CHAPTER 6

SYSTEM DESIGN, CONSTRUCTION, OPERATION, MAINTENANCE, AND RESTORATION

6-1. Design. For existing structures, a current requirement test should be made to accurately assess the overall system design. The designer should become familiar with the availability and suitability of types of commercially manufactured anodes which would satisfy the system requirements for cathodic protection. Chapter 5 provides guidance for selecting impressed current and sacrificial (i.e., galvanic) anode systems. The designer should become familiar with manufacturer recommendations for use and product performance claims. CPSs should be designed to attain and maintain a level of protection of the structure as defined in the section "Criteria and Other Considerations for Cathodic Protection" in NACE RP0169-2002. In order to achieve this level of protection, design calculations must be made to determine the number and types of anodes required. Examples of calculations can be found in Appendix B of this manual for impressed current cathodic protection design; in ETL 1110-9-10 for impressed current CPSs using ceramic anodes; and in MIL-HDBK-1004/10, "Electrical Engineering Cathodic Protection," which was developed from evaluations, surveys, and design practices of the Naval Facilities Engineering Command, other government agencies, and the private sector. Appendix C of this manual provides engineering formulae and reference tables for use in designing sacrificial CPSs for civil works applications, and Appendices D, E, and F present detailed examples of sacrificial anode CPS design for different types and sizes of structures using various anode geometries. MIL-HDBK-1004/10 can be a useful tool for design calculations in conjunction with the criteria that follow. These calculations must take into consideration the total area of the structure to be protected, the resistivity of the electrolyte, the present condition of the protective coatings on the structure, the predicted deterioration of these coatings due to physical damage, the normal paint change of state over a 20-year period, and the environment to which the structure will be subjected. The design of CPSs should be accomplished under the supervision of a NACE-certified corrosion specialist, a cathodic protection specialist, or a professional engineer licensed in corrosion engineering.

a. Criteria. Design of civil works hydraulic structures shall conform to NACE RP0169-2002, paragraph 6.2.2 inclusive, "Steel and Cast Iron Piping." Those criteria are specifically included here by reference.

b. Guide specification. Unified Facilities Guide Specification UFGS-13113A, "Cathodic Protection Systems (Impressed Current) for Lock Miter Gates," should be used in preparing contract documents for procurement of CPSs. This specification, in addition to providing the technical requirements for various items of equipment for the CPS, addresses methods for protection from ice and various debris of the string anodes and the electrical leads to the button and string anodes. This specification is based upon the use of impressed current systems, which are normally used on hydraulic structures having large areas requiring corrosion protection.

Button anodes are normally used on the skin plate side of the gate, with rod or string anodes installed in the compartment areas of the gate; however, button anodes may also be used in the compartment areas if practical from an installation standpoint.

c. Zebra mussel guidance. In areas with potential for zebra mussel infestations, the CPS components may be at risk of failure or disruption. Design considerations in preventing these infestations should be included. For control strategies, refer to Zebra Mussel Research Technical Note ZMR-3-05, compiled by the Zebra Mussel Research Program at Waterways Experiment Station, Vicksburg, MS.

6-2. Construction. Installation of a CPS by a construction contractor should be accomplished under the supervision of an NACE-certified corrosion specialist, senior corrosion technologist, or cathodic protection specialist or a licensed corrosion engineer.

a. Services of corrosion engineer. The construction contractor should be required to obtain the services of a licensed corrosion engineer to supervise the installation and testing of the CPS. The term “corrosion engineer” refers to a person who has knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, and who is qualified to engage in the practice of corrosion control on metallic structures. Such person may be a licensed professional corrosion engineer or may be certified as being qualified by NACE International if such licensing or certification includes suitable cathodic protection experience.

b. Workmanship. All material and equipment shall be installed in accordance with the requirements of the specifications and as recommended by the corrosion engineer and approved by the Contracting Officer. The installation, including testing, should be performed by an organization that has had at least 3 years experience in this type of work.

6-3. Operation and Maintenance. The reliability and effectiveness of any CPS depend upon the manner in which it is operated and maintained, as well as its proper design and installation.

a. Performance testing prior to acceptance. The primary purpose for testing of a CPS is to determine if it has been optimized in accordance with and effectively meets design criteria (typically RP0169-2002). A system that does not meet these criteria will not adequately protect the structure against corrosion.

b. Operations and maintenance manual. An operations and maintenance manual should be provided for each CPS installed. This manual should provide instructions for testing and optimizing the system and should specify test equipment required. Copies of the structure-to-electrolyte potential measurements, obtained by the contractor at the time of acceptance of the system by the Government, should be included for reference. Blank data sheets should be

provided for Government test personnel to record data obtained in future periodic testing of the CPS.

c. Troubleshooting guide. A troubleshooting guide should be provided for use with the CPS. This guide should address possible symptoms associated with failure of various items of equipment of the system. Recommendations and possible solutions should also be included. If a problem cannot be resolved by the corrosion protection coordinator, then it is recommended that the designer seek the assistance addressed in Chapter 3 of this manual.

6-4. Restoration. Existing inoperable CPSs should be restored whenever possible and feasible. Restoration of a CPS should be part of the corrosion mitigation plan and should include, but not be limited to, the following:

a. A list of materials and cost.

b. An assessment of impact protection and consideration of the need for additional impact protection devices.

c. A survey indicating the status and functional condition of rectifiers, anodes, terminal cabinets, anode system cables, and impact devices.

d. A copy of the latest structure-to-reference-cell potential readings.