BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE INSTRUCTION 32-1054

1 MARCH 2000

Civil Engineer

CORROSION CONTROL

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

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This instruction implements AFPD 32-10, *Installations and Facilities*. It provides responsibilities and general requirements for the corrosion control program at major commands and bases. It applies to personnel involved in design, construction, acquisition, operations, and maintenance of real property assets and installed equipment at installations and facilities. It implements Environmental Protection Agency, Department of Transportation, and Occupational Safety and Health Administration regulations, and guidelines pertaining to corrosion control activities. It follows selected industry standards published by NACE International (formerly National Association of Corrosion Engineers). Paragraphs not applicable to the Air National Guard contain parenthetical phrases, usually at the end of the paragraph. Send comments and suggested improvements on AF Form 847, **Recommendation for Change of Publication**, through major commands to HQ AFCESA/CESM, 139 Barnes Drive, Suite 1, Tyndall AFB FL 32403-5319. AFI 21-105, *Aerospace Equipment Structural Maintenance*, explains the corrosion control program for aerospace and electronic systems.

SUMMARY OF REVISIONS

This revision incorporates additional design guidance for underground storage tanks (**4.3.7.**); prescribes AF Forms 3221 and 3222 for recordkeeping in industrial water treatment programs (**5.2.**); deletes RCS (Report Control Symbol) requirement and associated paragraphs 3.1.8, 3.2.5, and 3.5.3.

1. Objectives. The primary goals of the corrosion control program are to develop and maintain dependable and long-lived structures, equipment, plants, and systems; conserve energy; reduce costs due to corrosion, scale, and microbiological fouling; and ensure compliance with Environmental Protection Agency, Department of Transportation, Occupational Safety and Health Administration, and other applicable regulations and guidance.

2. Scope. Corrosion control keeps the effects of electrochemical or chemical attack on materials by the environment to a minimum. The program includes:

2.1. Corrosion control by design and materials selection.

2.2. Use of cathodic protection to eliminate electrochemical reactions (corrosion).

2.3. Use of industrial water treatment to reduce corrosion, scale-forming deposits, and biological growths in heating and cooling systems.

2.4. Use of protective coatings to reduce atmospheric corrosion or cathodic protection current requirements.

2.5. Analysis of logs and records for failure prediction and selection of corrective actions.

2.6. Incorporation of corrective actions in repair and construction projects when corrosion, scale, or material deterioration occur due to materials, design, construction, operation, or the environment.

3. Responsibilities:

3.1. Headquarters Air Force Civil Engineer Support Agency. The Air Force Civil Engineer Support Agency (AFCESA) oversees the Air Force's facility corrosion control program in the Technical Support Directorate, Mechanical/Electrical Engineering Division (HQ AFCESA/CESM). The agency:

3.1.1. Assists HQ USAF (HQ USAF/ILE) in formulating corrosion control policy.

3.1.2. Maintains Air Force corrosion control technical publications and coordination on tri-service technical publications. Develops technical standards, criteria, and procedures with Department of Defense staff elements and other Federal agencies.

3.1.3. Provides specialized field assistance and consultation to Air Staff and major commands on special corrosion control problems, including designs, construction acceptance, and failure analysis.

3.1.4. Provides corrosion literature searches and deliver any publicly available, but difficult to find, engineering document. Through agreement between HQ AFCESA and the Air Force Research Laboratory, Airbase and Environmental Technology Division (AFRL/MLQ), contact the Technical Information Center as follows for literature or documents:

Technical Information Center

AFRL/MLQ-TIC (FL 7050)

139 Barnes Drive, Ste 2

Tyndall AFB FL 32403-5323

Defense Switching Network (DSN) 523-6285

FAX: (904) 283-6286

FAX: DSN 523-6286

3.1.5. Approves corrosion control methods and equipment not specified in Air Force publications.

3.1.6. Maintains a list of all corrosion points of contacts at the major command level to include full name, complete mailing address, DSN and commercial telephone and fax numbers, training received, and assigned corrosion duties.

3.1.7. Compiles each fiscal year a summary of funded projects justified all or in part by corrosion control and a summary of leak records. Catalogs and analyzes these data for trends.

3.2. Major Commands. Major command civil engineers assist bases in developing and executing corrosion control programs (including aqueous, atmospheric, and underground corrosion) to ensure compliance with Department of Defense and Air Force policy; Environmental Protection Agency, Department of Transportation, and Occupational Safety and Health Administration regulations; and local (including host country) requirements. Major command civil engineers, or designated representatives:

3.2.1. Assign the office of primary responsibility for the program. Appoint command corrosion engineers to act as the overall focal point in all corrosion control related matters. Appoint staff engineers as required to work with the command corrosion engineers as technical consultants in the three major areas of corrosion control: cathodic protection, industrial water treatment, and protective coatings.

3.2.2. Provide installations with technical assistance and guidance on corrosion control. Develop a major command training policy for corrosion control to support budget requests. Past experience indicates that some type of annual contact with others involved in corrosion control maintains interest, allows networking on day-to-day problems, and cross-feeds new approaches and solutions. This is significant as most corrosion control positions are one-deep.

3.2.3. Regard corrosion control as a functional design requirement of all facilities exposed to the environment. Ensure data and justifications are part of each project. This applies to all phases, from planning, project definition, and programming through design and construction to final acceptance. Programming documents should include environmental and safety factors and associated costs. Ensure key corrosion control features of projects have separate design documentation, including drawings, specifications, and design analyses.

3.2.4. Ensure accomplishment of designs, design reviews, and construction inspection by qualified individuals according to major command policy for Military Construction Program and Operations and Maintenance projects. Past experience indicates design qualifications should include recognition by professional organizations, such as NACE International or state registration authorities, or 5 years' experience in design and maintenance of the corrosion control measures under review. Consult HQ AFCESA for review support when necessary.

3.3. Design Agents (Air Force, Army, Navy, or Air National Guard). Design agents will:

3.3.1. Ensure design according to publications referenced in attachment 1.

3.3.1.1. Accomplish surveys and design before construction contract advertisement or before construction in design-build contracts.

3.3.1.2. For design of corrosion control measures, ensure designer or design reviewer meets qualifications according to major command policy. For example, an experienced NACE International Accredited Corrosion Specialist, NACE International Certified Cathodic Protection Specialist, or a Registered Professional Corrosion Engineer accredited or registered in cathodic protection should perform contracted cathodic protection surveys and designs.

3.3.2. Not delete corrosion control measures from any design without the specific approval of the command corrosion engineer.

3.3.3. Coordinate with the command corrosion engineer and the base corrosion control engineer during preliminary design. This coordination will ensure compatibility of design with existing corrosion control systems and maintenance of successful techniques within craftspersons' capability. Installation personnel will approve the updating of systems and equipment per designer's recommendations.

3.3.4. Perform failure analysis for replacement projects that did not achieve life expectancy. Ensure complete understanding of the failure and include procedures in the specifications to prevent recurrence. This analysis shall be part of the preliminary design submittals.

3.3.5. Coordinate among design team members to ensure material selections and system designs are compatible with the corrosion control approach selected.

3.3.6. Not allow the construction contractor to continue with any work until approval of the corrosion control system shop drawings. The technical reviewer, usually the contracting officer's technical representative, shall be knowledgeable in the installation of the corrosion control systems.

3.3.7. Ensure the contractor notifies the contracting officer a minimum of 24 hours prior to installation, testing, or final acceptance of corrosion control systems.

3.3.8. Ensure the construction inspector understands the corrosion control system installation or will involve the base corrosion control engineer or craftsperson as technical advisor. This involvement includes construction surveillance during installation, testing, and final acceptance. If the construction agent cannot ensure the presence of an in-house inspector during cathodic protection work, the construction agent will use Title II Construction Inspection Services to obtain a full-time qualified inspector.

3.3.9. Ensure the specifications contain acceptance testing to ensure achievement of design criteria and the contractor performs this acceptance testing with installation representatives in attendance.

3.3.10. As-built drawings shall provide the location of corrosion control system equipment, testing points, sampling points, and items requiring periodic maintenance.

3.4. Designers. Designers will:

3.4.1. Use field surveys, field tests, and experience of installation personnel in the design.

3.4.2. Specify the testing necessary for the final acceptance of the corrosion control system. Target values of system operating parameters will be part of this testing to ensure the facility will function within design limits. Ensure the acceptance testing protocol includes procedures if acceptance testing differs from target values. Consult operations personnel, equipment manufacturers, and the construction contractor to determine solutions and set new equipment operating points.

3.4.3. Incorporate operability and maintainability into the overall design of the corrosion control systems. Designs will provide minimum life cycle cost over the facility life expectancy.

3.4.4. Provide detailed calculations and one-line diagrams at the preliminary design stage to show the magnitude and layout of the corrosion control system. For example, validate the use of pre-engineered tanks with factory installed cathodic protection through appropriate calculations and field tests.

3.4.5. Provide corrosion control system drawings to show location of equipment, test points, sampling points, potential cathodic protection interference, items requiring periodic maintenance, and installation details.

3.5. Civil Engineer Squadrons. Base Civil Engineers will:

3.5.1. Ensure appropriately qualified and trained personnel develop and execute a comprehensive corrosion control program, encompassing the three areas of corrosion control. Ensure compliance with applicable Federal, state, local, and host nation laws and regulations, particularly those related to public safety and environmental protection. The program will include applying and maintaining effective corrosion control methods in design, operations and maintenance, quality assurance, and acceptance testing.

3.5.2. Publish a squadron operating instruction for the corrosion control program. Ensure civil engineer squadron craftspersons receive annual training on the requirements of the squadron operating instruction.

3.5.3. The base corrosion control engineer must:

3.5.3.1. Develop and manage the base corrosion control program.

3.5.3.2. Assist programmers in narrative and cost estimates for corrosion control line items on DD Forms 1391.

3.5.3.3. Participate in project design and design review related to corrosion control. Sign all project drawings when corrosion control measures, operability, and maintainability are adequate.

3.5.3.4. Provide technical advice to the construction inspector during installation, testing, and final acceptance of corrosion control systems.

3.5.3.5. Coordinate operations and maintenance of corrosion control systems with the operations flight, including preventive maintenance scheduling. Ensure control charts for industrial water treatment detail the frequency and actions for testing and adjustment of each system.

3.5.3.6. Review corrosion control records and take action to correct deficiencies.

3.5.3.7. Investigate leaks from corrosion, tuberculation, and scaling in heating and cooling systems, and premature failure of protective coatings. Take corrective action in each case, other than simple repair by replacement.

4. Requirements:

4.1. Environmental. Consult AFPD 32-70, *Environmental Quality*, and associated Air Force Instructions (AFI) to understand the impact of corrosion and corrosion control activities on the environment.

4.1.1. The primary environmental impact of cathodic protection is in the prevention of petroleum, oil, and lubricants corrosion-induced leakage into the environment from underground and on-ground tanks and underground piping. Cathodic protection is already a requirement on new

tank installations. The goal is to prevent all notices of violation due to corrosion. Ensure compliance with AFI 32-7044, *Storage Tank Compliance*; Title 40, Code of Federal Regulations, Part 280; and applicable state and local requirements.

4.1.2. The primary environmental concern of industrial water treatment is the proper disposal of chemically treated water. Consult AFI 32-1067, *Water Systems*. Also consult environmental engineering and bioenvironmental engineering prior to selecting any industrial water treatment chemical.

4.1.3. The following environmental laws apply to industrial water treatment. Consult with bioenvironmental engineering and environmental engineering to determine methods of compliance with laws and local practices.

4.1.3.1. *Toxic Substances Control Act* (15 U.S.C. 2601) authorizes the U.S. Environmental Protection Agency to control existing and new chemical substances determined to cause unreasonable risk to the public health or environment.

4.1.3.2. *Clean Water Act* (33 U.S.C. 1251) includes the *Federal Water Pollution Control Act* and amendments. This act establishes limits for the discharge of pollutants to navigable waters, regulations on specific toxic pollutants in wastewater discharges, and control of oil and hazardous substance discharges.

4.1.3.3. *Safe Drinking Water Act* (42 U.S.C. 300) provides for protection of underground sources of drinking water and establishes primary and secondary drinking water standards.

4.1.3.4. *Federal Insecticide, Fungicide, and Rodenticide Act* (7 U.S.C. 136-136y) requires the U.S. Environmental Protection Agency to register all pesticides.

4.1.3.5. *Resource Conservation and Recovery Act* (42 U.S.C. 690) addresses the control of solid and hazardous waste. The act defines hazardous waste and controls it by a complex manifest system designed to track a waste from its generation to final disposal.

4.1.3.6. *Comprehensive Environmental Response, Compensation, and Liability Act* (42 U.S.C. 9601), also commonly referred to as "Superfund," defines procedures for responding to existing uncontrolled hazardous waste sites, establishes the National Priorities List and the National Contingency Plan, and requires the reporting of hazardous substance releases into the air, land, and water.

4.1.3.7. *Clean Air Act* (42 U.S.C. 7401) regulates air emissions from stationary and mobile sources to protect public health and welfare. State and local governments have the primary responsibility to prevent and control air pollution.

4.1.4. Do not use chromates in any industrial water treatment application.

4.1.5. The environmental concerns of protective coatings center upon metal content in the dried paint and volatile organic compounds that evaporate from solvent-based paint.

4.1.5.1. Lead-containing paint has a lead content of more than 0.06 percent lead by weight (calculated as lead metal) in the total nonvolatile content of liquid paint or in the dried film of the paint already applied. Do not use lead-containing paint on any Air Force facility. Note that nonlead-containing paint must still pass a Toxicity Characteristic Leaching Potential Test or be considered hazardous waste during disposal.

4.1.5.2. The U.S. Environmental Protection Agency restricted the use of mercury-containing fungicides in solvent-thinned, oil-based paint. Exterior water-thinned paints may contain a maximum of 0.2 percent mercury (calculated as metal) in the total weight of the paint. Clear markings indicating the mercury content must be on the container. The U.S. Environmental Protection Agency banned the use of mercury in interior paint applications.

4.1.5.3. The U.S. Environmental Protection Agency identified six major pollutants that may harm the public health and welfare. Ozone is one of these pollutants. Since the presence of organic materials in the air directly relates to the ozone concentration in the air, volatile organic compounds used in the drying and curing of coatings have environmental impact. Volatile organic compound limits vary by region of the country and the end-use surface coating operation.

4.2. Safety. Consult AFPD 91-2, *Safety Programs*, and AFPD 91-3, *Occupational Safety and Health*, as well as their associated AFIs, for guidance to minimize the risk of corrosion and corrosion control activities on facility and worker safety.

4.2.1. For cathodic protection, consult AFI 32-1064, *Electrical Safe Practices*. The Department of Transportation regulates flammable utilities. The *Natural Gas Pipeline Safety Act of 1968*, as amended, and the *Hazardous Liquid Pipeline Safety Act of 1979*, as amended, provide the minimum criteria to ensure safe operation.

4.2.2. Many of the chemicals used to treat industrial water may be harmful to the health of the operator and other base personnel. They range from highly toxic to mildly irritating to the persons handling them. Handle water treatment and testing chemicals with care, following guidance in Occupational Safety and Health Administration directives, manufacturer's recommendations, and the material safety data sheets. Install eye wash stations and safety showers according to ground safety requirements. Consult with wing safety, bioenvironmental engineering, and environmental engineering on potential safety issues and the use of less hazardous substitutes.

4.2.2.1. A cross-connection is a physical connection between a potable water supply system and a non-potable system (such as an industrial water system) through which contaminated water can enter the potable water system. Consult AFI 32-1066, *Plumbing Systems*. Permit only Class III backflow prevention devices (air gap or reduced pressure principle) to provide makeup from a potable water system to an industrial water treatment system.

4.2.2.2. Morpholine, cyclohexylamine, and similar chemicals added to protect condensate lines from corrosion make the steam and condensate unfit for consumption or other uses normally reserved for potable water. Do not use treated steam in direct contact with food or for any direct steam humidification, such as in a gymnasium steam room or humidity control for electronic equipment.

4.2.3. Most paint and protective coatings are hazardous to some degree. All, except water-thinned paints, are flammable; many are toxic; and others can irritate the skin. By following simple precautions, most paints are quite safe during application. Surface preparation also has intrinsic hazards. For example, sandblasting operations generate clouds of blasting media, paint, and substrate material. Dry sanding on lead-containing paint and on certain types of non-lead-containing paint can generate excessive amounts of airborne lead dust. The Occupational Safety and Health Administration controls the permissible exposure limit of these airborne

particulates and the personal protective equipment required. Consult wing safety and bioenvironmental engineering for specific information.

4.3. Design:

4.3.1. Design, construction, and application of cathodic protection, industrial water treatment, and protective coatings are functional requirements for almost all projects. Designs shall achieve the minimum life cycle cost for the overall facility. Base personnel must be able to operate and maintain the final facility design, including the corrosion control systems, without extensive training or equipment investment, unless this is the best approach to achieve minimum life cycle cost.

4.3.2. Corrosion resistance is not the only criterion for material selection. When selecting a material, investigate all aspects of its physical properties in the application environment, during both normal operation and typical system failure.

4.3.3. Clearly and distinctly document corrosion experience for future reference. This experience should refer to design, material selection, selection of corrosion control technique, or decisions of no requirement for corrosion control. Document all design and selection decisions in project design analyses. Pass this information to the operations and maintenance elements to assist future decisions.

4.3.4. Revisit the design and selection decisions when a system malfunctions or leaks due to corrosion, scaling, or premature failure of the corrosion control system. This is especially important for the rare case when a designer justified no corrosion control being needed.

4.3.5. Ensure new or supplemental corrosion control systems are compatible with existing systems. The construction contractor shall not select the warranty period industrial water treatment.

4.3.6. Construct pipelines in a manner that facilitates use of in-line inspection tools.

4.3.7. Cathodic protection and coatings work together. Ensure these items are part of the design. Do not design submerged or buried coated metallic facilities without cathodic protection and do not design cathodic protection on bare metallic facilities. Recommend fiberglass-clad underground storage tanks be installed with galvanic anodes. This recommendation is made even though many such tanks are EPA-approved for installation without cathodic protection.

4.3.8. Do not use unbonded coatings, such as loose polyethylene wraps. Use of unbonded coatings is a direct violation of Department of Transportation regulations and Air Force criteria for pipelines.

4.3.9. Provide both cathodic protection and protective coatings for buried or submerged metallic facilities, regardless of soil or water corrosivity, when the facility:

4.3.9.1. Carries flammable product.

4.3.9.2. Is mission critical.

4.3.9.3. Would be expensive to maintain.

4.3.9.4. Would waste energy or impact the environment if corroded.

4.3.9.5. Requires corrosion control as identified by major command.

4.3.10. For other buried utilities, generally provide cathodic protection and protective coatings if the soil resistivity is below 10,000 ohm-centimeters. Follow the documented recommendations of a qualified corrosion engineer when the soil resistivity is above 10,000 ohm-centimeters.

4.3.11. Provide both cathodic protection and protective coatings for the following aboveground tanks based upon qualified analysis:

4.3.11.1. All ferrous tanks in contact with the earth, unless built on an oil-filled sand pad with plastic liner underneath.

4.3.11.2. Interiors of steel water distribution storage tanks.

4.3.12. Consider the need for lightning and fault current protection at isolating devices (dielectrically insulated unions and flanges) when designing cathodic protection systems. Consult AFI 32-1065, *Grounding Systems*.

4.3.13. Installed cathodic protection systems shall provide protective potentials meeting criteria in NACE International Standard RP0169, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*, Section 6, *Criteria and Other Considerations for Cathodic Protection*. Structure-to-soil potentials are to be potential drop (current times resistance) free.

4.3.14. Special conditions sometimes exist where cathodic protection is ineffective or only partially effective. Corrosion personnel may deviate from this instruction after documenting the achievement of objectives and receiving command corrosion engineer approval.

4.3.15. Industrial water treatment designs or decisions begin with an analysis of the system makeup water. Consult bioenvironmental engineering and AFI 48-119, *Medical Service Environmental Quality Programs*, for sampling potable water sources that feed industrial systems. Use AF Form 2752A, **Environmental Sampling Data**, for complete analyses to identify the quantity and relationship of water constituents for industrial water treatment purposes.

4.3.16. Acceptance testing of new heating and cooling systems will ensure the industrial water treatment system meets design and operation parameters. Boiler steam purity tests will determine total dissolved solids limits. Correlate the total dissolved solids level selected for boiler operation to the conductivity reading of a typical sample. The Water or Wastewater Laboratory at associated plants or Base Supply's Fuels Laboratory usually can measure total dissolved solids using American Society For Testing and Materials standard methods. Verify the selected condensate treatment meets design parameters by testing for copper, iron, and pH at near, medium, and far points from the boiler throughout the system.

4.3.17. Indicate locations to install corrosion coupon racks following American Society For Testing and Materials *Standard Test Methods for Corrosivity of Water in Absence of Heat Transfer (Weight Loss Methods*), D26888-92, Test Method B. The coupons are the best confirmation of industrial water treatment effectiveness.

4.3.18. Do not use nonchemical industrial water treatment devices on Air Force systems either regularly or on a test evaluation basis except as indicated below. This includes the Management and Equipment Evaluation Program.

4.3.18.1. Basic research and application development of nonchemical industrial water treatment devices has been underway since before 1935. However, many variables affect performance, and no criteria and standards have been developed which may be incorporated into

guide specifications or statements of work. Such criteria and standards are necessary for standard Air Force contracting methods to ensure devices will perform as advertised. Additionally, due to downsizing and outsourcing, the technical capability to perform installation-specific test evaluations is not available at installation level.

4.3.18.2. Battelle Memorial Institute is researching applications of nonchemical industrial water treatment under the Department of Energy's Federal Energy Management Program. Various Energy Services Companies (ESCO) are investigating use of these devices for energy and water conservation measures under Energy Savings Performance Contracting (ESPC). Under ESPC, the ESCO provides guaranteed savings that are validated each year to reconcile payments, using an agreed-upon measurement and verification methodology. As the ESCO has the responsibility for measuring and verifying performance, problems cited in paragraph 4.3.18.1 are overcome. Currently, HQ AFCESA/CESM is developing measurement and verification standards to allow nonchemical devices to be available for use under ESPC.

4.3.19. Light reflective floor coatings include chemically resistant urethane for existing hangar floors and dry shake metallic floor topping applied to the top layer of freshly poured concrete for new floors. Ensure electrostatic discharge and slip resistance are part of the design. Include the daily cleaning requirements to cover equipment, supplies, and frequency as part of the maintenance instructions provided to the using agency.

4.3.20. Avoid using chemical strippers. If specified, perform effectiveness tests prior to award of any contract. This is especially necessary for removing lead-based paint from wood. Also, specify procedures to confirm neutralization of alkaline paint stripper through chemical testing. Alkaline residue left on the substrate is a recurring paint failure mechanism.

4.4. Maintenance:

4.4.1. Perform routine maintenance checks, surveys, and inspections of cathodic protection, industrial water treatment, and protective coating systems. Each installation must have the basic equipment and training to perform tests and measurements of installed corrosion control systems. Consult associated manuals and tables of allowances for the minimum required field inspection instruments.

4.4.2. Investigate when corrosion control actions do not achieve results. This information provides the basis for selecting corrective actions and ensuring future projects do not continue the same problems.

4.4.3. Select and apply methods for determining voltage drops during cathodic protection testing using sound engineering practices, such as contained in NACE International Technical Report 10A190, *Measurement Techniques Related to Criteria for Cathodic Protection of Underground or Submerged Steel Piping Systems* (see attachment 1).

4.4.4. Cathodic protection situations involving stray currents and stray electrical gradients require special analysis. For additional information, see MIL-HDBK 1136, *Maintenance and Operation of Cathodic Protection Systems*, Section 7*;* and NACE International Standard RP0169, Section 9, *Control of Interference Currents.*

4.4.5. Industrial water treatment requires testing at a frequency that ensures the prevention of scale, corrosion, and biological formation in the heating and cooling systems. The time between

testing depends on system integrity and operations. A mechanically sound system will require less frequent testing as less chemical leaves the system over time.

4.4.6. Develop and post, in appropriate locations, control charts for each boiler, cooling tower, and closed system showing the treatment chemicals used, the amount to add per operating parameter, the testing required, the limits to maintain in the system, what to do if the chemical levels are above or below the limits, and any other information peculiar to the system.

4.4.7. Perform periodic surveys to ensure effective industrial water treatment.

4.4.7.1. Annually check the capacity of ion exchangers. Do not rely on a timed regeneration cycle.

4.4.7.2. Once at the start of heating season and once at the end of heating season, test the condensate throughout the return system to identify potable water leakage into the condensate return system at heat exchangers. This identifies leaks at the earliest stages.

4.4.7.3. When adding or deleting buildings to a steam system or significantly changing industrial water treatment chemicals, perform the design acceptance tests for the boiler total dissolved solids limit and verify the total protection of the condensate return system.

5. Recordkeeping. Corrosion control logs and reports are valuable in any failure analysis when problems arise. They provide the facts to make decisions. They also provide managers the status of the systems and the ability to make incremental improvements to achieve the expected life cycle of facilities, equipment, and piping. The goal is to solve the small problems at the operational level before they become so large that a major project is the only solution.

5.1. Cathodic protection recordkeeping, using prescribed forms as explained in MIL-HDBK 1136, includes the following:

5.1.1. Initial close interval, anode bed, and annual corrosion surveys of installed impressed current and sacrificial systems. Use AF Form 491, **Cathodic Protection Operating Log for Impressed Current Systems**; AF Form 1686, **Cathodic Protection Operating Log for Sacrificial Anode System**; and AF Form 1688, **Annual Cathodic Protection Performance Survey**, to record these tests.

5.1.2. Impressed current system checks every 60 days. Use AF Form 491 to record these checks.

5.1.3. Initial and annual water tank calibrations of installed systems. Use AF Form 1689, **Water Tank Calibration**, to record these tests.

5.1.4. Annual update of the Cathodic Protection Annual Performance Booklet, sent to major command. For the ANG, booklets will be maintained at the installation and made available upon request.

5.1.5. Leak investigation using AF Form 1687, **Leak/Failure Data Record**. Use the information captured on AF Forms 1687 to provide justification for system repair or replacement, for installation of corrosion control measures, and for the project narrative on DD Forms 1391. Consult AFI 32-1069, *Gas Supply and Distribution*; MIL-HDBK 1164, *Operation and Maintenance of Water Supply Systems*; and MIL HDBK 1022, *Petroleum Fuel Facilities*, for leak detection and survey requirements on these systems.

5.2. Industrial water treatment records should reflect the minimum entries needed to effectively manage the control of the industrial water treatment program and indicate the need for additional testing. A future publication will update treatment, testing and reporting procedures previously contained in rescinded AFP 91-41, *Industrial Water Treatment Procedures* (will be replaced by MIL HDBK 1149). The reverse of prescribed forms explains their use. Associated recordkeeping includes the following:

5.2.1. Accomplish industrial water treatment operating logs based upon one log for each individually treated system (each boiler, each cooling tower bank, and each closed system).

5.2.2. Use AF Form 1457, **Water Treatment Operating Log for Cooling Tower Systems**, as a minimum.

5.2.3. Use AF Form 1459, **Water Treatment Operating Log for Steam and Hot Water Boilers**, as a minimum.

5.2.4. Keep other industrial water system records on modifications of these forms or a log developed locally for the specific tests required.

5.2.5. Keep the maintenance and history of industrial water treatment, other than that contained in the logs, in a historical record for each system. This book should contain a record (including dates) of occurrences of corrosion and scale, major maintenance and surveys performed on the system, replacements of piping and equipment, accidents, outages, changes in methods of operation and treatment used, and other pertinent data to assist troubleshooting and provide facts for management decisions on process improvement.

5.2.6. Use AF Form 3222, **Centrifugal/Reciprocating Operating Log**, and AF Form 3221, **Absorption Operating Log**, to evaluate the mechanical aspects of the equipment and determine the efficiency of the IWT program.

5.3. Maintain records following MIL HDBK 1110/1, *Paints and Protective Coatings*. Perform evaluations using these records after any paint failure and before any protective coatings contract. These records replace undocumented hearsay experience and allow fact-based decisions with costs and verified life expectancies of completed work to determine the following:

5.3.1. Effectiveness of a particular paint system on different surfaces or in varying environments.

5.3.2. Comparison of different paint systems under similar conditions.

5.3.3. Comparison of different equipment for surface preparation or application.

5.3.4. Frequency of spot painting and repainting.

6. Forms Prescribed: AF Form 491, **Cathodic Protection Operating Log for Impressed Current Systems**

AF Form 1457, **Water Treatment Operating Log for Cooling Tower Systems**

AF Form 1686, **Cathodic Protection Operating Log for Sacrificial Anode System**

AF Form 1687, **Leak/Failure Data Record**

AF Form 1688, **Annual Cathodic Protection Performance Survey**

AF Form 1689, **Water Calibration**

AF Form 3221, **Absorption Operating Log**

AF Form 3222, **Centrifugal/Reciprocating Operating Log**

JOHN W. HANDY, Lt General, USAF
DCS/Installation & Logistics

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

Public Laws

Clean Air Act, Title 42, United States Code, Section 7401

Clean Water Act, Title 33, United States Code, Section 1251

Comprehensive Environmental Response, Compensation, and Liability Act, Title 42, United States Code, Section 9601

Federal Insecticide, Fungicide, and Rodenticide Act, Title 7, United States Code, Section 136-136y

Hazardous Liquid Pipeline Safety Act of 1979, Public Law 96-129, title II, 30 Nov 79, 93 Stat. 1003, (49 U.S.C. (United States Code) 1811, 2001 et. seq.), as amended

Natural Gas Pipeline Safety Act of 1968, Public Law 90-481, 12 Aug 68, 82 Stat 720 (49 U.S.C. 1671 et. seq.), as amended

Resource Conservation and Recovery Act, Title 42, United States Code, Section 690

Safe Drinking Water Act, Title 42, United States Code, Section 300

Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST), Title 40, Code of Federal Regulations (CFR), Part 280, Environmental Protection Agency

Toxic Substances Control Act, Title 15, United States Code, Section 2601

DoD Publications

Air Force

AFPD 32-70, *Environmental Quality*

AFPD 91-2, *Safety Programs*

AFPD 91-3, *Occupational Safety and Health*

AFI 21-105, *Aerospace Equipment Structural Maintenance*

AFI 32-1064, *Electrical Safe Practices*

AFI 32-1065, *Grounding Systems*

AFI 32-1066, *Plumbing Systems*

AFI 32-1067, *Water Systems*

AFI 32-1069, *Gas Supply and Distribution*

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Abbreviations and Acronyms

AFI—Air Force Instruction

AFP—Air Force Pamphlet

AFPD—Air Force Policy Directive

AFRL/MLQ-TIC—Air Force Research Laboratory, Airbase and Environmental Technology Division, Technical Information Center

ESCO—Energy Services Companies

ESPC—Energy Savings Performance Contracting

HQ AFCESA/CESM—Headquarters Civil Engineer Support Agency, Mechanical/Electrical

Engineering Division

HQ USAF/ILE—Headquarters US Air Force, The Office of the Civil Engineer

MIL HDBK—Military Handbook

NACE—National Association of Corrosion Engineers

RCS—Report Control Symbol