

Specification 2400-400c
September 2014
Superseding
Specification 2400-400b
May 2013

**UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SPECIFICATION FOR
PAINT, TREE MARKING, WITH TRACER**

1. SCOPE AND CLASSIFICATION.

1.1. Scope. The tree marking paint (TMP) described in this specification is intended for designating timber for forest operations.

1.2. Classification. The following types and colors are defined in this specification:

Type A – waterborne TMP available in seven colors (yellow, pink, orange, blue, green, white, and black).

Type B – waterborne TMP containing citrus solvent available in two colors (orange and blue).

Type C – rain-resistant TMP available in seven colors (yellow, pink, orange, blue, green, white, and black) in bulk containers.

Type D – rain-resistant TMP available in seven colors (yellow, pink, orange, blue, green, white, and black) in aerosol containers.

2. APPLICABLE DOCUMENTS.

2.1. Government Documents. The following documents form a part of this specification to the extent specified herein. Unless a specific year of issue is identified, the issue in effect on the date of this specification shall apply.

Federal Standards.

FED-STD-141 – Paint, Varnish, Lacquer, and Related Paints; Methods of Inspection, Sampling, and Testing

FED-STD-29CFR1910.1200 – Safety Data Sheets, Transportation Data and Disposal Data For Hazardous Material Furnished To Government Activities

Beneficial comments, recommendations, additions, deletions, and any pertinent data that may be used in improving this document should be addressed to the Qualifying Activity.

FED-STD-595 – Colors Used in Government Procurement

United States Department of Agriculture – Forest Service, San Dimas Technology and Development

Center (SDTDC)

9624 1808 – Tracer Paint Security Guidelines

Copies are available from USDA Forest Service, San Dimas Technology and Development Center, 444 East Bonita Avenue, San Dimas, CA 91773-3198.

United States Department of Transportation – Federal Highway Administration (FHWA)

Highway Color Tolerance Charts PR Color #1 and #6

Copies are available from Hale Color Charts, Inc., 11765 Old Frederick Road, Marriotsville, MD 21104.

2.2. Non-Government Documents. The following documents form a part of this specification to the extent specified herein. Unless a specific year of issue is identified, the issue in effect on the date of this specification shall apply.

American Society for Quality

ANSI/ASQ Z1.4 – Sampling Procedures and Tables for Inspection by Attributes

Address requests for copies to the American Society for Quality, P.O. Box 3005, Milwaukee, WI 53201-3005.

ASTM International

D 1640 – Drying, Curing, or Film Formation of Organic Coatings at Room Temperature

D 1729 – Visual Evaluation of Color Differences of Opaque Materials

D 2244 – Calculation of Color Differences from Instrumentally Measured Color Coordinates

D 2697 – Volume Nonvolatile Matter in Clear or Pigmented Coatings

D 3924 – Standard Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials

D 3925 – Sampling Liquid Paints and Related Pigmented Coatings

D 4587 – Conducting Tests on Paint and Related Coatings and Materials Using a Fluorescent UV-Condensation Light- and Water-Exposure Apparatus

G 155 – Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water Exposure of Nonmetallic Materials

Copies are available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

APA – The Engineered Wood Association

Voluntary Product Standard PS 1-95 for Construction and Industrial Plywood

Copies are available from the APA – The Engineered Wood Association, P.O. Box 11700, Tacoma, WA 98411. www.apawood.org

2.3. Order of Precedence. In the event of conflict between the text of this document and the references cited herein, the text of this document takes precedence. However, nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS.

3.1. Qualified Products List Number. The paints furnished under this specification shall be products which are listed on the TMP Qualified Products List. The contractor shall possess a currently valid notice of qualification with associated Qualified Products List (QPL) number obtained in accordance with 4.1. The date of issue for the QPL number shall precede the contractor's contract date.

3.2. Tracer Requirements. TMP shall contain both laboratory and field tracers. Field tracer allows the TMP to be identified easily in the field, for comparison with non-tracer paints. A laboratory tracer shall provide absolute identification of a product supplied under this specification, by analysis conducted by a laboratory approved by the Government. To maintain uniqueness of tracer used in TMP, other than to the qualifying activity, the paint manufacturer and the contractor shall never divulge the identity of the laboratory or field tracers used in any product on the QPL. The paint manufacturer and the contractor shall not supply the field or laboratory tracer to other buyers for a minimum period of 10 years after expiration or removal from the QPL.

3.2.1. Type A and B. The TMP shall test positive for the presence of both field and laboratory tracers for a minimum period of 4 years after the date of application.

3.2.2. Type C and D. The TMP shall test positive for the presence of both field and laboratory tracers for a minimum period of 8 years after the date of application.

3.2.3. Tracer Registration. The unique laboratory tracer shall be registered for the exclusive use of the U.S. Government. Only users who have been authorized by the qualifying activity may order and use this product.

3.2.4. Field Tracer Identification. A test kit and instructions shall be available that will enable trained personnel to determine the presence of field tracer in the TMP. The test kit shall be labeled specifically for the U.S. Government and show appropriate warnings for use. Ingredients shall not be listed on the test kits. Each test kit shall contain a minimum of 25 test applications. The field test method must be approved by the qualifying activity.

3.2.5. Tracer Analysis. For a period of 10 years following expiration or termination of a contract the paint manufacturer shall furnish, at no additional cost, interpretation and advice on laboratory analyses and reports to confirm presence, or absence, of the paint manufacturer's tracers. Additionally, occasional expert testimony may be needed from the paint manufacturer, which will be compensated at rates negotiated with the requesting Government Agency.

3.2.6. Field Tracer. When tested in accordance with 4.7.1, TMP shall indicate the presence of field tracer.

3.3. Quantitative Requirements.

3.3.1. TMP Types. TMP shall be provided in four types:

Type A – waterborne TMP containing mineral spirits with water as the primary solvent and is available in seven colors (yellow, pink, orange, blue, green, white, and black).

Type B – waterborne TMP containing citrus solvent with water as the primary solvent and is available in two colors (orange and blue).

Type C – rain-resistant TMP containing citrus solvent as the primary solvent and is available in seven colors (yellow, pink, orange, blue, green, white, and black) in bulk containers.

Type D – rain-resistant TMP containing citrus solvent as the primary solvent and is available in seven colors (yellow, pink, orange, blue, green, white, and black) in aerosol containers.

3.3.2. Limited Substances.

3.3.2.1. Solvent content.

3.3.2.1.1. Type A, C, and D TMP shall not contain mineral spirits, referenced to Stoddard reagent CAS #8052-41-3, exceeding 9.0 percent weight of wet paint.

3.3.2.1.2. Type B TMP shall not contain citrus solvent, CAS #5989-27-5, exceeding 9.0 percent weight of wet paint.

3.3.2.2. Worker exposure. The paint shall not contain any substance which results in any worker exposure while applying tree marking paint which exceeds the most conservative occupational exposure limit of either the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL), the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL), or the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV).

3.3.2.2.1. At the discretion of the qualifying activity, worker exposure testing may be performed to verify compliance with 3.3.2.2. If employee exposure testing is performed, sampling shall be performed for at least the metals and solvents listed in tables 1 and 2. Worker exposure testing shall be performed in accordance with accepted industrial hygiene practices during routine tree marking activities. The testing and data interpretation shall account for extended work shifts and use the OEL mixture calculation to address additive health effects of paint components.

3.3.2.3. Annual certification.

3.3.2.3.1. The paint manufacturer shall certify annually that the paint formulation has not been revised within the previous 12 months.

3.3.2.3.2. The paint manufacturer and contractor shall certify annually that chlorinated solvents, alcohols, cellosolves, and formaldehyde are not added to the paint as part of the formulation or any manufacturing

process.

Table 1—Metals

Arsenic
 Antimony
 Barium
 Beryllium
 Cadmium
 Chromium
 Cobalt
 Copper
 Lead
 Manganese
 Magnesium
 Mercury
 Nickel
 Titanium
 Vanadium
 Zirconium
 Zinc

Table 2—Solvents

Benzene
 (m-, o-, p-) Xylenes
 Trimethyl benzene (all forms/isomers)
 Ethyl benzene
 Toluene
 Methyl ethyl ketone (MEK)
 Methyl ethyl ketone oxime (MEK oxime)
 Methyl isobutyl ketone (MIBK)
 Butyl acetate
 Naphthalene
 n-hexane (C6)
 n-nonane (C9)

3.4. Performance Requirements.

3.4.1. Condition in container. When tested in accordance with 4.7.2, TMP as-received shall be ready for use and shall meet the mixing requirements in 3.4.1.1.

3.4.1.1. Mixing Requirements. TMP shall require no more than 1 minute of shaking by hand for containers to disperse the paint to a useable condition. When the paint is mixed in this manner the solids shall remain in suspension a minimum of 8 hours.

3.4.2. Color. When tested in accordance with 4.7.3, TMP shall match the central color specified on the Highway Color Tolerance Chart for yellow and orange. Blue, green, white, pink, and black shall meet the description below:

Yellow: PR Color #1, max delta E of 6.0.

Orange: PR Color #6, max delta E of 6.0.

Blue: FED-STD-595 color 35260, max delta E of 6.0.

Green: FED-STD-595 color 34350, max delta E of 6.0.

White: ASTM D 2244 minimum reflectance of 80.

Pink: Lightness 68.56, chromaticity coordinates (a) 21.92 (b) -0.19, max delta E of 6.0.

Black: ASTM D 2244 maximum reflectance of 4.

3.4.3. Spraying Properties.

3.4.3.1. Type A and B. When tested in accordance with 4.7.4.1, TMP shall be capable of producing a 3- to 5-inch-diameter spot at a minimum distance of 6 feet at temperatures of -20 °F to 104 °F and relative humidities to 100 percent.

3.4.3.2. Type C. When tested in accordance with 4.7.4.2, TMP shall be capable of producing a 3- to 5-inch-diameter spot at a minimum distance of 6 feet at temperatures of 20 °F to 100 °F and relative humidities to 100 percent.

3.4.3.3. Type D. When tested in accordance with 4.7.4.3, Type D paint shall deliver a minimum of 95 percent of net contents without sputtering or interruption. When tested in accordance with 4.7.4.3.1 and 4.7.4.3.2 the nozzle(s) shall project a thin solid stream of marking paint and be capable of writing numbers or letters and producing a solid band of marking paint.

3.4.4. Adhesion. When tested in accordance with 4.7.5, TMP shall adhere to cold and to wet wood surfaces and shall show no evidence of blistering or film failure.

3.4.5. Accelerated Weathering. When tested in accordance with 4.7.6, TMP shall show no checking or peeling and the color change shall not be greater than a delta E value of 12. The field and laboratory tracers shall be detectable after weathering.

3.4.6. Odor. When tested in accordance with 4.7.7, the odor of the paint shall be acceptable at time of paint application at the field site.

3.4.7. Contrast Ratio. When tested in accordance with 4.7.8, the minimum contrast ratio of 12 mil of wet film shall be:

White, yellow, orange, pink	0.90
Blue, green	0.95
Black	0.99

3.4.8. Sag Resistance. When tested in accordance with 4.7.9, the sag resistance shall be a minimum of 8.

3.4.9. Dry Time. When tested in accordance with 4.7.10, the dry hard time shall not exceed 48 hours. When tested with accordance with 4.7.10.1 Type C and D TMP shall dry to the point of rain resistance at 90 percent relative humidity within 30 minutes maximum. TMP shall show no signs of thinning of the film, fading, or color change. There shall be no changes in the color of runoff water used in the test chamber.

3.4.10. Coarse Particles Test. When tested in accordance with 4.7.11, the maximum acceptable

percentage of grits retained on the sieve screen shall be 0.1 percent.

3.4.11. Total Solids. When tested in accordance with 4.7.12, the total solids shall be no less than 7 percent by volume.

3.4.12. Freeze/Thaw Cycles. When tested in accordance with section 4.7.13, Type C and D TMP shall be able to withstand 5 cycles of freeze/thaw and maintain original condition.

3.4.13. Viscosity. When tested in accordance with section 4.7.14, the viscosity for Type C TMP shall not exceed 800 centipoises or be less than 200 centipoises, measured at a speed of 100 revolutions per minute (rpm).

3.5. Containers.

3.5.1. Paint Containers.

3.5.1.1. Quart. Type A and C TMP in all colors, and Type B TMP in blue and orange colors, shall be supplied in 1-quart containers. These containers shall be metal cans of commercial construction with a round, conical top having threads compatible with the Nelson Nelspot D-103, DT-105, and LT-104 and the Treccoder Spot Gun. These containers shall be filled to a minimum of 0.94 quart, and allow insertion of the Nelson spray gun without causing overflow. Press-in metal inner seals shall not be used on these containers.

3.5.1.2. One Gallon. Type A TMP in all colors and Type C TMP in blue and orange colors shall be supplied in 1-gallon Style F (oblong) containers.

3.5.1.3. Aerosol. Type D TMP in all colors shall be supplied in commercial metal aerosol dispensers of nominal 1-pint (16 fluid ounces) capacity. These containers shall be filled to a minimum of 9 ounces (266 milliliters) of paint, exclusive of propellant or sprayability enhancers. An odorless, non-flammable inert propellant shall be used. Each container will be supplied with an actuator. The actuator shall be firmly seated and withstand separation from the valve. The color of the cap shall identify the color of the contents generically.

3.5.1.4. Marking. Container labels shall not indicate that the paint contains a tracer.

3.5.1.4.1. Container labels shall contain the following information:

- a. Paint type (A, B, C, or D) and color.
- b. Date of manufacture, batch number, and national stock number (NSN).
- c. Bar Code marking of NSN and batch number.
- d. Applicable warnings for use.

3.5.1.4.2. Quart cans shall have information required in 3.5.1.4.1a and 3.5.1.4.1b printed directly on the bottom of the cans.

3.5.2. Tracer Field Test Containers. Containers shall contain a minimum of 25 test applications. Container

shall be of a type that can withstand forestry field use for a period of 8 years without deterioration or leaking. The container shall be labeled with the date of manufacture.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES.

4.1. Qualification Testing.

4.1.1. Contractor Submission for Qualification Tests. The prospective contractor shall provide, without cost to the government:

- a. A letter listing the proposed tracers (3.2) and requesting approval for their use. The paint manufacturer shall certify that the proposed tracers have never been supplied in a form which could be construed as a tracer, in any paint to any consumer other than the USDA Forest Service.
- b. A letter listing all metals and solvents and the amount used in each type and color of paint and copies of all applicable material safety data sheets.
- c. Certificates of conformance (4.6).
- d. A signed collection agreement.
- e. The estimated test fee.

All of the above shall be delivered to the attention of the Tree Marking Paint Project Leader at the Forest Service, San Dimas Technology and Development Center, 444 E. Bonita Avenue, San Dimas CA 91773.

4.1.2. Qualification Test. Qualification inspection and tests shall be conducted by the Government and at the expense of the contractor at a fee to be determined by the Government. If requested by the contractor, the Government will inform the contractor of date and place of inspection and tests. The contractor may send a representative (who has been designated in writing) to be present and observe the inspection and tests, but they will not be permitted to be a participant. Upon completion of tests, the sample may be retained by the Government. Upon a single failure qualification shall stop and the test sample shall be rejected. The Government shall not be obligated to continue testing a nonconforming product once it is known to be nonconforming, or when it is considered to be in the best interest of the Government. The contractor will be informed as to the nature of the failure.

4.1.3. Field Tests. After the contractor has complied with requirements in 4.1.1 to the satisfaction of the Government the contractor's product will be applied to field test sites established by the Government. The test sites represent extremes in ultraviolet (UV) exposure, winter weather, heavy rainfall, and high humidity respectively. The product will be evaluated for performance under conditions similar to the actual intended use. The product must pass the field tests to the satisfaction of the Government, including:

- a. Field tracer (3.2.6).
- b. Condition in the container (3.4.1).
- c. Mixing (3.4.1.1).
- d. Color (3.4.2) when applied to a variety of tree species.
- e. Spraying properties (3.4.3) at the prevailing temperature and humidity.
- f. Adhesion when applied to a variety of tree species (3.4.4).

- g. Odor (3.4.6).
- h. Dry time (3.4.9).

4.1.3.1. Field Test Samples. Samples must be submitted for each of the colors and types. Samples shall be supplied in seven 1-quart containers (3.5.1) of each type and color submitted for qualification. The samples and one field test kit (3.2.4) shall be delivered to the attention of the Tree Marking Paint Project Leader at the Forest Service, San Dimas Technology and Development Center, 444 E. Bonita Avenue, San Dimas CA 91773. The supplied products will be applied by the Government within 2 months of delivery (access and weather conditions permitting).

4.1.3.2. Durability. A Government representative shall visit each test site at the discretion of the procuring activity to evaluate long-term product durability. Type A and B TMP shall meet the requirements of this specification for a minimum of 4 years from the date of application. Type C and D TMP shall meet the requirements of this specification for a minimum of 8 years from the date of application. Field tracer, color, adhesion, and weathering shall be evaluated to determine compliance with this specification. Any product which is deemed by the Government to fail this review is subject to removal from the Qualified Products List (QPL).

4.1.4. Facilities. The paint manufacturer and contractor shall submit a written security plan which meets the requirements of "Tracer Paint Security Guidelines" (9624 1808 SDTDC). All production (including mixing, packaging, etc.) and distribution facilities (including shipping and returning shipments) utilized by either the paint manufacturer and/or contractor will be reviewed by, and must be approved by, the Government as meeting the security guidelines in "Tracer Paint Security Guidelines." All production (including mixing, packaging, etc.) and distribution facilities will be reviewed by the Government for production and delivery capability. Production facilities also will be reviewed by the Government for quality-assurance testing facilities.

4.1.5. Formulation. The manufacturer shall have the complete product formulation and associated information available for review to evaluate and approve the safety of the products for their proposed use. The Government shall treat this information as proprietary.

4.1.6. Notice of Qualification. Notice of Qualification shall be issued to the contractor upon the successful completion of qualification tests. A copy shall be retained in the qualifying activity file.

4.1.7. Notice of Failure to Qualify. The contractor shall be notified by letter of a failure to qualify if the submitted product does not meet the requirements of this specification.

4.1.8. Requalification. After qualification, the contractor shall notify the Government immediately in writing if any changes are made in the formulation of a product; where it is manufactured, packaged, or distributed; or any change to the submitted written security plan. The need for requalification shall be determined by the Government when there are changes to the product, production, distribution of the product, or to this specification.

4.2. Responsibility for Inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for performance of all inspection requirements as specified herein, except the odor requirement as specified in 3.4.6, prior to submission for U.S. Government acceptance inspection and tests. The contractor may utilize their own facilities or any commercial laboratory acceptable to the Government. All inspection and test records shall be kept complete and available to the Government.

4.2.1. Inspection and Test Sites. The Government may conduct lot acceptance inspection and tests to determine compliance with the specification. If lot acceptance and tests are conducted at locations other than the paint manufacturer's and/or contractor's facilities, the contracting officer will specify the location and arrangements. In the case of onsite inspections at the paint manufacturer's or contractor's facility, the paint manufacturer or contractor shall furnish the inspector all reasonable facilities for their work. During any inspection, the inspector may take from any lot one or more samples and submit them to an independent test laboratory approved by the Government or to a Government test facility for inspection and tests.

4.2.2. Testing With Referenced Documents. The contractor is responsible for ensuring that components and materials used were manufactured, inspected, and tested in accordance with referenced specifications and standards. The Government reserves the right to perform any of the inspections or tests set forth in this specification, where such action is deemed necessary to assure products, facilities, and security measures conform to prescribed requirements. The Government shall not be obligated to continue testing a nonconforming product once it is known to be nonconforming or when it is considered to be in the best interest of the Government.

4.3. Responsibility for Compliance. All products shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in this specification shall not relieve the contractor of the responsibility of ensuring that all products submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known nonconforming products, either indicated or actual, nor does it commit the Government to accept nonconforming material.

4.4. Sampling for Lot Acceptance Inspections and Tests. Sampling for lot acceptance testing shall be S-2 in accordance with ANSI/ASQ Z1.4.

4.4.1. Lot. All paint of the same type and color, presented together in one delivery, shall be considered a lot for the purposes of inspection. A sample shall be one container of paint.

4.5. Lot Inspection. When selected in accordance with 4.4 each sample item shall be inspected in accordance with table 3 to determine conformance with this specification. If the sample is found to have any major nonconformities, as identified in table 3, the lot shall not be accepted. Additionally, if the number of minor nonconformities (table 3) in the sample exceeds an AQL of 2.5 percent nonconforming, the lot shall not be accepted.

Table 3. Lot acceptance inspection and testing

<u>Nonconformance</u>	<u>Paragraph</u>	<u>Classification</u>	
		<u>Major</u>	<u>Minor</u>
1. Does not test positive for field tracer.	3.2.6	X	
2. Not ready for use.	3.4.1	X	
3. Does not meet mixing requirements.	3.4.1.1		X
4. Color not as specified on product label.	3.4.2	X	
5. Spraying properties not as specified.	3.4.3	X	
6. Container size not as specified on product label.	3.5.1	X	
7. Labeling not as specified.	3.5.1.4	X	
8. Missing material safety data sheet.	5.2		X

4.6. Certificate of Conformance. Where certificates of conformance are required, the Government reserves the right to determine the validity of the certification. These certificates shall be based on the testing of the paint and raw materials and may be performed by the paint manufacturer. The contractor shall provide certificates of conformance for 3.2.6, 3.3.2.1, 3.3.2.2, 3.3.2.3, 3.4.1, 3.4.2, 3.4.3, 3.4.4, 3.4.5, 3.4.7, 3.4.8, 3.4.9, 3.4.10, 3.4.11, 3.4.12, and 3.4.13.

4.6.1. Certification. The contractor shall provide the following information on certificates of conformance:

- a. Specification, standard, or test method.
- b. All characteristic test values.
- c. Date of test.
- c. Test company name, address, and telephone number.
- d. Responsible technician/manager name, title, and signature.

4.6.2. Test Results. The paint manufacturer and the contractor shall maintain complete records, including test results. At the request of the Government, the contractor shall provide test results and other records, as described in the certificates of conformance, for all materials used in the manufacture of an item.

4.7. Performance Testing. Samples shall be subjected to the following tests to determine if the samples meet the requirements of this specification. The contractor may sample for test prior to filling containers, but the U.S. Government shall sample the paint in accordance with ASTM D 3925. Unless otherwise specified, all tests shall be conducted at conditions specified in ASTM D 3924.

4.7.1. Field Tracer. As required by 3.2.6, TMP shall be tested for presence of field tracer. After mixing, apply TMP containing tracer to separate 6-inch by 6-inch by 0.5-inch Medium Density Overlay (MDO) plywood (PS 1-95) panels and allow to dry. Use the field test kit supplied by the contractor to verify the presence of tracer.

4.7.2. Condition in Container. As required by 3.4.1, TMP shall be tested for mixing requirements. TMP shall be mixed as specified in 3.4.1.1. Containers shall be shaken by hand for 1 minute \pm 1 second. TMP will be sprayed using a Nelson Nelspot D-103 spray gun immediately after mixing and again after 8 hours.

4.7.3. Color. As required by 3.4.2, TMP shall be tested for color matching. After mixing, the TMP shall be sprayed on a 6-inch by 6-inch by 0.5-inch MDO plywood (PS 1-95) panel to obtain complete hiding and allowed to dry for 48 hours. Yellow and orange shall be matched to the Highway Color Tolerance Chart in accordance with ASTM D 1729. Blue, pink, and green shall be matched to the specified color chip in accordance with ASTM D 2244. The reflectance at complete hiding (tristimulus value Y) shall be determined in accordance with ASTM D 2244 for white and black.

4.7.4. Spraying Properties. As required by 3.4.3, TMP shall be tested for spraying properties.

4.7.4.1. Type A and B. After mixing, condition the bulk TMP in a quart container along with a Nelson Nelspot D-103 spray gun (use a 0.029-inch nozzle) at -20 °F for 8 hours. Spray paint from a distance of 6 feet onto a 6-inch by 6-inch by 0.5-inch MDO plywood (PS 1-95) panel using two trigger pulls with a pause

of approximately one-half second between pulls. Heat the container and spray gun to 104 °F and repeat the test on a separate plywood panel. A spot 3 to 5 inches in diameter shall be produced at each temperature.

4.7.4.2. Type C. After mixing, condition the bulk TMP in a quart container along with a Nelson Nelspot D-103 spray gun (use 0.029-inch nozzle) at 20 °F for 8 hours. Spray paint from a distance of 6 feet onto a 6-inch by 6-inch by 0.5-inch MDO plywood (PS 1-95) panel using two trigger pulls with a pause of approximately one-half second between pulls. Heat the container and spray gun to 100 °F and repeat the test on a separate plywood panel. A spot 3 to 5 inches in diameter shall be produced at each temperature.

4.7.4.3. Type D. Weigh the full aerosol containers before performing the test. Condition an aerosol container at 20 °F for 4 hours and shake by hand for 1 minute. Container shall be sprayed until the paint sputters or the flow is interrupted. Invert container and dispel excess gas. The container shall be weighed to determine the weight of paint discharged. Return the container to room temperature. The can shall be opened and rinsed with solvent to remove the residual paint. Dry the can at 221 °F for 1 hour, cool and weigh to determine the weight of paint in the full container. Condition an aerosol container at 100 °F for 4 hours and hand shake for 1 minute. Repeat the above procedure. The percentage of paint discharged shall be determined.

4.7.4.3.1. Low Temperature. Condition the aerosol container with nozzle at 20 °F for 4 hours and shake by hand for 1 minute. Hold the container perpendicular to and 3.0 feet away from the vertical target. Depress the nozzle and hold open for 2 seconds. A spot no larger than 3 to 5 inches in diameter shall be produced on the target. Hold the container perpendicular and 1.0 foot or more away from the vertical target. Depress the nozzle and write a series of letters and numbers. Readable letters and numbers 8 inches or less in height shall be produced on the target.

4.7.4.3.2. High Temperature. Condition the aerosol container at 100 °F for 4 hours and shake by hand for 1 minute. Hold the container perpendicular to and 3.0 feet away from the vertical target. Depress the nozzle and hold open for 2 seconds. A spot no larger than 3 to 5 inches in diameter shall be produced on the target. Hold the container perpendicular and 1.0 foot or more away from the vertical target. Depress the nozzle and write a series of letters and numbers. Readable letters and numbers 8 inches or less in height shall be produced on the target.

4.7.5. Adhesion. As required by 3.4.4, TMP shall be tested for adhesion.

4.7.5.1. Adhesion to cold wood. Condition one piece of 6-inch by 6-inch by 0.5-inch MDO plywood (PS 1-95) and the already mixed TMP at -20 °F for 4 hours. Apply the TMP by spraying to a wet-film thickness of 4 mils. Observe for proper film formation and immediately return the panel to the cold box. Remove the panel after 7 days cold exposure and allow to equilibrate to room temperature for 48 hours. Check for adhesion by performing the dry-through test as specified in 7.7 of ASTM D 1640. Removal of any portion of the film shall constitute failure of the requirement.

4.7.5.2. Adhesion to wet wood. Immerse one piece of 6-inch by 6-inch by 0.5-inch MDO plywood (PS 1-95) in water for 4 hours at room temperature. Remove from water and drain for 15 minutes. Apply the mixed TMP by spraying to a wet film thickness of 4 mils. Allow to dry for 48 hours and check for adhesion by performing the dry-through test as specified in ASTM D 1640. Removal of any portions of the film shall constitute failure of the requirement.

4.7.6. Accelerated Weathering. As required by 3.4.5, TMP shall be tested for accelerated weathering.

4.7.6.1. Type A and B.

4.7.6.1.1. Panel Preparation. Apply mixed TMP by spraying to a wet-film thickness of 15 mils for full coverage on three 6-inch by 6-inch by 0.5-inch MDO plywood panels and air dry 7 days.

4.7.6.1.2. Exposure. Expose the panels to 700 hours accelerated weathering in accordance with ASTM G 155, Method A, with a cycle of 102 minutes of light followed by 18 minutes of light and water spray.

4.7.6.2. Type C and D.

4.7.6.2.1. Panel Preparation. Apply mixed TMP by spraying to a wet film thickness of 5 to 15 mils for full coverage on three 6-inch by 6-inch by 0.5-inch MDO plywood panels and air dry 7 days.

4.7.6.2.2. Exposure. Expose the panels to 700 hours accelerated weathering in accordance with ASTM D 4587. Use an exposure cycle of 4 hours fluorescent UV at 140 °F followed by 4 hours of condensation at 104 °F. Use UV-B 313 lamps.

4.7.6.3. Evaluation. Examine the exposed panels for checking, peeling, and color change. The color change shall be determined in accordance with ASTM D 2244 or ASTM D 1729, as applicable. Test TMP on plywood panels with the field test method and submit the exposed panels for laboratory analysis to determine the presence of the tracer.

4.7.7. Odor. As required by 3.4.6, TMP shall be tested for odor. The odor shall be acceptable as evaluated by members of the National TMP Committee present at the time of application at a field site. A consensus of the members present determines pass or fail.

4.7.8. Contrast Ratio. As required by 3.4.7, TMP shall be tested for contrast ratio. TMP shall be applied on a black and white Leneta Card 2DX or equivalent, to 12 mils wet-film thickness and allowed to dry 48 hours. The contrast ratio is the ratio of the reflectance of the paint on a black substrate, to that of an identical film on a white substrate. The reflectance Tristimulus Y may be measured using a spectrophotometer or colorimeter.

4.7.9. Sag Resistance. As required by 3.4.8, TMP shall be tested for sag resistance in accordance with FED-STD-141.

4.7.10. Dry Time. As required by 3.4.9, TMP shall be tested for dry time in accordance with ASTM D 1640 using 4 mils wet-film thickness on MDO plywood.

4.7.10.1. Wash-off. Type C and D TMP shall be tested at two temperatures and a relative humidity (RH) exceeding 90 percent. Test temperatures shall be 86 ± 3 °F and 36 ± 3 °F. Prior to preparation of test panels, the test chamber shall be brought to the operating temperature and RH specified for the test. TMP shall be applied to smooth MDO plywood (PS 1-95) panels 6 inches by 10 inches by 0.5 inches. Paint will be applied using a doctor blade to achieve a wet-film thickness of 6 mils. Panels shall be placed in the test chamber within 1 minute of being painted. All panels for a given test shall be prepared within 3 to 5 minutes. Test panels shall be maintained in the test chamber at the required temperature and RH (without simulated rain) for 30 minutes. The simulated rain shall be started and the test allowed to proceed for an additional 30 minutes. The color of the runoff water will be observed for changes during the 30 minutes of rain. Panels will be removed and checked for thinning of film, fading, and color changes.

4.7.11. Coarse Particles Test. As required by 3.4.10, TMP shall be tested for coarse particles

4.7.11.1. Type A and B. Take a 3-inch No. 325 USA Standard Test Sieve (0.020 inch) and dry in an oven at 221 °F for 1 hour. Cool the sieve to room temperature and then weigh the sieve to the nearest milligram to establish the tare weight. Add 25 ± 1 g of paint into a 5 ounce glass beaker. Add 3.4 ounces of tap water to the paint and mix with a glass stirring rod. Pour mixture through the sieve. Rinse the stirring rod and beaker with tap water, making sure that all of the paint goes through the sieve. Carefully rinse the sieve to ensure that all pigment is removed and all that remains on the sieve screen are the solid coarse particles. Then dry the sieve in an oven at 221 °F for 1 hour. Cool to room temperature and reweigh to the nearest milligram. The following formula will establish the percentage of coarse particles retained on the sieve screen:

$$\left[\frac{\text{Sieve with Grits Wt (g)} - \text{Sieve Tare Wt (g)}}{\text{Paint Wt (g)}} \right] \times 100 = \text{Grits Percent}$$

4.7.11.2. Type C. Take a 3-inch No. 325 USA Standard Test Sieve (0.020 inch) and dry in an oven at 221 °F for 1 hour. Cool the sieve to room temperature and then weigh the sieve to the nearest milligram to establish the tare weight. Add 25 ± 1 g of paint into a 5 ounce glass beaker. Add 3.4 ounces of citrus solvent to the paint and mix with a glass stirring rod. Pour mixture through the sieve. Rinse the stirring rod and beaker with citrus solvent, making sure that all of the paint goes through the sieve. Carefully rinse the sieve to ensure that all pigment is removed and all that remains on the sieve screen are the solid coarse particles. Then dry the sieve in an oven at 221 °F for 1 hour. Cool to room temperature and reweigh to the nearest milligram. The following formula will establish the percentage of coarse particles retained on the sieve screen:

$$\left[\frac{\text{Sieve with Grits Wt (g)} - \text{Sieve Tare Wt (g)}}{\text{Paint Wt (g)}} \right] \times 100 = \text{Grits Percent}$$

4.7.12. Total Solids. As required by 3.4.11, TMP shall be tested for total solids in accordance with ASTM D 2697. Alternatively total solids can be calculated from batch card data but in case of dispute the method specified must be used.

4.7.13. Freeze/Thaw Cycles. As required by 3.4.12, TMP shall be conditioned and tested in accordance with ASTM D 2243.

4.7.14. Viscosity. As required by 3.4.13, TMP shall be tested in accordance with ASTM D 2196 using a test speed of 100 rpm.

5. PREPARATION FOR DELIVERY.

5.1. Packaging, Packing, and Marking. TMP in quart containers shall be packed 12 containers per carton. TMP in gallon containers shall be packaged 4 containers per carton. Additional requirements regarding packaging, packing, and marking shall be as specified on the contract or order. Each carton shall include the contractor's address and a toll free telephone number for contact in case of lost or damaged shipments.

5.2. Safety Data Sheet. A safety data sheet shall be submitted in accordance with FED-STD-

29CFR1910.1200.

6. NOTES.

6.1. Intended Use. This description describes weather-resistant paints for marking and identifying trees. The paint is suitable for application through a temperature range of -20 °F through 104 °F for Type A and B TMP and temperature range of 20 °F through 100 °F, for Type C and D TMP. Type A and B TMP is waterborne and capable of water cleanup. Type C and D TMP is rain resistant.

6.2. Acquisition Data. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.

(b) Color(s) and container sizes required.

(c) Packaging, packing, and marking (see 5.1).

6.3. Tracer Registration. Tracers are required to be registered for the exclusive use of the U.S. Government. See 3.2.3.

6.4. Qualification. The contracting officer should verify that the bidder possesses a currently valid notice of qualification with associated Qualified Products List (QPL) number obtained in accordance with 4.1. This QPL shall have already been obtained with a date of issue prior to the closing date of the invitation for bids.

6.5. Preparing Activity. USDA Forest Service, San Dimas Technology and Development Center, 444 East Bonita Avenue, San Dimas, CA 91773-3198.