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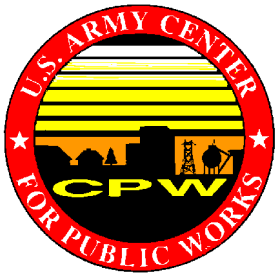
OIL/WATER SEPARATOR SELECTION, INSTALLATION, AND MAINTENANCE: LESSONS LEARNED



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DEPARTMENT OF THE ARMY
U.S. Army Center for Public Works
7701 Telegraph Road
Alexandria, VA 22315-3862

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OIL/WATER SEPARATOR SELECTION, INSTALLATION, AND MAINTENANCE: LESSONS LEARNED

1. Purpose. The purpose of this Public Works Technical Bulletin (PWTB) is to transmit lessons learned on problems identified when installing and maintaining oil/water separators.

2. Applicability. This PWTB applies to all U.S. Army facilities engineering/public works and environmental activities.

3. References.

a. AR 200-1, Environmental Protection and Enhancement, 21 February 1997.

b. American Petroleum Institute, Publication 421, Monographs on Refinery Environmental Control - Management of Water Discharges, Design and Operation of Oil-Water Separators, February 1990.

4. Discussion.

a. The military is one of the largest purchasers of oil/water separators in the United States. An analysis of Environmental Programs Review Reports (A106) for the years 1995 and 1996 indicate that, not only is the Army spending large amounts of money on separators, but the amount is increasing each year. The U.S. Army currently owns and operates thousands of oil/water separators. A typical installation may have more than 150.

b. Installation personnel often assume that simply installing a separator solves all compliance problems. Consequently, separators are often installed with little preliminary investigation and are then forgotten. Improper equipment selection and lack of monitoring causes many problems, to the point where many separators do not work. This PWTB discusses problems common throughout the Army and steps to solve those problems.

c. Lessons learned regarding installation and maintenance of oil/water separators are:

(1) Separators should be designed for convenient access to ease maintenance and must be well maintained.

(2) Installation personnel should specify separator equipment to treat the most complex waste stream common to the target installation.

(3) Large quantities of extraneous flow (such as stormwater) should be diverted from separators to avoid adverse effects on separators and associated wastewater treatment plants.

(4) Army installations should not rely on manufacturer's literature or claims to determine performance.

(5) Installations should not rely on gravity separators to remove emulsified oils.

d. Appendix A includes more detailed information on the installation and maintenance of oil/water separators.

5. Points of Contact. Questions and/or comments regarding this subject that cannot be resolved at the installation level should be directed to:

Directorate of Engineering
ATTN: CECPW-ES/Mr. Malcolm McLeod
7701 Telegraph Road
Alexandria, VA 22315-3862
Telephone: (703) 806-5196; DSN: 656-5196
e-mail: malcolm.e.mcleod@cpw01.usace.army.mil

or

U.S. Army Construction Engineering Research Laboratories
ATTN: CECER-UL-T/Ms. Michelle Hanson
PO Box 9005
Champaign, IL 61826-9005
Toll-Free: 1-800-USACERL, ext. 3389
e-mail: m-hanson@cecer.army.mil

FOR THE DIRECTOR:

Frank J. Schmid, P.E.
Director of Engineering

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APPENDIX A
Oil/Water Separator Selection, Installation,
and Maintenance: Lessons Learned

1. Background

a. Oil/water separators are devices used to treat mixtures of oil and water prior to discharge to either a storm, sanitary, or industrial sewer. Most separators operate utilizing the specific gravity differential between oil and water. (Other types of separators are beyond the scope of this document.) Oil is essentially "lighter" than water; therefore, given enough time and under quiescent conditions, an oil and water mixture will separate into two fractions, an oil layer floating on a layer of water. This allows oil to be removed and water to pass through the separator and enter the sewer system. Separator manufacturers include:

(1) ENCO Pollution Control, 324-T S. Main, Suite 607, Tulsa, OK 74103, Tel.: (918) 585-9991, FAX: (918) 585-9667.

(2) Highland Tank & Mfg. Co., 99 W. Elizabethtown Rd., Manheim, PA 17545-9410, Tel.: (717) 665-6877, FAX: (717) 665-2790.

(3) Monarch Separators, Inc., 5410-T Trafalgar Dr., Houston, TX 77046, Tel.: (713) 433-7441, FAX: (713) 433-9105.

(4) Purification Industries, Inc., PO Box 26346, Shawnee Mission, KS, 66225-6346, Tel.: (913) 764-1763, FAX: (913) 764-2851.

b. The most common sources of wastewater requiring treatment for oil or grease separation are associated with vehicle maintenance activities. Within a motorpool or aircraft hangar, there are numerous areas that produce wastewaters that will require treatment. Typical areas include, but are not

limited to: washracks; maintenance bays; fueling areas; and, POL storage areas.

c. The military is one of the largest purchasers of oil/water separators in the United States. The number of separators currently owned and operated by the U.S. Army is over 5000. A typical installation, such as Fort Carson, has in excess of 150 oil-water separators. In the Spring of 1995, 6000 submissions of A106 software ("Environmental Program Requirements") related to Clean Water Act compliance; of these, over 1000 concerned the installation, upgrade, and/or repair of oil/water separators, totaling over $150 million in funding. It is apparent through the A106 submission data that many of these separators are not performing as anticipated. Inadequacies have often resulted from poor design, improper selection of pre-manufactured, off-the-shelf units, failure to adequately understand the character of waste-waters being treated or pretreated, and lack of maintenance.

d. Wastewater pretreatment is now a focus of Federal and state regulations. The Army's program to privatize wastewater collection and treatment systems will intensify the impact those regulations will have on Army installations. When a Federally Owned Treatment Works (FOTW) receives wastewater, the Army is primarily concerned with meeting National Pollution Discharge Elimination System (NPDES) discharge limits for one discharge location. If a wastewater system is privatized, the installation may be required to meet pretreatment discharge limits at dozens of locations. The performance of Army oil/water separators will then become critical to maintaining regulatory compliance.

e. Much work is needed to solve the problems associated with oil/water separators at DOD facilities. However, due to the huge number of separators the Army owns, the wide variety of separator types, and the differing waste streams found on Army installations, it is difficult to address every separator problem found within the Army. As a first step toward resolving this issue, installations need to be informed of problems incurred at other installations. This PWTB includes scenarios of the most common problems found at various Army and Army Reserve installations. The following lessons learned relate to installing and maintaining oil/water separators.

2. Separators Should Be Designed for Convenient Access To Ease Maintenance and Must Be Well Maintained.

a. The widespread failure of oil/water separators in the military is frequently the result of improper or inadequate maintenance. Personnel at one installation reported that approximately 80 percent of the problems they currently experience with oil/water separators stem from poor maintenance. Often separator systems are not designed or installed to provide convenient access for maintenance. Many separator designs have only manhole access, and some are installed completely below paved surfaces with small access ports. These factors make timely and effective maintenance impossible. Further complicating this problem are reductions in the installation personnel staffs responsible for maintaining pretreatment devices.

b. Maintenance Impacts Performance.

(1) The Directorate of Public Works (DPW) provides routine maintenance at installation motorpool facilities, including maintenance of oil/water separators. As DPW resources decrease, routine maintenance becomes a low priority and is often ignored. Separators sit for long periods without being cleaned. New separators are installed and then forgotten. Separators are cleaned only when they overflow or otherwise become an obvious problem. At some installations, particularly large ones, there may be separators of which the DPW personnel are not aware.

(2) When separators go unchecked for long periods of time, sediment and oil begin to accumulate. Sediment accumulation decreases the area within the separator that is used to detain the wastewater. This reduces detention time that allows the oil and water to separate, and results in oil passing through the separator and entering the sewer system. Also, oil that is allowed to accumulate in the separation chamber can be flushed

from the separator with surges in flow. When either of these conditions occur, the separator is rendered useless, becoming nothing more than a "wide spot" in the pipe.

(3) To combat these problems, installations need to develop pretreatment programs to ensure that all devices are receiving proper maintenance. To develop this program, DPW staffs should check facility maps and blueprints, purchase records, etc., and ensure that the locations of all of their separators are known. Once this is complete, they should set up a maintenance schedule for each separator based on use, flow rate, and solids loading, assuring that all effluent requirements are being met at all times. One installation in the southeast set up a maintenance program that includes cleaning all separators and grit traps once a month, whether they need it or not. While not as "scientific" as using flow rates and solids loading, this system works for this installation. Installations can also generate contracts for separator maintenance with outside personnel based on an established schedule. A protocol for setting up a management program for oil/water separators is currently being prepared by the U.S. Army Construction Engineering Research Laboratories (USACERL) for the Army Environmental Center (AEC). This guidance should be available to installations in late 1997.

(4) Note: At one installation observed in this study, maintenance of separators is a requirement in the installation's NPDES permit. Failure to perform clean-outs and other maintenance results in a Notice of Violation.

c. Design Impacts Maintenance.

(1) The most common complaint about pre-fabricated separators is that they are not designed so that they can be easily maintained. Many separators are installed either below grade with only manhole access or with a cover that is heavy, secured by many bolts, or is otherwise difficult to remove. Figure A1 shows a common type of prefabricated separator. The manhole provides limited access and makes visual inspection and cleaning of the various sections of the separator quite difficult.

(2) Some examples that show how these design problems can occur at installations follow.

(a) An installation in the southern United States installed new pre-fabricated separators at several washracks.

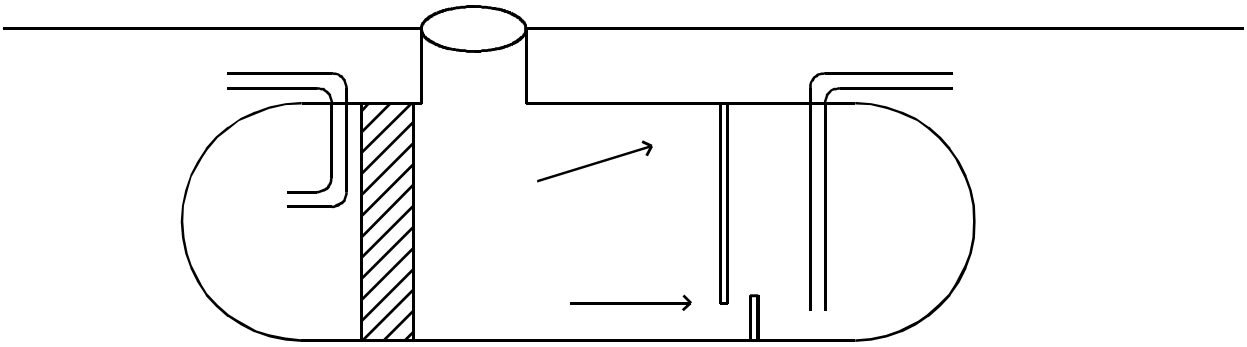


Figure A1. Common type of prefabricated separator.

These separators were below grade with access only through a small manhole, the lid of which was secured by approximately 30 bolts. According to installation personnel, in the three years since the separators had been installed, the covers had not been removed. Obviously, these separators are not being inspected. Note that human entry into the separator may require a Confined space permit. If so, the logistics of coordination with the Safety Office and the Fire Department must be considered when defining the costs and scheduling of inspection and maintenance activities.

(b) An installation in the southwestern United States has an oil/water separator with a large, thick concrete lid. Personnel must use a bobcat type vehicle to remove the cover. This makes maintenance extremely difficult. Further complicating the problem is the fact that the actual opening to the separator is quite small. When performing inspections, personnel must enter the separator. For safety, air must be pumped in during this process, or a Self Contained Breathing Apparatus (SCBA) must be used.

(c) An installation in the southern United States installed a cast-in-place separator at a large storage area. The separator has a large grated cover that allows personnel to easily inspect most sections of the separator. However, the cover is so heavy that it cannot be removed without a forklift or other heavy equipment. Guard rails also surround the separator, presumably to keep personnel from driving over it or storing items on top. These guard rails prevent heavy equipment from getting too close, making removal of the cover difficult.

(3) To ensure that maintenance is as easy as possible, avoid installing separators that are below grade with only manhole access. Ideal separators are installed at or above grade and are open to the atmosphere. If a cover is required, it should be completely removable by one person without the use of special equipment; it should be installed in sections if necessary. Covers should open such that users have complete access to each section of the separator (figure A2). This will allow for easy visual inspection, cleaning, and maintenance. If plate packs are required, they should be completely removable for cleaning.

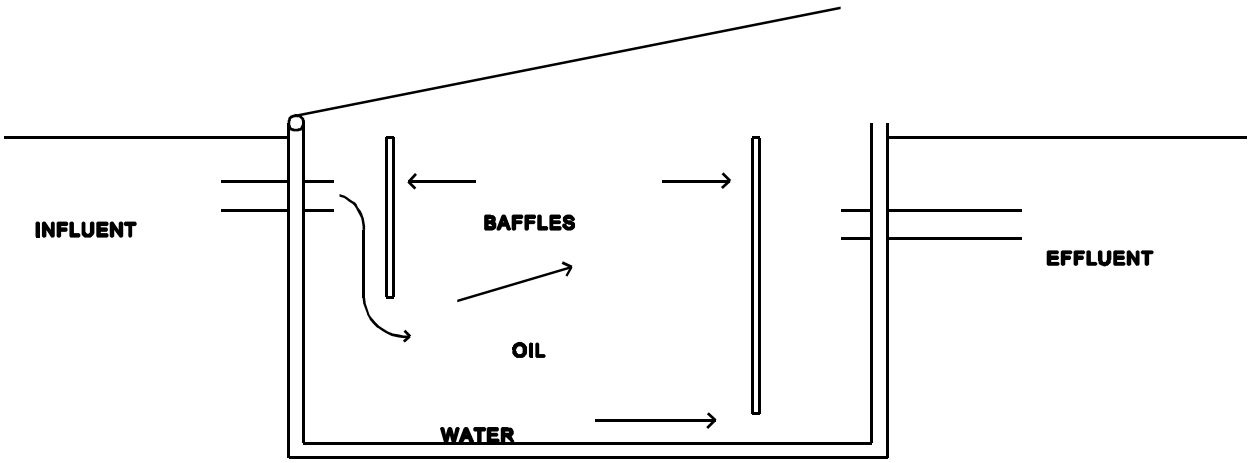


Figure A2. Open cover that allows complete access to separator.

3. Installations Personnel Should Specify Separator Equipment To Treat the Most Complex Waste Stream Common to the Target Installation.

a. The most common military applications seldom involve simple oil and water mixtures. Waste streams frequently contain significant quantities of dirt, cleaning aids, fuels, and debris. Waste streams will also differ at various unit types. Influent to a separator at an armored motorpool washrack will be quite different from that at a troop support maintenance shop, which will be different from an application at a reserve center organizational maintenance shop (OMS). Some influents will exhibit high solids levels and low levels of oil, while others will display the opposite. Therefore, treatment for these differing waste streams will vary. Pretreatment equipment selection should be based on performance criteria (i.e., the selected separator should treat a specifically characterized waste and produce a specific quality discharge). Most military waste streams are not simple oil and water mixtures.

b. An installation in the Southwest illustrates multiple variables influencing the complexity of treatment equipment selection. Most of the separators at this installation are used exclusively for treating waste streams from various tactical vehicle operations. They are open, cast-in-place, gravity separators with grit chambers. There is a large problem with the buildup of sediment in the grit chambers of the separators, often requiring cleaning on a daily basis. These chambers are obviously undersized for the high solids levels in the waste stream they are treating.

c. Another problem at this installation concerns debris in the waste stream. The separator systems are designed with a 3-in. or 4-in. pipe, which easily handles the expected flow rate. However, these pipes become clogged easily with beverage cans or styrofoam cups that are washed out of vehicles or are thrown into

the separator by troops. Plugged lines cause the separator influent to back up and overflow. This can lead to process water entering stormwater conveyances. Unplugging these lines is difficult and time consuming. Easily accessible screens placed over inlet pipes will prevent most debris from entering the plumbing and reduce plugging.

d. The environmental office at another installation recently purchased a separator for a motorpool application. They specifically requested the purchasing agent not to consider a separator with coalescing plate packs; their experience proved that plate packs did not function properly for that particular application. The installation wanted a cast-in-place, open top, rope skimmer type separator with a sedimentation basin. The response was that those (requested) types of separators were too expensive and that the new pre-fabricated units were "state of the art." However, these "state of the art" separators were not designed for use at an Army installation where typical waste streams contain very high levels of solids. The prefabricated separator was installed and is currently a maintenance problem.

e. In each of the above cases, a better understanding of the waste stream being treated would have resulted in a more properly sized, more appropriate equipment selection. When installing new separators, it is imperative that users gather as much information as possible about the waste stream to be treated, and then use this information to make purchasing and installation decisions. USACERL is beginning a new research program that involves characterizing waste streams from various Army and Army Reserve activities. This information can be used to aid in the separator selection process and should be available to installations in fiscal year 1998 (FY98).

4. Extraneous Flow Should Be Diverted From Separators To Avoid Adverse Effects on the Separators and Associated Wastewater Treatment Plants.

a. Many separators are installed in areas where they will receive considerable flow from stormwater runoff. This flow is often significantly higher than the process stream. Adding large quantities of extraneous flow to the process stream creates several problems. Accumulated oil may be "flushed" out of the separator, stormwater bypasses may produce unpermitted discharges, and sewage treatment plants may be adversely affected.

b. Excess flow will cause water levels in separators to rise. This will flush out accumulated oil held within the separator or will flood oil skimming devices and fill waste oil collection tanks with water. The result in both cases is that oil is passing through the separator and entering sewer conveyances. If the separator is connected to a storm sewer, oil passing through may cause a violation of the installation's NPDES permit. Also, many separators are installed with stormwater by-passes. These by-passes are often ignored, allowing discharges that are also in violation of NPDES permits. If the separator is connected to a sanitary sewer, the additional flow may exceed the capacity of the sewage treatment plant (STP). This is especially true at installations with large numbers of separators. Stormwater infiltration may also be prohibited by Privately Owned Treatment Works (POTW) standards. In addition, significant quantities of oils and greases that are flushed out with the stormwater can have detrimental effects on trickling filters at the STP.

c. Some examples of how these problems occur at Army installations follow.

(1) An installation in the Southeast has numerous separators that discharge to the installation's STP. Operators at this plant observe slugs of floating oil passing through the treatment system during storm events. These slugs consist of oil

that has accumulated in separators and is flushed out by stormwater.

(2) An installation in the southern United States installed a separator at a fuel supply point. The area draining to the separator is approximately 7800 sq. ft. This area is bermed, but uncovered. The separator treating flow from this area was rated at 30 gpm. During a 10-year storm event, flow to the separator is approximately 211 gpm, seven times the flow the separator can treat. Inspection of a manhole downstream from the separator revealed a significant quantity of fuel. This was most likely "flushed" from the separator during a storm event.

(3) A reserve center in the Midwest has a separator installed to treat effluent from a small area used for washing kitchen equipment. To provide convenient access to personnel, the wash pad is only a few feet away from the building. A downspout carrying run-off from approximately 1/4 of the roof empties onto the wash pad. Fortunately, this separator is used so infrequently that little grease or oil is flushed out during storm events. While not a problem with the separator itself, this example is indicative of common mistakes found in the separator maintenance and installation arena.

d. Reducing extraneous flow can be as simple as installing curbing to prevent flow from the surrounding hardstand entering the process stream, or diverting downspouts to ensure drainage to the proper storm sewer manhole. These are relatively low cost measures. If the area draining to the separator is curbed, but the design flow is still exceeded during storm events, as in the second example above, covering the area must be considered. This can be an expensive option, but is generally much cheaper than installing a new separator that will treat the total flow.

5. Installations Should Not Rely on Manufacturer's Literature or Claims To Determine Separator Performance.

a. Purchasers of oil/water separators are often ignorant of the device's capabilities and constraints. They do not know which types of separators will provide the desired results for a particular application and rely on manufacturer's literature or sales representatives for unit evaluation. However, vendor literature normally does not address important characteristics such as highly variable flow rates and variations in suspended solids and oil concentrations. Rather, performance is advertised according to ideal conditions of consistent flow and oil concentrations, and no other contaminants present. There are no industry standards that manufacturer's must meet. This has resulted in a large number of prefabricated separators hitting the market. Many of these manufacturer's are making unsubstantiated claims about their product's performance capabilities. Often times, performance tests are performed under unreasonable conditions.

b. An example of a manufacturer misrepresenting equipment performance capabilities was found at an installation in the Southwest. The installation wrote a contract for the purchase of 60 pre-fabricated separators with coalescing plate packs for treating vehicle wash water. The specifications of the contract stated that the separators should be designed to treat a waste stream of 100 gpm. The separators were purchased and installed. However, they only performed at the rated capacity for approximately 1 minute. After which, the separator could not treat the 100 gpm flow rate and became overloaded. Oil began passing through the separator, creating a continual discharge to the environment that violated the installation's NPDES permit. The installation currently continues to use the separators (with regulator approval), and cleaning up the discharged oil. This is an interim measure until the installation's Central Vehicle Wash Facility (CVWF) is complete. Once finished, 54 of the washracks

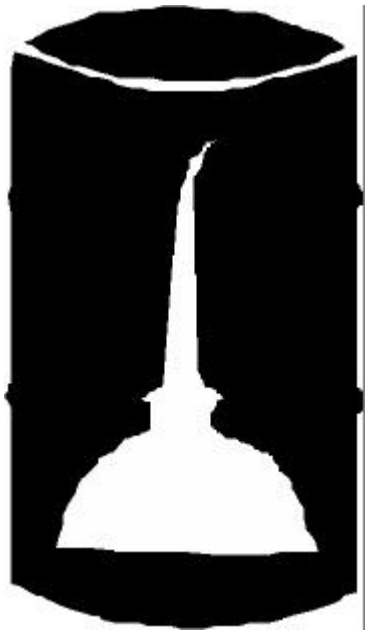
will be closed and the separators will be removed. The six that remain will be replaced with new separators that the installation designed. These will discharge to the CVWF.

c. A related incident occurred at an Army installation involving a manufacturer loosely interpreting the terms of a contract. The purchasing agent wrote a contract for the purchase of several prefabricated separators with coalescing plate packs to be installed at various Army Reserve centers. The contract specifications called for a minimum spacing between plates of 3/4 in. One company bidding on the contract supplied drawings and specifications stating their plates had a nominal spacing of 3/4 in. This company was the lowest bidder and was awarded the contract. However, another company, who had also bid on the contract, obtained copies of the specifications through the Freedom of Information Act, and contested the awarding of the contract. Upon closer examination of the drawings, it was noted that the spacing between the plates was less than 0.65 in., certainly less than the minimum requirement of 0.75 in. The agent contacted the company, who offered to adjust the plate spacing to bring the separator within spacing specifications. They kept the contract.

d. Many manufacturers attempt to provide a scientific basis for their performance calculations by presenting an oil droplet size distribution, and then suggesting that such a determination can be made by using the Susceptibility to Separation (STS) test described in American Petroleum Institute (API) Publication 421. The STS test does not produce such data. Manufacturer's literature will often depict data concerning oil droplet size distribution based on percentages of droplets greater than specific micron sizes. However, there is no known or recognized analytical procedure that will provide this information.

e. It is imperative that installations purchasing oil/water separators write their contract specifications carefully and in as much detail as possible. This means understanding as much as possible about the content of the process stream (see para 2d) and the capabilities of various separator types. Unfortunately, very little definitive guidance is available that describes various separator configurations and what level of performance to expect from that configuration. To ensure that the separator being installed will meet performance expectations, enter as much information as possible into the contract specifications, including influent characteristics (to the extent known) and

specific effluent requirements. Also include some type of testing requirements or quality assurance measures for after the separator is installed. This testing should represent worst case operation of the separator, not just ideal operating conditions.



6. Installations Should Not Rely on Gravity Separators To Remove Emulsified Oils.

a. Gravity oil/water separators are the type of separator most common at military installations. These are designed to remove only free oil, not oil that is emulsified or dissolved. One common problem with military oil/water separators is the introduction of detergents and cleaning agents into the process stream prior to discharge to the separator. These products will emulsify oil and prevent its removal by gravity separation and degrading the effluent quality. Introducing these products may result in not meeting effluent requirements for oil and grease limits.

b. Detergents and cleaning agents are being used in virtually every Army installation at one application or another. They are most commonly found at motorpool washracks and inside vehicle maintenance bays. It is imperative that the user and operator of an oil/water separator be informed that, if emulsifiers are allowed to enter the system, the effluent quality will be degraded and discharge limits may be exceeded. When discharging to a separator, detergent use should be eliminated to the greatest extent possible. The addition of high pressure/hot water washers at washing facilities can enhance the quality of cleaning in instances where detergent use is prohibited. Also, some companies are now beginning to market new "quick release" detergents. Emulsions created by these cleaners are said to break after a specified time and, therefore, allow the oil to separate. However, these cleaners have not been tested and proven for use in military applications.

7. Summary.

a. In recent years, it has become obvious that many of the separators the Army has purchased and installed are not performing as anticipated. Pretreatment is now a focus of Federal and state regulations. The Army's program to privatize wastewater collection and treatment systems will intensify the impact those regulations will have on Army installations.

b. Installation personnel should obtain as much information as possible about the characteristics of the waste stream to be treated and include these details and measures for quality assurance in any contract specifications for purchase and installation of oil/water separators. They should divert extraneous flow to the greatest possible degree and eliminate emulsifiers altogether. Then, once a separator is installed, it must be properly maintained.