

Section 13. CORROSION PROTECTION

13.1 Justification. Corrosion exists in every metallic substance to some degree and in many cases to a severe degree. A corrosion protection program against severe corrosion conditions must be justified on the basis of economy, necessity, and hazards.

13.1.1 Economy. The investment cost plus operating and maintenance costs of a program should be less than the sum of the following:

- a) Direct loss or damage costs resulting from corrosion of metal structures.
- b) Direct maintenance costs attributed to corrosion, including indirect losses, such as leakage-loss of tank contents.
- c) Increased costs for over design to allow for strength losses resulting from corrosion.
- d) Costs of shutdown, power failures, labor losses, and other items.

13.1.2 Operational Necessity. Military facilities must be maintained in a state of readiness at all times, with the importance and mission determining the degree of necessity for corrosion protection.

13.1.3 Hazards in Handling Materials. Corrosion preventive measures are necessary where deterioration of structures, and containers and piping serving fluids or gases may cause danger of fire and explosion.

13.2 Causes. For power plants, corrosion is caused primarily by oxidation, galvanic action, or chemical attack. For more detailed information see MIL-HDBK-1003/6.

13.3 Corrosion Controls. The control of corrosion involves the selection of appropriate materials, use of metallic, organic, inorganic, or plastic coatings, and cathodic protection systems. For additional detailed information, see MIL-HDBK-1003/6. For description and design of cathodic protection systems, see MIL-HDBK-1004/10.

Section 14. SAFETY PROTECTION

14.1 Personnel

14.1.1 OSHA Standards. All federal installations must comply with the Code of Federal Regulations, Title 29, Chapter XVII, Occupational Safety and Health Administration, Department of Labor, Part 1910 - Occupational Safety and Health Standards, Safety requirements, including those not covered by OSHA standards, should be the latest most stringent standards and practices followed by industrial organizations. Special attention shall be given to platforms, railings, occupational noise exposure, means of egress, safety signs, color code and markings, fire protection, safety relief valves, and control valves.

14.1.1.1 Equipment Guards. Guards shall be provided to cover all exposed rotating shafts, couplings, flywheels, belt sheaves, and driven belts. Safety cages and guards shall be provided for conveyor belt takeups.

14.1.1.2 Platforms and Stairs. Provide access platforms for operation and maintenance of all equipment and valves more than 8 feet 0 inches above the floor level. Handrails and toe guards shall be provided on platforms and floor openings. Stairs shall be provided where possible in lieu of ladders; landings shall be provided when stair run is in excess of 12 feet 0 inches. Stairs shall be constructed with abrasive treads or nosings and, preferably, closed risers.

14.1.1.3 Egress. Not less than two exits shall be provided from catwalks, platforms longer than 10 to 15 feet in length, boiler aisles, floor levels, and the boiler plant. Emergency lighting shall be provided for all modes of egress.

14.1.2 National Industrial Safety Codes. The following codes shall apply:

a) ANSI A12 - Safety Requirements for Floor and Wall Openings, Railings, and Toe Boards.

b) ANSI A14.3 - Fixed Ladders, Safety Requirements.

c) ANSI/ASME B15.1 - Mechanical Power Transmission Apparatus.

d) ANSI/ASME B20.1 - Conveyors and Related Equipment.

e) ANSI/ASME B30.2 - Overhead and Gantry Cranes.

f) ANSI/ASME B30.6 - Derricks.

g) ANSI B30.11 - Monorails and Underhung Cranes.

exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

14.1.3.2 Equipment Design Sound Levels. All equipment which produces noise as a side effect of operation shall be specified for noise level not in excess of 84 dBA (A scale rated sound pressure level referenced to 0.0002 microbar) when measured 5 feet above the mounting floor level and 3 feet from the equipment base. Equipment which cannot meet this specification shall be provided with appropriate silencers or enclosed as necessary to contain or direct the emanating sound.

14.1.3.3 Space Design Sound Levels. Power plant areas which require air conditioning usually require consideration of sound level also. These areas include central control rooms, offices, and laboratories. The acoustical design goals for these areas is the achievement of background sound levels which will not interfere with the occupancy requirements. For complete information relative to design, control, and testing of sound, see the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbooks, Fundamentals and Systems Volumes.

14.1.4 Handling of Toxic and Hazardous Substances

14.1.4.1 Hazard Communication Standard. OSHA standards for hazard communications are presented in Title 29, CFR Part 1910, Subpart Z, paragraph 1910.1200.

14.1.4.2 Local Exhaust. For design guidance of local exhaust systems for mixing tanks, local feed systems, test bench hoods, etc., see MIL-HDBK-1003/17 Industrial Ventilation Systems, and ACGIH Industrial Ventilation Manual.

14.1.4.3 Storage. For design criteria pertaining to storing of all types of toxic and hazardous substances, see MIL-HDBK-1032/2, Covered Storage.

14.1.4.4 Dry Chemicals. Provide storage per manufacturer's recommendations or instructions.

14.1.4.5 Liquid Chemicals. Provide curbed area around liquid storage or mixing tanks and chemical feed equipment. Volatile toxic chemicals will require special ventilation and adequate personnel protective clothing; included in this category are chemicals such as acids, morpholine, hydrazine, etc. For design criteria, refer to ACGIH Industrial Ventilation Manual.

14.1.4.6 Gaseous Chemicals. See 29 CFR 1910, Subpart H - Hazardous Materials and Subpart Z - Toxic and Hazardous Substances.

14.1.4.7 Emergency Shower and Eye Wash Fountain. Provide an emergency shower and eye wash fountain, meeting ANSI Z358.1, within any work area in which personnel eyes or body may be accidentally exposed to injurious corrosive materials.

14.2 Piping and Equipment

14.2.1 Piping. Provide safety relief valves on piping in accordance with ANSI/ASME B31.1, Power Piping (ASME Code for Pressure Piping).

14.2.2 Boilers and Pressure Vessels. Provide safety relief valves on boilers, receivers, heat exchangers, and other pressure vessels in accordance with the ASME Boiler and Pressure Vessel Code.

14.2.3 Air Compressors and Positive Displacement Pumps. Provide safety valves as necessary to protect air compressors and positive displacement pumps in the event a discharge valve is closed with the equipment in operation.

14.2.4 Equipment Enclosures. To protect both equipment and personnel, provide enclosures for batteries, machine shop, and laboratory equipment. Battery rooms shall be provided with forced ventilation exhaust type fans.

14.3 Air Navigation. To determine if any part of the power plant, such as the stack, presents an obstruction to air navigation, refer to Title 14 Code of Federal Regulations, Part 77. See also Federal Aviation Administration advisory circular AC 70/7460-1F, Obstruction Marking and Lighting; FAA 150/5345-43c, Specification for Obstruction Lighting Equipment; MIL-HDBK-1023/1, Airfield Lighting; and NAVAIR 51-50AAA-2, General Requirements for Shorebased Airfield Marking and Lighting.

14.4 Security. See NAVFAC DM-5.12, Fencing, Gates, and Guard Towers, for security fencing.

Section 15. FIRE PROTECTION

15.1 General Requirements. See MIL-HDBK-1190 and MIL-HDBK-1008, Fire Protection for Facilities Engineering, Design and Construction. The designer shall be governed by the above Navy criteria. Where Navy criteria do not address a particular subject, applicable Factory Mutual Engineering Loss Prevention Data Sheets and National Fire Protection Codes shall be consulted. All questions concerning fire protection should be directed to the fire protection branch. For additional requirements, see MIL-HDBK-1003/6.

15.2 Fuel. For fire protection of coal facilities, see MIL-HDBK-1003/6. For fire protection requirements for oil fuel, see NFPA 30, Flammable and Combustible Liquids Code and NFPA 31, Oil Burning Equipment, Installation of.

15.3 Transformers. Outdoor generator step up transformers and outdoor auxiliary transformers shall be protected by automatic, dry pilot, deluge water spray fire protection equipment.

15.4 Lubricating and Hydrogen Seal Oil Equipment. The turbine lubricating oil reservoir and conditioner, and hydrogen seal oil unit, if any, shall be protected by automatic, dry pilot, deluge water spray fire protection equipment.

15.5 Standpipe and Fire Hose Stations. Standpipe and fire hose stations shall be strategically located at various levels of the power plant and at various locations on each floor.

15.6 Portable Hand-Held Extinguishers. Portable hand-held fire extinguishers shall be provided at all standpipe hose stations and other strategic locations. The extinguishing agent shall be selected based on the fire hazards encountered in the immediate area.

15.7 Typical Fire Protection Systems for Power Plants. Table 28 lists the various areas or pieces of power plant equipment that should be considered relative to the need for fire protection. Whether or not an area or piece of equipment requires the installation of fire protection equipment depends on the initial costs of buildings and equipment being considered and the relative cost of the fire protection system. The criticality of an area or piece of equipment to the mission of the power plant must also be considered. Table 28 also lists the recommended type of fire suppression system, type of detection, and operation.

Table 28
 Typical Fixed Fire Detection and Suppression Systems

<u>Location</u>	<u>Type of Fire Suppression System</u>	<u>Type of Detection</u>	<u>Operation</u>
Administration Area (excluding Halon protected areas)	Wet pipe sprinkler	Fixed temperature quartzoid bulb	Automatic
Plans and records storage room	Halon 1301	Cross-zoned ionization and photo-electric smoke detection system	Automatic
Control room (below ceiling)	Not applicable	Ionization smoke detection	Alarm only
Control room (above ceiling)	Not applicable	Ionization smoke detection	Alarm only
Control room (main control panel)	Not applicable	Ionization smoke detection	Alarm only
Control equipment room	Halon 1301	Cross-zoned ionization and photo-electric	Automatic
Cable spreading room	Wet pipe sprinkler	Fixed temperature quartzoid bulb	Automatic
	--	Ionization smoke detection	Alarm only
Turbine underfloor area, grade and mezzanine level	Dry pipe sprinklers	Fixed temperature quartzoid bulb	Automatic
Turbine generator bearings	Preaction spray	Fixed temperature	Manual
Boiler feed pump turbine	Deluge spray	Dry pilot	Automatic

Table 28 (Cont.)
 Typical Fixed Fire Detection and Suppression Systems

<u>Location</u>	<u>System</u>	<u>Type of Detection</u>	<u>Operation</u>
Warm-up guns and igniters	Preaction spray	Fixed temperature	Automatic
Igniter oil pumps	Deluge spray	Dry pilot	Automatic
Hydrogen seal oil unit	Deluge	Dry pilot	Automatic
Turbine lube oil reservoir and conditioner	Deluge spray	Dry pilot	Automatic
Main generator and auxiliary transformers	Deluge spray	Dry pilot	Automatic
Reserve auxiliary transformers	Deluge spray	Dry pilot	Automatic
Switchgear areas and major motor control center	None	Smoke detection only	Alarm
Coal conveyors within generation building	Dry pipe sprinklers	Fixed temperature quartzoid bulb	Automatic
Air heaters	Deluge spray	Infrared hot spot detectors	Manual
Coal pulverizers	Steam inerting	Carbon monoxide monitoring	Manual
	Waterwash		Manual (for B&W only)
Coal dust collectors	Preaction sprinkler	Thermistor wire	Automatic

Table 28 (Cont.)
Typical Fixed Fire Detection and Suppression Systems

<u>Location</u>	<u>System</u>	<u>Type of Detection</u>	<u>Operation</u>
Coal silos	Low pressure CO ₂	--	Automatic on master fuel trip or manual for fires
Silo fill galleries and plant conveyor gallery	Dry pipe sprinklers	Fixed temperature quartzoid bulb	Automatic
Coal feeders	Provisions for CO ₂ inerting or for water hose streams	--	Manual

Section 16. MISCELLANEOUS

16.1 Piping. For design of power plant piping and selection of piping materials, see ANSI/ASME B31.1, Power Piping (ASME Code for Pressure Piping). See also MIL-HDBK-1003/8, Exterior Distribution of Utility Steam, High Temperature Water (HTW), Chilled Water (CHW), Fuel Gas, and Compressed Air.

16.2 Insulation, Lagging, and Jacketing

16.2.1 Insulation. Insulation shall be non-asbestos composition and shall be applied to piping, equipment, and ductwork to conserve energy and for comfort and safety. Thickness for energy conservation shall be dictated by an economic comparison of the value of heat energy saving versus the cost of additional thickness of insulation.

For additional information, see MIL-HDBK-1003/6.

16.2.2 Lagging. Metal lagging is used to cover insulation applied to breeching, ductwork, scrubbers, baghouse filters, electrostatic precipitators, large fans, and other equipment having large flat surfaces. Lagging can be aluminum, aluminized steel, galvanized steel, or stainless steel in a variety of profiles with the selection depending on the application and exposure. Lagging can be plain, corrugated, embossed, unpainted, or painted with a variety of finishes.

Lagging surface temperature shall not exceed 150 degrees F (66 degrees C).

16.2.3 Jacketing. All insulated piping and equipment should be completely covered with aluminum or stainless steel jacketing. Aluminum jacketing should not be used for piping in trenches or buried directly in the ground.

To prevent galvanic corrosion, avoid permanent contact of aluminum jacketing with copper, copper alloys, tin, lead, nickel, or nickel alloys including Monel metal.

16.3 Freeze Protection. Piping that is subject to freezing shall be protected with electric heating cable. Follow manufacturer's recommendations and instructions for application.

16.4 Pipe Supports. Use rigid (rod or roller) or spring type pipe hangers for supporting overhead piping. Piping located near floors, platforms, or other suitable surfaces is often supported from below by rigid floor stands. See Federal Specification WW-H-171E, Hangers and Supports, Pipe, for type selection. See also MIL-HDBK-1003/8.

Locate anchors to control heat pipe movement or to limit movements of branch takeoffs from a main line.

Provide adequate flexibility (by use of change in pipe direction, expansion loops, or expansion joints) in all steam or hot liquid piping. Perform formal piping flexibility and hanger support calculations to make certain that pipes will be adequately and properly supported, that pipe stresses will not exceed limitations permitted by ANSI/ASME B31.1, and that piping reactions and movements at equipment piping connection or piping anchors will not be excessive. For piping hanger and flexibility calculations, refer to publications such as Piping Handbook, Sabin Crocker or Piping Design and Engineering, ITT Grinnell, Inc. Providence, RI. Computer programs for analyzing piping flexibility (stress, forces, and moments) such as ADLPIPE can also be used.

16.5 Heating, Ventilating, and Air Conditioning. Refer to MIL-HDBK-1003/6 and NAVFAC DM-3.03, Heating, Ventilating, Air Conditioning and Dehumidifying Systems for boiler plant requirements.

16.5.1 Heating. Heating systems shall be provided for boiler room, turbine room, pump and equipment rooms, shops, warehouses, and administration areas if required for comfort or for freeze protection. Heat from boiler and equipment operation shall not be taken as a credit.

16.5.2 Ventilating. Provide adequate forced ventilation for the boiler room and the turbine room by use of roof-mounted exhausters fans. Central control rooms and offices should utilize air handling units with duct systems for air distribution. Other areas to be ventilated include shops, tunnels, enclosed coal galleries, toilets and washrooms, locker rooms, lunch rooms, and other areas where personnel are expected to operate or maintain equipment. Exhaust air from areas with suspended particulate shall be cleaned sufficiently to satisfy environmental regulations.

16.5.3 Air Conditioning. Use air tempering (heating and cooling) for central control rooms and for areas such as offices where air conditioning for comfort is justified. Include humidification where necessary for comfort. In dry climate regions, humidification of the boiler and turbine rooms may also be necessary for personnel comfort.

16.6 Cranes and Hoists

16.6.1 General. Refer to NAVFAC DM-38.01, Weight-Handling Equipment.

16.6.2 Cranes. Provide turbine room crane for erection and maintenance of turbine generators.

16.6.3 Hoists. Provide hoists and supports for maintenance on water intakes, pumps, compressors, fans, and other heavy equipment. Provide a beam

into the plant, and provide steel above an opening between floors to hoist large equipment to an upper level.

16.7 Metering. Meters shall be provided on fuel lines, electrical and water services to the buildings, and to the major equipment and boilers in the building. Steam output metering of the header and at each steam generator shall be provided for periodic reports and testing.

16.8 Drainage. Refer to MIL-HDBK-1003/6, under Drainage and NAVFAC DM-3.1, Plumbing Systems.

16.9 Seismic Design Criteria

16.9.1 Power Plant Buildings. Power plant buildings shall be in accordance with Seismic Design for Buildings, NAVFAC P-355.

16.9.2 Piping. All piping systems shall be designed to permit freedom of movement of the pipes in all directions. Pipe penetration through building walls and floors shall be made through pipe sleeves and with swing joints or other means of permitting independent pipe movements.

All piping critical to the operation of the power plant shall be steel, if possible, in lieu of a brittle material.

Cast-iron or cement-asbestos pipe shall not be used for condenser cooling waterlines.

16.9.3 Equipment. All mechanical equipment and tanks shall be securely anchored to their foundations. Supports for equipment shall be steel in lieu of cast iron.

16.9.4 Controls. Control systems shall be designed so that loss of the control media (air or electricity) will leave the control in a fail-safe position.

16.10 Architectural Criteria

16.10.1 Outdoor and Semi-Outdoor Plants. Boiler plants and generators, completely outdoors, may be feasible in warm and temperate climates, thereby reducing construction costs. Proper measures against freezing of stationary water must be made.

Definitive steam electric-generating plants have semi-outdoor boilers. Weatherproofing equipment for outdoor service saves a good part of building construction. However, weatherproofing equipment makes operation and maintenance more difficult.

An economic study should decide whether indoor or outdoor housing should be used.

16.10.2 Arrangements. Architectural arrangements should provide for:

- a) Minimum total building volume.
- b) Centralization of electrical equipment and controls.
- c) Sufficient aisle and laydown space.
- d) Adaptability to various makes of equipment.
- e) Adaptability to definitive designs.
- f) Localization of operations.
- g) Ease of replacing equipment and extending a plant.
- h) Loading and unloading fuel and equipment.
- i) Parking.
- j) Toilets, lockers, work shops, offices, storage, and control rooms.
- k) Equipment platforms with access.

16.10.3 Criteria Source. For general architectural design criteria, see MIL-HDBK-1003/6, under Architectural Criteria.

16.11 Structural Criteria

16.11.1 Foundations. Power plant foundations require careful design because a site is frequently on marsh or filled ground close to the sea. Where low water levels are anticipated, a detailed subsurface study is necessary.

- a) Extra piling may be required for stack foundations, turbine generators, boilers, fuel oil tanks, coal silos, and other heavy equipment. Seismic conditions at the site should be investigated.
- b) Where heat from a furnace is transmitted to a boiler foundation, it should be separated from other foundations and floor slabs, and an expansion joint at floor slab level installed around its periphery.
- c) Equipment foundations should be designed in accordance with manufacturers' instructions.

16.11.2 Platform and Ladders. Provide platforms for all systems more than 4 feet above the ground floor requiring access for operation and cleaning. Connect the platforms to two means of exit.

- a) Systems and access doors for inspection need only ladders.
- b) Platforms shall have toe guards and railings.

16.11.3 Typhoon or Hurricane Considerations. Exterior mechanical equipment and systems should be anchored, braced, or guyed to withstand the wind velocity specified for design of structures (see MIL-HDBK-1002/2, Loads). Designs for construction, installation, and anchorage of the typical mechanical features, as listed below, shall be given special attention to ensure minimum damage due to typhoon or hurricane phenomena:

16.11.3.1 Miscellaneous. Coal silos and conveying systems, cooling towers, evaporative condensers and coolers, boiler stacks, outside boilers, duct work, and roof-mounted heating and air conditioning units.

16.11.3.2 Exterior Piping Systems. Steam, water, compressed air, and fuel distribution lines mounted above ground on structural supports.

16.11.4 Collateral Reading. See MIL-HDBK-1003/6.

16.12 Electrical Criteria. Refer to MIL-HDBK-1003/6, under Electrical Criteria.

16.13 Operation and Maintenance Manuals. Each power plant shall be provided with a complete set of operating and maintenance manuals covering the plant, each process system and subsystem, and each piece of equipment. Preparation of operating and maintenance manuals shall be in accordance with the latest revision of Military Specification MIL-M-38784, Manuals, Technical: General Style and Format Requirements.

16.13.1 Plant Operation and Maintenance Manual. The plant operation and maintenance manual shall be divided into volumes separating mechanical and electrical systems. The manual shall be composed of sections or parts, each covering a complete operating system. Each section or part shall be formatted as follows:

16.13.1.1 System designation

16.13.1.2 Description of system and associated major equipment. Include pictures as necessary. List special tools or test equipment that are needed or furnished with equipment. Describe system function. Reference Equipment Data Manual for each piece of equipment. List all valves, state valve function, and state normal valve position (open, closed, or throttled). Include pipeline listing of pipeline section description, pipe material, and thickness and type of insulation. List and describe all electrical components.

16.13.1.3 Operation. Operation of system including procedures for prestart, starting, shutdown, post-shutdown, and monitoring. Include list of monitor description, location, units (such as ON/OFF), status, and alarm.

16.13.1.4 Maintenance. Maintenance of system including safety precautions, preparation, maintenance procedures (refer to data contained in Equipment Data Manual wherever possible). List maintenance actions, frequency (monthly, quarterly, semi-annually, annually, etc.) and Equipment Data Manual reference. Include description of each maintenance action by steps.

16.13.1.5 Troubleshooting. Troubleshooting of system including safety precautions, preparations, and troubleshooting. List troubleshooting activity by equipment piece including reference to Equipment Data Manual. Include list of trouble, probable cause, and corrective action for each piece of equipment.

16.13.1.6 Drawings. Foldout drawings including system descriptive drawings, schematic diagrams, flow diagrams, piping and instrument diagrams, heat balances, electrical one-line diagrams, control panel layouts, and reduced copies of sheets of construction plans, as necessary.

16.13.2 Equipment Data Manual. The Equipment Data Manual shall consist of one or more volumes, as necessary, to contain manufacturer's literature and data covering operation and maintenance procedures. This data manual should be indexed and sectioned by major pieces of equipment, including original equipment manufacturer's accessories. Equipment data should include the following information:

a) Master equipment list including equipment identification or tag number, name of item of equipment, location of item, name of supplier/manufacturer, other identifying characteristics such as capacity or type, and data location in the manual.

b) Manufacturer's data for each piece of equipment including:

- (1) General description.
- (2) Sequence of operation (startup, operating, and shutdown).
- (3) Operational checks and tests.
- (4) Adjustments.
- (5) Maintenance, lubrication, and inspection procedures and intervals.

- (6) Parts lists, including price list.
- (7) Recommended spare parts.
- (8) Manufacturer's data report for boilers, pressure vessels, and heat exchangers.
- (9) Manufacturer's certified pump performance curves and factory test data sheets.
- (10) Piping and wiring diagrams.
- (11) Original equipment manufacturer's data for associated auxiliary or accessory equipment.