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SSPC: The Society for Protective Coatings

PAINTING SYSTEM GUIDE NO. 17.00

Guide for Selecting Urethane Painting Systems

1. Scope

1.1 This guide outlines urethane painting systems for structural steel surfaces. There are three types of urethane coatings covered by the guide. They are Types II, IV, and V, as classified by ASTM Standard D 16.

COMMENT: One-Package Moisture-Cured Urethane Coating (Type II): This coating contains moisture curing isocyanate terminated prepolymers which cure by reaction with moisture from the atmosphere. Reduced cure rate will result from insufficient atmospheric moisture (low relative humidity).

Two-Package Catalyzed Urethane Coating (Type IV): This coating contains isocyanate terminated prepolymers which cure by reaction with a low molecular weight reactive catalyst. One package contains a prepolymer similar to Type II; the second package contains a relatively small quantity of catalyst to accelerate the room temperature cure. This coating has limited pot life after mixing.

Two-Package Polyisocyanate Polyol-Cured Urethane Coating (Type V): This coating contains isocyanate terminated prepolymers which cure by reaction with hydroxylbearing polyols. One package contains the isocyanate terminated prepolymers and the second package contains a large quantity of resinous material containing active hydrogen groups. This coating also has limited pot life after mixing.

1.2 These painting systems are suitable for use on parts or structures exposed in varied types of environments ranging from severely corrosive environments to mild atmospheric conditions.

1.3 These painting systems are intended principally for structural steel where excellent weathering, color retention, and chemical resistance is desired. The color of the finish must be specified.

2. Description

2.1 This guide outlines the components of a complete urethane painting system. A painting system shall consist of surface preparation by commercial blast cleaning or pickling, one coat of a compatible primer, and one or more urethane topcoats.

3. Reference Standards

3.1 The standards referenced in this guide are listed in Section 3.4 through 3.7 and form a part of the specification.

3.2 The latest issue, revision, or amendment of the reference standards in effect on the date of invitation to bid shall govern unless otherwise specified.

3.3 If there is a conflict between the requirements of any of the cited reference standards and the specification, the requirements of the specification shall prevail.

3.4 SSPC STANDARDS AND JOINT STANDARDS:

PA 1	Shop, Field, and Maintenance Painting of Steel
PA 2	Measurement of Dry Coating Thickness With Magnetic Gages
PA Guide 3	A Guide to Safety in Paint Application
PA Guide 4	Guide to Maintenance Repainting with Oil Base or Alkyd Painting Systems
SP 2	Hand Tool Cleaning
SP 3	Power Tool Cleaning
SP 5/NACE No. 1	White Metal Blast Cleaning
SP 6/NACE No. 3	Commercial Blast Cleaning
SP 8	Pickling
SP 10/NACE No. 2	Near-White Blast Cleaning

3.5 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARD:

D 16	Terminology Relating to Paint, Varnish, Lacquer, and Related Products
D 3925	Practice for Sampling Liquid Paints and Related Pigmented Coatings

4. Surface Preparation

4.1 SSPC-SP 6, "Commercial Blast Cleaning," or SSPC-SP 8, "Pickling." If specified in the procurement documents, better degrees of blast cleaning shall be substituted (SSPC-SP 5, "White Metal Blast Cleaning," or SSPC-SP 10, "Near-White Blast Cleaning").

COMMENT: For new steel, blast cleaning or pickling of the steel is the minimum recommended surface preparation. Better degrees of blast cleaning (SSPC-SP 5 or 10) may be substituted. These methods are more thorough,

and the better cleaning they provide may be more economical or may be required in corrosive conditions. Millscale is particularly detrimental to the life expectancy of coatings in immersion or wet service.

In maintenance repainting, if blast cleaning is not feasible, hand or power tool cleaning (SSPCSP 2 or 3) may suffice. These lesser degrees of surface preparation will reduce the service life of the coating system.

5. Paints

5.1 PRIMERS: After cleaning, the steel shall be primed with one coat of compatible primer.

COMMENT: Typical types of compatible primers include organic and inorganic zinc rich, epoxy, universal type copolymer primers, urethane, and wash primers.

Primers which can be topcoated with urethane coatings are available for use over lesser degrees of surface preparation (SSPC-SP 2, "Hand Tool Cleaning," or SSPC-SP 3, "Power Tool Cleaning"). Over such cleaned surfaces these primers will perform less effectively.

5.2 INTERMEDIATE COAT: Where an intermediate coat is required, it must be compatible with both the prime coat and the finish coat, but preferably in a contrasting color. Other generic intermediate coats as recommended by the coating supplier can also be used.

5.3 URETHANE TOPCOATS: Aliphatic and aromatic urethane topcoats can be used.

COMMENT: Aliphatic urethane topcoats are recommended where the highest degree of gloss and color retention, along with chemical resistance and recoatability, are desired.

Aromatic urethane topcoats are recommended where gloss and color retention are not required, but where chemical and abrasion resistance are desired. Aromatic urethanes require mechanical abrasion prior to recoating.

Typical properties of these urethane topcoat types are shown in Table 1.

6. Paint Application

6.1 PAINT APPLICATION: Follow requirements of SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel."

COMMENT: The primer and all subsequent coats must be compatible. Therefore, before using urethane coatings on previously coated surfaces other than those recommended, compatibility tests should be made for possible lifting or intercoat adhesion problems. Aliphatic urethanes normally have good recoatability while aromatic urethanes require mechanical abrasion prior to recoating.

Application may be by brush, roller, air spray, airless spray, electrostatic spray, or a combination of these methods. Dipping, flow coating, or hot spray is permitted only when specifically authorized by the coating supplier.

Some urethane coatings cure at temperatures as low as -7°C (20°F) and some can be applied as thick as 150 to 200 micrometers (6 to 8 mils) dry film thickness in one application. Drying times and minimum elapsed time permissible between coats of urethane coatings may vary with type and coating supplier. Particular attention should be paid to these points. Usually, it is good practice to obtain the complete coating system from one supplier.

Consult the coating supplier for special handling, industrial hygiene, and storage instructions.

6.2 FIELD TOUCH-UP PAINTING: In accordance with specification SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel" and in particular with the Section thereof entitled "Field Painting."

6.3 MAINTENANCE PAINTING: For maintenance painting procedures, see SSPC-PA Guide 4, "Guide to Maintenance Repainting with Oil Base or Alkyd Painting Systems."

COMMENT: This guide covers the steps necessary for repainting previously painted steel surfaces.

6.4 NUMBER OF COATS: A minimum of two.

COMMENT: The number of coats will depend upon the service environment, and the recommendations of the coating supplier should be followed.

6.5 DRY FILM THICKNESS OF PAINT SYSTEM: Film thickness shall be measured in accordance with SSPC- PA 2, "Measurement of Dry Coating Thickness with Magnetic Gages."

COMMENT: The recommended dry film thickness of each coat of the complete paint system may vary with the end use and metal surface preparation. Prior to application, the desired thickness of each coat should be agreed upon. The recommendations of the supplier should be followed.

7. Inspection

7.1 All work and materials supplied under this specification is subject to timely inspection by the purchaser or his authorized representative. The contractor shall correct such work or replace such material as is found defective under this specification. (See Note 10.1.) In case of dispute, unless otherwise specified, the arbitration or settlement procedure established in the procurement documents shall be followed. If no arbitration procedure is established, the procedure specified by the American Arbitration Association shall be used.

7.2 Samples of paints under this painting system may be requested by the purchaser and shall be supplied upon request along with the manufacturer's name and identification for the materials. Samples may be requested at the

TABLE 1
RECOMMENDATIONS FOR PHYSICAL AND CHEMICAL PROPERTIES OF URETHANE COATINGS

	TYPE II		TYPE IV		TYPE V	
	Aliphatic	Aromatic	Aliphatic	Aromatic	Aliphatic	Aromatic
	(One Package Moisture Cure)		(Catalyzed Moisture Cure)		(Two Package)	
Weatherability	R	LR	R	LR	R	LR
Gloss Retention*	R	LR	R	LR	R	LR
Color Retention	R	LR	R	LR	R	LR
Flexibility	R	R	R	R	R	R
Abrasion Resistance	R	R	R	R	R	R
Chemical Resistance, (Splash, Spill, Fumes)**						
Acids (Mineral)	LR***	LR***	LR***	LR***	LR***	LR***
Acids (Organic)	LR	LR	LR	LR	LR	LR
Alkaline	R	LR	NR	NR	R	LR
Gases (Atmospheric)	R	R	R	R	R	R
Oxidizing Agents	LR	LR	NR	NR	LR	LR
Solvents	R	R	R	R	R	R
Salt Spray	R	R	LR	LR	R	R
Weather Resistance	R	R	LR	LR	R	R
Performance Range (Dry) -40° to 120°C (-40° to 250° F)	R	R	R	R	R	R

LEGEND:
R = Recommended
LR - Limited Recommendation
NR = Not Recommended

*Depends on pigmentation.
**For immersion, see supplier.
***See supplier for specific end-uses.

NOTE: Aromatic urethanes are not recommended for outdoor exposure where color and gloss retention are of prime importance.

time the purchase order is placed, or may be taken from unopened containers at the job site.

7.3 Unless otherwise specified, the sampling shall be in accordance with ASTM D 3925.

8. Safety

8.1 All safety requirements stated in this specification and its component parts apply in addition to any applicable federal, state, and local rules and requirements. Instructions of the paint manufacturer and requirements of insurance underwriters must be considered.

8.2 Paints are hazardous because of their flammability and potential toxicity. Proper safety precautions shall be observed to protect against these recognized hazards. Safe handling practices are required and should include, but not be limited to, the provisions of SSPC-PA Guide 3, "A Guide to Safety in Paint Application."

8.3 The paints specified herein may not comply with some air pollution regulations because of their hydrocarbon solvent content.

8.4 Ingredients in urethane coatings which may pose a hazard include isocyanates and solvents. Applicable regulations governing safe handling practices shall apply to the use of urethane coatings.

8.5 The main items to consider and keep in mind when working with urethane paint systems are as follows:

- Become informed and aware of the hazards and appropriate control procedures. This can be done by reading the label, the material safety data

sheet, if available, or by contacting the supplier of the paint system for other literature and information.

- Follow the recommendations prescribed for use during handling and application as set forth by the supplier.
- Follow all applicable local, state, and federal regulations.

8.6 Label information should be available if medical attention is required.

COMMENT: Toxicological research as well as practical experience has shown that diisocyanates can cause irritation of the skin, respiratory tract, eyes, nose and throat. In addition, sensitization resulting in allergic dermatitis or asthmatic symptoms can occur following overexposure to diisocyanates. Toxicological research has shown that polyisocyanates have a reduced potential to cause irritation and sensitization relative to their monomeric precursors.

Irritation is an acute response which results from the direct contact of isocyanates on the body surface, i.e., skin, mucous membranes of the nasal passages, throat and respiratory tract, eyes, etc. Symptoms usually include watering of the eyes, and a burning sensation in the nose and throat. The amount of irritation is dependent upon the dose, tissue exposed and individual susceptibility, but it is generally independent of the individual's exposure history. These acute symptoms are generally reversible soon after the individual is removed from the contaminated area or removal of the material from the skin in cases of skin contact.

Sensitization is a systemic response and is not limited to the area of contact. Sensitization usually occurs as a result of numerous overexposures or one exposure to very high concentrations. Both respiratory and dermal sensitization can occur depending upon the toxicologic properties of the diisocyanate, route of exposure and individual susceptibilities. Exposures subsequent to the exposure(s)) which actually resulted in sensitization may cause a very strong allergic type of reaction. In the case of respiratory sensitization the reaction is similar to asthma, i.e., coughing, wheezing, tightness in the chest, and shortness of breath. The skin sensitization reaction is allergic dermatitis which may include symptoms such as rash, itching, hives, and swelling of the arms and legs. A sensitized individual may react to extremely low airborne levels even well below the threshold limit value (TLV).

If an individual experiences an irritation response while handling an isocyanate it should be determined whether or not the isocyanate was the cause of the irritation. If the isocyanate is the cause, it is an indication that the operation, as performed, allows an overexposure to isocyanates which can result in later sensitization of that worker or others. A careful evaluation of the controls, protective equipment, and work practices, should be made to reduce the exposure. If irritation persists in spite of proper ventilation and protective measures, the individual must be removed from areas where isocyanates are being processed or used.

If an individual is sensitized to isocyanates, complete removal from areas of potential exposure is mandated. This is true regardless of whether the isocyanate is present in vapor or mist form. Also, exposure to an isocyanate, other than the one suspected of causing the sensitization, must be avoided.

Solvents are also present in paints. Prolonged or repeated exposure or overexposure to these solvents by either inhalation or direct skin contact may also cause injurious health effects. The effects are dependent upon the solvent, the extent of exposure, and the route of exposure.

Protective Measures: Since isocyanates have the potential to irritate and sensitize those working with or around them, it is important that proper steps be taken to protect those potentially exposed from excessive contact with vapor, mist, or overspray. This includes those actually handling the isocyanate as well as those in the immediate vicinity. Even during brush, roller, and curtain coating applications, it is possible to be exposed to airborne concentrations of solvents and isocyanate vapors. During spray application, not only will vapors be present, but also spray mists or aerosolized droplets. These droplets contain pigments, solvents, resins, additives, and polymeric materials, as well as isocyanate and unreacted polyisocyanate. Each of these will have their own physiological effect on the organism.

Ideally, control of health hazards posed by vapors and spray mist is performed by engineering controls. Effective engineering controls should be used whenever possible to eliminate or reduce workers' exposure. There are several engineering controls available to reduce exposure to isocyanate vapors and mists. The most common is a properly designed and ventilated enclosure. General ventilation, local ventilation, or isolation may prove adequate under certain conditions. Use of alternative application equipment, e.g., airless or electrostatic spray equipment, may help reduce spray mist generation during spray painting. Brush and roller application of the coating may be feasible in some cases. To reduce environmental contamination, exhausted air may need to be cleaned by means of filters or scrubbers. The final design and combination of these control measures is dependent upon the specific application.

Whenever a paint system is spray-applied it is essential that the applicator be protected from inhalation of both vapors and spray mists by the best possible respiratory protection. Under certain conditions, a fresh air supplied respirator will be required. In other cases, an air purifying type with a particulate filter may be employed. Applicators are urged to consult with their suppliers concerning the type of respiratory protection appropriate in a given application.

The appropriate selection and use of a respirator is an important part of protection from work related chemical hazards. Other things also must be remembered and followed:

TABLE 2
LISTING OF TYPICAL URETHANE SPECIFICATIONS AND END-USE APPLICATIONS

SPECIFICATION	END-USE APPLICATIONS
Canadian Government Specifications Board 1-GP-177 (November 1977), "Coating, Polyurethane Two-Package, Interior and Exterior, Non-Yellowing, Non-Chalking."	Interior and exterior use on metal, wood, glass fiber reinforced plastic, and concrete where excellent resistance to chemicals, abrasion, impact, water, corrosion, and superior exterior durability, non-yellowing, and non-chalking properties are desired.
Canadian Government Specifications Board 1-GP-180 (November 1977), "Coating, Polyurethane Two-Package, Interior and Exterior, General Purpose."	This specification applies to a two-package polyurethane coating for interior and exterior use on metal, wood, glass fiber reinforced plastic, and concrete, where excellent resistance to abrasion, impact, water, and corrosion are desired, and where some yellowing and chalking are not objectionable.
MIL-PRF-85285*, Coating: Polyurethane, High-Solids	For use on aircraft as a topcoat, steel storage tanks and ground equipment where gloss, chalk resistance, and weathering resistance are required. Exterior coating for low infra-red reflectivity.
BMS-10-60, Boeing Material Specification, Protective Enamel.	Exterior decorative paint system. Protective urethane topcoat
MIL-PRF-23236** (Ships), "Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast (Class 4)."	Steel ship tanks, fuel, and salt water ballast.
NFGS-09970***	Protective linings for petroleum fuels.
MIL-C-46168A (NR), "Coating: Aliphatic Polyurethane, Chemical Agent Resistant."	Exterior coating for military combat vehicles.

* MIL-PRF-85285 has replaced MIL-P-85285 and MIL-P-83286 which have been canceled.
** Formerly MIL-P-23236 or DoD-P-23236 which have been canceled.
*** NavDocks 47Y6 was changed to NFGS-09872B, which was canceled. Use NFGS-09970.

- Users of respirators must be properly trained in their use.
- Always be sure the respirator is in good working order.
- Know its limitations.
- Be sure it fits properly. Clean it after each use.

Respirator manufacturers may be helpful in developing a good respirator program.

In addition to respirators, other forms of recommended personal protective equipment include safety glasses or goggles. Nevertheless, should spray mist get into the eye, rinse immediately and sufficiently with lukewarm water and consult an eye doctor should irritation persist.

Regarding skin contact, it is suggested that as much of the exposed skin area as possible be covered with clothing or skin creams. Cured coating cannot be removed easily. Application of a protective skin cream to the hands prior to start of work will facilitate the soap and water removal of paint splashes or overspray. Skin areas covered only by protective creams should be kept to an absolute minimum. Aggressive solvents are unsuitable for skin cleaning as they wash oils out of the skin and can cause secondary reactions.

9. Disclaimer

9.1 While every precaution is taken to ensure that all information furnished in SSPC standards and specifications is as accurate, complete, and useful as possible, SSPC cannot assume responsibility nor incur any obligation resulting from the use of any materials, coatings, or methods specified herein, or of the specification or standard itself.

10. Notes

Notes are not a requirement of this specification.

10.1 The procurement documents should establish the responsibility for samples, testing, and any required affidavit certifying full compliance with the specification.

10.2 Table 1 offers suggested areas of usage for urethane coatings. However, the coating supplier should be consulted for specific recommendations and resistances.

10.3 Table 2 is a listing of typical urethane specifications and their end-use applications. This listing includes both one and two-component coatings used as primers, intermediates, and topcoats.