



Paint Specifications

Document: SF-ENG-SPEC - 001

Revision: A

Date: 08/02/2021

Owner Approval	Approval Date
Jeff Stabell	08/02/2021

1.0 PURPOSE

- 1.1 This document is to quantify and standardize the communication of paint system performance requirements and the means to determine conformance. Many of the conformance/validation tests rely on the appropriate ASTM standard to guide the testing.

2.0 DEFINITIONS:

- 2.1 Category Detail: A specific chosen category in a performance requirement i.e. performance requirement = UV Resistance and category detail = High.

- 2.2 Delta E: The difference between two L.A.B color readings

ΔL^* (L^* sample minus L^* standard) = difference in lightness and darkness (+ = lighter, - = darker)

Δa^* (a^* sample minus a^* standard) = difference in red and green (+ = redder, - = greener)

Δb^* (b^* sample minus b^* standard) = difference in yellow and blue (+ = yellower, - = bluer)

$$\Delta E_{ab}^* = \sqrt{(L_2^* - L_1^*)^2 + (a_2^* - a_1^*)^2 + (b_2^* - b_1^*)^2}$$

- 2.3 Normal Sightline: Roughly considered to be above the knees and below the head of an average height person (~5'9" tall).
- 2.4 Paint Performance: The appearance and protective capabilities of a paint system.
- 2.5 Paint Performance Requirements: The requirements that ensure the painted part will meet the Safe Fleet required paint performance for the required amount of time. The communication of these requirements is detailed in this document.
- 2.6 Paint System: This system contains the paint itself as well as the means and method of applying the paint to the part substrate. The paint system is required to *successfully meet* all of the Safe Fleet identified paint performance requirements. Each particular paint system will have its own requirements but these may vary between suppliers of the paint and the different substrates and parts that are painted.
- 2.7 Paint System Requirements: The paint system application and pretreatment requirements *dictated by the paint system supplier*. These can include specifics such as cure time/temperature, drying time/temperature, line speed, needed pretreatments, priming, surface conditioning, cleaning solutions, paint thickness, and other requirements needed to ensure paint performance.
- 2.8 Performance Requirement: A specification category. i.e. UV Resistance, Gloss, Texture, or Impact Resistance.
- 2.9 Safe Fleet: This includes Safe Fleet as a whole and any of its divisions known by other names (FRC, SMI, ROM, Prime Design, Randall, Roll Rite, American Van, etc...)
- 2.10 Substrate: The base material that is to be painted before any pretreatment or primer.

3.0 **RESPONSIBILITIES:**

- 3.1 The Paint System supplier is responsible for meeting the required paint performance specifications as outlined in this document. They must also communicate any application/paint system requirements needed to satisfy the required paint performance as outlined under section 2.1/2.2.
- 3.2 Safe Fleet Quality is responsible for determining conformance to the required paint performance specifications.
- 3.3 Safe Fleet Engineering is responsible for specifying the required paint performance in accordance with this document. They must also update and maintain the individual Safe Fleet Plant color reference chart detailed in section 6.1 and designate all surface classes on the part drawing as needed. All new painted part drawings after September 2021 will comply, and where possible any older drawings that are being revised should also have this information captured on the drawing.
- 3.4 Safe Fleet Program/Project/Sales departments are responsible for determining colors and/or finding and communicating the customer paint color and system performance requirements to Safe Fleet Engineering.
- 3.5 It is the ultimate responsibility of the Plant Manager to see that this procedure is understood and followed.
- 3.6 It is the responsibility of all affected Safe Fleet Employees to understand and know how to use the standards outlined in this work instruction.

4.0 **GENERAL APPLICATION**

- 4.1 This is for all paint systems used in the painting of parts in all of Safe Fleet's products.
- 4.2 Suppliers of products covered in this specification shall not deviate from the paint performance requirements outlined, unless prior written approval is provided by Safe Fleet through the Supplier ECN process or Supplier Deviation process as defined in the Safe Fleet Supplier Quality Manual. Safe Fleet may request evidence of compliance at any time.
- 4.3 This specification is not intended to limit the paint system, but for parts that are painted by Safe Fleet, awareness needs to be maintained of individual plant process limitations. These limitations may restrict the kinds of pretreatment, washing, cure timing/temperature, and other paint system needs.

5.0 **TECHNICAL GUIDELINES**

- 5.1 **Basic Requirements:** Unless otherwise specified by Safe Fleet, painted parts and paint systems used in Safe Fleet products shall meet the paint performance specifications stated.
- 5.2 **Hazardous Requirements:** Coatings cannot contain or be manufactured with any heavy metals (i.e. Cadmium, Mercury, Lead), Hexavalent Chrome or any other material that in itself or as a result of the manufacturing process is considered hazardous or creates a byproduct that is considered hazardous.
- 5.3 **Determining Basic Requirements:** Requirements are chosen by the Safe Fleet engineering group from each requirement's detailed categories using specific part application knowledge. Every effort should be made to use the categories as detailed in this standard, but Customer

specified paint performance might supersede any specific detail category. There may be parts that are not required to meet a particular performance requirement and will be noted as N/A for that particular requirement.

- 5.4 Paint Performance Requirements: Each performance requirement below is detailed below with several categories.

5.4.1 UV Resistance:

Table 1 UV Resistance Standards

UV Resistance	Warranty	Use	Test Time	Measurement for Conformance
Standard	18 Months	Internal/Light Duty	500 Hours	<=3 Delta E
High	36 Month	External/Heavy Duty	1000 Hours	<=3 Delta E

5.4.1.1 Validation based on ASTM D45878.

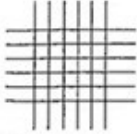
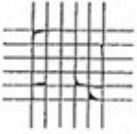
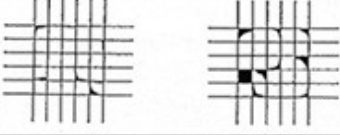
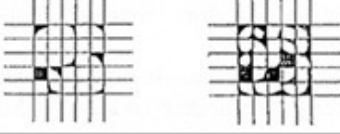
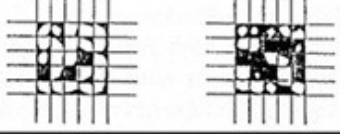
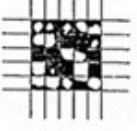
- 5.4.1.1.1 Validation to be conducted on a minimum of four paint coupons made of the same substrate material and painted with the same specified paint system.
- 5.4.1.1.2 Paint coupons to be roughly 3"x6" in dimensions
- 5.4.1.1.3 Delta E to be judged using a L.A.B. Delta E comparison between ½ of the coupons being unexposed to UV and ½ of the coupons going through the UV testing cycle. The two results are averaged for review.

5.4.2 Adhesion

- 5.4.2.1 Validation of Paint Adhesion to be judged for conformance using the ASTM D 3359 Test Method B – Cross Hatch

- 5.4.2.2 All Painted parts must be =>4B

Table 2 Crosscut Reference Chart

Classification	% of Area Removed	Surface of Cross-cut Area From Which Flaking has Occured for 6 Parrallel Cuts & Adhesion range by %
5B	0% None	
4B	Less than 5%	
3B	5 - 15%	
2B	15 - 35%	
1B	35 - 65%	
0B	Greater than 65%	

5.4.3 Impact Resistance

Table 3 Impact Resistance

Impact Resistance	Impact Force		Conformance Criteria
Low	Up to 50 lb-in	Up to 57 kg-cm	No Cracking Observed
Standard	50-140 lb-in	57 – 161 kg-cm	No Cracking Observed
High	>140 lb-in	>161 kg-cm	No Cracking Observed

5.4.3.1 Validation of impact resistance is to be performed per ASTM D2794

5.4.4 Flexibility

5.4.4.1 Validation to be performed per ASTM D522-D522M Mandrel Bend test

5.4.4.1.1 Conformance to be judged based on the test being performed and the sample shows no cracking or tearing.

5.4.5 Paint Curing/MEK Test: Test for under cured powder coating.

5.4.5.1 Equipment required:

- Reagent B (a solution mix of 10% MEK and 90% Xylene by volume). Store solution in a MEK squeeze bottle (make sure it is properly labelled).
- 2 lb. ball peen hammer.
- Soft cloth or folded into a 3" x 3" pad, 1/2" thick.
- Fastening device to attach pad to ball end of hammer.
- Painted test samples.

5.4.5.2 MEK Process

5.4.5.2.1 Fold the cloth into a 3" x 3" approximately 1/2" thick. (Approximately 4 - 6 layers of folded cloth.)

5.4.5.2.2 Attach the 3" x 3" cloth to the ball end of the ball peen hammer using an O-ring or wire to secure it. - this cloth should be changed with each test, as paint build-up will affect the test

5.4.5.2.3 Saturate the pad in Reagent B. Caution: Reagent B is flammable - use with adequate ventilation.

5.4.5.2.4 Select a test area that is flat and free of blemishes.

5.4.5.2.5 Holding the handle of the hammer parallel to the test piece, stroke/slide the saturated pad approximately 1 1/2" on the test piece using only the weight of the hammer as pressure. Look for obvious signs of fatigue. Do 100 double rubs (i.e.: forward and back equals 1 rub). Warning: Do not rub too hard or too quickly as this will result in an inaccurate rub.

5.4.5.3 Rate as follows:

- Dissolve to metal: No cure. (NC)
- Some film removal and softening: Partial cure. (PC)
- Gloss reduction only with no or minimal effect on the paint: Cure. (C) (As per known cure sample)

5.4.5.4 A rating of anything less than "Cure" is an indication of under-cured powder coat and as such is a non-conformance and the appropriate corrective action needs to be taken. All parts must "Cure" before being

released into production.

5.4.6 Corrosion Resistance

Table 4 Corrosion Resistance

Corrosion Resistance	Hours of Salt Spray Testing	Use	Conformance Criteria
Light Duty	100 Hours	Internal	<= 1/8" Creep
Standard Duty	500 Hours	External	<= 1/8" Creep
Heavy Duty	1000 Hours	Salt Belt/Coastal	<= 1/8" Creep
Extreme Duty	>2000 Hours	Marine	<= 1/8" Creep

5.4.6.1 Validation testing to be performed according to ASTM B117 using a minimum of two samples.

5.4.6.2 Use the actual part substrate material in a 3"x 6" coupon with one 1/4" hanging hole and coat according to the paint system being evaluated.

5.4.6.3 No scoring of paint is to be used

5.4.6.4 At the end of the salt spray testing, corrosion creep from hanging hole must be less than 1/8" to conform.

5.4.7 Rework Criticality

5.4.7.1 The part must be identified as either being rework critical (Yes) or not (No).

5.4.7.2 A non-critical part will be able to tolerate up to 200% of the nominal paint system thickness without out negatively affecting part function or fitment.

5.4.7.3 A Rework Critical part will not tolerate paint thickness being 200% of nominal. Fitment and as a result function maybe negatively affected.

5.4.8 Color

5.4.8.1 Paint color will be identified by name, L.A.B., Pantone, and RAL

5.4.8.1.1 L.A.B to be identified by a colorimeter/spectrophotometer on an approved sample paint coupon.

5.4.8.1.2 Pantone and RAL can be found by using an online web based conversion tool to convert from the L.A.B. reading. (Example: <https://www.e-paint.co.uk/convert-lab.asp>)

5.4.9 Color Conformance

Table 5 Color Conformance

Conformance Level	Delta E Allowed
Relaxed	≤ 3
Close	≤ 2
Exact	≤ 1

5.4.9.1 Color Conformance will be judged based on the above chart using the previously identified color L.A.B. and new L.A.B. readings from the suspected part.

5.4.9.1.1 The Delta E will be calculated using the formula in Section 2.2.

5.4.10 Texture

5.4.10.1 Paint texture must be identified

5.4.10.1.1 The part will either have an *intended* texture (Yes) or not (No).

5.4.10.1.2 Conformance will be based on comparing the suspected finish vs. the approved sample coupon from the paint system supplier with the correct color and texture applied.

5.4.10.1.3 Texture sample coupons to be inventoried and maintained by the plant personnel responsible for determining conformance. Care should be taken to prevent damage, fading from UV, and oxidation of the approved sample coupons.

5.4.10.1.4 Viewing practices will be the same as those required for cosmetic acceptance (Figure 1).

5.4.11 Gloss Level

Table 6 Gloss Level

Gloss Level	Angle of Incidence	Gloss Meter Reading
Low	85	3-40
Medium	60	50-90
High	20	90-100


5.4.11.1 Conformance to be performed using a gloss meter and comparing the readings to the chart above.

6.0 Documentation of Requirements

6.1 Color Reference Chart

- 6.1.1 The color reference chart is created and maintained by engineering at each Safe Fleet location. (See form Safe Fleet Corporate Color Chart SF-ENG-SPEC-002.xlsx)
- 6.1.2 Suppliers must contact the local Safe Fleet Plant for latest released Color Chart for that plant location. Each plant location will have a different Color Chart.
- 6.1.3 The color reference chart will have the Color Name, LAB/CEILAB numbers, RAL, Pantone, Gloss, Texture, and approved supplier's names with paint system part number.

Table 7 Safe Fleet Color Reference Chart Example

SAFE  FLEET		Plant: FRC							
		Rev: A							
		Date of Rev: 7/23/2021							
Safe Fleet Color Reference Chart									
Color #	Color Name	LAB/CIELAB			RAL	Pantone	Gloss	Texture	Approved Suppliers & Ref Number
		L	A	B					
1	Ultramarine Blue	24.179	11.008	-42.748	5002	208	High	No	AksoNobel JJ008QF, PPG 1234
2									
3									
4									

- 6.1.4 The Spec Matrix tab within the color reference chart file will be used to create the Required Paint System table (Table 8).
- 6.1.4.1 This will document the Color Name (can be more than one), Impact Resistance, Color Delta E Allowance, Default Surface Classification, UV Resistance, Corrosion Resistance, and Rework Critical designation.
- NOTE:** *Some of the requirements can/must be labeled "N/A" should the plant engineering team decide that conformance to that specification is not needed in that particular application.*
- 6.1.4.2 Once the Required Paint System Specification table (Table 8) is filled out, it will be copied into the appropriate note section of the part drawing. Part drawing revision control will control any release or modification of this information

Table 8 Required Paint System Specification Record Example

Required Paint System Specifications			
Color Name	Ultramarine Blue	Impact Resistance	Standard
Color Delta E Allowance	Close	Default Surface Classification	B
UV Resistance	High	Corrosion Resistance	Standard Duty
	Rework Critical	No/200% ok	

7.0 Recommended Tool list

7.1 The following tools are recommended for implementing this specification.

Related Specification	Tool Type	Tool Name	Approximate cost as of July 2021	Implementation
Color/Color Conformance	Color Photospectrometer	Color Muse	\$59.99/Amazon	All Plants
Gloss	Gloss Meter	Glossmeter	\$138 - \$184/Amazon	All Plants
Adhesion	Cross Hatch Tester	Adhesion tester	\$45/Amazon	All Plants
Flexibility	Mandrel Bend Tester	ZQ-II Bending Tester	\$230/Amazon	All Plants
UV Resistance	UV Cabinet	N/A	N/A	SMI/External Lab
Corrosion Resistance	Salt Spray Chamber	N/A	N/A	SMI/External Lab
Impact Resistance	Impact Tester	Heavy Duty Impact Tester IM-IG-1120	\$2196/Gardco.com	TBD/External Lab

8.0 Cosmetic Acceptance Criteria for Painted Parts

8.1 **General Inspection Requirements:**

8.1.1 Cosmetic inspection for painted parts from Safe Fleet or its suppliers shall use the following time, distance and angle method to inspect as described in different sections of this document.

8.1.2 The cosmetic standards defined in this Workmanship Standard shall be used for

training personal, checking surface quality produced by any process and used in making "Accept/Reject" decisions.

8.2 Viewing Conditions:

- 8.2.1 All Inspections will be made under normal artificial lighting as typically found in an office-working environment. During cosmetic inspection, only visual (appearance) of the part surface shall be considered.
- 8.2.2 Light source shall be typical of office lighting and intensity; the light shall be positioned generally overhead and distanced to provide optimal viewing and minimize glare and shadowing of the sample.
- 8.2.3 Viewing distance shall be 36".
- 8.2.4 Viewing angle shall be approx. 45° to the inspected surface and manipulation of the part during surface inspection should be avoided.

8.3 The following are Inspection criteria:

- 8.3.1 Inspection shall be conducted using the unaided eye and limited to the amount of inspection time specified for each class of surface being inspected.
- 8.3.2 Where subjectiveness intervenes in the assessment, form/fit/function shall take precedent. If uncertainty is still present, a quality team member or other management team members should be consulted.

8.4 General Guidelines: (surface classifications)

- 8.4.1 Surface classes are identified on the production released part print. Some older prints may not have been updated yet to contain this information. If this is the case contact a designated Engineering team member for definition prior to inspection.
- 8.4.2 The Surface Class identified is a "Default" class for the part. Default is considered the majority of part surfaces.

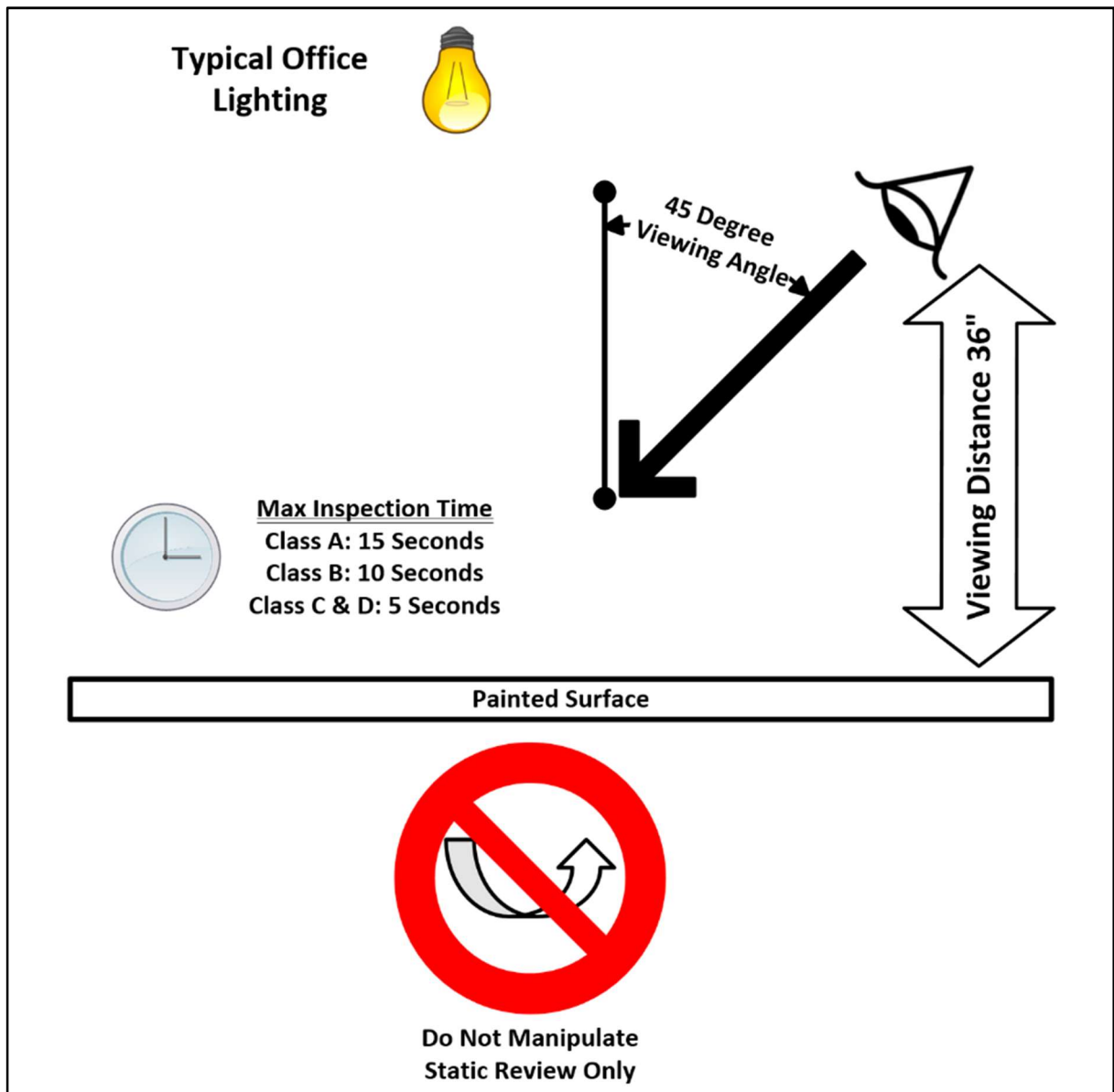
NOTE: For all parts, some judgement will need to be used in interpreting what surfaces carry what Surface Classes. i.e. The inside of a small hole or internal facing and non-customer facing mounting surface may relax to a "D" surface class, while threaded portions of the part (whether internal or external) may not be coated at all.

- 8.4.3 Drawings may include exceptions with a higher Class than the default Surface Class. These shall be designated with a text box that include the words "Surface Class X" (with X being the exception surface class) and arrows pointing to the affected surfaces.

Table 9 Surface Class Definitions

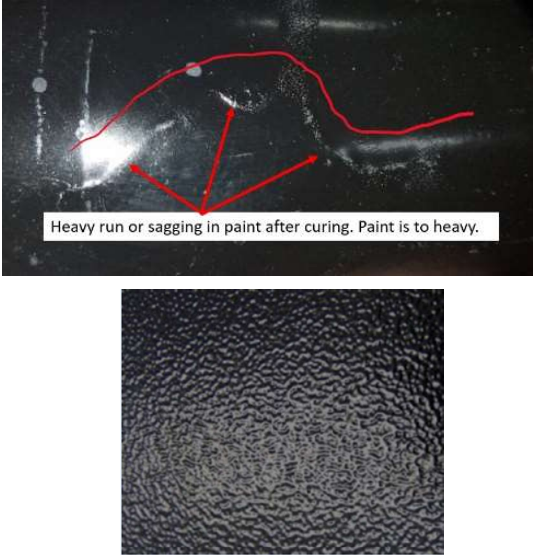
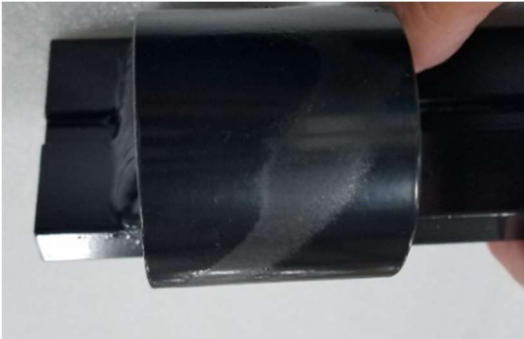
Classes		Typical Description	Inspection Time
A	Very High Visibility	Highly decorative surface in constant view and in the normal sightline of the customer.	15 Seconds
B	High Visibility	Moderately decorative surface in occasional view or outside the normal sightline of the customer. Surface must be visible without the unit being removed or disassembled. May also apply to parts that are packaged and seen up close by the customer only upon installation.	10 Seconds
C	Moderate Visibility	Non-decorative surface not readily visible to the customer. The underside of parts, recessed areas, or areas visible only when a unit is briefly opened as part of its normal function.	5 Seconds
D	Low Visibility	Any area of a painted surface that is normally covered by another part and not visible unless disassembled. Could also be the backside of a part not normally seen by the customer – Must be coated effectively to prevent corrosion and in a way that does not impede part assembly or functionality.	5 Seconds



Figure 1 Viewing Conditions

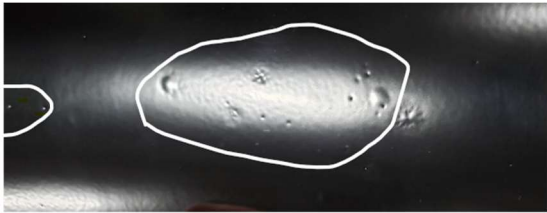








8.5 **Defects Definition:** The following table will set the standard for acceptance and non-acceptance criteria.

Table 10 Defect Definitions

Defect Code/Name	Sample	Description	Acceptance limits
C01-Heavy Paint\Runs		Paint that appears to be running/wavy or have a non-intended orange peel look	Class A/B Not allowed.
			Class C – ¼" in diameter, 6" apart no more than 3 per part
C02-Light Paint		Substrate (part base material) shows through	Class A/B Not allowed
			Class C - ½" in diameter, 6" apart, no more than 4 per part – as long as corrosion protection is maintained
			Class D – allowed - corrosion protection is maintained

C03-Chipped Paint		Paint missing	Class A – none allowed
			Class B ¼" allowed 6" apart limit 3 per part
			Class C – same as B
			Class D - allowed - corrosion protection is maintained
C04-Scratches		Hair lines that are felt with the fingernail	Class A -none allowed
			Class B Hair line no longer than ½" 6" apart no more than 3 allowed.
			Class C - Hairline no longer than 1" 6" apart no more than 5 allowed.
			Class D- Allowed, but no substrate showing - corrosion protection is maintained

C05-Out Gassing\Bubbles	 	Also called graters, or looking like blisters/fish eyes	Class A – none allowed
			Class B 6 allowed in a 2" diameter. Defects no more than 1/16" diameter. No large clusters.
			Class C-Surface: 4 allowed in a 1" diameter circle. Defects no more than 1/8". No large clusters.
			Class D – Allowed. No substrate showing - corrosion protection is maintained
C06-Scuffed/Marred	 	Paint is marred or has unintended texture – (non-scratch)	A Surface: None allowed
			B-Surface no longer than ½' long, 10" apart, no more than 3 per part.
			Class C - : no longer than 3/4" long, 10" apart, no more than 3 per part.
			Class D - No substrate showing - corrosion protection is maintained

C07-Contamination		Dirt or other substance in the coating	Class A– None allowed
			Class B – no larger than ¼” in diameter, 6” apart no more than 3 per part
			Class C – no larger than 3/8” in diameter, 6” apart no more than 3 per part
			Class D – Some – as long as it does not impede part function
C08-Voids		No/missing paint	Not allowed – All classes
C09-Adhesion/Peeling		Paint falling/peeling off part	Not allowed – All classes
C10-Wrong Coating	Wrong color of type of paint used or the result is off color more than the specified paint delta E detailed on the part print.	Wrong color/type of powder used	Not allowed – All classes

9.0 Quality

- 9.1 General: All product supplied shall be clean and free from dirt, oils, or defects harmful to product performance. Color and texture shall be uniform and consistent with the samples, which were originally approved.
- 9.2 Qualification: Engineering qualification of painting sources is required in advance of

production shipments. Suppliers shall submit PPAP/First Article/samples and documentation for approval of finish, color and appearance, and performance as appropriate. Samples shall be accompanied by test data certifying that all requirements of the specification have been met.

- 9.3 Control Plan: A Quality Control Plan for products supplied to the requirements of this specification will be established by mutual agreement between Safe Fleet and the supplier.

10.0 Supply Requirements

- 10.1 Components: Parts supplied against contracts or purchase orders citing this specification shall be equivalent in all respects to those samples, which were approved by the purchaser. No changes in formulation or processing practices are permitted without approval. In the event that changes in material, properties, processing practices, construction, color, or labeling of the product are required, the supplier shall notify Safe Fleet as indicated in Section 3.2. Test data indicating conformance to all requirements of this specification, test samples, and new, amended, or updated Material Safety Data Sheet(s) (MSDS), in accordance with CFR Title 29, Part 1910 shall be submitted with the request for change.
- 10.2 Shipping and Packaging: Shipping, packing, and identification shall be in accordance with Safe Fleet requirements. Parts shall be packaged to avoid any damage in shipment detrimental to the appearance of the part.

11.0 REFERENCES

- | | | |
|------|-------------------------|--|
| 11.1 | W-PR-30 | SMI Supplier Quality Manual |
| 11.2 | ASTM D523 | Standard Test Method for Specular Gloss |
| 11.3 | ASTM B117 | Standard Practice for Operating Salt Spray (Fog) Apparatus |
| 11.4 | SAE J2334 | Laboratory Cyclic Corrosion Test |
| 11.5 | ASTM D1735 | Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus |
| 11.6 | ASTM D3359 | Standard Test Methods for Measuring Adhesion by Tape Test |
| 11.7 | ASTM D1729 | Standard Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials |
| 11.8 | ASTM D552 | Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings |
| 11.9 | CFR Title 29, Part 1910 | Occupational Safety and Health Standards |

REVISION

REV LEVEL	REV DATE	DETAILS		DESCRIPTION OF CHANGE
		Page	Para.	
A	8/2021			Initial release of specification

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