also be an issue.

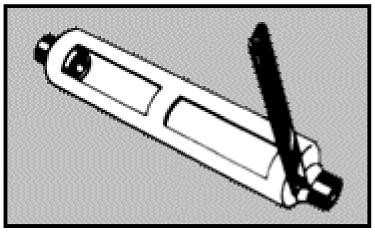
Table 9-1 - Skimmer Descriptions

TYPE OF SKIMMER	**DESCRIPTION** (Abanaki, Undated)
Rotating-Slotted Pipe (Commonly used at military installations)	The manually operated, rotating-slotted pipe skimmer has performed with varying degrees of success. This type of system requires frequent attention. The hand wheel operated type is preferred over the "lever" operated type (DA USACE, 1994). This type of system may pick up large volumes of water with the skimmed oil (EPA, 1995b). Screening of the influent to remove floating debris may improve skimmer effectiveness (DA USACE, 1994).
Belt	An endless belt made of stainless steel, elastomer or polymer medium, which is lowered into the tank to be skimmed. The floating oil adheres to the belt. The belt then passes through resilient wiper blades where the oil is removed from both sides of the medium.
Disk	A disk-shaped medium is rotated by a small motor through the liquid. Oil is removed and discharged to a collection container. Oil removal capacity is relatively low.
Drum/Barrel	Similar to a disk skimmer, but it uses a rotating drum-shaped medium. These systems are usually more rugged and have a higher oil removal rate (with relatively little water removed (EPA, 1995b)) than disk skimmers. These skimmers may be made of carbon or stainless steel, aluminum or plastic.
Mop	An endless rope-shaped medium with mop-like tendrils that pick up the oil. As the medium leaves the liquid and enters the drive unit, it is pressed and wrung out with pinch rollers. The medium tends to mat down and loose effectiveness when removing higher viscosity oils.
Flexible Tube (Recommended for use with a Load Equalization Tank)	The unit consists of a flexible, polyurethane collector tube which is in contact with the water surface at all times. Floating oil, grease, and solids adhere to the surface of the tube. The tube is circulated through a drive unit where scrapers clean the surface and divert used oil to holding. This type of skimmer requires a relatively large amount of surface area for proper operation.
Floating or Fixed Weir	An adjustable weir sets the overflow depth below the oil layer surface. These units are best applied where separated oil is allowed to accumulate for a number of days and is then skimmed in a single operation. There is a greater potential for skimming significant amounts of water with this device (DoD, 1988b).

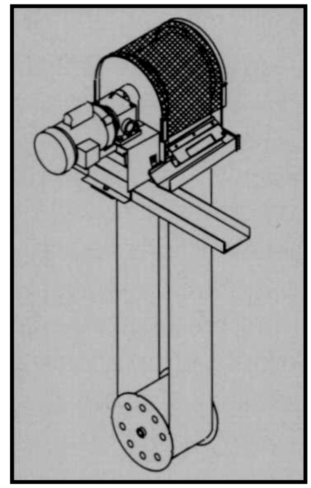
Some separators do not have a skimming device. Under this mode of operation, oil accumulates on the water surface in the separator, and is removed by suction equipment on a periodic basis.

> Separators without skimming devices may not produce as high a quality effluent as separators having a skimmer.

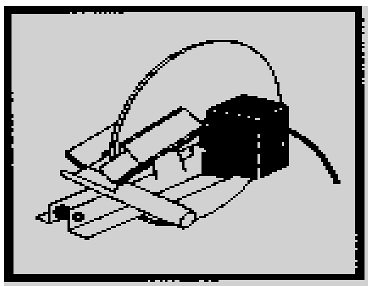
Figure 9-1 Skimmer Diagrams



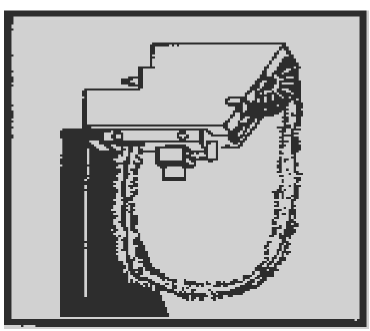
Rotary Pipe Skimmer (AFL, 1999)



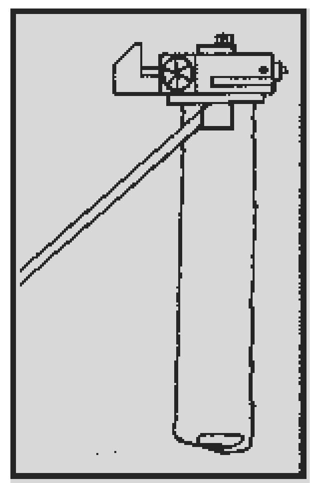
Belt Skimmer (Abanaki, Undated)



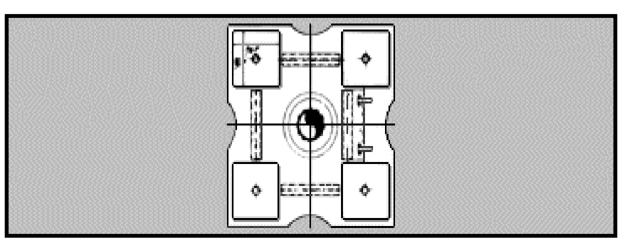
Disk Skimmer (Abanaki, Undated)



Mop Skimmer (Abanaki, Undated)



Tube Skimmer (Abanaki, Undated)



Floating Skimmer (AFL, 1999)

9.2.3 "Used Oil" Holding Configurations

"Used oil" holding may take place over a wide range of configurations. These configurations include: no holding (oil floats on top of the separation chamber), integral holding (oil holding sump is built into the separator), and separate holding (drum, aboveground tank, or underground tank) systems.

The "used oil" tank should be constructed such that confined space entry **(Section 2.1.9)** is not required for operation or maintenance.

> It is suggested that oil holding sumps have high and low level alarms to guard against sump overflow and transfer pump cavitation, respectively (API, 1990).

9.2.3.1 No Holding

This type of oil holding system is typical of a standard gravity oil/water separator. The separated oil is contained on the surface of the middle chamber by the underflow effluent weir. The oil is relatively hard to isolate from the wastewater when it is being pumped out for recycling or disposal.

9.2.3.2 Integral Holding

The definition of integral (as interpreted by the regulatory agencies) may be as 'literal' as the holding tank physically being located within the separator structure or as 'loose' as a tank connected to the separator by a pipe. One approach to the definition of integral is that if the holding tank was disconnected from the separator, the separator would no longer function as designed. An example is the oil collection sump usually found with a belt skimmer. For this document, integral will be defined as holding fully contained within the overall structure of the separator.

> If skimmers are used, "used oil" should be routed to a holding tank made integral with the separator tank (DA USACE, 1994).

9.2.3.3 Separate Holding

> Detached or separate holding tanks should <u>not</u> be used unless the large volume of collected oil makes the use of integral holding tanks impractical (DA USACE, 1994).

Separate "used oil" holding generally involves tanks or drums that are removed from the actual separator structure. The tanks are connected to the separator via a pipe that conveys skimmed oil from the separator into the holding tank. Oil removed from a separate holding tank may not contain significant amounts of water near the surface due to additional separation time and is therefore more readily recyclable. A negative aspect of separate holding is that some states consider "used oil" underground holding tanks to be subject to the requirements of a regulated UST. If the "used oil" is placed in an aboveground tank, the tank may be covered under the installation's spill prevention control and countermeasure (SPCC) plan.

> UST regulations (40 CFR 280) exempt oil/water separators from being defined as a UST (DA USACE, 1994). The exemption may not apply to separate underground used oil holding tanks. State regulators should be consulted on these issues.

> **NOTE**: Contact with state or local regulators should be coordinated through the installation environmental office.

9.2.4 Solids Holding

For units without solids collectors, there may be a bottom baffle in the separator to retain settled solids. Units may also incorporate a flat, sloped or hopper-type bottom for accumulation and ultimate discharge of settled material (DoD, 1996a). Solids blowdown from the bottom hoppers may be automated.

Where large amounts of solids are anticipated, mechanical equipment may be provided to move the solids to a collection point. A chain-drive mechanism is most common. Attached between a pair of chains are crosspieces, or "flights," extending the full width of the tank or bay and spaced at specific intervals. Flights have been wooden in the past but are now being constructed of alternative materials. Settled solids are dragged to the solids hopper at one end of the tank and removed (DoD, 1997e).

9.2.5 Effluent Chamber

The effluent chamber may be separated from the main chamber by upper (retains oil) and lower (retains solids) baffles. Wastewater flows under and over the baffles into the effluent chamber. The wall of the effluent weir should be located less than 2 feet downstream of the oil retention baffle (API, 1990). From the effluent chamber, the treated water is discharged to an outfall, the sanitary sewer, or to another treatment system.

9.3 STANDARD GRAVITY OIL/WATER SEPARATORS

The primary method of treating or pretreating oily wastewater generated by the military services is the gravity oil/water separator. This type of system has also been referred to as an API separator. These units are typically installed in industrial and maintenance areas to receive and separate oils at low concentrations from wastewater generated from processes such as aircraft and vehicle maintenance and washing. These systems are adequate for capturing incidental oil or fuel in wastewater from operation and maintenance activities.

> **How they operate:**
> Gravity oil/water separators rely on the different densities of oil, water, and solids for successful operation. The wastewater is fed to a tank containing sufficient capacity to provide a quiescent retention zone, which allows the oil to float to the top and the solids to settle to the bottom.

Gravity separators are typically rectangular tanks, constructed of reinforced concrete (RC), steel, or fiberglass reinforced plastic (FRP). The units are durable and simple to operate, requiring a minimum level of operator sophistication. Gravity oil/water separators come in two basic configurations: those designed in accordance with guidelines established by the American Petroleum Institute (API), and corrugated plate or parallel plate interceptors (CPI or PPI) **(Section 9.4)** (DoD, 1996a).

> Conventional gravity-type, cast-in-place separators should be used for sites producing wastewater:
> - with a high suspended solids or debris loading (DA USACE, 1994); or
> - where oil is present in quantities greater than roughly 1% (10,000 mg/L), to achieve bulk separation (Cheremisinoff, 1995).

A gravity oil/water separator is designed to remove **<u>only</u>** free oil and readily settleable suspended solids. Well designed and operated API gravity separators are capable of achieving effluent concentrations as low as 100 mg/L (API, 1990). Some references attribute gravity separators with attaining free oil concentrations as low as 20 mg/L (Cheremisinoff, 1995) in the effluent.

> Many references list anticipated effluent concentrations as “free oil.” This statement is required because most separators do not remove “emulsified or dissolved oil,” which will also be measured by most analytical techniques. The total oil concentration of the effluent may therefore be greater, due to the amount of emulsified and dissolved oil present in the discharge **(Section 7.6.2 and 7.6.3)**.

9.3.1 Structures and Processes Involved in Gravity Oil/Water Separators

The literature descriptions of a typical gravity oil/water separator include various chambers: influent, solid separation, oil separation, main, and effluent. The structural configurations of these systems are not always consistent, but the processes addressed by the chamber descriptions do occur within all systems to some degree. Structures and processes related to gravity oil/water separators are described below (influent and effluent structures are described in **Section 9.2**):

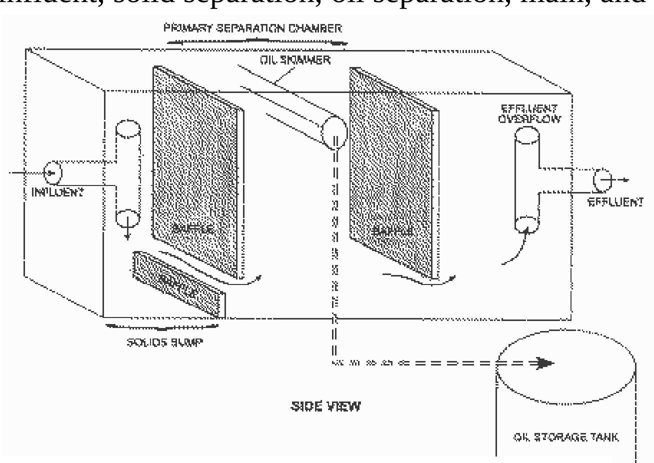


Figure 9-2 Gravity Oil/Water Separator (DoD, 1997f)

9.3.1.1 Separation Chamber

In the separation chamber, the wastewater flows from one end to the other under quiescent conditions. The wastewater velocity is kept low, typically less than 3 feet per minute to prevent turbulent mixing (DoD, 1997e). Solids sedimentation and oil separation will take place in this chamber.

> The separation chamber should have sufficient volume to:
> - allow the holding of separated oil (on the liquid surface) and solids (on the bottom of the tank); and
> - provide a quiescent wastewater flow-through area.

The most reliable way of determining the size of holding and flow-through volumes is by analysis of the actual wastewater flow to be treated. Simple separation testing can be accomplished with representative samples in graduated cylinders that are allowed to settle for variable periods of time. For example, allowing a one-liter sample to settle for one hour will result in measurable quantities of oil and sediment in the cylinder **(Section 8.2.1.3)**. This assumes sufficient damping of turbulence in the inlet chamber, and other considerations.

Regarding the separation zone or flow-through volume, there are numerous "rules of thumb" addressing the dimensions of this chamber. These “rules of thumb” **(Table 9-2)** attempt to limit turbulence and short-circuiting within the separation zone and provide a reasonable depth for maintenance while considering construction costs (DA USACE, 1994).

9.3.1.2 Sedimentation

While gravity separators are designed to remove oil, they also function as a sedimentation unit. Solids separation may take place at any time following mixing of the “dirt” with the wash water. The efficiency of solids removal depends upon the soil particle size, water velocity, and amount of oil attached to the particle (buoyancy).

> Solids should be removed from the wastewater, to the degree practicable, prior to entering the separator to reduce maintenance requirements. This can be accomplished by installing upstream sand or grit chambers.

The settling velocity of a particle is a function of the size, shape, and specific weight of the particle and the specific weight and viscosity of the surrounding water. All things beings equal except particle size, the order in which material will settle is: gravel, sand, silt, and clay.

9.3.1.3 Oil Separation

As the wastewater flows through the separation chamber, oil droplets rise to the top of the water. Free oil is retained in the unit by a surface baffle located upstream of a fixed level control device, usually a weir. The oil droplets lighter than water accumulate on top of the wastewater and may be routed to a separate holding chamber or tank.

> An oil-retention baffle should be located no less than 12 inches downstream from a skimming device and should have a maximum submergence of 55% of water depth (API, 1990).

9.3.2 General Design Considerations

Design of gravity separator systems requires proper characterization of the wastewater, establishment of the design flow, sizing of the separator, and proper influent attenuation/equalization **(Chapter 7)**. The effectiveness of a gravity separator depends on proper hydraulic design and the wastewater detention time. Longer retention times generally increase separation efficiency. **Table 9-2** contains a summary of general gravity oil/water separator design criteria and accepted “rules-of-thumb” concerning tank configuration.

> A minimum of two channels (separator chambers) is recommended for only continuous wastewater discharges to allow for separator maintenance without bypassing the treatment system in total (API, 1990).

9.3.2.1 Oil Droplet Size

The American Petroleum Institute (API) has specified design criteria for simple gravity separators based on the removal of free oil droplets larger than 150 microns in diameter. Stokes law (Section 8.2.1.1) describes the rise rate of these oil droplets.

Manufacturers may provide a “scientific” basis for their calculations by presenting an oil droplet size distribution. There is no totally accurate test to characterize the oil droplet size distribution in the wastewater. In lieu of droplet size, API has developed a bench-scale test to determine the ability of a standard gravity system to separate free oil from wastewater, “Determination of Susceptibility of Separation” **(Section 8.2.1.3)**, which provides free oil removal information under optimum wastewater treatment conditions.

9.3.2.2 Overflow Rate

As in the case of conventional clarification equipment, the rise velocity can be translated into a design overflow rate, expressed in gallons per day per square foot of surface area. The overflow rate term is quite useful in calculating the surface area required for a given clarification problem **(Section 8.2.1.2)** (Cheremisinoff, 1995).

> Any oil droplet with a rise rate greater than or equal to the surface loading rate will reach the separator surface and be removed (API, 1990).
>
> API survey data indicate that increasing separator size, as measured by surface loading rate, results in improved performance, as measured by effluent oil and grease.
>
> **Tables 9-2 through 9-6 entitled “General Design Information” are provided to the reader as a basis for system comparison, and should not be used for design purposes.**

Table 9-2 - Gravity Oil/Water Separators - General Design Information

Mode of Operation	Continuous - a backup channel or unit should be provided for continuous wastewater sources
Category of Oil Removed	Free - 150 microns
Recommended Use	Sites producing wastewater with a high suspended solids or debris loading; or if the oil is present in concentrations greater than roughly 1%
Maximum Horizontal Velocity Above this limit, the effect of turbulence tends to redistribute oil droplets.	2 to 3 feet per minute or equal to 15 times the rise rate of the oil droplets, whichever is smaller
Depth of Flow in Separator , ft. This limits the height that must be traversed by a rising oil droplet. Increase the depth to provide oil and solids holding volume as required.	Minimum: 3 - 4 Maximum: 8
Width of Separator, ft.	Minimum: 6 Maximum: 20
Length-to-width Ratio Provides more uniform flow distribution and minimizes influent and effluent turbulence (API, 1990).	Between the limits 3:1 to 5:1
Depth-to-width Ratio	Between the limits 0.3:1 to 0.5:1 Maximum: 1:1
Surface Loading Rates, gpd/ft^2: The overflow rate term is useful in calculating the surface area required for a given clarification problem (Cheremisinoff, 1995).	Between the limits 60 to 1,000
Detention Time at Design Flow Longer retention times generally increase separation efficiency (Cheremisinoff, 1995).	Common: 45 minutes to 2 hours High: 8 hours
Average Effluent Oil Concentration, mg/L	20 - 100
Design Information Source(s)	API Publication 421 ETL 1110-3-466 MIL-HDBK-1005/9 MIL-HDBK-1005/16

9.3.3 Other Gravity Type Oil/Water Separators

9.3.3.1 Load Equalization Tank

The load equalization tank is currently being replaced by the bilge and oily wastewater treatment system **(Section 9.14)**.

The load equalization tank (LET) is primarily associated with shipboard generated oily wastewater and is a variation of the standard gravity oil/water separator.

How they operate:
The basis of oil removal is identical to a typical gravity system, but there are no baffles or separate chambers in the tank. The LET is an open tank with internal sludge and oil collection systems. LETs are operated as a batch (single unit), or fill and draw-off (multiple units), treatment systems.

Oily waste is discharged from ships and other on-site sources into a LET for short-term holding/separation. The waste is received for a predetermined number of days and then allowed to sit quiescently for about 24 hours to insure optimum gravity separation. Free oil floats to the surface and is skimmed off. Solids settle and are scraped to a hopper for withdrawal and disposal. The usual construction of a LET is a reinforced, rectangular, concrete tank. LETs of less than 15,000-gallon capacity may be a circular steel structure. A typical LET effluent contains less than 50 mg/L of oil and grease (DoD, 1988b).

> A coalescing gravity (parallel plate) separator should be provided for additional treatment when LET effluent contains more than 50 mg/L of oil and grease.

Multiple LETs should be provided for semi-continuous (fill and drawoff) operation. Typical solids settling time is 24 hours. Longer operating periods or large volume upstream receiving tanks should not be used since they promote anaerobic conditions and H_2S gas production. (H_2S concentrations above 10 ppm will corrode metal and concrete, cause odor problems, and create potential health hazards.)

A water supply should be provided for tank cleaning, foam control, and general housekeeping. Potable quality is not essential.

Table 9-3 - Load Equalization Tank - General Design Information

Mode of Operation	Batch or sequential fill and draw.
Category of Oil Removed	Free
Recommended Number of Tanks	2 to 3
Tank Capacity, Each	7 days holding at average design flow
Basis of Design Flow	Number of ships berthed (or historical data) Estimated oily wastewater volume: Aircraft Carrier: 50,000 gallons/day Other classes: 3,750 gallons/day
Typical Settling Time	24 hours
Solids Withdrawal Frequency	Daily
Recommended Oil Skimming Device	Flexible tube skimmer
Average Effluent Oil Concentration, mg/L	50
Design Information Source(s)	MIL-HDBK-1005/9

9.3.3.2 Oil Interceptor

The use of oil interceptors is not recommended.

Oil interceptors are systems placed in shops and other activities that may generate low volume petroleum contaminated wastewater.

How they operate:
These systems are typically small, e.g., located in a manhole or a single sump. The interceptors will collect waste from a floor drain and provide wastewater holding for a non-specific period of time. During this period, free oil will float to the top and solids settle to the bottom. The water may be discharged through a “T” pipe located in the middle of the manhole to a sanitary sewer or to a downstream gravity oil/water separator.

Solids and oil must be manually pumped out. If the separated material is not appropriately removed from the interceptor, the system will become ineffective and will no longer “treat” the wastewater before it is released.

There are no known standard design specifications for an oil interceptor system.

9.4 GRAVITY OIL/WATER SEPARATORS WITH COALESCING PLATES

Coalescing separators are usually recommended only for light oil loading when a higher level of oil removal is required; when the wastewater contains minimal solids concentrations; and when the facility is committed to the additional maintenance procedures required to keep the coalescing pack free of debris (DoD, 1997e).

Gravity is the primary force driving the separation of particles in both conventional and coalescing oil/water separators. The term "enhanced" or "coalescing" is often applied to separators which contain parallel plates, tubes, or media packs to aid the gravity process.

How they operate:
The coalescing pack may consist of a series of parallel plates or a volume of packing. The purpose of this material is to provide surface area to contact and intercept small oil droplets. Oil droplets become removed by adhering to the packing. On the packing, the small oil droplets will agglomerate, forming larger oil droplets. Coalescing (binding together) the smaller oil droplets makes them larger and more buoyant, causing them to rise faster (DoD, 1996a).

The effectiveness of oil removal depends in part on the rate that oil droplets rise through the water column. This rate is dependent on the oil droplet size. Small oil droplets may not rise fast enough to be captured for removal. For example, according to Stoke's Law, a 100-micron diameter oil droplet will rise about 6 inches in water in ten minutes. A 20-micron diameter oil droplet will take over two hours to rise the same distance (AF, 1996a).

In a typical gravity type oil/water separator an oil droplet must rise approximately 48 inches to reach the water surface. Many of the smaller droplets therefore pass through the separators. Addition of inclined coalescing plates will allow the droplet to separate after rising only 1/4 inch before hitting the upper plate and being removed (AF, 1996a).

These types of systems have various names and configurations including parallel plate interceptors, corrugated plate interceptors, and induced-gravity separators.

9.4.1 Parallel Plate Separators

> API Publication 421 states, "petroleum industry data are insufficient to conclude that parallel-plate units offer overall superior performance."

Parallel plate separators function on the same principles as conventional gravity separators, but they require less space and are theoretically capable of achieving lower oil concentrations in the effluent. The unit size is reduced by incorporating an array of closely spaced parallel plates within the separator chamber, thereby increasing the surface settling area. Flow through a parallel plate unit can be two to three times that of an equivalently sized conventional separator. Parallel plate separators (also known as parallel plate interceptors - PPI) can meet effluent limits as low as 50 mg/L of free oil (DoD, 1997e).

> **How they operate:**
> The oil is removed by passing the wastewater at laminar velocity through the pack of closely spaced plates. These oil droplets rise and are trapped along the bottom of the plates. The oil droplets coalesce and gradually move upward along the bottom of the plates, eventually collecting at the surface of the tank.

According to the manufacturer's literature (Great Lakes, 1997), a slant rib coalescer can attain effluent concentrations to 10 mg/L of non-emulsified oil, utilizing off-the-shelf systems with design capacities up to 100 gallons/minute. These separators may also be combined with emulsion breaking (acid cracking and/or polymers) and neutralization systems. A similar slant rib system is offered at design flows to 4,000 gallons per minute, with oil droplet removal down to 20 microns. These systems are constructed of molded polyester fiberglass or stainless steel and can operate in temperatures from 32 to 130^{o}F.

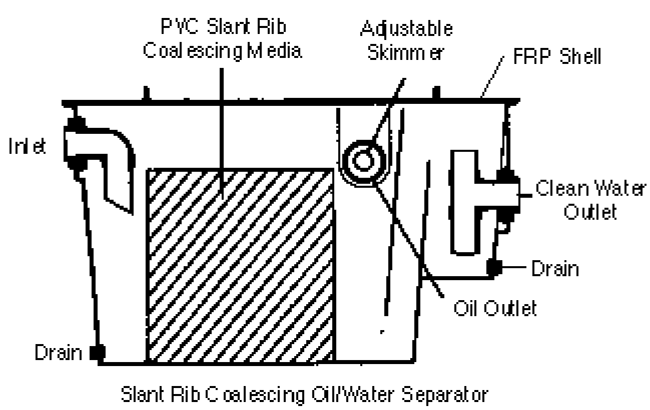


Figure 9-3 Slant Rib Coalescing Separator (Remtech, 1999)

9.4.1.1 General Design Considerations for Parallel Plate Separators

Parallel plate separators are furnished as pre-engineered, factory-assembled units. In general, the parameters and procedures used for parallel plate separator design are the same as conventional separators **(Section 9.3)**, except that a smaller design droplet of 60 microns is usually assumed.

> Flow through a parallel plate unit can be two to three times that of an equivalently sized standard gravity separator (API, 1990).
>
> Careful handling of flows (equalization) often permits separation of oil droplets finer than free oil (Cheremisinoff, 1995).

9.4.1.2 Parallel Plate Design

The plates aid in separation by (DoD, 1997e):

- preventing short-circuiting of the wastewater;
- increasing the effective settling area; and
- enhancing contact/agglomeration of oil particles.

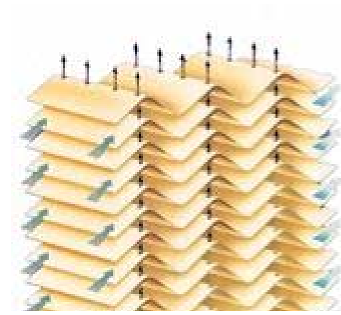


Figure 9-4 Parallel Plates (Freylit, 1999)

The perpendicular distance between plates typically ranges from 0.75 to 1.5 inches (2 to 4 cm), and the angle of plate inclination from horizontal typically ranges between 45 and 60 degrees. The preferred construction materials for plate packs are a stainless steel frame with individual fiberglass plates (DoD, 1988b). The plates may also be constructed in a corrugated configuration with alternate troughs and ridges, such as in the Corrugated Plate Interceptor (CPI).

> The plates/media should be removable and capable of being cleaned or replaced as required.

The plates may be made of an oleophilic (oil attracting) material, such as polypropylene, polyethylene, fiberglass, or nylon, to promote oil droplet coalescence. API Publication 421 does not contain data on oleophilic type, coalescing separators. Manufacturer's claims of greatly enhanced efficiencies based on the oleophilic properties of their media pack should be investigated thoroughly before being accepted.

> Aqueous film forming foam (AFFF) and penetrating oils which contain solvents, antifreeze (glycols), and silicones have a detrimental effect on polypropylene coalescers (Hudson, 1998b), as the emulsion coats the plates inhibiting coalescence (NAVSEA, 1998).
>
> The plates tend to foul and become blocked with debris and suspended particles attached to the oil. If the coalescing pack is constructed of an oleophilic material, the problem may be magnified (DA USACE, 1994).

If coalescing separators are required, then only models which use the inclined plate (or tube type) coalescer pack with surface area designed using Stokes' Law, are recommended by the Corps of Engineers (COE).

Two major types of parallel plate separators are marketed (API, 1990):

Cross-flow separator - Flow enters the plate section from the side and flows horizontally between the plates. Oil and solids accumulate on the plate surfaces above and below the wastewater flow.

Downflow separator - Wastewater flows down between the parallel plates. Solids deposited on the lower plates flow to the bottom of the separator. Oil accumulated between the upper plates flows countercurrent to the top of the separator.

> If significant solids levels are expected (and they cannot be removed before entering the system), the plate inclination should be about 60 degrees, which exceeds the angle of repose of practically all solids typical to these systems (API, 1990).

9.4.1.3 Solids

Knowledge of the solids content of the influent wastewater is particularly important in the selection of parallel-plate separators because they are prone to increased maintenance and clogging problems.

> If high solids concentrations are present or anticipated in a new waste stream, it is advisable to install a sedimentation basin upstream of the separator.

Table 9-4 - Parallel Plate Oil/Water Separators - General Design Information

Other Names for Parallel Plate Type of Separators	Coalescing Plates, Induced Gravity Separators, Slant Rib Separators, Corrugated Plate Interceptors, Enhanced Separators
Mode of Operation	Continuous
Category of Oil Removed	Free and dispersed (DoD, 1988b), > 60 microns (API, 1990)
Recommended Use	Light oil loading, when the wastewater stream contains minimal solids
General Design Criteria	Same as gravity separator
Design Capacity	Two to three times that of an equivalently sized conventional separator
Spacing Between the Plates	Minimum spacing between inclined plates is 3/4 inch General spacing range: 0.75 - 1.50 inches
Angle of Inclining Plates	45 to 60 degrees (DoD, 1997e), 45 to 90 degrees (API, 1990)
Surface Loading Rate	0.33 gal/min/sq. ft. of plate area (King County, 1996)
Plate Cleaning Interval	A minimum interval of every 6 months is appropriate (DoD, 1997f)
Average Effluent Oil Concentration, mg/L	10 - 50
Design Information Source(s)	Equipment Manufacturers API Publication 421

9.4.2 Corrugated Plate Interceptors

Corrugated Plate Interceptors (CPIs) are typically supplied by vendors and are proprietary designs. A CPI consists of a tank containing a number of parallel corrugated plates mounted from 0.8 to 1.6 inches apart and inclined at an angle to the horizontal (DoD, 1997f).

How they operate:
Wastewater flows downward between the corrugated plates, with the oil droplets floating upward and collecting on the underside of adjacent plates where they coalesce. The coalesced oil droplets move up the plates to form a floating layer that is skimmed from the surface of the tank. Settled solids from the wastewater collect on the top side of adjacent plates, migrating down the plates and dropping into the bottom of the CPI vessel.

CPI separators are smaller, and may cost less than API-type separators. However in practice**,** the smaller size has sometimes been a disadvantage since it may not provide sufficient volume to accommodate slugs of oil, and may not provide sufficient detention time for breaking emulsions. In some cases, severe fouling of the plate packs has occurred. CPI separators may be prone to mechanical emulsion problems (Storehouse, Undated).

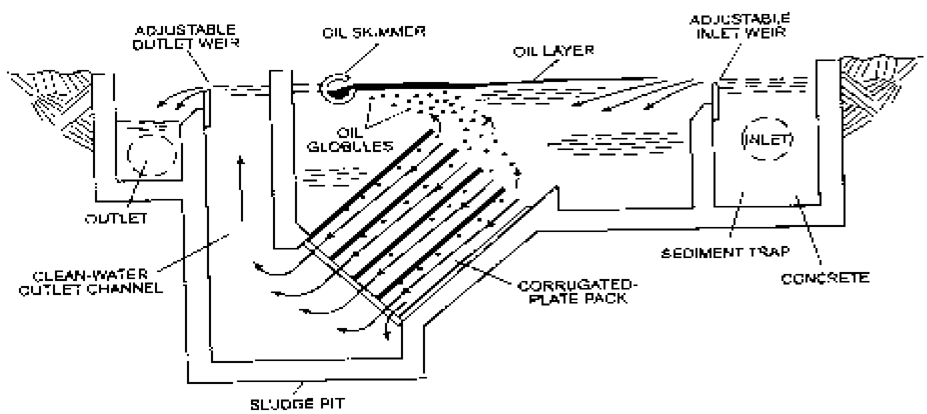


Figure 9-5 Corrugated Plate Separator (DoD, 1997f)

9.5 OTHER COALESCING SEPARATORS

> If coalescing separators are required, the use of media packs (other than inclined plate or tube type) such as coalescing or oleophilic filters or screens are not recommended by the Corps of Engineers.
>
> Coalescing-type separators are recommended only for light oil loading when a higher level of oil removal is required, the wastewater stream contains minimal solids concentrations, and the facility is committed to the additional maintenance procedures required to keep the unit free of debris (DoD, 1997e).

Coalescers are a variation of multi-media filtration **(Section 9.7.1)** used for the removal of free and emulsified oils and suspended solids. Three types of coalescers are found in the wastewater industry: fixed-media and loose-media coalescers, and parallel plate separators (DoD, 1997d). Parallel plate separators are discussed in **Section 9.4**.

> **How they operate** (DoD, 1997d)**:**
> Coalescers work by promoting collisions of small dispersed oil droplets so that they can join in a larger accumulation of oil that can be more easily separated from the water phase. A solid surface that can be wetted by oil serves as the coalescing surface. As oil droplets collide with the coalescing surface, an oil film is formed. Larger, more easily separated oil droplets are later shed from the surface with the assistance of gravity and/or viscous forces caused by fluid flow.

9.5.1 Fixed-media Coalescers

> Fixed-media coalescers rely on foam materials or cylindrical cartridges, and are usually reserved for low flow applications with very little suspended solids (DoD, 1997d).
>
> Fixed-media should be installed such that they are easily removed from the separator for maintenance or replacement.

Emulsified oil may be removed by mechanical impingement devices, which induce coalescence of dispersed oil droplets. Coalescing filters and cartridge-type emulsion breakers are representative of mechanical impingement devices. Cartridge units contain a medium with numerous small (25 microns), irregular, continuous passages through which the wastewater flows. The emulsion is broken by impingement of the oil droplets on the surface of the medium. The cartridge can be backwashed and/or replaced (DoD, 1997d).

The effectiveness of the system depends on, among other things, the mechanical forces of the influent passing through the filter. If the volume and/or force of the pumping are too great, the oil droplets tend to be prematurely carried into the mainstream flow and are insufficient in size to gravity-separate from the effluent. Despite drawbacks, filter coalescers are effective. The effluent quality achievable with such devices is in the range of 1-50 mg/L oil depending on such factors as the surfactant content, loading conditions, and oil type (Cheremisinoff, 1995).

Some proprietary fixed media systems contain oleophilic (oil loving) and hydrophilic (water loving) media that allegedly enhance the coalescence of oil droplets. This type of system allows higher flow rates (10 times) and smaller vessel sizes than a CPI, but requires that all solids be removed before the wastewater enters the separator. The media also requires inspection annually and probable washing with a mild solvent (Storehouse, Undated).

9.5.1.1 Coalescing Media

Coalescing media used for oil separation vary in the materials used and the effective pore size. In some coalescing media, a fibrous material such as nylon or propylene (oleophilic - oil loving fiber) is wound about a rigid spool to form a cartridge. The tightness of the wrap and the fiber diameter largely control the effective porosity for these devices. Other coalescing media incorporate the use of tightly woven or tightly wrapped sheets of fiberglass. Since coalescing media tend to plug with particulates, less costly pleated paper-type elements are often used as coalescing media or as pre-filtration media. More recently, reticulated polyurethane foams have come into use as coalescing media. These foams are natural sorbents, are light in weight, are relatively inexpensive, and can be molded to control the effective pore size (Cheremisinoff, 1995).

Breaking the emulsion into separate surface-active properties tends to alter the surface wetting properties of the coalescing fibers, which usually leads to "poisoning" of the media. In most cases, the separators incorporating coalescence are designed for the replacement of the media once it is poisoned, plugs, or otherwise fails. The cartridge-type media are favored in these designs. Some separators incorporate media backwash as a means of removing entrained solids and any adhering surface-active agents. Steam, hot water, solvents, or high-pressure air (Water Refining, Undated) are at times prescribed for these situations (Cheremisinoff, 1995). When the captured oil within the media thickens, due to bacterial action or through a matrix with contaminants, disposable media must be replaced (Water Refining, Undated).

9.5.1.2 Coalescing Element Configuration

The geometry and orientation of coalescing elements in separator devices vary. Most manufacturers utilize long, relatively small-diameter, standard-size cartridges stacked in parallel to handle the required throughput. Several stages operating in series are often utilized to achieve a greater degree of removal and to act as a backup. The media may be installed vertically or horizontally depending on the design. Horizontal orientation normally decreases the effective oil droplet rise height, but is more difficult to service, since the entire vessel must be completely drained before opening (Cheremisinoff, 1995).

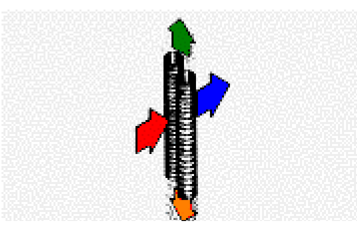


Figure 9-6 Vertical Coalescing Tube Pack (AFL, 1999)

If chemical emulsions are present, they should be treated before contacting coalescer media. Prefiltration should be used to increase coalescer life when applicable.

9.5.2 Loose-media Coalescing Filters

The internal components of coalescing (loose-fill) media filters are similar to those of a conventional dual-media pressure filter. A strainer plate supports layers of gravel and intermediate and fine mesh filter sand so that the upward-flowing water will contact media of decreasing particle size. When the droplets collide with media particles, they coalesce into a film. Eventually, the film thickness reaches a point at which the buoyant force allows the shedding of large droplets through a gravity section at the top of the vessel. Oil is periodically skimmed or drained from the top of the vessel. The outlet for treated water is located in the lower part of the separation section. Solids are trapped in the media and are removed by backwashing. Backwashing normally occurs at a fixed time interval (e.g., once per day) or when the pressure drop reaches a preset limit, typically 5 to 10 psi (DoD, 1997d).

For wastewaters containing heavy oils, it has proven difficult to prevent long-term fouling of the sand media. Normal backwashing procedures have proved insufficient to prevent oil buildup on a routine basis, particularly after an upset in feed oil concentrations. After a year, it may become necessary to completely replace the filtration media (DoD, 1997d). This fouling has not been a problem when lighter oils are removed and influent solids concentrations are equal to, or less than, 100 mg/L (DoD, 1997e).

9.6 FLOTATION (DISSOLVED AIR FLOTATION)

Flotation systems usually follow bulk treatment and are considered polishing units.

Flotation is commonly used to remove oil and grease and suspended solids from industrial wastewaters. In the air flotation process, separation of oil and solid particles is brought about by introducing fine air bubbles into the waste stream. Diffused air and induced air flotation are the two most common types of flotation units (DoD, 1997f).

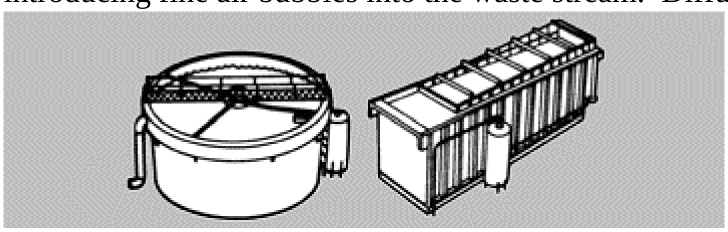


Figure 9-7 Circular and Rectangular DAF Units (AFL, 1999)

Flotation systems incorporate a flotation vessel with a baffle to retain floated oil, an oil-skimming mechanism, and sometimes a bottom scraping mechanism to remove very heavy particles that do not float.

How they operate:
The bubbles attach to the particulate matter and oil droplets, and the buoyant force of the air bubbles causes both particles and small oil droplets to rise to the surface. The oil/solids/air bubble mixture forms a froth layer at the surface, which is skimmed away (DoD, 1997e).

A dissolved air flotation (DAF) unit is usually installed aboveground and will often require pumping of influent flow. The unit may be divided into two sections (flocculation and flotation). The influent enters a flocculator chamber where it is mixed with coagulant. The flotation chamber has a skimmer on the surface to remove the scum and an outlet to remove the settled solids from the bottom by gravity displacement or pumping (DoD, 1988b). Significant mechanical equipment is associated with these systems.

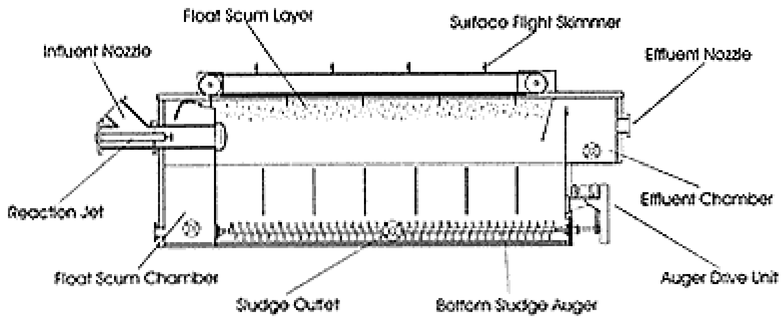


Figure 9-8 HydroFloat - Dissolved Air Flotation (Core-Rosion, 1999)

> Adequate justification for the additional maintenance requirements should be documented before selecting an air flotation unit for oil/water separation.

The removal efficiency of air flotation separators for free oil is similar to that of gravity separators. Flotation devices utilize the gravity separation concept but tend to be more effective than sedimentation devices in removing dispersed/emulsified oil in the 40 to 150 micron range. The buoyancy differential is increased by the attachment of small air bubbles to the slow-rising oil droplets. Coagulant aids such as polyelectrolytes are commonly used to promote agglomeration of the oil-bearing matter into large floc which are more easily removed. Coagulation with aluminum or iron salts is generally effective. The resultant hydroxide sludge is difficult to dewater and may limit the reusability of the recovered oil. Air flotation type equipment is reported effective in producing an effluent with 1-20 mg/L oil (DoD, 1997e).

> Typically, gravity oil/water separators are used in front of flotation units to remove gross quantities of free oil and settleable solids. This reduces the volume of dissolved air and flocculating chemicals required to treat the waste, and provides optimum water clarification in the air flotation unit.

According to industry literature (Great Lakes, 1997), a DAF unit, with chemical treatment using coagulants and flocculants, can remove up to 90% of the influent emulsified fats, oils and greases (FOG). This type of unit should be expected to attain floatable solids concentrations of 2 to 10%.

9.6.1 Bubble Formation

The air-to-solids ratio influences the solids rise rate, which affects the required detention time to achieve good separation (DoD, 1988b).

Two general methods are commercially used in forming the minute air bubbles (Cheremisinoff, 1995):

- The vacuum method involves aerating the waste to saturate it with air at atmospheric pressure, releasing the excess air, and then forming the small bubbles by applying a vacuum.

- In the pressurization method, air is dissolved into the wastewater under pressure and then the pressure is released forming minute bubbles. This method is more common in the treatment of oily wastes. There are three variations of the pressure method: full-flow, split-flow, and recycle operation. Recycling a portion of the clarified effluent allows a larger quantity of air to be dissolved and dilutes the feed solids concentration. This dilution reduces the effect of particle interference on the separation rate.

The air pressure used in flotation determines the size of the air bubbles formed. Air bubbles smaller than 100 microns are the most suitable for being adsorbed and entrapped by the chemical floc and oil droplets. An excessive amount of air can destroy the fragile floc formed in the flocculator, resulting in poor performance (DoD, 1988b).

The principal design variables for DAF are shown below. The equipment manufacturer will specify most of these parameters.

Table 9-5 - Dissolved Air Flotation System (DoD, 1988b) **- General Design Information**

Mode of Operation	Continuous
Category of Oil Removed	Free and Dispersed; Emulsified oil may be removed (with chemical coagulants) 40 - 150 microns
Suggested Preliminary Treatment	Gravity oil/water separator
Surface Loading Rate, gpm/ft^2	1.0 - 3.0
Depth-to-width or -diameter Ratio	Between the limits 0.4:1 to 0.8:1
Feed Solids Concentration	0.5 to 5 lb/ft^2/hr
Air-to-solids Ratio	Between the limits 0.02:1 to 0.05:1
Maximum Bubble Size	< 100 microns
Pressure	40 - 60 psig
Detention Time at Design Flow	10 to 30 minutes
Recycle Ratio	30 - 70%
Chemical Aids	Determined by field testing
Average Effluent Oil Concentration, mg/L	10 - 20
Design Information Source(s)	EPA Manual 625/1-79-001 Equipment Manufacturers Military Handbook 1005/9

9.6.2 Coalescing DAF

Several vendors of flotation equipment incorporate the use of interceptor plates in the flotation tank. As in the case of gravity separators, these plate surfaces tend to substantially reduce the height to which a rising oil droplet of or solid must traverse before being separated (Cheremisinoff, 1995).

9.7 FILTRATION

Filtration systems are usually considered polishing units.

9.7.1 Multi-media Filtration

Multi-media filtration is the most practical process of polishing treated oily wastewater. Multimedia filtration systems are available that operate by gravity or under pressure. Pressure filters operate at higher loading rates and require less area than gravity units with comparable capacity. In colder climates, enclosing the system indoors may be necessary. The system may have automatic backwashing capabilities, initiated by sensing a predetermined head loss across the filter bed. A reservoir may be provided for backwashing the filter with effluent.

Table 9-6 - Multi-media Filter System (DoD, 1988b) **- General Design Information**

Mode of Operation	Continuous
Category of Oil Removed	Mechanically emulsified oil
Suggested Preliminary Treatment	Gravity or flotation units
Filtration Rate: (1) Gravity (2) Pressure	 (1) 3 - 8 gpm/ft^2 (2) 12-18 gpm/ft^2
Bed Depth	24 - 36 inches
Filter Media	Combination sand, gravel, anthracite (garnet optional)
Filter Solids Loading	2 - 6 lb/ft^2/hr
Pressure Drop: (1) Clean (2) Loaded	 (1) 2 - 4 psig (2) 8 - 12 psig
Backwash Rate	15 - 20 gpm/ft^2
Air Scour Flow Rate, If Necessary	3 - 6 sft^3/min/ft^2 @ 12 psig
Average Effluent Oil Concentration, mg/L	< 10
Design Information Source(s)	Military Handbook 1005/9 Equipment manufacturers

9.7.2 Pressure Filters

Pressure filters may be used to remove dilute concentrations of mechanically emulsified oil, usually as a polishing step downstream of gravity or flotation units. Activated carbon, other proprietary solid phase sorbents, or bentonite clay/anthracite are typically used as the media. Application of filters at military installations strictly for oil removal is expected to be extremely rare, so the design of these units is not covered here (DoD, 1997e).

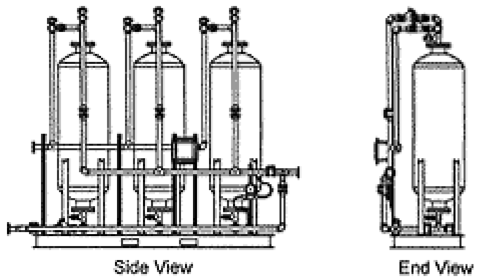


Figure 9-9 HydroCell - Pressure Sand Filters (Core-Rosion, 1999)

9.8 CENTRIFUGAL SEPARATORS

Centrifugal separators have found limited use in the treatment of oil-in-water emulsions, but have widespread use in the treatment of water-in-oil emulsions (Cheremisinoff, 1995).

Centrifugation separators take advantage of the difference in specific gravity between oil and water. Separators based on centrifugation principles are quite effective in the removal of oil-wet solids. Effluent qualities averaging 50-70 mg/L oil have been reported. Other devices which use centrifugal separation principles include hydroclones, swirl concentrators, and vortex separators.

How they operate:
The more dense water phase is moved to the outer region of a rotating volume of fluid. The lighter oily materials collect near the vortex and are subsequently removed.

The air-sparged hydrocyclone (ASH) is an advanced system that combines hydrocyclone and flotation technologies to obtain greater separation effectiveness (Chirkis, 1997). An ASH reactor can provide efficient removal of hydrophobic particles in an aqueous waste stream. This includes chemically stabilized emulsions of petroleum, oil and lubricant (POL) products and AFFF.

The reactor consists of a porous tube, a conventional cyclone header, and a froth underflow structure that is at the bottom of the porous tube. Wastewater is fed through the cyclone header to develop a swirl flow inside the porous tube. Pressurized air is sheared into numerous fine bubbles by the high-velocity swirl flow of the suspension. Hydrophobic particles/oil droplets in the suspension collide with these bubbles and, after bubble/particle attachment, are transported into a froth phase. The froth phase is discharged as an overflow product. Cleaned water remains in swirl motion and is discharged as an underflow product.

The ASH technology is mature and capable of effectively removing 90-100% of oil, grease, oily solids, residual fuels and AFFF from aqueous waste streams.

9.9 EMULSION BREAKING

Emulsified oil **(Section 8.1.2)** cannot be removed by gravity separation unless it can first be converted to free oil by breaking the emulsion. Emulsion-breaking (demulsification) methods consist of physical and chemical processes. Chemical methods are in widest use for breaking oil-in-water emulsions (Cheremisinoff, 1995). Electrical processes, wetting agents and polyelectrolytes (organic polymers) can break water-in-oil emulsions (DoD, 1988b).

The focus of this section will be to generally describe those methods that are applicable to the breaking of oil-in-water emulsions.

> Formation of oil emulsions should be minimized as much as possible. Segregate emulsions for special treatment wherever possible.
>
> Chemical treatment of an emulsion is usually directed toward (Cheremisinoff, 1995):
> - destabilizing the dispersed oil droplets (DoD, 1997e) causing them to coalesce and form free oil, or
> - chemically binding or destroying any emulsifying agents present.

Chemical emulsion breakers will balance or reverse interfacial surface tension, neutralize stabilizing electrical charges, or precipitate-emulsifying agents. Chemicals commonly used include alum, ferrous sulfate, ferric sulfate, ferric chloride, sodium hydroxide, calcium chloride, sulfuric acid, lime, sodium silicate, borax, sodium sulfate, and polymers. Proprietary chemical emulsion breakers are very effective, but they are more costly than iron or aluminum salts.

> The emulsified oil-in-water droplets usually carry negative charges. Therefore, a cationic (positive charge) emulsion breaker should be used (Acurex, 1997).

Some factory manufactured separators are designed with emulsion breaking chambers where chemicals are added and mixed; otherwise, emulsion breakers should generally be added to the wastewater as far upstream of the separator as practical.

> Emulsions are usually complex, and bench or pilot plant testing is generally necessary to determine an effective method for emulsion breaking.

The various chemical and physical methods of breaking oil-in-water emulsions are listed in **Table 9-7**.

Table 9-7 - Methods of Breaking Oil-in-Water Emulsions (DoD, 1988b)

CHEMICAL	DESCRIPTION
Coagulation	Coagulation/flocculation typically consist of rapidly mixing coagulant chemicals with the wastewater, followed by gentle mixing (flocculation). Coagulants allow droplets of emulsified oil to agglomerate into a larger floc, which is more easily separated from the water.
Anions	OH^- and PO_4^{-2}.
Cations	H^+, $A1^{+3}$ and Fe^{+3} . Coagulation with aluminum or iron salts is generally effective. The resultant hydroxide sludge is difficult to dewater and limit the reusability of the recovered oil (DoD, 1997e).
Organic	Generally produces a better quality effluent, often requires lower dosages, and reduces the amount of sludge generated by 50 to 75 percent.
Acidification or Acid Cracking	The pH of the wastewater is reduced to 3 or 4. Neutralization of the discharge is required. Acids generally cleave emulsions more effectively than coagulant salts but are more expensive (Cheremisinoff, 1995). If acid is added to bilge water to a pH of about 2, the oil will float and can be removed (Waste Reduction, 1997).
Salting Out	Large quantities of an inorganic salt are added, thereby increasing the dissolved solids content of the water phase. Sodium chloride (NaCl) is not recommended since it is slow, requires large amounts of the salt and results in a corrosive liquid.
PHYSICAL	
Mechanical Impingement	(Coalescing filters and cartridge-type emulsion breakers) The emulsion is broken by impingement of the oil droplets on the surface of the medium. The medium contains numerous small (25 microns), irregular, continuous passages through which the wastewater flows (DoD, 1997e).
Filtration	Breaks some stable emulsions. The emulsion is filtered through a layer of diatomaceous earth normally deposited on a continuously rotating drum filter.
Heating	Heating will not normally in itself break the emulsion. The application of heat and pressure, however, will improve the separating effect achieved by the addition of caustic or acid. If bilge water is heated to about 200 degrees F, the oil will float and can be skimmed (Waste Reduction, 1997).
Ultrasonic Radiation	Not suitable for application to typical oily wastes from military installations.
Precoat Filtration	Not normally recommended because of its high operating costs.

> **Sections 9.10** through **9.12** present technologies involved with removal of the oil droplets, rather than separation.

9.10 BIOTECHNOLOGY

> Biotechnology systems are only effective in treating oily wastewater if suitable pretreatment and high dilution can be achieved.

The treatment of dissolved oils and other types of chemically stabilized emulsions that cannot be destabilized by chemical addition **(Section 9.9)** can pose serious problems. Biological treatment with acclimated microorganisms is generally effective in degrading much of this material and is commonly used in petroleum refineries and animal-rendering plants (Cheremisinoff, 1995). In trickling filters, oil at higher concentrations tends to coat the microbial surfaces and reduce the transfer of more readily oxidizable organics. Trickling filters can treat oil concentrations of up to 100 mg/L with no adverse effect. In activated sludge systems, the adsorbed oil tends to impair sludge-settling characteristics. Activated sludge systems show no effect if the oil concentration is less than 25 mg/L. Biologically treated effluents typically contain less than 10 mg/L oil.

9.11 CARBON ADSORPTION

> Carbon adsorption is a polishing system that removes dissolved oil and trace concentrations of non-dissolved oil.

Carbon adsorption has been addressed quite extensively as a means of removing trace quantities of oil. Treatment by carbon adsorption generally requires a large capital investment for carbon inventory and regeneration equipment and has, therefore, not found widespread use in oil separation where high concentrations are involved (Cheremisinoff, 1995). Where pretreatment of dissolved oil at an upstream location is required, adsorption would be the probable method of choice (DoD, 1997e).

9.12 MEMBRANE SYSTEMS

Membranes are asymmetric surface filters with extremely small pore sizes. A thin membrane layer is bonded onto a more porous substrate. Contaminants such as emulsified oil droplets are too large to pass through the separation layer and are rejected at the membrane surface. Clean water passes through the separation layer. A layer of rejected oils and other substances is prevented from building up on the surface by imposing a cross-flow of liquid parallel to the surface, which sweeps the surface clean (Tompkins, Undated).

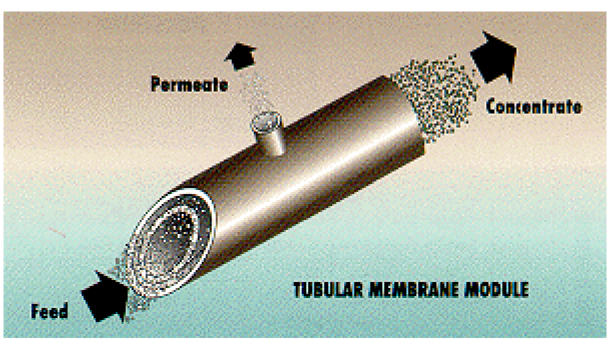


Figure 9-10 Tubular Membrane Module (SpinTek, 1999)

All membranes eventually exhibit symptoms of fouling and must be cleaned or replaced. The fouling rate is a function of membrane type, cross-flow velocity, temperature, permeate flow rate, and the character of the feed and retentate (liquid retained behind the membrane) streams (Tompkins, Undated).

These systems should only be used for polishing as the membranes may be damaged or blinded by solids or free oil, respectively (Water Refining, Undated).

9.12.1 Micro-Filtration and Ultra-Filtration

Micro-filtration and ultra-filtration are excellent tools for removing emulsified oils and very fine suspended contaminants. These disks and hollow tubes have a specific membrane affixed to a porous substrate (Water Refining, Undated).

Micro-filtration is a method for separating suspended particles from dissolved substances. These membranes have pore sizes above 0.05 micron, and are generally designed to retain particles in the “micron” range (greater than about 0.5 micron). There is a potential for oil breakthrough in high emulsion concentration (FMC, 1996).

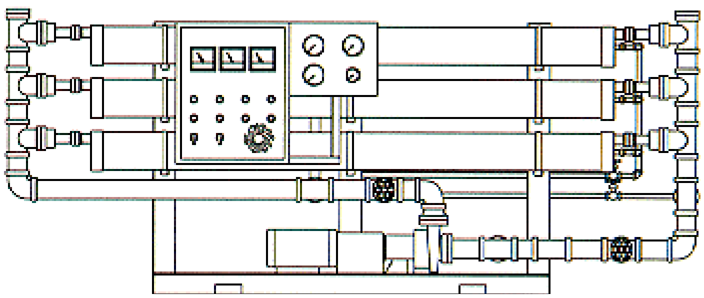


Figure 9-11 Ultra-Filtration System (SpinTek, 1999)

Ultra-filtration is a method for simultaneously purifying, concentrating, and fractionating macromolecules. These membranes have pore sizes below 0.01 micron. The smallest particle retained by the membrane is 0.05 micron (CAE, Undated).

These systems can be used to produce essentially oil-free effluents, but require large capital investment and have high operating costs.
How they operate: Micro-filtration and ultra-filtration are based on the sieving action of a polymeric membrane controlling the flow of molecules larger than the membrane pores. Applied pressure is used to increase the flux of the liquid across the membrane. The membranes tend to foul with particulates and the flux therefore decreases. The fouling is normally removed by back flushing and/or detergent washing (Cheremisinoff, 1995).

The Navy is currently evaluating an ultra-filtration membrane polishing system following parallel plate separators for use in treating bilge water to a concentration of less than 5 mg/L oil (Tompkins, Undated).

9.12.2 Reverse Osmosis

Reverse osmosis is generally considered a water purification technique.

Reverse osmosis is similar to ultra-filtration in that an applied pressure forces the water through the membrane against a concentration gradient while oil is retained due to the small size of the membrane pores. In reverse osmosis, the pore sizes are smaller and the applied pressures are significantly higher than ultra-filtration. Reverse osmosis is generally considered to be a water purification technique in which the smallest molecules retained by the membrane are 0.0001 to 0.001 micron (CAE, Undated).

> **How they operate:**
> Reverse osmosis operates the same as ultra-filtration units, but the pore sizes are smaller and the applied pressures are significantly higher.

9.13 Closed-Loop, Recycle Systems

Most current treatment/pretreatment systems employ the use of settling basins for the removal of sediments followed by an oil/water separator for the removal of oil and grease. If stringent effluent limitations are an issue with oil/water separators, closed-loop recycle treatment systems should be considered.

> Certain activities mandate that only fresh (not recycled) water be used to wash a particular piece of equipment, vehicle, or aircraft, which would eliminate the use of a closed-loop recycle system.

Manufacturers' performance claims are frequently based on ideal treatment conditions. These ideal conditions, however, almost never exist at DoD facilities. High solids loading and unique military use affect the performance of closed-loop recycle treatment systems (Engbert, 1997).

9.13.1 Lessons Learned

In the spring of 1996 at the request of the Army Environmental Center (AEC), a phone survey was conducted on all known closed-loop recycle treatment system owners within the DoD. Results from that survey show that installations have decided to purchase closed-loop recycle treatment systems as an alternative to discharging systems. The survey also showed that installations purchased closed-loop recycle treatment systems based on the sales representative's claims and suggestions. The AEC also sponsored an evaluation of two commercial recycle treatment systems. The systems were used at an Army maintenance shop to enable the use of steam cleaning wastewater. Several important factors regarding the operation and maintenance of closed-loop recycle treatment systems were documented (Gerdes, 1998):

- Operation costs will be high due to labor requirements and consumables.
- High equipment downtime should be expected for operation/maintenance and repair.
- Recycling systems may not adequately handle contaminant slugs.
- Wastewater contained within a recycling system will eventually need to be discharged into a sanitary sewer or otherwise removed for disposal (accumulated levels of contaminants require monitoring). The removed material may be considered a hazardous or industrial waste.
- Manufacturer's contract should provide for: training, on-site support and troubleshooting; and a user's manual that is easy to understand and assists in daily, weekly, and monthly maintenance record keeping.
- Recycle systems should be installed and operated inside a closed and heated building due to environmental factors.
- Daily operation and maintenance is required, sometimes up to 30 minutes each day.

- Periodic inspections are necessary to insure that the system is operating in closed-loop mode (problems can be encountered due to a limited size of the washrack basin, sump pump reservoir, or recycle treatment system controls).

> System overflows are possible if problems occur with system controls.

- Limited handling of hazardous materials may be required (e.g. aluminum sulfate as a coagulant, sodium hydroxide for pH control, etc.).
- Closed-loop systems require make-up water due to evaporation or water carried off on vehicles.
- Disinfection of the wastewater may be required to prevent clogging of the system and for operator safety.

9.13.2 General Recycling Systems

The hydraulic capacity, treatment methods, and wastewater sources associated with recycling systems will vary widely. Common elements associated with recycling systems include equalization, grit removal, oil separation (with or without chemical addition), sand/mixed media filtration, "used oil" and grit holding, and a treated wastewater holding tank. Other system elements can include, but are not limited to, sorption of dissolved petroleum based compounds (activated carbon), ozonation to burn-up organics, and membrane systems (reverse osmosis).

> The unit choice is dependent upon the contaminant, concentration, and amount of water to be processed (Cain, 1996b).

Recycling systems can serve a wide range of activities throughout the military including, but not limited to: plating, degreasing, phosphatizing, aqueous parts cleaners, etc. The types of recycling systems serving these activities would be too numerous to address in this document. As washracks are one of the primary sources (by volume) of oily wastewater in the military, it was determined that recycling washracks would be a good example of closed-loop systems.

> Improper use of a system, e.g., washing lawn mowers in a system not designed to remove grass, may cause system damage or render the system inoperable.

9.13.3 Washrack Recycling Systems

One operation common to all services is the washrack. The size of a washrack can range from less than 10 square feet (small equipment wash area) to acres (central vehicle wash facility). Noticeable problems are usually associated with the larger (vehicle washing) systems.

> Closed-loop recycle treatment systems entail higher installation costs and create a considerable addition to the amount of operation and maintenance required.

In order to maintain mission readiness, military units must periodically wash their vehicles. Vehicle washing is conducted in a designated area called a washrack. Discharging washrack treatment systems utilizing an oil/water separator are the most common due to their low cost.

Closed-loop recycle treatment systems are currently being installed due to their limited discharges to the environment (Engbert, 1997). Examples of vehicle washrack recycle systems are listed below:

The wastewater generated at a typical Navy vehicle washrack (recycling rates of 1 to 50 gallons per minute) may go through three treatment units before being reused (DoD, 1997b):

> **Free oil and dirt removal from the wastewater.**
> Wastewater goes through a vertical zigzag solids-liquid separator; a polypropylene oil coalescing pack; a high density adsorption filter for removal of very small oil droplets; and flow baffling. An oil/skimmer removes oil from the separator for holding.
>
> **Removal of fine dirt particles and remaining hydrocarbons.**
> Wastewater then goes through a 20-micron quad cartridge filter; an adsorbent media filter that removes contaminants down to 5 to 20 microns; and a carbon filter for removal of trace contaminants.
>
> **Holding**
> The holding unit consists of a corrosion-proof polyethylene tank; a centrifugal pump with surge tank; a recycled water level control valve; an overload drain system; and an ozone generator. The clean water is placed under high pressure and reused.

The wastewater generated at an Air Force, vehicle/aircraft washrack (recycling) system may be treated using the following system (Ellis, 1997):

> **Free/dissolved oil and dirt removal from the wastewater.**
> The wastewater enters an oil/water separator with polypropylene coalescing plates. Alum is added as a flocculant to enhance oil and solids removal. An oil skimmer removes oil from the separator for holding.
>
> **Removal of fine dirt particles and remaining hydrocarbons.**
> The wastewater then passes through filters containing sand, gravel, and anthracite. The filters screen out dirt and other solids down to 20-40 microns. The filter is back washed under pressure. The clean water is placed under high pressure and reused.

9.14 BILGE AND OILY WASTEWATER TREATMENT SYSTEM

The Naval Facilities Engineering Service Center has developed a shore-side system for treating bilge and other oily wastewaters. The Bilge and Oily Wastewater Treatment System (BOWTS) removes all major contaminants found in bilge waters. The water fraction leaving the system will be of a quality that can be discharged directly into a sanitary sewer or waters of the U.S. (DoD, 1997a).

The BOWTS hardware is a stationary system with secondary containment equipped with redundant (duty/standby) intake pumps, each fitted with upstream strainers. After the ship's bilge water is transferred to a large holding tank, the feed is passed through a first stage oil/water separator, and then into a series of three chambers for chemical treatment. Three chemical metering pumps feed a reverse emulsion breaker, sodium hydroxide, and anionic polymer, respectively, into this subsystem, resulting in the removal of the emulsified oil and precipitation of the heavy metals. The effluent is pumped into an induced-air flotation unit, where the generated residues are removed. Two slop oil tanks collect the removed free oil, and a solids tank is provided for holding the collected solids in the separator and the induced-air flotation system.

The system has the flexibility to accommodate a wide range of contaminant concentrations and flows. Each system is designed to site-specific requirements (e.g., configuration, modifications, etc.). The BOWTS operation is completely automated but requires one person to monitor the process.

> **NOTE**: The previous sections of this chapter addressed industrial oil/water separators, that is, separators that were designed to treat industrial wastewater and may also receive storm water runoff. **Section 9.15** addresses storm water oil/water separators, which receive only storm water runoff.

9.15 STORM WATER SYSTEMS

Historically, oil/water separators have been installed to treat runoff from military industrial areas. Most separators do not have the capacity to handle large flow surges during storm events. These large quantities of storm water can create two problems (DA USACE, 1994):

- inadequate detention time, which results in poor treatment, and
- the flushing of large quantities of oily wastes into sewers or streams from scouring of the system contents.

> Storm water should be totally or substantially removed from industrial separator systems that discharge to sanitary sewers.

9.15.1 General Design Considerations

The design of oil/water separation systems to treat storm water runoff must consider highly variable flows and contaminant loadings. Listed below are some general guidelines:

> The use of oil/water separators as a storm water pollution prevention, best management practice is discouraged. The site conditions/operations draining to the separator should be improved to the point that treatment of the storm water is not necessary.

- Where feasible, segregate contaminated from uncontaminated runoff to minimize the volume of water requiring treatment.
- Sedimentation facilities should be considered upstream of the oil/water separator. Suspended solids in the runoff should be minimized to improve the effectiveness of the oil removal system.
- Use a temporary storm water retention facility that can release its contents to the separator at a controlled rate. This will minimize the size of the oil/water separator.
- The design flow should be based on a rainfall intensity-duration-frequency curve for a 1-year storm (return frequency) generated for your specific area (DoD, 1988b). Contact federal,

state, and local regulatory agencies to determine the adequacy of this storm frequency interval. The appropriate runoff coefficients should be applied to the drainage area.

Some states have established design standards for storm water gravity separators. For example, Washington State requires storm water separators be designed based on the following conditions (Rust, 1997):

V_t = terminal rise or settling velocity = 0.033 ft/minute
d_p = diameter of oil droplet = 60 microns
T = temperature of wastewater = 50^o F

9.15.2 Water Quality Inlets

Water quality inlets (WQIs) are structures designed to separate pollutants from the first flush of storm water. A water quality inlet typically consists of a sedimentation chamber, an oil separation chamber, and a discharge chamber. These systems may be constructed on site, precast, or manufactured by a vendor. Because of their separation capabilities, WQIs are occasionally referred to as oil/grit separators or oil/water separators (DoD, 1997c).

WQIs have minimal effect on the removal of nutrients, metals, and organic pollutants other than free petroleum products. The sedimentation chamber can be expected to partially reduce grit and sediments. WQIs are effective in separating free oil and grease from storm water. Separation of dissolved or emulsified oil from water is rarely achieved.

WQIs do not manage the total volume of storm water flow, due to limited capacity, and have limited removal efficiencies when not properly maintained. For these reasons, WQIs are often used to pretreat runoff prior to discharge to other best management practices.

How they operate:
Storm water runoff enters the sedimentation chamber in a water quality inlet where coarse materials settle. Flow from the sedimentation chamber is conveyed to the second chamber through an orifice covered with a trash rack and located halfway down the wall separating the two chambers. The second chamber functions as an oil separation chamber. Water that enters the third sequential chamber discharges through a storm water outlet pipe.

Listed below are some general design information concerning WQIs:

- The design should include permanent pools within the chambers, to reduce sediment resuspension during storm events, and manholes located above the chambers, to provide access for cleaning and inspection.
- The limited capacity of most WQIs typically means that the discharge rate is high and the detention time is relatively short. Most water quality inlets have an average detention time of less than a half-hour.
- The WQI should be located in a small, impervious area and close to a storm drain network to allow for future discharge from the WQI to the storm sewer system.
- WQIs are typically used as an off-line treatment process where lower flows will be encountered; high flows result in resuspension of settled material.

- The WQI should be watertight.

WQIs are useful for separating sediments and free oil from storm water runoff, which improves downstream water quality. The disadvantages of a WQI are: the systems cannot handle excessive flows adequately; require scheduled maintenance; and residuals may require disposal as a hazardous waste.

9.15.3 Skimming Dam and Diversion Pond

This system consists of two major components. The skimming dam is placed in a drainage pattern to convey dry weather flows; retain runoff and skim free oil from small storms; and divert larger flows to a secondary holding (diversion) pond. Some general design considerations for a skimming dam are listed below (DoD, 1988b):

- provide adequate room for ponding behind the dam;
- provide pass-through capability for dry weather flows;
- use float and boom to trap and divert floating oil and grease to the side of the channel;
- provide a movable belt-skimming device to skim oil to a collection hopper for holding;
- design the channel for a maximum horizontal velocity of 12 fpm, based on data for a 1-year frequency storm at the specified geographical location. Contact federal, state, and local regulatory agencies to determine the adequacy of this storm frequency interval.

A separate diversion pond may be used to accommodate potential large oily waste spills and more intense storm events. This prevents washout of the oil over the skimming dam before it can be removed.

9.15.4 Storm Water Drainage Pits

Some states require that storm water runoff be collected in drainage pits to recharge the groundwater. POL products collected in the pit may require removal utilizing a portable oil removal system (Cain, 1996a).

Table 9-8 - Summary of Oil/Water Separator Systems

OIL/WATER SEPARATOR TYPE	TREATMENT PRIOR TO SEPARATOR	COST ($1,000)	EFFLUENT CONCENTRATION *(Oil Type Removed)*	ADVANTAGES	DISADVANTAGES
GRAVITY SYSTEMS (Section 9.2 - 9.3)				• **Effectively removes free oil** • **Handles highest solids concentrations**	• **Cannot effectively remove emulsified or dissolved oil**
Standard Gravity (API) **(Section 9.3.1 & 9.3.2)**	Solids removal (suggested)	Installation cost: Low Operation cost: Low $5 - 60 (5 to 30 gpm)	20 - 100 mg/L *(Free, > 150 u)*	• Continuous mode of operation • Requires minimum operation and maintenance • Minimum construction cost • "Used oil" may be recycled • No electrical requirements	• Highly susceptible to fluctuating flows and wastewater characteristics • Primarily underground, may be disregarded.
Load Equal-ization Tank **(Section 9.3.3.1)**			< 50 mg/L *(Free, > 150 u)*		• Currently being replaced by BOWTS • Operates as a batch or fill and draw system
Oil Interceptor **(Section 9.3.3.2)**			N/A		• The use of oil interceptors is not recommended.

OIL/WATER SEPARATOR TYPE	TREATMENT PRIOR TO SEPARATOR	COST ($1,000)	EFFLUENT CONCENTRATION *(Oil Type Removed)*	ADVANTAGES	DISADVANTAGES
COALESCING GRAVITY SYSTEMS (Sections 9.4 and 9.5)	**Solids removal**	**Installation cost: low-to-moderate Operation cost: low-to-moderate $5 - 20 (5 to 100 gpm)**		• **Effectively removes free and some dispersed oil** • **Can handle higher flows (2 to 3 times) than standard gravity system of same size** • **Simple operation** • **Retrofit option**	• **Cannot effectively remove emulsified or dissolved oil** • **Cannot handle high solids loading as well as standard gravity** • **Requires slightly more maintenance than gravity system (fouling of plates)** • **Highly susceptible to fluctuating flows**
Parallel Plate Inclined Plate **(Section 9.4.1)**		$4 (small) $100 (1,300 gpm)	< 50 mg/L *(Free & Dispersed, > 60 u)*		
Corrugated Plate **(Section 9.4.2)**					
Fixed-Media (tube, etc.) **(Section 9.5.1)**	Solids and free oil removal		1 - 50 mg/L, generally < 10 mg/L *(Dispersed & Some Emulsified)*		• Recommended for only light oil and minimal solids loading • Usually reserved for low flow applications with very little suspended solids • Media will become blinded and must be replaced
Loose-Media **(Section 9.5.2)**	Solids and free oil removal Influent solids < 100 mg/L				• Recommended for only light oil and minimal solids loading • Heavy oils will foul the sand media

Oil/Water Separator Type	**Treatment Prior to Separator**	**Cost ($1,000)**	**Effluent Concentration** *(Oil Type Removed)*	**Advantages**	**Disadvantages**
Flotation (Dissolved Air) **(Section 9.6)**	**Solids and free oil removal**	**Installation cost:** **moderate-to-high** **Operation cost:** **$0.5 per 1,000 gallon** **$100 - 200 (100 to 200 gpm)**		• **Generally an aboveground system** • **Widely used** • **Resilient to oil concentration spikes**	• **Free oil will reduce the treatment efficiency** • **Considered a polishing unit, high maintenance** • **Influent must be pumped** • **Effluent potentially high in salt and may be corrosive** • **Sensitive to flow and oil concentration**
Without Chemicals		N/A	Removal Efficiency: Free oil - 75 to 90% Emulsified oil- 10 to 40%		
With Chemicals (Demulsification) **(Section 9.9)**		Installation cost: low Operation cost: $0.25 - 5.00 per 1,000 gallons	< 20 mg/L *(Free, dispersed, & emulsified, 40 - 150 u)*	• Can remove up to 90% of emulsified influent fats, oils, and grease	• Hydroxide sludges may limit the reusability of the recovered oil • Chemicals are customized for waste stream
Filtration (Section 9.7)	**Free oil removal**	**Installation cost:** **moderate-to-high** **Operation cost:** **moderate**		• **End of line retrofit** • **Wide range of flow rates**	• **Generally considered a polishing unit, high maintenance requirements** • **Media may require handling as a hazardous waste**
Multi-Media **(Section 9.7.1)**			< 10 mg/L		
Pressure **(Section 9.7.2)**			*(Dilute concentrations of dispersed oil)*	• Takes up less space than a gravity filter system	• Applicability to military oil removal systems is rare.

OIL/WATER SEPARATOR TYPE	**TREATMENT PRIOR TO SEPARATOR**	**COST ($1,000)**	**EFFLUENT CONCENTRATION *(Oil Type Removed)***	**ADVANTAGES**	**DISADVANTAGES**
CENTRIFUGAL (Hydroclones, swirl concentrators, and vortex separators) **(Section 9.8)**			**50 - 70 mg/L**	• **Widely used in treatment of water-in-oil emulsions.** • **Effective in removing oil-wet solids**	• **Limited use in treatment of oil-in-water emulsions**
Hydroclone		Installation cost: moderate Operation Cost: moderate-to-high $50 - 200 (2 - 200 gpm)	25 - 100 mg/L *(Free and dispersed oil)*	• Simple operation • Compact • Low maintenance • No moving parts	• Sensitive to flow and emulsion characteristics • Noisy • Pressurized air required • Polishing unit - best when used after gravity separation
Air-Sparged Hydroclone		Not commercialized Operation cost: $0.40 - 1.10 per 1,000 gallons	Reusable Quality - 90-100% removal of oil, grease, oily solids, fuel, and AFFF	• Simple operation • Portable • No external power • Online retrofit for gravity separators	• Not widely used. • Sensitive to flow and oil concentration.
BIOTECHNOLOGY (Section 9.10)	**Free oil removal**		**<10 mg/L *(Dissolved)***	• **At low concentrations of oil, pretreatment of waste streams is eliminated.**	• **High oil concentrations may inhibit or eliminate biological activity.**
Trickling Filter	Influent oil concentration < 100 mg/L				
Activated Sludge	Influent oil concentration < 25 mg/L				

Oil/Water Separator Type	Treatment Prior to Separator	Cost ($1,000)	Effluent Concentration *(Oil Type Removed)*	Advantages	Disadvantages
Carbon Adsorption (Section 9.11)	**Free oil and solids removal**	**Installation cost: high Operation cost: high**	***(Dissolved & trace non-dissolved)***	• **Produces essentially oil free effluent**	• **Polishing Unit** • **Limited use for high oil concentrations** • **Large capital investment for carbon and regeneration system** • **High operating costs**
Membrane (Section 9.12)	**Free oil and solids removal**	**Installation cost: high Operation cost: $20 - 30 per 1,000 gallons $13 - 45 (1,000 to 1,800 gallons per day)**	**< 10 mg/L** ***(Emulsified oil and very fine suspended contaminants)***	• **Produces essentially oil free effluent** • **Portable**	• **Polishing Unit** • **Large capital investment and high operating costs** • **Membranes may be damaged or blinded by solids or free oil**
Micro-Filtration **(Section 9.12.1)**		Filters $0.6 to $1	*(> 0.5 u)*		• Potential for oil breakthrough in high emulsion concentrations.
Ultra-Filtration **(Section 9.12.1)**		Filters $0.6 to $1	< 5 mg/L *(> 0.05 u)*		
Reverse Osmosis **(Section 9.12.2)**			*(>0.0001 to 0.001u)*	• Basically a water purification process.	

OIL/WATER SEPARATOR TYPE	TREATMENT PRIOR TO SEPARATOR	COST ($1,000)	EFFLUENT CONCENTRATION *(Oil Type Removed)*	ADVANTAGES	DISADVANTAGES
CLOSED-LOOP RECYCLE **(Section 9.13)**	**N/A**	**Installation cost: moderate-to-high** **Operation cost: moderate-to-high** **Equipment, only:** **$16 (16 gpm)** **$17 (20 gpm)** **$26 (30 gpm)** **Covered washrack facility with heated mechanical room - $100.**	**Reusable Quality**	• **Eliminates continuous discharge to sewer** • **Reduces the amount of raw water usage** • **System usually aboveground on a single platform**	• **Some military activities prevent the use of recycled water** • **The wastes removed from the system may be of higher strength than flow-through system** • **Higher complexity and frequency of operation and maintenance** • **Lower system reliability compared to standard separators** • **Weather protection (heat) may be required** • **Electricity required** • **Storm water protection required for closed-loop** • **Disinfection may be required for proper operation and operator safety** • **Some materials (ethylene glycol) not removed**

OIL/WATER SEPARATOR TYPE	**TREATMENT PRIOR TO SEPARATOR**	**COST ($1,000)**	**EFFLUENT CONCENTRATION** ***(Oil Type Removed)***	**ADVANTAGES**	**DISADVANTAGES**
BILGE & OILY WASTEWATER TREATMENT SYSTEM (Section 9.14)	**Equalization (cost listed under site prep)**	**Equipment: $650 (150 gpm) Site Prep: $100 to $1,000**	**To sanitary sewer**	• **System can accommodate wide range of flows and wastewater characteristics**	• **Operation and maintenance requirements**
STORM WATER (Section 9.15)			**Removes free oil and sediment**		
Water Quality Inlets **(Section 9.15.2)**		$5.2 to $16.7		• Separates free oil and sediment from runoff.	• Cannot handle excessive flow • Required scheduled maintenance • Residual disposal
Skimming Dam & Diversion Pond **(Section 9.15.3)**					
Oil Removal from Drainage Pits (Portable) **(Section 9.15.4)**		$13 (1,000 gallons per day)	Removes separated oil from drainage pit		

CHAPTER 10
SHOP LEVEL CLEANING ACTIVITIES - DETERGENTS/CLEANERS AND SOLVENTS

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CHAPTER 10
SHOP LEVEL CLEANING ACTIVITIES - DETERGENTS/CLEANERS AND SOLVENTS

The activities at military installations require that materials and equipment be cleaned periodically in concert with scheduled maintenance. The type of cleaning compound and cleaning method used, may emulsify the oil thereby preventing removal by gravity separation. (For a discussion on emulsions and emulsion breaking/cracking systems, see **Section 9.9**.) Cleaning may be accomplished by the methods described below:

> **Important:** Prior to implementing any process change or material substitution be sure that technical orders are not violated. Do not implement any process change that conflicts with existing technical orders and other service technical directives.

10.1 CLEANING METHODS USED BY THE SERVICES

10.1.1 Cleaning Dry

"Cleaning dry," for the purposes of this document, means that no wastewater from the cleaning operation is discharged to the separator. This method of cleaning can be incorporated into a range of cleaning operations, from shop floors to engine parts. Shop floors may be cleaned by using sorbents, sweeping, and wet-dry vacuum. Some engine parts may be wiped off with a rag, rather than being placed in a parts cleaner.

"Cleaning dry" also incorporates liquid systems whose wastewaters are reused/recycled (central vehicle wash racks, aqueous parts cleaners, etc.). If the recycling system does not discharge, it is considered dry. If the removed liquid is shipped off-site for treatment/disposal, it is considered dry. If the liquid from the recycling system is removed and discharged to the sanitary sewer or separator, it is not considered dry.

> Liquid/solids removed from a recycling system for disposal should be evaluated for hazardous waste characteristics, before the final disposal method is established.

10.1.2 Pre-Cleaning

Pre-cleaning is practiced to remove gross contamination from floors and equipment prior to regular cleaning. Pre-cleaning includes, but is not limited to: sweeping floors before washing; preliminary cleaning of a part with a squeegee, rag, or wire brush; or two-stage cleaning where the material is pre-cleaned with material previously used for final cleaning (counter-current). Some non-detergent cleaning methods (steam, high pressure, and hot water) may be used to pre-clean.

If the material is pre-cleaned, the need for, or the required amount of, cleaner, may be substantially reduced.

10.1.3 Low Pressure, Cold Water

Detergents are normally used in conjunction with the low pressure, cold water (LPCW) method, along with large volumes of water (DA USACE, 1994).

> Use no higher concentration of cleaner than is necessary to clean the equipment. This will minimize emulsification (Gedlinske, 1997).

10.1.4 High Pressure, Hot Water (HPHW)

High pressure, hot water (HPHW) washers can reduce the use of cleaners or eliminate their need altogether. Some studies on hot water washers used for aircraft cleaning show that the use of solvents for cleaning can be reduced by as much as 80 percent. HPHW washers also decrease both cleaning time and water usage. This results in a significantly lower flow rate, and simpler wastewater for treatment (DA USACE, 1994).

> The informed use of HPHW cleaning systems can greatly reduce the use of cleaning aids.

10.1.5 Steam Cleaning

Steam cleaning is a viable alternative to solvent cleaning for removing oily or greasy residue. Heat is primarily used in the steam cleaning process. Heat accelerates emulsification, breakdown, and removal of caked-on dirt and grease. Steam's high temperature and low specific heat allow surfaces to be heated to relatively high temperatures. High temperature is maintained on the surface long enough for the steam to vaporize or liquefy the oil, grease, or dirt. The residue can then be effectively washed away with the condensate remaining from the condensed steam. Steam cleaning can also be used with a degreasing agent (often a surfactant) that enhances the solubility of grease in water (DoD, 1996b).

Steam cleaners are available to perform medium (e.g. auto parts, engines, etc.) to heavy duty (e.g. large machinery and oil drilling rigs) cleaning jobs. Steam cleaning units can be electric or fired with gasoline or diesel fuel.

> Flash rusting may be a problem for certain types of steel. Preventive measures may have to be taken. Prior to implementing this technology, performing a test case is recommended to ensure that the desired finish product is achieved (DoD, 1996b).

10.1.6 Dip Tanks/Parts Cleaning Stations

Certain parts require high levels of cleaning which may involve the use of highly alkaline cleaners or solvents. These systems may be closed (parts cleaning station) or a portion of a larger operation (plating, painting, etc.).

> The discharge from dip tanks and parts cleaning stations are generally recycled or treated by a system specifically designed for the waste stream.

10.2 Chemicals and Cleaning Agents - Definitions

Some general definitions related to cleaning compounds are supplied below:

Table 10 - 1 Definitions

TERM	DEFINITION (EPA, 1994b)
Cleaners	water-based and generally contain additives that allow them to remove contaminants. Cleans by displacing, dissolving, or chemically altering a contaminant.
Detergents	a cleaning agent. A surface active (wetting) agent or surfactant describes the special active ingredients that give detergents their unusual properties: detergency, emulsification, and wetting action (EPA & RTI, 1997). Synthetic detergents dissolve or tend to dissolve in water or other solvents. Detergents will contain hydrophilic (water loving) and hydrophobic (water hating) groupings (Hi Tech, 1996). Anionic and non-ionic detergents are most often used in cleaning.
Aqueous cleaners	mixtures of water, detergents, and other additives that promote the removal of organic and inorganic contaminants from hard surfaces.
Alkalinity	promotes detergency. Aqueous cleaners range in alkalinity from mildly (pH of 8) to highly alkaline (pH of 12 or higher).
Emulsifiers	disperse contaminants in water. Oil-in-water emulsifiers cause water-immiscible contaminants, such as oil or grease, to become dispersed in the water. Before disposal, the emulsion must be “cracked” or ultra-filtered to remove the oils. Cracking requires time and heat or acid (EPA, 1995a).
‘Weak’ emulsifiers	will keep oil in suspension as long as certain conditions exist. Some weak emulsions may be broken by stopping agitation or allowing the liquid to cool (EPA, 1995b).
Surfactants	"surface action agents" or “wetting agents” provide detergency by lowering surface and interfacial tensions of the water so that the cleaner can penetrate small spaces better, get below the contaminant, and help lift it from a substrate. Surfactants may be cationic, anionic, or nonionic in nature. Most surfactants can be emulsifiers and/or chelators (keep metal ions in suspension).
Solvents	used to dissolve semi-fluids and soils. A solvent could be defined as any substance that can dissolve another substance. Pure water and petroleum hydrocarbons are both considered solvents. In most of the industrial trade literature the term solvent refers to non-aqueous substances, whereas the term cleaner refers to substances that use water.

10.3 CLEANING AGENTS APPROVED BY THE MILITARY FOR USE WITH OIL/WATER SEPARATOR SYSTEMS

The Navy and Coast Guard have found a product (Formula P-98, MIL-D-16791) to be “effective and compatible” with their respective oil/water separator systems. A Navy memorandum authorized use (of P-98) for shipboard operations, provided that all cleaning procedures and handling precautions are followed (Hudson, 1998b).

At the time of printing, the Defense Logistics Agency (DLA) lists only one cleaner/degreaser product as compatible with oil/water separators (Formula P-98), a quick release detergent. The DLA lists Formula P-98 as a possible replacement for petroleum distillates and other hydrocarbons. It is available through DLA in:

5-gallon (NSN 6850-01-278-4421),
30-gallon (NSN 6850-01-278-3858), and
55-gallon (NSN 6850-01-278-4420) containers.

10.4 Quick Release Cleaning Agents and Weak Emulsifiers

> Acceptance of vendor claims without verification is not recommended.
>
> DLA issues disclaimers stating that performance claims are based upon vendor supplied materials.
>
> Prior to implementing any process change or material substitution be sure that technical orders are not violated.

A quick release cleaning agent, diluted with fresh or salt water will clean and emulsify hydrocarbons such as oil, grease, and diesel from a variety of surfaces. When the quick release cleaning agent comes into contact with the oil, it breaks the oil into microscopic droplets.

The breaking process may occur within five minutes of the oil being emulsified. The bond between the quick release cleaner and the oil weakens. The oil finally breaks away and rises to the surface of the water. In a test case, within 10 minutes, 93% of the breaking process was completed (Global, 1997).

'Weak' emulsions formed by some aqueous cleaners will keep oil in suspension as long as the solution is agitated, but the emulsion breaks when the agitation stops. Other cleaning solutions emulsify oils at a high temperature, but separate as the emulsion cools (EPA, 1995b).

10.5 "Environmentally Friendly" Cleaners/Detergents

> "Environmentally friendly" cleaners are not necessarily compatible with gravity oil/water separators.

The term "environmentally friendly" is contained on many cleaning compounds. Some of the characteristics of environmentally friendly cleaners include:

- biodegradability - the material degrades within a given period of time;
- the cleaners may not be toxic to certain organisms when used in accordance with manufacturer's directions; and
- the cleaner may not be corrosive, explosive, or flammable.

If a cleaner is considered "environmentally friendly," it does not mean that it is appropriate to discharge the material to an oil/water separator for treatment. There are several reasons for this:

- Usually "environmentally friendly" cleaners are water soluble and therefore may not separate or release emulsified oil during gravity separation.
- Biodegradability is perceived as a positive characteristic, but requires oxygen to occur. If the material stays in the separator too long and uses up all the oxygen in the wastewater, the liquid could become septic and may generate sulfides (corrosive). On the other hand, biodegradability rates may be for extended periods of time. If the cleaner requires days to degrade, the material could pass through the treatment system and enter waters of the U.S. without substantially degrading.

- An “environmentally friendly” compound that is used/reused in a parts washer may exhibit elevated metals and petroleum concentrations.
- An “environmentally friendly” compound may not be equipment friendly and may adversely affect a downstream treatment system.

10.6 Required Cleaning Compounds

At first glance the answer to the emulsified oil problem is to eliminate the use of emulsifying cleaning agents. While this form of pollution prevention (source reduction) may be acceptable in many applications, some military maintenance actions require the use of cleaning agents to ensure equipment readiness (Hudson, 1998b).

> A broad based elimination of the use of detergents in processes preceding conventional gravity separators should not be made because of its potential impact on military readiness.

The general type or specific cleaning compound to be used for a specific military activity may be listed in the respective technical orders, maintenance manual, technical manual, qualified products list, or contained in a military specification (MIL spec).

One military specification, MIL-D-16791G, for “ Detergents, General Purpose (liquid, Nonionic)” contains a performance requirement that the detergent produce an emulsion, which has a limited amount of phase separation over a specified time interval. In other words, these detergents are “required” to stay in emulsion.

Aircraft cleaning compounds are qualified to MIL-C-87937B (Cleaning Compound, Aerospace Equipment), and only products listed on the Qualified Products List (QPL) are currently authorized for use as a cleaning compound (Bishop, 1996) on such equipment (aircraft, engines, and aerospace and ground equipment). There are four types of cleaning compounds contained in this MIL spec all of which are considered biodegradable, water dilutable, and “environmentally safe”:

Table 10 - 2 Aircraft Cleaning Compounds

Type of Cleaning Compound	**Description/Information** (Reed, 1995)
Type I	Terpene-Based Solvent Emulsion, and Water Dilutable
Type II	Water Dilutable with No Flash Point
Type III	Gel-Type
Type IV	Heavy Duty, Water Dilutable with No Flash Point

10.7 Suggested Cleaning Evaluation

> **Important:** No changes in the current cleaning procedures should be undertaken without appropriate approvals.

It is suggested that each cleaning procedure contributing to an oil/water separator be evaluated. The evaluation flow chart is depicted in **Figure 10-1**. The figure lists in order the various steps the installation should undergo to establish the lowest degree of oil emulsification in the discharge to an oil/water separator. The first situation encountered in the flow diagram that meets the minimum operation cleaning requirements should be used. Information concerning the flow diagram is provided below and referenced in the figure.

10.7.1 Is the Cleaning Practice Required?

The first determination to be made is whether there is any flexibility concerning the existing cleaning practices. If the existing procedures cannot be changed, the oil/water separator should be evaluated as to whether the current procedures are affecting the system's ability to meet regulatory requirements **(Chapter 2 and Sections 4.4 and 4.5)**. If the current procedures cause problems, the separator should be evaluated as to the need for upgrading or replacing **(Chapter 7)** or should the wastewater be diverted to a system that is designed to adequately treat the wastewater.

If the cleaning procedures may be altered with justification, the cleaning process(es) should be reviewed.

> **Important:** Prior to implementing any process change or material substitution be sure that the item or program manager approves the change.

10.7.2 Is Cleaning Necessary?

If cleaning is not required or suggested, it should be eliminated.

10.7.3 Can Cleaning be Accomplished without Using Cleaners?

There may be alternatives to using cleaners and obtaining the appropriate degree of cleanliness. These processes can include cold water, hot water, high-pressure, and steam cleaning. Some of these processes may mechanically emulsify the oil, but the impact on the separator would not be as great, as the use of cleaners/detergents.

10.7.4 A Cleaner is Required

The remainder of **Figure 10-1** lists in preferred order, the type of cleaners that may be necessary to complete the cleaning process. The first type of cleaners that should be reviewed are those that have been approved by the military for use with an oil/water separator **(Section 10.3)**.

If the approved cleaners are not adequate, quick release cleaners or cleaners that form weak emulsions **(Section 10.4)** should be evaluated. The problem associated with these cleaners is that the military, has not approved the compounds for use with a separator. If these cleaners are to be used, they should be field tested by the installation to ensure that: the compound is compatible with the material being cleaned; will clean adequately; and will release the oil in accordance with the manufacturer's literature.

If a standard type of cleaner must be used, even if it is "environmentally friendly," the cleaner may adversely affect the treatment capability of the separator. The impact of the cleaner on the operation of the separator should be determined by monitoring the separator discharge to make sure that the effluent meets all petroleum-based regulatory requirements **(Sections 4.4 and 4.5)**. The use of this type of cleaner should be carefully controlled. If the cleaner causes effluent violations, the installation should review **Chapter 7** concerning the options for adequately treating the wastewater.

Table 10-3 - Warnings and Disadvantages of Various Cleaning Methods and Compounds

CLEANING METHODS	WARNINGS/DISADVANTAGES
Recycling System - Closed Loop	• Higher equipment and maintenance costs than flow-through system. • When liquid/solid is removed, it may be hazardous waste or require special handling as an industrial waste. • In general, removed liquid/solid should not be discharged to a standard gravity oil/water separator.
Low Pressure, Cold Water (LPCW)	Cleaners/detergents may: • allow oily wastewater to pass through separator without treatment, or • may emulsify the previously removed oil layer in the separator.
High Pressure, Hot Water (HPHW)	• Use of high-pressure water causes mechanical emulsification, but is generally less detrimental to gravity oil/water separation than the use of detergents (DoD, 1997e).
Steam Cleaning	• May mechanically emulsify oil. • May enhance emulsification due to elevated temperature of the wastewater. • Not recommended for any equipment, component, or material that is temperature or moisture sensitive (DoD, 1996b). • Water can penetrate and/or damage joints, seals, and bonded areas (DoD, 1996b). • Poor visibility of objects being cleaned. • Potential flash rusting.
Dip Tanks/Parts Cleaning Stations	• Hazardous materials must not be discharged to oil/water separators, and require pretreatment, if discharged to a sanitary sewer.
CLEANING COMPOUNDS	
Alkaline Cleaners (should not be discharged to a separator without proper evaluation of the impacts on the system)	• May require a wastewater treatment system specifically designed for the wastewater stream. • May be corrosive. • May contain elevated metal concentrations. • May cause pH violations in the separator effluent. • May increase the emulsification of some oils. • May be a hazardous waste (pH and metals).
Solvent Cleaners	• **Prohibited from being discharged to a separator.**

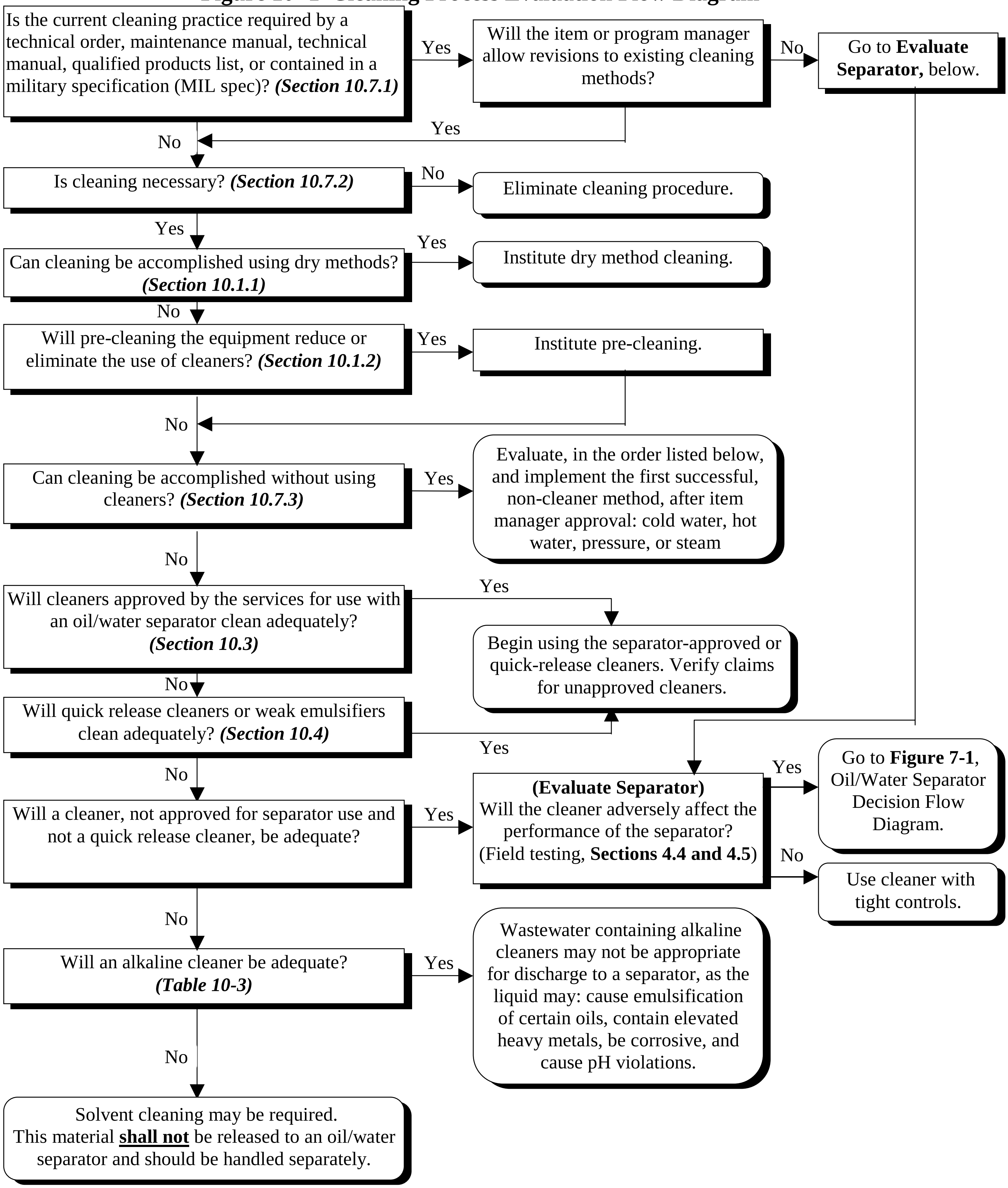
"Environmentally Friendly" Cleaners	• "Environmentally Friendly" cleaners may form a very stable emulsion, which is not compatible with standard oil/water separator systems. • Reuse of "Environmentally Friendly" cleaners in a recycling system, may cause the cleaner to exhibit hazardous waste characteristics. • May exhibit a high oxygen demand.
Quick Release Cleaners and Weak Emulsifiers	Unless the cleaner has been specifically approved by the military, all claims by the manufacturer must be verified.
Aqueous Film Forming Foam (AFFF) (formerly used as a bilge cleaner) **AFFF shall not be used as a bilge or equipment cleaner.**	A surfactant that creates a strong chemical emulsion that is resistant to gravity oil/water separation. The emulsion will coat polypropylene plates within a separator and inhibit the coalescence of oil on the plates (NAVSEA, 1998).
Terpene Cleaners include: d-limonene (derived from citrus fruit oil) l-limonene (derived from Douglas Fir needles)	A non-chlorinated organic solvent. Wastewater containing terpenes (Resta, 1998): • cannot be pretreated completely in a gravity oil/water separator due to emulsified oil formation; and • will inhibit biological treatment at a concentration of 100 mg/L (potential aquatic toxicity).

10.7.5 Completion of Cleaning Process Evaluation

Once the review of the cleaning process has been completed, necessary approvals should be obtained for any proposed modifications to existing guidance. The existing guidance documents and standard operating procedures (SOPs) should be revised to reflect the approved modifications.

> **Important:** Prior to implementing any process change or material substitution be sure that technical orders are not violated. Do not implement any process change that conflicts with existing technical orders and other service technical directives.

Figure 10- 1 Cleaning Process Evaluation Flow Diagram



CHAPTER 11
OPERATION, MAINTENANCE, AND INSPECTION GUIDANCE

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Chapter 11
OPERATION, MAINTENANCE, AND INSPECTION GUIDANCE

This chapter provides information to help the installation establish and conduct an operation and maintenance program. Inspection/maintenance of more advanced oil/water separator systems, such as dissolved air flotation, are system specific and will not be addressed (Please refer to operation and maintenance manuals provided for the system.). The gravity oil/water separators are mechanically simple and inspection/maintenance activities are therefore fairly straightforward. Details are provided concerning grounds maintenance; oil and solids monitoring, removal and disposal/reuse; and major component maintenance/inspection guidance.

11.1 GENERAL

According to the American Petroleum Institute (API), the most frequently encountered operational problems with gravity systems are (API, 1990):

(1) Mechanical failures:
- of flight skimmers or scrapers caused by foreign objects (tools, gloves, rags, etc.) or buildup of grit or silty solids; and
- plugging of suction lines (serving solids removal pumps) and failure of pump seals.

(2) Oil skimmers:
- debris and solids floating in the oil layer;
- excessive water being removed; and
- buildup and discharge of oil due to infrequent skimming operations.

(3) Parallel plate separators:
- plugging of the plate chambers with buildup of solids and foreign matter.

(4) Bar Screen (upstream):
- solids removal problems.

> Many of the operational problems are associated with solids buildup and solids removal.

Oil/water separators require periodic servicing to maintain their performance. Accumulated solids on the bottom of the separator and oil floating at the top of the separator must be removed regularly. The frequency for servicing is not directly mandated by regulation, but requirements may be contained in associated discharge permits or sewer use ordinances. Maintenance requirements may be based on the size of the separator or the volume and make-up of the treated wastewater. Periodic inspections allow facility personnel to determine when the solids must be pumped out and/or the oil removed.

> Lack of proper maintenance is one of the biggest causes of oil/water separator failure (DoD, 1997e).

A survey of the oil/water separator maintenance practices at one installation was conducted by USACERL in 1991-92 (Gerdes, 1993). The findings were that each oil/water separator was serviced (pumped) between 1 and 9 times per year, with the median being 3 times per year. Approximately 33% of the pumping involved only surface oil removal, the remaining 67% of the removal operations involved oil and solids. The quantity of solids removed from each separator ranged from 0 to 24 cubic yards per year, with a median value of 8 cubic yards per year.

Throughout this chapter you will note boxes ("example" below) with the word "Questions:" at the top. This box will list certain questions that should be asked concerning the maintenance and inspection of the system/equipment. As the questions are reviewed the user will address typical situations found at separators. It is not mandatory that these questions be answered, but failure to resolve the issues contained in the box may lead to problems down the road.

Questions:

"Example"

Listed below are major points of concern and general maintenance guidance.

11.1.1 Determine the Existing Conditions

Before an effective maintenance/inspection program can be established, certain information concerning the existing systems, their limitations/design capability, and contributing sources should be evaluated and summarized **(Section 3.1, Worksheet 3-5 or 3-6)**.

11.1.2 Delineation of Responsibility

The success of a separator operation and maintenance program depends upon the clear delineation and coordination of organizations that are responsible for the various activities associated with the system. The following lines of responsibility, at a minimum, should be delineated:

- Control of releases to the separator;
- Inspection of separators and internal components;
- Maintenance of separators and internal components;
- Maintenance/inspection of "used oil" tanks;
- Maintenance/inspection of upstream treatment systems (oil interceptors, grit chambers, equalization tanks, etc.);
- Compliance monitoring for oil, solids, and the wastewater discharge;
- Removal and disposal/reuse of oil;
- Removal and disposal/reuse of solids;
- Compliance of separator with all applicable permits/regulations/ordinances;
- Purchasing (chemicals and equipment); and
- Contracting.

If certain activities are carried out under other programs, the requirements for maintaining the oil/water separator system may be reduced. For example, if the "used oil" is held in an underground tank, the tank may be evaluated under the installation's UST program. Therefore the separator inspector would only have to measure the available holding remaining in the tank and not be concerned about other UST issues.

Table 11-1 is provided to generate a summary of responsible organizations for the various operations conducted on separators.

11.1.3 Location

The location of a separator in relation to known structures and to other separators **(Section 3.1.3)** will allow the installation to canvas an area relatively quickly, making optimum use of its personnel.

11.1.4 Type of Separator

Some separators are of sufficient complexity that the maintenance requirements cannot be addressed by this document. The operation and maintenance information for advanced/complex systems must be provided by the supplier/contractor. Even if the system is considered complex, this chapter should be reviewed as there may be issues discussed that are applicable to the system. The system types generally addressed by this chapter are gravity and coalescing gravity systems.

11.1.5 Elevation of Separator

The primary concern related to separator elevation is associated with underground and in-ground separators, potential releases to the groundwater, and any UST requirements.

Questions:
1. Does the state consider in-ground or underground separators USTs? (**Section 9.2.3.3**, Separate Holding)
2. Does the state require leak detection monitoring?
3. Is there a secondary containment system?

Whether a state regulates an oil/water separator system (separator and/or "used oil" holding tank) under the UST regulations has not been standardized. It is therefore necessary for each installation environmental office to contact their state regulatory agency for decisions concerning the oil/water separator and "used oil" holding tanks. The kind of information you should have available when contacting the agency is listed below:

1. *Is the oil/water separator discharge covered under the Clean Water Act?*
   You should know if the separator discharges to a POTW, FOTW, or to waters of the U.S. Are there any discharge (industrial or storm water) or pretreatment permits specifically associated with the separator? Does the discharge go to a drainfield, dry well, non-discharging lagoon, or land application system?

2. *Is "used oil" holding an integral part of the separator?*
   If there is a separate "used oil" tank that is not built into the separator, it may not be considered an integral part of the separator **(Section 9.2.3.2)**.

3. *What is the capacity of the "used oil" holding tank?*
   Some states will not regulate a holding tank as a UST if the capacity is less than 110 gallons.

4. *How much oil is stored in the tank at any one time?*
If "used oil" holding is limited to less than 1 inch of free product, the amount of oil is considered *de minimis* (such a small quantity that it is not regulated). This may remove the holding tank from regulation.

11.1.6 Accessibility

The ease with which the separator can be accessed will impact the maintenance/inspection requirements **(Section 3.1.8)**.

Questions:
1. Does maintenance/inspection require confined space entry permits?
2. Will heavy equipment be required? (fork-lift to remove a grate, etc.) If the equipment is required, is there a paved or graveled road near the separator that can be used?
3. Will special tools be required? (un-bolting and lifting a manhole cover)
4. Is it important to inspect those areas of the separator that are inaccessible or not readily accessible?
5. Can access to the separator be made easier? (for example, permanently removing 40 of the 60 bolts)
6. Can the coalescing plates be removed for cleaning?

11.2 INFLUENT WASTEWATER SYSTEMS

There are certain structures or operations that may precede a separator to enhance separator efficiency or are required to convey consistent wastewater to the system. Each are described below:

11.2.1 Preliminary Solids Removal

The operation of a separator, particularly as it affects maintenance, could be greatly enhanced by removing significant quantities of solids from the wastewater before it enters the separator. External grit/sand traps can accomplish this.

Questions:
1. What is the total sediment holding capacity within the system?
2. How is the current sediment capacity to be measured?
3. What is the available capacity at the time of the inspection?
4. What is the usual rate at which sediment is accumulated?
5. What is the time between inspections?
6. How is the sediment to be disposed?
7. Who is responsible for removing the sediment?
8. How much lead time is required to have the sediment removed?
9. Sediment monitoring methods, parameters, and frequency

11.2.2 Equalization

The use of an equalization system will greatly enhance the operation of a separator by providing a constant flow to the system and preventing surges. The tank/pond used for equalization should be inspected for proper operation of the wastewater conveyance devices to ensure that they are clean and functioning properly. Build-up of oil, solids, and debris should be noted and controlled as necessary. It is also important to evaluate the available hydraulic capacity (freeboard) of an equalization system, to ensure that the system will not overflow.

Past designs have utilized orifice control in shear gates, knife gate valves and small pipe diameter inlets as methods of limiting hydraulic overload of the oil/water separator. A problem observed at several installations was fouling of the flow restriction device by cups, bottles, and debris. Even orifice shear gates that are readily cleared of obstructions by lifting the handle are commonly left unattended, or are wired into the open position. An associated problem with providing flow restriction is that the pipe ahead of the separator becomes a sediment basin instead of a carrier pipe (DA USACE, 1994).   It should be noted that under appropriate design and maintenance conditions, the use of flow control devices might be beneficial.

11.2.3 Screens or Trash Racks

Screening of the wastewater could occur prior to, or within, the oil/water separator. These systems remove and collect floating debris from the wastewater. This action prevents blockage within the separator systems, particularly the oil skimmer. The screens should be cleaned on a regular basis to prevent blinding (clogging). The frequency of cleaning will depend on the type of materials discharged to and removed by the screen.

The material removed from the screen should be placed in a bucket or other holding container with a perforated bottom that drains to the separator to allow any oil on the material to be removed. After the debris has drained off most of the excess oil, it should be removed from the container and appropriately disposed of.

Exterior grit collection and trash racks or screens should be properly cleaned and maintained to prevent debris and abrasive solids from entering the separator.
Questions: 1. What is the screen cleaning procedure? 2. How often should the screen be cleaned? 3. Is there a receptacle to place oily material removed from the screens? 4. How is the screened material to be disposed of?

11.2.4 Influent Weir

A slotted baffle influent weir evenly distributes the wastewater throughout the depth of the separator (DoD, 1997f).   A vertical-slot baffle consists of upright members spaced across the channel inlet so that the open areas between members are at least ½ inch wide and larger than bar screen openings (API, 1990).   Manual cleaning of the baffle is occasionally necessary.

11.3 GENERAL SEPARATOR MAINTENANCE/INSPECTION GUIDANCE

11.3.1 Grounds Maintenance/Debris Control

The materials that could impact the separator include: cut grass, other vegetation, cans, rags, cigarette butts, paper, drums or containers of various materials, etc. The debris may be located in and around the separator, sitting on the side of the separator, or on the grate covering the separator. Debris may also be located in the influent channel and within areas that drain to the separator.

The decomposition of cut grass and other vegetation in separators has adversely affected the wastewater pH to the degree that violations of NPDES effluent limitations occurred.

> The area around the separator should be kept free from debris and other objects that could fall or blow into the separator (API, 1990).

11.3.2 Leaks and Spills

The separator and appurtenant equipment (pumps, holding tanks, etc.) should be inspected to determine if wastewater or residual material has leaked from the systems. Leaking, if unchecked, may cause environmental problems and/or damage to the treatment system.

The area around the separator should be inspected to determine if spills have occurred during transfer of residual materials. If leaks and spills are noted, appropriate personnel should be contacted, immediately.

11.3.3 Construction Material

The primary concerns with the construction material are cathodic protection (steel), structural stability, damage, and water-tightness of liners. Indications of problems include significant cracks, shifting of the tank, and loss of liquid level during low flow conditions.

11.3.4 Mechanical Parts

All moving parts should be kept clean and properly lubricated. It is particularly important to keep exposed gear mechanisms greased (API, 1990).

11.3.5 High Water Bypasses and Overflows

> "Bypasses" are wastewater diversions at or near the influent structure of the separator.
> "Overflows" are wastewater diversions at or near the effluent structure of the separator.

Some separators were constructed such that if the influent flow exceeds the design capacity, the wastewater (usually runoff) would be diverted around the system without treatment. The "bypass" systems range from passive (open pipe) to automatic (float actuated pumps). The separators may contain alarm systems to indicate when a bypass is occurring.

Other separators were constructed such that the system would "overflow" downstream of the separation chamber to a different discharge point during periods of high flow. The "overflow" discharge may be diverted from the sanitary sewer to a storm sewer. As the point of overflow is after the separation chamber, this type of discharge does not bypass the treatment system. The problem with overflows is that the excess water is not removed prior to reaching the separation chamber, therefore, under certain circumstances "used oil" and solids contained in the separator may be flushed into the "overflow" pipe.

An “overflow” has a greater potential for environmental harm than a “bypass,” due to the potential scouring or flushing of the separation chamber.

> All “bypasses” or “overflows” should be issued a permit or eliminated. There may be monitoring and/or reporting requirements associated with the discharge.
>
> **Questions:**
> 1. Does the separator have a high water “bypass” or “overflow”?
> 2. Where does the “bypass” or “overflow” discharge?
> 3. Is the discharge covered by a permit?
> 4. Is there an associated alarm system?
> 5. Are pumps and/or sensors associated with the discharge?
> 6. Does the “bypass” or “overflow” have to be reported or monitored?
> 7. Does the “bypass” or “overflow” system require cleaning or maintenance?

11.3.6 Pumps - Wastewater/Solids

Pumps may be required to convey wastewater to, or within, the separator system. Pumps should be periodically tested, to ensure that all electrical systems are operating properly. The wet well or sump serving the pumps should be inspected and cleaned to the degree necessary to protect the pumps and allow proper wastewater holding capacity. The pumps should be inspected and maintained to ensure proper operation.

> Two of the major mechanical failures associated with oil/water separators are plugging of suction lines (serving solids removal pumps) and failure of pump seals (API, 1990).
>
> **Questions:**
> 1. Are the pumps operating properly?
> 2. Does the wet well/sump need cleaning to maintain proper wastewater holding capacity?
> 3. What are the maintenance requirements for the pump(s)?
> 4. Does the wet well/sump have a bypass? Does it require cleaning?
> 5. Are there high water alarm systems? Are they functioning?
> 6. Are pumps rotated? Is the system that activates secondary pumps operational?
> 7. Does the flow rate from the pump exceed the receiving capacity of the oil/water separator?

11.3.7 Separator Vents

Underground or sealed separators may utilize a vent system. This system should be kept clean to prevent content siphoning or the creation of backpressure, which could prevent the influent wastewater from entering the tank.

11.4 "USED OIL" SYSTEMS

There are numerous requirements that should be evaluated concerning the holding of "used oil." Two general requirements are that the holding compartment/tank has adequate capacity to hold the removed oil during the time between inspections; and details concerning "used oil" characterization, removal and disposal/reuse.

Questions:
1. What is the total capacity of the holding system?
2. What is the available capacity at the time of the inspection?
3. What is the usual rate at which used oil is accumulated?
4. What is the time between inspections?
5. How is the oil to be disposed/reused?
6. Who is responsible for removing "used oil"?
7. How much lead time is required to have the oil removed?
8. What are the oil monitoring methods, parameters, and frequency?

11.4.1 No "Used Oil" Holding

This type of oil holding system **(Section 9.2.3.1)** is typical of a standard gravity oil/water separator. The separated oil is contained on the surface of the middle chamber by the underflow effluent weir. If this type of system is neglected and the oil is allowed to build-up, hydraulic surges could cause the release of a significant quantity of oil downstream.

Questions:
1. What is the allowable depth of accumulated oil within the separator and how often is the oil to be removed?
2. How is the oil thickness measured?
3. How often does the oil thickness have to be measured?

11.4.1.1 Allowable Oil Accumulation within A Separation Chamber

The basis for oil removal from the separation chamber for disposal/reuse has not been standardized. The decision to remove oil from the separator may be contractual in nature. For example, one military contract requires that the oil be pumped from the separator when the layer of oil on the surface is greater than 1/4 to 1/2 inch. A second consideration would be maintaining a *de minimis* quantity of oil in the separator, which would require an accumulation of less than a 1-inch oil layer. (A *de minimis* quantity is smaller than the minimum quantity controlled by a regulation. For example, if a regulation governs oil storage at a volume in excess of 110 gallons and your tank storage capacity is 90 gallons, the oil volume would be *de minimis*.) Another approach to removal would be to prevent an excessive amount of oil from flushing through the separator during a hydraulic surge (the floating oil layer should not exceed 2 inches) (DoD, 1997f), (King County, 1996).

If the floating oil is maintained at a depth of less than 1 inch, the quantity of oil is generally considered *de minimis* (40 CFR 280.70(a)) by the regulatory agencies as related to underground storage tanks.

If the contained oil layer depth is found to affect the quality of the separator effluent, the allowable accumulation of oil should be reduced to the minimum practicable.

> It is recommended that the target maximum amount of oil accumulated in the separation chamber be 1 inch, and should not exceed 2 inches under any circumstances.

11.4.1.2 Oil Layer Measurement Methods

The method generally used by the military to measure the oil layer in the separation chamber is the "stick" method. A stick is swirled in the water and an estimate of the oil layer thickness is made by observation. Other methods to measure oil thickness include the application of an indicator (water) paste to a measuring stick or the use of an electronic probe (Oil layers less than 1/8 inch should not be measured with a probe.).

11.4.1.3 Oil Removal Frequency

The removal of oil from separators without "used oil" holding should occur when the oil layer thickness is approximately 1 inch. Under no circumstances should the oil thickness exceed 2 inches. The time required for the above conditions to be reached is based on the characteristics of the raw wastewater and the removal efficiency of the separator. For planning purposes, oil removal should be scheduled every 6 months. This frequency may not be appropriate for all separators.

11.4.1.4 Removing Oil from a Separator with No "Used Oil" Holding

Reliable oil removal from the surface of the separation chamber is a frequent problem with both commercially available units and custom-designed separators. Currently, the most satisfactory method involves suction removal by installation personnel using equipment normally used for cleaning catch basins. This equipment is commonly referred to as a "vacuum" or "vac-all" truck (DoD, 1997e).

When oil is removed from a separation chamber for final use or disposal, the oil is skimmed from the liquid surface in the separation chamber until water is detected (Headquarters AFDTC, 1996). This type of removal may generate "used oil" with excessive water content.

Additional water separation/removal may be necessary to utilize these oils for combustion. The oil may be placed in an off-site reclamation facility, which will typically have two holding tanks. The oil separates in the first tank of the reclamation facility and is then diverted to the second tank for holding prior to final use or disposal (DoD, 1988b).

> Oil removal programs should be monitored by the installations and records maintained on an in-house log.

Other approaches to oil removal:

- After the oil is pumped off the surface of the separator, the hauler drives the truck to a washrack, where the water is allowed to separate in the truck tank. The water is then decanted from the truck to the washrack separator and the oil is placed in the installation "used oil" system for recycling. Care should be taken by the installation to ensure that the water decanted from the truck to another separator should not contain significant amounts of oil.

- The entire liquid content of the separator is pumped out. The liquid is placed in a centralized secondary "used oil" separation tank. The separated oil is then placed in the installation "used oil" system for recycling. "Used oil" that is considered a hazardous waste should not be mixed with non-hazardous "used oil."

11.4.2 Separate or Integral "Used Oil" Holding

Separate "used oil" holding **(Section 9.2.3.3)** generally involves tanks or drums that are not a physical part of the separator structure. The tanks are connected to the separator via a pipe or trough that conveys skimmed oil from the separator into the holding tank. The skimmed liquid has additional time for the oil and water to fully separate in the oil holding tank before the oil is removed for recycling or disposal.

> **Questions:**
> <u>Aboveground Holding Tank or Drum</u>
> 1. Is the AST subject to SPCC requirements?
> 2. Is the tank/drum within secondary containment?
> 3. How much uncontaminated water is allowed within the secondary containment before it must be removed?
> 4. What is the method for disposing of uncontaminated water collected in the secondary containment?
>
> <u>Underground Holding Tank</u>
> 1. Is the tank regulated as a UST? **(Section 2.1.6.1)**
> 2. If so, is there overfill protection, cathodic protection, leak detection?
> 3. Is tightness testing required?
> 4. What is the required maintenance of the UST components?

The definition of integral (as interpreted by the regulatory agencies) holding **(Section 9.2.3.2)** may be as literal as the holding tank physically being located within the separator structure or as liberal as a tank connected to the separator by a pipe. If the "used oil" holding compartment/tank is considered by the state regulator to be an integral part of the oil/water separator, the compartment/tank will not be subject to UST regulations.

11.4.2.1 Oil Skimming

> One of the major mechanical failures of oil/water separators is associated with flight skimmers or scrapers caused by foreign objects (tools, gloves, rags, etc.) or buildup of grit or silty solids (API, 1990).

The separated oil must be moved from the separation chamber to an oil holding tank by an oil-skimming device **(Section 9.2.2)**. Manual and automatic skimming devices are available. The contained oil is removed by pumping, or by activating a rotary drum or slotted pipe that allows the surface material to drain to a drum or oil holding tank.

> Screening of the influent to remove floating debris may improve skimmer effectiveness (DA USACE, 1994).

It has been suggested (DoD, 1997f) that the oil layer in the separation chamber be checked daily for systems with surface skimmers. The oil layer inspection frequency could range from several times per day to several times per month, depending on the rate of oil accumulation. All references agree that the measurement should be done “regularly.” If there is a solid layer of oil on the surface, the material should be skimmed manually to the “used oil” holding compartment/tank.

Major operational problems with separators and oil skimmers are (API, 1990):

- debris and solids floating in the oil layer;
- excessive water being removed; and
- buildup and discharge of oil due to infrequent skimming operations.

All floating debris should be removed from the separation chamber prior to oil skimming, to prevent blockage or other interference. The removed debris should be placed in a drain pan (with holes) to bleed the oil back into the separator, before debris disposal.

The surface, manually controlled, slotted-pipe skimmers should be left in the upright or off position when unattended (Headquarters AFDTC, 1996).

A manual skimmer should be inactivated following oil skimming to prevent water from entering the holding compartment/tank.

Questions:

1. What type of skimming device is located at the separator? **(Section 9.2.2)**
2. Is it automatic or manual?
3. Operation/maintenance requirements for automatic and some manual systems should be provided by the manufacturer or contractor. How can you determine that the automatic skimmer is operating properly?
4. What is the procedure for manual operation/maintenance of the skimmer?
5. What is the frequency for manual operation/maintenance of the skimmer?
6. What is the procedure for cleaning (debris removal) skimming devices and the separation chamber?
7. How is the debris to be stored and/or disposed of?

11.4.2.2 Oil Removal Frequency

Separate or integral “used oil” holding tanks should be pumped when the oil volume approaches 75% of the tank capacity. The time required for the above condition to be reached is based on the characteristics of the raw wastewater and the removal efficiency of the separator. For planning purposes, oil removal should be scheduled every 6 months. This frequency may not be appropriate for all separators.

11.4.2.3 Removing Oil from a Separator with a Separate "Used Oil" Holding Tank

Oil should not be skimmed from the separator to the holding tank just prior to pumping the holding tank, as the action may mix the previously separated oil and water. The oil should be pumped from the holding tank or compartment until water or solids are detected (Headquarters AFDTC, 1996). Upon completion of oil removal, actuate the skimmers (if equipped) to remove oils and fuels from the separator water surface to the holding tank.

11.4.3 "Used Oil" Analysis and Disposal/Reuse Options

> Oil/water separator solids and oil must be analyzed separately to determine disposal and recycling options (DA, 1997a).

The oil collected in an oil/water separator normally consists of petroleum hydrocarbons. Recycling options for this material depend on the waste characteristics.

Oils removed from the separator may be disposed of by reuse/recovery, incineration, sale by the Defense Reutilization and Marketing Office (DRMO), or disposal by a contract hauler.

> "Used oil" removed from an oil/water separator shall not be used:
> - as a dust suppressant, or
> - for fire training.

Contract Hauler/Disposer

If you use a contract hauler to remove and/or recycle/dispose of non-hazardous "used oil" or solids from the separator, certain information is required to ensure that the installation has made every reasonable effort to determine that the materials are handled properly. The contractor shall provide the installation:

- certification that all relevant licenses have been obtained from federal, state, and local regulators to conduct the contracted activities (CCAR, 1996);
- a certificate of receipt listing the type and amount of material removed, and the date of custody transfer (DA, 1997a); and
- information as to where and how the material is being reused/disposed.

> Liability for the hauler misuse of waste generated at the separator may be jointly shared between the hauler and the installation.

The oil collected in the separator is considered "used oil". Under current EPA regulations "used oil" falls into one of three categories: on-specification and off-specification "used oil," and hazardous waste fuel (**Figure 11-1**).

11.4.3.1 Hazardous Waste Fuel

If the “used oil” contains more than 1,000 ppm total halogens, EPA considers the oil a hazardous waste. This oil is subject to all hazardous waste regulations, including those associated with the burning of hazardous waste as fuel. If you wish to “rebut” the presumption that the oil is hazardous, the oil could be analyzed for specific halogen compounds listed in Appendix VIII of 40 CFR 261.

The first question to be resolved is whether the "used oil" is a hazardous waste (hazardous waste fuel). Only one analysis is required to determine if the oil is a hazardous waste fuel, total halogens. If the result of total halogen analysis is less than 1,000 ppm, the oil is not considered a hazardous waste fuel. If the measured total halogen analysis is equal to or greater than 1,000 ppm, the oil must be handled as a hazardous waste unless the finding is “rebutted.” The source of the halogens should be immediately identified and eliminated.

> Commercially available field test kits can determine in about 10 minutes if a container of “used oil” is contaminated with halogens above the 1,000 ppm regulatory level.

The “used oil” should be analyzed for relevant hazardous waste characteristics prior to initial removal for disposal/reuse. Additional hazardous waste analyses will be at the discretion of the installation, based on confidence that illegal dumping has not occurred, and on the requirements of the hauler and state and local regulations.

> Contact the state regulatory agency for monitoring, handling, transport, storage, and disposal requirements.

11.4.3.2 “Used Oil” (Non-Hazardous) - Used for Energy Recovery

If the oil will be used for energy recovery, additional analyses are suggested to determine if the “used oil” is on-specification. On-Specification “used oil” must meet all allowable levels noted in the table below. If on-specification “used oil” is to be burned for energy recovery, it can be exempted from many of the requirements contained in 40 CFR 279.

Parameters[1]	Allowable Levels
Arsenic, mg/L	5 (Max)
Cadmium, mg/L	2 (Max)
Chromium, mg/L	10 (Max)
Lead, mg/L	100 (Max)
Flash Point	100^{o}F (Min)
Total Halogens, mg/L	4,000[2] (Max)

1 - It should be noted that the analyses are not the result of a TCLP, but analysis for total metals.

2- Based on an analysis of total halogens, there are two total halogen limits: 1,000 mg/L for specific halogens of concern identified by EPA and 4,000 mg/L for all halogens measured.

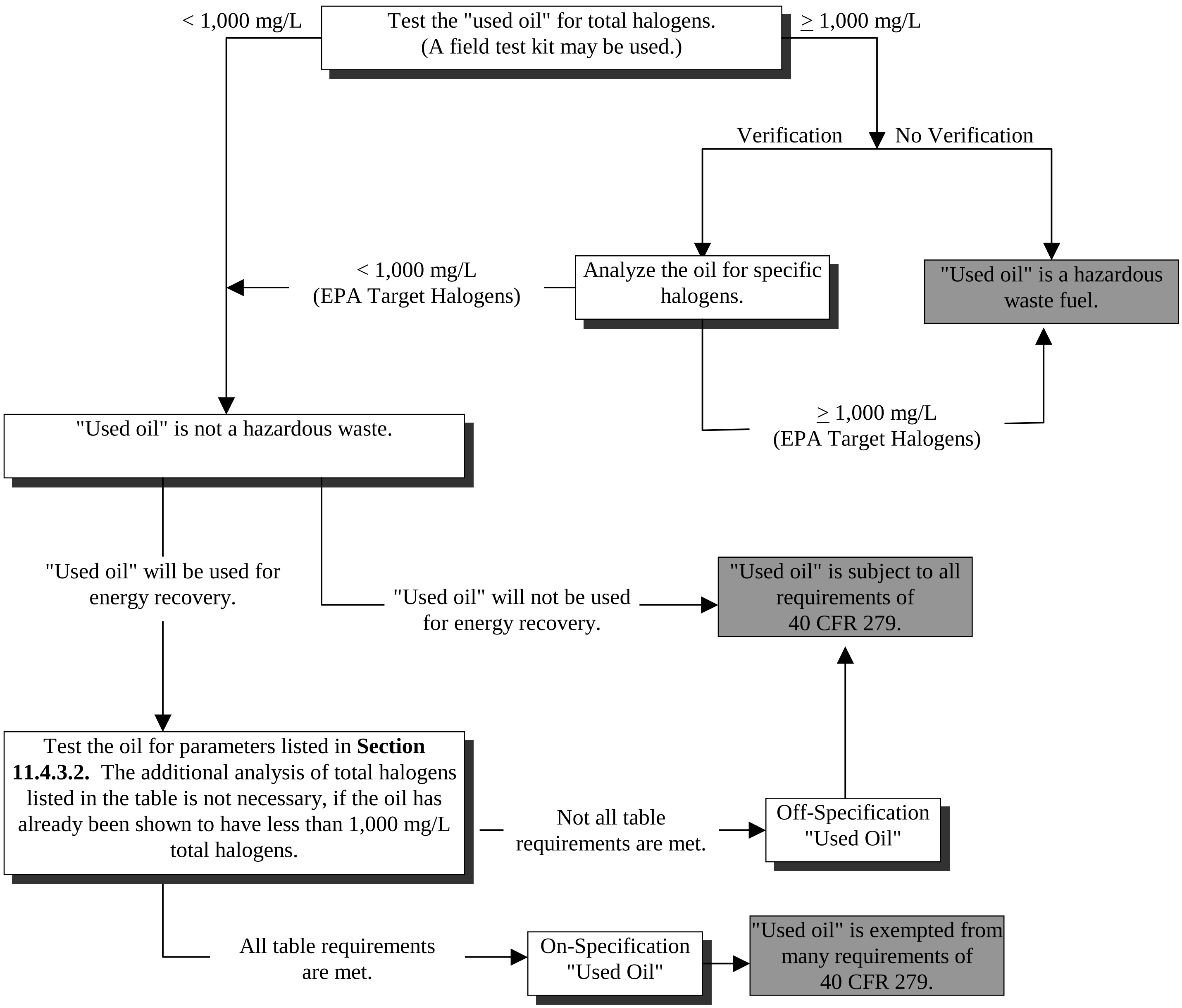
If the additional analysis yields results that do not satisfy the above requirements, the “used oil” is off-specification and must meet all "used oil" requirements contained in 40 CFR 279.

11.4.3.3 "Used Oil" (Non-Hazardous) - Not Used for Energy Recovery

If the "used oil" will not be reused for energy recovery, no additional analysis after total halogens is necessary, as the oil will be subject to all requirements contained in 40 CFR 279 whether the oil is on- or off-specification.

> State and local requirements may be more restrictive and include additional monitoring.

Figure 11-1 Monitoring Requirements for "Used Oil" Recycling



State and local requirements may be more restrictive and include additional monitoring.

11.4.4 "Used Oil" System - O&M and Inspection Frequency

The criterion to set the oil layer monitoring/skimming schedule is based on establishing a target oil layer depth and determining how long it will take to accumulate that quantity of oil. The frequency will have to be determined from experience.

Standard frequency guidelines for measuring contained oil volume (thickness) in the separator have not been established. It has been suggested (DoD, 1997f) that the oil layer be checked daily for systems with surface skimmers. All references agree that the measurement should be done "regularly." Minimum inspection frequencies may be established within the regulatory permits (NPDES or pretreatment permits, or a sewer use ordinance) governing the discharge. If the operation and maintenance of the separator is not 'mandated' within permits or ordinances, it is suggested that the oil layer thickness (for systems without skimmers) be checked once per week for several months. At the end of the initial period, establish a reasonable inspection period based on the quantity of oil accumulated and measure the oil layer regularly at the frequency established for each specific separator.

> The estimated inspection frequency for oil should be compared to the frequency determined for solids measurement. The more restrictive schedule should be used for both activities.

11.5 SOLIDS SYSTEMS

The oil removal efficiency of the separator can be severely impacted by the significant accumulation of solids. It is of the utmost importance that the solids not be allowed to collect within the tank beyond its allowable solids holding capacity. The solids holding compartment/tank should have adequate capacity to store the removed solids during the time between inspections without impacting separator efficiency.

> **Questions:**
> 1. What is the allowable solids holding capacity within the separator? **(Worksheet 3-4 or 3-6)**
> 2. How often does the solids level have to be measured?
> 3. How is the solids level measured?
> 4. How often do the collected solids have to be removed?
> 5. What is the available capacity at the time of the inspection?
> 6. What is the usual rate at which solids accumulates?
> 7. What is the time between inspections?
> 8. How are the solids to be disposed?
> 9. Who is responsible for removing the solids? **(Section 11.1.2)**
> 10. How much lead time is required to have the solids removed?
> 11. What are the solids monitoring methods, parameters, and frequency?

11.5.1 Solids Collection/Accumulation Systems

For a discussion of solids accumulation systems in oil/water separators see **Section 9.2.4**.
Some units incorporate a hopper-type bottom for accumulation and ultimate discharge of settled material. Other separators may have automatic solids removal equipment that will rake accumulated solids to a hopper where it can be pumped from the tank periodically.

> Pumps have experienced problems when used to remove solids from separators. Pump failure rates are generally higher than normal due to the erosive effect of silt. The pumps also tend to draw water along with the solids (API, 1990).

In parallel-plate separators, solids settle to the bottom and are collected in a well. From the well, solids are pumped or withdrawn by gravity to waste. If solids transfer is by gravity displacement, an automatic valve is usually provided and should be operated frequently to avoid excessive buildup.

11.5.2 Allowable Solids Accumulation within a Gravity Separator

The allowable solids accumulation level for a separator should be based on the impact of solids holding on the wastewater detention time in the separation chamber. Solids accumulation guidance contained in the literature range from 10% (DoD, 1997f) to 50% (individual NPDES permit requirement) of the separator operational capacity. One municipality recommends that the solids be removed when a depth of 8 inches is collected in the tank inlet chamber (King County, 1996).

The most accurate method is to determine what solids volume the separator can store without reducing the wastewater detention time to less than 45 minutes under maximum operational flow. This can be accomplished by completing **Worksheet 3-4** or utilizing the Excel® program **(Worksheet 3-6)**, which was provided with the guidance manual.

> The solids layer should not accumulate to the degree that the wastewater detention time (maximum operational flow) is less than 45 minutes.

If the calculations noted above demonstrate that the separator is hydraulically overloaded, the separator should be allowed to utilize no more than 10% of the operational volume for solids holding, during the interim period while the separator is under further evaluation.

If the calculations indicate that the separator has adequate solids holding capacity, the allowable volume for solids holding will not exceed 25% of the separator operational volume.

> Allowable solids holding in the separator will be no less than 10%, and no more than 25%, of the total operational volume.

11.5.3 Solids Measurement Methods

The primary method used by the military to measure the solids level is using a stick. There are several approaches to using the stick. The pressure method is that the stick is placed vertically in the separator and the depth, at which slight resistance is encountered, is estimated. The stick is then forced to the bottom of the tank. The difference between the two reference points is the depth of the sediment. The second method involves estimating the staining length on the stick from the oily sediment.

Another method involves a piece of equipment used at the installation sewage treatment plant, a sludge witch. This is a clear tube that is used to collect a water/sediment column sample. The depth of the solids may then be measured directly. One problem with using this method is that the solids within the separator are more consolidated, heavier and coarser than sewage sludge, which may make collecting a full-column sample difficult. It should also be noted that the sludge witch might compact the sediment yielding a slightly lower solids thickness reading.

Solids thickness may vary throughout the separator.

Some of the newer or more advanced separators may have gauges that allow the direct reading of the solids depth.

11.5.4 Solids Removal Frequency

There are several approaches that can be used to determine when the solids need removal:

11.5.4.1 Volumetric Method

Solids are removed when they take up a certain percentage of the separator. Most guidance is arbitrary and may require that the separator be pumped more or less than necessary. The best approach to the volumetric method is to calculate the capacity of the separator that is available for solids holding **(Section 11.5.2)** and remove the contained solids when the holding capacity is approached.

11.5.4.2 Scheduled Method

Under the "scheduled method," solids are removed from the system at a given time interval. Some references suggest cleaning out the separators once every 6 to 12 months (CCAR, 1996), while others recommend removing solids every 2 to 6 months (King County, 1997). The best approach is to monitor solids accumulation over a given period of time (measure the solids level once per month) and project when the solid holding capacity would be met (see above) with no changes in the operation discharging to the system. For example, if the solids measurements indicate that 10 months would be required to reach solids holding capacity, have the separator pumped every 6 to 8 months. If there is only an interior shop drain with no significant solids loadings contributing to the separator, it could be several years before solids removal is required. If contributing operations change, the required solids holding should be recalculated and the removal schedule adjusted, accordingly.

Be aware that loadings to a separator may be seasonal in nature and highly variable.

It is suggested that grouping the separators for cleaning, based on contributing waste streams, limits the quantity of hazardous waste generated. For example, one separator group contained sludge from an operation involving unleaded gasoline, while the other group of separators contained only "used oil" or diesel fuel. Therefore, only a few drums of the collected solids would be shipped as a hazardous waste.

Using the scheduled and grouping method may save the installation money, in that planning ahead will prevent emergency solids removal situations that are always costly. It will also help project expenses for the following fiscal year. If the removal schedule is too conservative, the separator will be pumped more often than needed, thereby unduly increasing operational costs.

11.5.5 Separator Solids - Hazardous Waste Considerations

> The hazardous waste characterization sample(s) should be collected from the separator and analyzed prior to any removal actions.

11.5.5.1 Hazardous Waste Characterization of Separator Solids

The following analyses should be conducted to determine if the solids are a characteristic hazardous waste:

- Toxicity Characteristic Leachate Procedure (TCLP) for metals, volatiles and semi-volatiles;
- TCLP for herbicides/pesticides (optional - based on knowledge of system);
- Ignitibility;
- Corrosivity; and
- Reactivity (optional - based on knowledge of system concerning cyanide and sulfide).

The separator solids are considered hazardous if the material:

- exhibits a characteristic of ignitibility, corrosivity, reactivity, and/or toxicity (40 CFR 261.20-261.24), or
- is a mixture containing listed waste (F, K, P, U) according to 40 CFR 261.30-261.33.

> If the separator solids are hazardous, immediate actions should be taken to identify and eliminate the source of the hazardous pollutants. The installation hazardous waste management plan should be followed (DoD, 1997f).

If the solids are hazardous, based on laboratory results or generator knowledge, it must be disposed as a hazardous waste. If the material is placed in drums, it must be marked "Hazardous Waste" and assigned a proper shipping name based on the laboratory results.   Hazardous solids generated by the oil/water separator cannot be land applied without first undergoing treatment to comply with the land disposal restrictions of 40 CFR 268.   It is suggested that the installation use contract haul and disposal companies.

> Contact the state regulatory agency for handling, transport, storage, and disposal requirements.

11.5.5.2 Treatment of Separator Solids that are a Characteristic Hazardous Waste

If the separator solids are found to be characteristically hazardous, can the material be treated to render it non-hazardous? One example is a product that is advertised as a material that can be added to oil/water separators to render the solids non-hazardous (Lehman, 1996). The product encapsulates the solids, and once it is in a granular form, which indicates all material has been encapsulated, it is not flammable or leachable. (For a discussion concerning regulators' opinions concerning the treatment of characteristic hazardous solids see **Section 2.1.6**.)

> Due to the diversity of regulatory opinions, if the installation decides to "treat" characteristically hazardous oil/water separator solids (**NOTE**: All actions should be coordinated through the installation environmental office.):
>
> 1. Determine if the treatment methodology, as proposed by the vendor, is effective on your solids.
> 2. Obtain a description of how the solids will be treated (how the material is to be added and mixed) and the basis for treatment (how does it work) from the vendor.
> 3. Submit the vendor's data with relevant installation permit information (RCRA and CWA) to the state agency implementing the hazardous waste regulations requesting a determination as to whether the proposed actions would be considered treatment under RCRA or require a Part B application.
> 4. Do not implement any hazardous waste "treatment" schemes, until <u>written</u> comments/approvals are received by the implementing agency.

11.5.5.3 Frequency of Separator Solids Hazardous Waste Characterization

The solids collected in the separator should be analyzed for relevant hazardous waste characteristics prior to initial removal for disposal/reuse. If the process/raw materials contributing to the separator change, the installation should review the contributions to determine if retesting the solids for hazardous waste characteristics is warranted. Additional analyses will be at the discretion of the installation, based on confidence that illegal dumping has not occurred, and on the requirements of the hauler and state and local regulations.

11.5.5.4 Hazardous Waste - Sample Collection (Oil/Water Separator)

Collecting the solids sample from the separator for hazardous waste characterization:

- efforts should be made to keep from smearing the solids sample with oil that is contained on the surface of the separator (either remove the oil prior to sampling or use equipment that protects the sample from contact with the liquid in the tank);
- it is suggested that the solids sample be a composite of 4 discrete sub-samples located throughout the tank; and
- each sub-sample should be a full-depth sample (the sub-sample should reflect the solids from the top of the solids layer to the bottom, as a solids surface sample may contain a disproportionate amount of oil).

If proper sampling procedures are not utilized, the results may yield a false positive; that is, the solids may be considered a characteristic hazardous waste, when they are not.

The wastewater characteristics to the separator may be highly variable, thereby placing doubt that a sample collected prior to solids removal would be representative. Under these circumstances, the collected solids could be placed in drums and characterized. Pending receipt of the analytical results, the drums should be labeled and placed in a hazardous waste storage area.

11.5.6 Separator Solids - Non-Hazardous Waste Considerations

Once the solids have been characterized and found to be non-hazardous, the material should undergo an evaluation to determine what options are available for reuse/disposal. The required parameters are generally established in federal (landfills), state and local regulations. Additional parameters may be required by the company/individual handling and/or disposing/reusing the solids. The major disposal/reuse options for non-hazardous solids are landfilling, land application, and incineration. The characterization required for each option could vary significantly.

11.5.6.1 Non-Hazardous - (Disposal/Reuse) Solids Characterization

> The final use/disposal sludge samples should be collected just prior to the use or disposal, not necessarily from the separator.

The chosen reuse/disposal option should be reviewed with the respective regulators and disposal/reuse facility operators to establish minimum monitoring requirements.

The final use/disposal solids samples should be collected just prior to use or disposal, not necessarily from the separator. For example, if the solids are to be placed in a municipal landfill, a “Paint Filter” test is required. If the solids are sampled at the separator, it may fail the paint filter test; but if the material is sampled in drying bins, it may pass the test.

Four typical tests that may be required for non-hazardous disposal options are listed below:

> All analyses associated with final use/disposal, except percent solids, should be reported by the laboratory as a dry-weight.

Total Petroleum Hydrocarbons

State legislation controlling the levels of Total Petroleum Hydrocarbons (TPH) in solids to be land applied or placed in landfills is becoming stricter. Some states are reducing maximum TPH levels for land application to as low as10 mg/kg. Past studies have shown TPH levels may be greater than 20,000 mg/kg in some separator solids (DA USACE, 1994). States have also imposed TPH limits on solids placed in municipal and industrial landfills.

It should be noted that there are several available methods for analyzing TPH (418.1, 8015, etc.) **(Table 4-1)**. States may restrict the analysis to one particular method. Some states have substituted other organic compound group analyses for TPH such as polyaromatic hydrocarbons (PAH).

> If the solids are required to be analyzed for TPH, and there are no state restrictions on the analytical method, the installation should analyze the solids by Method 8015 - Diesel Range Organics.

Free Liquids

Current regulations (40 CFR 258.28) require that material disposed in a landfill, either hazardous or non-hazardous, have no “free liquids.” The presence of “free liquids” is determined by the "Paint Filter Liquids Test" (Method 9095, EPA Publication SW-846). Most separator solids have “free liquid” when they are removed for disposal and may not pass this test.

Polychlorinated Biphenyls (PCBs)

Landfills (40 CFR 258) may not receive PCB waste. A PCB waste (40 CFR 761) is a substance that contains a PCB dry-weight concentration of more than 50 mg/kg. The analytical method for PCBs is Method 8080, EPA Publication No. SW-846. (The analysis of landfilled solids for PCBs will be conducted at the discretion of the installation to meet state/local requirements.)

Ignitibility

Current regulations require that wastes have a flash point greater than 60^{O}C (140^{O}F). Past studies have shown that some separator solids may have a flash point less than 60^{O}C, which is a hazardous waste characteristic. This is generally due to high levels of petroleum products found in the solids.

Other Parameters

Landfill operators and/or state and local regulators may impose analysis of additional parameters. It should be noted that any analytical results (except for percent solids) should be reported as a dry-weight.

11.5.6.2 Disposal/Reuse Options for Non-Hazardous Solids

Oil/water separator solids and oil must be analyzed separately to determine disposal and recycling options.
The characteristics of solids are specific to the separator, and must be determined before a disposal method is selected.

For non-hazardous solids removed from an oil/water separator, there are several disposal/reuse options:

- landfill (municipal/industrial) disposal;
- agricultural land application;
- incineration; and
- contract hauler/disposer.

The reuse/disposal option for separator solids should be in accordance with the current guidance of the installation environmental office and relevant management plans.

Options available for solids disposal are determined based on the material characteristics.

Landfill Disposal
Solids removed from a separator may be placed in one of three types of landfills (municipal, industrial, or hazardous waste). The type of landfill where the solids are placed usually depends on the quality of the material. The cleanest material may be allowed to go to a municipal landfill.

> The use of a debris landfill for disposal of separator solids is discouraged. If the installation is considering placing the solids in an on-site debris (construction rubble) landfill, written approval from the regulating agency is required.

Bulk or non-containerized “liquid waste” may not be removed from the separator and placed directly in a municipal solid waste landfill in accordance with 40 CFR 258.28 unless the waste is household waste (excluding septic waste) or leachate or condensate derived from a landfill unit. “Liquid waste” means any material that is determined to contain "free liquids" as defined by the EPA's Paint Filter Liquids Test. Therefore the liquid waste may require dewatering or solidification before disposal in accordance with federal and state regulations (DA USACE, 1994). Technologies used to reduce the volume (dewatering) of the oily solids include air drying, centrifugation, evaporation, vacuum filtration, and pressure filtration (Chirkis, 1997).

Some states place maximum total petroleum hydrocarbon (TPH) concentrations on solids that are placed in municipal and industrial landfills. The landfill must be also be approved to accept the solids. In addition to TPH analysis, the solids may have to be characterized for gasoline content as measured by BTEX (benzene, toluene, ethyl-benzene, and xylene) analysis.

Land-Application
Oily solids may be incorporated into the soil in a land application system. The site must be approved by the state to accept the solids. There may also be other permitting requirements placed on this practice by state/local regulatory agencies. One installation places the solids in bins in a central location for drying and testing. If the total petroleum hydrocarbon results are equivalent to that found in the heavy vehicle test area soils, the solids are placed on the vehicle testing course.

Incineration
When other disposal methods are not practical or where toxic materials are contained in oily solids, incineration should be considered. Determine air pollution control requirements from the controlling regulatory agency.

Contract Hauler/Disposer
See **Section 11.4.3**.

11.5.6.3 Non-Hazardous - (Disposal/Reuse) Characterization Frequency
The agencies or operators controlling the reuse/disposal activity mandate the frequency at which the separator solids must undergo non-hazardous characterization. It is suggested that the solids be evaluated at least once, prior to initial reuse/disposal.

> Local/state regulators could require the characterization of solids for non-hazardous disposal/reuse options as often as once per load.

11.5.6.4 Non-Hazardous - (Disposal/Reuse) Sample Collection

Solids may be removed from the separator and transported directly to final reuse/disposal or to an interim holding area to dry and/or allow the petroleum contained in the solids to biodegrade. (NOTE: These areas may require permitting by state or local agencies.) The sample collection method will vary based on the solids location prior to final reuse/disposal.

If solids removed from the separator go directly to final reuse/disposal, the non-hazardous parameter samples should be collected in the separator. This method is described in **Section 11.5.5.4**.

If separator solids are transported to interim holding, non-hazardous parameter samples could be collected from the separator or from the interim holding area. The latter is the recommended location. It is suggested that the interim holding sample consist of at least 4, full-depth sub-samples collected from a pile, drying bed, or holding bin.

11.5.7 Removing Solids from the Separator

Solids removal methods vary according to the bottom configuration of the separator:

> *Flat-bottom chambers*: Removal of settled solids is typically accomplished when the chamber is out of service. The chamber is then drained and accumulated solids are removed either manually or by a vacuum truck (DoD, 1997e).

> If the separator is taken out of service for solids removal, certain impacts or actions must be considered:
> - The system will be out of service and will therefore not be available to treat influent wastewater.
>   - How will the wastewater be prevented from entering the separator?
>   - How will the wastewater be stored or treated?
> - The solids removal may involve confined space entry.
> - The separator should be filled with clean water (or the water previously removed from the separator) up to its normal operating level before the unit is placed back on line (CCAR, 1996). This prevents the pass-through of free oil or other floatables to the separator effluent while the system is refilling and stabilizing.

> *Sloped-bottom chambers*: Settled solids are removed from the hopper or V-bottom trough by pumping or by gravity discharge while the unit is still in service (DoD, 1997e).

One example, of a solids removal activity is listed below (Headquarters AFDTC, 1996):

- Remove oil from the separator surface into one truck;
- Water and solids shall be removed using two separate trucks;
- Water will be removed first and stored in one of the trucks;
- The second truck will then remove the solids; and
- After solids removal, the water in the first truck will be placed back in the separator at the proper operating level.

It is suggested that proper water level in the separator be maintained to prevent pass-through of oils and other floatables during solids removal (CCAR, 1996).

11.5.8 Separator Solids - O&M and Inspection Frequency

Standard frequency guidelines for measuring solids volume in the separator have not been established. All references agree that the measurement should be done "regularly." Minimum inspection frequencies may be established within the regulatory permits (NPDES or pretreatment permits, or a sewer use ordinance) governing the discharge. Two NPDES permits issued in Maryland contained inspection frequencies ranging from once per week to once per month.

The local sewer use ordinance may not contain specific language on oil/water separators, but may require 'proper maintenance' of any pretreatment or treatment systems. That determination of proper maintenance is left up to the system user.

If the operation of the separators is not 'mandated' within permits or ordinances, it is suggested that solids be measured once per week for several months. At the end of the initial period, establish a reasonable inspection period based on the quantity of solids accumulated and measure the solids regularly at the frequency established for each specific separator.

The sampling and analysis of separator solids serve two purposes:
- to determine if the solids are hazardous; and
- if not, does it meet the required characteristics for the final reuse/disposal method.

The frequency of the two types of analyses may vary. Hazardous waste analysis should be conducted soon after the system is placed in service, and again if processes/raw materials contributing to the separator change such that hazardous waste generation is suspected; while the reuse/disposal analyses could be as frequent as every load removed.

11.6 Cleaning the Separator or Its Component Parts

Cleaning of the separator or its component parts may be conducted for multiple reasons, including:
- maintenance - improve separator efficiency (coalescing plates and storm water systems);
- allow inspection of the tank to ensure that the underground or in-ground tank is structurally sound; and
- improving the operational conditions by cleaning collected material from skimming devices or sludge collection systems.

Certain impacts must be considered regarding separator cleaning (see informational box **Section 11.5.7**).

11.6.1 Maintenance Cleaning of Separators with Coalescing Systems

> Separators with coalescing plates, tubes, etc. require frequent cleaning of the devices. The preferred method of cleaning is the removal of the device from the separator and the use of high pressure cleaning equipment.

The use of any type of coalescing device will complicate operation and maintenance of the separator. The devices tend to foul and become blocked with debris and suspended particles attached to the oil (DA USACE, 1994). Accessibility is essential for removing and maintaining parallel plates, tubes, coalescing filters, and other devices inserted into the separation chamber. These devices require frequent cleaning.

Sand entering the plate system can collect at the entrance to the plate assembly and reduce flow through the lower plate sections. Should blockages develop, they may be cleared by: removing the accumulated solids, flushing the plate pack with water or air, or mechanical cleaning (API, 1990).

Cleaning the coalescing devices may be conducted in two ways:

- The cleaning procedure of choice is the removal of the plates from the separator and the use of high-pressure cleaning equipment (DoD, 1997e).
- If the plates cannot be removed, parallel- and corrugated-plate separators may be drained and hosed down on a routine basis to clean the plates (DoD, 1997f). A hose connection and proper provisions to minimize worker health and safety risks should be provided.

> Operating experience over time will dictate how often the coalescing devices will require cleaning, but a minimum interval of every 6 months is appropriate (API, 1990).

11.6.2 Cleaning of Water Quality Interceptors and Other Storm Water Systems

The required maintenance will vary from site to site, but cleaning storm water systems before the start of each season and inspection after every storm event should ensure proper functioning of the separator. Cleaning of storm water systems does not require the degree or type of cleaning associated with coalescing systems. The cleaning of storm water systems is primarily associated with removing debris (vegetation, etc.), solids, and free oil collected within the system (DoD, 1997c).

11.6.3 Total Cleaning and Internal Inspection of In-ground and Underground Separators

A standard gravity oil/water separator does not require the same degree of cleaning as coalescing gravity systems. It is suggested that on a “regular” basis underground and in-ground systems, without liners/containment, be cleaned and inspected for structural problems and cracks which may allow the release of petroleum contamination into the environment. One military contract contained provisions for pressure washing the separators to remove all debris from the walls, weir, and skimmer on the fourth year of the agreement (Headquarters AFDTC, 1996). Cleaning should be conducted to the point that the interior of the tank may be inspected to determine if there are any potential structural problems.

The frequency of cleaning in-ground or underground tanks is at the discretion of the installation. Cleaning should be undertaken, if there is an indication that the structure may be failing (shifting of the structure, significant cracks along an entire face of a tank side, failure of the system to maintain its liquid operating level under low or no loading situations.).

11.7 EFFLUENT MONITORING

If a permit regulates the separator discharge, effluent monitoring may be required. Under these circumstances, it may be appropriate to sample the effluent during the maintenance activities.

Questions:

1. How often is the discharge to be monitored?
2. What parameters are to be analyzed?
3. What is the sample collection methodology?
4. How are field parameters to be tested (flow, pH, chlorine residual, and dissolved oxygen)?

11.8 PHYSICAL CHARACTERISTICS INDICATIVE OF POTENTIAL PROBLEMS WITHIN A SEPARATOR

During inspection **(Worksheet 11-2)** and maintenance **(Worksheet 11-3)** visits to the separator, physical characteristics (smell, color, staining, or foaming) of the wastewater and tank should be evaluated to determine if there are potential problems.

Based on the noted physical characteristics, it may be necessary to contact the contributors to the separator to alter the current operations/activities or perform maintenance on the separator to eliminate equipment problems.

11.9 DEVELOPING AN OPERATION/MAINTENANCE PROGRAM

To develop an operation/maintenance program, each of the units comprising the oil/water separator system should be listed and the appropriate tables incorporated into the program format. This will provide a list of the major points to address at each separator and, to some degree, the frequency.

- Complete the oil/water separator inventory **(Chapter 3)**.
- Fill out **Table 11-1** delineating those groups responsible for various activities at the oil/water separator.
- Contact the state concerning regulation of in-ground or underground oil/water separators and their associated “used oil” holding tanks.
- Fill out the “Oil/Water Separator Summary Sheet for Maintenance/Inspection Program” for each separator, to include schedules for maintenance and inspections.
- Using the separator IDs fill out O&M Procedures at Separators. Make sure all procedures have been developed for field use.
- Fill out the O&M Schedules for Separators.
- Using the locations of the separators, group the separators for inspection/maintenance purposes.
- Modify general inspection form for each separator based on existing equipment and guidance from the equipment supplier.

- Implement and track program.

> An example of a standard statement of work (SOW) for contracted oil/water separator operation and maintenance programs may be found on the Air Force Civil Engineer Support Agency homepage (www.afcessa.af.mil). The SOW is contained on competitive sourcing, market research, SOW templates.

Worksheet 11-1

OIL/WATER SEPARATOR SUMMARY SHEET

(Page 1 of 2)

Attach Worksheets 3-1 and 3-5 or 3-6.

For Maintenance/Inspection Program

Separator ID: ____________ Installation: _______________

Building(s) and/or Area(s) Served: ____
Point-of-Contact: ____________________________________Phone: ___________________

Processes Discharging to Separator:____
____
____

Confined Space Entry Issues: ____
Special Tools Required: ____
Area(s) of the Separator not accessible to inspectors or heavy equipment:__________________
____

Hazardous waste issues associated with the oil or solids:_________________________________
____

SOLIDS

Allowable Solids Holding: _____ ft (thickness), ______ gallons, ______ % of tank
Solids Deposition Rate: _____ ft per __________ (time: week, month, etc.)
Solids Disposal/Reuse Method: ____
Contract Hauler: ________________________________ Phone: ___________________

"USED OIL"

Allowable Oil Layer Thickness in Separation Tank: _______ inch(es)
"Used Oil" Holding Type: _______________________ Holding Volume: ________ gallons
"Used Oil" Disposal/Reuse Method: ____
Contract Hauler: _________________________________Phone: ___________________

ACTIVITY FREQUENCY

Inspection: _______________ Maintenance: _______________
Tank Cleaning: _______________
Oil Removal: _______________ Solids and Oil Removal: ______________
Analyses Required:
Hazardous Waste Characterization: (oil) _______________ (solids):_______________
Reuse/disposal: (oil) _______________ (solids):_______________
Effluent Monitoring : _______________

Worksheet 11-1

OIL/WATER SEPARATOR SUMMARY SHEET

(Page 2 of 2)

Separator ID: ____________ Installation: ___________________

Oil/Water Separator Inspection and Removal History

DATE	INCHES OIL	INCHES SOLIDS	OIL ONLY REMOVED	OIL & SOLIDS REMOVED	VOLUME (GALLONS)	NOTED PROBLEMS OR COMMENTS

Worksheet 11-2 - Suggested Inspection Activities
Mark an "X" next to each applicable inspection activity.

Separator ID: ____________ Date of Inspection:______________
Name of Inspector(s):____

Confined Space Entry Required: ( ) No ( ) Yes (attach permit)
Special Tools Required: ____
Special Conditions: ____

	INSPECTION ACTIVITY	DESCRIPTION	COMMENTS	FREQUENCY
	GENERAL INSPECTION			
X	Grounds maintenance/debris control **(Section 11.3.1)**	Material that could enter the separator system littering: • the area near the separator, • in the influent channel, or • on separator grates.	( ) No significant debris ( ) Significant debris, requires clean-up	Per inspection.
	Equalization system **(Section 11.2.2)**	• Adequate freeboard. • Floatables require removal. • Oil, solids, debris require removal. • Flow structures clear.	( ) Adequate freeboard ( ) Yes ( ) No ( ) Oil, ( ) solids, ( ) debris require removal Flow structures clear ( ) Yes ( ) No	
	Preliminary solids removal system **(Section 11.2.1)**	See SOLIDS section of worksheet.	( ) Solids build-up minimal ( ) Solids require removal	
X	Solids build-up in influent line prior to the separator	Constriction of influent pipe that allows wastewater to back up in the line.	( ) No significant solids build-up ( ) Significant solids	
X	Spills, overflows, leaks from the separator, lines, and holding tank **(Section 11.3.2)**	Inspect secondary containment serving holding tank (if appropriate) and the general area around the separator and lines for signs of spillage/leakage.	( ) No signs of leakage, spills, or tank overflows ( ) Release noted: ________________ ( ) Clean-up required	Per inspection.

	INSPECTION ACTIVITY	DESCRIPTION	COMMENTS	FREQUENCY
X	Structure/Construction Material/Lines **(Section 11.3.3)**	• Cathodic protection operable (if applicable). • Condition of separator liner (if applicable). • Inspect for potential structural problems/damage (system shifting, significant cracks, low liquid level, etc.).		Per inspection.
	Screening or trash racks **(Section 11.2.3)**	• Does the screen/trash rack require cleaning? • Does the material in the draining drum require removal disposal?	( ) Requires cleaning ( ) User requires notification ( ) Material in the draining drum requires removal disposal	Per inspection.
	Exposed mechanical parts **(Section 11.3.4)**	• Are mechanical parts adequately lubricated? • Inspect for build-up of materials that may adversely impact operation.	( ) Requires maintenance ( ) Does not require maintenance	
	Separator vents **(Section 11.3.7)**	Are vents plugged?	( ) Vent requires cleaning ( ) Cleaning not required	
	Pumps - Wastewater/solids ( ) Wastewater ( ) Solids **(Section 11.3.6)**	• Evidence of pump failure or leaking. • Obstructions in wet well. • Pumps operational.	Evidence of pump failure or leaking ( ) Yes ( ) No Obstructions in wet well ( ) Yes ( ) No Pumps operational ( ) Yes ( ) No Maintenance required ( ) Yes ( ) No	

	INSPECTION ACTIVITY	DESCRIPTION	COMMENTS	FREQUENCY
	WASTEWATER CHARACTERISTICS (Section 11.8)			
X	Foaming (non-aerated system)	Foam may indicate the discharge of detergents, cleaners, or other surfactants to the system.	( ) No foam ( ) Foam noted: ___________________	Per inspection.
X	Anaerobic conditions	Organic (biological) material may be entering the separator and decomposing, if: • Discrete bubbles pop to the surface of the separator, and/or • Septic or sulfide ("rotten egg") smells are noted.	( ) No anaerobic conditions ( ) Sulfide smell ( ) Bubble formation	Per inspection.
X	Smell (gasoline or solvent)	Gasoline or solvent smell may indicate that materials are being discharged to the separator that may cause the generation of hazardous waste and/or unsafe conditions.	( ) No smell ( ) Typical petroleum smell ( ) Gasoline ( ) Solvent ( ) Other _______________	Per inspection.
X	Depth of wastewater in the tank	If the wastewater level is below the effluent discharge pipe, the tank may be leaking.	( ) Water level appropriate ( ) Potential leaking	Per inspection.
X	Color of the wastewater	Certain materials have distinctive colors that could indicate the discharge of wastewaters to the separator that should be eliminated. For example, antifreeze is generally yellow green.	( ) Clear ( ) Turbid ( ) Blackish ( ) Other: _______________________	Per inspection.
	COALESCER SYSTEM			
	Gravity separator with coalescing system **(Section 11.6.1)**	Inspect coalescer for fouling.	( ) Fouling/blockage ( ) No problems	Weekly.
	STORM WATER SYSTEM			
	Storm water systems **(Section 11.6.2)**	Inspect for existing conditions: debris, solids, free oil.	( ) System requires cleaning ( ) Cleaning not necessary	After each storm.

	INSPECTION ACTIVITY	DESCRIPTION	COMMENTS	FREQUENCY
	FLOTATION SYSTEM (61)			
	Surface skimmer mechanism	Inspect drive, flight, roller.		Weekly (visual), Annually (detailed).
	Bottom rake	Inspect flight.		Annually.
	Pressurization pump and tank			Weekly.
	Back pressure valve	Valve holds recommended back pressure.		Weekly.
	Solids valve	Operates freely, closes tightly.		Weekly.
	Skimming/bottoms pump(s)			Weekly.
	OIL SYSTEMS			
X	Oil layer thickness in separation chamber **(Section 11.4.1.2)**	Visual estimate, indicator paste, or stick method.	( ) None ( ) Sheen - ( ) heavy, ( ) light ( ) Free product: Approximately _____ inches ( ) Requires removal or skimming	(w/out skimmer) Per inspection. (w/skimmer) Range: several times/day to several times/month.
X	Floating debris in separation chamber **(Section 11.4.2.1)**	Look for floating materials that may interfere with oil removal or the operation of the skimmer.	( ) No ( ) Yes ( ) Requires removal ( ) User requires notification	Per inspection.
X	Observe oil removal from surface of separation chamber or "used oil" holding tank (as applicable) **(Sections 11.4.1.4 and 11.4.2.3)**	Ensure removal is conducted in accordance with SOPs and spills do not occur.		Per occurrence.
	Skimmer **(Section 11.4.2.1)** Type: ______________________ **(Section 9.2.2)**	Skimmer is clean, balanced, and apparently operating as intended. Is the skimmer in the appropriate operating position?	( ) Skimmer requires maintenance ( ) Skimmer is clean, balanced, and apparently operating as intended. Skimmer ( ) is or ( ) is not in the appropriate operating position.	Per inspection.
X	Oil staining above the usual water line	Indicates hydraulic overloads or blockage of the effluent structure.	( ) No ( ) Yes	Per inspection.

	INSPECTION ACTIVITY	DESCRIPTION	COMMENTS	FREQUENCY
X	Excessive oil build-up in the separation chamber	Could indicate batch dumping of relatively large quantities of oil.	( ) No ( ) Yes	Per inspection.
X	No build-up of oil in the separation chamber	Could indicate hydraulic overload and flushing of the system or continuous discharge of detergents or other emulsifying agents.	( ) No ( ) Yes	Per inspection.
	Available capacity in "used oil" holding tank **(Section 11.4.2.3)**	Measure the quantity of used oil/water in the holding tank.	( ) Requires pumping ( ) Approximate % of tank available: ___________	
	Underground "used oil" holding tank	Inspect to ensure compliance with UST regulations, if required.		
	SOLIDS			
	Solids collection system (automated system)	System is operating properly.	( ) System is operating properly ( ) System requires maintenance	Weekly.
X	Accumulation of solids in separation chamber **(Sections 11.5.2 and 11.5.3)**	Visual estimate or stick measurement.	( ) No significant accumulation ( ) Approximate thickness of solids: _______ ft. ( ) Requires solids removal	Range: once/week to monthly, depending on the rate of solids accumulation.
X	Observe the removal of solids from separation chamber **(Section 11.5.7)**	Ensure removal is conducted in accordance with SOPs and spills do not occur.		Per removal.
	BYPASSES AND OVERFLOWS			
	High water bypasses and overflows **(Section 11.3.5)**	Is bypass/overflow operable? Is alarm system operable?	( ) Operational ( ) Requires maintenance	
	EFFLUENT STRUCTURE			
X	Sheen or staining in effluent structure	Could indicate hydraulic surges, discharge of surfactants, discharge of oils not appropriately treated by the separator.	( ) Could not be inspected ( ) Staining ( ) No sheen ( ) Light sheen ( ) Heavy sheen ( ) Requires maintenance	
	Effluent weir	Is weir clean and balanced (if adjustable)?	( ) Could not be inspected ( ) Weir OK ( ) Requires cleaning ( ) Needs balancing	

Comments on separator inspection: ____
____
____
____

Worksheet 11-3 - Suggested Maintenance Activities

Mark an "X" next to each applicable maintenance activity.

Separator ID: ____________ Maintenance Date: __________________

	MAINTENANCE ACTIVITY	DESCRIPTION	COMMENTS	FREQUENCY
	GENERAL MAINTENANCE			
X	Grounds maintenance/debris control	Remove materials that could enter the separator system from the immediate area, the influent channel, and the top grates of the separator.		Per maintenance visit.
	Equalization system	• Remove debris and floatable material. • Remove contained oil/solids as needed. • Ensure flow structures are clear and operational. • Maintain equipment, as necessary.		
	Preliminary solids removal system	See SOLIDS section of worksheet.		
X	Influent line	Remove any built-up solids that would impede flow. Check separator influent structure for blockage.		
X	Spills, overflows, and leaks	Clean-up any released materials, correct/eliminate any source, ensure regulatory contact, if necessary.		Per maintenance visit.
	Bypasses and Overflows	• Clean bypasses and overflows, as necessary. • Test any bypass/overflow alarm systems.		
	Screening or trash racks	• Clean screen or trash rack. • Place removed material in a draining drum, if necessary. • Notify contributors if persistent problem.		Per maintenance visit.
X	Component parts	• Clean equipment such as skimmers, weirs, sludge collection equipment, etc. • Lubricate exposed mechanical parts, as necessary.		As necessary, to ensure proper operation of the equipment.

	MAINTENANCE ACTIVITY	DESCRIPTION	COMMENTS	FREQUENCY
	Separator vents	Clean separator vents.		As necessary.
	Pumps - Wastewater/solids pumps	• Periodically test pumps to ensure electrical systems are functioning properly. • Clean wet well, as necessary. • Conduct required pump maintenance.		
	UNDERGROUND SEPARATOR CLEANING			
	Clean in-ground or underground separator	Cleaned to the degree that structural problems would be noted.		Discretion of the installation based on potential structural problems.
	COALESCER CLEANING			
	Clean gravity separator with coalescing system	Two methods: • (preferred) removal of the plates from the separator and the use of high-pressure cleaning equipment; and • parallel- and corrugated-plate separators may be drained and hosed down on a routine basis to clean the plates.		Suggested minimum interval of every 6 months.
	STORM WATER SYSTEM CLEANING			
	Clean storm water systems	Remove collected debris, solids, and free oil.		Before the start of each season, and as needed during the year based on inspections.
	FLOTATION SYSTEM			
	Flotation system maintenance	See system manuals.		

	MAINTENANCE ACTIVITY	DESCRIPTION	COMMENTS	FREQUENCY
	OIL SYSTEMS			
X	Remove floating debris from separation chamber	Place removed debris in a drain bucket.		Per maintenance visit.
	Measure oil depth in separation chamber (w/out skimmer)	Measure oil thickness using a stick, indicator paste, or probe.		Once per week initially (frequency may be increased or decreased).
	Skim oil to holding tank (manual system)	• Determine if there is adequate capacity in the separate/integral holding tank. • Divert oil when separation chamber is fully covered. Maximum target oil thickness is 1 inch, not to exceed 2 inches. • Ensure that a significant amount of water is not diverted with the oil. • Manual skimmers should be inactivated when not in use.		As necessary.
	Oil skimmer (manual and automatic systems)	Skimmer moves freely, level, not plugged. Operating properly. Clean, maintain and adjust, as necessary.		Weekly, initially (DoD, 1997f).
	Skimming pumps	Pumps operate properly. Maintain as necessary.		Weekly, initially (DoD, 1997f).
X	Oil hazardous waste characterization	Analyze oil for total halogens (kit may be used).		Prior to initial removal for disposal/reuse. Additional hazardous waste analyses will be at the discretion of the installation.
	Oil characterization - if used for energy recovery	Analyze oil for arsenic, cadmium, chromium, lead, and flash point to determine if oil is "on-specification." If exemption from "used oil" requirements is not sought, no analysis is necessary.		Prior to initial removal for disposal/reuse, if exemption to some of the "used oil" requirements is sought. Additional analyses will be at the discretion of the installation.

	MAINTENANCE ACTIVITY	DESCRIPTION	COMMENTS	FREQUENCY
X	Oil characterization - state/local requirements	Analyze oil for any additional parameters required by state/local regulations.		As stipulated in state/local regulations.
	Pump oil from surface of separation chamber (w/out skimmer)	Remove oil when the layer is approximately 1 inch thick. The layer thickness shall not exceed 2 inches.		Once per 6 months, or when target oil layer thickness is met.
	Pump "used oil" holding tank	Remove oil for reuse disposal when holding tank is filled to 75% capacity. Skim oil from the separator to the holding tank after, not before, the holding tank is pumped.		Once per 6 months, or when target capacity is met.
	SOLIDS			
	Solids flight mechanism	Flights, chains, sprockets, rails, drive are operating properly. Lubricate as necessary.		Weekly (visual) , Annually (detailed) (DoD, 1997f).
	Solids hopper valves	Valves open/close freely, close tight. Lubricate as necessary.		Weekly (DoD, 1997f).
	Solids pump(s)	Pumps operating appropriately. Maintain as required.		Weekly (DoD, 1997f).
X	Measure solids thickness	Estimate or stick method.		
X	Solids hazardous waste characterization	Sample & analyze solids in separation chamber for: • TCLP for metals, volatiles, and semi-volatiles; • TCLP for herbicides/pesticides (optional based on knowledge); • Ignitibility and corrosivity; and • Reactivity (optional based on knowledge).		Prior to initial removal for disposal/reuse. Additional hazardous waste analyses will be at the discretion of the installation.
X	Solids characterization - State/local requirements	Analyze solids for any additional parameters required by state/local regulations. Sample should be collected from holding area (if appropriate). Analyses could include: • total petroleum hydrocarbons; • polychlorinated biphenyls; and • paint filter test.		As stipulated in state/local regulations.

	MAINTENANCE ACTIVITY	**DESCRIPTION**	**COMMENTS**	**FREQUENCY**
X	Remove solids from separator	Remove solids for reuse/disposal when target capacity of holding is attained, or when scheduled.		When target capacity is met, or on scheduled date.
X	Wastewater conditions during separator cleaning and solids removal (flat bottom)	• The separator may be out of service and not be available to treat influent wastewater. • The water used to clean the tank may contain emulsified oil, which may require removal of the water for additional treatment elsewhere. • The tank should be filled with clean water up to its normal operating level before the unit is placed back on line to prevent pass through of separated oil or other floatable material.		Per cleaning or solids removal operation for flat bottomed separator.
	BYPASSES AND OVERFLOWS			
	High water bypasses and overflows	Clean bypasses and overflows.		As necessary.
	EFFLUENT STRUCTURE			
	Effluent weir	Clean and adjust.		As necessary.

Comments on maintenance: ____
____
____
____

TABLE 11-1 - DELINEATION OF OIL/WATER SEPARATOR O&M RESPONSIBILITY

Installation Organizations

Areas of Responsibility													
Control of Releases to Separator													
Maintenance/inspection of Upstream Systems													
Inspection of Separators													
Maintenance of Separators													
Maintenance/inspection of Waste Oil Tanks													
Compliance Monitoring (oil, solids, discharge)													
Removal and Disposal/reuse oil													
Removal and Disposal/reuse solids													
Permit/regulation/ordinance Compliance													
Purchasing (equipment & chemicals)													
Contracting													

CHAPTER 12
CLOSURE OF OIL/WATER SEPARATORS

CHAPTER 12
CLOSURE OF OIL/WATER SEPARATORS

This chapter provides general guidance on the closure of oil/water separators. Only "clean closure" (no releases to the environment) is addressed. If releases to the environment have occurred (could be due to structural or operational problems), the state and local regulators should be contacted immediately to determine the appropriate actions.

12.1 WHEN SHOULD AN OIL/WATER SEPARATOR BE CLOSED

The closure of an oil/water separator may be required for various reasons. The primary reasons are:

- the system is no longer required to treat the current/future wastewater from an operation;
- the source area/building is being demolished;
- the site is being excessed due to Base Realignment and Closure (BRAC) or other actions; or
- the separator system is being replaced.

12.2 WAS HAZARDOUS WASTE DISCHARGED TO THE SYSTEM

If hazardous waste was discharged to the system, the closure may be addressed under RCRA regulations (see discussion on solid waste management units, **Section 2.1.6.2**). It is suggested that the state be contacted to determine any specific closure requirements associated with systems that have received hazardous waste. For completion of the closure report **(Section 12.8)**, a history of the various wastewaters discharged to the separator should be developed.

12.3 DEFINE THE COMPONENTS OF THE SYSTEM TO BE CLOSED

When closing an oil/water separator there are more issues to address than the closure of just the separator. Such things as the "used oil" holding tank must be considered. For example, the storage tank may have more stringent closure requirements than those placed on the separator.

Reviewing the inventory inspection conducted on the system can identify many of the tank components. The inventory should supply information on pumps, alarms, coalescing systems, etc. located in and around the separator.

Information on the source location and type of pipes (influent, effluent, bypass and overflow) and where they tie into the separator will be beneficial.

12.4 CLOSURE OPTIONS

There are two options for types of oil/water separator closure: in-place and removal. An in-place closure means that the separator is not removed but left in-place. An in-place closure is not always accepted by state or local regulators, unless very strong rationale is provided as to why the tank cannot be removed, such as removal would jeopardize the structural integrity of a building. An in-place closure refers to the separator itself and does not mean that appurtenant equipment is not removed. If a separate "used oil" underground holding tank is also proposed to be closed in-place, there is an additional issue to be addressed by the regulators.

A removal means that the tank and all appurtenant equipment are removed from the premises. This type of closure is recommended as all potential future sources of contamination associated with the system are removed and full documentation is provided that any residual contamination was removed. (When a separator is closed in-place, it is difficult to obtain soil samples immediately below the tank.)

12.5 WHAT ARE THE STATE AND LOCAL CLOSURE REQUIREMENTS

Each state and locality may have their own particular requirements concerning the closure of a separator and associated activities, or there may be no specific requirements at all. The state and local regulators should be contacted and, at a minimum, the following questions should be clarified:

> Any state and local agency that could have responsibility for the separator or the handling/disposal of the generated waste (Clean Water Act (CWA), RCRA, underground storage tanks, etc.) should be contacted. For example, one installation contacted the state CWA agency and received guidance on closing a separator. As the closure progressed the state RCRA agency became involved and informed the installation that the closure was inadequate as the separator was considered a solid waste management unit (SWMU).
>
> Agencies/groups that should be contacted:
>
> - municipality (building codes, sewer regulations, landfill requirements, excavation permits, utility information, etc.)
> - utilities
> - sewer authority (closing existing pretreatment permits, line closure)
> - state agencies (CWA, RCRA, underground storage tanks)
> - local agencies (CWA, RCRA/landfill, underground storage tanks)
>
> AS YOU MAY OBTAIN CONFLICTING INFORMATION FROM THE VARIOUS AGENCIES/GROUPS, USE THE MOST RESTRICTIVE GUIDANCE PROVIDED, TO ENSURE COMPLIANCE WITH ALL RELEVANT CODES/REGULATIONS.

- Is there a standardized closure procedure for oil/water separators?
- (These questions need only be asked, if the installation is considering in-place system closure.) Can a system be closed in-place under certain circumstances, such as potential structural problems with adjoining buildings? Any particular requirements for in-place closure?
- Are permits or associated monitoring activities required for system closure?

- Are there monitoring requirements for clean closure of a system? (Obtain a list of parameters, analytical methods, sampling procedures, and maximum clean closure concentrations.)
- Does a representative of the agency have to be on-site during the closure activity or inspect the site prior to closure?
- Is a closure report to be filed? (If so, is there an approved format, schedule, and mailing list?)
- Are there specific closure requirements for a separate "used oil" holding tank that is underground?
- Is over-excavation of potentially contaminated soil allowed during a "clean closure?"

12.6 PREPARATION FOR CLOSURE

12.6.1 Separator Location

It is important to note, to some degree of accuracy, where the separator was located prior to closure. This can be accomplished by locating the tank using a GPS unit or pacing distances from multiple structures or other benchmarks and noting the distances on a site sketch. There may be some circumstances where the location of the separator may require an actual survey be conducted.

12.6.2 Establish Safety Procedures

The closure of separators and appurtenant equipment should be evaluated as to potential safety hazards including confined space entry and explosion hazard. Appropriate entry permits, monitoring equipment, and personal protection equipment should be established and made available.

12.6.3 Material Disposal /Reuse Options

Each of the materials and byproducts to be removed from the separator system should be reviewed related to disposal/reuse options. The materials could include:

- Used oil;
- Solids;
- Wastewater in the separator;
- Cleaning and rinse liquids;
- Tanks (particularly USTs);
- Over-excavated soil (if allowed under "clean closure");
- Debris - concrete, grating, fencing, piping, etc. (Hazardous debris information is found in 40 CFR 268.45.); and
- Equipment - parallel plates or other coalescing equipment, pumps, sensors, skimmers, lighting fixtures, etc.

If materials such as concrete are properly cleaned, the material may be allowed to be disposed in a debris landfill. Local and state requirements should be reviewed.

12.6.4 Utility Information

As the usual closure activities involve destructive/intrusive actions, the various utility locations in the immediate area of the separator should be reviewed and located. The types of utilities include, but are not limited to overhead electrical/phone wires, steam lines, buried cable/phone/electrical, natural gas pipelines, water and sewer lines, and other underground systems (material transfer, storage tanks, etc.). “Miss Utility” or similar organizations should be contacted to locate and mark utilities in the immediate area. The municipality may require excavation permits.

12.6.5 Permits Information

State and local government entities may require permits to remove/close separator systems, install monitoring wells, conduct soil borings, etc. **(Section 12.5)**.

12.7 CLOSURE PROCEDURES

12.7.1 Remove Residual Materials

The residual materials ("used oil," solids, and contained wastewater) should be removed and appropriately reused/disposed of **(Sections 11.4 and 11.5)**.

12.7.2 Isolate Piping

The preferred method of addressing the influent pipe is to flush the pipe contents into the separator with clean water (no detergents); expose the pipe and inspect for leaks; disconnect the pipe from the source area and the separator; totally remove the pipe draining any contained liquid to the separator or a container; and over-excavate (if allowed) any noted contaminated areas along the pipe trench. Over-excavated areas of the trench should be analyzed for any target parameters provided by the regulators **(Section 12.5)**.

> If the separator is being removed as it is no longer needed for treatment, but the wastewater discharge will continue, special provisions will be required to disconnect the wastewater line from the separator and then connect the wastewater source area to the appropriate sewer.

The effluent pipe should be disconnected from the separator. If possible the pipe should be removed from the separator to the nearest downstream manhole and the connection sealed to prevent backflow of wastewater from the manhole up an unsealed pipe. At a minimum, at least one section of the pipe should be removed just downgrade of the separator. After the separator closure is near finalization seal the exposed end of the effluent pipe near the separator, and if possible without causing problems with other discharges, at the downstream manhole or outfall.

Any bypass or overflow pipes should be disconnected from the separator and removed. If removal is not possible, both exposed ends should be permanently sealed.

All "used oil" conveyance piping/trenches should be drained to the storage tank or separate container and disconnected (prior to any system cleaning).

Short term plugs should be installed in the holes generated by the removal of pipes to prevent releases during cleaning and/or removal of the separator.

> Source areas that discharged to the separator, such as floor drains, should be permanently sealed to prevent future discharges to an open pipe.

12.7.3 Preparing the Separator for Closure

Interior separator equipment that is to be reused/disposed or would otherwise impair system cleaning and closure, should be cleaned and removed. For example, if parallel plates were to be transferred to another separator, they should be cleaned and removed at this point. Even if the plates were to be disposed of, they should be cleaned and removed as cleaning of the entire separator could not be accomplished with the plates in-place.

> Detergents should not be used to clean equipment or interior of the separator unless absolutely necessary. If detergents are used, the collected cleaning water should be removed and treated as an emulsified oil wastewater.

Clean the interior of the tank to remove residual oil and solids that have built-up. Some materials may be extremely hard to remove due to concretion. These materials should be removed to the extent practicable without resorting to solvent use. The liquids and solids generated during separator cleaning should be removed for treatment off-site.

12.7.4 Closure in-Place

Many states discourage in-place closure of underground storage tanks, which may also be applied to in-ground or underground separators.

> State and local regulators **(Section 12.5)** should be contacted before a decision is made to close a separator in-place.

If the separator is to be closed in-place, the extent of soil contamination around the separator should be determined. If there is no specific guidance provided to characterize the site by the state/local regulators, the following approach should be used:

- Soil borings should be conducted within 5 feet of, and midway along, each side of the separator. The continuous cores should be field screened for organic compounds with a photo-ionization detector (PID) or flame ionization detector (FID) to a depth of approximately 2 feet below the bottom of the separator. (NOTE: A PID is sensitive to humidity and may yield a false positive reading.) The area of each core exhibiting the highest field screen reading and the bottom of the core should be collected and analyzed for total petroleum hydrocarbons (TPH - Method 8015 - Diesel Range Organics). If no variation in the field screening values is noted along the entire core,

analyze only the bottom of the core. Soil samples should not be collected below the water table. The boring locations should be noted on a site drawing.
- If free oil is visually noted in any boring contact the appropriate regulator immediately. Smell alone could be deceiving as an indicator of significant contamination.
- If the state/local regulators do not provide a target concentration for TPH, use a value of 100 mg/kg, dry-weight. If the analytical results are above this value, contact the regulators concerning the next required actions.
- The analysis should be a 24-hour turn around and the system should not be closed until the soil analyses have been received and compared to a target value.
- Executed chain-of-custody forms, sample locations, and the analytical results should be maintained by the installation.

If the state or local regulators do not have a recommended protocol, the tank, following removal of interior equipment, cleaning, removal of any residual cleaning materials, inspection, and photo documentation, should be filled with inert material such as cement slurry or sand. For concrete separators, it may be more appropriate, after cleaning and residual removal, to puncture the bottom of the tank, and collapse the cover into the tank and backfill with clean inert material. Obtain approvals/comments from regulators before undertaking this action.

12.7.5 Total Removal of System

After the appurtenant piping has been removed, the tank cleaned, and the cleaning residuals removed, the tank may be exposed and pulled. The tank should be inspected for any historic areas of release and photo documentation obtained.

The extent of soil contamination within the pit following separator removal should be determined. If there is no specific guidance provided to characterize the site by the state/local regulators, the following approach should be used:
- Soil samples should be collected along each pit face and in the middle of the bottom of the pit. Samples should not be collected below the water table. The locations should include any noticeably stained surfaces. The samples should be field screened with a PID or FID. Each of the five samples should be analyzed for total petroleum hydrocarbons (TPH - Method 8015 - Diesel Range Organics).   The sample locations should be noted.
- If free oil is visually noted within the pit, contact the appropriate regulator immediately. Smell alone could be deceiving, as an indicator of significant contamination.
- If the state/local regulators do not provide a target concentration for TPH, use a value of 100 mg/kg, dry-weight. If the analytical results are above this value, contact the regulators concerning the next required actions.
- The analysis should be a 24-hour turn around and the pit should not be closed until the soil analyses have been received and compared to a target value.

- Executed chain-of-custody forms, sample locations, and the analytical results should be maintained by the installation.

If all samples are found to be below the target TPH concentration, obtain excavation photo documentation, and close the excavation with clean fill material. If the tank is to be destroyed, obtain the necessary documentation.

12.7.6 Photographic Documentation

At some point in time, the closure of the system will undergo scrutiny. An example of an outside evaluation could involve a BRAC action and the development of an Environmental Baseline Study (EBS). To simplify the questions that could be posed about the system and its closure, it is suggested that photographic documentation of the closure be collected. (This information should be incorporated into the Closure Report.) The photographs, at a minimum, should include:

- the site and appurtenant equipment prior to any closure activity;
- the disconnected piping;
- if the separator is to be closed in-place:
  the interior of the separator after it is pumped down, but not cleaned,
  the interior of the separator after cleaning and removal of internal equipment,
  close-ups of any structural/cracking problems, and
  the interior of the tank after filling with inert material;
- if the separator is removed during closure:
  tank as it is being pulled from the ground and another photo after it is fully exposed, close-ups of any noted tank problems,
  the open hole after the tank is removed, prior to any over-excavation,
  the open hole following over-excavation (if allowed), and
  the over-excavated soil storage pile and storage area;
- the site following completion of the closure; and
- if the oil storage tank is underground or in-ground, take the same type of pictures as those suggested for removal (above) and a picture of the destroyed tank, if conducted.

12.8 CLOSURE REPORTS

The state or local regulators may require closure reports. Any existing formats should be adhered to. If formats and regulatory submittals are not required, relevant information should be compiled into a closure report and kept on file.

An example table of contents for a closure report is listed below:

I. Site Description
   A. Location
   B. General Site Geology and Groundwater Conditions
   C. Separator Description
   D. Historic Discharges to the Separator
II. Separator Closure
III. Sample Collection, Analyses and Results
IV. Conclusions

Appendices:

- Site Map
- Sample Locations
- Chain-of-Custody Forms, Analytical Results
- Manifests and Permits
- Photo Documentation

CHAPTER 13
GREASE TRAPS

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CHAPTER 13
GREASE TRAPS

13.1 INTRODUCTION TO GREASE TRAPS

Grease traps are designed to remove grease from wastewater before it enters the sanitary sewer system. The grease must be removed because the material may clog sewer lines or adversely affect the operation of a downstream wastewater treatment system. Grease traps are also known as grease interceptors or grease separators. More complex systems are known as grease recovery devices (Massachusetts, 1997a).

13.1.1 Blockage of Sewer Lines

Grease and fat congeal as the wastewater cools, which may decrease pipe capacity and require sewer cleaning and/or replacement sooner than otherwise expected (Kennewick, 1998). The deposition of grease and fat in sewer lines may restrict sewage flow to the point that the wastewater may back-up and overflow open structures. This release of raw sewage generates health, environmental and aesthetic concerns. It is therefore extremely important to prevent sewer line blockage.

> Grease may block the sewers by one of two methods: occlusion or aggregation.

The typical grease blockage is the occlusion of pipes that occurs as the grease collects on the pipe walls and grows inwards. This blockage, if left for a long period of time, will result in the grease forming a hardened tubular material similar to a baked clay, and reducing the hydraulic capacity of the sewer (Wehrenberg, 1993).

> Grease deposits on the walls of pipes and other structures may become hard when neglected (Dowde, Undated).

A second type of blockage occurs when grease globules cool and collect solids. In this case an aggregate is formed. This grease-based aggregate takes on the characteristics of gravel. The dimensions of the "gravel" may grow to basketball size or larger. The grease aggregate plugs pipes by collecting in low areas. If blockage occurs, it may be automatically purged as head pressures increase upstream of the blockage (Wehrenberg, 1993).

13.1.2 Effects on Wastewater Treatment Systems

In downstream wastewater treatment systems, grease may causes floating mats in settling tanks, digesters, and pipes, which may cause a shutdown of the treatment plant units. The discharge of excessive grease can also shorten the effective life of septic tank/drainfield systems.

13.2 OPERATIONS THAT GENERATE WASTEWATER CONTAINING FATS, OILS, AND GREASE

The food processing industry (e.g., meat, fish, and dairy processing; vegetable oil extraction; margarine production) can produce waste streams that contain high concentrations of free oils as well as emulsified oils. These industries may use more complex methods of physical (dissolved air flotation) or chemical separation to remove the fats, oils, and greases. These systems are not typically used to remove grease from discharges at DoD facilities and, therefore, are not discussed in this chapter.

Food service operations, especially those that prepare or cook meat products, have grills or deep fryers, or require grease extraction hoods, contribute grease and oil to wastewater systems.

Fats, oils, and greases (FOG) enter the wastewater from a number of sources. Meat and dairy products naturally contain oil and grease that may be released during cooking; vegetable oils are used in baking and condiments (salad dressing, margarine, etc.); and both animal and vegetable oils are used in frying. During food preparation and cleaning operations, these fats, oils, and greases are washed down the drain.

Most food service operations have two wastewater systems: a sanitary system for toilets, urinals, and bathroom sinks; and a kitchen system for floor drains, dishwashers, and prep sinks. To prevent grease from entering the sanitary sewer system, wastewater from all kitchen sinks (without garbage disposals), wash down hoods, Chinese cookers, and floor drains should discharge into a grease trap (Vancouver, 1997).

Below is a list of those food service operations that may or may not require wastewater pretreatment by a grease trap.

OPERATIONS THAT USUALLY REQUIRE GREASE TRAPS: (Massachusetts, 1997b)

- Bakeries (with deep frying)
- Restaurants, and other commercial kitchens
- Mess halls, cafeterias, clubs
- Hotels
- Hospitals
- Schools
- Super markets
- Other establishments where grease can be introduced in quantities that can cause line stoppage or hinder sewage disposal

OPERATIONS THAT USUALLY DO NOT REQUIRE GREASE TRAPS: (Vancouver, 1997)

- Bakeries (no deep frying)
- Canteens, coffee shops
- Delicatessens (extracting hood not required)

Eating establishments fall into three major categories: fast food restaurants, full service restaurants, and institutional and large commercial kitchens (Shreveport, 1998).

> Factors affecting the wastewater production and quality include: type of eating establishment, ware-washing equipment, production equipment, menu, and management/operating practices (Thermaco, 1997).

13.2.1 Fast Food Restaurants

Fast food restaurants have the simplest kitchen wastewater stream. Over 93% of the effluent grease comes from the pot wash sink in the kitchen. The remaining grease comes from the floor drains and the mop sink (Thermaco, 1997). The more fryer-type cooking appliances in a kitchen, the higher the levels of grease in the wastewater.

> Typically, a drive-in restaurant will require a 70 to 100 pound grease interceptor (Global, 1997).

13.2.2 Full Service Restaurants

Full service restaurants offer table service and washed plateware. The pot wash sink is the major contributor of grease. It, along with the pre-rinse sink, contributes 90% of wastewater grease. The dishwasher, mop sink, floor drains, and food preparation area contribute the remaining grease (Thermaco, 1997).

13.2.3 Institutional and Large Commercial Kitchens

Institutional and large commercial kitchens, such as those for prisons, hospitals, and military mess halls, use a wide range of dishwashing and food preparation equipment. The pot wash sink and the pulper (garbage disposal), if present, are the two greatest contributors, followed by the tilt kettles. (Tilt kettles are used to cook large volumes of meats, soups, sauces, and other food.) The remaining sources make up less than 20% of wastewater grease (Thermaco, 1997).

Table 13-1 Percent of Total Grease & Oil Loading from Various Restaurant Types (Thermaco, 1997)

SOURCE	FAST-FOOD RESTAURANT	FULL SERVICE RESTAURANT	INSTITUTIONAL AND LARGE COMMERCIAL KITCHEN
Pot Wash Sink (ware washing)	93%	75%	36%
Pre-Rinse Sink		15%	8%
Food Prep		1%	<1%
Mop Sink	4%	3%	1%
Floor Drains	3%	2%	1%
Dishwasher		4%	4%
Pulper			35%
Tilt Kettles			15%
FOG, mg/L	634	510	830

13.3 REGULATIONS AND CODES GOVERNING GREASE TRAPS

Grease traps may be regulated by various agencies at the state and local level. In the absence of state/local regulation and guidance, DoD installations should be guided by nationally recognized building codes and best management practices.

13.3.1 Federal, State, and Local Regulations

The federal government does not regulate the installation, operation, or closure/removal of grease traps. State or local health departments may regulate grease traps to prevent problems due to improper maintenance. For a discussion of various permits, see **Chapter 2**.

Many localities/sewer authorities require nonresidential establishments that have kitchen facilities (e.g., restaurants, schools, hospitals, nursing homes, motels/hotels, and correctional facilities) to install grease traps to eliminate food grease from wastewater. Other types of controls placed on food service operations include pretreatment permits or sewer bill surcharges for excessive grease input into the sanitary system (North Carolina, 1998).

Sources of information concerning grease trap regulatory requirements are: local governments; sewer authorities; state and local health departments; and environmental regulatory agencies.

> All outlets from subsistence buildings and other points where grease can enter the sewer system should have a grease trap (DoD, 1988a).

> **NOTE**: Contact with state or local regulators should be coordinated through the installation environmental office.

13.3.2 Plumbing Codes

Many plumbing codes (e.g., the International Plumbing Code, the National Plumbing Code, the Uniform Plumbing Code, Plumbing and Drainage Institute, etc.) address the installation, sizing, and closure of grease traps. These codes are industry standards for performance, not mandatory requirements, except where they have been incorporated by reference into state or local codes. The Uniform Plumbing Code, published by the International Association of Plumbing and Mechanical Officials appears to be the code most referenced by local regulations.

> The Plumbing and Drainage Institute (PDI), standard PDI-G101 is included as the basic grease trap testing and rating requirement of Military Specification MIL-T-18361 (PDI, 1981).

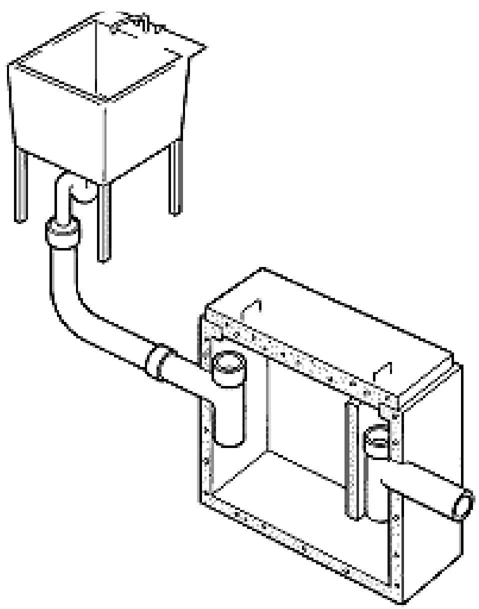
13.4 PRINCIPLES OF GREASE SEPARATION

For the purpose of this manual, a grease trap is a device that houses a quantity of water and is designed so that animal and vegetable oils/greases from commercial kitchens or other sources are separated from wastewater prior to entering the sanitary sewer system. More advanced grease removal systems that would be used for industrial operations, such as dissolved air flotation (**Section 9.6**), are not covered in this chapter.

Grease traps are designed to separate fats, oils, and grease (FOG) from wastewater. Grease traps rely on sedimentation and flotation to treat the wastewater. The FOG generally has a lower specific gravity than water and will rise to form a grease layer on the water surface. Grease weighs approximately 90% as much as water (specific gravity of 0.89 to 0.90). Heavier solids (food wastes) will settle to the bottom of the trap (Wehrenberg, 1993).

Wastewater enters the grease trap through an inlet or influent structure. The incoming flow rate may be restricted by flow-control fittings. Once inside the trap, a baffle or series of baffles slows the flow of the warm wastewater. This allows the water to cool and the grease to separate from the liquid and float to the surface. Solids will settle to the bottom of the trap. An outlet or discharge pipe is placed on the opposite side of the tank from the influent or input pipe. Baffles or a "T" connection prevent grease from exiting the trap while allowing the effluent to discharge into the sewer system.

Figure 13-1 Grease Trap (Russell Reid Professional Services)



13.5 COMPONENTS OF GREASE TRAPS

A grease trap consists of a tank with one or two compartments, a vented flow control, internal baffling, and an internal air relief bypass (Massachusetts, 1997a). Most of the potential components that can be incorporated into a grease trap system are listed below.

13.5.1 Solids Trap/Separator

Grease traps are not solids traps. Solids collected in a grease trap will reduce wastewater detention time. Almost every grease trap will function for a short time as a solids trap, but the primary purpose of a grease trap is to trap grease. Including a solids separator, to collect food particles, between the sink and the grease trap reduces objectionable odors and should improve trap performance. To encourage frequent solids removal and minimize objectionable odors associated with decaying solids, the solids separator should be relatively small and separate from the grease trap (Wehrenberg, 1993).

Some grease traps contain a separate tray at the bottom of the trap that collects solids. This tray is designed so that it can be easily removed for cleaning.

13.5.2 Flow Control Device

The flow from a sink, or other fixture, to the trap must be regulated by a device so the velocity and quantity of water entering the trap is not greater than its design (Massachusetts, 1997a). Grease traps are not designed to operate at flows greater than their rated capacity.

13.5.3 Baffles or "T" Connections

All traps use a baffle, a series of baffles, or "T" connections to lengthen the flow path, reduce turbulence and create a grease separation/collection chamber (Wehrenberg, 1993).

13.5.4 Air Source and Air Relief Bypass

Separation of grease from water is enhanced by air entering the trap with the wastewater from a constant air source. An air vent line at the flow control device is recommended by several references (Massachusetts, 1997a), (Wehrenberg, 1993).

To prevent a trap from overflowing or siphoning its contents into the sanitary sewer, an air relief bypass (air relief port) and a positive supply of air are necessary. These two systems also regulate the running water flow heights. The air provides a slight cushion of positive pressure over the top surface of the trap. This pressure regulates the running and static water levels in the separation chamber at almost the exact same level. Without this slight pressure, the contents of the separation chamber could rise and actually vent grease from the chamber through the air relief bypass or the trap cover. The individual fixtures or the grease trap itself should be vented to prevent siphoning of sewage into the trap from farther down the system (Wehrenberg, 1993).

13.5.5 Internal Grease Removal Systems

Automated grease traps remove the grease from the trap by scraping the material from a plate, disk, belt, or drum which is passed through the floating layer of grease (See oil skimmers, **Section 9.2.2**).

13.5.6 Ports

A grease trap may have four ports: inspection ports on the inlet and outlet pipes, an access port (for removing grease) and a sampling port on the outlet pipe. For exterior traps, it may be necessary to provide traffic bearing port structures.

13.5.7 Heating Systems

Some automatic and semi-automatic grease traps have heating systems that can be activated to liquefy the trapped grease prior to its removal to a holding reservoir.

13.5.8 Water Cooled Systems

The use of water cooled grease traps is generally prohibited by the Uniform Plumbing Code.

13.5.9 Sensors and Timers

Newer automated grease traps use computer controlled sensors. When grease is sensed at a given percent of its rated grease holding capacity, a grease draw-off cycle is initiated. Older automated grease traps are controlled by a 24-hour timer, which is preset by the manufacturer or set by the customer to remove grease from the system (Wehrenberg, 1993).

13.5.10 Grease Holding Reservoirs

Above-the-floor systems with automatic and semi-automatic grease removal systems may have individual compartments to hold the removed grease.

13.6 GENERAL GREASE TRAP DESIGN INFORMATION

The design of a grease trap is a relatively simple process when compared to other wastewater systems. The only parameter of concern is sizing of the trap based on the design flow contributing to the system. Once that value has been established, manufacturers will provide a trap based on the design flow.

> It is very important to note that the traps provided by the manufacturer should be evaluated/approved by the Plumbing and Drainage Institute, the Universal Plumbing Code, or similar organizations.

The capacity of a grease interceptor is based on two factors: grease retention and design flow rate (Woodson, 1993). The usual minimum grease retention capacity of a trap is two pounds of grease for each gallon per minute of design flow (Massachusetts, 1997b). The local authority may place maximum and minimum approved flow rates on grease traps. The Uniform Plumbing Code does not approve grease traps with flow rates greater than 55 gallons per minute or less than 20 gallons per minute unless approved by the local authority (IAPMO, 1991). The Plumbing and Drainage Institute rates grease traps from 4 to 50 gallons per minute (PDI, 1981).

The volume of a properly designed underground grease trap approximates its calculated 24-hour flow volume. Most small interceptors (above-the-floor) may have a detention time of 10 to 30 minutes (Dowde, Undated).

There are certain requirements that may be placed on the design of a grease trap by health departments, receiving sewage treatment plants, and/or regulatory agencies. Examples of these guidelines and requirements are listed in **Table 13-2**.

Table 13-2 Examples of Grease Trap Guidelines and Requirements

GREASE TRAP CRITERIA AND GUIDELINES	DESCRIPTION
Grease Trap Volume	The volume of a properly designed underground grease trap approximates its calculated 24-hour flow volume (Dowde, Undated).
Multiple Underground Grease Traps	Where an underground trap larger than 1,250 gallons is required, two or more grease traps may be placed in series (DoD, 1997f).
Maximum Number of Fixtures Connected to One Grease Trap	Not more than 4 separate fixtures shall be connected or discharged to any grease trap (IAPMO, 1991).
Approved Flow Rates for Grease Traps	20 to 55 gallons per minute (Unified Plumbing Code) (IAPMO, 1991) 4 to 50 gallons per minute (Plumbing and Drainage Institute) (Massachusetts, 1996).
Minimum Volume of Outside Concrete Interceptors	130 gallon liquid capacity (Vancouver, 1997)
Testing and Rating Requirements	Grease traps shall not be installed unless tested, rated, and bear the seal of acceptance of Plumbing and Drainage Institute (PDI), etc. (Massachusetts, 1997b)
Grease Storage Capacity	Installed grease traps shall have a grease retention capacity of not less than two pounds for each gpm of flow (Massachusetts, 1997b).
Flow Rate Controls	Grease traps shall be equipped with devices to control the rate of water flow through the system so that it does not exceed the rated flow capacity.
Food Waste Grinders	The waste from food waste grinders (garbage disposals) shall not discharge to a grease trap (Massachusetts, 1997b).
Water Cooled Interceptors	The use of water cooled grease traps is prohibited (IAMPO, 1991).
Location of grease traps relative to source area.	Traps should be located as near as possible to the source (Massachusetts, 1996).

13.7 SIZING THE GREASE TRAP

> The sections below describe some of the various methods used to size grease traps and should not be used for actual design purposes.
>
> Check the state and local plumbing codes and contact the local government/sewer authority and health department (through the installation environmental office) to determine specific sizing regulations.

There are numerous methods by which the volume (size) of a grease trap may be determined. The locality, sewer authority, the local or state health department(s), various plumbing codes, and/or other regulatory agencies may establish these methods. The sizing variables used by these organizations include: the number of seats in the food service establishment; the number of serving periods; whether or not a commercial dishwasher is present; the sum of the surge flow rates from all plumbing fixtures connected to the trap; the hours of operation; and the number of peak hour meals.

Three methods of determining the size of a grease trap are provided in subsequent sections.

13.7.1 Uniform Plumbing Code

The Uniform Plumbing Code provides the following guidelines for calculating the operational volume of a grease trap (IAPMO, 1991):

Grease Trap Size (operational volume, gallons) = M x F x T x S

where:
M = number of meals served at peak hour
F = waste flow rate

With dishwashing machine	6 gallons
Without dishwashing machine	5 gallons
Single service kitchen	2 gallons
Food waste disposal	1 gallons

T = retention times

Commercial kitchen waste, dishwasher	2.5 hours
Single service kitchen, single serving	1.5 hours

S = storage factor

Fully equipped commercial kitchen, 8 hour operation	1
Fully equipped commercial kitchen, 16 hour operation	2
Fully equipped commercial kitchen, 24 hour operation	3
Single service kitchen	1.5

13.7.2 Plumbing and Drainage Institute

The Plumbing and Drainage Institute (PDI) provides a procedure and example (**Table 13-3**) to establish hydraulic loading to the grease trap based on flows from the contributing fixtures (Wehrenberg, 1993). The calculated hydraulic loading to the grease trap is equivalent to the PDI size, that is, a grease trap with a loading of 10 gallons/minute is also a PDI size of 10 (**Table 13-4**). This table also provides the maximum recommended fixture size contributing to the trap and grease retention capacity.

Table 13-3 Procedure for Sizing a Grease Trap - PDI (Wehrenberg, 1993)

STEP	FORMULA	EXAMPLE
1	Determine volume of fixture by multiplying length x width x depth	A sink 48" long by 24" wide by 12" deep. Volume = 48 x 24 x 12 = 13,824 cubic inches
2	Determine fixture capacity in gallons. 1 gallon = 231 cubic inches	Contents in gallons = 13,824 / 231 = 59.8 gallons
3	Determine actual drainage load. The fixture is normally filled to about 75% of capacity with water. The items being washed displace about 25% of the fixture content, thus actual drainage load = 75% of fixture capacity.	Actual drainage load = 0.75 x 59.8 = 44.9 gallons
4	Determine flow rate and drainage period. In general, good practices dictate a one-minute drainage period, however, where conditions permit, a two-minute drainage period is acceptable. Drainage period is the actual time required to drain the fixture. Flow rate = Actual Drainage Load/Drainage Period	Calculate flow rate for one-minute period: 44.9 / 1 = 44.9 gpm Calculate flow rate for two-minute period: 44.9 / 2 = 22.5 gpm
5	Select the grease trap from **Table 13-4**. Select the trap that corresponds to the calculated flow rate. NOTE: Select next larger size when flow rate falls between two listed sizes.	For one-minute period: 44.9 gpm requires PDI size "50" For two-minute period: 22.5 gpm requires PDI size "25"

Table 13-4 Sizing a Grease Trap - PDI (Wehrenberg, 1993)

	FLOW RATE (gpm) and PDI SIZE SYMBOL	GREASE RETENTION CAPACITY (lbs.)	RECOMMENDED MAXIMUM CAPACITY OF FIXTURES CONNECTED TO TRAP (gallons)
For Small Domestic Use	4	8	10
	7	14	17.5
For Large Domestic, Commercial, And Institutional Use	10	20	25
	15	30	37.5
	20	40	50
	25	50	62.5
	35	70	87.5
	50	100	125

13.7.3 Municipal Regulation

This example of a municipal regulation provides a method for calculating the minimum volume of a grease trap for eat-in and take-out restaurants (Shreveport, 1998).

Minimum Size of Interceptors for an establishment providing eat-in services:

no commercial dishwashers

12-hour or less operation:	seating capacity x 7 gallons
Over 12-hour operation:	seating capacity x 7 gallons x 2

with commercial dishwashers

12-hour or less operation:	seating capacity x 9 gallons
Over 12-hour operation:	seating capacity x 9 gallons x 2

For take-out service use the same equations for eat-in services, substituting peak hour meals served for seating capacity.

13.7.4 Number of Fixtures Connected to a Grease Trap

Some codes and regulations limit the number of fixtures that can be connected to a grease trap. For example, the Uniform Plumbing Code, (IAPMO, 1991) states that not more than 4 separate fixtures shall be connected or discharged to any one grease trap. "Fixture" is defined as each plumbing fixture, appliance, apparatus or other equipment required to be connected or discharge to a grease trap. Examples of fixtures that may be connected to a grease trap and anticipated flows are listed in **Table 13-5**. The values used in **Table 13-5** should not be used for design purposes. The estimated design flow rate for the number of connected fixtures is listed in **Table 13-6**.

Table 13-5 Examples of Fixtures and Estimated Flow Rates (Vancouver, 1997)

FIXTURE	SURGE FLOW RATE (GALLONS/MINUTE)
Hand Sink	7.5
Restaurant Kitchen Sink	15
Single Compartment Scullery Sink	20
Double Compartment Scullery Sink	25
Triple Compartment Sink	30
Two Single Compartment Sink	25
Two Double Compartment Sink	30
Floor Drain	5

Table 13-6 Grease Trap Information - Uniform Plumbing Code (IAPMO, 1991)

TOTAL NUMBER OF FIXTURES CONNECTED	REQUIRED RATE OF FLOW, GALLONS/MINUTE	GREASE RETENTION CAPACITY, POUNDS
1	20	40
2	25	50
3	35	70
4	50	100

13.7.5 Example of Manufacturer's Guidelines

Table 13-7 lists the operational volume, recommended flow rate and grease storage capacity for a prefabricated grease trap.

Table 13-7 Grease Trap Sizing - Manufacturer's Guidelines (Thermaco, 1996)

GREASE INTERCEPTOR SIZE (GALLONS)	GREASE RETENTION (POUNDS)	MANUFACTURER'S RECOMMENDED FLOW RATE (GALLONS/MINUTE)
750	2,004	21
1,000	2,600	28
1,500	3,900	35
2,000	4,790	35
2,500	7,420	43

13.8 CATEGORIES OF GREASE TRAPS

All grease traps discussed in this document work on the principle of gravity separation. These grease traps are categorized by the method of grease removal and by location.

13.8.1 Grease Removal Method

Generally, there are three types of grease traps based on grease removal method: manual, semi-automatic, and automatic.

13.8.1.1 Manual

Manual grease traps, which are the most common type, do not have a built-in method to remove grease. The cleaning of manual systems **(Section 13.11.5)** can involve mechanical (scraping, ladling, etc.), chemical, and/or biological (bioaugmentation) methods.

13.8.1.2 Semi-automatic

In a semi-automatic trap, which requires an above-the-floor installation, the grease accumulates and may be discharged into a separate container through a special valved connection (Harris, 1991). The semi-automatic trap may have a draw-off spigot to remove grease in the form of a hot liquid (Massachusetts, 1996).

13.8.1.3 Automatic

Automatic traps remove grease continuously from the effluent. This type of trap is generally practical only where very large quantities of grease are discharged, such as in the food processing industry (Harris, 1991). These automatic systems (grease recovery devices) remove the grease by scraping the material from a plate, disk, belt, or drum, which is passed through the floating layer of grease. The removed grease then flows into a small chamber or reservoir for holding and subsequent recycling/disposal. A 24-hour timer generally controls these systems. If the timer is not accurately set, the system could remove only water (no grease being discharged to the trap) or not remove grease (the removal system is in scheduled shutdown when grease is released to the trap) (Wehrenberg, 1993).

Newer grease recovery devices (fully automated systems) have been developed which use computer controlled sensors. When grease is sensed at a level of 40% of its rated capacity, a grease draw-off cycle is initiated. If necessary, the cycle starts with actuation of a heating system to liquefy the trapped grease, which is then removed to a reservoir following activation of the draw-off valve. Since grease is removed from the chamber surface, little water should be present in the waste grease reservoir. These newer systems have alarms denoting full reservoirs or blockage. Influent flows will be cut off until the sensed problems are corrected (Wehrenberg, 1993).

13.8.2 Grease Trap Location

Grease traps can be placed either underground or above-the-floor depending on the space available and local requirements.

13.8.2.1 Underground Systems

Under the floor or underground grease traps are watertight concrete tanks with inlet and outlet piping. They may be precast or custom designed. Generally, they are larger than the under-sink models, ranging in capacity from 750 to 1,250 gallons (DoD, 1997f). Health codes or municipal ordinances may require underground grease traps be located outside. Due to smell, safety, and sanitary considerations, food preparation staff often objects to grease traps that have a cleanout cover located in the kitchen area.

Large capacity underground traps have larger grease retention capability, but may have less separating efficiency, than an under-sink trap, because grease is more effectively removed near the source. Cooling grease may gel and attract, or be attracted to solids, which begins to form a globule that has a specific gravity approaching or even exceeding that of water. When this happens, the grease is no longer easily separated (Wehrenberg, 1993).

Underground grease traps generally require less frequent maintenance than under-sink models due to their greater capacity. Grease accumulated in an underground grease trap may not be as easily recycled/disposed, due to its water content (Thermaco, 1998).

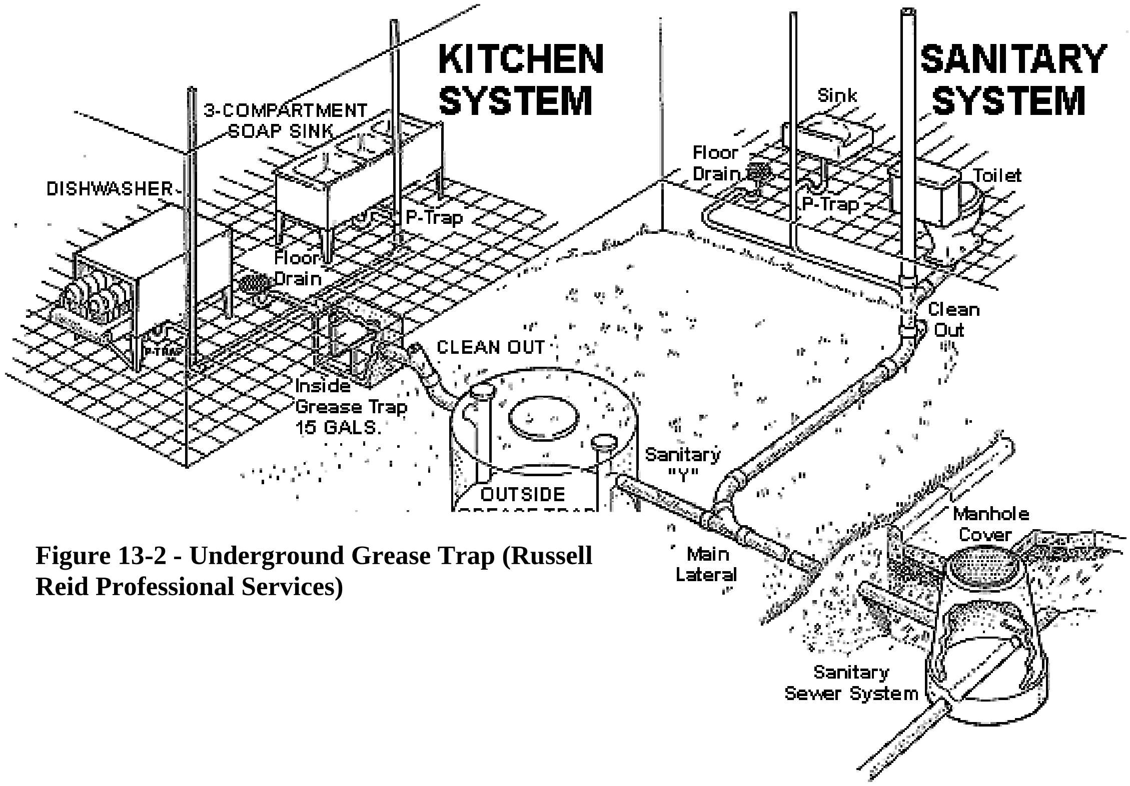


Figure 13-2 - Underground Grease Trap (Russell Reid Professional Services)

13.8.2.2 Above-the-Floor Systems

Above-the-floor (under-sink) systems are small, grease traps that are located in the kitchen food preparation areas near the drains. If under-sink traps are used, generally they are connected to only one drain. This type of trap requires frequent maintenance and often does not provide adequate grease removal (Reid, 1996). New innovations are improving the success of under-sink models. Recent developments include an automatic grease/oils removal system with an automatic solids transfer design that can handle flows with high levels of solids while reportedly providing up to 98.6% grease separation efficiency (WEF, 1997). Alarm probes and lights, and automatic grease transfer pumps are options that can aid in proper maintenance and operation.

Under-sink traps may be installed to augment inadequately sized existing underground traps; thereby, avoiding replacement. They can reduce or eliminate grease trap pumping costs and local sewer surcharges. They can also be installed where limited space prevents installing a larger, underground, concrete trap. Another advantage of an under-sink automatic transfer model is that the grease trapped can be collected for recycling by a rendering company.

Table 13-8 Advantages/Disadvantages of Grease Trap Locations

	ADVANTAGES	DISADVANTAGES
Underground Traps	• Larger capacity • Less frequent maintenance • Not in food preparation area • Exterior installation allows for easy inspection • Exterior trap may be required by the local authority	• Require more space • Not visible (easily ignored) • Recovered grease may not be recyclable • Extraneous wastewater lines may discharge to the trap.
Above-the-Floor Traps	• Require less space • Easily accessible • Grease recyclable • Eliminate grease trap pumpout charges • May be used to pretreat wastewater prior to an underground trap	• Smaller capacity • In food preparation area • More frequent maintenance • Exterior trap may be required by local authority

Table 13-9 Type and Cost of Grease Traps (Massachusetts, 1996)

TRAP TYPE	COMMENTS	ESTIMATED COST (10/96) * @ 35 gallons/minute capacity
PASSIVE OR MANUAL TRAP		
Passive or Manual Trap (Small Engineered Traps)	Most commonly used. Most basic design. Passive in their action and must be emptied frequently. Generally ineffective mainly due to lack of cleaning/maintenance.	$4,000
Exterior Underground or Large Capacity Traps	Not technically a grease trap but a holding tank. Substantial operating cost (regular pump-out). Usually 1,000-gallon capacity.	$20,000 - $30,000 (Operating cost - $3,000 to $4,000 per year)
GREASE RECOVERY DEVICES (GRD)	Solids must be removed from strainer at least daily.	
Semi-automatic Trap	Not in common use. Has a draw-off spigot to remove grease in the form of a hot liquid.	$4,500
Automatic Trap	A timer set by the user must be set in accordance with restaurant sink use, to control duration of operation.	< $13,500
Fully Automated Trap	Not comparable to a passive or semi-automatic trap. Electronically controlled. Includes solids separators and grease storage reservoirs. Monitors its own functions.	$13,500

* Does not include installation cost

13.9 SOURCES THAT SHOULD NOT BE DISCHARGED TO GREASE TRAPS

It has been suggested that certain operations should not discharge to a grease trap. The reasons for the prohibitions are that the discharges may adversely affect the removal efficiency of the grease trap (heat, solids or emulsifiers), reduce the hydraulic capacity (cooling water/clean condensate), or will affect the reuse of the collected grease (sewage).

13.9.1 Garbage Disposal/Grinders, Produce Preparation Sinks, or Other High Solids Wastewaters

Waste from garbage disposals or grinders should not be allowed to enter the grease trap because the high solids content will fill the trap and render it useless until properly cleaned (DoD, 1997f). As food scraps decay, they release organic acids (Usually the pH of the water in a neglected grease trap is about 4 standard units). Anoxic or septic conditions develop as bacteria metabolize the organic materials in the waste. Very offensive orders accompany the septic conditions (Dowde, Undated).

As well as increasing the grease and solids in the wastewater, disposal of food waste via the sanitary sewer system is more costly than landfill disposal (North Carolina, 1998).

> Unless specifically required by the agency controlling the discharge or installation of the system, no food waste disposal unit should be connected to or discharged into a grease trap (IAPMO, 1991).

Some references feel that not treating the discharge from garbage disposals is a mistake, in that the wastewater from this major source of fats, oils and grease will be released unabated and may cause future blockage of sewer lines. The references are aware of the solids problem with garbage disposals and suggest the installation of a solids trap prior to the grease trap.

13.9.2 Dishwashers

Dishwashers are another source of wastewater that can interfere with the function of grease traps, especially if the trap is placed close to the dishwasher. Hot water and high detergent content in the dishwasher wastewater can emulsify a high percentage of the separated grease in the trap and wash it further down the sewer system (Thermaco, 1997). Some local authorities do not allow dishwashers to be connected to grease traps (Vancouver, 1997).

Other references feel that dishwasher discharges should be treated, but only by a grease trap solely dedicated to this one source.

13.9.3 Sanitary Waste/Sewage

Grease traps should be installed such that no sanitary wastewater (toilets, urinals, and other similar fixtures) enters the trap (IAPMO, 1991). Grease traps should be installed in the waste line leading from sinks, drains, and other fixtures or equipment prior to joining the sanitary sewer.

13.9.4 Hot Water

It is suggested that a grease trap should never be "hot flushed" (running hot water continuously through the trap) (North Carolina, 1998). Elevated temperature wastewaters may undergo less effective treatment by the trap (DoD, 1997f), as the solubility of grease may be increased, thereby allowing pass-through.

13.9.5 Cooling Water/Clean Condensate

Cooling water and clean condensate water should not be connected to the kitchen wastewater system because potential high volume flows could hydraulically overload the grease trap, and treatment of these wastewaters by the grease trap is not necessary (Vancouver, 1997).

> Check with the agency controlling the discharge or installation of the system for regulations concerning drains required to be connected to a grease trap and drains banned from being connected to a grease trap (e.g., dishwashers, garbage grinders).

13.10 POLLUTION PREVENTION

Reducing grease and solids entering the grease trap increases the time interval between necessary maintenance of the trap. This results in time and money savings. Also, it prevents the grease trap from becoming overloaded and ceasing to function properly. The amount of grease entering kitchen wastewater can be greatly reduced by implementing the following good housekeeping measures:

13.10.1 Collect Free Grease

Collect free grease that is used for or generated by cooking and has not been mixed with water. It should not be poured down the drain. Free grease is generated from pots, pans, grills, and deep fat fryers and comes from butter, lard, vegetable fats and oils, meats, nuts, and cereals and may be sold to rendering companies for recycling (North Carolina, 1998).

13.10.2 Pre-clean Equipment

Pre-clean equipment and utensils with scrapers, squeegees, or absorbents prior to washing or rinsing to prevent food materials from going down the drain. Waste collected from this initial cleaning may be set aside for rendering, composting or disposing of in the garbage (North Carolina, 1998).

13.10.3 Dry Clean-up

Use dry methods to clean spills. If possible, food spills should cleaned by sweeping or using a dry vacuum. Avoid flushing spilled food down floor drains.

13.11 OPERATION, MAINTENANCE, AND INSPECTION

Grease traps must be maintained to operate properly. The primary function involved in grease trap maintenance is removing the collected grease and solids. If the system is not adequately maintained, odors will develop (from the decay of organic material) and grease will be discharged from the trap, which may plug downstream sewers.

> It is estimated that 25% of all grease traps are installed backwards (NRPC, Undated-a).

13.11.1 Properly Maintained Grease Trap

A properly maintained grease trap will have a small grease mat that is a fraction of an inch to three inches thick (NRPC, Undated-b). The grease cap is composed primarily of lipids (triglycerides and free fatty acids) (Kallestad, 1997). Below this mat is the gray or clear water which will comprise the major volume of the trap. The downstream sewer should not clog from grease since the gray water contains a very minimal amount of grease. On the bottom is the sludge layer of food particles and other organic materials. This layer should not be more than a few inches thick (NRPC, Undated-b).

13.11.2 Improperly Maintained Grease Trap

Symptoms of an improperly maintained trap are a large grease mat and sludge layer. Between these layers is a slurry mixture of fats, oils, greases, suspended solids, and water. This slurry, when discharged, leaves deposits of grease, resulting in backups. The most noticeable symptoms of an overloaded trap are odors (NRPC, Undated-b). The pH of the water in a neglected grease trap could reach 4 standard units, due to release of organic acids from decaying food scraps (Dowde, Undated).

In the past, a solidified grease cake blocking the flow was a good indicator that cleaning was needed. Currently, that condition may not occur, because today's diets have less animal fats and more vegetable oils, which do not solidify at room temperature (Wehrenberg, 1993).

13.11.3 Types of Waste Grease

"Free" grease is used for, or generated by, cooking and has not been mixed with water **(Section 13.10.1)**. Rendering facilities may provide storage and collection services and purchase the "free" grease (North Carolina, 1998). "Trap" grease is collected in a grease trap. Rendering services and septic haulers will pump out the traps for a fee.

13.11.4 Inspection and Cleaning Frequency

A grease trap has one function; to trap grease. Thus when a trap is working correctly it must be cleaned or pumped out frequently. Servicing frequency is site specific and dependent on the amount of oil and grease and suspended solids generated at each operation. Underground grease traps generally require less frequent maintenance than under-sink models due to their greater capacity (Thermaco, 1998).

> If an underground grease trap has to be cleaned more than twice per month, a larger grease trap should be considered (Kennewick, 1998).

Grease and accumulated wastes should be removed as often as necessary to maintain at least 50% of the grease retention capacity. Some automated systems remove the collected grease at 40% of the rated storage capacity (DoD, 1997f).

> Make sure that grease removal takes place before the capacity of the trap has been exceeded.

Table 13-10 Examples of Suggested Inspection and Cleaning Frequencies

TYPE OF SEPARATOR	INSPECTION FREQUENCY	CLEANING FREQUENCY
Above-the-Floor		
(automatic)		**Criteria:** Maintain 50 to 60% of grease retention capacity (DoD, 1997f)
	N/A	1 to 2 times/day (Massachusetts,1997a) or once/shift (Wehrenberg, 1993)
Solids Strainer (automatic system)	N/A	1 to 2 times/day (Massachusetts, 1997a)
Underground (to sanitary sewer)		**Criteria:** Maintain at least 50% of the grease retention capacity (DoD, 1997f)
	Once/week (Vancouver, 1997)	Every two weeks (Kennewick, 1998) to every three months (Vancouver, 1997). Maximum time between cleaning: Six months (Kennewick, 1998)
Underground (to septic system) (Massachusetts, 1997b)		**Criteria:** Level of grease is 25% of the effective depth of the trap.
	Once/month	Maximum time between cleaning: Three months

13.11.5 Manual Grease Removal

Manual grease traps, which are the most common type, must have the grease removed by hand. The cleaning of manual systems can involve mechanical, chemical, and/or biological methods.

> It is recommended that the waste be mechanically removed rather than dissolved with chemical treatments (DoD, 1997f).

13.11.5.1 Mechanical Cleaning

Mechanical methods of removing grease, such as pumping and routing the traps, is a common practice, but may be inconvenient, messy, smelly, and expensive. During the mechanical cleaning of an underground trap, the grease cap is removed, the sides are scraped or hosed down to remove and collect the grease, and the trap is refilled with water (North Carolina, 1998). In cleaning a small aboveground grease trap: dip the accumulated grease out of the interceptor; bail out any water to facilitate cleaning; scrape the sides and lid; and remove and deposit the grease in a water-tight container for disposal or recycling (Kennewick, 1998).

13.11.5.2 Chemical Cleaning

Chemical treatments generally liquefy the grease through heat (generated by the addition of acids or caustics) or emulsification (addition of solvents) (NRPC, Undated-b). The liquefied grease may solidify downstream in the effluent line or a lift station. The speed at which the grease returns to the hydrophobic state is affected by a variety of factors, including a drop in temperature of the effluent.

> The use of chemical treatment generally transports the grease further into the sewer system where it will tend to plug pipes by deposition or forming aggregates (Wehrenberg, 1993).

13.11.5.3 Bioaugmentation

Enzyme/bacteria products are the most common treatments available. This technology began in the early 1970's and is available in liquids, gels, dry powders or blocks. These products consist of cultured bacteria that produce an enzyme to liquefy the grease (NRPC, Undated-a). Cultures are ready for application after soaking for 8-10 hours in 80^o to 100^o F water (Kallestad, 1997). The cultured bacteria most aggressively attack starches and proteins, which bond the grease together. Some bacteria will partially digest the grease into fatty acids and glycerin. Apparently, no bacteria will completely break grease down (NRPC, Undated-a).

The effectiveness of bioaugmentation is determined by detention time in the trap, temperature and strength of the wastewater, and contact surface area. It has been inferred that for completely effective bioaugmentation, a detention time of 1 to 5 days is needed; however, a typical grease trap is designed for a detention time of one day (North Carolina, 1998). Ideal pH and temperature conditions for bioaugmentation are 7 S.U. and 80^o F, respectively (Kallestad, 1997). Actual conditions in the trap may vary with a pH range of 5 to 9 S.U. and a temperature range of 41 to 120^o F. These bacteria may also be rendered ineffective by the presence of soaps and sanitizers (NRPC, Undated-b).

Some additional problems associated with cultured bacteria are: they have a short shelf-life and may be less resistant, than natural bacteria, to temperature variation, disinfectants, sanitizers and soaps.

In lieu of cultured bacteria, there are bacteria growth enhancers, which are plant material that contain cell growth regulators. According to the manufacturer, they stimulate the naturally occurring bacteria to their maximum metabolic rate for breaking down the grease (NRPC, Undated-b).

> Do not rely only on drain cleaners, enzymes or bacteria agents. They may merely soften the grease and transfer the problem downstream. Even when used properly they may only convert grease into other types of wastes to be treated (Kennewick, 1998).

13.11.6 Semi-automatic and Automatic Grease Removal

Some grease traps are designed to periodically heat the trap to de-solidify grease, so that it can be automatically skimmed and collected. Other automatic systems remove and collect the grease by scraping the material from a plate, disk, belt, or drum which is passed through the floating layer of grease. These systems may be controlled by a 24-hour timer or computer-based sensors.

13.12 DISPOSAL/REUSE OF GREASE

The reuse and disposal options for waste grease are fairly limited. The primary means of addressing waste grease are described below:

13.12.1 Rendering/Recycling

Recovered oil and grease may be sold to a local rendering company, or reclaimed by a recycler. Most codes which are being proposed or in effect require waste grease, which is to be recycled, to be 95% water free (Wehrenberg, 1993). Free grease (never mixed with water) and grease recovered from automatic and semi-automatic removal systems are generally amenable to rendering/recycling.

13.12.2 Landfill/Land Application

Grease collected removed from the trap may be disposed of in an approved landfill. If a contractor is used, a letter should be provided listing the proposed landfill, including the permit number. The contractor should also provide a copy of each disposal record. The same information should be supplied if the material is land applied. The grease removed from an underground trap would be more likely to be landfilled or land applied.

13.12.3 Biological Treatment

One military installation collects grease trap wastes and treats the material biologically using an independent extended aeration system and “designer bugs.” The grease and water removed from an underground trap would be more likely to be biologically treated.

13.13 CLOSURE OF A GREASE TRAP

A grease trap may undergo closure if the building mission is changed, that is, the wastewater sources treated by the system are eliminated, or if the existing system is replaced. The Uniform Plumbing Code requires that abandoned grease traps be pumped and filled with an inert material in accordance with procedures outlined in Section 1119 of the code (IAPMO, 1991).

> There are no federal regulations on grease trap closure.

The state or local health department, environmental regulatory agencies, or applicable building codes may regulate closure of a grease trap **(Section 12.5)**.

> **NOTE**: Contact with state or local regulators should be coordinated through the installation environmental office.

Appendix A
ABBREVIATIONS AND ACRONYMS

AEC	Army Environmental Center
AFFF	Aqueous Film Forming Foam
AFI	Air Force Instruction
AFPD	Air Force Policy Directive
API	American Petroleum Institute
AR	Army Regulation
ASH	Air-Sparged Hydrocyclone
AST	Aboveground Storage Tank
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BOWTS	Bilge and Oily Wastewater Treatment System
BRAC	Base Realignment and Closure
BTEX	Benzene, Toluene, Ethyl-Benzene, and Xylene
CARC	Chemical Agent Resistant Coating
CFR	Code of Federal Register
COD	Chemical Oxygen Demand
COE	Corps of Engineers
CPI	Corrugated Plate Interceptor
CVWF	Central Vehicle Wash Facility
CWA	Clean Water Act
DAF	Dissolved Air Flotation
DLA	Defense Logistic Agency
DoD	Department of Defense
DRMO	Defense Reutilization and Marketing Office
EBS	Environmental Baseline Study
EPA	US Environmental Protection Agency
ETL	Engineering Technical Letter
FFCA	Federal Facility Compliance Act
FID	Flame Ionization Detector
FOG	Fats, Oils, and Greases
FOTW	Federally Owned Treatment Works
FRP	Fiberglass Reinforced Plastic
GIS	Global Information System
GPS	Global Positioning System
GRD	Grease Recovery Device
HPHW	High Pressure, Hot Water
LET	Load Equalization Tank
LPCW	Low Pressure, Cold Water
LUFT	Leaking Underground Fuel Tank
MBAS	Methylene Blue Active Substance
MIL-HDBK	Military Handbook
MIL SPEC	Military Specification
N/A	Not Applicable
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
O&G	Oil and Grease

Appendix A
ABBREVIATIONS AND ACRONYMS

O&M	Operation and Maintenance
OPA	Oil Pollution Act of 1990
OSHA	Occupational Safety and Health Administration
P2	Pollution Prevention
PAH	Polyaromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PDI	Plumbing and Drainage Institute
PID	Photoionization Detector
POL	Petroleum, Oil, and Lubricants
POTW	Publicly Owned Treatment Works
PPA	Pollution Prevention Act of 1990
PPC	Parallel Plate Coalescer
PPI	Parallel Plate Interceptor
QA/QC	Quality Assurance/Quality Control
QPL	Qualified Products List
RC	Reinforced Concrete
RCRA	Resource Conservation and Recovery Act
REC	Regional Environmental Coordinator
SCAQMD	South Coast Air Quality Management District
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	Spill Prevention Control and Countermeasures
SPDES	State Pollutant Discharge Elimination System
SWDA	Solid Waste Disposal Act
SWMU	Solid Waste Management Unit
TCLP	Toxicity Characteristic Leachate Procedure
TPH	Total Petroleum Hydrocarbons
TSDF	Treatment, Storage or Disposal Facility
TSS	Total Suspended Solids
UIC	Underground Injection Control
USACE	U.S. Army Corps of Engineers
USACERL	U.S. Army Construction Engineering Research Laboratories
UST	Underground Storage Tank
VSS	Volatile Suspended Solids
WQI	Water Quality Inlet

Units of Measure

C	Centigrade
cm	Centimeter
fpm	Feet Per Minute
F	Fahrenheit
ft	Feet
gpm	Gallons Per Minute
kg	Kilogram
L	Liter
mg	Milligram
ppm	Parts Per Million
ppm	Parts Per Million
psi	Pounds Per Square Inch
S.U.	Standard Units
u	Micron

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