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EVALUATION REPORT FOR THE BILGE WATER PLANT AT NAVAL WEAPONS STATION - EARLE LEONARDO, NEW JERSEY

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RE: U.S. NAVY CONTRACT NO. N62472-94-D-0398
DELIVERY ORDER NO. 0034-010, NWS EARLE, COLTS NECK, NJ
PRELIMINARY EVALUATION REPORT FOR BILGE WATER
TREATMENT PLANT SYSTEM UPGRADES

INTRODUCTION:

Foster Wheeler Enviromental Corporation (Foster Wheeler) has been contracted by the Northern Division, Naval Facilities Command to evaluate the bilge water treatment operations at the Bilge Water Plant (Building R-30) at Naval Weapons Station Earle (Waterfront) located in Colts Neck, New Jersey.

SUMMARY:

The following represents a preliminary evaluation report of the referenced bilge water treatment plant located in Building R-30, waterfront area, pursuant to the memorandum from Steve Lehman dated January 22, 1999. Bilge water, from ships docked at the pier, is transported to the Bilge Water Plant via rail tank cars. Tank cars being utilized have capacities of 10,000, 12,000 or 14,000 gallons. The bilge water that is processed through the Bilge Water Plant is a mixture of potable water, seawater, and contaminants from a number of sources. The typical contaminants may include fuels, oils, hydraulic fluids, detergents, septic waters, Aqueous Film Forming Foam (AFFF), solvents and paints.

The basis for the bilge water treatment plant evaluation is due to the high operation and maintenance costs and persistent fouling of the existing treatment system. The system fouling is primarily occurring in the existing ultrafiltration (UF) membranes. Once the UF units become fouled, the process flow rate is greatly reduced from approximately 10 gpm down to 1–3 gpm. The replacement cost of the fouled UF units is substantial and occurs more frequently than estimated at the time of the existing system's original design. By extending the life of UF units, if

possible, the operation and maintenance costs can be reduced. The UF fouling issues are further described below.

There are several tasks that this evaluation report identifies and provides potential solutions. The first task is to increase the overall removal efficiency of the treatment system by modifying some of the system components and/or adding other components. The second task is to increase the process capacity of the treatment system to 20 gallons per minute (gpm) from the current capacity of 10 gpm. The third task is to increase the process capacity of only the oil/water separator and influent transfer pump(s) to 50 gpm for water batches that are known to contain only oily water.

Table 1 represents a compilation of several laboratory analytical reports to establish a basis for potential influent bilge water quality. Table 1 lists the contaminants and their anticipated average and maximum concentrations in the influent stream to the oil/water separator as well as the discharge permit limits. In addition, the mass rates for the various contaminants are calculated in Table 1, assuming a process flow rate of 20 gpm.

EXISTING TREATMENT SYSTEM:

Influent Transfer Pump

The existing influent transfer pump is currently set-up to pump water at approximately 10 gpm @ 30 psi. The pump is configured in a belt & sheave arrangement so operating flow rates can be adjusted. By modifying the belts & sheaves the maximum flow rate that can be produced by the existing pump would be approximately 20 gpm at 10 psi, but the pump would be turning at about 600 RPM. The pump motor speed should remain below 300 RPM to minimize emulsion effects by the pump. The existing pump Model 1L6 type SSF (Moyno) cannot be modified to produce 25 gpm at 30 psig working at around 300 rpm. The pump has to be changed to Model B2F to reduce the operating speed and reduce amount of emulsion in the oil-water. The new pump will operate at about 210 rpm to produce 25 gpm at 30 psig and will require a 3 horsepower (Hp) motor. Therefore the existing 2 Hp motor on the 1L6 pump cannot be reused. The cost of two pumps Model B2F, including the overpressure protection, low suction pressure protection, and starter box, is estimated to be approximately $20,000.

Oil/Water Separator

The existing oil/water separator is sized for a process flow rate of 10 gpm. The Bilge Plant operators state that they need to have an oil/water separator that is capable of processing at least 25 gpm under nominal treatment conditions. In addition, the capability of batch treating up to 50 gpm is desired. The 50-gpm batches are in reference to the occasional bilge water rail tank car that is contaminated with only an oily-water mixture and the newly-installed rail tank car spill containment system that would collect oily rainwater. These batches would only require treatment by the oil/water separator, therefore, it would be more expedient to treat them quickly and discharge them than to process them through the entire treatment system and delay treatment of the more contaminated rail car batches.

A retrofit kit is available from the manufacturer (Facet International, Inc.) to increase the process flow rate to a maximum of 20 gpm. The oil/water separator Model OPB-10NP by Facet International has flat plates as coalescing media. When solids settle on these plates, the velocity of water increases. This makes the oil/water separator operate at lower efficiency. High oil carryover from the oil/water separator contributes to the operating problems of the UF system. A retrofit kit with W-pack in place of flat plates will improve the operation of the oil/water separator. The retrofit kit along with a low velocity transfer pump(s) feeding the oil/water separator should improve the operation of the overall system. Additional features required to be changed on the oil/water separator are the top cover plate of the separator and the control panel. The overall cost for this modification is estimated to be approximately $22,000.

Particulate Separator

A vortex type particulate separator is located after the oil/water separator. The existing vortex type particulate separator causes a large flow restriction. An additional or a larger vortex separator should be installed to increase the flow capacity or replaced with a different type of particulate removal device (i.e. sand filter, bag filter, etc.) to provide greater flow capacity. Since the solids loading rate is anticipated to be low, a particulate bag filter unit is recommended.

Ultrafiltration System

The existing UF system is frequently fouled with solids and oily residue, which results in high maintenance expenses. Factors, which effect the performance (i.e. filtration rate/capacity) of membrane separation systems, include:

- Influent oil concentration levels,
- Cross-flow velocity or turbulence at the membrane surface,
- Formation of a concentrated polarization layer,
- Pressure drop across the membrane, and
- Incompatible solvents in the process stream.

Each of the factors listed above influences the filtration capacity and efficiency of a membrane separation system. The turbulence generated by a hollow-fiber UF membrane system is not high enough to minimize the formation of the concentrated polarization layer. Hollow-fiber membranes are the most susceptible to fouling and plugging out of any of the membrane separation systems (Chemical Engineering, September 1998).

Due to the small inner diameter of the UF membrane fibers, which range from 0.5 to 1mm, large diameter particulates and high solids concentrations cannot be processed efficiently by hollow fiber membrane systems (Chemical Engineering, September 1998). Hollow-fiber membrane filtration is typically used in water purification applications with very low solids concentrations (Chemical Engineering, September 1998). The diameter of the hollow-fiber membranes used at Earle is 1 mm. It is probable that the 1 mm diameter hollow-fiber membranes used at Earle are being plugged by bilge water containing high concentrations of oil (30 to 300 ppm) and suspended solids.

Membrane systems are typically configured in one of the following ways:

- Hollow-fiber membrane systems
- Tubular membrane systems
- Spiral-wound systems
- Plate-and-frame systems

Of the four configurations, hollow-fiber membrane systems have the highest potential for clogging. The plate-and-frame configuration is rated to have the least potential for fouling and clogging when used in an oily wastewater application.

In ultrafiltration, particles tend to "blind" or block membrane surface pores, causing fouling of support materials and diminishing its efficiency. When particles with a diameter larger than 0.01 micrometers need to be retained (filtered), an increase in operating pressure causes a decrease in the permeate flow rate (fluid flow rate through the pores), and thus a performance decrease. The performance decrease occurs because, once the system's differential pressure increases to a certain threshold (typically about 1 atmosphere), a polarization layer forms at the membrane surface. The polarization layer acts as a blinding gel that impedes the flow of permeate through the pores and fouls the channels that pass down through the membrane support structure. As the pressure drop across the membrane continues to increase, the flux (permeate flow rate) will continue to decrease. To enhance the performance of the UF system at Earle, any system modifications should include providing a high turbulence on the membrane surface.

ULTRAFILTRATION MEMBRANE OPTIONS:

There are two alternatives available to evaluate with regards to the operation of the existing hollow-fiber UF membrane system: A) retaining the 10 gpm process flow rate but improving the removal efficiency and B) increasing the process flow rate to 20 gpm and increasing the removal efficiency. The following discusses the options associated with these two potential choices.

A) <u>Retaining the 10 gpm Process Flow Rate</u>

In order to improve the removal efficiency of the existing UF system and maintain a treatment rate of 10 gpm, the following three options should be considered:

1. The existing UF system can operate to concentrate the waste to a volume reduction factor of 2 to 3 (20 to 30 ppm concentrate with 10 ppm feed) and send this concentrate to a second UF system. The second system will be cross-rotational (CR) membrane type construction. In a variety of applications, CR filtration has demonstrated volume reductions of up to 1,000. The concentrate from the hollow-fiber system will be further processed by a CR filter to an estimated volume reduction factor of less than 10. Before a final design is adopted, laboratory and pilot tests will have to be performed. The estimated cost for this modification is $150,000.

2. Replace the hollow-fiber UF system with a tubular silica ceramic membrane system. The existing 16 hollow-fiber modules will be replaced by 10 silica ceramic modules. Ceramic membranes generally operate at approximately 100 psig. The recirculation pump will be replaced to meet the needs of the ceramic membranes. A new heat exchanger may be required along with piping modifications. The estimated cost for these changes are approximately $125,000. It is not certain as to whether the tubular ceramic membranes will be immune to plugging. Pilot tests shall be performed before this design can be adopted.

3. Another type of ceramic membrane system that can be used is a monolithic ceramic type. This type of membrane is produced from a ceramic block by making 2.5 mm diameter channels in the block. The supply of these membranes is irregular. The pressure required to operate them will be 100 psig. The recirculation pump will be replaced. The 16 hollow-fiber modules will be replaced with 7 monolithic based ceramic modules. There is no guarantee that it will be immune to plugging without performing pilot testing. Pilot tests will be conducted before this design can be adopted. The estimated cost for this system is $147,000.

The advantage to the silica ceramic cartridges (#2) is that they resist some solvents better than the existing polymeric cartridges. However, there are several disadvantages in using the silica ceramic cartridges. The tube lumen diameter is larger (2 - 3 mm) than the existing cartridges (1 mm), which means that the housings would contain a fewer quantity of tubes and less overall surface area per cartridge, which translates to lower removal potential per cartridge. A larger lumen diameter also requires a significantly higher recirculation rate (i.e. larger recirculation pump, piping, fittings, etc.). In addition, the silica ceramic cartridges are prone to fouling almost as often as the hollow-fiber membranes and have an adverse reaction to phenols.

B) Increasing the Process Flow Rate to 20 gpm

In order to increase the capacity of bilge water treatment plant to 20 gpm and improve the removal efficiency, the following options should be considered. It should be noted that additional modifications to pumps, piping, valves, etc. would also have to be included for each of the listed options.

1. Operate the existing hollow-fiber system at a low concentrate reduction factor. Install additional hollow-fiber UF modules to increase the capacity to 20 gpm. Install a new cross-rotational (CR) membrane system in series to operate the overall system at 20 gpm. The CR membrane system would further concentrate the waste stream to acceptable levels. The estimated cost for this modification would be approximately $250,000.

2. Replace the existing hollow-fiber UF membrane system with a CR membrane system capable of treating the waste stream at a capacity of 20 gpm. The cost for this system is estimated to be approximately $300,000.

3. Replace the existing hollow-fiber UF membrane system with a polymer-based membrane in a vibratory plate-and-frame system (proprietary) to minimize oil, solids, and bio-film fouling. The estimated cost is approximately $184,000.

4. Replace the existing hollow-fiber UF membrane system with a tubular silica ceramic membrane system consisting of 20 modules (see #2 in the 10 gpm options above for other details). The estimated cost for this system is approximately $330,000.

5. Replace the existing hollow-fiber UF membrane system with a monolithic ceramic membrane system consisting of 14 modules. The estimated cost for this modification is approximately $374,000.

6. Replace the existing hollow-fiber UF membrane system with similar hollow-fiber UF membranes that have a larger surface area (95 ft^2 with larger housings instead of 40 ft^2), but with the same pore size (100,000 nominal molecular weight cutoff [NMWC]).

7. Replace the existing hollow-fiber UF membrane system with the same size surface area filters, but with a larger pore size (300,000 or 500,000 NMWC).

8. Install additional hollow-fiber UF membranes to the existing units (add 8 to 16 more units) to increase the process flow rate.

Any combination of the above listed options is also possible.

ALTERNATE TREATMENT EQUIPMENT:

In addition to the options already discussed, there are several options available to modify or replace other treatment components in the existing system.

Option 1:

The first observation is that the bilge water that has been sitting in the railcar tanks for a period of time is suddenly drained into a sump and pumped through the system. This process agitates and re-emulsifies the oil(s) in the bilge water and makes it more difficult to separate the oil(s) back out. By using the idle time of the bilge water in the railcars to our advantage, the bilge water could be gravity drained directly through a below ground oil/water separator. The separated water could then be pumped through the system for final treatment.

The below ground oil/water separator provides a good alternative by minimizing the re-emulsification effects caused by transferring the bilge water from the rail cars to the treatment system. The disadvantage of this approach is that there is little room available for the installation of such a unit below ground on-site. The shallow water table and the proximity to the bay would complicate the installation with tidal effects and salinity factors. Another difficulty is that the existing below grade piping would have to be rearranged to accommodate this unit.

Option 2:

As an alternative, a different treatment technology could be added to the existing treatment train. The influent wastewater stream could be directed through a larger oil/water separator at 20 gpm (50 gpm maximum). The effluent from the oil/water separator could then be directed through a dissolved air floatation (DAF) unit, tertiary filter and then either polished with the existing UF units or discharged to the Publicly Owned Treatment Works (POTW).

The DAF unit is used to remove suspended solids and emulsified oils from the wastewater stream. The DAF unit uses compressed air to produce microscopic bubbles along with a coagulant and a flocculent (long-chain polymer). The floc particles float to the surface of the DAF unit where they are continuously skimmed off into a holding tank. Higher density particles settle to the bottom of the DAF unit where an auger mechanism continuously directs the solids to a separate collection chamber. The coagulants and flocculents each need to be contained, mixed and properly metered into the DAF unit. The actual amounts of coagulant and flocculent to be metered will periodically vary and must be continuously monitored.

The tertiary filter is used to remove suspended solids and metals. Tertiary filters are generally used in sets of three to facilitate automatic use and cleaning. Through instrumentation and controls sequencing, the three units will work separately to treat the wastewater stream and work in pairs to backwash the third unit. The units are automatically alternated to be on-line. The units process the wastewater stream continuously, even during the backwashing cycle. The backwash water would be circulated into a holding tank for solids separation.

The DAF and tertiary filter units will provide good treatment for the removal of emulsified oils. However, the disadvantage of the DAF unit is that it requires frequent monitoring while operating, and the system generates additional waste streams (flocculation foam and solids) that need to be managed and disposed. The DAF unit should not be operated unattended as per the manufacturer's recommendations. Also, there is an added expense for coagulants and flocculents, which need to be metered into the DAF at a continuous rate. The tertiary filter can run with little supervision, but the backwashing cycle will require a tank to recycle into, which is another waste stream. Both the DAF and tertiary filter units require an oil/water separator as pretreatment and polish treatment of UF units, granular activated carbon or other similar units. In addition, auxiliary equipment that is needed to properly operate a DAF system are an equalization tank, filter press, and other sludge management equipment.

Option 3:

Similar to Option 2, the effluent from the oil/water separator could be directed through a new treatment unit, an air stripper. A shallow tray type air stripper would work well for the removal of volatile organic compounds (VOCs). A counter-current air stream is forced upward through a series of perforated trays at the same time the wastewater stream is flowing downward. This process greatly agitates the wastewater stream and VOCs are released into the effluent vapor stream. The effluent wastewater stream would proceed to additional treatment processes. The influent wastewater stream to the air stripper is generally filtered of particulates to reduce stripper

fouling. The effluent wastewater stream of the air stripper is generally filtered due to the air stripper process itself causing the oxidation and precipitation of metals.

The air stripper would provide good VOC removal, but the effluent vapor stream may need to be treated prior to discharge to the atmosphere. The air stripper off-gas is generally treated with a catalytic/thermal oxidizer or vapor-phase granular activated carbon. High off-gas concentrations of chlorinated compounds could produce acid gases by an oxidizer (which would have to be scrubbed) or a high carbon change-out frequency. The off-gas treatment costs could be very significant.

Option 4:

The use of an organo-clay filter unit to remove oils, VOCs, and some suspended solids would be another potential treatment method, similar to Option 2, with the effluent of the oil/water separator entering the organo-clay filter. The organo-clay filter is a pressure vessel that contains chemically modified clay and anthracite filtration media. The anthracite is placed at the bottom of the filter housing and is used to better facilitate drainage through the filter unit. The organo-clay filter unit is backwashed when its pressure differential is 15 pounds per square inch (psi). When backwashing the filter unit does not reduce the pressure differential, the organo-clay filter media must be changed-out.

The organo-clay filter unit is recommended by the manufacturer to be operated with a particulate filter installed between the organo-clay filter and the UF units. The particulate filter should be capable of filtering down to 0.5 microns (μm). In addition, the manufacturer recommends that liquid-phase granular activated carbon should be placed on-line as a final polish after the UF units.

The organo-clay filter unit would provide good VOC and suspended solids removal after the oil/water separator. This filter unit can operate with minimum supervision and most often unattended. The disadvantage of this unit is that the filter media would need to be changed-out periodically. Based upon loading estimates, the filter media would need to be backwashed weekly and changed-out after approximately 25 days assuming a constant operation of 20 gpm. An additional tank would be installed for backwashing activities.

Option 5:

Treatment of the bilge water stream could be accomplished utilizing liquid-phase granular activated carbon adsorbers after the oil/water separator. The liquid-phase carbon adsorbers could also be used to polish the wastewater stream after the UF units, after an air stripper or a number of other combinations. Liquid-phase carbon adsorbers operate best when used as a polish treatment for the removal of VOCs. In addition, the wastewater stream entering the liquid-phase carbon adsorbers should be filtered of particulates, which could mask the carbon granules and reduce the adsorption potential.

The liquid-phase carbon adsorbers are an efficient treatment for VOCs when used as a polishing method. However, certain chemical compounds that could be processed as part of the bilge water

stream could have an adverse reaction with the carbon if they are present in sufficient concentration (i.e. ketones). Also, depending upon the mass loading rate onto the carbon adsorbers (if they are the only treatment after the oil/water separator) the cost associated with carbon change-outs could be excessive. Therefore, the carbon adsorbers would be best used as a polish.

Option 6:

Enhanced oil removal from the influent bilge water stream could be accomplished by replacing the existing oil/water separator with a liquid centrifuge oil removal system manufactured by CINC Corporation. The CINC separators use an electric motor to directly drive a rotor, which produces centrifugal forces from 100 to 1,000 times that of gravity to separate immiscible liquids of different densities. Internal weirs allow the different density liquids to flow out of separate ports. The centrifugal separators are capable of removing oil from down to 15 ppm. The separators are manufactured to be self-cleaning and easily disassembled.

The centrifugal separators are available in different flow rates. The CINC model V-10 is capable of processing up to 30 gpm. The next larger unit (model V-16) can process up to 90 gpm. Therefore, the intended process rate of up to 50 gpm would best be met by using two model V-10 units operated in parallel. The CINC model V-10 separator is powered by a 7.5 Hp direct drive motor. The model V-10 would occupy a footprint of approximately 2 ft x 2 ft, stands 5 ft tall, and weighs approximately 750 pounds. Additional equipment such as particulate filters, strainers, holding tank and transfer pump will be required for proper operation of this type system. Further contaminant removal processes, as described above, would have to be added to this system to meet discharge requirements.

PRELIMINARY COST OF NEW EQUIPMENT:

FWENC has obtained preliminary cost estimates from equipment vendors for the large equipment items, which could be used for system upgrades. Costs for labor, subcontractor fees and other minor equipment and instrumentation/controls have not been included unless otherwise indicated. The large equipment item costs are presented in the table below for each option.

Option	Description	Cost
1	Below ground oil/water separator (50 gpm)	$28,500
	Influent pumps (two 25 gpm units)	$20,000
	(Plus other treatment equipment to be selected below)	
2	Oil/water separator	$8,000
	Influent pumps (two 25 gpm units)	$20,000
	Dissolved air flotation (with metering & mixing components)	$100,000
	Automatic tertiary filters	$30,000
	Equalization tank and control/instrumentation systems	$50,000
	Filter press and sludge management equipment	$30,000

Option	Description	Cost
3	Shallow tray air stripper (off-gas treatment is additional)	$24,000
	Oil/water separator	$8,000
	Influent pumps (two 25 gpm units)	$20,000
	Transfer pump	$3,500
	Particulate filters (2 units)	$3,000
4	Organo-clay filter	$6,000
	Organo-clay media change-out and disposal (per event)	$2,200
	Influent pumps (two 25 gpm units)	$20,000
	Transfer pump	$3,500
	Backwash/holding tank	$2,000
	Particulate filter	$1,500
	Liquid-phase carbon adsorbers for polishing (2 units)	$3,000
5	Liquid-phase carbon adsorbers (2 units)	$20,000
	Oil/water separator	$8,000
	Influent pumps (two 25 gpm units)	$20,000
	Transfer pump	$3,500
	Particulate filter	$1,500
6	Centrifugal V-10 oil separators (2 units)	$80,000
	Holding tank	$2,000
	Influent pumps (two 25 gpm units)	$20,000
	Transfer pump	$3,500
	Particulate filters and strainers (2 units each)	$5,500
	(Plus other treatment equipment to be selected above)	

Other costs, which FWENC has obtained, were for a new full-scale system approach. These costs ranged from $116,000 to $202,000. These systems utilized the DAF type treatment, however, the scale of the systems would occupy most of the room in the existing building and did not adequately address the reuse of the existing UF. Additionally, these approaches were not intended to be procured and installed in steps. They must be installed and operated as a package system.

An additional option to any of the above listed treatment options is an oil-in-water automatic sampler analyzer installed prior to the UF membrane system. The analyzer would be capable of detecting the presence of oil in the water stream to prevent oil from loading onto and fouling the UF membranes. The unit shall have alarm set points and a 4-20 mA output. In addition, the analyzer includes automatic turbidity compensation, automatic cell flushing, self-diagnostics and continuous operation. The cost of this unit (not installed) is estimated to be approximately $15,000.

RECOMMENDATIONS:

It is FWENC's recommendation that the best approach to the enhancement of the bilge water treatment system is to proceed in steps. The first step would be to maximize the usefulness of the existing hollow-fiber UF membrane system. Following discussions with the UF membrane

manufacturer, there was some concern that the UF units were not being properly or thoroughly cleaned or that maybe the operation could be modified to produce better efficiency. The manufacturer's concern stems from the fact that since the bilge water treatment application using the UF units could contain a dramatic change in contaminants and their concentrations from batch to batch, the operation and cleaning procedures should be dynamic. To accomplish this, the recirculation pump rates/pressures should be frequently monitored and modified if needed. Also, a different or modified solvent or cleaning procedure could be performed to clean the UF units than what is currently being done. The switching of the UF units to a silica ceramic type would be costly compared to the limited benefit and is not recommended.

The next step would be to perform a pilot test with organo-clay filter units. FWENC currently has two organo-clay filter units that could be connected to the existing bilge water treatment system and operated to determine their effectiveness under on-site conditions.

Pending the results of the pilot testing, a larger oil/water separator and the organo-clay filter would be installed as the next step. The organo-clay filters can be added between the oil/water separator and the UF units as a step treatment. The organo-clay filters would prolong the life of the UF units. Other ancillary equipment needed for this arrangement would be: larger capacity influent pump(s); an additional transfer pump between the oil/water separator and the organo-clay filter; a particulate filter between the organo-clay filter and the UF units; and a holding tank to be used for backwashing the organo-clay filter (see Figure 1). As a potential further step, the addition of liquid-phase granular activated carbon could be installed as a final system polish.

ATTACHMENT A

Performance Specification NFGS-11311

NFGS-11311

CORRUGATED PARALLEL PLATE OIL/WATER SEPARATOR

PART 1 GENERAL

1.1 References

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN PUBLIC HEALTH ASSOCIATION (APHA)

APHA SMEWW	Examination of Water and Wastewater

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME/ANSI B16.5	(1988; Errata 1988) Pipe Flanges and Flanged Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1993; Rev. A) Structural Steel
ASTM E 165	(1992) Liquid Penetrant Examination

AMERICAN WELDING SOCIETY, INC. (AWS)

AWS D1.1	(1994) Structural Welding Code Steel

ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA MCAWW	Chemical Analysis of Water and Wastes

FEDERAL SPECIFICATIONS (FS)

FS SS-S-210	(Rev. A Reinst) Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints

MILITARY SPECIFICATIONS (MIL)

MIL-P-24441	(Rev. B; Supp. 1) Paint, Epoxy-Polyamide
MIL-S-45180	(Rev. D) Sealing Compound, Gasket, Hydrocarbon Fluid and Water Resistant

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC SP 10	(1991) Near-White Blast Cleaning

1.2 System Description

1.2.1 Applications

The separator shall remove free oil and suspended solids from oil-in-water mixtures originating from navy ship operations termed as bilge water. Bilge water consists of various shipboard sources including evaporator drains, condensate drains, boiler water, septic and pump shaft seal leakage. The oil in bilge water is usually fuel or lubricating oil from slow fitting leaks or gland leaks in transfer pumps. Other potential contaminants in the bilge water may be paints, solvents, detergents or Aqueous Film Forming Foam (AFFF). The bilge water is transferred and temporarily stored in railcar tanks. The railcars are then batch treated through the treatment plant. Every batch of bilge water contains varying concentrations and contaminants. The bilge water will be pumped into the oil/water separator by a positive displacement pump. Bilge water is typically classified as a hazardous waste due to the presence of chlorinated hydrocarbon compounds and metals.

1.2.2 Influent Characteristics

Provide an oil/water separator designed for a nominal flow rate of 50 gallons per minute (gpm). Operating temperatures of the influent oil-in-water mixture will range from 40 to 100°F and ambient air temperatures will range from -15 to 100°F. The influent bilge water stream to the oil/water separator is anticipated to have total petroleum hydrocarbon concentrations that may range from 3,500 to 16,000 milligrams per liter (mg/L).

The oil/water separator shall be 36" W x 133" L x 60" H model MAS 22-2 as manufactured by Facet International, Inc. or equal. If a comparable unit is proposed, the footprint shall not be any larger than 40" W x 140" L. The maximum anticipated influent concentrations to the oil/water separator are listed below.

Oil-in-Water Mixture	Maximum Anticipated Influent Concentrations
Total Suspended Solids	300 mg/L
Total Petroleum Hydrocarbons	16,000 mg/L
pH	7.5

1.2.3 Performance Requirements

The total petroleum hydrocarbon concentration in the effluent stream of the oil/water separator shall not exceed 10 mg/L for droplet diameters greater than 20 microns at a flow rate of 50 gpm.

1.3 Submittals

Submit the following in accordance with section entitled "Submittal Procedures."

1.3.1 Drawings

a. Separator
b. Accessory equipment

Submit shop drawings for separator and accessory equipment including principal dimensions, location of fittings and unit foundation. Include data to verify center of gravity with the unit empty and filled with water.

1.3.2 Design Data

a. Separator
b. Accessory equipment

Submit analysis, signed by a registered professional engineer, which indicates that at the calculated overflow rate, the separator will be provided with the required square feet of projected plate separation area to achieve the specified performance under laminar flow conditions. Calculations shall take into account the rate of flow, potential surge flow, influent concentrations, particle characteristics, fluid temperature, fluid specific gravity and pH.

1.3.3 Instruction

a. Separator system

1.3.4 Factory Test Reports

a. Shop hydrostatic test

Submit results of hydrostatic and dynamic testing.

1.3.5 Field Test Reports

a. Inspection
b. Field hydrostatic test
c. Pre-Operational test
d. In-service test

1.3.6 Certificates

a. Separator corrosion protection

Submit written verification on the fabricator's letterhead that surface preparation and coating application were performed in accordance with the manufacturer's printed recommendations for the coating system.

1.3.7 Operation and Maintenance Manuals

a. Separator system
b. Accessory equipment

Submit operation and maintenance data in accordance with Section 01781, "Operation and Maintenance Data."

1.4 Delivery, Storage and Handling

1.4.1 Delivery and Storage

Inspect materials delivered to the site for damage. Unload and store materials with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, such as subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. If special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.

1.4.2 Handling

Handle separator in such a manner as to ensure delivery to final location in sound, undamaged condition. Take special care not to damage interior and exterior surfaces of separator, coalescing plates, or tubes and associated supports and pipe coatings or linings. Make satisfactory repairs to damaged materials at no cost to Government. Carry and do not drag materials.

PART 2 PRODUCTS

2.1 Materials

Provide shop fabricated and assembled oil/water separator, which is comprised of a tank containing an inlet compartment, multiple oil coalescing-type angle plate compartment, separated oil holding compartment, sludge holding chamber, and outlet compartment.

Use ¼-inch minimum thick carbon steel conforming to ASTM A 36/A 36M or material having equivalent structural properties and corrosion resistance for tank. Weld in accordance with AWS D1.1 to provide watertight tank that will not warp or deform under load. Use welders qualified in accordance with AWS Standard Qualification Procedure. Grind welds smooth and remove weld spatter. Fabricate free of kinks and sharp bends in a manner not to reduce the strength of steel to a value less than that intended by the design. Size and shape of bends shall be uniform. Clean and finish carbon steel surfaces as described in paragraph entitled "Separator Corrosion Protection."

2.1.1 Separator Corrosion Protection

2.1.1.1 Steel Separator

After shop conducted hydrostatic tests have been successfully completed, provide a MIL-P-24441 coating system to the interior and exterior surfaces of the separator. Prior to shop painting, abrasive blast clean the surfaces in accordance with SSPC SP 10 to a surface profile of 0.025 to 0.0625 mm (1 to 2.5 mils). Apply primer conforming to MIL-P-24441/1, Formula 150 applied to a minimum dry film thickness of 0.075 to 0.10 mm (3 to 4 mils). Apply intermediate coat conforming to MIL-P-24441/2, Formula 151 applied to a minimum dry film thickness of 0.075 to 0.10 mm (3 to 4 mils). Apply topcoat conforming to MIL-P-24441/3, Formula 152 applied to a minimum dry film thickness of 0.075 to 0.10 mm (3 to 4 mils). Total dry film thickness shall not be less than 0.23 mm (9 mils). Repair and replace areas of the coating system, which are found to be damaged or defective upon delivery of equipment to the site or found to be defective due to work of the applicator. An interior polytetrafluoroethylene liner with a minimum thickness of 1/8-inch may be provided in lieu of paint coating the interior tank surfaces.

2.1.2 Substitutions

Separators constructed of reinforced fiberglass may be provided in lieu of carbon steel. Provide fiberglass tanks with lifting straps. Glass fiber reinforced plastic weirs may be accepted as a suitable weir and baffle material provided that the necessary requirements for anchoring these items include provisions for contraction and expansion. Surfaces shall be seamless, chemically resistant to oil-in-water mixture, and resistant to ultraviolet deterioration. Preserve wood components prior to applying resin laminates to prevent deterioration.

2.1.3 External Surfaces

External tank surfaces and appurtenances shall be resistant to corrosion from the surrounding atmosphere including seawater.

2.1.4 Internal Surfaces

Parallel plate material and orientation shall enhance oil coalescence and solids removal, and be corrosion and chemically resistant to the oil-in-water mixture and atmosphere as specified in paragraph entitled "SYSTEM DESCRIPTION."

2.1.5 Hardware

Bolts, stiffeners, washers, nuts, screws, pins, and fittings as required shall be corrosion resistant and resistant to seawater. Provide materials that are inherently corrosion resistant and not merely treated with a corrosion-resistant coating, such as provided by the galvanizing process.

2.1.6 Accessibility

Parts subject to wear or requiring adjustment, inspection, cleaning or repair shall be accessible and capable of convenient removal when required.

2.2 Tank

Provide aboveground tank to withstand hydraulic and particulate loading under static and dynamic conditions while empty and during operating conditions. Provide adequate support for additional loading from tank appurtenances including weirs, hoppers, internal supports, parallel coalescing plates, equipment transportation, and rapid lowering and braking of load during handling operations. Bolt tank [and accessories] to weld-fabricated, structural steel skid base, or mount on manufacturer's standard base.

2.2.1 Lifting Mechanism

Fit tank with lifting lugs for handling and installation. Each lug shall carry the total dry weight of the tank and attendant appurtenances. Prominently display lifting instructions on anodized aluminum plate located on outside of tank.

The lid(s) of the tank shall be fit with lifting handles to facilitate their removal by one person. The lid(s) shall be capable of being unsecured and safely tilted or moved aside by one person to facilitate access into the separator compartments for cleaning and other maintenance activities.

2.2.2 Nozzles

Fit tank with nozzles specified.

Nozzle	Inside Diameter (inches)
Influent	6
Primary Solids Outlet	4
Effluent Water	6
Effluent Separated Oil	4
Water Drain	4
Vents (2 minimum)	6

2.2.3 Flanges

Use only flat face flanges and drill 150-pound ANSI Standard bolt circle pattern and remove burrs. Use flanged piping connections that conform to ASME/ANSI B16.5, welding neck type.

2.2.4 Weirs

Attach stationary weirs and adjustable weir supports to tank sidewalls to provide a watertight seal between adjoining compartments and trough to prevent hydraulic short-circuiting. Use stainless steel for weir plates

and baffles. Provide sharp crested weirs of size and section specified by manufacture. Provide slotted holes in weir plates and baffles or supports to permit horizontal and vertical adjustment of weir or baffle. Use non-deteriorating sealant or gaskets for mounting weir plates. Fill voids between tank wall and weir plate with sealant to make watertight.

2.2.5 Low Point Drains

Provide means at low points for draining the water from the tank.

2.2.6 Identification Plates

Provide identification and instruction plates, and stamp necessary data. Securely affix plates in a prominent location on the tank with nonferrous screws or bolts

2.2.7 Instruction Plates

Instruction plates shall describe special or required procedures to operate and service equipment, and shall include warnings of hazardous procedures and notice of safety and health requirements. Plates shall be durable and legible throughout equipment life.

2.2.8 Warning Sign

On entrances to the tank place a permanent sign which states the following: "DO NOT ENTER TANK OR PERFORM HOT WORK ON OR IN TANK UNTIL THE ATMOSPHERE HAS BEEN TESTED AND CERTIFIED GAS FREE AND SAFE."

2.3 Inlet Compartment

Inlet compartment shall reduce suspended solids to non-clogging level for multiple angle plates and provide a uniform oily wastewater loading across inlet face or oil coalescing compartment under laminar flow conditions. Inlet compartment to be provided with an inlet nozzle with a non-clogging flow distributor and energy dissipater device, and adjustable surface oil skimmer. Separator manufacturer shall provide a separate oil holding tank compartment with a minimum capacity of 150 U.S. gallons with 4-inch nozzle for product removal/transfer. The inlet compartment and the oil holding tank compartment shall both be designed with a vent nozzle, or a passageway to a vent nozzle, to provide vapors a route to freely discharge to the atmosphere.

2.4 Oil Coalescing Compartment

2.4.1 Parallel Plates

Provide parallel plates at an angle 40 to 60 degrees with respect to longitudinal axis of the plate corrugations and space not less than ¼-inch and not more than ¾-inch apart for removal of free oil and settleable solids. Configuration used shall not promote solids buildup on plates, which would increase velocities to point of discharging an effluent of unacceptable quality. Maintain laminar flow at maximum

design flow rate throughout plate packs including entrance and exit so as to prevent re-entrainment of oil(s) with water. Flow through plate packs shall be in a down-flow mode parallel to plate corrugations or cross-flow perpendicular to plate corrugations, so that the oil collects and coalesces at the high point of corrugations and rises to the top of the packing without clogging by oil or settleable solids. The oil coalescing compartment shall be designed with a vent nozzle, or a passageway to a vent nozzle, to provide vapors a route to freely discharge to the atmosphere.

2.4.2 Supports

Brace and support plate packs to withstand loads associated with transportation and operation of units, including in-place cleaning. Equip each plate pack with lifting lugs or other attachments for handling and installation. Each lug shall carry total weight of plate pack. Provide adequate structural supports to facilitate in-place cleaning of plate pack bundles.

2.4.3 Baffles

Provide oil retention baffle, adjustable surface oil overflow weir with trough, and stationary underflow baffle. Position underflow baffle to prevent re-suspension of solids that have accumulated in secondary solids hopper.

2.5 Outlet Compartment

Provide outlet compartment of sufficient size with an adjustable overflow effluent weir, a sampling port, and nozzles. The effluent water nozzle shall be designed to gravity drain at an elevation not less than 48 inches above the base of the unit. The outlet compartment shall be designed with a vent nozzle, or a passageway to a vent nozzle, to provide vapors a route to freely discharge to the atmosphere.

2.6 Accessories [and Accessory Equipment]

Provide bolts, stiffeners, washers, nuts, screws, pins, gaskets, and fittings as required for adjustable weirs and parallel plate packs. Provide tank covers with a vapor proof seal for vapor control with vapor vents and suitable access ports to each separator compartment.

2.7 Fabrication

Provide shop fabricated, skid mounted oil/water separator approved by the Contracting Officer, which is comprised of a tank containing an inlet compartment, parallel plate oil coalescing compartment, and outlet compartment.

2.7.1 Shop Hydrostatic Test

Prior to applying coatings, perform hydrostatic test at atmospheric pressure by filling tank with water in the shop for a minimum of 4 hours. Testing shall be conducted after all seams have been cleaned and all welds have been inspected in accordance with ASTM E 165. The acceptance criteria for the hydrostatic test is to not visibly observe any leaks after 4 hours.

2.7.2 Reduction of Solids

Inlet compartment shall reduce suspended solids to a non-clogging level for parallel plates and provide a uniform oily wastewater hydraulic loading across inlet face of oil coalescing compartment under laminar flow conditions. Submit proof that separator will not clog given the influent characteristics. Equip compartment with an inlet nozzle with wastewater sampling port, non-clogging flow distributor and energy dissipater device, and adjustable surface oil overflow weir with trough.

2.7.3 Oil Coalescing Compartment

Equip the oil coalescing compartment with easily removable and re-installable, parallel, corrugated plates arranged to optimize separation of free oil from liquid carrier. Provide adjustable surface oil overflow weir with trough, oil outlet nozzle and stationary underflow baffle, oil retention baffle positioned to prevent discharge of free oil that has been separated from the carrier liquid in inlet and oil coalescing compartments. Provide access to each plate pack from top. Each bundle shall be equipped with handles or lifting rings. Plate designs that permit cleaning of plate packs in place are acceptable. When plate design permits cleaning in place; provide sufficient access to permit complete cleaning of the plates and removal of the sludge.

The effective surface area of the coalescing media shall be a minimum of 1,240 square feet.

The inlet compartment, oil holding tank compartment and the oil coalescing compartment shall each be designed with a vent nozzle, or a passageway to a vent nozzle, to provide vapors a route to freely discharge to the atmosphere. The vent nozzles will be connected via a manifold and piped outside of the building so the vapors will freely migrate to the atmosphere without accumulating within the building. Therefore, all penetrations/seams/seals into the separator shall be vapor-tight.

2.7.4 Wastewater Sampling Port

Equip inlet and outlet compartments, adjustable overflow effluent weir, effluent trough, and wastewater outlet nozzle with wastewater sampling ports permitting easy access for obtaining isokinetic influent and effluent samples.

2.7.5 Connections

Connect the separator at the inlet and outlet pipe invert elevations as specified by the manufacturer. Follow equipment manufacturer's recommendation for setting and adjusting top of weir elevations throughout unit.

2.7.6 Storage

Provide oil and suspended solids collection, storage, and transfer systems as an integral part of proposed oil/water separator system. At a minimum, the separator oil storage compartment shall have a capacity of not less than 10 percent of the total tank volume.

PART 3 EXECUTION

3.1 Inspection

Inspect each component of separator for compliance with requirements specified in "PART 2 PRODUCTS". Redesign or modification of equipment to comply with specified requirements, or necessary redesign or modification following failure to meet specified requirements, shall receive particular attention for adequacy and suitability. This element of inspection shall encompass visual examinations and dimensional measurements. Noncompliance with specified requirements, or presence of one or more defects preventing or lessening maximum efficiency of separator operation, shall constitute cause for rejection.

3.2 Installation

Lift tank as required without parallel plate packs in place onto a level foundation using lifting mechanism provided. Level tank and bolt to supports to prevent hydrostatic uplift and ensure unit stability. Use a lifting bar through lugs to insert plate packs into tank and place on supports. Caulk around packs and pack supports with sealing compound conforming to FS SS-S-210 or to MIL-S-45180 to prevent hydraulic short-circuiting. Avoid abrupt contact between the packs and the tank walls and pack supports to avoid damage. Separator system installation shall be conducted in accordance with manufacturer's recommendations.

3.3 Field Quality Control

3.3.1 Field Hydrostatic Test

After separator has been leveled and secured to foundation and parallel plate packs are in place, level effluent overflow weir at elevation specified by manufacturer and hydrostatically test unit at operational pressure for an additional 8 hours by filling with water.

3.3.2 Pre-Operational Test

The manufacturer's service representative shall inspect, operate, and test unit before in-service testing by the Contractor.

3.3.2.1 Tests

Tests shall include but not be limited to the following:

a. Soundness (without cracked or otherwise damaged parts).
b. Completeness in all details, as specified.
c. Correctness of setting, alignment, and relative arrangement of each component.
d. Verification of proper operation for all system components.

3.3.2.2 Pre-Operational Investigation and Test Report

Submit manufacturer's service representative's pre-operational test report. Document inspections, operations, adjustments, and tests performed and indicate whether they were acceptable or not. For unacceptable items, describe corrective action taken or recommended. Include detailed descriptions of points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. Include the manufacturer's certificate that equipment conforms to specified requirements and is ready for permanent operation and that nothing in installation will render manufacturer's warranty null and void.

3.3.3 In-Service Test

After the hydrostatic and pre-operational tests have been successfully completed and the unit has been properly connected to influent and effluent piping, allow influent oil-in-water mixture previously described in paragraph entitled "SYSTEM DESCRIPTION" to flow into separator filled with water. Adjust and level the surface oil overflow weirs to optimize oil skimming and minimize water overflow to oil recovery. Optimize operation of unit within 5 working days. Operate unit for a minimum of ten tank volume changes prior to testing for removal of contaminants and document testing results.

3.3.3.1 Analytical Methods

Test and sample preservation methods for test contaminants shall be in accordance with the latest revisions of APHA SMEWW, APHA Standard Methods for the Examination of Water and Wastewater, EPA MCAWW, EPA Methods for Chemical Analysis of Water and Wastes, or those substitute methods approved by the governing regulatory agencies having jurisdiction.

3.3.3.2 Test for Contaminants

Verify the separator efficiency by testing influent and effluent for contaminants described in paragraph entitled "Performance Requirements." If effluent quality is found to be unacceptable, then verify influent to effluent performance in particle size removal at the site. An independent certified testing laboratory shall perform tests.

3.3.3.3 Sampling Procedures

Within an 8-hour period and at regular intervals collect a minimum of 10 influent and effluent samples from sampling ports provided as part of the separator. Purge each sampling port to remove built-up solids or other material prior to collecting sample. Collect wastewater samples isokinetically in clean glass containers with polytetrafluoroethylene lined caps. Collect duplicate wastewater samples in separate glass containers. Do not attempt to split sample. Use containers for other contaminants as recommended in references listed in paragraph entitled "Analytical Methods."

3.3.3.4 Acceptance Criteria

The effluent samples taken shall not exceed the maximum of 10 mg/L for total petroleum hydrocarbons. If the separator does not meet the requirements of this specification, due to poor workmanship and wrong fabrication dimensions, the unit may be rejected. If the unit is not operating at design efficiency 5 days after installation, Government may reject system. In the event Government rejects unit, Contractor shall remove separator or defective components and replace with acceptable unit or components and test as specified above.