

## Distillation and Reverse Osmosis Brine Discharge Summary

### Description of Discharge

**How is this discharge generated?** This intermittent discharge is the concentrated seawater (brine) produced as a byproduct of the processes used to generate freshwater from seawater. Distillation and reverse osmosis plants are two types of water purification systems that generate freshwater from seawater for a variety of shipboard applications, including potable water for drinking and hotel services, and high-purity feedwater for boilers. Distillation plants boil seawater, and the resulting steam is condensed into high-purity distilled water. The remaining seawater concentrate, or “brine,” that is not evaporated is discharged overboard. Reverse osmosis systems separate freshwater from seawater using semi-permeable membranes as a physical barrier, allowing a portion of the seawater to pass through the membrane as freshwater and concentrating the suspended and dissolved constituents in a saltwater brine that is subsequently discharged overboard.

**Which vessels generate this discharge?** Distillation or reverse osmosis systems are installed on approximately 540 Armed Forces vessels.

**How often and where is this discharge generated?** This discharge can occur in port, while transiting to or from port, or while operating anywhere at sea (including within 12 n.m.). Distillation plants on steam-powered vessels may be operated to produce boiler feedwater any time a vessel’s boilers are operating; however, operational policy limits its use in port for producing potable water because of the increased risk of biofouling from the water in harbors and the reduced demand for potable water. MSC steam-powered vessels typically operate one evaporator while in port to produce boiler feedwater; most diesel and gas-turbine powered MSC vessels do not operate water purification systems within 12 n.m.

### Analysis

**Nature of Discharge:** Pollutants detected in distillation and reverse osmosis brine include copper, iron, lead, nickel, and zinc. The sampling data indicate that copper, lead, nickel, iron, and zinc can exceed acute Federal criteria or State acute water quality criteria. The distillation and reverse osmosis brine discharge can also contain nitrogen (in the form of ammonia, nitrates and nitrites, and total Kjeldahl nitrogen) and phosphorus in concentrations exceeding the most stringent State water quality criteria. The mass loadings of copper and iron are estimated to be significant. Thermal effects modeling of distillation plant discharges indicates that the thermal plume does not exceed State water quality criteria.

## Distillation and Reverse Osmosis Brine Discharge Summary (continued)

### Analysis (continued)

The following table lists the concentration of constituents that are expected to exceed acute Federal criteria or State water quality criteria and the resulting annual mass loadings.

Constituent	Concentration ( $\mu\text{g/L}$ )	Annual Mass Loading (=Effluent - Influent) (lbs)
<i>Copper</i>		
Dissolved	49.7 - 71.15	1183.69
Total	127 - 325.5	4376.25
<i>Iron</i>		
Total	576.5 - 1590	21566.83
<i>Lead</i>		
Dissolved	BDL - 12.95	225.03
Total	BDL - 24.4	482.65
<i>Nickel</i>		
Dissolved	BDL - 20.1	162.70
Total	BDL - 32	220.14
Zinc	93 - 174	2111.14
Total Phosphorus	160 - 270	1021.83
Ammonia as Nitrogen	BDL - 330	735.35
Nitrate/Nitrite	BDL - 220	-24.99
Total Nitrogen <sup>A</sup>	--	-2139.43

<sup>A</sup> Total nitrogen is the sum of nitrate/nitrite and total Kjeldahl nitrogen.

### Discussion and Discharge Determination

**Discussion:** Review of existing practices indicate that certain operational controls limiting the use of distillation plants and reverse osmosis units can reduce the potential for this discharge to cause adverse environmental impacts in some instances. Additionally, it appears that, for some vessels, reverse osmosis units may present an acceptable alternative to the use of distillation plants. Reverse osmosis units discharge brines are expected to contain lower concentrations of metals because these systems have non-metallic membranes and ambient operating temperatures, resulting in less system corrosion. Further analysis is necessary before determining whether distillation plants should be replaced by reverse osmosis units. Nevertheless, existing operational practices for distillation and reverse osmosis plants and the availability of reverse osmosis units to replace distillation units on some vessels demonstrates the availability of MPCDs to reduce the effects of this discharge.

**Determination:** A marine pollution control device is required.