Section 10: FIELD INSPECTION INSTRUMENTS

10.1 Introduction. This section describes field instruments commonly used in inspection of field painting. The References section of this handbook lists the full title and sources of standard test methods referenced in this section. For equipment descriptions having no referenced standards, no standards are available. Typical suppliers include:

a) Paul N. Gardner Company, Inc., Gardner Building, P.O. Box 10688, Pompano Beach, FL 33060-6688.

b) KTA-TATOR, Inc., 115 Technology Drive, Pittsburgh, PA 15275.

c) ZORELCO, P.O. Box 25500, Cleveland, OH 44125.

d) Pacific Scientific, 2431 Linden Lane, Silver Spring, MD 20910.

e) S. G. Pinney & Associates, 2500 S.E. Midport Road, P.O. Box 9220, Port St. Luice, FL 34952.

10.2 Illuminated Microscope. A pocket-sized illuminated microscope is frequently used to detect mill scale, other surface contamination, pinholes, fine blisters, and other microscopic conditions during painting operations. These microscopes are available with magnifications of 5 and higher.

10.3 Instruments for Use With Abrasive Blasting. A few instruments are available for testing the operational readiness of equipment for abrasive blasting of metals for painting.

10.3.1 Gage for Determining Nozzle Pressure. A pocket-sized pressure gage with a hypodermic needle is used to determine the blasting pressure at the nozzle. The needle is inserted in the blasting hose just before the nozzle in the direction of the flow. Instant readings can be made up to 160 pounds per square inch (gage) (psig).

10.3.2 Wedge for Determining Diameter of Nozzle Orifice. A hand-held calibrated wedge is inserted in the direction of flow into the nozzle orifice to determine its size (inches) and airflow (cfm at 100 psig). The orifice measuring range is 1/4 to 5/8 inch, and the airflow range is 81 to 548 cfm.

10.3.3 Surface Contamination Detection Kit. The level of cleanliness of abrasive blast cleaned steel can be determined by comparing it with SSPC VIS 1 photographic standards. SSPC VIS 3 photographic standards are used for determining level of cleanliness of hand-cleaned steel and power-tool cleaned steel. Standard coupons of steel blasted to different levels of cleanliness are also available for comparison from NACE, and procedures for their use are given in NACE TM0170. Test kits for detection of chloride, sulfate, and ferrous ions, as well as pH, are commercially available. They contain strips, swabs, papers, and operating instructions for simple chemical testing.

10.3.4 Profile of Blasted Steel. There are three methods for determining the profile (maximum peak-to-valley height) of blasted steel surfaces described in ASTM D 4417.

10.3.4.1 Comparators. Several types of comparators are available for determining surface profile. These include ISO, Clemtex, and Keene-Tator comparators. Basically, they use a 5-power illuminated magnifier to permit visual comparison of the blast-cleaned surface to standard profile depths. Standards are available for sand, grit, and shot-blasted steel.

10.3.4.2 Surface Profile Gages. A surface profile gage is an easy instrument to use to determine surface profile, but 10 to 20 measurements must be averaged to obtain reliable results. The gage consists of an instrument with a flat base that rests on the profile peaks and a tip that projects into the valleys. The tip can be blunted by dragging it across steel surfaces. This prevents the tip from reaching the bottom of the valleys in the profile, resulting in a profile value that is less than the correct value.

10.3.4.3 Testex Press-O-Film Replicate Tape. Testex Press-O-Film replicate tape produces the most precise profile measurements, according to the precision statement of ASTM D 4417. The tape consists of a layer of deformable plastic bonded to a polyester backing. The tape is rubbed onto the blast-cleaned surface with a plastic swizzle stick to produce a reverse replicate of the profile. The tape profile is then measured with a spring micrometer. The micrometer can be set to automatically subtract the 2-mil non-deformable polyester backing. After measurements, the tapes can be stored as records of profile heights.

10.3.5 Thermometers. Several different types of thermometer and temperature recorders are available for field use. They are used to measure ambient temperatures, surface temperatures of steel, and temperatures of wet paints.

10.3.6 Psychrometers. Several different manual or battery-powered psychrometers are available for measuring air temperatures, relative humidity, and dew point. In most cases, two glass thermometers are used with the instrument, as described in ASTM E 667, Clinical Thermometers (Maximum Self-Registering, Mercury-in-Glass). One thermometer has a clean "sock" or "wick" on it that is wetted with water. Air is circulated around the thermometers by the motorized fan or by whirling the hand-held sling psychrometer. Whirling should be with a steady, medium speed. Both thermometers should be read periodically and the airflow (whirling) continued until the reading becomes constant.

The "wet" bulb thermometer temperature will be lowered by evaporation of the water on the sock. The evaporation rate is related to the relative humidity and barometric pressure. Psychrometric tables relate temperature depression (difference between "dry" and "wet" bulb readings) to relative humidity and dew point. These standard tables, available from suppliers of psychrometers, cover the range from 23.0 to 30.0 inches barometric pressure. The effect of barometric pressure is relatively small; if it is unknown, use the 30.0-inch pressure table near sea level and the 29.0-inch pressure table at high elevations.

10.3.7 Wind Meter. A pocket-size wind meter is available for determining wind speed in miles per hour and velocity of air moving across a spray booth. Spraying on days with excessive winds can cause overspray or dry spray problems.

10.3.8 Moisture Meter. Meters are available for determining the moisture content of wood, plaster, concrete, or other materials. Some are nondestructive, while others require contact pins to be driven into the surface. An alternate non-destructive procedure for determining if too much moisture is present in cementitious surfaces is described in ASTM D 4263.

10.3.9 Wet Film Gage. Gages for determining paint wet film thickness are available in different types, two of which are described in ASTM D 1212 and one in ASTM D 4414. All are destructive in that they disturb the paint and require touching up the film.

10.3.9.1 Notched Metal Gage. The most widely used type of wet film thickness gage, described in ASTM D 4414, consists of a thin rigid metal notched gage, usually with four working faces. Each of the notches in each working face is cut progressively deeper in graduated steps. The gage with the scale that encompasses the specified thickness is selected for use. To conduct the measurement, the face is pressed firmly and squarely into the wet paint immediately after its application. The face is then carefully removed and examined visually. The wet film thickness is the highest scale reading of the notches with paint adhering to it. Measurements should be made in triplicate. Faces of gages should be kept clean by removing the wet paint immediately after each measurement. An alternative circularly notched gage ("hot cake") is rolled perpendicularly through the wet film and the clearance of the deepest face wetted is noted.

10.3.9.2 Cylindrical Gage. A cylindrical wet film thickness gage is described in ASTM D 1212. These gages are also rolled through the paint rather than being pressed into it. They have an eccentric center wheel with constantly changing clearance supported by two outer wheels. The position on the exterior scale corresponding to the point that the wet paint first touches the eccentric wheel indicates the wet film thickness.

10.3.10 Dry Film Thickness Gages for Coatings on Aluminum, Copper, and Stainless Steel. Gages are available to determine the dry film thickness of organic coatings on aluminum, copper, and stainless steel. Alternating current from the instrument probe coil induces eddy currents in the metal that in turn induce magnetic fields that modify the electrical characteristics of the coil. ASTM D 1400 fully describes the instrument and its operating procedure.

10.3.11 Magnetic Dry Film Thickness Gages for Coatings on Steel. There are many different types of gages available for nondestructively determining the film thickness of cured organic coatings on metal surfaces. Most rely on the ferromagnetic properties of steel. Their use is described in detail in ASTM D 1186 and SSPC PA 2. They are available in different thickness ranges to provide the best accuracy with different coating thicknesses. Each has a probe or tip that is placed directly on the coating during measurement.

a) Magnetic thickness gages should be calibrated before use. It is also a good practice to check the calibration during and after use. Gage suppliers provide a set of standard thickness nonmagnetic (plastic or nonferrous metal) shims to cover their working ranges. The shim for instrument calibration should be selected to match the expected coating thickness. It is placed on a bare steel surface and the gage probe placed on it for calibration. If the instrument scale does not agree with the shim, it should be properly adjusted. If adjustment is difficult, the reading for bare steel can be added or subtracted from field readings to determine actual thicknesses.

b) The steel surface used for calibration should be a masked-off area of the steel being painted or an unpainted reference panel of similar steel, if possible. Pull-off gages are best calibrated using small chrome-plated steel panels of precise thickness (Standard Reference Material No. 1358, Certified Coating Thickness Calibration Standard) available from the National Institute of Standards and Technology (formerly the

National Bureau of Standards), Gaithersburg, MD 20899. These panels should not be used on magnetic flux gages, because the mass of steel is insufficient for their proper operation. Shims from pull-off gages should not be interchanged with those from magnetic flux gages.

c) About five field measurements should be made for every 100 square feet of painted surface. Each of these five measurements should be an average of three separate gage readings taken within an inch or two of each other. Measurements should be made at least 1 inch away from edges and corners.

10.3.11.1 Pull-Off Gages. Pull-off gages measure film thickness by stretching a calibrated spring to determine the force required to pull an attached permanent magnet from a coated steel surface. The simplest type of pull-off instrument is the pencil gage with a coil spring attached to the magnet. It is held in a vertical position on the coated steel and lifted away slowly until the magnet pops off the surface. The paint thickness is indicated by the position of the indicator on the calibrated scale. The attractive force of the magnet varies inversely with the paint thickness.

Banana gages (long, narrow instruments) represent another form of pull-off gage. They are more versatile and precise than pencil gages. A helical spring is stretched by manually turning a graduated dial, and a pin pops up when the magnet is lifted. At least one company sells an automatic gage with a dial that turns and stops automatically. Cheaper models have a rubber foot contact for the painted surface. More expensive models have a more durable tungsten carbide foot for greater durability and precision. “V” grooves are cut in the probe housing of these gages and the electrically operated flux gages described below to permit more accurate measurement of paint dry film thicknesses on cylindrical surfaces.

10.3.11.2 Flux Gages. Magnetic flux gages measure changes in the magnetic flux within the probe or the instrument itself. Flux changes vary inversely with distance between the probe and the steel. Mechanically operated instruments of this type have a horseshoe magnet that is placed directly on the coating, and readings are made from the position of a needle on a calibrated scale.

Electrically operated magnetic flux instruments have a separate instrument probe that houses the magnet. Thickness measurements are presented in a digital read-out. Some of these gages have a probe attached to the instrument to permit greater accessibility, especially in laboratory work. They may also have attachments for strip recorders for repetitive work or alarms to produce sounds if minimum thicknesses are not met. For the paint inspector, these more sophisticated attachments are normally unnecessary.

10.3.12 Destructive (Nonmagnetic) Dry Film Thickness Gage. There are several models of Tooke gage described in ASTM D 4138, Measurement of Dry Film Thickness of Protective Coating Systems by Destructive Means that measure paint dry film thickness on any surface by microscopic observations of precision-cut angular grooves in the film. The gage is not recommended with very soft or brittle films which distort or crumble, respectively, when cut.

A dark, thick line is first drawn on the painted surface for later reference under the magnifier. A groove is then firmly cut perpendicular across the line with a tungsten carbide cutter tip as it forms a tripod with two support legs. The width of the cut is determined visually using the illuminated magnifier portion of the instrument. Tips with three different cutting angles are available for use with films of thickness up to 50 mils. Visual observations are multiplied by 1, 2, or 10, depending upon the cutting angle of the tip, to determine the actual film thickness. Thicknesses of individual coats of a multi-coat system can be determined, if they are differently colored.

10.3.13 Holiday Detector. Instruments for detecting pinholes and other flaws in coatings on metal surfaces are used mostly on waterfront and fuel storage and distribution facilities but should be used on freshly coated critical metal structures. Holiday detectors are available in two types: low and high voltage, as described in NACE RP0188.

10.3.13.1 Low Voltage Holiday Detectors. Low voltage (30 to 90 volts) detectors are used on coatings up to 20 mils in thickness. These portable devices have a power source (a battery), an exploring electrode (a dampened cellulose sponge), an alarm, and a lead wire with connections to join the instrument to bare metal on the coated structure. A wetting agent that evaporates upon drying should be used to wet the sponge for coatings greater than 10 mils in thickness. The wetted sponge is slowly moved across the coated surface so that the response time is not exceeded. When a holiday is touched, an electric circuit is completed through the coated metal and connected wire back to the instrument to sound the alarm. Holidays should be marked after detection for repair and subsequent retesting.

10.3.13.2 High Voltage Holiday Detectors. High voltage (up to 30,000 volts or more) holiday detectors are normally used on coatings greater than 20 mils in thickness. The rule of thumb is to use 100 volts per mil of coating. The exploring electrode may consist of a conductive brush or coil spring. It should be moved at a rate not to exceed the pulse rate of the detector. If a holiday or thin spot in the coating is detected, a spark will jump from the electrode through the air space or a thin area of the coating to the metal. The resultant hole in the coating will locate the holiday or thin spot that requires corrective action.

10.3.14 Adhesion Tester. There are two basic types of testing for determining adhesion of coatings: the tape and the pull-off test. The tape test is mostly used in the field, and the pull-off test, in the laboratory. The tape test is most useful when adhesion is low. Thus, it is often used to determine whether an old coating has adequate adhesion to support another layer of paint, or whether there is compatibility between coating layers. This test cannot distinguish among good adhesion levels. The pull-off test is more time consuming to perform since a “dolly” or fixture must be glued to the surface of the coating. The test measures the tensile force needed to remove the fixture. Pull-off forces up to several thousand pounds per square inch can be measured.

10.3.14.1 Tape Adhesion Test. In the tape test, ASTM D 3359, an X or a lattice pattern is cut through the coating to the substrate. Special pressure-sensitive tape is applied over the cut and rapidly pulled off at an angle of 180 degrees. The cut area is then examined for extent of deterioration. A kit is available with a knife, chrome-plated steel template and tape for performing the test.

10.3.14.2 Pull-Off Adhesion Test. In the pull-off test, ASTM D 4541, a metal dolly is bonded to a coated surface at a perpendicular angle with an adhesive, usually a two-component epoxy. After the adhesive has fully cured, a force is gradually and uniformly applied to the dolly until it is detached from the coating (or until the desired pull-off level is reached). One type of pull-off tester has a hand wheel that is turned to apply the force. The hand wheel/ratchet spanner is tightened until the dolly is detached or a prescribed force is applied. Another type applies the pull force pneumatically with compressed gas. Machine application of pull produces more accurate results than manual application. In both cases, care must be taken to make sure the dolly and instrument are both aligned perpendicular to the coated surface. A horizontal surface is preferred.

10.3.15 Portable Glossmeter. Battery-powered, pocket-size gloss meters can provide accurate measurements in the laboratory or field. ASTM D 523, Specular Gloss, describes a method for measuring gloss in the laboratory which could be adapted for use with a portable device. Measurements can be made on any plane surfaces.

10.3.16 Hardness Tester. A series of hardness pencils (drawing leads) are available for determining rigidity or hardness of organic coatings on rigid substrates. The film hardness is that of the hardest lead that does not cause damage, as described in ASTM D 3363, Film Hardness by Pencil Test. The procedure is used to establish degree of cure, adverse effects of solvents from a wet layer upon a dry film, and softening effects caused by environmental exposure.

Section 11: ANALYSIS OF PAINT FAILURES

11.1 Definition. Organic coatings deteriorate and fail with time. Failure analysis does not concern itself with this type of deterioration. It is defined as an investigation to determine the cause or causes of premature deterioration of coatings or coating systems. It is obvious, however, that failure analyses are often also directed at obtaining additional information than that stated in the above definition. Thus, the failure analyst may also wish to determine the extent of the damage, whether all requirements of a specification of a contract or work order had been met, who might be responsible for the failure and thus be liable for repairs, or what is the best remedial action to correct the existing condition.

11.2 Documentation of Findings. Measurements, photographs, specimens, and other observations made at the job-site or later in the laboratory should be firmly documented with dates, locations, etc., because they may at a later time become legal evidence. Personnel conducting failure analyses should routinely follow the procedures necessary for such documentation to prepare for any eventuality.

11.3 Scope of Failure Analysis. Paint failure analysis can be conducted by anyone with a basic understanding of coatings. However, they are best conducted by someone specially trained for the work. This is particularly true if the investigation becomes part of a dispute, since credibility of the analyst may be a determining factor in a dispute. In some instances, an analysis need not be extensive, but care must be taken not to make important conclusions based on superficial observations. A complete paint failure analysis includes most or all of the following actions:

a) Review of specification including modifications

b) Review of supplier's data

c) Review of inspector's daily reports

d) Thoroughly documented on-site inspection

e) Laboratory analysis of retained and/or field samples

f) Analysis of data

g) Preparation of a report containing findings and conclusions

11.3.1 Review of Specification for Coating Work. The specification and the submittals required in the specification for the coating work should be thoroughly reviewed and understood. The specification states precisely the work that was to have been done and the methods and materials that were to be used, so that any deviations from them should become apparent. The review may also point out discrepancies or lack of clarity in the document that may have contributed to the failure.

11.3.2 Review of Supplier's Data. Supplier data sheets should be reviewed, because they describe the intended purpose of the coatings used, along with recommended surface preparation and application practices. They may also include compositional information that can be checked later by laboratory analysis to determine if the batch actually used was properly prepared.

11.3.3 Review of Inspector's Daily Reports. The inspector's daily reports should be reviewed, because they provide information about the conditions under which the work was accomplished and the quality of the surface preparation and coating application. Any compromises in the conditions required by the specification or recommended by the supplier may lead to early failure. These reports may also reveal field changes that were made to the original specification.

11.3.4 On-Site Inspection. Just as the inspector on the job, the person analyzing paint failures must have access to areas where failures have occurred. This may require ladders or lift equipment, lighting, or mirrors. The analyst should also have photographic equipment to document conditions and be skilled in its use. Scales should be used to show relative size, and permanent markings should be made on each photographic exposure for positive identification. Dates should also be placed on the photographs.

The analyst should have a standard kit of field test equipment including one or more thickness gages and calibration standards, a knife, a hand lens, and containers for samples. Obviously, he should be well trained in their use and use them systematically, as described elsewhere in this text. A container of methyl ethyl ketone (MEK) or other strong solvent may be useful in either determining paint solubility (e.g., verifying the general paint type or its complete cure) or to strip off a coating to examine the condition of the underlying surface or the thickness of the underlying galvanizing or other insoluble coating. Standard forms for manually recording data or equipment for voice recording are also very useful. A failure analysis checklist can ensure that no important item is overlooked. Obviously, all items on the list may not be important at all times, but to inadvertently skip an important one may be a serious oversight.

11.3.5 On-Site Inspection Techniques. An overall visual analysis should first be made to determine the areas where the deterioration is most extensive and where any apparent deviation from specification may have occurred. This should then be followed by a closer examination as to the specific types of deterioration that may be present.

a) Use of a hand lens may provide information not otherwise visually apparent. All types of failure, including color changes and chalking, should be described fully. For example, does peeling occur between coats or from the substrate? Are blisters broken or filled with water? This detailed information may be necessary for finalizing conclusions as to the type of failure. The terms defined later in this section should be used to describe failures rather than locally used terms that may not be clear to other people. Care must be taken not to come to final conclusions until all the data are analyzed. It is a good practice to state at the inspection site that the final conclusions on causes of failure cannot be made until completion of laboratory testing.

b) Dry film thicknesses should be routinely measured and recorded, as any significant deviations from recommended thicknesses can be a factor contributing to coating failure. The procedure for measurement of these thicknesses required in the specification should be followed.

c) Other measurements that may be important are coating adhesion and hardness, since they may provide important information on application or curing of the coating. Adhesion can be easily determined with a simple tape test described in Section 9 or by using more sophisticated instrumentation (refer to Sections 8 and 9). Hardness can be tested in the field with a knife or special hardness pencils.

d) It is generally important to verify the identity of the finish coatings and occasionally the identity of the entire coating system. If wet samples of the paints used have been retained, they can be submitted for laboratory analysis for conformance to specification or manufacturer’s data sheet. If these are not available, a simple solvent rub test may be useful in determining whether the exterior coatings are thermoplastic, thermosetting, or bituminous. A cotton-tipped swab stick is dipped in MEK or acetone and rubbed against the paint surface. A thermosetting coating such as a vinyl which has been deposited on the surface by simple solvent evaporation will redissolve in the solvent and be wiped onto the cotton. A bituminous (coal tar or asphalt) coating will also behave in this manner, but it will impart a characteristic brown stain to the cotton. Properly cured multiple-component thermosetting coatings such as epoxies that cure by chemical reaction will not be affected by the solvent. These solvents can also be used at the job site to remove thermoplastic coatings to examine the condition of the underlying substrate. The presence of mill scale may establish the extent of surface cleaning. If rust is found, care must be taken to determine if it was present before painting or resulted from underfilm corrosion. Samples of the finish coat can also be removed by sanding and taken to the laboratory for identification as described in par. 11.3.6.

e) Once the various types of failure that may be present have been identified, the extent of each type of deterioration should be estimated. Standard block methods that help to quantify the extent of coating deterioration are described in ASTM F 1130, Inspecting the Coating System of a Ship. Two sets of drawings are used to illustrate failures. One set is used to identify the portion of the surface on which the paint is deteriorated. The other set is used to identify the level of deterioration within the deteriorated areas. For example, a fourth of the surface could exhibit blistering and within the areas 10 percent of the surface could be blistered.

11.3.6 Laboratory Testing. A more definitive laboratory analysis of deteriorated paint is generally desired and may become critical if the problem goes into litigation. Such analyses require several representative paint samples to be collected at the job site. Peeled and blistered paint is easily sampled, but it may be necessary to obtain samples from sound paint by scraping or sanding. Each sample should be placed in a sealed container and properly identified and dated. Chain of custody procedures (ASTM D 4840, Sampling Chain of Custody Procedures) should be used if litigation is involved.

If samples of wet paint used on the job are available, they can be tested by standard laboratory tests for conformance to any SSPC, Federal, military, or State specification referenced in the contract specification. If none of these standards was referenced in the specification, the paints can be tested for conformance to manufacturer's listed composition or properties.

11.3.6.1 Microscopic Examination. Samples of paint collected at the job site should be examined under a light microscope. An edge examination may reveal the number of coats and the thickness of each coat. An examination of the surface may reveal fine cracking or other irregularities. Examination under a scanning electron microscope (SEM) can reveal much more detailed information about the paint film. Also, the SEX often has an attachment for energy dispersive x-ray analysis which can identify the metals and other elements in the pigment portion of small areas of the coating.

11.3.6.2 Spot Tests. There are several simple laboratory spot tests that can be run on samples of deteriorated paint collected at the job site. They generally provide specific information about the paint binder (ASTM D 5043, Field Identification of Coatings) or pigment. Special chemicals and training are usually required by the analyst.

11.3.6.3 Infrared Spectrophotometric Analysis. The most widely used technique in laboratory analysis of paint failures is the infrared spectrophotometry. The use of new Fourier transform infrared (FTIR) spectrophotometers permits much more versatility and precision than earlier instruments. The technique can identify the resin components of paints from the shapes and locations of their characteristic spectral peaks. It is highly desirable to separate the resin from the paint pigment before analysis, because the pigment may cause spectral interference. This is easy to do with thermoplastic but not thermosetting paints. Thermoplastic resins can be dissolved in solvents that are transparent in part or all of the infrared region, filtered to remove the pigment, and the solution placed in standard liquid cells or cast as films onto sodium chloride or other plates that are transparent in the infrared region. Thermosetting coatings can be pressed into potassium bromide pellets or their spectra measured using diffuse reflectance equipment. Although the pigment is not separated in these procedures, the spectrum of the pigment can often be separated from that of the total coating by the FTIR spectrometer. Spectra of field samples are compared against published standards or authentic samples. It should be remembered that exterior weathering may cause oxidation that may appear in spectral analyses.

11.3.6.4 Other Specialized Instrumentation. There are other specialized instruments that can be very helpful in failure analysis. These include emission spectroscopy, atomic absorption spectroscopy, and x-ray fluorescence instruments that can identify and quantity the metals present in a coating. Their methods of operation are beyond the scope of this document.

11.3.7 Forming Conclusions and Preparing Reports. Field and laboratory data should be analyzed logically and systematically to form conclusions as to the causes of paint failure. No data should be overlooked, and the conclusions should be consistent with the data. The report should include conclusions and recommendations requested by the activity for which the analysis was made.

The report is perhaps the most important part of the failure analysis, because it presents the findings and conclusions of the investigation. No amount of good field or laboratory work will be useful unless it is presented well in the report. There must be a clear, systematic, and logical presentation of the findings, so that the conclusions are well supported. The report should not contain errors or otherwise be subject to challenge. Where conclusions are not firm, the extent of uncertainty should be stated.

11.4 Expert System for Failure Analysis. An expert system for failure analysis provides a systematic approach first to make a preliminary identification based on visual observations and then to verify it with supplementary information. The initial identification is based upon the answers to a series of questions designed to distinguish one type of failure from another. Decision trees 1 and 2 are used for this, one for surface defects and one for film failures. This same approach can be used in an expert system for a computer. The importance of a systematic approach cannot be overemphasized. One should be careful not to make permanent decisions on types and causes of failure until all the evidence is considered.

The first step in the identification of a coating failure is to determine which decision tree to use. Tree l for cosmetic defects should be used if only surface damage is present, i.e., if the surface coat has not been completely penetrated to the underlying coat or structural substrate. Tree 2 for film failures should be used if coating damage has completely extended through the surface coat.

After a preliminary decision of the type of failure has been made, look at the additional comments in the verification section below to obtain further support for this selection. If this information does not support the initial decision, reexamine the evidence or reconsider answers to the decision tree, until you are satisfied that you received the best overall answer.

Remember, answers are not always easily obtained in failure analysis, and there may be multiple types and causes of failure. Thus, one may in some cases have to be content with the most probable cause or causes of coating failure.

11.4.1 Cosmetic Defects. The following paragraphs further describe the cosmetic defects chosen in the initial decision.

11.4.1.1 Chalking. Chalking occurs only on exterior surfaces, since it is caused by the sun's ultraviolet rays. The loose chalk will be the same color as the coating, and, if it is severe, an undercoat may be visible. Chalking should not be confused with loose dirt which will not be the same color as the finish coat.

11.4.1.2 Mildew. Mildew may resemble dirt but generally grows in discrete colonies rather than being uniformly distributed. In addition, it can be bleached with household bleach, but dirt cannot. Also, it can also be identified microscopically by its thread-like (hyphae) structures and its groups of spherical spores. Mildew is usually black in color but some microorganisms on coatings may have a green or red coloration.

11.4.1.3 Dirt. Dirt may be tightly or loosely held. It can normally be removed by washing with detergent solution. However, it may resist washing, if the dirt became embedded in the wet or soft paint.

11.4.1.4 Uneven Gloss. Localized glossy spots may often be detected only if observed from a particular angle. They occur most frequently from spray application of heavy areas that do not penetrate into wood or concrete/masonry surface.

11.4.1.5 Blushing. Blushing is a defect from spraying fast-evaporating coatings, particularly lacquers such as vinyls and chlorinated rubbers, on hot, humid days. Condensation of moisture on the wet film dulls the finish to cause an opalescence.

11.4.1.6 Bleeding. Bleeding occurs when solvent-containing coatings are applied to a bituminous coating or pavement. The stronger the solvent and the slower its evaporation, the greater will be the tendency to dissolve the bituminous material and cause it to bleed to the surface of the finish. New asphalt pavements or toppings should be allowed to remain 4 weeks before marking with paint to allow evaporation of volatile materials in the asphalt.

11.4.1.7 Fading. Fading of paint pigments occurs greatest in the sunlight. Thus, there will be less fading of coatings under eaves and other shaded areas. It also occurs more with synthetic organic pigments than with naturally-occurring mineral pigments (earth tones).

11.4.1.8 Discoloration. Discoloration is caused by exposure of unstable pigments or resins to sunlight. Unstable resins like polymerized linseed oil may yellow. The only prevention is to use light-stable materials.

11.4.1.9 Pigment Overload. Pigment overload frequently results in a mottled appearance or a poor quality film. It can occur when attempting to tint a white paint to a deep tone. Latex paints are particularly susceptible to this problem. By specifying colors produced by the supplier, this problem can be avoided.

11.4.1.10 Checking. Early checking may be caused by improper formulation or application that causes the coating to shrink upon curing. Excessive thickness or rapid curing may be responsible. Aging will eventually cause checking of most coatings. It will often occur when existing paints are topcoated with more rigid finish coats that do not expand or contract as easily.

11.4.1.11 Dry Spray. Dry spray produces an uneven, pebbly finish with holidays. The holidays can be verified on a metal substrate with a holiday detector. It occurs most frequently when applying coatings with fast evaporating solvents on warm days or when the spray gun is held too far from the surface being painted.

11.4.1.12 Sagging. Sags may not permit complete curing of the body of oil-based coatings and so may be soft below the surface. Reduced film thickness in the areas where the sagging initiated may be detected using a magnetic thickness gage on steel surfaces and by using a Tooke gage on other surfaces.

11.4.1.13 Orange Peel. Orange peel is a defect of spray application. It usually is widespread, when it occurs, and is easily identified by its resemblance to the skin of an orange.

11.4.1.14 Wrinkling. Wrinkling occurs mostly with oil-based paints that are applied so thickly on hot days that the surface of the film cures rapidly to form a skin that does not permit oxygen to reach the interior of the film to cure it. The coating under the ridges is usually soft. Ridges generally occur in parallel rows.

11.4.2 Film Failures. The following paragraphs further describe the film defects chosen in the initial decision.

11.4.2.1 Crawling. Crawling, sometimes called bug eyeing or fish eyeing, occurs during coating application, frequently on contaminated surfaces. It can usually be detected at the time of application. The smooth, oval shapes resembling eyes are characteristic of crawling.

11.4.2.2 Alligatoring. The characteristic checkered pattern of cracked coating will identify alligatoring. The coating is quite inflexible and cannot expand and contract with the substrate. It is a special form of cracking or checking.

11.4.2.3 Intercoat Delamination. Intercoat delamination is simply the peeling of a stressed coat from an undercoat to which it is poorly bonded. It may occur in a variety of situations, but occurs frequently when a chemically curing coating such as an epoxy or a urethane has cured too hard to permit good bonding of a topcoat. It may also occur when coating a contaminated surface.

11.4.2.4 Intercoat Blistering. Intercoat blistering in a storage tank or other enclosed area is likely due to solvent entrapment. In water tanks or other areas exposed to water, the trapped solvent will cause water to be pulled into the blister. If the blisters are large, unbroken, and filled with water, it is sometimes possible to smell the retained solvent after breaking them. Intercoat blistering may lead to intercoat delamination.

11.4.2.5 Pinpoint Rusting. Pinpoint rusting is frequently caused by applying a thin coating over a high profile steel surface. A thin coating can be verified using a magnetic thickness gage. It may also occur when steel is coated with a porous latex coating system. Pinpoint rusting may initiate corrosion undercutting of the coating.

11.4.2.6 Cracking. Cracking is the splitting of a stressed film in either a relatively straight or curved line to an undercoat or the structural substrate. Cracking may occur from rapidly curing coatings such as amine-cured epoxies. Mudcracking is a more severe condition caused by rapid drying, particularly by heavily pigmented coatings such as inorganic zincs. It also occurs with latex coatings applied too thickly on hot days. On wood, too thick or too inflexible a film (usually a buildup of many layers) can cause cracking perpendicular to the grain of the wood.

11.4.2.7 Blistering to Substrate. The blisters that arise from the substrate may be broken or unbroken. If broken, they may lead to peeling and be hard to identify. Blistering to wood or concrete/masonry substrates may be caused by moisture in the substrate.

11.4.2.8 Peeling. Peeling is the disbanding of stressed coatings from the substrate in sheets. It is generally preceded by cracking or blistering.

11.4.2.9 Flaking (Scaling). Flaking or scaling is similar to peeling, except the coating is lost in smaller pieces. Flaking of aged alkyd coatings occurs commonly on wood.

11.4.3 Examples of Using Decision Trees. The decision trees 1 and 2 (Figures 24 and 25) can best be understood by using examples.

11.4.3.1 Example of Surface Defect. This example is a surface defect that does not penetrate the finish coat so that use of decision tree 1 is required. We start with Question 1, “Does detergent washing remove the defect?” In our example, the answer is “Yes,” so we proceed to Question 2, “Does wiping with a dry felt cloth remove defect?” This time the answer is “No,” so we proceed to Question 3, “Does defect disappear when treated with household bleach?” In our example, the answer is “Yes,” so we have tentatively identified the defect as “Answer 2” mildew.

11.4.3.2 Example of a Film Defect. This example is a defect that penetrates the finish coat so that use of decision tree 2 is required. We start with Question 10, “Do oval voids that originate at time of coating application expose an undercoat or the structural substrate?” In our example, the answer is “No,” so we proceed to Question 11, “Does the failure expose only an undercoat?” This time the answer is “Yes,” so we proceed to Question 12, “Which best describes the failure?” In our example, the answer is “Peeling topcoat to expose undercoat,” so we have tentatively identified the defect as “Answer 17” intercoat delamination.

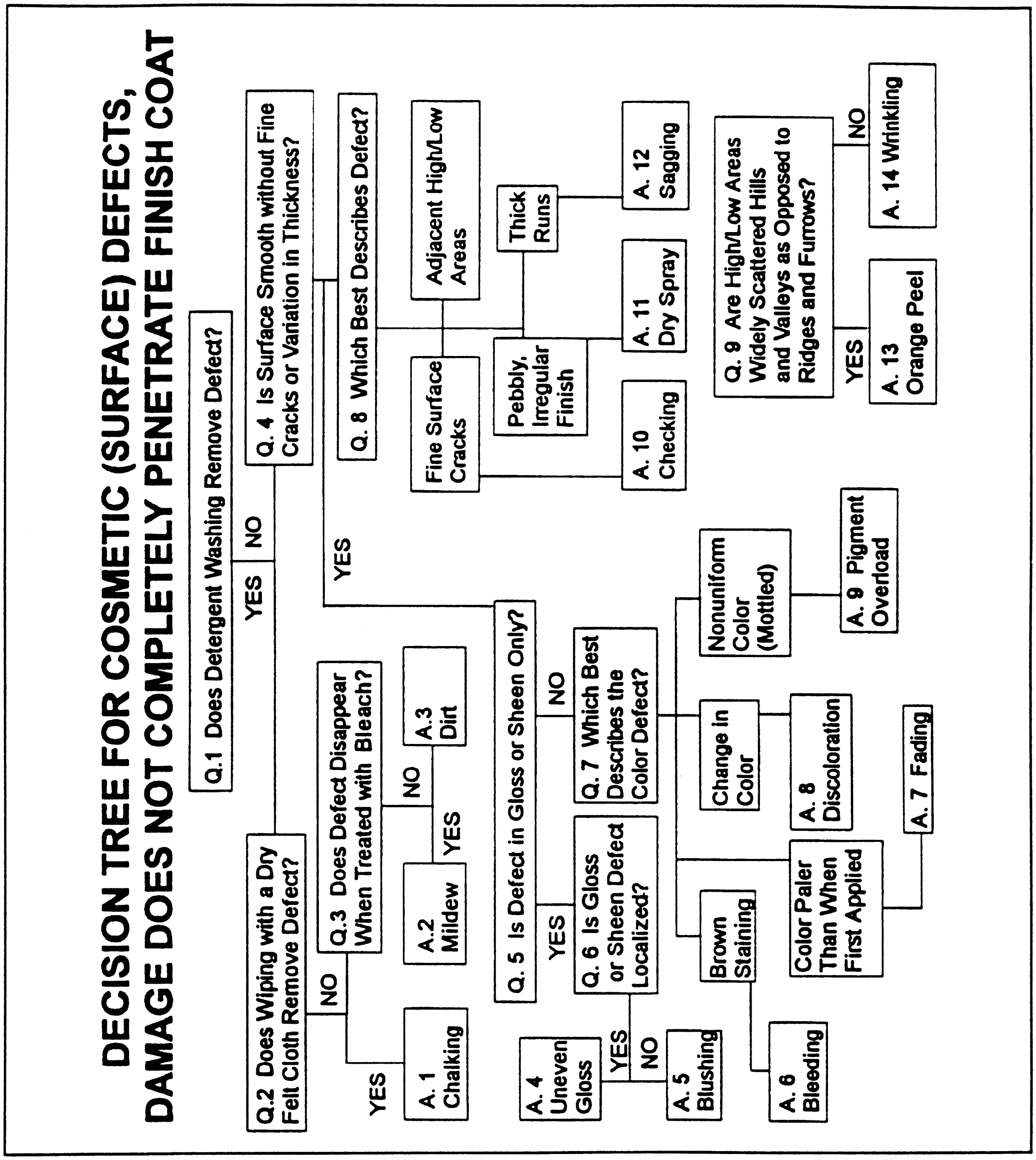

Figure 24
Decision Tree 1: Support for Analysis of Coating Failures That Do Not Penetrate the Finish Coat

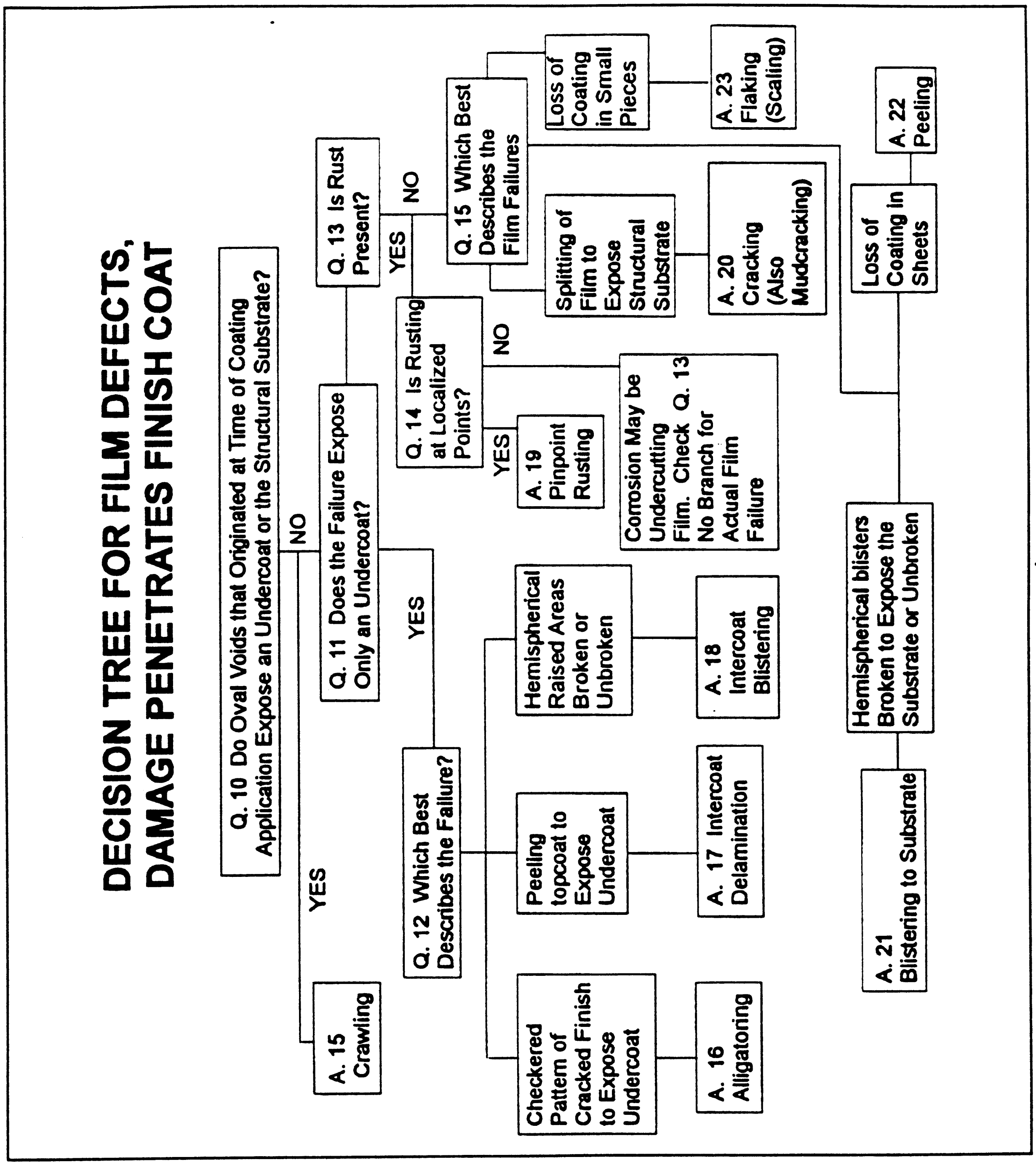

Figure 25
Decision Tree 2: Support for Analysis of Coating Defects That Penetrate the Finish Coat

Section 12: PROGRAMMING MAINTENANCE PAINTING

12.1 Definitions of Programmed Painting and Maintenance Painting. Paint programming is a systematic planning process for establishing when painting is required, what painting should be done, by whom, at what times, and in what manner. Maintenance painting is a vital adjunct to programmed painting. It is defined as a field procedure for maintaining existing coatings in an acceptable condition.

12.2 Components of Programmed Painting. There are three basic components of successful paint-programming plans: plans for initial design of the facility, plans for monitoring conditions of structures and coating systems, and plans for maintenance painting. Each plan must be prepared properly and completely for the total program to be successful.

Programmed painting can best be implemented as a computer program. This program will contain the initial design data, data on the conditions of the structures and their coating systems obtained from an annual inspection report, and recommended maintenance painting schedules and procedures. The latter should include cost estimates for each item of work so that funding can be requested well in advance of the time it will be spent. Cost estimating programs for construction work are available in the Construction Criteria Base (CCB) (National Institute of Building Sciences, Washington, DC) and proprietary sources.

12.2.1 Initial Design. The design of both new structures and their coating systems is critical to achieving maximum life of each.

12.2.1.1 Structural Design. Structures should be designed so that they are easy to coat initially and to maintain in an acceptable condition. Common structural design defects include:

a) Contact of Dissimilar Metals. The more active metal will rapidly be consumed by galvanic corrosion to protect the less active metal. This includes contact of steel and stainless steel.

b) Water Traps. Structural components that collect rainwater corrode more rapidly. These components should either be turned upside down or have weep holes of sufficient size and correct placement drilled in them. Weep holes should be as large as possible and placed at the bottom of the structure.

c) Configurations That Permit Vapors or Liquids to Impinge on Structural Components. Structures such as steam lines.

d) Configurations Restricting Access. Structures that restrict access for painting receive poor quality maintenance.

e) Designs Creating Crevices. Crevices are difficult to coat, and the oxygen deficiencies in them produce a type of galvanic corrosion.

f) Other Difficult to Paint Surfaces. Sharp edges and welds should be ground, pits should be filled, and corners should be avoided.

12.2.1.2 Design of Coating System. The original coating system must be designed to be compatible with both the environment in which it is to be located and the substrate to which it is to be applied. Sections 4 and 5 of this handbook list systems that meet this requirement and are cost effective. As far as possible, it is desirable to specify coating systems that are easy to apply and maintain. It is always preferable to do the surface preparation and the paint application in the controlled environment of a shop as compared to the field. If this is not possible, this work should be accomplished at the work site before rather than after erection.

12.2.2 Plan for Monitoring Conditions of Structures and Their Protective Coatings. Annually, each coated structure at each military activity should be inspected for deterioration of both the substrates and their coatings. Both the types and the extent of deterioration should be noted, and the generic type of the finish coat should be determined if it not already known. An estimate should also be made as to when structural and coating repairs should be made to prevent more serious damage. Other structures at the activity that require the same type of maintenance should also be noted, since it would be more economical to include as many structures as appropriate in a single contract. An example of an inspection form which has been successfully used for routine inspections and could be modified to meet an installation’s needs is shown in Figure 26.

12.2.2.1 Determining the Type of Coating Failure. The type of coating failure can be determined by following the procedure given in Section 11.

12.2.2.2 Determining the Extent of Coating Failure. In maintenance painting, it is necessary to determine the extent of coating failure to permit realistic bidding for the repair work.

To do this, both the severity of the deterioration and its distribution must be defined. The level of severity will indicate whether only the finish coat or other coats are involved in the deterioration and how it can best be repaired. If the distribution is limited, spot repairing is likely to be practical; if it is extensive, it is probably best to remove all the coating and repaint.

Standard block diagrams for estimating coating deterioration on ships for “Overall Extent” and “Extent Within Affected Areas” are generally also appropriate for shore structures. They are described in ASTM F 1130. First, draw an imaginary line enclosing all deterioration and select the standard “Overall Extent” diagram that best matches the imaginary area. Then, select the standard “Extent Within Affected Area” diagram that best matches the areas within the imaginary line. The number and letter of the selected diagrams establish the extent of deterioration. Whatever system is used to determine the extent of deterioration, it should utilize a standard format so that evaluations of different structures can be compared and priorities can be established.

It is also important in maintenance painting to determine precisely the amount of loose and peeling paint to establish the amount of work to be done. This will eliminate any controversy over a “site variation,” i.e., the contractor claiming that there was much more work necessary than described in the specification. It is a standard practice to define “loose and peeling paint” as that paint that is easily removed with a dull putty knife.

12.2.2.3 Determining the Generic Type of the Finish Coat. Once a painting program is set up, the identifications of paints being applied will automatically be entered into the database. If the generic type of the finish coat is not known, it can be determined by infrared spectrophotometric analysis as described in Section 11. The general compatibility of a coating can be determined by the solvent rub test, also described in Section 11.

12.2.3 Types of Maintenance Painting. In planning maintenance painting, it is first necessary to determine the general scope of the work. There are four different approaches to maintaining an existing coating in an acceptable condition:

a) Cleaning only to restore to an acceptable condition. This may be accomplished by pressure washing or steam cleaning.

Structure Number ____________	Date _____________
Reason for Inspection ______________________	
Inspector's Name ____________________________	
Substrate: Wood Aluminum Concrete Transite Steel Galvanized Steel Other _____________	Component: Siding Window Frame Door Door Pocket Door Frame Eaves Other _____________
Appearance: Chalking Fading Mildew Other _____________	Deterioration: Cracking Blistering Peeling Other _____________
MEK Rub Test: - (no effect) + ++ +++ (large effect)	Evaluation (1=good, 4=bad): 1 2 3 4
Suspected Binder Type: Alkyd Latex Epoxy Factory Finish Other _____________	Samples Collected: Chip Sample Photograph

Figure 26
Coating Condition and Identification Form

b) Spot repair (priming and topcoating) of areas with localized damage but otherwise sound paint. This should be done before the damage becomes more extensive.

c) Localized spot repair plus complete refinishing with topcoat only. This should be done when localized repair only would produce an unacceptable patchy finish.

d) Complete removal of existing paint and total repainting. This should be done when the damage is so extensive that types “b” or “c” are impractical or uneconomical.

Repair of exterior coatings may not be warranted with the first appearance of weathering, but deterioration should not proceed to the point that damage occurs to the substrate, or more costly surface preparation or application techniques become necessary. If lead-containing paint is present, the costs for paint repair or removal will be much more expensive. If the paint can be maintained in place, a great deal of savings will result. New restrictions on abrasive blasting and other surface preparation techniques may also significantly increase total costs. Thus, scheduling of repairs should be made to avoid such costly operations.

12.2.4 Plan for Maintenance Painting. The plan for maintenance painting includes selection of the surface preparation, application, and inspection methods and the materials to be used.

12.2.4.1 Selecting Materials for Maintenance Painting. For localized repairs to an otherwise sound coating system (12.2.3 types “b” and “c”), it is wise to repair a damaged coating system with the same coating previously used or one of the same generic type or curing mechanism to avoid incompatibility. If in doubt as to the compatibility of a paint to be applied to an existing finish, apply a small patch to it and inspect it after 2 to 3 days for any bleeding, disbanding, or other sign of incompatibility.

For total recoating (12.2.3 type “d”), select the coating as described for new work in Section 4 or 5.

12.2.4.2 Surface Preparation for Maintenance Painting. For making localized repairs, it is best to use the surface preparation methods for different substrates described in Section 6. It may be more practical or necessary, however, to use hand or power tools rather than abrasive blasting where the amount of work to be done is small, or where abrasive blasting would contaminate an area.

Loose and peeling coating should be removed, and the adjacent intact coating should be sanded to produce a feathered edge and roughened paint surface extending 2 inches beyond the repair area. The feathered edge will produce a smoother transition between the old and new paint and roughening the adjacent intact paint will permit good adhesion of the new primer.

Feather edging of steel may be accomplished by blasting with a fine abrasive (e.g., 60 mesh grit or finer) with the nozzle held at a low angle about 3 or 4 feet from the surface. However, even fine abrasive may damage adjacent coating. Thus, it is best to determine if there are any adverse effects with a surface preparation procedure before proceeding will it.

12.2.4.3 Application for Maintenance Painting. Spot application of paint in maintenance painting is usually done by brush or spray, as the painter determines to be most efficient. Brushing of the primer is usually preferred where the surface is rough or otherwise difficult to paint. Patches should be extended 2 inches beyond the areas of damaged coatings where the adjacent intact paint has been previously roughened.

12.2.4.4 Inspection of Maintenance Painting. Inspection of maintenance painting usually consists of visual inspection for workmanship, dry film thickness, and adhesion. Fuel tanks and lines, waterfront structures, and other critical structures should also be tested for holidays Imperfections in the coating). These inspection procedures are described in Section 9.

12.2.5 Scheduling the Work. By planning work well in advance, it is possible to schedule it at a time when minimum inclement weather is expected. It may also be possible to schedule it when there will be less interference with other trades doing construction work or personnel utilizing the structures.

Section 13: GENERAL SAFETY PRACTICES DURING PAINTING OPERATIONS

13.1 Introduction. This section discusses general safety concerns during painting operations and appropriate actions to be taken to protect those conducting these operations and others in the immediate area. Installation safety and industrial hazards offices should be consulted to determine detailed requirements for worker safety, including protection from toxic materials. General concerns will be discussed, much as they are discussed for safety paint application in SSPC PA 3, Safety in Paint Application. OSHA provides requirements for safety in the workplace. These requirements include:

29 CFR 1910.106/29 CFR 1926.152, Flammable and Combustible Liquids
29 CFR 1910.1200/29 CFR 1926.59, Hazard Communication
29 CFR 1910.146, Permit-Required Confined Spaces
29 CFR 1910.151, Medical Services and First Aid
29 CFR 1910.25, Portable Wood Ladders
29 CFR 1910.26, Portable Metal Ladders
29 CFR 1910.28, Safety Requirements for Scaffolding

Written policies are available at installation safety offices. These offices are responsible for providing necessary safety support, and it is important that personnel interact freely and positively with them in a total safety program. Attitude is of great importance in ensuring a safe working environment.

13.2 Standard Operation and Safety Plans. Every operation that involves any type of hazard should have a standard operating plan incorporating safety and health considerations. Contracted operations should have safety and health requirements clearly addressed in the contract specifications. Personnel have the right to learn of any unsafe or unhealthful conditions or operations that they will be involved with and to receive training or equipment necessary to conduct their work safely. Personnel must also be able to report hazardous conditions and conditions suspected of being hazardous without fear of retaliation. Workers, on the other hand, also have the responsibility of conducting their work in a safe and healthful manner, correcting or reporting unsafe or unhealthful conditions, and wearing appropriate personal protection equipment. This includes reducing exposures as much as possible. Only necessary personnel should be present in the hazardous areas.

13.3 Hazard Communication. The best way to protect yourself from chemical products used in painting operations is to know their identification, the hazards associated with them, and their proper and safe use. Every employer must provide this information to his employees. Each container of hazardous material must be labeled to identify its contents. Unlabeled products should never be used. Other important information on chemicals, including health and safety data, precautions for handling, and emergency and first aid procedures, can be obtained from the material safety data sheet (MSDS) for the product. These sheets are required to be present when hazardous materials are being shipped, stored, or used in any operation. Finally, the activity must have a written program providing personnel with information about the hazardous chemicals used in each operation and an inventory of hazardous chemicals on site. The activity must also provide employees with necessary safety training.

13.3.1 Labels. Labels should be replaced, if they are torn, hat, or illegible. When materials are transferred to other containers for easier use, these containers must also be properly labeled. Labels usually contain the following information:

a) Complete identification - may include several alternative names

b) Basic warnings - list hazardous chemicals and precautions

c) First aid requirements - what to do when splashed on eyes or skin

d) Fire actions - how to properly extinguish fires

e) Treatment of spills - equipment and materials for cleaning up spills

f) Handling and storage procedures - safety equipment and practices for proper handling

g) Disposal procedures - describe methods for safe and legal disposal

13.3.2 Material Safety Data Sheets. MSDSs provide the following information:

a) Chemical identification - identify chemicals present

b) Hazardous ingredient data - list hazardous chemicals and safety limits

c) Physical data - describe odor, appearance, etc., of chemicals

d) Fire and explosion data - list flash point and extinguishing media

e) Health hazards - symptoms of overexposure and emergency action

f) Reactivity data - stability and reactivity with other chemicals

g) Spill or leak procedures - clean-up and disposal procedures; always notify safety office

h) Special protection - necessary respirators, clothing, eye protection, etc.

i) Special precautions - special handling precautions, including safety signs and standby clean-up kits

Note: Specific requirements for personal protective equipment and use of the chemical should be based on a local evaluation by an industrial hygienist or health professional.

13.4 Toxicity Hazards. Many toxic materials may be encountered during cleaning and painting operation, such as organic solvents and lead- and chromate-containing pigments. Personnel working with toxic materials should be knowledgeable about how to protect themselves from them.

13.4.1 Entrance of Toxic Materials Into Body. Although toxic materials can enter the body during any part of a coating operation, surface preparation and coating application activities may present the greatest hazard. Toxic materials can enter the body by three different routes:

a) Inhaling in the lungs

b) Ingestion through the mouth

c) Absorption through the skin

13.4.1.1 Inhalation. Toxic vapors or suspended particles inhaled into the lungs may be rapidly taken into the rest of the body. Individual solvents in blends in paints vary widely in human toxicity. Exposures can be reduced with ventilation and respirator protection.

13.4.1.2 Ingestion. Ingestion through the mouth usually occurs from contaminated hands not washed before eating, drinking, or smoking. Good personal hygiene (hand washing, avoidance of clothing contamination and keeping tools/surfaces clean) should be practiced even when gloves are used.

13.4.1.3 Skin Absorption. Skin absorption must occur through contact. This can be minimized by use of protective clothing. Contaminated clothing should be removed and disposed of at the job site and be completely cleaned, and the contaminated person should thoroughly shower before leaving the job site. The appropriate protective clothing is paramount to preclude significant skin contact as some chemicals easily permeate (pass through) the protective material.

13.4.2 Types of Toxic Materials. Toxic substances are of four major categories:

a) Irritants - inflame eyes, nose, throat, and lungs

b) Asphixiants (e.g., carbon monoxide, nitrogen) - Interfere with oxygen assimilation or displaces available oxygen to breathe

c) Nerve poisons (organic solvents, lead compounds, etc.) - attack nervous system

d) Systemic poisons - affect heart, liver, kidney, or blood forming organs

13.5 Respiratory Hazards. There are four types of respiratory hazards:

a) Dusts - dry particles from grinding and blasting operations

b) Mists - liquid particles from cleaning and spraying operations

c) Gases and vapors of liquids - evaporated cleaning or paint solvent

d) Oxygen deficiencies - especially in confined areas

Dusts include smoke particles from combustion. Gases and some particles may not be seen by the naked eye. Any of these products resulting from painting operations may require a cartridge-type respirator. Specific recommendations for respiratory protection should come from a workplace evaluation of potential exposures.

13.6 Hazards in Different Painting Operations. Painting procedures may include one or more of the following hazardous operations: surface preparation, paint application, and working in high, confined, or remote places.

13.6.1 Surface Preparation. Surface preparation hazards occur in abrasive and water blasting operations, mechanical cleaning, chemical cleaning, and high temperature operations. Protection of workers and the environment from dust containing toxic metals (such as lead, cadmium, or chromate compounds) produced during removal of old paint is discussed in Section 3.

13.6.1.1 Abrasive and Water Blasting. Abrasive and water blasting are by far the most dangerous operations concerned with surface preparation for painting. High-pressure nozzles (over 100 psi for abrasive and over 30,000 psi for water blasting) pose major threats. Hoses and couplings must be checked for soundness, and the pot pressures must be checked to ensure that the maximum allowable pressures are not exceeded. The blast nozzle must have a deadman valve, so that it will automatically shut off, if it is lost by the blaster. No attempt should be made to override this or other safety devices. No safety omissions should be permitted, even for very small blasting jobs. The blasting area should be posted for no admittance, and the pot tender located in a protected area behind the blaster, so that no one is in the vicinity of the blaster. Each person in the operation should wear the proper safety equipment, including an air-supplied respirator (type CE) specifically designed for the blaster.

Isolation from the blaster and use of deadman valves are also important during water blasting. Electrical operations should be shut down at that time to prevent electrical shock. Care should also be taken to avoid slipping on wetted surfaces.

13.6.1.2 Mechanical Cleaning. Grinders, sanders, and other powered cleaning tools require special attention to meet the safety provisions of Subpart P of OSHA Standard 29 CFR 1910. They should have safety shields or devices to protect eyes and fingers. OSHA regulations do not permit the use of faulty hand and power tools such as cracked grinders and wheels or damaged rotary brushes. Power tools should only be operated as recommended by the manufacturer.

13.6.1.3 Chemical Cleaning. Chemical cleaning is inherently dangerous and requires special precautions. Chemicals must be properly labeled (refer to par. 13.3.1), stored, and used.

Chemicals should be stored off the floor in a secured and ventilated room separated from other chemicals with which they may react. Any shelving used for storage should be secured to the wall and have a lip on each shelf to prevent being accidentally knocked onto the floor.

Chemicals should be used in accordance with written standard operating procedures or the manufacturer's instructions. Proper eye, face, hand, and skin protection should be taken by using appropriate chemical protective clothing, eye/face equipment and following recommended operating procedures when working with caustic chemicals or solvents. Where the eyes or body of any person may be exposed to corrosive materials, suitable facilities for quick drenching or flushing of the eyes (eye washes) and body (deluge showers) shall be provided in the work area for immediate emergency use. Contaminated personnel or the work areas should be appropriately cleaned and treated as soon as possible. Spill kits and instructions for their use should be available for each type of chemical.

13.6.1.4 High Temperature Operations. High temperature cleaning can be achieved with steam, flame, or heat guns. They should be thermostatically controlled and used only where appropriate and according to standard operating procedures. Insulated gloves should be used where necessary to protect hands from heat.

13.6.2 Painting Operations. Hazards occur during storage, mixing, and application of paints.

13.6.2.1 Storage of Paints. Coating materials should be stored off the floor under cover in secured and well ventilated areas away from sparks, flames, and direct sunshine. The temperature should be well below the flash point of stored products. Flash point is the minimum temperature at which a liquid gives off enough vapor to become ignited in the presence of a spark or flame. Flammable liquids such as turpentine and toluene have flash points below 100 degrees F; combustible liquids have flash points of 100 degrees F or greater. The flash points of individual solvents vary greatly. So do the explosive limits - the concentration range in air at which combustion may occur.

Any shelving used for storage should be secured to the wall and have a lip on each shelf to prevent being accidentally knocked onto the floor. Equipment for removal of spills should be present.

13.6.2.2 Mixing and Applying Paints. Mixing and application operations have associated spill, fire, and toxicity hazards. Eye protection, gloves, and other appropriate equipment and clothing should be used during paint mixing operations. Individual solvents in blends in paints vary widely both in solvency and in human toxicity. They can remove moisture and natural oils from the skin to make it more sensitive to other irritants.

a) When mixing and applying paints, the following precautions should be observed:

(1) Protect eyes, face, hands, and skin

(2) Keep paint well below flash point

(3) Use in well ventilated areas. Consult the facility's safety office, if in doubt, for evaluation of the work space

(4) Use slow-speed stirrers to prevent buildup of static charge

(5) Permit no matches, sparks, or flames in area

(6) Ground equipment and work

b) When spraying paint:

(1) Ground equipment and metal work

(2) Use only non-sparking tools

(3) Permit no matches, open flames, or smoking in the area

(4) Perform in a well ventilated area or in an approved spray

Airless guns should only be used by trained personnel and with protective guards because, at the high pressures (over 2000 psi), paint droplets can penetrate flesh. They should never be pointed at any part of the body, and their nozzle guards should never be removed.

13.6.3 Work in High, Confined, and Remote Places. Work in high, confined, and remote places presents special hazards.

13.6.3.1 Work in High Places. Working safely in high places requires the proper use of equipment designed to provide access to the work site. Safety requirements for ladders, scaffolding, and stages can be found in OSHA Safety and Health Standards (29 CFR 1910), Paragraphs 1910.25 (Portable Wood Ladders), 1910.26 (Portable Metal Ladders), 1910.28 (Safety Requirements for Scaffolding), and 1910.29 (Manually Propelled Ladder Stands and Scaffolds (Towers)).

a) General requirements for ladders used in painting operations include

(1) Do not use if rungs/steps are loose, bent, or split

(2) Keep ladders away from power lines

(3) Never use as horizontal scaffold members

(4) Use only as intentionally designed

b) General requirements for scaffolds include:

(1) The footing/anchorage shall be sound and rigid (do not use bricks, boxes, etc., to support)

(2) Have rigid guard rails (never ropes) and toeboards or rails

(3) Keep them clean and free of abrasive, mud, grease, and other debris

(4) Remove unnecessary equipment

(5) Keep platforms level at all times

(6) Regular inspection and repair, as necessary

(7) Never use ladders on their platforms to add height

(8) Do not move when occupied

c) Additional requirements for swing (suspended) scaffolds suspended by block and tackle are:

(1) Secure life lines to personnel on them

(2) Never allow then to swing freely

(3) Limit to two the number of personnel on them

(4) Follow OSHA requirements for suspension

d) Additional requirements for rolling scaffolds are:

(1) Always set caster brakes when in a fixed position

(2) Never ride while moving

(3) Remove materials from platform before moving

Permanent scaffolding should be built for routine maintenance operations on aircraft or other standard configurations. Powered lift platforms or boom machines are often used to reach high places. Some extend as high as 100 feet. Scissor lifts, the most common type, only go straight up. Booms can provide greater access where there are obstructions in the way. Continuous forced-air ventilation may be used to control any hazardous atmosphere. Gas monitoring during the operation may be necessary where unsafe conditions could develop. When painting bridges, towers, or other tall structures, safety nets or harnesses should be utilized. They not only provide safety but also result in better workmanship. Safety harnesses are much preferred to safety belts because they distribute the shock from the safety line. Some harnesses have breakaway sections to further distribute the shock. Suppliers of harnesses provide detailed instructions for proper use.

13.6.3.2 Confined Areas. Confined areas such as fuel storage tanks, boilers, and utility tunnels present the following hazards:

a) Buildup of flammable or explosive atmospheres or materials

b) Buildup of toxic atmospheres or materials

c) Insufficient oxygen to support life

d) Excess oxygen posing fire or explosion hazard

Confined areas being cleaned or painted should be well ventilated to prevent the accumulation of toxic or combustible airborne contaminants. Mechanical equipment should be grounded, along with conductive substrates being cleaned or coated, to prevent sparking. Otherwise, an explosion may occur.

Confined spaces with limited ventilation and access may have hazards that are not easily detected. They should be checked for safety requirements before entering. Specific safety requirements for confined spaces can be found in OSHA Safety and Health Standards (29 CFR 1910) Paragraph 146 (Permit Required Confined Spaces). Paints with "safety solvents" (relatively high flash points) should be used in these areas. Hand and power tools and other electrical equipment including lighting should be non-sparking and explosion-proof. Because paint solvent vapors are heavier than air, ventilation of confined spaces requires exit of contaminated air from the lowest point. Other special considerations may apply. Installation safety offices generally provide guidance and support for confined space operations.

13.6.4 Remote Areas. When doing field work at remote locations, personnel should have a response plan for emergencies. Access to a telephone and medical treatment should be established. Knowledge of first aid, especially CPR, for immediate action is also beneficial.

13.7 Personal Protective Equipment. Hazards in painting operations can be greatly reduced by use of protective clothing, respirators, and other personal protective equipment.

13.7.1 Clothing. Protective garments must resist chemical attack from three different routes of entry:

a) Permeation - chemical works its way through the suit

b) Penetration - entry through physical imperfection (damage)

c) Degradation - properties of material chemically degraded

Selection of the chemical protective clothing must be based on the chemical, the operation (i.e., need for abrasion resistance), and the effectiveness of the clothing material as a barrier against the chemical. Contaminated clothing should be discarded at the job site or thoroughly cleaned before reuse.

Personnel exposed to contamination should thoroughly shower and put on clean clothes before leaving work area. Torn clothing should not be worn, because it can get caught in machinery or on structural projections. Trouser cuffs and ties present a similar problem.

13.7.1.1 Gloves. Gloves come in different lengths and chemical compositions. The length should provide full protection, and the material should be resistant to the chemicals and materials with which it will come into contact. Selection of the right work glove can protect you from unnecessary injury or contamination. Commonly used protective gloves include:

a) Disposable gloves - usually lightweight plastic; protect from mild irritants

b) Fabric gloves - cotton or other fabric; improve grip; minimal protection from contaminants

c) Rubber gloves - may also be of different plastics; protection from chemical contamination

d) Leather gloves - protect from abrasion

e) Metal mesh gloves - protect from cuts/scratches; used with cutting tools

f) Aluminized gloves - insulates hands from intense heat

13.7.2 Protective Headgear. Head injuries can be very devastating and can result in brain damage or death. Selection of the proper head protection for different hazards is especially important. Protective headgear includes:

a) Hard hats

b) Bump hats

c) Hair covers

13.7.2.1 Hard Hats. Hard hats are made of rigid, impact-resistant, nonflammable materials such as fiberglass or thermoplastics. A network of straps and harnesses holds the shell on the head and serves as a cushion. A full-brimmed hard hat provides general protection to the head, neck, and shoulders, while the visored brim which does not, is often used in confined spaces. Hard hats must be worn in areas designated to require them.

13.7.2.2 Bump Hats. Bump hats are made of lightweight plastic that only protect the head from minor bumps. They should be worn only where there are minor head hazards and never as a substitute for a hard hat.

13.7.2.3 Hair Covers. Hair covers are made of breathable fabric or lightweight materials and are adjustable to fit properly. They are intended to prevent hair from becoming caught in moving machine parts.

13.7.3 Eye Protection. Installation safety offices have eye protection equipment available in many forms to protect eyes from flying particles, dust, sparks, splashes, and harmful rays. The appropriate type of eye protection should be used for each job.

13.7.3.1 Safety Glasses. Safety glasses have impact-resistant frames and lenses that meet OSHA and American National Standards Institute (ANSI) standards. Safety glasses may also have side shields, cups, or tinted lens to provide additional protection. Assistance in procuring safety glasses with prescription lenses may be available at the safety office. Safety glasses should be cleaned as described by the supplier and stored in a clean, dry place available for use when needed.

13.7.3.2 Safety Goggles. Safety goggles may be impact resistant, or provide chemical splash protection or optical radiation protection. The appropriate goggle should be procured and used for that purpose only. Goggles form a secure seal around each eye to provide protection from all sides. They may have direct or indirect ventilation to eliminate fogging.

13.7.3.3 Safety Shields. Safety shields or helmets have sheets of clear, resistant plastic to protect the face from splash or flying particles during grinding and welding operations or when working with molten materials. Safety shields are ordinarily worn with goggles or safety glasses to provide additional protection.

13.7.4 Hearing Protection. Hearing loss occurs over time from repeated exposure to excessively loud noises. Muffs, plugs, and canal caps offer a variety of devices to protect our hearing. Check the noise reduction rating (NRR) provided with each device to determine its noise protection capabilities.

13.7.4.1 Ear Muffs. Ear muffs come in a variety of styles. Most have spring-loaded head bands to secure them in place covering the entire ear. Ear muffs can reduce noise levels by 15 to 30 decibels.

13.7.4.2 Ear Plugs. Ear plugs of deformable rubber or plastic materials are positioned in the outer part of the ear. Ear plugs may be disposable or reusable. The latter should be cleaned and properly stored after use.

13.7.4.3 Canal Caps. Canal caps (headband plugs) close off the ear canal at its opening. A flexible headband ensures a close fit. Canal caps must also be cleaned and properly stored after use.

13.7.5 Safety Shoes. About 12,000 accidental foot injuries occur each year. Steel-reinforced shoes are designed to protect feet from common machine accidents - falling or rolling objects, cuts, and punctures. The entire toe box and insole are ordinarily reinforced.

Safety boots offer more protection from splash. Neoprene or nitrile boots are often required when handling caustics, solvents, or oils. Quick-release fasteners may permit speedy removal in case a hazardous substance gets in the boot. Slip-resistant soles are required for both shoes and boots, if a slip hazard is present.

13.7.6 Respirators/Ventilation. Respiratory hazards can be minimized by a good ventilation system. Note that respiratory protection is considered a secondary line of defense to protect the worker when ventilation cannot control exposures.

a) Further protection can be provided by one of the following types of respirator:

(1) Disposable dust masks/filters (fiber masks over nose and mouth filter particulates)

(2) Half masks - fits over nose and mouth; cartridges absorb or trap the contaminate; select the appropriate cartridge for the particulate (dust) or vapor

(3) Full face mask (they also protect eyes and face; vapors absorbed by canisters or cartridges; may also have dust filter)

(4) Air-supplied respirators (air from line or self-contained; positive air pressure in helmet or mask; provides greatest protection)

b) Personnel using respirators must do the following for full protection from respiratory hazards:

(1) Receive medical examination before wearing respirator

(2) Receive knowledge of respiratory hazard

(3) Receive proper respirator training

(4) Get proper respirator fitting and testing

(5) Keep the respirator clean and properly stored

(6) Use the right respirator/cartridge for the job

(7) Receive periodic medical monitoring

13.8 Safety Program. A safety program should be a vital part of every shop conducting cleaning or painting operations. Each routine operation should have a standard operating procedure that includes a safety plan. Each non-routine operation should have a special operating plan that includes safety. Each worker should receive periodic training to keep him aware of pertinent Government regulations, potential health hazards, and measures that may be taken to minimize the hazards.

REFERENCES

NOTE: THE FOLLOWING REFERENCED DOCUMENTS FORM A PART OF THIS HANDBOOK TO THE EXTENT SPECIFIED HEREIN. USERS OF THIS HANDBOOK SHOULD REFER TO THE LATEST REVISIONS OF THE CITED DOCUMENTS UNLESS OTHERWISE DIRECTED.

FEDERAL/MILITARY SPECIFICATIONS, STANDARDS, HANDBOOKS, AND GUIDE SPECIFICATIONS:

Unless otherwise indicated, copies are available from the Naval Printing Service Detachment Office, Building 4D (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094.

P-PUBLICATION

P-309	Colors for Navy Shore Facilities.

MILITARY HANDBOOK

MIL-HDBK-1004/10	Electrical Engineering Cathodic Protection.

MILITARY SPECIFICATIONS

MIL-B-131	Barrier Materials, Water Vaporproof, Greaseproof, Flexible, Heat-Sealable.
MIL-A-22262	Abrasive Blasting Media, Ship Hull Blast Cleaning.
MIL-P-24441	Paint, Epoxy-polyamide.
MIL-E-24635	Enamel, Silicone Alkyd Copolymer (Metric).
MIL-P-24647	Paint System, Anticorrosive and Antifouling, Ship Hull.
MIL-P-24648	Primer Coating, Zinc Dust Pigmented for Exterior Steel Surfaces (Metric).
MIL-E-24763	Enamel, Emulsion Type, for Shipboard Use.
MIL-P-28577	Primer, Waterborne, Acrylic or Modified Acrylic, for Metal Surfaces.

MIL-P-28578	Paint, Waterborne, Acrylic or Modified Acrylic, Semigloss, for Metal Surfaces.
MIL-P-28582	Primer Coating, Exterior, Lead Pigment-Free (Undercoat for Wood, Ready-Mixed, White and Tints)
MIL-E-29245	Epoxy Resin Systems for Concrete Repair.
MIL-P-53022	Primer, Epoxy Coating, Corrosion Inhibiting, Lead and Chromate Free.
MIL-C-85285	Coating: Polyurethane, High-Solids.
MIL-P-85582	Waterborne Epoxy Primer With 340 Grams per Liter Maximum VOC Content.

MILITARY STANDARD

DOD-STD-2138(SH)	Metal Spray Coatings for Corrosion Protection Aboard Naval Surface Ships (Metric).

Lead-Based Paint (LBP) - Risk Assessment, Associated Health Risk in Children and Control of Hazards in DOD Housing and Related Structures.

FEDERAL SPECIFICATIONS

TT-B-1325	Beads (Glass Spheres) Retro-Reflective.
TT-C-555	Coating, Textured (for Interior and Exterior Masonry Surfaces).
TT-E-489	Enamel, Alkyd, Gloss, Low VOC Content.
TT-E-2784	Enamel (Acrylic-Emulsion, Exterior Gloss and Semigloss).
TT-P-19	Paint, Latex (Acrylic Emulsion, Exterior Wood and Masonry).
TT-P-25	Primer Coating, Exterior (Low VOC Undercoat for Wood, White and Tints).
TT-P-28	Paint, Aluminum, Heat Resisting (1200 Degrees F).
TT-P-29	Paint, Latex.

TT-P-31	Paint, Oil: Iron-Oxide, Ready-Mixed, Red and Brown.
TT-P-85	Paint, Traffic and Airfield Marking, Solvent Base.
TT-P-87	Paint: Traffic, Premixed, Reflectorized.
TT-P-95	Paint, Rubber: For Swimming Pools and Other Concrete and Masonry Surfaces.
TT-P-102	Paint, Oil (Alkyd Modified, Exterior, Low VOC).
TT-P-110	Paint, Traffic, Black (Nonreflectorized).
TT-P-115	Paint, Traffic (Highway, White and Yellow).
TT-P-645	Primer, Paint, Zinc-Molybdate, Alkyd Type.
TT-P-650	Primer Coating, Latex Base, Interior, White (for Gypsum Wallboard, or Plaster).
TT-P-664	Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant.
TT-P-1510	Paint, Latex, Exterior, for Wood Surfaces, White and Tints.
TT-P-1511	Paint, Latex (Gloss and Semigloss, Tints and White) (for Interior Use).
TT-P-1728	Paint, Latex Base, Interior, Flat, Deep-Tone.
TT-P-1952	Paint, Traffic and Airfield Marking, Water Emulsion Base.
TT-P-001984	Primer Coating, Latex Base, Exterior (Undercoat for Wood), White and Tints.

TT-P-002119	Paint, Latex-Base, High-Traffic Area, Flat and Eggshell Finish (Low Lustre) (for Interior Use).
TT-S-001992	Stain, Latex, Exterior for Wood Surfaces.

FEDERAL STANDARDS

FED-STD-141	Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling, and Testing. Method 3011.2, Condition in Container Method 6271.2, Mildew Resistance.
FED-STD-595	Colors Used in Government Procurement.

COMMERCIAL ITEM DESCRIPTIONS

A-A-50542	Coating System: Reflective, Slip-Resistant, Chemical-Resistant Urethane for Maintenance Facility Floors.

NAVFAC GUIDE SPECIFICATIONS

NFGS-02761	Pavement Markings.
NFGS-02821	Chain Link Fences and Gates.
NFGS-09900	Paints and Coatings.
NFGS-09967	Coating of Steel Waterfront Structures.
NFGS-09970	Interior Coatings for Welded Steel Tanks (for Petroleum Fuels).
NFGS-09971	Exterior Coating System for Welded Steel Petroleum Storage Tanks.
NFGS-09973	Interior Coating System for Welded Steel Petroleum Storage Tanks.
NFGS-09980	Interior Linings for Concrete Storage Tanks (for Petroleum Fuels).
NFGS-13112	Cathodic Protection System (Steel Water Tanks).

NFGS-13217	Fiberglass-Plastic Lining for Steel Tank Bottoms (for Petroleum).
NFGS-13219	Cleaning Petroleum Storage Tanks.
NFGS-13283	Removal and Disposal of Lead-Containing Paint.

OTHER GOVERNMENT PUBLICATIONS:

ARMY CORPS OF ENGINEERS GUIDE SPECIFICATIONS

CEGS 02090	Removal of Lead-Based Paint.
CEGS 02580	Joint Sealing in Concrete Pavements for Roads and Airfields.
CEGS 02831	Fence, Chain Link.
CEGS 09900	Painting, General.
CWGS 09940	Painting: Hydraulic Structures and Appurtenant Works.
CEGS 16641	Cathodic Protection System (Steel Water Tanks).
CWGS 16643	Cathodic Protection Systems (Impressed Current) for Lock Miter Gates.

ARMY TECHNICAL MANUAL

TM 5-807-7	Color for Buildings.

(Unless otherwise indicated, copies are available from the Naval Printing Service Detachment Office, Building 4D (Customer Service), 700 Robbins Avenue, Philadelphia, PA 19111-5094.

CENTER FOR DISEASE CONTRL (CDC)

Strategic Plan for Elimination of Childhood Lead Poisoning 1991 Strategic Plan.

(Unless otherwise indicated, copies are available from the Center for Disease Control (CDC), 4770 Buford Highway N.E., Mail Stop F-42, Room 1160, Atlanta, GA 30341-3724.)

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT (HUD)

Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing.

(Unless otherwise indicated, copies are available from

ENVIRONMENTAL PROTECTION AGENCY (EPA)

40 CFR 50-99	EPA National Ambient Air Quality Standards.
40 CFR 60	Method 24, Test Measuring VOC Content in Coatings—Appendix A.
40 CFR 240-280	
40 CFR 261	EPA Toxic Characteristic Leaching Procedure (TCLP)—Appendix II.

(Unless otherwise indicated, copies are available from the Environmental Protection Agency (EPA), Public Affairs Office, Rockville, MD 20852; or the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

FEDERAL AVIATION ADMINISTRATION (FAA)

AC 70/7460-1G

(Unless otherwise indicated, copies are available from the Department of Transportation, FAA Aeronautical Center, AAC-492, P.O. Box 25082, Oklahoma City, OK 73125-5082.)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

Standard Reference Material No. 1358, Certified Coating Thickness Calibration Standard.

(Unless otherwise indicated, copies are available from National Institute of Standards and Technology (NIST), Chief, Office of Standards Code and Information, Admin. Building 101, Room A629, Gaithersburg, MD 20879.)

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA)

29 CFR 1910.25	Portable Wood Ladders.
29 CFR 1910.26	Portable Metal Ladders.

29 CFR 1910.28	Safety Requirements for Scaffolding.
29 CFR 1910.29	Manually Propelled Ladder Stands and Scaffolds (Towers).
29 CFR 1910.106/ 29 CFR 1926.152	Flammable and Combustible Liquids.
29 CFR 1910. 146	Permit-Required Confined Spaces.
29 CFR 1910.151	Medical Services and First Aid.
29 CFR 1910. 1200/ 29 CFR 1926.59	Hazard Communication.
29 CFR 1926.62	

(Unless otherwise indicated, copies are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

NON-GOVERNMENT PUBLICATIONS:

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment.

(Unless otherwise indicated, copies are available from the American Conference of Governmental Industrial Hygienists (ACGIH),

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 522	Mandrel Bend Test of Attached Organic Coatings.
ASTM D 523	Specular Gloss.
ASTM D 823	Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels.
ASTM D 1186	Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base.
ASTM D 1212	Measurement of Wet Film Thickness of Organic Coatings.

ASTM D 1400	Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base.
ASTM D 1475	Density of Paint, Varnish, Lacquer, and Related Products.
ASTM D 2369	Volatile Content of Coatings.
ASTM D 2621	Infrared Identification of Vehicle Solids From Solvent-Reducible Paints.
ASTM D 3273	Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
ASTM D 3274	Evaluating Degree of Surface Disfigurement of Paint Films by Microbial (Fungal or Algal) Growth or Soil and Dirt Accumulation.
ASTM D 3359	Measuring Adhesion by Tape Test.
ASTM D 3363	Film Hardness by Pencil Test.
ASTM D 4128	Identification of Organic Compounds in Water by Combined Gas Chromatography and Electron Impact Mass Spectrometry.
ASTM D 4214	Evaluating Degree of Chalking of Exterior Paint Films.
ASTM D 4258	Surface Cleaning Concrete for Coating.
ASTM D 4259	Abrading Concrete.
ASTM D 4260	Acid Etching Concrete.
ASTM D 4261	Surface Cleaning Concrete Unit Masonry for Coating.
ASTM D 4262	pH of Chemically Cleaned or Etched Concrete Surfaces.
ASTM D 4263	Indicating Moisture in Concrete by the Plastic Sheet Method.
ASTM D 4285	Indicating Oil or Water in Compressed Air.

ASTM D 4414	Wet Film Thickness by Notch Gages.
ASTM D 4541	Pull-Off Strength of Coatings Using Portable Adhesion Testers.
ASTM D 4840	Sampling Chain of Custody Procedures.
ASTM D 4940	Conductimetric Analysis of Water Soluble Ionic Contamination of Blasting Abrasives.
ASTM D 5043	Field Identification of Coatings.
ASTM E 667	Clinical Thermometers (Maximum Self-Registering, Mercury-in-Glass).
ASTM F 1130	Inspecting the Coating System of a Ship.

(Unless otherwise indicated, copies are available from the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.)

MAPLE FLOORING MANUFACTURERS ASSOCIATION (MFMA)

Heavy Duty and Gymnasium Finishes for Maple, Beech, and Birch Floors.

(Unless otherwise indicated, copies are available from the Maple Flooring Manufacturers Association (MFMA), 60 Revere Drive, Suite 500, Northbrook, IL 60062.)

NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

NACE No. 1	White Metal Blast.
NACE No. 2	Near-White Blast.
NACE No. 3	Commercial Blast.
NACE No. 4	Brush-Off Blast.
NACE RP0188	Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings.
NACE TM0170	Visual Standard for Surfaces of New Steel Air Blast Cleaned With Sand Abrasive.

NACE TM0175	Visual Standard for Surfaces of New Steel Centrifugally Blast Cleaned With Steel Grit and Shot.

(Unless otherwise indicated, copies are available from the National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 77218.)

NATIONAL SANITATION FOUNDATION (NSF) INTERNATIONAL

NSF 60	Drinking Water Treatment Chemicals - Health Effects.
NSF 61	Drinking Water System Components - Health Effects.

(Unless otherwise indicated, copies are available from National Sanitation Foundation (NSF) International, 3475 Plymouth Road, P.O. Box 1468, Ann Arbor, MI 48106.)

SOCIETY FOR NAVAL ARCHITECTS AND ENGINEERS

Abrasive Blasting Guide for Aged or Coated Steel Structures.

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

Steel Structures Painting Manual, Volume 2, Systems and Specifications.

SSPC Guide 6I (CON)	Containment of Lead-Based Paints.
SSPC Guide 7I (DIS)	Disposal of Lead-Contaminated Surface Preparation Debris.
SSPC Guide 23	Coating Systems.
SSPC AB 1	Mineral and Slag Abrasives.
SSPC PA 1	Shop, Field, and Maintenance Painting.
SSPC PA 2	Measurement of Dry Paint Thickness With Magnetic Gages.
SSPC PA 3	Safety in Paint Application.
SSPC PAINT 16	Coal Tar Epoxy-Polyamide Black (or Dark Red).
SSPC PAINT 24	Latex Semi-gloss Exterior Topcoat.

SSPC PAINT 25	Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer.
SSPC QP 2	Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint.
SSPC SP 1	Solvent Cleaning.
SSPC SP 2	Hand Tool Cleaning.
SSPC SP 3	Power Tool Cleaning.
SSPC SP 5	White Metal Blast Cleaning.
SSPC SP 6	Commercial Blast Cleaning.
SSPC SP 7	Brush-off Blast Cleaning.
SSPC SP 8	Pickling.
SSPC SP 10	Near-White Blast Cleaning.
SSPC SP 11	Power Tool Cleaning to Bare Metal.
SSPC SP COM	Surface Preparation Commentary.
SSPC VIS 1	Abrasive Blast Cleaned Steel (Standard Reference Photographs).
SSPC VIS 3	Power- and Hand-Tool Cleaned Steel.

(Unless otherwise indicated, copies are available from the Steel Structures Painting Council (SSPC), 4516 Henry Street, Suite 301, Pittsburgh, PA 15213-3728.)

GLOSSARY

Painting operations often use terms that are peculiar to this field and, as such, may require some explanation or definition. This glossary is designed to provide the reader with some basic understanding of terms commonly used in painting and thus, eliminate possible misunderstandings resulting from conflicting interpretations of terms and improve communication between persons involved in the painting operation.

Abrasion. Act of being worn away.

Abrasive. Material used for abrasive blast cleaning; for example, sand, grit, steel shot, etc.

Absorption. Process of soaking up, or assimilation of one substance by another.

Accelerator. Catalyst; a chemical material which accelerates the hardening of certain coatings.

Acetone. A fast evaporating, highly flammable organic solvent.

ACGIH. American Conference of Governmental Industrial Hygienists.

Acoustic Paint. Paint which absorbs or deadens sound.

Acrylic Resin. A clear resin derived from polymerized esters of acrylic acids and methacrylic acid, often used in water-based paints, e.g., TT-P-l9.

Activator. Catalyst or curing agent; accelerator.

Adhesion. Bonding strength; adherence of coating to the surface to which it is applied.

Agglomeration. Formation of masses or aggregates of pigments; not dispersed.

Air Bubble. Bubble in paint film caused by entrapped air.

Air Cap. Housing for atomizing air at head of spray gun.

Airless Spraying. Spraying using hydraulic pressure to atomize paint.

Air Manifold. Device that allows common air supply chamber to supply several lines.

Air Quality Control Regions. Geographical units of the country, as required by U.S. law reflecting common air pollution problems, for purpose of reaching national air quality standards, for example California's South Coast Air Quality District.

Alcohols. Flammable solvents; alcohols commonly used in painting are ethyl alcohol (ethanol) and methyl alcohol (methanol, wood alcohol).

Aliphatic Polyurethane. Type of polyurethane resin resistant to ultraviolet light.

Aliphatic Solvent. Weak organic solvent, such as mineral spirits.

Alkali. Caustic, strong base, high pH, such as sodium hydroxide, lye, etc.

Alkyd Resins. Resins prepared from polyhydric alcohols and polybasic acids.

Alligatoring. Surface imperfections of paint having the appearance of alligator hide.

Ambient Temperature. Temperature or temperature of surroundings.

American Gallon. 231 cubic inches, 3.8 liters.

Amides. Possible curing agent for epoxy resins.

Amines. Possible curing agent for epoxy resins.

Anchor Pattern. Profile or texture of surface, usually attained by blasting.

Anhydrous. Dry, free of water in any form.

ANSI. American National Standards Institute.

Antifouling Coating. Coating with toxic material to prevent attachment and growth of marine fouling organisms.

Arcing. Swinging spray gun or blasting nozzle in arc at different distances from substrate.

Aromatic. Type of polyurethane with good chemical resistance but poor urethane ultraviolet resistance.

Aromatic Solvents. Strong organic solvents, such as benzene, toluene, and xylene.

Asphalt. Residue from petroleum refining; also a natural complex hydrocarbon.

ASTM. American Society for Testing and Materials.

Atomize. Break steam of liquid into small droplets.

Baking Finish. Paint product requiring heat cure, e.g., as used on factory coated metal siding.

Barrier Coating. Coating that protects by shielding substrate from the environment.

Batch. Industrial unit or quantity of production used in one complete operation.

Binder. Resin; non-volatile vehicle; film forming portion of paint, such as oil, alkyd, latex emulsion, epoxy, etc.

Bituminous Coating. Coal tar or asphalt based coating.

Blast Angle. Angle of blast nozzle to surface; also angle of particle propelled from rotating blast cleaning wheel with reference to surface.

Blast Cleaning. Cleaning with propelled abrasives.

Bleaching. Removing color.

Bleeding. Penetration of color from the underlying surface to surface of existing paint film, e.g., brown color from asphalt coatings.

Blisters. Bubbles in film, areas in which film has lost adhesion to substrate.

Blocking. Undesirable sticking together of two painted surfaces when pressed together under normal conditions.

Blooming. Whitening of surface of paint film; moisture blush; blushing.

Blow-back (Spray Term). Term relating to rebounding of atomized sprayed droplets.

<u>Blushing</u>. Whitening and loss of gloss of paint film due to moisture or improper solvent balance.

<u>Body</u>. Consistency; to thicken.

<u>Bonding</u>. Adhesion.

<u>Bounce-back</u>. Rebound of paint spray particles, similar to blow-back.

<u>Boxing</u>. Mixing of paint by pouring back and forth from one container to another.

<u>Bridging</u>. Forming a skin over a depression, crack, inside corner, etc.

<u>Broadcast</u>. To sprinkle solid particles on a surface.

<u>Brush-off Blast</u>. Degree of blast cleaning in which surface is free of visible oil, grease, dirt, dust, loose mill scale, loose rust, and loose paint; SSPC SP 7, NACE No. 4, <u>Brush-off Blast</u>.

<u>Bubbling</u>. A term used to describe the formation of blisters on the surface while a coating is being applied.

<u>Burnish</u>. To polish or rub to a smoother or glossier surface.

<u>Caking</u>. Hard settling of pigment from paint.

<u>Catalyst</u>. Accelerator; curing agent; promoter.

<u>CCB</u>. Construction Criteria Base.

<u>CDC</u>. Center for Disease Control.

<u>Cellosolve</u>. Proprietary name for the monoethyl ether of ethylene glycol, used as a solvent in paints.

<u>CEGS</u>. Corps of Engineers Guide Specification.

<u>CERL</u>. Construction Engineering Research Laboratory.

<u>CFR</u>. Code of Federal Regulations.

<u>Chalking</u>. Powdering of surface of paint film.

<u>Checking</u>. Formation of slight breaks in the topcoat that do not penetrate to the underlying paint films.

Chlorinated. Type of resin used as a paint binder that cures by solvent rubber evaporation.

CID. Commercial item description.

Coal Tar-Epoxy Paint. Paint in which binder or vehicle is a combination of coal tar with epoxy resin.

Coatings. Surface coverings; paints; barriers.

Cobwebbing. A spider web effect on surface of film caused by premature drying of sprayed paint.

Cohesion. Property of holding self together.

Cold-checking. Checking of film caused by low temperatures.

Color-fast. Non-fading.

Color Retention. Ability to retain original color.

Commercial Blast. Degree of blast cleaning in which surface is free of visible oil, grease, dirt, dust, loose mill scale, loose rust, and loose paint; SSPC SP 6, NACE No. 2, Commercial Blast.

Compatibility. Ability to mix with or adhere properly to other component or substances.

Continuity. Degree of being intact or pore-free.

Conversion Coating. System used to convert rusted surface to one that is paintable without abrasive or mechanical cleaning.

Conversion Treatment. Treatment of metal surface to convert it to another coating chemical form, e.g., a phosphate on steel.

Copolymer. Large molecule resulting from simultaneous polymerization of different monomers.

Corrosion. Oxidation of material; deterioration due to interaction with environment.

CPVC. Critical pigment volume concentration.

CQC. Contractor quality control.

Cracking. Splitting, disintegration of paint by breaks through film to substrate.

<u>Cratering</u>. Formation of holes or deep depressions in paint film as paint film dries.

<u>Crawling</u>. Shrinking of paint to form uneven surface shortly after application.

<u>Crazing or Cracking</u>. Development of non-uniform surface appearance of myriad tiny scales as a result of weathering.

<u>Cross-linking</u>. A particular method by which molecules unite to form films.

<u>Cross-spray</u>. Spraying first in one direction and then at right angles.

<u>CSI</u>. Construction Specification Institute.

<u>Curing</u>. Setting-up or hardening of paint film.

<u>Curing Agent</u>. Hardener; promoter.

<u>Curtaining</u>. A kind of sagging or running of paint when applied.

<u>Deadman Valve</u>. Valve at blast nozzle for starting and automatic shutoff of abrasive flow.

<u>Degreaser</u>. Chemical (i.e., solvent or detergent solution) for grease and oil removal.

<u>Delamination</u>. Separation and peeling of one or more layers of paint from underlying substrate.

<u>Density</u>. Weight per unit volume.

<u>Descaler</u>. Tool used to remove heavy scale.

<u>Detergent</u>. Cleaning agent.

<u>Dew Point</u>. Temperature at which moisture condenses.

<u>DFT</u>. Dry film thickness.

<u>Diluents</u>. Thinners; reducer.

<u>Dispersion</u>. Suspension of one substance in another.

<u>Distillation</u>. Purification or separation by liquid volatilization and condensation.

Doctor Blade. Knife applicator for applying paint of fixed film thickness.

Drawdown. Preparation of a paint film of a fixed uniform thickness using a doctor blade.

Drier. Chemical which promotes oxidation or drying of paint, particularly those made with oils.

Dry Film. Thickness of applied coating when dry, thickness usually expressed in mils (1/1000 inch).

Dry Spray. Overspray or bounce-back; sandy or pebbly finish due to spray particle being partially dried before reaching the surface.

Drying Oil. An oil which hardens in air.

Drying Time. Time interval between application and a specified condition of dryness.

Dry to Recoat. Time interval between application and ability to receive next coat satisfactorily.

Dry to Touch. Time interval between application and ability to be touched lightly without damage (tack-free time).

DTM. Direct to metal coating (self-priming).

Dulling. Loss of gloss or sheen.

Efflorescence. Powdery white to gray soluble salts deposited on surface of brick and other masonry.

Eggshell. Paint having gloss between semi-gloss and flat; paint having high sheen.

Elasticity. Degree of recovery from stretching.

Electrostatic Spray. Spraying with electrically charged paint and substrate to attract paint to surface.

Emulsion Paint. Water-thinned paint with resin or latex vehicle dispersed in water.

Enamel. A paint which is characterized by an ability to form an especially smooth and usually glossy film.

EPA. Environmental Protection Agency.

Epoxy Resins. A type of resin; film formers usually made from bisphenol A and epichlorohydrin.

Erosion. Wearing away of paint films to expose the substrate or undercoat.

Etch. Surface preparation of metal by chemical means.

Evaporation Rate. Rate at which a solvent evaporates.

Explosive Limits. A range of the ratio of solvent vapor to air in which the mixture will explode if ignited. Below the lower or above the higher explosive limit, the mixture is too lean or too rich to explode. The critical ratio runs from about 1 to 12 percent of solvent vapor by volume at atmospheric pressure.

Extender Pigment. Pigment which can contribute specific properties to paint, generally low in cost.

External Mix Nozzle. Spray nozzle in which the paint and air are mixed outside the gun.

FAA. Federal Aviation Administration.

Fading. Reduction in brightness of color or change in color of paint film as a result of weathering.

Fan Pattern. Geometry or shape of spray pattern.

Feathered Edge. Tapered edge.

Feathering. (1) triggering a gun at the end of each stroke; (2) tapering edge of paint film adjacent to peeled area.

Ferrous. Iron.

Field Painting. Painting at the job site.

Filler. Extender; building agent for paint; inert pigment.

Film Build. Thickness of one coat of paint.

Film-former. Paint component that cures to form a dry film; binder; resin.

Film Integrity. Degree of continuity of film.

Film Thickness Gage. Device used for measuring film thickness; both wet and dry gages are available.

Filter. Strainer; purifier.

Fineness of Grind (Dispersion). Measure of pigment size or roughness of liquid paint; degree of dispersion of pigment in the binder.

Fire-Retardant Paint. Paint which will delay flaming or over-heating of substrate.

Fish Eye. Pulling apart of paint film similar to cratering to form holes.

Flaking. Disintegration of dry film into small pieces or flakes; see scaling.

Flammability. Measure of ease of catching fire; ability to burn.

Flash Point. The lowest temperature at which a given flammable material will flash if a flame or spark is present.

Flash Rusting. Rusting of steel after cleaning, particularly in humid environments or after wet blasting.

Flatting. Loss of gloss in coating film.

Flexibility. Elongation; ability to bend without damage.

Floating. Separation of pigment colors on surface of paint film.

Flooding. Floating; separation of pigment colors on surface of paint.

Flow. A property of self-leveling.

Fog Coat. Thin or mist coat (about 1/2 mil dry film thickness).

FTIR. Fourier transform infrared.

Fungicide. Mildewcide; toxic chemical to control fungal growth.

Galvanized Steel. Zinc-coated steel, usually by dipping in a bath of molten zinc.

Generic. Basic class or type; generic type of paint is denoted by the type of resin present.

Gloss. Luster; sheen; brightness.

Graffiti-Resistant Coating. Coating from which graffiti can be removed by scrubbing.

Grit. Abrasive from slag and other sources used in blast cleaning.

Grounding. Dissipation of electric charge.

GSA. General Services Administration.

Hardener. Catalyst; curing agent.

Hazing. Clouded appearance.

Hegman Number. Measure of fineness of grind or dispersion of pigment into the vehicle.

Hiding Power. Ability of paint film to obscure underlying surface.

High Build Coating. Coating that can be applied so as to obtain a thick film in one coating application.

Hold out. Ability to prevent nonuniform soaking into the substrate resulting in a nonuniform appearing film.

Holiday. Pinhole, skip, or other discontinuity in paint film.

HUD. Department of Housing and Urban Development.

HVLP. High-volume, low-pressure.

Humidity. Measure of moisture content; relative humidity is the ratio of the quantity of water vapor in the air compared to the greatest amount possible at a given temperature. Saturated air has a humidity of 100 percent.

Hydroblasting. Water blasting; cleaning a surface with water at extremely high pressures.

Hydrolysis. Chemical reaction in which a compound, such as an oil resin, is split into two parts by reaction with water; see saponify.

Impermeable. Restricting the passage of moisture, air or other substance.

Incompatibility. Inability of a coating to perform well over another coating because of bleeding, poor bonding, or lifting of old coating; inability of coating to perform well on a substrate.

Induction Time. Time interval required between mixing of components and application of two or more component paints to obtain proper application properties.

Indicator Paper (pH). Vegetable dyed paper indicating relative acidity or paper basicity (alkalinity).

Inert Pigment. A non-reactive pigment.

Inhibitive Primer. Primer pigment that retards the corrosion process.

Inorganic Silicate or Coating. Those employing inorganic binders or vehicles such as phosphate rather than organic, that is those of petroleum, animal, or plant origin.

IPM. In-place management.

Internal Mix Nozzle. Spray nozzle in which the fluid and air are combined before leaving gun.

Intumescent Ignition. Fire-retardant coating that forms a voluminous char on coating.

Ketones. Flammable organic solvents; commonly used ketones are acetone; methyl ethyl ketone (MEK); and methyl isobutyl ketone (MIBK).

Krebs Unit (KU). Arbitrary unit for measuring viscosity.

Lacquers. Coatings which dry by solvent evaporation.

Laitance. White to gray deposit on surface of new concrete.

Latex. Natural or synthetic binder for emulsion (water) paints.

LBP. Lead-based paint.

Leafing. Orientation of pigment flakes in wet paints in horizontal planes to increase impermeability of dry film.

Leveling. Flowing of paint to form films of uniform thickness; tendency of brush marks to disappear.

Lifting. Softening and raising of an undercoat by application of a top coat.

Livering. Condition of paint in can having curds or gelling.

Low Pressure Spraying. Conventional air spraying.

Mastic. Heavy-bodied, high build coating.

MEK. Methyl ethyl ketone, strong flammable organic solvent.

MFMA. Maple Flooring Manufacturers Association.

MIBK. Methyl isobutyl ketone.

Mil. 0.001 inch.

Micron. Micrometer, 0.001 of a millimeter.

Mildewcide. Toxic chemical added to paint to control mildew.

Mill Scale. Bluish layer of iron oxide formed on surface of steel by hot rolling.

Mistcoat. A thin (about 1/2 mil dry film thickness) coat applied to existing paint for bonding of a subsequently applied coat.

MSDS. Material safety data sheet, described in Section 13.

Mud Cracking. Irregular cracking of dried paint resembling cracked mud, usually caused by paint being too thick.

NACE. National Association of Corrosion Engineers.

Naphtha. F1ammable aliphatic hydrocarbon (weak) solvent.

Near White Blast. Grade of blast cleaning in which surface is free of visible oil, grease, dirt, dust, mill scale, rust paint oxides, corrosion products, and other foreign matter, except for staining; SSPC SP 10, NACE No. 2, Near-White Blast.

NFGS. Naval Facilities Engineering Command Guide Specification.

NIOSH. National Institute of Safety and Hygiene.

NIST. National Institute of Standards and Technology.

Nonvolatile Vehicle. Resin; binder; film-forming component of paints.

<u>NRR</u>. Noise reduction rating.

<u>NSF</u>. National Sanitation Foundation.

<u>Oleoresinous</u>. Vegetable or fish oil resin that cures by air oxidation.

<u>Opacity</u>. Hiding power; ability to obscure underlying surface.

<u>Orange Peel</u>. Hills and valleys in paint resembling the skin of an orange.

<u>Organic Coating</u>. Coating with organic binder, generally of petroleum or vegetable origin.

<u>OSHA</u>. Occupational Safety and Health Administration.

<u>Overcoat</u>. Top coat.

<u>Overlap</u>. Portion (width) of fresh paint covered by next layer.

<u>Overspray</u>. Dry spray, particularly such paint that failed to hit target.

<u>Paint</u>. Coating materials used in painting.

<u>Paint Heater</u>. Device for lowering viscosity of paint by heating.

<u>Paint Program</u>. Comprehensive painting plan.

<u>Paint System</u>. Surface preparation, and the complete number and type of coats comprising a paint job.

<u>Pass (Spray)</u>. Motion of spray gun in one direction.

<u>Peeling</u>. Failure in which paint curls or otherwise strips from substrate.

<u>Perm</u>. Unit of permeance; grains of water vapor per hour per square foot per inch of mercury-water vapor pressure difference.

<u>Phosphatize</u>. To form a thin inert phosphate coating on surface usually by treatment with phosphoric acid or other phosphate compound.

<u>pH Value</u>. Measure of acidity or alkalinity; pH 7 is neutral; the pH values of acids are less than 7, and of alkalies (bases), greater than 7.

Pickling. A dipping process of cleaning steel and other metals; the pickling agent is usually an acid; SSPC SP 8.

Pigment. Solid, opaque, frequently colored component of paint.

Pigment Grind. Dispersing of pigment in vehicle.

Pigment Overload. Mottle surface from too much pigmentation.

Pigment Volume Concentration (PVC). Percent by volume occupied by pigment in wet paint.

Pitting. Formation of small, deep or shallow cavities formed in steel by rusting.

Pinholing. Formation of small holes through coating from improper application.

Plasticizer. Paint component added to increase flexibility.

Polyvinyl Acetate (PVA). Synthetic resin used extensively in emulsion (water) paints.

Polymer. Large molecule formed by reaction of smaller molecules; used to make synthetic resins.

Pot Life. Time interval after mixing of components during which the coating can be satisfactorily applied.

Primer or Prime Coat. First coat on a substrate usually containing inhibitive pigments when formulated for use on metals.

Profile. Surface texture, particularly of abrasive blast cleaned steel.

Proprietary. Commercially available under a brand name.

Psychrometer. Instrument for measuring humidity.

PVC. Pigment volume concentration; pigment concentration by volume in the whole paint.

QC. Quality control.

RCRA. Resource Conservation and Recovery Act.

Rebound. Paint spray bounce-back.

Reducer. Thinner; solvent added to reduce paint viscosity for easier application.

Resin. Binder; nonvolatile vehicle; film-forming component of paints.

Run. Sag; curtain; associated with too heavy a paint film.

Rust. Corroded iron; red iron oxide deposited on metal.

Rust Bloom. Discoloration indicating the beginning of rusting.

Safety Valve. Pressure release valve preset to be released when pressure exceeds a safe operating limit.

Sag. Run in coating film; curtain.

Sand Blast. General term used to mean blast cleaning; blast cleaning using sand as an abrasive.

Sandy Finish. A surface condition having the appearance of sandpaper; may result from overspray or dry spray.

Saponify. Chemical reaction between some resins (e.g., oil and alkyds) and alkaline solutions converting resin to soaps. Saponified paint may become sticky and lose adhesion to substrate. See also hydrolysis.

Scale. Heavy layer of iron oxide on surface of steel, could be rust or mill scale; see also mill scale.

Scaling. Process of removing scale.

Seal Coating. Coating used to prevent excessive absorption of the first coat of paint by the substrate; a primer.

Sealer. A low viscosity (thin) liquid sometimes applied to wood, plaster, gypsum board, concrete, or masonry to reduce permeability.

SEM. Scanning electron microscope.

Settling. Caking of paint pigments in wet paint; sediment.

Sheen. Appearance characteristic of dry film in which film appears flat when viewed at an angle near to perpendicular and glossy when viewed at an angle near to grazing, such as 85 degrees.

Shelf-Life. Maximum interval in which a material may be stored and still be in usable condition.

Shop Coat. Coating applied in fabricating shop.

Shot Blasting. Blast cleaning using steel shot as the abrasive.

Silicate Paints. Those employing silicates as binders; used primarily in inorganic zinc-rich coatings.

Silicone Resins. A particular group of film formers; used in water-repellent and high-temperature paints.

Silking. A surface defect characterized by parallel hair-like striations in dry coating films.

Skinning. Formation of a solid membrane on top of liquid paint.

Skips. Holidays; misses; uncoated area; voids.

Sling Psychrometer. Instrument to measure relative humidity consisting of dry/wet bulb thermometers suitably mounted for swinging through the air.

Solids By Volume. Percentage of total volume of wet paint occupied by non-volatile compounds.

Solubility. Degree to which a substance may be dissolved.

Solution. A liquid in which a substance (solute) is dissolved in a solvent.

Solvent. A liquid in which another substance may be dissolved; thin liquid used to add to paint to reduce viscosity.

Solvent Balance. Ratio of amounts of different solvents in a mixture of solvents.

Solvent Pop. Blistering of paint film caused by entrapped solvent.

Solvent Wash. Cleaning surface to be painted with solvent.

Stalling. The cracking, breaking, or splintering of the surfaces of substrates, such as cinder block, from the bulk material.

Spreading Rate. Area covered by a unit volume of paint at a specific thickness.

SSPC. Steel Structures Painting Council.

STEL. Short-term exposure limit.

TCLP. Toxic characteristic leaching procedure.

Thermoplastic. Paint softened by heat or solvent (type of one-component coating made up of high molecular resins which dry/cure by solvent evaporation, e.g., vinyls).

Thermosetting. Paint that cures by undergoing a chemical reaction leading to a relatively insoluble material (e.g., epoxies, polyurethanes).

Thinner. Reducer; solvent added to reduce paint viscosity for easier application.

Thixotropic. Paint of gel consistency in the can that becomes a liquid paint when stirred or brushed but becomes a gel again upon standing.

Through Drying. Curing of paint film through the entire thickness as opposed to curing only on the surface.

Tiecoat. Thin coat applied to a cured paint to enhance the bonding of a topcoat.

TLV. Threshold limit value.

Tooth. Profile; mechanical anchorage; surface roughness.

Top Coat. Finish coat.

Triggering. Intermittent squeezing and releasing of spray gun trigger.

TWA. Time weighted average.

Ultraviolet Radiation. Portion of sunlight having a shorter wavelength than visible light.

Undercutting. Blistering and/or peeling of paint from underfilm corrosion in areas of a paint defect.

Urethane Resins. A particular group of film formers.

Useful Life. The length of time a coating is expected to remain in service.

UV. Ultraviolet.

VM&P Naphtha. Varnish and paint manufacturers naphtha; a low power flammable hydrocarbon solvent.

Vapor Degreasing. A cleaning process utilizing condensing solvent as the cleaning agent, usually done in a shop.

Vaporization. Conversion of material from liquid to a gaseous state.

Varnish. Liquid composition which converts to a transparent or translucent solid film after application as a coating.

Vehicle. Liquid portion of paint; binder or resin and solvent components of paint.

Venturi Nozzle. Blast nozzle with tapered lining for increased blasting speed and a large, more uniform blast pattern.

Vinyl Coating. One in which the major portion of the binder is of a vinyl resin.

Viscosity. Consistency; a measure of fluidity.

VOC. Volatile organic compound.

Volatiles. Fluids which evaporate rapidly.

Volatile Content. Amount of materials which evaporate when paint cures; usually expressed as a percentage.

Volatile Organic Compound (VOC). As defined by California Air Quality Districts, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate, methane, l,l,l-trichloroethane, methylene chloride, and trichlorotrifluoroethane, are compounds which may be emitted to the atmosphere during the application of and/or subsequent drying or curing of coatings.

Wash Primer. A thin rust-inhibiting primer with phosphoric acid and rust inhibitor which provides improved adhesion to subsequent coats.

Water Blasting. Blast cleaning using high velocity water.

Weld Spatter. Beads of metal left adjoining a weld.

Wet Edge. Fluid boundary.

Wet Film Gage. Device for measuring wet film thickness.

White Metal Blast. Highest degree of cleaning, when surface is viewed without magnification it is free of visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter; SSPC SP 5, NACE No. 1, White Metal Blast.

Wrinkling. Rough, crinkled surface, usually related to surface skinning over uncured paint.

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PROJECT NO.
FACR-1131

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-HDBK-1110	2. DOCUMENT DATE (YYMMDD) 950117

3. DOCUMENT TITLE HANDBOOK FOR PAINTS AND PROTECTIVE COATINGS FOR FACILITIES

4. NATURE OF CHANGE (identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) DSN (If applicable)	7. DATE SUBMITTED: (YYMMDD)

8. PREPARING ACTIVITY

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c. ADDRESS (Include Zip Code) ATTN Code 164 10 Industrial Highway, Mail Stop 82 Lester, PA 19113-2090	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 DSN 289-2340