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# Standard Practice for
# Field Identification of Coatings[1]

This standard is issued under the fixed designation D5043; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice describes procedures and portable apparatus for determining the generic type of coating films most likely to be encountered on structures. The coating can either be weathered from exposure or be freshly applied.

1.2 Most commonly used coatings can be divided into the broad categories and subgroups shown in Table 1 on the basis of the nonvolatile component (generic types) of their vehicle (film forming resin, binder). Although the curing of some coatings involves more than one process and coatings may contain more than one type of resin, they can usually be assigned to one of the basic classes and generic types listed in Table 1.

1.3 For field exposed coatings, it is suggested that these test methods be used as part of a complete evaluation of a coated surface as it is frequently helpful to consider the environment of exposure and how the coating has performed in the environment when drawing conclusions from these tests.

1.4 These procedures will not result in the identification of components of a coating beyond general classification of the coating by generic type and are not appropriate if more detailed analysis is required, for example, as a part of failure analysis or to identify between different manufacturers of the same type of coating. They also may not be definitive enough to identify complex systems that include multiple layers of different generic types of coatings.

1.5 The evaluation of results is quite subjective. Practice and experience are required to minimize misinterpretation. Repeat tests may be required.

1.6 None of the test is to be taken alone as grounds for identifying the generic type. Only the combination of results from several or all of the tests is to be used in conclusions regarding generic types.

1.7 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for in formation only.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements see 5.3.4, 6.3.1, 6.3.3, 7.4, and 8.4.

## 2. Summary of Practice

2.1 Samples of coatings films are tested with solvents and chemicals and subjected to pyrolysis to provide evidence of their generic type. Fig. 1 shows a flow chart for suggested order of tests and classification of results.

## 3. Significance and Use

3.1 Information about the generic type of coating on a surface is required to select compatible coatings for repainting and can be used when evaluating the performance of a coating in an environment in decisions on upgrading or replacing a coating system. This guide provides a systematic procedure for identifying the generic type of a coating. The procedure can be performed in the field by personnel with limited laboratory experience, and requires a minimum of equipment and materials.

## 4. Sampling

4.1 The sample of coating is obtained by chipping or scraping with a knife or by sanding and then brushing the material into a specimen container or clean envelope. Care should be taken not to cut into substrates, such as plastic or asphalt, that contain polymeric or bituminous materials. Small portions of untreated wood, masonry, or steel do not ordinarily interfere with the tests. Some tests can be conducted directly on the coating surface. If a liquid sample of coating is to be evaluated, a film of the coating should first be cast on a glass plate or similar surface from which it can conveniently be removed after drying.

NOTE 1—To develop familiarity with the subjective evaluations that follow, it is good practice to make films of known resin composition by applying control paints to glass plates or similar surfaces from which they can be readily removed after drying.

## 5. Pyrolysis

5.1 *Summary of Test Procedure*—A sample of coating placed in a small glass test tube is burned over a hot flame. The

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**TABLE 1 Classification of Coatings Frequently Used**

| Basic Class | Examples |
|---|---|
| Air-drying or baking (oxidizing) paint and enamel | Unmodified drying oil |
| | Oleoresinous (oil-modified, alkyd, epoxy ester, phenolic and other resins) |
| Lacquer (drying by evaporation of water) | Vinyl (poly[vinyl chloride-vinyl acetate]) |
| | Poly(vinyl butyral) |
| | Chlorinated rubber |
| | Styrene-butadiene rubber and similar rubbers |
| | Bituminous (coal, tar, asphalt) |
| | Cellulose nitrate |
| Latex (drying by evaporation of water) | Poly(vinyl acetate) |
| | Acrylic |
| | Styrenated acrylic |
| Chemically curing single package and multi-component coating | Epoxy |
| | Bituminous epoxy |
| | Urethane |
| | Polyester |
| Inorganic | Silicates and cement |
| Miscellaneous | Flame-sprayed |
| | Silicones |

way the coating burns, its odor, and other characteristics of the fume generated are recorded. The Beilstein test identifies the presence of chlorinated and other halogens. In coatings, chlorine-containing material is most often encountered. For coatings not containing halogens, the odor is recorded.

5.2 *Apparatus:*

5.2.1 *Flame Source,* including butane or propane utility torch. (Lighters do not provide a hot enough flame.)

5.2.2 *Glass Test Tubes*—A suitable size is 10 by 75 mm (disposable culture tubes).

5.2.3 *Copper Wire,* a length of single-strand 16 to 18 gage. AWG copper electrical wire, stripped of insulation sufficiently far that melted insulation cannot interfere with the test, is satisfactory. Leave about 6 in. of insulation as a heat insulator or provide a wrapping or handle for protection from heat.

5.2.4 *Lead Acetate Paper.*

5.2.5 *Test Tube Clamp.*

5.3 *Procedure:*

5.3.1 Put a small specimen of coating, preferably of one type, in the test tube. Hold the tube briefly in the hot flame. Limit flame contact to the end of the test tube immediately around the specimen. As the specimen is heated, observe the nature of deterioration and identify coating type as follows:

| Observation | Identification |
|---|---|
| No change in shape; possible change in color; continued heating causes sample to glow red | Inorganic |
| Rapid deterioration, almost explosive in nature | Cellulose nitrate or similar |
| Swelling | Some vinyl-type coatings |

NOTE 2—Melting, bubbling, and charring are common with most generic types and not definitive.

5.3.2 Continue heating until fume (smoke) fills the test tube. Most fumes are white or near-white; slight condensation of a clear liquid on the upper test tube wall is sometimes observed. Other observations and identifications include:

| Observation | Identification |
|---|---|
| Dark fume; clear brown liquid condensate | Possibly epoxy |
| Very dark, possibly sooty fume; dark condensate | Bituminous |

NOTE 3—Bituminous coatings may be asphalt, coal tar, or combinations. The test is not definitive.

NOTE 4—Silicone coatings will form an ash upon pyrolysis at 800°C. Such temperatures are outside the scope of this test.

5.3.3 *Beilstein Test*—Conduct the Beilstein test by first heating the bare copper wire in the flame until no color is imparted to the flame. Insert the heated wire into hot fume in the test tube briefly (1 to 2 s). Withdraw the copper wire from the test tube and immediately hold it in the flame again. Observe the flame over the copper wire for color and make identifications as follows:

| Observation | Identification |
|---|---|
| No color | No chloride (or other halogen) content |
| Traces of green color | Chloride contaminants from environment or minor component of coating |
| Strong green color | Chlorinated resin or chlorinated resin modifier |

With practice the intensity of the green flame can be used to determine whether the chlorine containing component is major or minor.

5.3.3.1 *Example 1*—A very intense, relatively long-lasting repeatable green flame indicates chlorinated rubber or vinyl coating.

5.3.3.2 *Example 2*—An intense or moderately intense relatively short-lived green flame, which may or may not be repeated, indicates chlorinated plasticizer in a nonchlorinated resin binder.

NOTE 5—Although fluorinated resins also give a positive Beilstein test, they are less likely to be encountered in the industrial applications than chlorinated resins.

NOTE 6—If the sample includes hydrated material, for example, concrete or plaster, water will be liberated by burning and will condense on the wall of the test tube. Halogen liberated from the paint will be absorbed into the condensate. The copper wire must be brought into contact with the condensate to avoid a false negative.

NOTE 7—Those experienced with the Beilstein test may prefer to run it on a specimen not subjected to pyrolysis.

5.3.4 *Odor Test*—Conduct the odor test only if the Beilstein test is negative (no green flame). Tip the test tube so that the fumes flow toward the open end of the tube. Gently wave a hand over the mouth of the test tube and carefully smell the odor of the fumes as they dissipate from the mouth of the test tube. (**Warning**—Hot chlorine or fluorine-containing vapors and gases are extremely irritating and potentially hazardous. In addition, coatings may contain lead or other toxic metals that volatilize and form metal fumes during this test procedure. Care must be taken to avoid inhalation of the vapors, gases and fumes.)

5.3.4.1 Indications are subjective, but the following classes can be assigned:

| Observation | Identification |
|---|---|
| Oily | Oleoresinous |
| Very sweet | Acrylic latex |
| Vinegary; acetic acid | Poly (vinyl acetate) |
| Burning hair | Epoxy, epoxy ester, bituminous epoxy |
| Burning rubber | Polysulfide |
| No strong odor | Inorganic, cementitous |
| Acrid (biting) odor with sooty or tarry smoke | Bituminous |

5.3.5 Use the lead acetate paper to verify the presence of a sulfide component by holding a piece of moistened lead acetate paper over or in the mouth of the test tube. A sulfur-containing component is present if the paper rapidly darkens.

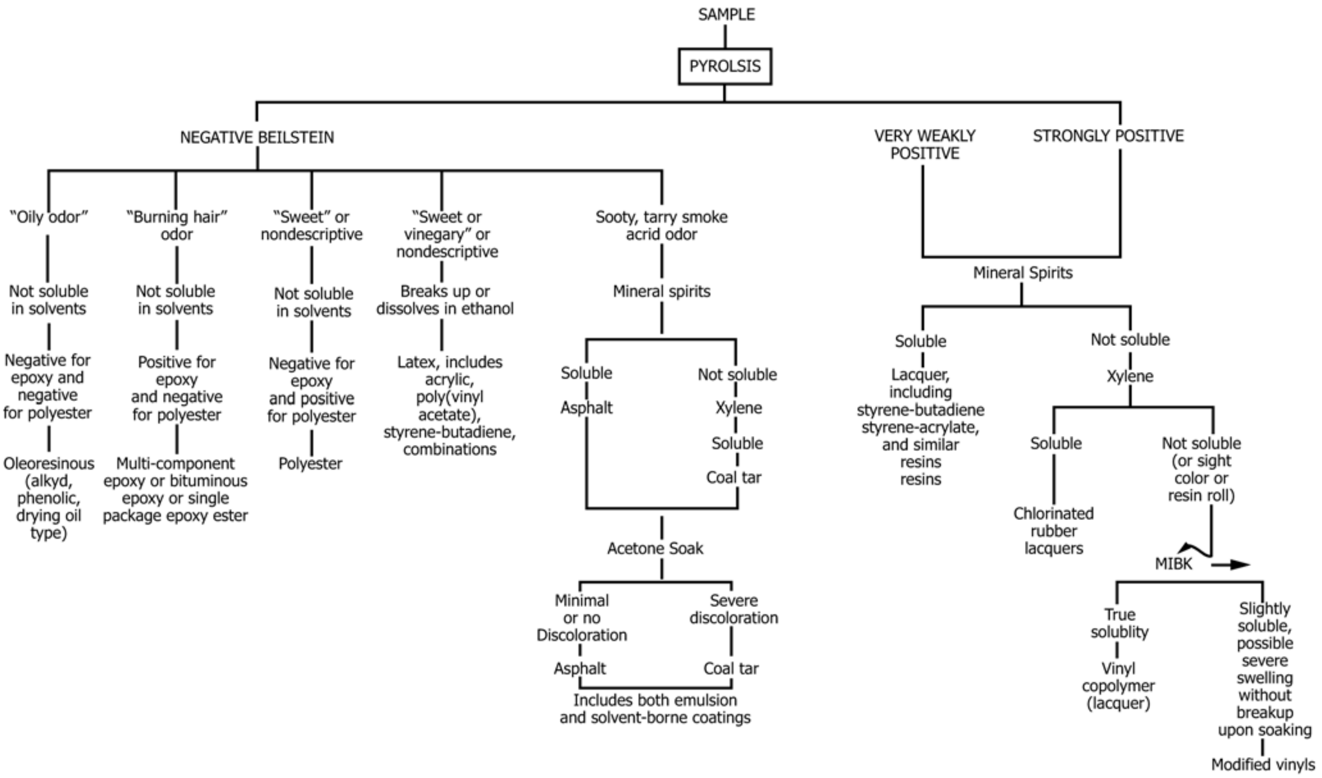

FIG. 1 Suggested Test Flow Chart for Coatings Identification

## 6. Solubility Tests

6.1 Chemically cured, inorganic, and aged oleoresinous coatings are not resoluble in the solvents originally used in producing the coatings. Lacquers and some latex coatings are resoluble and the strength of the solvent required to cause the coating to dissolve can be used to classify the coating.

6.2 *Reagents*—Solvents used, listed in order of increasing power of solvency (that is, ability to dissolve a resin), are as follows:

6.2.1 *Denatured Alcohol (Ethyl Alcohol).*

6.2.2 *Mineral Spirits (Petroleum Spirits),* aliphatic hydrocarbon solvent with typical Kauri-Butanol value (KB) of 25 to 45.

6.2.3 *Xylene (Xylol),* aromatic hydrocarbon solvent with typical KB of 98.

6.2.4 *Methyl Isobutyl Ketone (MIBK, 4-Methyl-2-Pentanone).*

6.2.5 *Acetone (Dimethyl Ketone, 2-Propanone).*

6.3 *Procedure:*

6.3.1 Use a stirring rod or a gloved fingertip to conduct the rub test. The test is perhaps best done by a finger-rub technique on the coating film itself because the sensations perceptible by touch are valuable in interpreting results. Alternatively, the solubility tests may be done by soaking portions of the film in solvents, in which case porcelain spot plates and glass stirring rods can be used. (**Warning—**These solvents can cause skin irritation and dermatitis. Minimize time of contact of solvents with skin and discontinue use if irritation occurs.)

6.3.2 *Rub Test*—Beginning with ethanol, dampen a fingertip or glass rod and rub the surface of the film briskly in a circular motion 5 to 10 mm (¼ to ½ in.) in diameter. Renew the test solvent frequently as required. Continue rubbing at least 30 s or until definite effects are observed. Continue with each solvent in increasing power of solvency. Cleaning the fingertip or glass rod in each succeeding solvent before using that test solvent. Select a new spot on the film or an untested chip of paint for each solvent used.

NOTE 8—If the coating film on the test surface is chalky, the first finger-rub test done with ethanol will liberate much of the chalk, which will dry quickly as a powder. Repeating the test will reveal much less or no color and the test surface will appear unchanged. If chalk is liberated, use ethanol to clean the test spot for subsequent solvent tests.

6.3.3 *Solvent-Soak Test*—The full series of solvents can be run concurrently. Place five chips in a spot plate dish and pour a small amount of each solvent over one of the chips. Periodically stir the solvent and rub the chip with a glass stirring rod until definite changes occur. Add additional solvent, if necessary due to evaporation, and observe extent of discoloration of the solvent and whether the chip softens, breaks apart, swells, dissolves, or a combination thereof. Note whether a color different from the color of the topcoat is imparted to the solvent, indicating dissolution of an intermediate or primer coat. If portions of the chip dissolve or discolor the solvent, soak up the solvent with a paper towel and add fresh solvent if undissolved chip remains. If no further effect occurs, wash the remainder of the chip by gentle swirling, soak up the solvent, allow the chip to dry, and proceed with pyrolysis or other tests. (**Warning**—Do not attempt to burn a solvent-wet chip or heat solvent in a test tube, as the liquid may suddenly boil, possibly causing burns or loss of specimen.)

6.3.4 Observe the effects of rubbing or soaking and classify as follows (the results for the soaking test are more difficult to interpret than for the rub test):

6.3.4.1 No effect or small amount of color transfer to the fingertip or rod (due to chalk or film surface abrasion while rubbing).

6.3.4.2 Softening of the film, with resin rolling into small balls under the fingertip or rod.

6.3.4.3 True solubility with film dissolving, becoming sticky, and transferring in relatively large liquefied quantity to the fingertip or rod.

6.3.5 Succeeding layers in a coating system may be individually tested if they are visually different; for example, colored topcoat, white or gray intermediate coat, and brown or red primer coat. To test visually different layers, repeatedly rub the spot with an effective solvent and wipe away dissolved coating periodically until a sub layer of different color is clean, then continue the test with the effective solvent on the sub layer. If that solvent is ineffective, repeat the test on the same spot with the next stronger solvent in the series. If that solvent is effective, repeat the test on a new specimen or area, and when the sub layer is uncovered, allow the solvent to evaporate, then test the coating with the weakest solvent in the series, continuing up the series until solubility is again observed. If a sub layer of coating is not affected by any solvent in the series, that layer may be separated and collected by chipping or scraping for a pyrolysis test.

6.4 *Interpretation of Results:*

6.4.1 *No Effect with Any Solvent*—Chemically cured, oxidized (aged) oleoresinous, or inorganic.

Note 9—With prolonged contact, oleoresinous coatings may soften and wrinkle. Absence of wrinkling, however, is not indicative of absence of oleoresinous coatings.

6.4.2 *Breaks up or Dissolves in Ethanol*—Latex coating or poly(vinyl butyral).

Note 10—Latex coatings are normally not soluble in mineral spirits and are only slightly affected the in the short time of the test by xylene and MIBK (resulting in surface slickness). Ethanol will not dissolve any other common coating type in this test, but it may affect considerable color transfer from weathered epoxy films. Bituminous emulsions do not break up or dissolve in ethanol.

6.4.3 *Dissolves in Mineral Spirits*—Asphalt coatings and lacquer coatings other than chlorinated rubber and vinyls. Susceptible resins include styrene-butadiene, styrene-acrylate, and similar resins, but do not include polymers such as neoprene which are not normally used in solvent solution coatings.

Note 11—Lacquer coatings other than chlorinated rubber and vinyl may contain chlorinated plasticizers that give a positive Beilstein test.

Note 12—Some coal tar coatings strongly discolor mineral spirits but are not significantly dissolved by the solvent.

6.4.4 *Dissolves in Xylene but not in Mineral Spirits*—Coal tar coatings and chlorinated rubber-based coatings. Frequently associated with solution of a chlorinated rubber resin is the ability of the resin to "string" between surface of the film and finger when the finger is pulled away from the film.

6.4.5 *Dissolves in MIBK but Not in Xylene*—Poly(vinyl chloride-vinyl acetate) solution coatings.

Note 13—Vinyls may soften with resultant "resin roll" in the finger-rub test with xylene. Some vinyls, modified with polymers such as polyethylene, may not readily dissolve in MIBK, but feel slick with strong color transfer in the finger-rub test and may swell up to 2½ times without dissolving in the MIBK soak test. They may also feel similarly slick with some color transfer in xylene.

Note 14—Latex binders merely soften in the short time the test is run.

6.5 It may be possible to further differentiate between asphalt and coal tar coatings using acetone. Soak a chip of bituminous coating in a test tube of acetone for several minutes. Agitate gently and observe for extent of discoloration. Asphalts only very slightly discolor acetone while coal tars strongly discolor it, but there can be intermediate degrees of discoloration that do not permit discrimination. It is not possible by simple methods to differentiate between a solvent-borne (cutback) and water-borne (emulsion) bituminous coating.

## 7. Test for Polyester Coatings

7.1 This test identifies polyester-based coatings from the group of chemically cured coatings that are not affected by the solubility test.

7.2 *Apparatus:*

7.2.1 *Test Tube.*

7.2.2 *Medicine Droppers.*

7.3 *Reagents:*

7.3.1 *Potassium Hydroxide in Methanol.*

7.3.2 *Hydroxylamine Hydrochloride Solution in Methanol,* 10 %.

7.3.3 *Ferric Chloride Solution,* saturated in distilled water.

7.3.4 *Hydrochloric Acid,* 3 %.

7.3.5 *Warm Water,* 125°F (50°C).

7.4 *Procedure*—Place a small quantity of the film sample in a test tube. Add 10 drops of potassium hydroxide solution and 6 drops of hydroxylamine hydrochloride solution. Place the test tube in a container of warm water for 2 min. Add 10 drops of hydrochloric acid and one drop of ferric chloride solution. (**Warning**—Safety glasses or goggles should be worn when handling acids and alkalis.)

7.5 *Interpretation of Results:*

| Observation | Identification |
|---|---|
| Muddy violet color | Dibasic polyester is present |
| Absence of color or light yellow color | Dibasic polyester is not present |

## 8. Test for Epoxy Coatings

8.1 All common epoxy coatings give positive results in this test. Epoxy ester coatings may also give positive results.

8.2 *Apparatus:*

8.2.1 *Ashless or Low-Ash Filter Paper,* 90 to 110-mm diameter.

8.2.2 *Medicine Droppers.*

8.3 *Reagent:*

8.3.1 *Sulfuric Acid,* concentrated.

8.4 *Procedure*—Support the filter paper off surfaces that may be damaged or could cause interference in the test. A watch glass can be used to support the paper. Place a specimen of coating in the filter paper. Place 2 or 3 drops of sulfuric acid directly on the coating. Place 1 or 2 drops of acid elsewhere on the filter paper not in contact with the coating. Let stand for 1 to 2 min. Carefully hold and tilt the filter paper toward the vertical until the acid runs down the paper away from the specimen. Wait 10 to 30 s or until there is development of color in the acid itself, not on the coating. (**Warning**—Safety glasses or goggles and rubber gloves should be worn when handling concentrated sulfuric acid.)

8.5 *Interpretation of Results:*

| Observation | Identification |
|---|---|
| Development of red to violet color in the acid | Presence of epoxy |
| Absence of color in the acid | Coating is not epoxy |

8.5.1 If red to violet color develops in the drop of acid not in contact with the specimen, then the paper is contaminated with or was placed on an epoxy-coated surface. Discard and repeat the test. A very slight pink color may develop in the acid. This is not a positive result. Bitumen-filled epoxies may discolor the acid enough to mask color development. If the acid stream is discolored brown to black, carefully rinse the filter paper briefly in water or under running water if available. Color from a positive epoxy test will remain in the filter paper after the discoloration is washed off. The filter paper itself will be charred brown by the acid and eventually dissolve. The color of a positive test should occur early enough to be seen before the paper chars.

## 9. Test for Pigments that Contain Lead and Hexavalent Chromium

9.1 *Summary of Test Method:*

9.1.1 Knowledge of the presence of pigments that contain lead and hexavalent chromium in an existing coating system may be important in a decision on whether the coating system is to be retained and recoated or on the method of removal and disposal of the coating system residue.

9.1.2 Pigments that contain lead or hexavalent chromium, or both, may be used both in primers as rust-inhibitive pigments and in topcoats as weather-resistant colored pigments. Depending on the ease with which a coating system can be separated, topcoats and primer coats may be individually tested for lead or hexavalent chromium, or both.

9.1.3 The presence of lead and hexavalent chromium containing pigments can be qualitatively determined in the field with the following two tests. Both tests can be done directly on the coated surface or on chips or dust of the coating placed in the well of a spot plate.

9.2 *Apparatus*—Glass beakers, jars or bottles, porcelain spot plates, sandpaper, razor blade or knife.

9.3 *Reagents:*

9.3.1 *Sodium Sulfide Powder or Crystals.*

9.3.2 *Hydrochloric Acid,* concentrated.

9.3.3 *Diphenylcarbohydrazide Powder.*

9.3.4 *Phosphoric Acid,* concentrated (85 %).

9.3.5 *Acetone.*

9.3.6 *Denatured Ethanol.*

9.3.7 *Distilled or Deionized Water.*

9.3.8 *Lead Acetate Paper.*

9.4 *Preparation of Test Solutions:*

9.4.1 A solution of sodium sulfide in water is used to test for the presence of lead. Prepare the solution by dissolving 1.5 g of sodium sulfide in 20 mL of distilled water and adding hydrochloric acid drop-wise while swirling the solution until a white precipitate forms and remains with continued swirling (pH should be about 8). A proportionally smaller or larger amount of solution can be made up. The solution loses strength with age. Test the solution by placing a drop on a strip of lead acetate paper and observing the paper for the development of the black color of lead sulfide. If color development does not occur, discard the solution and make a fresh one.

9.4.2 A solution of 1, 5-diphenylcarbhydrazide is used to test for the presence of hexavalent chromium. Prepare the solution using the following or proportionally smaller or larger amounts of ingredients. Dissolve 0.5 g of 1,5- diphenylcarbohydrazide in a mixture of 20 mL of acetone and 20 mL ethanol in a beaker, warming the beaker in warm water if necessary to facilitate solution. Carefully add 20 mL of phosphoric acid to 20 mL of cold distilled water in a separate container. Slowly add the acetone-ethanol mixture to the dilute acid solution and mix thoroughly by swirling. The 1,5- diphenylcarbohydrazide solution is not stable. It may be stored for short periods of time in an opaque glass bottle but is best prepared just prior to use. The solution can be tested by placing a drop on a material known to contain a hexavalent chromium pigment. If a blue to violet color does not rapidly develop in the drop of solution, discard the solution and prepare a fresh solution.

9.5 *Procedure:*

9.5.1 Abrade two separate spots on the coating film with sandpaper or knife if the tests are to be done on the coating surface. Alternatively, abrade one spot of the coating and collect the dust and flakes in two wells of a spot plate. Abrasion of the film is required to expose pigments in an aged, weathered film.

9.5.2 On one abraded spot or on the specimen in one well of the spot plate, place 1 or 2 drops of sodium sulfide solution. Development of a black or dark gray color on the film or flakes indicates the presence of lead. Lack of color development indicates less than 0.1 % by weight lead (approximate practical limit of sensitivity of this test procedure).

9.5.3 Metals other than lead, for example, those in driers, may cause a darkening of the test area. Usually, these metals, and others that form dark sulfides, are not present in high enough concentrations to form black or other very dark colors. If there is doubt, laboratory testing beyond the scope of this test method is required to confirm the presence of lead.

9.5.4 On one abraded spot or to the second well of the spot plate place 1 or 2 drops of 1, 5- diphenylcarbohydrazide solution. Rapid development of blue to violet color in the solution droplets indicates the presence of hexavalent chromium.

9.6 *Interpretation of Results*—The combination of results from the two tests, together with consideration of the color of the coating, may be used to establish more definitely the pigments that are present, as shown in the following scheme, which is not all inclusive:

| Observation | Identification |
|---|---|
| Positive for lead, negative for chromium | Pigment is red lead, white lead, or lead suboxide (white) |
| Negative for lead, positive for chromium | Pigment is zinc or strontium chromate (yellow) |
| Positive for lead, positive for chromium | Chrome yellow, chrome green, chrome orange or molybdate orange (all color pigments containing lead chromate) or basic lead silicohromate (orange-red inhibitive pigment) |

## 10. Keywords

10.1 coating identification; field identification; field testing; paint field analysis

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