Recommended Practice for Internal Coating of Line Pipe for Non-corrosive Gas Transmission Service

API RECOMMENDED PRACTICE 5L2
FOURTH EDITION, JULY 2002

REAFFIRMED, MAY 2015

AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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FOREWORD

This Recommended Practice is under the jurisdiction of the Subcommittee on Tubular Goods of the American Petroleum Institute. It was prepared by a Formulating Committee which included representatives of Pipeline Operators and Line Pipe Manufacturers and advisors from coating manufacturers and coating applicators as well as other interested individuals.

The purpose of this Recommended Practice is to present methods of qualifying coating materials, production application of such materials, and a final acceptance test of coated pipe for non-corrosive natural gas transmission. Some benefits to be derived from internally coated line pipe are: (1) Improved flow characteristics (2) Corrosion protection during the period preceding construction (3) The enhancement of visual inspection of the internal pipe surfaces (4) The Improvement of pigging efficiency.

Recommendations made in this Recommended Practice need not necessarily be considered as minimum standard requirements. However, the Recommended Practice is written in such a manner that it may be adopted as part of a contract specification. The Recommended Practice does not in any way intend to recommend one type of coating over any other type and regards all types which can pass the specified qualification as being suitable for the intended purpose. As new materials and practices are developed they will be considered for inclusion in this Recommended Practice.

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Suggested revisions are invited and should be submitted to the standardization manager, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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API Recommended Practice for Internal Coating of Line Pipe For Gas Transmission Service

1 Scope

This Recommended Practice provides for the internal coating of line pipe used for non-corrosive natural gas service. The recommendations provided herein cover:

a. Section 1 Scope
b. Section 2 Coating Material Specification
c. Section 3 Laboratory Coating Testing
d. Section 4 Application Practices
e. Section 5 Production Inspection and Acceptance

The Recommendation is limited to the application of internal coatings on new pipe prior to installation.

It is intended that the applicator be responsible for complying with all of the provisions of this Recommended Practice, but that the Purchaser may make any investigation necessary to satisfy himself of compliance by the applicator.

1.1 GENERAL

1.1.1 Coating Supplier Information

The coating material supplier shall furnish to the purchaser and/or applicator the following information in a written form with each batch:

a. Directions for mixing and/or thinning with solvents as required.
b. Directions for handling and storing of the coating materials.
c. Specification of the basic physical properties and performance test results of the material. These basic physical properties and performance test results shall be within the range permitted in this Recommended Practice (Section 2).
d. Certification of the determined physical properties (2.3) of each batch of coating material shipped.

1.2 DEFINITIONS

1.2.1 Applicator: The "Applicator" is the organization responsible to the purchaser for the application of the coating.

1.2.2 Purchaser: The "Purchaser" is the owner company or the authorized agency that buys the coated pipe.

1.2.3 Supplier: The "Supplier" is the manufacturer and/or distributor of the coating material and its authorized qualified technician.

1.2.4 Inspector: The "Inspector" is the authorized agent of the purchaser.

1.2.5 Coating Material: "Coating material" indicates the liquid material prior to application on the substrate.

1.2.6 Coating: "Coating" indicates the coating film as applied to the substrate.

1.2.7 Batch: A "Batch" is the quantity of coating material manufactured at one time in a single vessel and identified by a unique batch number.

2 Coating Material Specification

2.1 PURPOSE

This section describes laboratory methods of identifying and qualifying coating materials suitable for use under the intent of this Recommended Practice.

2.2 DESCRIPTION

2.2.1 Coating Materials

2.2.1.1 The material normally consists of the following:

a. Pigmented or clear base.
b. Pigmented or clear converter.
c. Pigment that includes sufficient rust inhibitor to pass salt spray test. (See 3.5.1)
d. Application solvent for adjusting to suitable spray viscosity.

2.2.1.2 The coating material shall contain no substances which could be released from the coating in service and prove detrimental to the operation of the pipeline and/or quality of the gas.

2.2.1.3 The coating material, including repair materials, shall neither degrade nor produce hazardous vapors when later subjected to external coating thermal cycles up to 575°F (300°C).

2.2.2 Mixing

The coating materials shall be mixed before use by agitating together portions of base and converter as recommended by the supplier.

2.2.3 Thinning

The coating material may be thinned by mixing with the solvent supplied and/or specified by the supplier.

2.3 PHYSICAL PROPERTIES

2.3.1 Individual Components

	Property	Value	Range Permitted	Method
Base	Gal. Wt	(1)	±0.2 lb (±90 g)	ASTM D1475
Converter	Gal. Wt.	(1)	±0.2 lb (±90 g)	ASTM D1475
Solvent	Boiling Range	(1)	Specify Initial and 95%	ASTM D1078
Base	Boiling Range	(1)	Specify Initial and 95%	ASTM D1078
Converter	Boiling Range	(1)		ASTM D1078
Application	Boiling Range	(1)		ASTM D1078
Base	Settling	(1)	4, minimum	ASTM D1309 (testing) ASTM D869 (reporting)
Converter	Settling	(1)	4, minimum	ASTM D1309 (testing) ASTM D869 (reporting)

2.3.2 Mixed Components

Property	Value	Range Permitted	Method
Volume Solids	(1)	±1%	Appendix #1
Grind	(1)	#4 minimum (Hegman Scale)	ASTM D1210
Coarse Particles	(1)	None, 200 Mesh	ASTM D185 (except use ETHYLENE GLYCOL MONOBUTYL ETHER as wash liquid)

2.3.3 Thinned (In ratio according to Supplier's instructions)

Property	Value	Range Permitted	Method
Flow	(1)	No non-uniform ppearance when applied on vertical surface	Spray application on steel at 50°F (10°C), 100°F (37°C) 150°F (66°C) to result in 3.0 mil (76 micron) minimum dry film.
Pot Life		Max. 100% viscosity increase in 3 hr 77°F (25°C). (2) 250 g sample.	
Viscosity	(1)	±5 seconds	ASTM D1200 #4 Ford Cup at 77°F (25°C)

(1) Designates value specified by supplier.
(2) Shorter pot life may be used subject to mutual agreement between purchaser and applicator.

3 Laboratory Coating Testing

3.1 PURPOSE

This section describes laboratory tests required to qualify coating materials. Qualification of coating by laboratory methods is required prior to production. Once qualification is made, no further qualification tests are required unless the coating materials or laboratory application methods change. For each qualified material, the supplier shall provide a qualitative analysis. An acceptable method is an infra-red spectrum. The supplier shall certify to the applicator and/or purchaser the results of tests performed under Section 3 for each qualified coating material.

3.2 STEEL PANELS FOR PERFORMANCE TESTING

Test Panels shall be mild carbon steel 3 x 6 x 0.032 in. (75 x 150 x 0.81 mm). The surface to be coated shall be sand blasted to any of the following standards:

1. NACE No. 1 white metal finish in accordance with NACE Visual Standard TM-01-75.
2. Steel Structures Painting Council SSPC-Vis 1-82T SP5.
3. Swedish Pictorial Standard SIS 05-59-00 S.a.3.
4. DIN 55928 PART 4.

3.3 LABORATORY APPLICATION OF COATING MATERIALS

3.3.1 Mixing

Coating material shall be mixed or thinned to normal spray viscosity in accordance with supplier's recommendation.

3.3.2 Application

Application shall be made by spray on the prepared side of a test panel. The atmospheric environment, during spraying, shall be controlled to 77 ± 5°F (25 ± 3°C), and a maximum relative humidity of 80%. The back and edges of the panel shall be protected.

3.3.3 Dry Film Thickness

Test thickness of film on completed panel (conditioned per 3.4) shall be 2.0 ± 0.2 mils (51 ± 5 microns) measured by a film thickness gauge calibrated with a National Bureau of Standards Coating Thickness Calibration Standard, of a thickness within 20% of the specified nominal thickness.

3.4 CONDITIONING OF COATED PANELS

3.4.1 For qualification tests, the following schedule of conditioning shall apply:

Air dry for 10 days at 77 ± 5°F (25 ± 3°C), followed by a 24 hour bake in a circulating air oven at 120 ± 5°F (49 ± 3°C). Relative humidity during the air drying shall not exceed 80%.

3.4.2 After completing the schedule of conditioning outlined above, panels may be stored at room temperature until needed for testing, but not longer than 90 days.

3.5 PERFORMANCE OF LABORATORY COATED STEEL PANELS

3.5.1 Testing

The tests in Table 3.5 shall be performed on test panels which have been prepared, coated, and conditioned in accordance with the above procedures. Tests shall be performed on duplicate panels. A test result is acceptable when results from both test panels comply with the criteria listed below. In case of failure of either panel, the test shall be repeated on duplicate panels. One such retest shall be permitted.

3.5.2 Additional Tests

At the option of the purchaser or applicator, additional performance tests may be specified to meet individual requirements.

3.6 PERFORMANCE TESTING—GLASS PANELS

3.6.1 Panel Preparation

3.6.1.1 Panel Size

Test panels shall be standard 1 X 3 in. (25 X 75 mm) glass slides, frosted one side.

3.6.1.2 Cleaning

Panels shall be solvent cleaned by rinsing first in xylol, then in acetone, immediately prior to coating application.

3.6.2 Application of Coating Material

Follow 3.3.1 and 3.3.2, making the coating application on the frosted side of the panel only. The wet film thickness shall result in a 2.0 ± 0.2 mil (51 ± 5 micron) dry film.

3.6.3 Performance of Laboratory Coated Glass Panels

Test	Acceptance Criterion	Test Method
Pinhole (Wet Film)	No pinholes	Appendix G
Pinhole (Cured Film)	No pinholes	Appendix G

4 Application Practices

4.1 PURPOSE

This section prescribes equipment and practices used in the surface preparation of line pipe for internal coating and the application of internal coating on the prepared surface.

4.2 GENERAL

4.2.1 Applicator

The applicator is responsible for the quality control production tests outlined in Section 5 to ensure conformance with this Recommended Practice.

4.2.2 Plant Access

The Inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the application site which concern surface preparation, coating of the pipe, and quality control tests.

4.2.3 Material

4.2.3.1 Selection

By agreement between the purchaser and applicator stat a list of coating materials previously qualified by either the purchaser or applicator under Coating Material Specification, Section 2, shall be prepared. The applicator and/or purchaser, shall then choose the coating material to be applied from this list. Approval or selection of the materials shall be done far enough in advance (preferably not less than 30 days) to provide material at the scheduled start of the work. Selection of alternate coating materials from the approved list may be made at any time by agreement between the purchaser and the applicator.

4.2.3.2 Batch Samples

It shall be the right of the purchaser or applicator to procure a coating material batch sample prior to or during the coating application, for the purpose of verification of conformance to the coating material specification.

Table 3.5—Performance of Laboratory Coated Steel Panels

Test	Acceptance Criterion	Test Method
Salt Spray	Appendix #2	ASTM B 117,500 hr (See Appendix #2)
Water Immersion	No blistering over 0.25 in. (6.3 mm) from edges.(1)	Saturated $CaCO_3$ solution in distilled water—100% immersion, room temperature, 21 days.
Mixture, equal parts by volume, methanol & water	No blistering over 0.25 in. (6.3 mm) from edges.(1)	100% immersion at room temperature for 5 days.
Stripping	Appendix #3	Appendix #3
Bend	At 0.5 in. (13 mm) diameter and larger the panel shall show no flaking, loss of adhesion, or cracking of the coating as determined by unaided visual inspection.	ASTM D 522
Adhesion	No lifting of any material other than cuttings	See Appendix #4
Hardness	Minimum 94 Buchholz at 77 ± 2°F (25 ± 1°C)	DIN 53 153
Gas Blistering	No blistering	Appendix #5
Abrasion	Minimum 23 Coef. Of Abrasion	ASTM D 968, Method A
Hydraulic Blistering	No blistering	Appendix #6

(1) Slight softening is permitted.

4.3 HANDLING OF PIPE

Pipe shall be handled in a manner to prevent damage to pipe walls, beveled ends, and coating. Pipe that is damaged by handling operations shall be repaired in compliance with applicable pipe specifications.

4.4 HANDLING OF COATING MATERIALS

4.4.1 Storage and Shipping

Coating materials shall be identified by batch numbers. Materials shall be shipped and stored under cover in such a manner to prevent contamination and adverse effects on application or performance.

4.4.2 Mixing

4.4.2.1 Procedure

The applicator shall handle, mix and thin the coating materials in accordance with the supplier's recommendations or as directed by an authorized, qualified technician of the supplier.

4.4.2.2 Rejection

Coating material shall be rejected if any indication of defective or contaminated material is found. The coating material shall be such that it can be easily mixed into a homogeneous state free from skinning, curdling, and other irregularities.

4.4.2.3 Pre-Mix Agitation

A power operated agitator shall be used to pre-mix the pigmented component materials to a completely homogeneous state before any material is withdrawn from the shipping container.

4.4.2.4 Component Parts

Proportioning and measuring of the component parts of base and converter shall be done within measuring limits of ± 3% of the volume amounts specified by the supplier.

4.4.2.5 Agitation

Mixing of the components must be done with power equipment that will agitate the contents of the entire container and not excessively entrain air in the material. After the material is mixed, it shall be continuously agitated at slow speed.

4.4.2.6 Gun Supply

Continuous power agitation equipment must be used on the gun supply tanks or paint sumps to maintain uniformity during short production interruptions.

4.4.2.7 Pot Life

Any material which has exceeded its pot life shall be rejected.

4.5 CLEANING OF PIPE

4.5.1 General

The cleaning shall be of sufficient quality to allow a firm continuous bond of the cured coating to the pipe, and should be performed immediately preceding the application of the coating material. Surface conditioning, such as grinding, shall result in pipe surface finish compatible with cleaning requirements. The cleaning method used (wet, brush, or abrasive cleaning) is at the applicator's option, unless the purchaser specifies a specific method. If the purchaser specifies abrasive cleaning, the degree of cleaning (e.g., Sa $2^1/_2$) shall also be specified.

4.5.2 Degree of Cleaning

All loose mill scale and rust, water, oil, graphite, grease, marking materials, and other foreign materials that adversely affect the quality of the coating shall be removed from the surface to be coated.

4.5.3 Wet Cleaning

When wet cleaning is performed with detergents, this process shall be immediately followed by sufficient rinsing with clear water to remove all harmful residue of any cleaning agents or detergents.

4.5.4 Drying

Removal of water may be accelerated by heating, but in no case shall this heating adversely affect the metallurgical properties of the steel, or deposit surface contaminations. Pipe surface shall be thoroughly dry before application of coating material.

4.5.5 Dry Cleaning

4.5.5.1 Method

Dry cleaning methods are brushing or abrasive blasting of the pipe. All components of the cleaning machine that enter the pipe shall be clean to prevent the deposition of grease, dirt, or other foreign material on the cleaned pipe surface.

4.5.5.2 Cleaning Machine Brushes

The cleaning machine brushes should be maintained at even pressures on all surfaces of the pipe interior to ensure adequate cleaning of the weld and adjacent areas. Burnishing of pipe surfaces should be avoided.

4.5.5.3 Cleaning and Coating

The cleaned surface shall not be allowed to deteriorate prior to the coating application. Cleaning and coating shall be done in separate stages to permit surface examination and prevent coating contamination.

4.5.6 Use of Air

Clean air may be used to accelerate drying and cleaning.

4.6 COATING OF PIPE

4.6.1 Equipment

4.6.1.1 Air Atomization

Air atomization application is not permitted under this Recommended Practice, except as permitted in 4.7.3.

4.6.1.2 Filters

Adequate filters shall be present in the equipment to ensure that foreign substances or detrimental particles are not carried to application assemblies.

4.6.1.3 Pressure Gauges

The coating material line to the spray guns should be equipped with a pressure gauge. For accurate pressure readings on airless spray unites, the pressure gauge should be equipped with a pulsation dampener. The location of this gauge should be downstream of all pressure drop causing devices, as near to the gun tips as is practicable.

4.6.2 Temperature of Pipe Surface

The temperature of pipe at time of application shall not exceed 150°F (66°C), or be less than 50°F (10°C).

4.6.3 Thickness of Coating

4.6.3.1 Dry Film Thickness

The minimum dry film thickness of the cured coating should be specified by the purchaser at the time the order is placed. Where no minimum thickness is specified, the minimum dry film thickness shall be 1.5 mils (38 microns).

4.6.3.2 Wet Film Thickness

The supplier shall recommend the range of wet film thickness that will be necessary to produce the required dry film thickness. This applies to coating material that has been thinned to proper application viscosity.

4.6.3.3 Pipe Ends

The purchaser should specify an internal cutback distance, if required. Suitable means shall be used to prevent depositing

coating material on bevels and lands. Coating material deposited on bevels and lands of the pipe ends or in cutback areas shall be removed immediately after coating.

4.6.4 Protection of Uncured Coating

Coating shall be applied in a covered or enclosed space shielded from high winds, blowing dust and dirt and inclement weather. Protection from these conditions shall be provided until the coating is tack free.

4.6.5 Acceleration of Initial Cure

Heat may be used to accelerate cure, providing it produces no adverse effects to the pipe or coating.

4.6.6 Coating Film

4.6.6.1 Unfavorable Operating Conditions

Coating operations must be stopped when conditions as defined by the other provisions of this Recommended Practice indicate that an inferior coating will result.

4.6.6.2 Retention of Coated Pipe

Applicators should have provisions for coated pipe to be retained following coating application for inspection purposes.

4.6.6.3 Relative Humidity

If heat is not used to accelerate cure, coating operations should be suspended when the relative humidity is 90% or greater in the coating area.

4.7 REPAIRS TO COATING

4.7.1 Repair Limitations

Defective or damaged coating shall be repaired by the applicator. If the total area of repair exceeds 1% of the total internal pipe surface, the entire pipe shall be recoated. Smaller areas may be spot repaired per 4.7.3.

4.7.2 Film Thickness

Minimum film thickness of coating applied during repair shall comply with 4.6.3.1.

4.7.3 Repair to Small Areas

Spot repairs may be made with a manual atomizing spray gun or brush.

4.7.4 Runs and Sags

Heavy runs or sags of coating should be smoothed out by sanding or scraping prior to recoating. Coating that overlays areas which were inadequately cleaned shall be completely removed and the surface properly cleaned prior to recoating. Unbonded coating shall be completely removed.

4.7.5 Roughened Surface

Roughened coating should be smoothed and all edges of bonded material must be “feathered out” prior to recoating.

4.7.6 Repair and Recoating

Any operation such as coating repair, pipe wall repair, etc., must not be attempted until sufficient cure and hardening of coating film has occurred, so that film damage is prevented. Prior to recoating, pipe should be thoroughly cleaned to remove dust and accumulated debris.

4.8 PIPE MARKING

4.8.1 Identification

When identification stencils and other markings are applied to the inside pipe wall, application shall be done in a manner that will not damage the internal coating. Stenciling or marking paint must be compatible with the coating on the pipe and of a contrasting color.

4.8.2 Restenciling

If a pipe requires rework which invalidates existing stencil information, then that pipe must be restenciled when repairs are completed.

5 Production Inspection and Acceptance

5.1 PURPOSE

This Section defines the limits of acceptance of internally coated pipe and methods of final testing to assure compliance therewith.

5.2 GENERAL

5.2.1 Working Area

A safe working area that is suitable for the performance of their duties shall be provided by the applicator for the purchaser’s inspectors and representatives.

5.2.2 Applied Coating Film

The applied coating film should be uniform in gloss, thickness and color and should be free of irregularities. Blushing, regardless of the degree of color change, shall not be considered detrimental provided the affected area meets the requirements of 5.3.4.4 Bond (Adhesion) Test and 5.3.4.2 Film Thickness Test.

5.2.3 Special Requirement

Any pipe which requires closer inspection shall be set aside upon curing of the coating. Purchaser may require that the applicator set aside such pipe as their representative may request for testing, providing that the amount of such pipe shall not exceed two joints for each eight-hour production period on a current basis, or one pipe from each four-hour production period.

5.3 PRODUCTION TESTS

The following production tests are recommended for proper quality control of the coated pipe and should be conducted at a frequency that will assure control. The pinhole test (5.3.4.1) and the film thickness test (5.3.4.2) shall be conducted hourly and whenever production is interrupted, or production parameters change. All other production tests shall be conducted once per shift.

5.3.1 Test for pH on Bare Surface of Pickled or Wet Cleaned Pipe

Water having an initial pH value of 6.0 to 8.5 as determined with a pH meter, is poured into the pipe at one end and gathered in a cup at the other end. Limits of pH: within 0.5 of initial pH value, and between 6.0 to 8.5, immediately prior to coating application.

This test for pH is not applicable to the bare surface of mechanically cleaned pipe.

5.3.2 Panel and Slide Preparation

Metal panels shall be prepared in accordance with 3.2 or in a manner simulating pipe surface condition before coating.

5.3.3 Coating and Curing of Panel or Slide

A panel or slide is attached to the inside of a clean pipe. The panel or slide is coated as the pipe is coated. The panel or slide is to remain in the pipe a minimum of five minutes. After the panel or slide is removed, the test area on the pipe is spot repaired. After 15 to 30 minutes of air drying, the test panel or slide is dried for 10 minutes at 150 to 175°F (66 to 79°C). The slide or panel is baked in an oven at 300 ± 10°F (149 ± 6°C) for 30 minutes or as supplier specifies.

5.3.4 Evaluation of Test Panels and Slides

5.3.4.1 Pinhole Test

Observe glass slide before and after curing, holding slide over a slot in a container which houses a 100 watt bulb, the bulb being a distance of between 4 and 5 in. (100 and 130 mm) from the coated slide. Evaluation shall be made by purchaser's representative. Pinhole dispersion shall be held to a minimum.

5.3.4.2 Film Thickness Test

Using a micrometer with rachet, measure the uncoated slide, then coat and measure the cured slide at the same location for slide-plus-coating thickness. The difference of the two is the coating thickness and shall be at least 0.2 mils (5 microns) greater than the minimum dry film thickness specified by the purchaser.

5.3.4.3 Bend Test

Bend a cured panel 180° around a conical mandrel. At 0.5 in. (13 mm) diameter and larger, the panel shall show no flaking, loss of adhesion or cracking of the coating, as determined by unaided visual inspection.

5.3.4.4 Bond (Adhesion) Test

See Appendix D.

5.3.4.5 Cure Test

Immerse cured panel or slide in solvent* for a period of four hours. No softening, wrinkling or blistering of the coating film shall be observed after 30 minutes recovery period at room temperature.

*Same as thinner used for the coating material.

5.3.4.6 Water Test

After a minimum of 4 hours immersion in either fresh water or an aqueous solution, containing (by weight) 1% sodium chloride, 1% sodium sulfate, and 1% sodium carbonate, the cured panel shall exhibit no loss of adhesion, softening, wrinkling, or blistering of the coating film.

5.3.4.7 Stripping Test

See Appendix C.

5.3.5 Production Tests on Pipe

Any of the applicable production tests in 5.3.4 may be made on cured coating for quality control purposes.

APPENDIX A—METHOD OF DETERMINING VOLUME SOLIDS

Method:

1. Mix the materials as specified by the Supplier.

2. Allow mixed coating material to stand for three hours at 70 to 80°F (21 to 27°C).

3. Determine the percent of solids by mass of the mixed coating material by method ASTM D 1644.

4. Report the percent of solids by weight of the mixed coating material on the basis of the average of three determinations.

5. Determine the specific gravity of the mixed coating by the method of ASTM D 1475.

6. Select three aluminum test panels, each 18 to 24 $in.^2$ (11,600 to 15,500 mm^2) in area per side, made of 0.025 in. (0.64 mm) thick material.

   a. Heat in circulating air oven at 221 ± 4°F (105 2°C) to constant weight and cool in a desiccator to between 70°F and 80°F (21°C and 27°C).

   b. Weigh aluminum panels in the air to 0.01 gram accuracy.

   c. Weigh aluminum panels in distilled water at 70°F (21°C) to a 0.01 gram accuracy.

   d. Replace panels in oven at 221 ± 4°F (105 ± 2°C) for one hour for drying. Cool to between 70°F and 80°F (21°C and 27°C) in desiccator.

7. Coat panels as set out in Paragraph 3.3 with a portion of the materials prepared in Step 1 of this Appendix.

8. Air dry (cure) panels 16 to 24 hours at 70 to 80°F (21 to 27°C) at a maximum relative humidity of 80%. Place in circulating air oven at 221 ± 4°F (105 ± 2°C) for time necessary to achieve constant weight.

9. Reweigh coated panels in air and in distilled water as outlined in Steps 6b and 6c above.

10. Calculate and report volume solids percentage using values determined above and as follows:

A = mass of coated panel in air less weight of bare panel in air (grams)

B = mass of coated panel in water less weight of bare panel in water (grams)

$$\% \text{ Vol. Solids} = \frac{(A - B)\ (\text{S.G.})\ (\% \text{ Solids by Mass})^{*}100}{A}$$

*expressed as a decimal.

Note: All testes are to be made in triplicate and reported as the average of same.

APPENDIX B—SALT SPRAY LABORATORY TEST

Method:

Cured panels shall be scored to bare metal between diagonal corners by an "X" configuration inscribed on the coated side of the test panel. The inscribed side shall face the salt source. The duration of the test shall be 500 hours.

Reporting:

The test result shall be satisfactory if after 30 minutes of drying upon removal from fog and spray, the coating exhibits no blistering, and not more than 0.125 in. (3.2 mm) of coating can be removed in any direction from the area surrounding the scribe with a pull by clear plastic tape.

APPENDIX C—STRIPPING TEST

The panel shall be placed on a flat surface with the coated side up. A sharp blade, held at approximately 60° to the surface should be pushed so that the blade has a tendency to lift the coating. The coating shall not be removed from the test panel in strips but shall flake off. The flakes when rolled between the thumb and forefinger shall produce powdery particles.

APPENDIX D—ADHESION LABORATORY TEST

In an area of the panel at least 1/2 in. (13 mm) removed from an edge, using a new stiff razor blade, cut the coating through to the metal with 16 lines evenly spaced over one inch. Then make 16 similar cuts at 90° through the previously made 16 cuts.

The cuttings will thus produce 225 squares of coating attached to the metal, each about 1/16 in. (1.6 mm) on a side. Apply 1 in. (25 mm) wide clear plastic tape to the area. Firmly press with the thumb nail so as to yield a uniform color of contact area. Remove the tape with a snapping action.

Inspect the squares thus produced. Acceptance is constituted by lifting of no material other than cuttings.

APPENDIX E—GAS BLISTERING LABORATORY TEST

The panel shall be placed in suitable pressure equipment. Using dry nitrogen gas, build the pressure within the equipment to 1200 psi ± 100 psi (8.3 ± 0.7 MPs). Continue test as follows:

1. The temperature shall be adjusted to 77°F ± 10°F (25 ± 6°C).
2. The pressure shall be maintained during 24 hours and then released during a period of not more than five seconds.
3. The coating shall be examined within three minutes from the release of pressure. Any blister found shall constitute a failure.

APPENDIX F—HYDRAULIC BLISTERING LABORATORY TEST

The panel shall be placed in suitable hydraulic pressurizing equipment. Using distilled water saturated with calcium carbonate, increase the hydraulic pressure to 2400 ± 500 psi (16.5 ± 3.4 MPs). Continue as follows:

1. Maintain 77 ± 5°F (25 ± 3°C) in the pressure equipment.
2. Maintain test pressure for 24 hours.
3. Quickly release pressure.
4. Observe panel within 5 minutes. Any blister found shall constitute a failure.

APPENDIX G—PINHOLE LABORATORY TEST

The coating application shall be made on prepared glass panels as described in 3.3. Examination of panels shall be made as follows:

a. Wet Film—Five minutes after application of the coating material, an examination for pinholes in the film shall be made by momentarily holding the panel to a strong light source, 5 in. (130 mm) from an illuminated 100-watt bulb. An opaque shield to prevent light interference to observation of the panel being viewed shall support the panel over a viewing slot. The opaque shield shall extend a minimum of 6 in. (150 mm) around all sides of the panel. Any pinhole shall constitute a failure.

b. Cured Film—If the coating is acceptable in the wet state above, it shall be held an additional 15 to 30 minutes for air curing and then placed in a circulating warm air oven at 150 to 175°F (66 to 79°C) for a minimum 30 minutes. Observation at the light source described above shall be repeated. Any pinhole shall constitute a failure.

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