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INCH-POUND
MIL-PRF-30099
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PERFORMANCE SPECIFICATION

TREATMENT SYSTEM, BLACKWATER AND COMBINED BLACKWATER/GRAYWATER, FOR SURFACE SHIPS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers a fully automated, self-contained treatment system that provides treatment of either blackwater (see 6.4.2) or combined blackwater and graywater (see 6.4.13) found onboard Naval surface ships equipped with blackwater vacuum collection, blackwater gravity collection, and graywater gravity collection systems. Treatment systems intended to comprise this system will provide the entire process required to treat the incoming wastewater (see 6.4.28) influent (see 6.4.15) in accordance with this specification. Systems that provide partial treatment, or that must be used in combination with other systems, do not comply with this specification.

1.2 Classification. Treatment systems covered by this specification are of the following treatment classes and influent category as specified (see 6.2):

Class 1 - Biological treatment system.

Category A - Vacuum-collected blackwater influent.

Category B - Combined vacuum-collected blackwater and gravity collected graywater influent.

Category C - Gravity collected blackwater influent.

Category D - Combined gravity collected blackwater and gravity collected graywater influent.

Class 2 - Physical/ chemical treatment system.

Category A - Vacuum-collected blackwater influent.

Category B - Combined vacuum-collected blackwater and gravity collected graywater influent.

Category C - Gravity collected blackwater influent.

Category D - Combined gravity collected blackwater and gravity collected graywater influent.

Class 3 - Advanced oxidation treatment system.

Category A - Vacuum-collected blackwater influent.

Category B - Combined vacuum-collected blackwater and gravity collected graywater influent.

Category C - Gravity collected blackwater influent.

Category D - Combined gravity collected blackwater and gravity collected graywater influent.

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901	-	Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-PRF-9000	-	Lubricating Oil, Shipboard Internal Combustion Engine, High Output Diesel
MIL-PRF-16884	-	Fuel, Navy Distillate
MIL-PRF-17331	-	Lubricating Oil, Steam Turbine and Gear, Moderate Service
MIL-PRF-23699	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number 0-156
MIL-F-24385	-	Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water
MIL-DTL-24643	-	Cables and Cords, Electric, Low Smoke, for Shipboard Use, General Specification for

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-167-1	-	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited)
MIL-STD-461	-	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-740-2	-	Structureborne Vibratory Acceleration Measurements Acceptance Criteria of Shipboard Equipment
MIL-STD-777	-	Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships
MIL-STD-810	-	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-1310	-	Standard Practice for Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety
MIL-STD-1399-300	-	Interface Standard for Shipboard Systems, Section 300, Electric Power, Alternating Current (Metric)
MIL-STD-1474	-	Noise Limits
MIL-STD-1553	-	Digital Time Division Command/ Response Multiplex Data Bus

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(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

NAVSEA S6480-A4-CAT-010 - U.S. Navy Surface Ship (Non-Submarine) Authorized Chemical Cleaning Products and Dispensing Systems Catalog

(Copies of this document are available online at http://nll.ahf.nmci.navy.mil or from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055.)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

EPA-821-R-98-002 - Method 1664, N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry

(Copies of this document are available online at www.epa.gov or from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, Document No. PB99-121949.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers (DoD adopted)

ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers (DoD adopted)

(Copies of these documents are available online at www.asse-plumbing.org or from the International Office, American Society of Sanitary Engineers, 901 Canterbury Road, Suite A, Westlake, OH 44145.)

ASTM INTERNATIONAL

ASTM F1166 - Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities (DoD adopted)

(Copies of this document are available online at www.astm.org or from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959.)

AMERICAN WATER WORKS ASSOCIATION

Standard Methods for the Examination of Water and Wastewater, 1995

(Copies of this document are available online at www.awwa.org or from the AWWA, 6666 W. Quincy Ave., Denver, CO 80235.)

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE 45 - Recommended Practice for Electric Installations on Shipboard (DoD adopted)

IEEE 1284 - Standard Signaling Method for a Bidirectional Parallel Peripheral Interface for Personal Computers

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IEEE 1451.2 - Standard for a Smart Transducer Interface for Sensors and Actuators - Transducer to Microprocessor Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats

(Copies of these documents are available online at www.ieee.org or from the Institute of Electrical and Electronic Engineers, Inc., 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

NEMA 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum) (DoD adopted)

(Copies of this document are available online at www.nema.org or from the National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Description. The treatment system shall be fully automatic, self-contained, and ready for operation with the ship's physical, electrical, electronic, and other architecture. The system shall include all equipment, controls, structure, non-hull integrated tanks, and special tools associated with processing the liquid waste stream.

3.1.1 Class 1 description. Class 1 treatment systems shall use microbes to digest dissolved and suspended organic matter from blackwater or combined blackwater and graywater to produce a liquid discharge (see 6.4.5) meeting the effluent (see 6.4.6) standards defined herein. Class 1 system processing shall include the pretreatment (if required), feeding, treatment, effluent removal, and process waste handling and removal that the biological treatment system employs to meet this specification. Class 1, Category A and C systems shall process blackwater and Class 1, Category B and D systems shall process combined blackwater and graywater.

3.1.2 Class 2 description. Class 2 treatment systems shall use an electrical, chemical, or physical process directly with blackwater or combined blackwater and graywater to separate or breakdown organic material in the waste and disinfect the waste to produce a liquid discharge meeting the effluent standards defined herein. Class 2 system processing shall include the pretreatment (if required), feeding, treatment, effluent removal, and process waste handling and removal that the electrical, chemical, or physical treatment system employs to meet this specification. Class 2, Category A and C systems shall process blackwater and Class 2, Category B and D systems shall process combined blackwater and graywater.

3.1.3 Class 3 description. Class 3 treatment systems shall use an oxidation process to degrade organic materials in blackwater or combined blackwater and graywater and disinfect the waste to produce a liquid discharge meeting the effluent standards defined herein. Class 3 system processing shall include the pretreatment (if required), feeding, treatment, effluent removal, and process waste handling and removal that the advanced oxidation treatment system employs to meet this specification. Class 3, Category A and C systems shall treat blackwater and Class 3, Category B and D systems shall treat combined blackwater and graywater.

3.2 First article. When specified (see 6.2), a system shall be subjected to first article inspection in accordance with 4.1.1.

3.3 Materials. The contractor shall select the materials, but the materials selected shall be capable of meeting all of the requirements specified in this section. In addition, all materials shall be commercially available and conform to applicable commercial marine standards and practices.

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3.3.1 Chemical resistance. All materials in contact with the wastewater influent and/or process byproducts shall be compatible, with no evidence of deleterious effect, with the following: blackwater; graywater (Category B and D systems only); fresh or seawater flush water; toilet bowl cleaners; detergents (household, laundry, and bilge cleaning type); any disinfectant required in the operation of the system; brominated potable water; any chemical compound in solid, liquid or gaseous form used in the operation and cleaning of the system; engine oil; ethylene glycol; navy distillate fuels specified in MIL-PRF-16884; MS-2190-TEP turbine and gear lubrication oils specified in MIL-PRF-17331; MS 9250 diesel lubricating oil specified in MIL-PRF-9000; synthetic turbine lubricating oil specified in MIL-PRF-23699; aqueous film forming foam specified in MIL-F-24385; mineral spirits; methyl alcohol; effluent and intermediate process fluids produced in the treatment system; and any vapors produced in the treatment system.

3.3.2 Dissimilar metals. Dissimilar metals shall not be used in intimate contact with each other unless protected against galvanic corrosion.

3.3.3 Material deterioration, prevention and control. The treatment system shall be fabricated from compatible materials, inherently corrosion resistant to or treated to provide protection against corrosion and microbial deterioration for the system's service life and in any environment specified herein.

3.3.4 Hazardous and ozone depleting materials. The materials and operational processes used for the treatment system shall not rely on hazardous or toxic materials or ozone depleting chemicals prohibited from use aboard the intended ship as specified (see 6.2) unless approved by the appropriate government authority (see 6.2). Any oxidizing agents generated/consumed within the treatment system must be enclosed at all times within corrosion resistant containers and piping to prevent the possibility of explosive decomposition.

3.3.5 Electrical cable and cord materials. All electrical cable and cord materials used in the treatment system shall be in accordance with MIL-DTL-24643.

3.3.6 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.4 Ship environment considerations. The treatment system shall be capable of meeting the following operational constraints and shipboard and storage environmental requirements.

3.4.1 Shock. The treatment system shall meet the shock requirements of MIL-S-901 for Grade B, Class 1 equipment.

3.4.2 Environmental vibration. The treatment system shall meet the requirements of MIL-STD-167-1, Type I, environmental vibration from 4 Hz to 50 Hz.

3.4.3 Internally excited vibration. All treatment system rotating machinery shall meet the requirements of MIL-STD-167-1, Type II, internally excited vibration.

3.4.4 Airborne noise. The treatment system shall meet the airborne noise requirements of MIL-STD-1474 for Grade E equipment during normal operation.

3.4.5 Structureborne noise. The treatment system shall meet the generated structureborne noise requirements of MIL-STD-740-2.

3.4.6 Electromagnetic interference and compatibility. The treatment system shall meet the applicable electromagnetic emissions and susceptibility requirements of MIL-STD-461 for auxiliary equipment operating in a machinery space of the intended ship, or class of ship, as specified (see 6.2).

3.4.7 High and low temperatures. The treatment system shall operate as specified herein when operating in an ambient air temperature environment range of 41 to 122 degrees Fahrenheit (°F), with inlet operating fluid temperatures varying from 36 °F to 90 °F for Category A and C influent and 36 °F to 150 °F for Category B and D influent. When empty and in a non-operating state, the treatment system equipment shall not be damaged nor shall subsequent operational performance be degraded as a result of being subjected to ambient air temperatures ranging from -40 °F to +140 °F.

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3.4.8 Humidity. The treatment system shall withstand humidity environments up to 95 percent maximum with no resulting evidence of absorption of water, change in mechanical properties, corrosion, or other forms of deterioration.

3.4.9 Salt fog. The treatment system shall not display evidence of corrosion, deterioration, or performance degradation when subjected to a salt fog mist.

3.4.10 Water spray. When in a non-operating state, the treatment system shall not be damaged nor shall subsequent operational performance be degraded as a result of all external system components being subjected to a water hose down test in accordance with NEMA 250.

3.4.11 Dynamic inclination. The treatment system, as fitted on the ship, shall be capable of operating as specified herein when subjected to roll angles of 45 degrees (30 degrees for aircraft carriers) applied on both sides of the vertical axis (starboard or port) at a cyclic rate of 10 seconds and pitch angles of 10 degrees applied on both sides of the transverse axis (bow up or bow down) at a cyclic rate of 10 seconds.

3.4.12 Static inclination. The treatment system, as fitted on the ship, shall be capable of operating as specified herein when subjected to a list angle of 15 degrees.

3.5 Physical characteristics.

3.5.1 Physical size. When in the installed position, the treatment system equipment and non-hull integrated tanks along with all access envelopes (operation, maintenance, repair, and equipment removal), shall fit within the reserved space and geometry of the intended ship as specified (see 6.2).

3.5.2 Weight. The wet weight of the treatment system shall not exceed the weight budget of the intended ship as specified (see 6.2).

3.5.3 Modularity. All treatment system parts and consumables requiring replacement per manufacturers' (see 6.4.17) maintenance schedules over the service life of the ship (see 6.1) shall be capable of passing through standard Navy doorways 26 inches wide by 66 inches high, reduced further by round corners on an 8-inch radius, and hatches 30 inches wide by 60 inches long, reduced further by round corners on a 7.5-inch radius.

3.6 Performance characteristics.

3.6.1 Processing performance.

3.6.1.1 Process rate. The system processing rate shall match or exceed the wastewater average daily and maximum daily hydraulic loading rates defined in Table I while processing the target waste stream category for the maximum number of accommodations served by the system for the intended ship as specified (see 6.2). Maximum daily flows (see 6.4.18) shall be assumed to occur 3 times a day to coincide with meal preparation periods. Additionally, the processing rate for Class 1 systems shall match the minimum daily hydraulic loading rates defined in Table I.

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TABLE I. Hydraulic loading rates.

System influent category	Hydraulic loading type	Loading rate per ship accommodation served (gallons/day)		
		Blackwater		Graywater (all ships)
		Ships with urinals	Ships without urinals	
Category A (vacuum-collected blackwater)	Average daily	3	5.5	N/A
	Maximum daily	3.3	6.1	N/A
	Minimum daily	0.6	1.1	N/A
Category B (combined vacuum-collected blackwater and gravity collected graywater)	Average daily	3	5.5	45
	Maximum daily	3.3	6.1	49.5
	Minimum daily	0.6	1.1	9
Category C (gravity collected blackwater)	Average daily	30	N/A	N/A
	Maximum daily	33	N/A	N/A
	Minimum daily	6	N/A	N/A
Category D (combined gravity collected blackwater and gravity collected graywater	Average daily	30	N/A	45
	Maximum daily	33	N/A	49.5
	Minimum daily	6	N/A	9

3.6.1.2 Cold start. The system shall meet the effluent quality and hydraulic requirements specified herein, or alternate requirements as specified (see 6.2), for the target waste stream and discharge standard (see 6.2) as outlined below from beginning of system "start-up" (initialization) when in an empty-tank condition (cold start).

a. Class 1 – the system shall comply within 120 hours.

b. Class 2 and Class 3 – the system shall comply within 12 hours.

3.6.1.3 Hot start. The system shall meet all effluent quality and hydraulic processing requirements specified herein, or alternate requirements as specified (see 6.2), for the target waste stream and discharge standard (see 6.2) as outlined below after the system has been restarted as a "hot start" following a shutdown period of 12 continuous hours.

a. Class 1 – The system shall comply within 24 hours from restart.

b. Class 2 and Class 3 – The system shall comply within 12 hours from restart.

3.6.1.4 Chemicals in the influent. The manufacturer shall provide a list of common and ship specific (see 6.2) shipboard chemicals and corresponding volumes of those chemicals that may detrimentally affect treatment system performance. Common shipboard chemicals that can be expected to be introduced into the treatment system include the following: fresh or seawater flush water; toilet bowl cleaners; detergents (household, laundry, and bilge cleaning type); cleaning concentrates and ready-to-use cleaning products in NAVSEA S6480-A4-CAT-010; brominated potable water; engine oil; ethylene glycol; navy distillate fuels specified in MIL-PRF-16884; MS-2190-TEP turbine and gear lubrication oils specified in MIL-PRF-17331; MS 9250 diesel lubricating oil specified in MIL-PRF-9000; synthetic turbine lubricating oil specified in MIL-PRF-23699; aqueous film forming foam specified in MIL-F-24385; mineral spirits; and methyl alcohol. The manufacturer shall also include any disinfectant required in the operation of the system and any chemical compound in solid, liquid, or gaseous form used in the operation and cleaning of the system.

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3.6.2 Effluent quality and removal.

3.6.2.1 Effluent discharge standards. When processing the target waste stream, the treatment system shall produce an effluent meeting the appropriate discharge standard(s) defined in Table II when tested in accordance with 4.4.4.1. United States Coast Guard (USCG) discharge standards shall be met. Section 6.2 shall define whether MARPOL or other discharge requirements are also applicable. The values shall be calculated using the same methods as noted in Table II (i.e. arithmetic mean for USCG standards and geometric mean for MARPOL standards).

TABLE II. Effluent discharge standards.

Parameter		USCG[1]	MARPOL[2]
Biochemical Oxygen Demand (BOD_5)[3] (see 6.4.10)	mg/L	-	≤ 50
Total Suspended Solids (TSS) (see 6.4.27)	mg/L	≤ 150	≤ 100 (ship test), ≤ 50 (shore test)
Fecal Coliform (FC)[4] (see 6.4.9)	MPN/100 mL	≤ 200	≤ 250
Free Available Chlorine (Cl)[5]	mg/L	-	See 6.2

Notes:
(1) 33 CFR 159 effluent limitations calculated as the arithmetic mean.
(2) MARPOL Annex IV effluent limitations calculated as the geometric mean.
(3) Five (5) day biochemical oxygen demand.
(4) MPN is abbreviation for Most Probable Number.
(5) Only required if chlorine is used as a disinfectant.

3.6.2.2 Effluent removal. The treatment system shall remove the treated effluent at a discharge pressure that overcomes the static head loss as seen on the intended ship as specified (see 6.2) when configured for overboard discharge or shore side removal, whichever is greater.

3.6.2.3 Material compatibility of effluent. The treated effluent shall be compatible, with no evidence of deleterious effect, with the ship's overboard discharge system, including 90-10 copper-nickel piping and bronze valves and fittings.

3.6.3 Process wastes management.

3.6.3.1 Process wastes holding capacity. The treatment system shall be capable of retaining all system generated process wastes (see 6.4.25) for the period required by ship mission of the intended ship for near shore operations as specified (see 6.2). The treatment system shall be capable of meeting this requirement while operating at rated capacity and producing an effluent discharge as specified herein.

3.6.3.2 Process wastes removal. Treatment systems producing process wastes shall be capable of removing process wastes at a discharge pressure that overcomes the static head loss as seen on the intended ship as specified (see 6.2) when configured for overboard discharge or shore side removal, whichever is greater.

3.6.4 Tank volume. Treatment systems relying on tanks integral with the ship's hull to meet this specification shall do so using the available tank volume provided by the intended ship as specified (see 6.2) for blackwater treatment or combined blackwater and graywater treatment.

3.6.5 Consumables volume. The volume required to store consumable materials needed to support treatment system operation for an overseas deployment shall not exceed the reserved storage space of the intended ship as specified (see 6.2).

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3.6.6 Tank cleaning. Any treatment system tank shall be capable of being flushed using ship supplied seawater to wash down all internal surfaces of the system tank vessels. The wash down water and tank residue shall be discharged from the system.

3.6.7 Back flow prevention. The treatment system shall have the capability of preventing back flow of wastewater through shipboard system supply and discharge interfaces. Any treatment system using ship supplied potable water shall be equipped with a reduced pressure principle sanitary back flow preventer conforming to ASSE Standard 1013 to protect the ship's potable water from cross-contamination. Where pressurized backflow is not possible, an atmospheric type vacuum breaker conforming to ASSE Standard 1001 shall be used.

3.6.8 System evacuation. The treatment system shall be capable of removing all wastewater, treated or untreated, and process wastes contained within the treatment system's plumbing system and tanks, within 60 minutes at a discharge pressure that overcomes the static head loss as seen on the intended ship as specified (see 6.2) when configured for overboard discharge or shore side removal, whichever is greater.

3.6.9 Discharged vapor/gas.

3.6.9.1 Properties of discharged vapor/gas. Any toxic, hazardous, flammable, explosive, or malodorous vapors produced by the treatment system shall not be vented, or allowed to escape, into any shipboard space. Any such vapors that are produced must be removed, diluted with air, or otherwise rendered safe before being discharged to the ship's ventilation exhaust system.

3.6.9.2 Material compatibility of discharged vapor/gas. Any vapor discharges from the treatment system shall be compatible, with no evidence of deleterious effect, with the ship's ventilation exhaust system, as applicable.

3.6.9.3 Air escapes. The treatment system shall be capable of being vented to the weather and provided with a means to prevent an explosion or over pressurization as a result of an accumulation of gases.

3.6.10 Control and operation. The treatment system shall be fully automatic and shall be equipped with a control system that performs the following: automatically monitors and controls operation, automatically activates alarms, automatically acquires system data, provides visual display of system data, and automatically precludes unsafe operation. The control system shall interface with the ship's centralized control system (Integrated Condition Assessment System (ICAS)) to provide remote monitoring and condition assessment.

3.6.10.1 Operational modes. The treatment system shall provide the following modes of operation:

a. Start-up (initialization): The treatment system shall include a start up mode in which power is turned on and, at a minimum, shall automatically accomplish the following:

(1) Achieve the internal operating parameters, such as temperature and pressure ranges, as recommended by the manufacturer to achieve steady state conditions needed for processing.

(2) Display current and stored initialization data.

(3) Prompt operator to make any required parametric changes.

(4) Enter the standby mode or process mode, as determined by manufacturer.

b. Standby mode: The treatment system shall include a standby mode in which the system shall power down automatically to a minimum power consumption level and remain ready for all other modes of operation. With the possible exception of compressed air, there is no flow into or out of the system in this mode. If necessary, the system shall automatically continue certain functions as needed by the treatment system such as recirculation of the wastewater to avoid settling of solids in system tanks and aeration to sustain the biomass. This operating mode shall allow the treatment system to stop processing if there is a problem.

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c. Process mode: The treatment system shall include a process mode in which the system automatically treats the wastewater influent. In this mode, the treatment system shall, at a minimum, automatically perform the following functions: receive the wastewater influent, control feed acceptance rate, transfer wastewater within the system, control internal pressure and temperature, replenish consumables (if applicable), perform operational self-cleaning cycles (if applicable), and deliver treated effluent. All operation of system equipment (i.e., pumps, blowers, and valves) shall be automatic and based on instrumentation and programmable logic controller (PLC) or equivalent control. The system will be in full unattended automatic operation during this mode.

d. Manual mode: The treatment system shall include a manual mode that overrides the automatic controls and interlocks, with exception of safety interlocks, to allow the following functions: local manual startup, operation for indefinite periods of time, manufacturers recommended maintenance including cleaning of system tanks, shutdown of the system, calibration of system sensors including sequential monitoring of all sensors during adjustments, cycling of system pumps and valves to allow operator checks, and testing of the system lamps and alarms. Manual mode system operation shall not be adversely affected by the loss of the entire automatic control system or any individual element of the control system.

e. Shutdown mode: The treatment system shall include a shutdown mode that safely returns the system to a non-powered state. The shutdown process shall be automatic and shall include all cleaning and purging actions needed to prepare the system for lay-up as well as subsequent startup.

3.6.10.2 Monitoring and control. The control system shall monitor and automatically adjust the appropriate subsystems to maintain system operation and performance as specified herein and prevent operation that might result in damage to the system or endanger the ship or personnel. All subsystems shall self-monitor their respective operating parameters (i.e., flow, pressure). The control system shall incorporate a programmable logic controller (PLC) or equivalent and a message display unit that provides a visible display of system status and allows operator access to all modes and conditions with, for example, keypad pushbuttons. The control system shall incorporate a system control switch (STARTUP, STANDBY, PROCESS, MANUAL, and SHUTDOWN) to provide control between operating modes. Emergency shut down switches shall be provided locally near the treatment system control panel, as well as remotely outside the space containing the treatment system. An elapsed-time meter shall be provided for each system pump. The main pump of any redundant pair (see 3.9.9) shall automatically be alternated between each operating cycle in order to balance pump wear. Emergency shutdown or automatic restart of the system shall be controlled and shall not cause a hazardous condition to the ship or personnel. The treatment system shall go into an automatic fail-safe (see 6.4.7) shut down, as determined by the manufacturer, upon entering any operating condition that might result in damage to the system, or endanger the ship or personnel. The treatment system shall restart operation automatically upon power return after a power loss to the system. The treatment system shall activate audible and visual alerts and alarms as specified herein. The treatment system shall have the means for logging data on all alerts and alarms triggered by the system.

3.6.10.3 Alerts and alarms.

3.6.10.3.1 Audible alerts and alarms. The treatment system shall provide audible alerts and alarms that automatically sound both locally and remotely via the ship's ICAS. The control system shall have the capability for the operator to acknowledge the alarm signal and silence/mute the audible signal for silent operations. All treatment system audible alerts and alarms shall remain active until the alert/alarm is silenced, or the cause is corrected when the alert/alarm is not silenced. An audible alarm shall be unique from an audible alert to allow the operator to discriminate between the two. Audible alerts shall be provided for the following: degraded operations, failure (see 6.4.8) of one or more non-critical components, maintenance action required, low consumables, power supply interruptions, and any tank change in status indicating discharge overboard or to shore. Audible alarms shall be provided for any operating condition that might result in damage to the system, failure of the system, or endanger the ship or personnel. All treatment system audible alerts and alarms shall employ procedures to prevent inadvertent or nuisance alerts and alarms during transient operations (i.e., system start-up, shutdown) or from transient conditions (i.e., electrical spikes or pulses, electronic noise, ship's dynamic motion). All treatment system audible alerts and alarms shall be capable of being tested at the control panel.

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3.6.10.3.2 Visual alerts and alarms. The treatment system shall provide visual alerts and alarms both locally at the control panel and remotely via the ship's ICAS. The control system shall have the capability for the operator to acknowledge the visual alert or alarm. All treatment system visual alerts and alarms shall remain in the viewing area until the alert/alarm cause is corrected. Visual alert and alarm indicators shall show what caused the alert or alarm. Visual alarms shall be unique from visual alerts to allow the operator to discriminate between the two. Visual alerts shall be provided for the following: degraded operations, failure of one or more non-critical components, maintenance action required, low consumables, power supply interruptions, and any tank change in status indicating discharge overboard or to shore. Visual alarms shall be provided for any operating condition that might result in damage to the system, failure of the system, or endanger the ship or personnel. All visual alerts and alarms shall employ procedures to prevent inadvertent or nuisance alerts and alarms during transient operations (i.e., system start-up, shutdown) or from transient conditions (i.e., electrical spikes or pulses, electronic noise, ship's dynamic motion). All visual alerts and alarms shall be capable of being tested at the control panel.

3.6.10.4 Displays. The treatment system shall display in English standard units the real time status of the system locally at the control panel and remotely via the ship's ICAS. The information displayed shall include, but not be limited to, key operating parameters such as the following: treatment status; flow rates of influent; treated effluent and process streams; volume of treated effluent; operating hours of equipment; system temperature; and tank status (i.e. treatment, overboard discharge). Additional display parameters required for the intended ship as specified (see 6.2) shall also be provided.

3.6.10.5 Data acquisition and retrieval. The treatment system shall, at a minimum, monitor, save data values and allow retrieval of data by trained personnel of the status conditions and operating parameters listed below as well as others as determined by the manufacturer. The control system shall be capable of saving data sets at 1-hour intervals for a period of 200 hours of operation before data retrieval is required. When operated beyond 200 hours, the control system shall be capable of saving the most recent data sets recorded within the last 200 hours of operation. Provisions shall be made to allow transfer of data from the control system PLC to an Ethernet port on a laptop computer that includes software as specified in 6.2. The physical connection on the treatment system control panel for the laptop computer shall be accessible without opening the control panel. Below is a list of the minimum set of status conditions and operating parameters that the system shall monitor, save, and allow data retrieval. Additional conditions and parameters required for the intended ship as specified (see 6.2) shall also be provided.

a. Date and time (year, month, day, hour, and minute in Greenwich Mean Time).

b. System status (standby, processing, cleaning, alarm conditions).

c. Alert and alarm log data.

d. Flow rates of influent streams and treated effluent discharged.

e. Total gallons of treated effluent discharged.

f. Total gallons of process wastes discharged (if produced).

g. Date, time, and subsequent duration of a process wastes discharge event (if produced).

h. Aeration pressure (if provided).

i. Status of measured consumables (if used).

j. All sensor inputs providing a controlling function.

k. Influent temperature.

l. Effluent temperature (for systems that raise water temp by more than 10 °F).

m. Pump and motor run time and temperature.

3.6.10.6 Sensors and instruments. All sensors used in the treatment system shall be calibrated to the minimum accuracy required by the sensor manufacturer.

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3.7 Shipboard interfaces.

3.7.1 Ship functional interfaces. The treatment system functional interfaces with the ship systems shall be compatible with the applicable shipboard electrical power, data, hydraulic, and pneumatic supply characteristics defined in Table III. The treatment system shall meet the user equipment interface requirements of MIL-STD-1399, Section 300 for ungrounded (as related to the electric power system ground) equipment using Type I power. Grounding and bonding of the treatment system electrical and electronic subsystems and equipment, including chassis and frames of electrical equipment with conductive cases to the ship's substructure, shall meet the electrical safety and effective low-impedance radio frequency (RF) connection requirements in MIL-STD-1310.

TABLE III. Shipboard interfaces.

System interface	Ship interface (ship side of the interface)
Blackwater Supply	System: Gravity or Vacuum Sewage Collection System Physical: Connection in accordance with (IAW) MIL-STD-777, Category R, Group 4. Supply characteristics: Temperature: 36 °F to 95 °F
Graywater Supply	System: Gravity Graywater Collection System Physical: Connection IAW MIL-STD-777, Category R, Group 3. Galvanized steel shall not be used for vents. Supply characteristics: Temperature: 36 °F to 150 °F
Treated Effluent Discharge	System: Overboard Discharge System Physical: Connection IAW MIL-STD-777, Category R, Group 1.
Process Wastes Discharge	System: Sewage Transfer System with Pier Connection Physical: Connection IAW MIL-STD-777, Category R, Group 4.
System Evacuation	System: Sewage Transfer System with Pier Connection Physical: Connection IAW MIL-STD-777, Category R, Group 4.
Tank Vent	System: Tank Air Escapes Physical: Connection IAW MIL-STD-777, Category R, Group 4.
Off-Gas Vent	System: Ventilation Exhaust System Physical: Connection IAW MIL-STD-777, Category R, Group 4.
Potable Water Supply (if used)	System: Potable Water System Physical: Connection IAW MIL-STD-777, Category C, Group 2. Supply characteristics: Pressure: 60 psig Flow rate: 10 gpm Temperature: 70 °F Bromine or chlorine residual: 0.2 mg/L

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TABLE III. Shipboard interfaces - Continued.

System interface	Ship interface (ship side of the interface)
Compressed Air Supply (if used)	System: Compressed Air Service System Physical: Connection IAW MIL-STD-777, Category J, Group 4. Supply characteristics: Pressure: 125 psig Wet bulb temperature: 81 °F (assuming space temp. is 90 °F max) Hydrocarbon Contaminant: Max. 50 ppm by weight Particulate Contaminant: Max. 5 micron
Seawater Supply (if used)	System: Sea Water Service System (firemain) Physical: Connection IAW MIL-STD-777, Category D, Group 1. Supply characteristics: Pressure: 100 to 175 psig Flow rate: 100 to 200 gpm Temperature: 28 °F to 85 °F Salinity: Min. near 0 ppt, Max. 40 ppt
Electrical Power Supply	System: Electrical Power Distribution System Physical: Conductor identification of control and signal cables IAW IEEE 45. Supply characteristics: IAW MIL-STD-1399, Section 300, Type I Power (440/115 Vac, 60 Hz, 3 phase).
Data (Remote Monitoring)	System: Integrated Condition Assessment System (ICAS) Physical: see 6.2. Functional: IAW IEEE 1451.2, IEEE 1284, MIL-STD-1553, and 6.2.

3.7.2 Ship physical interfaces. The treatment system interfacing pipe connections shall be compatible with the mating shipboard interface connection defined in Table III. The treatment system shall provide a means for attachment to a steel deck. The interfacing structural mounts shall be independent from the connecting shipboard pipes. The treatment system electrical and electronic subsystems and equipment, including chassis and frames of electrical equipment with conductive cases, shall provide a means for grounding the major metallic frames or assemblies to the ship structure in accordance with MIL-STD-1310.

3.8 Hydrostatic integrity. All portions of the treatment system designed to operate under pressure shall withstand a hydrostatic test pressure of 50 psi or 150 percent of the system design pressure as determined by the manufacturer, whichever is greater, using clean freshwater or seawater for a period of not less than 1 hour. When pressure is applied and maintained for the specified period, there shall be no sign of leakage, material deformation or rupture, or other defects that harmfully affect the performance and serviceability of the treatment system.

3.9 Reliability, maintainability, and availability.

3.9.1 Operational availability (A_O). The operational availability (see 6.4.24) of the treatment system shall be no less than 0.90 over a 6-month deployment period.

3.9.2 MTBCF. The predicted Mean-Time-Between-Critical-Failure (MTBCF) (see 6.4.20) of the treatment system shall be no less than 4,320 hours based on a 6-month deployment period.

3.9.3 MTBF. The Mean-Time-Between-Failure (MTBF) (see 6.4.21) of the treatment system shall be no less than 500 hours at a 90 percent confidence level.

3.9.4 Maintenance ratio. The maintenance ratio (see 6.4.16) for the treatment system shall not exceed 0.03 at the organizational level.

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3.9.5 MTTR. The Mean-Time-To-Repair (MTTR) (see 6.4.22) of any treatment system failure shall not exceed 5 man-hours, 95 percent of the time, at the organizational level by a U.S. Navy Hull Technician or Damage Controlman with no more than 5 hours of formal equipment training.

3.9.6 MaxTTR. The maximum time to repair (MaxTTR) (see 6.4.19) of any treatment system failure shall not exceed 12 man-hours, 95 percent of the time, at the organizational level by a U.S. Navy Hull Technician or Damage Controlman with no more than 5 hours of formal equipment training.

3.9.7 Accessibility. When installed on the intended ship as specified (see 6.2), the treatment system shall be constructed and arranged so that all major system assemblies, attachments, and non-hull integrated retention tanks are accessible for maintenance, repair, and replacement without requiring the removal of other major assemblies and temporary attachments. The maintenance access for system tanks shall be located near the top of the tank with an external access ladder provided where required. For systems where filter membranes, electrodes, or other components that must be routinely replaced, access shall be provided without the need to remove system components other than an access door or hatch.

3.9.8 Sampling ports. The treatment system shall allow manual sampling without opening the system tanks of the treatment system influent, treated effluent, sludge (see 6.4.26), and vapors produced by the treatment system.

3.9.9 Redundant pumps. The treatment system shall incorporate 100 percent redundancy for all pumps that are critical to meet system performance as specified herein. The manufacturer shall specify the maximum pump hours before maintenance is required and pump operation rotation schedule to balance pump wear.

3.10 Safety. The treatment system shall present no uncontrolled safety or health hazard to operating or maintenance personnel while the system is secured or during operation. The treatment system shall safely hold and transfer all malodors, gases, smoke, and toxic substances including collected wastewater, without risk of contamination or exposure to operating or maintenance personnel. Any fluid transfer subsystem shall prevent splatter, spillage, or other loss of liquids from any system component during operation or when secured.

3.11 Identification marking. All treatment system parts shall have permanently affixed and legible markings identifying the manufacturer's name, model and serial number, and inspection lot identification. In addition, electrical enclosures shall include permanently affixed and legible markings identifying the voltage, frequency, maximum horse-power rating, and low noise, if applicable. All system piping shall be identified for its specific service (i.e., potable water), pressure, size, and direction.

3.12 Human factors. All man-to-machine interfaces, such as controls, displays, alerts and alarms, labeling, environment, and accessibility, shall be suitable for user personnel with fifth through ninety-fifth percentile anthropometrical data as defined in ASTM F1166.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.1.1).

b. Conformance inspection (see 4.1.2).

4.1.1 First article inspection. A first article inspection shall be performed as specified herein on a minimum of one complete fully functional treatment system when a first article is required (see 3.2). This inspection shall consist of one or both of the following options:

a. Laboratory evaluation of a fully functional full-scale (see 6.4.11) treatment system or fully functional scaled-down (see 6.4.12) treatment system.

b. Shipboard evaluation of a fully functional treatment system (full-scale or scaled-down), if required (see 6.2).

4.1.1.1 Laboratory evaluation (full-scale). A full scale laboratory evaluation shall be performed if practical as specified (see 6.2). The full-scale laboratory evaluation shall consist of the examinations, analyses, and tests listed in Table IV and as specified in sections 4.2 through 4.4.

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4.1.1.2 Laboratory evaluation (scaled-down). If a full-scale laboratory evaluation is not practical, a laboratory evaluation shall be performed with a fully functional scaled-down treatment system as specified (see 6.2). The laboratory evaluation shall consist of the examinations, analyses, and tests listed in Table IV and as specified in sections 4.2 through 4.4.

4.1.1.3 Shipboard evaluation. A shipboard evaluation may be performed subsequent to a laboratory evaluation. This test shall be performed with a full-ship complement. The shipboard evaluation shall consist of the examinations, analyses and tests listed in Table IV and as specified in sections 4.2 through 4.4.

4.1.2 Conformance inspection. A conformance inspection shall be performed as specified herein on each production unit. This test shall include the examinations and tests listed in Table IV and as specified in sections 4.2 through 4.4.

TABLE IV. Inspection requirements.

Attribute	Requirement	Verification method	First article inspection			Conformance inspection
			Lab evaluation (scaled-down)	Lab evaluation (full-scale)	Shipboard evaluation	
Materials	3.3					
Chemical resistance	3.3.1	4.3.1	X	X	X	
Dissimilar metals	3.3.2	4.3.1	X	X	X	
Material deterioration, prevention and control	3.3.3	4.3.1	X	X	X	
Hazardous and ozone depleting materials	3.3.4	4.3.1	X	X	X	
Electrical cable and cord materials	3.3.5	4.3.1	X	X	X	
Recycled, recovered, or environmentally preferable materials	3.3.6	4.3.1	X	X	X	
Ship environment considerations	3.4					
Shock	3.4.1	4.4.2.1	X	X		
Environmental vibration	3.4.2	4.4.2.2	X	X		
Internally excited vibration	3.4.3	4.4.2.3	X	X		
Airborne noise	3.4.4	4.4.2.4	X	X		
Structureborne noise	3.4.5	4.4.2.5	X	X		

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TABLE IV. Inspection requirements – Continued.

Attribute	Requirement	Verification method	First article inspection			Conformance inspection
			Lab evaluation (scaled-down)	Lab evaluation (full-scale)	Shipboard evaluation	
Electromagnetic interference and compatibility	3.4.6	4.4.2.6	X	X		
High and low temperature	3.4.7	4.4.2.7, 4.4.2.8	X	X		
Humidity	3.4.8	4.4.2.9	X	X		
Salt fog	3.4.9	4.4.2.10	X	X		
Water spray	3.4.10	4.4.2.11	X	X	X	
Dynamic inclination	3.4.11	4.4.2.12	X	X		
Static inclination	3.4.12	4.4.2.13	X	X		
Physical characteristics	3.5					
Physical size	3.5.1	4.2a	X*	X	X	
Weight	3.5.2	4.3.2	X*	X	X	
Modularity	3.5.3	4.2b	X	X	X	
Performance characteristics	3.6					
Processing performance	3.6.1					
Process rate (Class 1)	3.6.1.1	4.4.4.1b, 4.4.4.1e	X*	X	X	
Process rate (Class 2 and 3)	3.6.1.1	4.4.4.1b	X*	X	X	
Cold start	3.6.1.2	4.4.4.1a	X	X	X	
Hot start	3.6.1.3	4.4.4.1f	X	X	X	
Chemicals in the influent	3.6.1.4	4.3.12	X	X	X	
Effluent quality and removal	3.6.2					
Effluent discharge standards	3.6.2.1	4.4.4.1	X	X	X	
Effluent removal	3.6.2.2	4.3.3		X	X	

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TABLE IV. Inspection requirements – Continued.

Attribute	Requirement	Verification method	First article inspection			Conformance inspection
			Lab evaluation (scaled-down)	Lab evaluation (full-scale)	Shipboard evaluation	
Material compatibility of effluent	3.6.2.3	4.3.1	X	X	X	
Process wastes management	3.6.3					
Process wastes holding capacity	3.6.3.1	4.4.4.1e	X*	X	X	
Process wastes removal	3.6.3.2	4.3.3	X	X	X	
Tank volume	3.6.4	4.3.4	X*	X	X	
Consumables volume	3.6.5	4.3.5	X*	X	X	
Tank cleaning	3.6.6	4.4.4.1g	X	X	X	
Back flow prevention	3.6.7	4.2c	X	X	X	
System evacuation	3.6.8	4.3.3		X	X	
Discharged vapor/ gas	3.6.9					
Properties of discharged vapor/ gas	3.6.9.1	4.2d	X	X	X	X
Material compatibility of discharged vapor/ gas	3.6.9.2	4.3.1	X	X	X	
Air escapes	3.6.9.3	4.2d	X	X	X	X
Control and operation	3.6.10	4.4.3.3	X	X	X	X
Operational modes	3.6.10.1	4.4.3.3	X	X	X	X
Monitoring and control	3.6.10.2	4.4.3.3	X	X	X	X
Alerts and alarms	3.6.10.3					
Audible alerts and alarms	3.6.10.3.1	4.4.3.3	X	X	X	X
Visual alerts and alarms	3.6.10.3.2	4.4.3.3	X	X	X	X
Displays	3.6.10.4	4.4.3.3	X	X	X	X
Data acquisition and retrieval	3.6.10.5	4.4.3.4, 4.4.4.1d	X (4.4.4.1d)	X (4.4.4.1d)	X (4.4.4.1d)	X (4.4.3.4)
Sensors and instruments	3.6.10.6	4.3.11	X	X	X	X

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TABLE IV. Inspection requirements – Continued.

Attribute	Requirement	Verification method	First article inspection			Conformance inspection
			Lab evaluation (scaled-down)	Lab evaluation (full-scale)	Shipboard evaluation	
Shipboard interfaces	3.7					
Ship functional interface	3.7.1	4.4.3.1, 4.4.3.2		X	X	X
Ship physical interfaces	3.7.2	4.2e			X	
Hydrostatic integrity	3.8	4.4.1		X	X	X
Reliability, maintainability and availability	3.9					
Operational availability	3.9.1	4.3.6	X	X	X	
MTBCF	3.9.2	4.3.7	X	X	X	
MTBF	3.9.3	4.4.5	X	X	X	
Maintenance ratio	3.9.4	4.3.8	X	X	X	
MTTR	3.9.5	4.3.9	X	X	X	
MaxTTR	3.9.6	4.3.9	X	X	X	
Accessibility	3.9.7	4.2f	X	X	X	X
Sampling ports	3.9.8	4.2g	X	X	X	X
Redundant pumps	3.9.9	4.2h		X	X	X
Safety	3.10	4.3.10, 4.4.6	X (4.3.10)	X (4.3.10)	X (4.3.10)	X (4.4.6)
Identification marking	3.11	4.2i	X	X	X	X
Human factors	3.12	4.4.7	X	X	X	
*Data shall be used to scale up to a full size system to ensure verification of requirement.						

4.2 Examination. The treatment system shall first be examined for compliance with the below requirements. This element of inspection shall encompass all visual examinations of static test item to determine that physical requirements have been met. Tools (e.g., measurement devices and scales) may be used to assist this process. Noncompliance with any specified requirements or presence of one or more defects shall constitute cause for rejection.

a. Physical size as specified in 3.5.1. For scaled-down systems, the system size shall be scaled up to a full size system to ensure compliance with the space restriction in 3.5.1.

b. Modularity of assembly as specified in 3.5.3. For scaled-down systems, the system modularity shall be scaled up to a full size system to ensure compliance with the access limitations in 3.5.3.

c. Use of a backflow preventer as specified in 3.6.7.

d. System is equipped and configured to vent discharged vapor/gases as specified in 3.6.9.1 and 3.6.9.3.

e. Ship physical interfaces as specified in 3.7.2.

f. Accessibility of system for maintenance as specified in 3.9.7.

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g. Use of sampling ports as specified in 3.9.8.

h. Use of redundant pumps as specified in 3.9.9.

i. Identification marking as specified in 3.11.

4.3 Analyses.

4.3.1 Material. Compliance with the material requirements in 3.3.1 through 3.3.6, 3.6.2.3 and 3.6.9.2 shall be determined by inspection of manufacturer records providing proof or certification that materials conform to requirements. Applicable records shall be as specified (see 6.2). Any hazardous materials used in the treatment system or system components, or that is required to be used during its shipboard operation, shall be screened for material compatibility and compliance with environmental, safety, and health (ESH) criteria for the intended ship as specified (see 6.2) to minimize potential hazards to human health and the environment.

4.3.2 System weight. Compliance with the weight restriction in 3.5.2 shall be verified by analysis providing proof or certification that the treatment system will meet the weight restriction provided for the intended ship as specified (see 6.2). For scaled-down systems, the system weight shall be scaled up to a full size system to ensure compliance with the weight restriction in 3.5.2.

4.3.3 Treated effluent and process wastes removal. Compliance with the treated effluent removal requirement in 3.6.2.2, process wastes removal requirement in 3.6.3.2, and system evacuation requirement in 3.6.8 shall be verified by analysis (i.e., ensuring pumps are sized sufficiently to overcome distance from bottom of ship to discharge point).

4.3.4 Tank volume. Compliance with the tank volume restriction in 3.6.4 for systems relying on tanks integral with the ship's hull shall be verified by analysis providing proof or certification that the treatment system will meet the tank volume restriction provided for the intended ship as specified (see 6.2). For scaled-down systems, the tank volume shall be scaled up to that required by a full size system to ensure compliance with the volume restriction in 3.6.4.

4.3.5 Consumables volume. Compliance with the consumables volume restriction in 3.6.5 shall be verified by analysis providing proof or certification that the treatment system will meet the consumables stowage volume restriction provided for the intended ship as specified (see 6.2). For scaled-down systems, the consumables volume shall be scaled up to that required by a full size system to ensure compliance with the volume restriction in 3.6.5.

4.3.6 Operational availability. Compliance with the A_O in 3.9.1 shall be verified by analysis providing proof or certification that the treatment system will achieve the stated A_O. Shutdowns or interruptions resulting from failures external to the system, such as loss of ship service air or electrical power, shall be exempted as a system failure.

4.3.7 MTBCF. Compliance with the MTBCF in 3.9.2 shall be verified by analysis using reliability prediction methods approved by the appropriate government authority. Shutdowns or interruptions resulting from failures external to the system, such as loss of ship service air or electrical power, shall be exempted as a system failure.

4.3.8 Maintenance ratio. Compliance with the maintenance ratio in 3.9.4 shall be verified by analysis using test data obtained during operational testing. The scheduled and unscheduled maintenance shall be timed, accumulated, and converted to a maintenance ratio. Only scheduled maintenance in the manufacturers recommended maintenance schedule shall be permitted. Scheduled maintenance time includes time to perform periodic prescribed inspection and servicing of the system that includes replacement of consumables. Unscheduled maintenance time includes the time for fault isolation, disassembly, repair or replacement of faulty components, re-assembly, and replacement of consumables if necessary. Administrative or logistics delay times shall not be included in either the scheduled or unscheduled maintenance times. Shutdowns or interruptions resulting from failures external to the system, such as loss of ship service air or electrical power, will be exempted as a system failure.

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4.3.9 MTTR and MaxTTR. Compliance with the MTTR in 3.9.5 and MaxTTR in 3.9.6 shall be verified by analysis using test data obtained for corrective maintenance (see 6.4.3) performed during operational testing, or if necessary, during a maintainability demonstration where faults are simulated (i.e., introduction of faulty parts, deliberate misalignment, open leads, shorted parts) to induce failures for repair. The observed MTTR and MaxTTR shall include time for maintenance preparation, fault location and isolation, fault correction, adjustment and calibration, as well as follow-up checkout time. The observed MTTR and MaxTTR shall not include the time required to shutdown and start-up the system or time lost due to administrative or logistical delays.

4.3.10 Safety (first article inspection). For first article inspection, verification of the safety requirements in 3.10 shall be accomplished by a hazard analysis and by the demonstration during the functional and operational testing specified herein.

4.3.11 Sensors. Compliance with the sensor calibration requirement in 3.6.10.6 shall be verified by analysis providing proof or certification that the system sensors are calibrated to the minimum accuracy required by the sensor manufacturer.

4.3.12 Chemicals in the influent. Compliance with the chemicals in the influent requirement specified in 3.6.1.4 shall be determined by inspection of documents provided by the manufacturer.

4.4 Tests.

4.4.1 Hydrostatic pressure test. All pressurized portions of the treatment system shall be subjected to a hydrostatic pressure test as specified in 3.8. The system shall be examined during and after the hydrostatic pressure test to verify the system experiences no damage or defects as defined in 3.8.

4.4.2 Ship environment compatibility tests.

4.4.2.1 Shock. The treatment system shall be shock tested in accordance with MIL-S-901 to demonstrate compliance with the shock requirement in 3.4.1.

4.4.2.2 Environmental vibration. The treatment system shall be tested in accordance with MIL-STD-167-1 to demonstrate compliance with the vibration requirement in 3.4.2.

4.4.2.3 Internally excited vibration. The treatment system shall be tested in accordance with MIL-STD-167-1 to demonstrate compliance with the vibration requirement in 3.4.3.

4.4.2.4 Airborne noise. The treatment system shall be tested for airborne noise in accordance with MIL-STD-1474 to demonstrate compliance with the noise requirement in 3.4.4.

4.4.2.5 Structureborne noise. The treatment system shall be tested for structureborne noise tests in accordance with MIL-STD-740-2 to demonstrate compliance with the noise requirement in 3.4.5.

4.4.2.6 Electromagnetic interference and compatibility. The treatment system shall be subjected to the electromagnetic interference and compatibility tests in MIL-STD-461 to demonstrate compliance with the requirement in 3.4.6.

4.4.2.7 High temperature. The treatment system shall be tested for high temperature storage and operation in accordance with MIL-STD-810, method 501.4, procedure I for storage, and procedure II for operation to demonstrate compliance with the high temperature requirements in 3.4.7. Procedure I shall be performed prior to procedure II. The maximum ambient test temperature for the operating temperature and storage temperature shall be the upper limits specified in 3.4.7 for the applicable environment. The constant temperature method shall be used for both the operating and storage high temperature tests. Two sets of operational high temperature tests shall be performed, one using the maximum influent temperature in 3.4.7 for the intended influent category as specified (see 6.2) and one at the minimum influent temperature in 3.4.7 for the intended influent category as specified (see 6.2).

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4.4.2.8 Low temperature. The treatment system shall be tested for low temperature storage and operation in accordance with MIL-STD-810, method 502.4, procedure I for storage, and procedure II for operation to demonstrate compliance with the low temperature requirements in 3.4.7. Procedure I shall be performed prior to procedure II. The lowest test temperature for operating and the lowest test temperature for the storage temperature shall be the lower limits specified in 3.4.7 for the applicable environment. The treatment system equipment shall be winterized in accordance with the manufacturers' instruction and system tanks emptied prior to the low temperature storage test. The constant minimum temperature shall be maintained for a period of 16 hours for the storage temperature test. Two sets of operational low temperature tests shall be performed, one using the maximum influent temperature in 3.4.7 for the intended influent category as specified (see 6.2) and one at the minimum influent temperature in 3.4.7 for the intended influent category as specified (see 6.2).

4.4.2.9 Humidity. The treatment system shall be tested for the effects of a warm humid environment in accordance with MIL-STD-810, method 507.4 to demonstrate compliance with 3.4.8. The maximum air temperature for this test shall be 122 °F, which is modified from MIL-STD-810/507.4 to reflect the maximum ambient air temperature in 3.4.7 for treatment system when operating.

4.4.2.10 Salt fog. The treatment system shall be tested for corrosion, electrical, and physical effects of an aqueous salt atmosphere in accordance with MIL-STD-810, method 509.4 to demonstrate compliance with 3.4.9.

4.4.2.11 Water spray. With the system powered off, demonstrate the water tightness of the treatment system, as required in 3.4.10, by exposing all parts of the system to a water hose down test in accordance with NEMA 250.

4.4.2.12 Dynamic inclination. The treatment system shall be subjected to the inclination angles and cyclic rate as specified in 3.4.11 for a period of 30 minutes and then returned its normal operating position. During this test, the treatment system shall then be operated to ensure that continuous operation can be maintained. Upon completion of this test, the system shall be subjected to the static inclination test in 3.4.12.

4.4.2.13 Static inclination. At the conclusion of the dynamic inclination test, the treatment system shall be subjected to the static inclination test specified in 3.4.12 for one side. While maintaining the inclination angle, the treatment system shall then be operated for a period of 1 hour to ensure that continuous operation can be maintained. This test shall be repeated once more with the treatment system rotated 180 degrees about the vertical axis.

4.4.3 Electrical tests.

4.4.3.1 Electrical power interface compatibility. The treatment system shall be tested in accordance with the user equipment tests defined in MIL-STD-1399, Section 300 to verify shipboard electrical power interface compatibility as defined in 3.7.1.

4.4.3.2 Grounding and bonding. Treatment system electrical and electronic equipment, including chassis and frames of electrical equipment with conductive cases, shall be inspected and tested in accordance with MIL-STD-1310 to verify equipment bonding and grounding potentials and RF impedance do not exceed the limit specified in 3.7.1.

4.4.3.3 Control system functional test. The treatment system shall be tested as follows to verify the control system's functional operation as specified in 3.6.10.1 through 3.6.10.4. For the duration of these tests, the system shall be filled with clean tap water. These tests shall be performed prior to first article testing. Verification of the data acquisition and retrieval functionality in 3.6.10.5 shall be accomplished as specified in 4.4.4.1d for first article inspection and as specified in 4.4.3.4 for conformance inspection.

a. With the treatment system powered ON, turn the control panel into all available modes of operation in accordance with the manufacturer's instructions to demonstrate the functional operation in 3.6.10.1 and 3.6.10.2. Verify that all mode switching occurs without any electronic errors and that the message display clearly indicates which mode the system resides. Verify the displays indicate as specified in 3.6.10.4.

b. Inspect the treatment system to verify that it is equipped with local and remote emergency shutdown switches. Separately activate each switch while the system is in operation to demonstrate emergency shut down is accomplished as specified in 3.6.10.2.

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c. Operate the treatment system in the automatic processing mode. After 1 hour of operation, simulate a catastrophic tank leakage for one system retention tank by manually draining the contents to demonstrate the audible and visual alarm reaction as specified in 3.6.10.3 and fail-safe shutdown reaction as specified in 3.6.10.2. Repeat this test for all other system retention tanks. During this test, verify that all elapsed time meters function as specified in 3.6.10.4.

d. Operate the system in the automatic processing mode and then either create a high discharge backpressure condition by shutting off the discharge valve leading from the treatment system under test, or simulate via PLC or control system. Verify the system alarms as specified in 3.6.10.3 and goes into fail-safe shutdown as specified in 3.6.10.2.

e. If pneumatically operated devices are used in the system, shut off the air supply while the treatment system is in operation to demonstrate the system either alerts or alarms as specified in 3.6.10.3 and goes into fail-safe shutdown as specified in 3.6.10.2. Furthermore, verify the valve's fail-safe closed.

f. All alert and alarm conditions shall be simulated to demonstrate the following: audio alerts and alarms function as specified in 3.6.10.3.1, visual alerts and alarms function as specified in 3.6.10.3.2, and fail-safe shut down is accomplished as specified in 3.6.10.2.

g. All sensors shall be tested to demonstrate that they display readings throughout the course of system testing.

4.4.3.4 Data acquisition/retrieval test (conformance). For conformance inspection, compliance with the data acquisition and retrieval requirements in 3.6.10.5 shall be demonstrated during a 24-hour test. For the duration of this test, the system shall be filled with clean tap water. During the test, the status of all saved data shall be viewed at least once to ensure data is saved in accordance with the manufacturer's specifications. All data sets from the control system PLC or equivalent saved during this test shall be downloaded at least once, then uploaded and viewed on a laptop computer that includes software as required to demonstrate the ability to retrieve data in accordance with the manufacturer's specifications.

4.4.4 First article operational test. This test shall demonstrate that the first article treatment system meets the operational capabilities specified herein for the intended ship or ship class, treatment class, influent category, and discharge standard as specified (see 6.2).

4.4.4.1 Test procedure. This test, which is a series of sub-tests, shall demonstrate that a first article treatment system meets the operational capabilities specified herein for the intended ship or ship class, treatment class, influent category, and discharge standard as specified (see 6.2). The treatment system shall be operated and maintained in accordance with the manufacturer's instructions during the test. The test influent for this test shall be as defined in 4.4.4.2. For each contaminant, effluent samples shall meet the effluent discharge standard in Table II in 3.6.2.1. The following shall be performed:

a. Cold start test. The treatment system shall be subjected to a cold start test in order to demonstrate the system's ability to comply with the target effluent discharge standard as specified (see 6.2) in Table II within the "cold start" time constraint in 3.6.1.2. The treatment system shall be placed into the automatic START-UP mode to begin the test. System feed and effluent sampling shall be as specified in 4.4.4.3a.

(1) Laboratory test. During this period, the system shall process the sample influent at the average daily hydraulic loading rate defined in Table I and the test influent characteristics defined in 4.4.4.2.

(2) Shipboard test. During this period, the system shall process available ship influent with a full ship complement.

b. Processing and effluent quality test. Upon successful completion of the "cold start test" above (see 4.4.4.1a), the treatment system shall be subjected to a processing test lasting a minimum of 10 consecutive days of normal operation. The cold start shall not be used as part of the processing test. System feed and effluent sampling shall be as specified in 4.4.4.3a. This processing test is the main evaluation procedure of this performance specification and shall demonstrate compliance of the system to meet effluent discharge standards in 3.6.2.1 and the processing capabilities in 3.6.1.1.

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(1) Laboratory test. For a laboratory evaluation, performance shall be demonstrated under the following conditions:

(a) Average daily feed volume from Table I shall be used 80 percent of the test time.

(b) Maximum daily feed volume from Table I shall be used 20 percent of the test time.

(2) Shipboard test. Performance shall be demonstrated under the ship conditions presented during the test period with a full ship complement.

c. Process wastes holding test. During the processing test in 4.4.4.1b, the treatment system shall demonstrate compliance with the process wastes holding requirement in 3.6.3.1. The system shall record when it begins to discharge process wastes and the duration and volume of the discharge.

d. Data acquisition/retrieval test (first article). For the first article inspection, compliance with the data acquisition and retrieval requirements in 3.6.10.5 shall be demonstrated during the processing test in 4.4.4.1b. The status of all saved data shall be viewed once per day during the processing test to ensure data is saved in accordance with the manufacturer's specifications. All data sets from the control system PLC or equivalent shall be downloaded at least four times at equal intervals throughout the test, then uploaded and viewed on a laptop computer that includes software as required to demonstrate the ability to retrieve data in accordance with the manufacturer's specifications.

e. Minimum processing and effluent quality test (Class 1 only). Upon successful completion of the processing test in 4.4.4.1b, the Class 1 treatment system shall be subject to a minimum processing test. System feed and effluent sampling shall be as specified in 4.4.4.3a. This processing test shall demonstrate compliance of a Class 1 system to meet effluent discharge standards in 3.6.2.1 and the processing capabilities for minimum daily hydraulic loading rates in 3.6.1.1.

(1) Laboratory test. For a laboratory evaluation, performance shall be demonstrated processing at the minimum daily feed volume from Table I for 5 consecutive days.

(2) Shipboard test. Performance shall be demonstrated under the ship conditions presented with the available ship complement during the test period in port for 5 consecutive days which shall include one weekend.

f. Hot start test. Upon successful completion of the processing tests in 4.4.4.1b and 4.4.4.1e (Class 1 only), the treatment system shall be shutdown for a period of 12 hours to simulate the maximum time to repair defined in 3.9.6. The system shall then be restarted as a "hot start" to demonstrate the system's ability to comply with the target effluent discharge standard as specified (see 6.2) in Table II within the "hot start" time constraint in 3.6.1.3. Feed and effluent sampling shall be as specified in 4.4.4.3a.

(1) Laboratory test. During this period, the system shall process the sample influent at the average daily hydraulic loading rate defined in Table I and the normal influent characteristics defined in 4.4.4.2.

(2) Shipboard test. During this period, the system shall process available ship influent.

g. Tank wash down test. Upon successful completion of the "hot start test" in 4.4.4.1f, the system tanks shall be emptied followed by a wash down of the internal surfaces to demonstrate compliance with the tank cleaning capability in 3.6.6. Upon completion of the cleaning cycle, the treatment system shall be emptied and inspected to ensure the device has been cleaned such that there is no tank residue apparent by visual examination.

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4.4.4.2 Test influent.

a. Laboratory test. For laboratory evaluations, the wastewater test influent characteristics for a 40-sample average (see 4.4.4.3) shall be within the concentration ranges defined in Table V for normal processing, and within the temperature range defined in Table III for the target wastewater influent category. The 20-sample average (see 4.4.4.3) range values are only for use in Class 1 minimum processing testing in 4.4.4.1e. The test influent characteristics values serve to create a representative Navy waste stream and provide a consistent set of influent parameters for all treatment systems being tested. Category A and C influent (blackwater) shall be raw, untreated human sewage consisting of fecal matter, urine, and toilet paper. Category B influent (combined blackwater and graywater) shall consist of approximately 90 percent graywater consisting of raw untreated laundry water, raw untreated galley water, and approximately 10 percent raw, untreated blackwater. Category D influent (combined gravity collected blackwater and gravity collected graywater) shall consist of approximately 60 percent gravity collected graywater consisting of raw untreated laundry water, raw untreated galley water, and 40 percent gravity collected raw, untreated blackwater. Graywater shall not include industrial waste, infectious wastes, and human body wastes. The description provided shall be used to obtain a raw untreated influent in the correct range outlined in Table V.

TABLE V. Test influent characteristics.

System influent category	Parameter	40-Sample Average Range (mg/L)	20-Sample Average Range (mg/L)*
Category A (vacuum- collected blackwater)	BOD_5	2,300-2,900	2,100-3,000
	TSS	4,000-7,400	3,500-8,400
Category B (combined vacuum-collected blackwater and gravity collected graywater)	BOD_5	530-1,300	450-1,600
	TSS	700-2,400	590-3,000
	Oil and Greases (O&G) (see 6.4.23)	100-220	80-260
Category C (gravity collected blackwater)	BOD_5	700-1,300	600-1,500
	TSS	1,400-4,000	1,100-4,700
	Salinity	32,000 to 40,000	32,000-40,000
Category D (combined gravity collected blackwater and gravity collected graywater	BOD_5	600-1,200	520-1,300
	TSS	970-2,400	790-2,800
	O&G	100-220	80-260
	Salinity	32,000 to 40,000	32,000-40,000
* Only for use with Class 1 minimum processing test (see 4.4.4.1e).			

b. Shipboard test. For shipboard evaluations, the influent shall be composed of the available shipboard wastewater generated during the test period.

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4.4.4.3 Sampling and analysis.

a. Sampling for cold start, processing, and hot start tests. For systems required to meet the MARPOL discharge standards as specified (see 6.2), effluent samples shall be taken and analyzed for each of the following contaminants: BOD_5, TSS, FC, and Cl (if chlorine is used as a disinfectant). To meet the USCG discharge standards as specified (see 6.2), effluent samples shall be taken and analyzed for TSS and FC. Any disinfectant residual in the treated effluent samples shall be neutralized when the sample is collected to prevent unrealistic bacteria kill or chemical oxidation of organic matter by the disinfectant brought about by artificially extended contact times. In addition, influent samples shall be taken for each contaminant listed in Table V for the applicable influent category as specified (see 6.2). The influent samples shall be taken concurrently with each treated effluent sample taken in order to ensure proper feed concentrations for laboratory evaluations, or monitor feed concentrations for shipboard evaluations. All samples shall be analyzed as specified in 4.4.4.3b. Further sampling requirements for specific test types are provided below.

(1) Cold start test sampling. This sampling method shall be used to establish compliance to the target effluent discharge standards as specified (see 6.2) in Table II within the "cold start" time constraint in 3.6.1.2. Triplicate (3) effluent samples for each contaminant controlled by the applicable discharge standard as specified (see 6.2) shall be collected within the specific class test period to verify compliance with 3.6.1.2 and mark the end of the cold start test. In addition, influent samples for each contaminant listed in Table V for the applicable influent category as specified (see 6.2) shall be taken concurrently with each treated effluent sample taken. Cold start samples shall not be included in the analysis of the processing test in 4.4.4.1b.

(2) Processing test sampling. This sampling method shall be used to establish compliance with the effluent quality requirements in 3.6.2.1. Forty consecutive effluent samples for each contaminant controlled by the applicable discharge standard as specified (see 6.2) shall be collected within the test duration of 10 consecutive days. In addition, 40 consecutive influent samples for each contaminant listed in Table V for the applicable influent category as specified (see 6.2) shall be taken concurrently with each treated effluent sample taken. Sampling frequency shall be as provided below for the applicable test location.

(a) Laboratory test. Sampling shall consist of 4 samples per each 24-hour period obtained at equally spaced 6-hour intervals for a total of 32 samples at average daily flow (see 6.4.1), and 8 samples obtained at maximum daily flow. If the 40-sample average value of each parameter is not within the 40-sample average range specified in Table V, then the processing test shall be terminated and all processing data eliminated. A new processing test will be required.

(b) Shipboard test. A total of 4 samples per each 24-hour period shall be obtained. Sampling shall consist of 3 samples per day obtained at 8-hour intervals, and one sample per day at maximum daily flow for a total of 30 samples at average daily flow, and 10 samples at maximum daily flow.

(3) Minimum processing test sampling (Class 1 only). This sampling method shall be used to establish compliance with the effluent quality requirements in 3.6.2.1. Twenty consecutive effluent samples for each contaminant controlled by the applicable discharge standard as specified (see 6.2) shall be collected within the test duration of 5 consecutive days. In addition, 20 consecutive influent samples for each contaminant listed in Table V for the applicable influent category as specified (see 6.2) shall be taken concurrently with each treated effluent sample taken. Sampling frequency shall be as provided below for the applicable test location.

(a) Laboratory test. Sampling shall consist of 4 samples per each 24-hour period obtained at equally spaced 6-hour intervals for a total of 20 samples at minimum daily flow. If the 20-sample average value for each parameter is not within the 20-sample average range specified in Table V, then the processing test shall be terminated and all processing data eliminated. A new minimum processing test will be required.

(b) Shipboard test. A total of 4 samples per each 24-hour period shall be obtained. Sampling shall consist of 4 samples per day obtained at 6-hour intervals for a total of 20 samples at minimum daily flow.

(4) Hot start test sampling. This sampling method shall be used to establish compliance to the target effluent discharge standards (see 6.2) in Table II within the "hot start" time constraint in 3.6.1.3. Triplicate (3) effluent samples for each contaminant controlled by the applicable discharge standard as specified (see 6.2) shall be collected no later than the test period specified for the specific class following re-start. In addition, one influent sample for each contaminant listed in Table V for the applicable influent category as specified (see 6.2) shall be taken concurrently with the treated effluent sample taken. Hot start samples shall not be included in the analysis of the processing test in 4.4.4.1b.

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b. Analysis methods. Concentrations for BOD_5, TSS, FC, O&G, salinity, and free available chlorine shall be measured by an Environmental Protection Agency (EPA) certified laboratory using Standard Methods from "Standard Methods for the Examination of Water and Wastewater" (see 2.3) as shown below. Concentrations for O&G shall be measured by an EPA certified laboratory using Method 1664 from EPA report number 821-R-00-003 (see 2.3).

(1) Standard Method 5210B for BOD_5.

(2) Standard Method 2540D for TSS.

(3) Standard Methods 9221C, E and/or 9222D for FC.

(4) EPA Method 1664 for O&G.

(5) Standard Method 2520B for salinity.

(6) Standard Method 4500-Cl G for Free Chlorine.

4.4.5 MTBF. The treatment system shall demonstrate it can achieve the MTBF and confidence level in 3.9.3 during first article testing. Shutdowns or interruptions resulting from failures external to the system, such as loss of ship service air or electrical power, will be exempted as a system failure.

4.4.6 Safety (conformance inspection). For conformance inspection, verification of the safety requirements in 3.10 shall be accomplished by demonstration during the conformance testing specified herein.

4.4.7 Human factors. Compliance with the human factor requirement in 3.12 shall be demonstrated throughout testing.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order as specified (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The treatment system described in this specification is intended for use onboard Naval surface ships to process blackwater or combined blackwater and graywater, to consistently produce a liquid discharge acceptable for overboard discharge. The overall intended service life of the treatment system is 30 years for all surface ships with the exception of the aircraft carriers (CVNs), where the intended service life is 50 years.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification.

b. Request for vendor to include proof of USCG certification and vendor data demonstrating that USCG 33 CFR 159 requirements can be met, as mandated by Department of Defense Directive (DODD) 6050.4 http://www.dtic.mil/whs/directives/. In addition, request vendor to include any performance data demonstrating performance specification requirement 3.6.2.1 can be met while processing influent with characteristics similar to that listed in Table V. Copies of USCG 33 CFR 159 are available online at www.gpoaccess.gov/cfr/index.html. Copies of DODD 6050.4 are available online at www.dtic.mil/whs/directives/.

c. Request for vendor to save all data generated during all testing and submit results to the government.

d. Request for vendor to submit process flow diagrams of the treatment system that quantitatively describe all ship interfaces and support services required.

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e. When the first article is required, type of first article (see 3.2, 4.1.1, 4.1.1b), and size of the treatment system.

f. When the conformance inspection is required (see 4.1.2).

g. Material certificates (see 3.4), along with system drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data (see 4.3.1).

h. Ship information required:

(1) Ship or class of ship for which the treatment system is intended, including number of ship accommodations (see 3.6.1, 3.6.2).

(2) Treatment class, wastewater influent category and if equipped with urinals (see 1.2, 3.6.1, 3.6.2).

(3) Applicable discharge standards (see 3.6.2.1). If MARPOL requirements are specified, the level of free available chlorine must also be indicated.

(4) List of hazardous or toxic materials or ozone depleting chemicals prohibited from use aboard the intended ship (see 3.3.4) developed with guidance in accordance with the program office Hazardous Materials Management Plan (HMMP).

(5) Electromagnetic emissions and susceptibility requirements (see 3.4.6).

(6) Geometry of the space or spaces reserved for installation of treatment system equipment and non-hull integrated tanks (see 3.5.1).

(7) Weight margin reserved for treatment system (see 3.5.2).

(8) Alternate cold start requirements (see 3.6.1.2) and hot start requirements (see 3.6.1.3).

(9) Based on ship's mission, the maximum allowable system start-up period from a cold start (see 3.6.1.3).

(10) A list of ship specific chemicals that could potentially be introduced into the treatment system (see 3.6.1.4). This list will supplement the common shipboard chemicals identified in 3.6.1.4.

(11) Static head losses seen by the treatment system for discharge overboard and to a shore receiving station of the all wastewater and process wastes contained within the treatment system's plumbing system and tanks in order to empty the system (see 3.6.8).

(12) Duration of near shore or littoral operations (see 3.6.3.1) and the percentage of time in brackish water. Influent salinity may affect treatment system performance.

(13) Static head losses seen by the treatment system for process wastes removal overboard, and to a shore receiving station (see 3.6.3.2).

(14) Volume of hull integrated (ship) tanks available for treatment of the wastewater influent category (see 3.6.4).

(15) Volume of storage available for consumable materials needed to support treatment of the wastewater influent category (see 3.6.5).

(16) Overseas deployment period of the intended ship (see 3.6.5).

(17) Static head losses seen by the treatment system for removal overboard, and to a shore receiving station (see 3.6.6).

(18) Physical and functional interface specifications for ship's ICAS (see Table III).

(19) Software installed on the laptop computer to be used for analysis of downloaded data (see 3.6.10.5).

(20) Data acquisition conditions and parameters for display and retrieval (see 3.6.10.4 and 3.6.10.5).

i. Packaging requirements (see 5.1).

6.3 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. The technical manuals must be acquired under separate contract line item in the contract.

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6.4 Definitions.

6.4.1 Average daily flow. The average flow rate occurring over a 24-hour period.

6.4.2 Blackwater (or sewage). Blackwater is human body wastes and the wastes from toilets and other receptacles intended to receive or retain body waste. Also referred to as sewage.

6.4.3 Corrective maintenance. All actions performed as a result of failure to restore an item to a specified condition.

6.4.4 Critical failure. A failure or combination of failures that prevents the treatment system from processing system influent and which cannot be repaired by the ship's force within the maximum time to repair.

6.4.5 Discharge. Includes spilling, leaking, pumping, pouring, emitting, emptying, and dumping.

6.4.6 Effluent. Treated wastewater produced by the treatment system.

6.4.7 Fail-safe. A design feature or component that automatically places itself in a safe operating mode in the event of a failure.

6.4.8 Failure. The event, or inoperable state, in which any item or part of the treatment system does not, or would not, perform as previously specified. For testing purposes, a failure is defined as any malfunction that requires corrective maintenance action or that results in any of the following:

a. Degradation of performance below specified levels.

b. Damage to the treatment system by continued operation.

c. Safety hazard to personnel.

6.4.9 Fecal coliform (FC). Organisms in the intestines of warm-blooded animals that are commonly used to indicate that fecal materials and organisms capable of causing human disease are present. The analytical parameter is measured in colony forming units per 100 milliliters (cfu/100 mL) or most probable number per 100 milliliters (MPN/100 mL).

6.4.10 Five-day biochemical oxygen demand (BOD_5). The amount of oxygen used by microorganisms that break down organic matter in water in five days. The analytical parameter is measured in milligrams per liter (mg/L).

6.4.11 Fully functional full scale. When the treatment system in an evaluation is the same size and design as the single system planned for shipboard installation or the same size and design as one of the multiple modules assembled to operate as a single ship system (i.e. If a complete ship system consists of four smaller uniform systems operated side-by-side or distributed throughout the ship, then each smaller system acts as a module and can be tested as a "full scale" system.).

6.4.12 Fully functional scaled-down. When the treatment system in an evaluation is a reduced size and design than the single system planned for shipboard installation.

6.4.13 Graywater. Graywater is discarded water from deck drains, lavatories, showers, dishwashers, laundries, and garbage grinders as well as discarded water from shipboard medical facilities, but does not include industrial wastes, infectious wastes, and human body wastes.

6.4.14 Hydraulic retention time (HRT). The average amount of time a theoretical wastewater molecule is retained in a treatment system before exiting (overboard) as effluent.

6.4.15 Influent. The blackwater stream, or combined graywater and blackwater stream to be processed by the treatment system.

6.4.16 Maintenance ratio. A measure of the total maintenance manpower burden required to maintain an item. The ratio of total active maintenance man-hours (scheduled and unscheduled) to the total operating time for the treatment system.

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6.4.17 Manufacturer. A company that manufactures, assembles, or imports treatment or elimination systems for marine vessels.

6.4.18 Maximum daily flow. The maximum flow rate occurring during a 24-hour period.

6.4.19 Maximum time to repair (MaxTTR). The maximum downtime allowed to repair a non-critical failure. It includes time for maintenance preparation, fault location and isolation, retrieval of replacement part(s), fault correction, adjustment and calibration, as well as follow-up checkout time. Repair times do not include the time required to start up the system nor times due to administrative or logistics delays.

6.4.20 Mean time between critical failure (MTBCF). The total amount of operational time divided by the total number of critical failures during a stated series of missions. The reliability requirements have been selected so a system must operate without a critical failure allowing the ship to meet its operational requirements during a 6-month deployment.

6.4.21 Mean time between failure (MTBF). A basic measure of reliability for repairable items. It is the average elapsed time during which the treatment system will continuously perform within its specified limits during a particular measurement interval under stated conditions.

6.4.22 Mean time to repair (MTTR). The average elapsed corrective maintenance time needed to repair any failure. It includes time for maintenance preparation, fault location and isolation, fault correction, adjustment and calibration, as well as follow-up checkout time. Repair times do not include the time required to start up the system nor times due to administrative or logistics delays.

6.4.23 Oil and grease (O/G). Oils represent the set of greasy substances that are liquid or can be liquefied easily, and that are soluble in solvents (such as ether) but not water. Greases represent the set of thick, oily, lubricant substances that can be formed of material such as lard, rendered fats, or from petroleum-derived or synthetic oils containing thickening agents. The analytical parameter is measured in milligrams per liter (mg/L).

6.4.24 Operational availability (A_o). Measure of probability that the treatment system will be operating or capable of operation when required.

6.4.25 Process wastes. Sludge and pre-screened solids separated from the influent during a pretreatment step, if used. Such pre-screened solids include rags, tampons, cigarette filters, and paper.

6.4.26 Sludge. Sewage sludge is solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.

6.4.27 Total suspended solids (TSS). A measure of the amount of suspended solids, both organic and inorganic, found in wastewater. The analytical parameter is measured in milligrams per liter (mg/L).

6.4.28 Wastewater. Used in this document to refer to blackwater or combined blackwater and graywater, not to include oily wastewater.

6.5 Subject term (key word) listing.

Advanced oxidation treatment

Biological treatment

Electrochemical treatment

Physical/chemical treatment

Sewage

Sewage vacuum, collection, holding, and transfer

Wastewater treatment

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Custodians:
Army – AT
Navy – SH
Air Force – 99

Review activities:
Army – GL, GL4
Air Force – 03, 84
DLA – CC

Preparing activity:
Navy – SH
(Project 4610-0027-000)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.