Cathodic Protection
Discharge Summary

Description of Discharge

How is this discharge generated? This discharge consists of the constituents released into the surrounding water from sacrificial anodes or impressed current cathodic protection systems used to prevent hull corrosion.

Steel-hulled vessels require corrosion protection. In addition to anti-corrosion hull paints, these vessels employ cathodic protection which is provided by either sacrificial anodes or Impressed Current Cathodic Protection (ICCP) systems. The most common cathodic protection system for vessels of the Armed Forces is the zinc sacrificial anode, although a few submarines use aluminum anodes. With the sacrificial anode system, zinc or aluminum anodes attached to the hull will preferentially corrode from exposure to the seawater and thereby minimize corrosion of the vessel's hull.

In ICCP systems, the vessel's electrical system passes a current through inert platinum-coated anodes. This current protects the hull in a manner similar to sacrificial anodes by generating current as the anodes corrode. Zinc anodes are approximately 99.3% zinc and contain small amounts of zinc, silicon, and indium (for activation). Aluminum anodes can contain 0.001% mercury as an impurity; mercury is a known bioaccumulator.

Which vessels generate this discharge? Approximately 2,170 Armed Forces' vessels use cathodic protection. Of these, nearly 270 have ICCP systems, fewer than five use aluminum sacrificial anodes, and the remaining use zinc sacrificial anodes.

How often and where is this discharge generated? The discharge is continuous while the vessel is waterborne and occurs both within and beyond 12 n.m. from shore.

Analysis

Nature of Discharge: Depending on the type of cathodic protection used, the discharge will include either zinc or aluminum from sacrificial anodes, or chlorine-produced oxidants (CPO) from ICCP systems. EPA and DOD modeled the discharge from cathodic protection systems to determine the range of constituent concentrations that could be expected in the water surrounding a vessel. This discharge is best described as a mass flux of reaction byproducts emanating from the electro-chemical reaction that occurs at the anodes. Two separate modeling techniques were used for both sacrificial anodes and ICCP systems. The first technique was a dilution model for harbors that takes into account the number of homeported vessels and harbor-specific volume and tidal flow information. Three Navy ports were modeled, representing a range of port sizes. The resulting constituent concentrations calculated for the three ports in this dilution model were below chronic Federal criteria and State chronic water quality criteria.

The second technique modeled mixing zones around a vessel using calculations for a hull size typical of vessels using cathodic protection systems. The mixing model results indicate that a mixing zone of five feet for CPO and 0.5 feet for zinc results in concentrations below the chronic Federal criteria or State chronic water quality criteria. For vessels with aluminum anodes, a mixing zone of less than 0.1 feet achieves concentrations below chronic Federal criteria and State chronic water quality criteria. Concentrations of mercury will be 1,000 times lower than the acute State water quality criteria and 35 times lower than the chronic criteria. The total amount of mercury discharged from aluminum anodes on all Armed Forces vessels is estimated to be less than 0.001 pounds annually.

For ICCP calculations, the modeling is based on an assumption that 100 percent of the supplied electrical current results in CPO generation. Less CPO is actually expected to be generated because the efficiency of the chlorine generation process is known to be less than 100 percent. In addition, using the generation rate alone does not account for the rapid decay of CPO in water through chemical reactions involving CPO, which occur within minutes.

Cathodic Protection
Discharge Summary (continued)

Discussion and Discharge Determination

Discussion: The dilution and mixing zone modeling performed for this discharge indicates that cathodic protection has a low potential for causing adverse impacts on the marine environment. Therefore, EPA and DOD determined that it is not reasonable and practicable to require the use of a MPCD to mitigate adverse impacts on the marine environment for this discharge.

Determination: A marine pollution control device is not required.