



FEDERATION INTERNATIONALE DE L'AUTOMOBILE

FIA Standard 3503-2018

Paints for Motor Racing Circuits

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FOREWORD

One of the main objectives within the FIA Safety Department is to increase safety on circuits by implementing new standard requirements for the equipment being used on them.

The aim of this standard is to provide design and performance requirements that will enable objective evaluation of the safety performance of paints intended for use in motor racing circuits.

This standard addresses only water-based paints, as they limit the emission of volatile organic compounds (VOC) and are therefore considered better for the environment and health.

In addition, water-based paints are much easier to clean up, because the solvent is mainly composed of water. For the purpose of this standard, water-based paint will be referred to as "paint".

1. GENERAL

1.1. HOMOLOGATION PROCEDURE

Any manufacturer applying for homologation agrees to have understood this standard and the FIA Homologation Regulations for Circuit Equipment (file available on the FIA website). The homologation application dossier shall be submitted to the ASN of the country of the manufacturer, which shall apply to the FIA for the homologation. The homologation application dossier shall consist of:

- a) Homologation application Template (file provided by the FIA upon request)
- b) Material Safety datasheet (MSDS), including VOC declaration
- c) Technical datasheet (TDS)
- d) Specifications of all raw materials and detailed information about the quality control procedures and testing required at each stage of the production process, to ensure that the stated values of the characteristics are maintained
- e) Manufacturer's guidelines and additional technical information, as specified in Appendix A of this standard
- f) A sample of the FIA Labelling
- g) A sample of the paint to be homologated
- h) The test report, which includes at least the information listed in Appendix B of this standard

The FIA reserves the right to decline the homologation request if the application procedure is considered not to be satisfactory. The performance of the paints shall be tested by a test house approved by the FIA.

The technical list of approved test houses is available on the FIA website (www.fia.com).

The FIA will also publish the technical list of all newly homologated paints on the FIA website (www.fia.com).

The FIA or any other FIA appointed body reserves the right to request post-homologation control tests in accordance with the FIA Homologation Regulations for Circuit Equipment.

The FIA also reserves the right to decline the homologation request should the application prove to be incomplete in accordance with the FIA Homologation Regulations for Circuit Equipment.

1.2. MANUFACTURER'S UNDERTAKING FOR THE STABILITY OF ITS PRODUCT

When applying for the homologation, the manufacturer undertakes not to modify the raw materials, characteristics and production processes of the final product. Extensions may be authorised at the discretion of the FIA in accordance with the FIA Homologation Regulations for Circuit Equipment.

1.3. NORMATIVE REFERENCES

This standard makes references to several international standards. It shall always be considered the latest publication of each reference:

- EN ISO 3504-3, *Paints and varnishes – Determination of hiding power*
- 1436:2018, *Road marking materials for road users*
- EN 13036-4:2011, *Road and airfield surface characteristics*
- EN 1062-1: 2005, *Paint and varnishes – Coating materials and coating systems for exterior masonry and concrete*
- ASTM D7 11, *No pick up time for road markings*

2. SCOPE

This standard aims to evaluate the safety performance of paints intended for use in motor racing circuits. It defines appropriate test methods for measuring the performance in terms of rate of consumption, drying time, luminance coefficient, chromaticity coordinates and skid-resistance in wet conditions.

Paints homologated in accordance with this standard are intended to be used for the white edge lines, as well as any other marking on the track, kerbs and asphalt run-off areas.

3. DEFINITIONS

3.1. PAINT

A system in liquid form, composed of binders, pigments, fillers and additives dispersed in water in the correct proportions. When applied onto a substrate, it dries to form a solid, smooth and continuous finished thin film of paint.

3.2. PAINT BATCH

Quantity of material (in litres) of paint, which shall be demonstrated by the manufacturer to have a uniform composition.

3.3. ASPHALT SUBSTRATE

Fluid mixture composed of bitumen (binder), stone aggregates, fillers and additives, over which the paint will be applied for testing purposes.

3.4. LUMINANCE FACTOR β

The ratio of the luminance of a film of the paint in a given direction to that of a perfect reflecting diffuser identically illuminated.

3.5. HIDING POWER

The ability of the paint to obscure the substrate over which it is applied.

3.6. SHELF LIFE

The usable storage time of the paint material, between date of manufacture and the time at which the paint does not satisfy the product and performance requirements any longer.

3.7. VOC

Any organic compound of the paint having an initial boiling point less than or equal to 250°C, measured at a standard pressure of 101,3 kPa, as indicated in the MSDS.

4. PRODUCT REQUIREMENTS

The paint shall meet all the product requirements specified below. Any alteration of these requirements constitutes a change of product (extension), for which an FIA authorisation is required in accordance with the FIA Homologation Regulations for Circuit Equipment.

The FIA reserves the right to refuse the homologation if the FIA Safety Department and the FIA Circuits Commission deem the product requirements unacceptable.

4.1. HIDING POWER

The paint shall have the necessary composition in order to be able to obscure the contrast substrate over which it is applied and dried. The measured hiding power will depend on the paint application method, as defined by the manufacturers within the application guidelines. The hiding power of the paint shall be listed in the Technical Data Sheet (TDS) and be $\geq 95\%$.

The FIA reserves the right to perform a test in accordance with the standard EN ISO 6504-3 to measure the hiding power of the paint and verify that it conforms to the given value.

4.2. LUMINANCE FACTOR β

The luminance factor for paints shall be ≥ 0.75 . The FIA reserves the right to perform a test in accordance with the standard EN 1436:2018 - Appendix A in three different measurement points, to measure the luminance factor of the paint and verify that it conforms to the given value.

4.3. BLEED RESISTANCE $\Delta\beta$

The paint must be formulated to inhibit the penetration of the colour from the underlying substrate through the layer of paint.

The difference in luminance factor $\Delta\beta$ (luminance factor of the paint on a transparent tape and that of the paint on the substrate) shall be $\Delta\beta \leq 0.03$.

The FIA reserves the right to perform a test in accordance with the standard EN 1871 –Appendix D, to examine the paint for discolouration, when applied over an asphalt substrate and verify that it conforms to the given value.

4.4. UV AGEING

The paint must be formulated such that it provides resistance to degradation by ultraviolet light. The difference of the original luminance factor and the luminance factor after test shall be $\Delta\beta \leq 0,05$.

The FIA reserves the right to perform a test in accordance with the standard EN 1871, to examine the film of paint for discolouration, when submitted to cycles of UV radiation and condensation.

5. PERFORMANCE ASSESSMENT

The performance assessment stated below are mandatory:

- a) Rate of consumption → Article 5.3
- b) Drying time → Article 5.4
- c) Luminance coefficient under diffuse illumination → Article 5.5
- d) Colour chromaticity → Article 5.6
- e) Skid resistance → Article 5.7

If deemed necessary by the FIA, paints may be subjected to additional tests.

If the paint is applied with an air-pressurised machine, tests a) to e) apply. In all other methods of application of the paint, tests a), c), d) and e) apply.

5.1. TEST PARAMETERS

The test parameters shall be in accordance with below Articles 5.1.1 and 5.1.2.

5.1.1. Test site

The test site must be selected by a test house that has been approved by the FIA and shall consist of a straight and flat field both in longitudinal and transversal directions, without substantial obstacles to daylight. The test site shall have dimensions as specified in the Appendix C of this standard.

The substrate that characterizes the test site should be an asphalt surface, which is in good condition and homogeneous in texture, with no major defects, such as cracks or similar. Highly porous surfaces shall be avoided.

Prior to commencing the performance assessment of the test paint, the skid resistance test values of the asphalt surface must be measured for each location that will be used for the performance assessment of the test paint. These measurements shall be carried out by the test house in accordance with Article 5.7 of this standard, within 24 hours prior to the performance assessment of the test paint.

5.1.2. Test paint

The test paint shall meet the complete design requirements as specified in Article 4 of this standard.

The test paint must be prepared and applied in accordance with the manufacturer's application guidelines and in patterns of lines as specified in Appendix D of this standard.

The applied test paint must produce a uniform smooth film without objectionable side splatters or similar.

Following the completion of the paint application, sampling of the test paint shall be done in such a way that the resulting sample is homogeneous and representative of the batch of paint to be tested. Sample shall be clearly labelled to uniquely identify the location and time of sampling. The sample size shall be at least equal to 1 litre of paint. Sampling must be done by the test house.

5.2. TEST INSTRUMENTATION

All weighting, measuring and testing equipment used to test the performance of the paint shall be calibrated and regularly inspected according to documented procedures and criteria, as specified in the relevant standards that have been approved by the FIA.

5.3. RATE OF CONSUMPTION

The method described below is to investigate the rate of consumption (areal density of the paint at a given speed) during application of the paint, when it is applied in accordance with the manufacturer's application guidelines.

5.3.1. Test apparatus

- a) Analytical balance (resolution 0.01 g and accuracy 0.1 g)
- b) 2x glass plates of predetermined mass and dimensions, should be laid in continuation of the lines of paints that will be applied. The first glass plate should be placed at the beginning of the lines and the second near the end, as specified in Appendix D of this standard.

5.3.2. Test procedure

During the application, note the average speed, s (in m/s) at which each of the lines of paint have been applied.

Determine the weight, m (in grams) of the paint applied to the glass plates, by subtracting the predetermined mass of the corresponding glass plates.

Knowing the area, A of the paint applied to the glass plates (in m²), the rate of consumption (in g/m²) is calculated according to the following formula:

$$\text{Rate of consumption} = \frac{m}{A}$$

The resulting dry film thickness of the paint shall be calculated in accordance with standard EN 1062-1.

5.3.3. Evaluation criteria

When the paint is tested in accordance with Article 5.3.2 of this standard, the resulting rate of consumption:

- a) must not deviate more than $\pm 25\%$ from the values of drying times declared by the manufacturer.
- b) The ratio between the mass of the paint (g) and the width of the line (m) measured at the beginning and the end of every paint line that is applied must not vary by more than 0.15 g/m.

5.4. DRYING TIME (NO-PICK-UP TIME)

This test method is used for determining the drying time, i.e. the period elapsed between the moment of application of the paint and when a rubber wheel passing over the applied paint no longer drags any paint trails.

5.4.1. Test apparatus

The apparatus should be in accordance with the standard ASTM D 711.

Additionally, 1x glass plate of pre-determined mass and dimensions shall be should be laid in continuation of the lines of paints that will be applied, as specified in Appendix C of this standard.

5.4.2. Test procedure

The exact time of application of every paint line that will be applied shall be recorded as t_1 . From 10 minutes after the application of the paint, perform the test as outlined in ASTM D 711, with the following amendments:

- a) Record t_2 as the time at which no paint adheres to the rubber rings of the steel cylinder when it is rolled over the painted asphalt surface, at a location near the end of the paint line.
- b) Record t_3 as the time at which no paint adheres to the rubber rings of the steel cylinder when it is rolled over the paint applied on the glass plate, which is positioned in continuation of the paint line.

Calculate the time elapsed between application of the paint t_1 and the corresponding measured times t_2 , t_3 as the drying times (in minutes), as follows:

$$\text{Drying time (asphalt)} = t_2 - t_1$$

$$\text{Drying time (glass plate)} = t_3 - t_1$$

The drying times should take into the weather conditions, the corresponding substrate (glass plate and asphalt surface) as well as exposure to sunlight.

5.4.3. Evaluation criteria

When the paint is tested in accordance with Article 5.4.2 of this standard, the resulting drying times:

- a) must not deviate more than 20% from the values of drying times declared by the manufacturer.
- b) when tested at a temperature of $20^\circ\text{C} \pm 5^\circ\text{C}$ and $50\% \pm 5\%$ Relative Humidity (RH), must not exceed 20 minutes on the asphalt surface.
- c) When tested at a temperature that differ from $20^\circ\text{C} \pm 5^\circ\text{C}$ and $50\% \pm 5\%$, the manufacturer must demonstrate that the measured drying times corrected to 20°C do not exceed 20 minutes.

5.5. LUMINANCE COEFFICIENT (Q_d)

This test method is used for determining the luminance coefficient, i.e. the ratio of the luminance of the film of the paint in the given direction to that of a perfect reflecting diffuser identically illuminated.

5.5.1. Test apparatus

The apparatus shall be in accordance with the standard EN 1436:2018.

5.5.2. Test procedure

Three consecutive measurements shall be carried out in at least three different measurement points evenly distributed along every paint line that will be applied and the average luminance coefficient shall be calculated for every measurement point, in accordance with the conditions set out in the standard EN 1436:2018 – Appendix A.

5.5.3. Evaluation criteria

When the paint is tested in accordance with Article 5.5.2. of this standard, the averaged luminance coefficient Q_d shall be $\geq 220 \text{ mcd m}^{-2} \text{ lx}^{-1}$.

5.6. COLOUR CHROMATICITY

This test method is used for determining the colour chromaticity, i.e. the chromaticity coordinates of the white paint.

5.6.1. Test apparatus

The apparatus shall be in accordance with the standard EN 1436:2018.

5.6.2. Test procedure

Three consecutive measurements shall be carried out in at least three different measurement points evenly distributed along every paint line that will be applied and the average luminance coefficient shall be calculated for each measurement point, in accordance with the conditions set out in the standard EN 1436:2018 – Appendix C.

5.6.3. Evaluation criteria

When the paint is tested in accordance with Article 5.6.2 of this standard, the x,y chromaticity coordinates of the white paint shall lie within the pre-defined region defined by the corner points given in Table 6 and illustrated in Figure 1 of the standard EN 1436:2018.

5.7. SKID RESISTANCE

This test method is for measuring the skid resistance of the paint, as the loss of energy when a rubber slider slides across a painted surface in wet conditions.

5.7.1. Test apparatus

The apparatus shall consist of a Pendulum Tester that is in accordance with the standard EN 13036-4:2011, with the following inclusion:

- a) It is required that the Pendulum be fitted with a digital screen (i.e. Intelligent Pendulum) to provide absolute clarity of results and remove any element of human uncertainty from the measurement process (parallax errors).
- b) The calibration of the Pendulum Tester along with its components must be carried out by an approved calibration body, in accordance with Appendix A of the standard EN 13036-4:2011.

Additionally, the following items must be made available by the test house:

- a) A back-up Pendulum Tester calibrated by an approved calibration body, in accordance with the standard EN 13036-4:2011-Appendix A
- b) A hand brush or similar for cleaning the surface prior to measurements
- c) Sufficient clean water in a clean container, which will be used to create conditions of wetness for measurements, as specified in the 5.7 of this standard
- d) A portable thermometer (accuracy of 1° and resolution of 0.1°), for measuring the substrate temperature following testing
- e) A portable hygrometer (accuracy of 1% and resolution of 0.1%), for measuring the relative humidity
- f) A portable anemometer accurate to 2 m/s (optional)
- g) Video and photo camera equipment, for documenting the testing procedures

5.7.2. Test procedure

The skid resistance shall be tested 24 hours after application of the paint (time is recorded as t_1). The measured value is the skid resistance tester value (SRT) and is in accordance with the conditions set out in the standard EN 13036-4:2011, with the following amendments.

A minimum of three measurement points shall be selected for every line of paint that will be applied, in accordance with Appendix D of this standard.

The Pendulum Tester shall be positioned over the surface to be tested by means of a rigid template (dimensions available from the FIA upon request), to ensure that the adjustable feet are restrained within pre-marked positions on the asphalt surface and that the pendulum swings over the particular area that is required for testing.

The test condition of wetness shall be created by using 100 ml clean water poured evenly over the test surface, so that the water uniformly covers the measuring field.

Release the arm of the Pendulum Tester, catch the pendulum arm on the early portion of the return swing and record the position of the pointer on the calibrated scale of the Pendulum Tester.

Return to the original position and perform the same operation, re-wetting the surface just before releasing the pendulum and recording the result each time. Repeat until three successive readings are within a range of ± 1 SRT (i.e. 69,70,69; 69,69,70; 70,70,69; 70,69,70).

Calculate the SRT value as the mean of these three readings and record this value.

Measure and note the temperature of the water of the wetted surface to the nearest whole number and perform the correction of the SRT values for temperatures.

5.7.3. Evaluation criteria

When the paint is tested in accordance with Article 5.7.2 of this standard, the average of the SRT values of the paint measured at three different locations and the corresponding SRT values of the asphalt surface measured at the exact three locations must be within the range -5 and +10 SRT.

6. FIA MARKING

Each paint having passed the requirements of this standard will have to be clearly marked as prescribed below:

- a) FIA Marking, as specified in Article 6.1
- b) FIA Hologram, to be glued onto the paint container and the FIA Homologation Certificate (file provided by the FIA upon request). The FIA Hologram must be purchased from the FIA

6.1. FIA MARKING

The FIA homologation label shall be affixed or printed onto each paint container and be clearly visible and remain so for the expected use and lifetime.

It shall contain the following information:

- a) FIA Standard Name
- b) FIA Homologation Number
- c) Name of the Manufacturer, which could be replaced by its logo (if not already visible)
- d) Batch number (if not already visible)
- e) Date of Manufacture (if not already visible)
- f) Expiry date (if not already visible)

The label must be indelible and made in such a way to avoid copying

6.2. FIA/FIM IDENTIFICATION OF PAINT BATCH

The manufacturer is required to provide the FIA with the documentary evidence that each production batch has undertaken factory production control tests, as specified in Appendix A2 and Table 1 of this standard for each container of FIA homologated paint.

6.3. DOCUMENTATION WITH DELIVERY

The manufacturer is required to provide the following documentation with each delivery:

- a) Application Guidelines
- b) Handling and Storage Guidelines
- c) Paint Removal Guidelines
- d) Disposal Guidelines
- e) FIA Homologation Certificate, which includes a unique FIA Hologram

APPENDIX A: ADDITIONAL INFORMATION PROVIDED BY THE MANUFACTURER

The additional information included herein must always be provided with each batch of FIA/FIM homologated paint. It is possible to provide the same information in electronic version.

A.1. MANUFACTURER'S APPLICATION GUIDELINES

The manufacturer's application guidelines shall include, at least, the following information:

- a) Paint preparation method, which includes the rate of dilution with water (if applicable)
- b) List of application methods (i.e. air-pressurised machine, etc.)
- c) Rate of consumption (in g/m²) together with the corresponding application method (if available, depending on the target substrate)
- d) Details of the equipment required, which includes at least the following
 - For air-pressurized machines: type of machine, nozzle diameter (mm), gun height (mm), air pressure (bar), paint pressure (bar)
 - For manual sprayer: type of sprayer gun, gun diameter (mm)
 - For manual roller: type of roller, fibre length (mm)

For all other possible application methods, the FIA reserves the right to require additional information other than the abovementioned on a case-by-case basis.

Paint application with air-pressurised machine is the preferred application method, as this ensures better repeatability.

A.2. MANUFACTURER'S GUIDELINES FOR HANDLING, STORAGE AND DISPOSAL

The manufacturer's guidelines for handling and storage must prescribe correct procedures to prevent damage or deterioration when the paint is sealed in its original container during its period of validity. The keeping qualities of the paint must be such that the paint is always free from skin and settlement that cannot be re-incorporated otherwise. The settled material must be readily reincorporated to produce a smooth uniform product consistent with the freshly manufactured product. No changes in product characteristics of the paint must occur.

A.3 REMOVAL PAINT GUIDELINES

The manufacturer's guidelines for the correct removal of the paint must prescribe the most effective methods as well as the information about the type of equipment to be used.

A.4 FACTORY PRODUCTION CONTROL TEST RECORDS

The manufacturer must declare to have undertaken Factory Production Control (FPC) tests. These tests include representative identification tests, to ensure conformity of the FIA homologated paint in the case of post-homologation controls. The manufacturer is responsible for organising the effective implementation of the FPC tests in line with and at the frequencies specified in Table 1 below.

Table 1. Frequency and type of Factory Production Control (FPC) Tests

Type of Test	Frequency
General appearance and colour	Every Batch
Density	Every batch
Infrared spectrum	Once per year
Volatile and non-volatile matter	Every 10 batches
Ash content	Every 10 batches
Thermogravimetry	Once per year
Viscosity/flow time	Every batch
Surface – dry – glass beads method	Every 10 batches

A.5 TABLE OF DRYING TIMES

The manufacturer is required to declare the drying times when measured in accordance with the standard ASTM D 711. Alternative methods to measure the drying times must be approved by the FIA.

The drying times shall be declared, at least, as a function of the temperature T (°C) and the relative humidity (%), as specified in Table 2 below.

Table 2. Drying times (min) vs. T (°C) & Air Relative Humidity (RH)

Drying times (in minutes)				
Air Relative Humidity (%)	T (°C)			
	5	10	20	30
50	VALUE	VALUE	VALUE	VALUE
80	VALUE	VALUE	VALUE	VALUE

A.6 CERTIFICATE OF CONFORMITY OF COLOURED PAINT

The manufacturer is required to declare the x and y chromaticity coordinates for coloured paints and confirms that the characteristics of the final products do not suffer alteration compared to the corresponding white paint formulation, on which the performance tests were made.

The manufacturer commits to obtaining the FIA's approval before any substantial modification to the approved product is carried out.

APPENDIX B: TEST REPORT

The test report should include all the information recorded as a result of the performance assessment of the paint, including the corrected skid resistance tester value (SRT) to the nearest whole number. Additionally, the test report should include at least the following information about the test site:

- a) Photograph of the test site location
- b) Surface texture evaluation (optional)
- c) SRT values of the asphalt surface for each location tested for the performance assessment of the paint, in accordance with Article 5.7 of this standard

Additional information as well as photographs shall also be included in the final reporting, as follows:

- d) A complete listing of the test equipment, which shall include instrument accuracy and calibration dates
- e) Calibration certificates of the test equipment
- f) Verification of conformity of the equipment and methods of application of the paint
- g) Verification of conformity of the paint preparation method. Includes the rate of dilution with water (if applicable)
- h) Photographs of the equipment used for the application of the paint
- i) For application with air-pressurised machine, a verification of conformity of the settings are in accordance with the manufacturer's application guidelines
- j) Photographs of the paint batch and annotation of the batch number and date of manufacture
- k) Photographs of the test site location after the application of the paint
- l) Detailed photograph of the painted line at every measurement location
- m) Any additional information requested at the discretion of the FIA

A template for the test report is provided by the FIA upon request.

APPENDIX C: TEST SITE SPECIFICATION

The test site shall be at least 20x2 m to correspond with paint patterns required for the performance assessment of paints.

It is desirable to have extra space at both ends of the test area of minimum 3 m, in order to allow safe working conditions and convenient operation of application with paint.

Additionally, the test site must be equipped with three glass plates for every longitudinal paint line that will be applied with the air-pressurised machine, as follows:

- a) 1x glass plate shall be placed at the beginning and 1x glass plate at the end of the paint line for measuring the rate of consumption, as specified in Article 5.3
- b) 1x glass plate shall be placed near the end of the paint line for measuring the drying time, as specified in Article 5.4

For all other application methods, the test site must be equipped with only one glass plate for every paint line that will be applied.

The glass plates shall be of pre-determined mass and dimensions. Recommended dimensions are 300 mm x 400 mm x 3 mm (Figure 1 below)

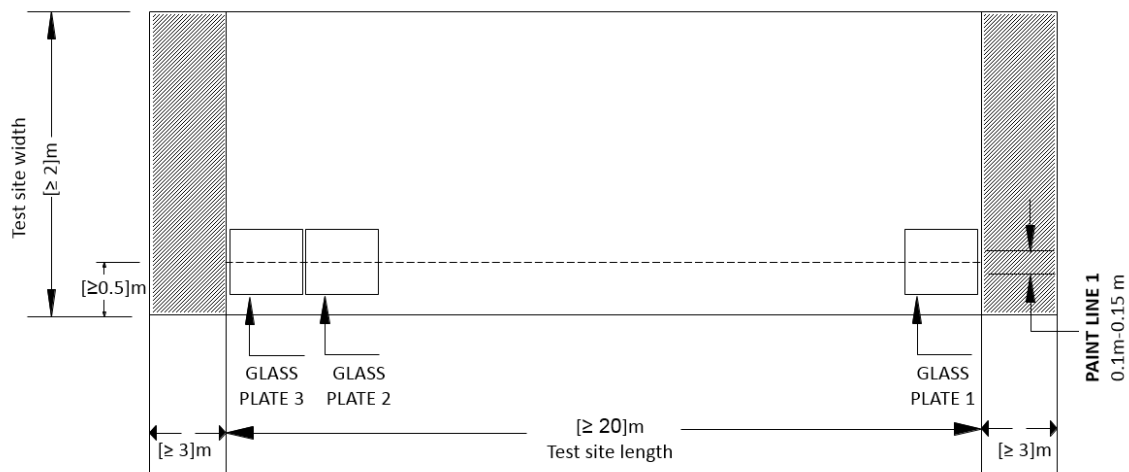


Figure 1. Recommended test site specifications ⁽¹⁾

(1) If deemed necessary for reasons of constraints relating to the available space, the test house can define secondary test sites in proximity of the main site, which may be used for the application of the paint with manual equipment, such as a sprayer or roller. The test house is required to consult the FIA for the minimum dimensions of the secondary test sites, to guarantee the execution of the tests for the performance assessment of paints.

APPENDIX D: TEST PAINT PATTERNS

Paint lines shall be applied longitudinal to the test site and, if possible, on the two furthest sides of the test site, so as to guarantee the greatest possible width clearance between them.

Every paint line that will be applied should be 0.10 m ÷ 0.15 m wide. The number and length of these lines depend on the application method, as follows:

- At least two (2) lines of at least 20 m long shall be applied following application with an air-pressurised machine, and including the glass plates that will be placed at the beginning and at the end of every line respectively
- At least one (1) line of at least 10 m long shall be applied with either manual sprayer and manual roller applications and including the glass plate that will be placed at the beginning of every line respectively. In these cases, it is possible to leave unpainted gaps between the measurement locations, where the skid resistance tester value of the paint will be measured.

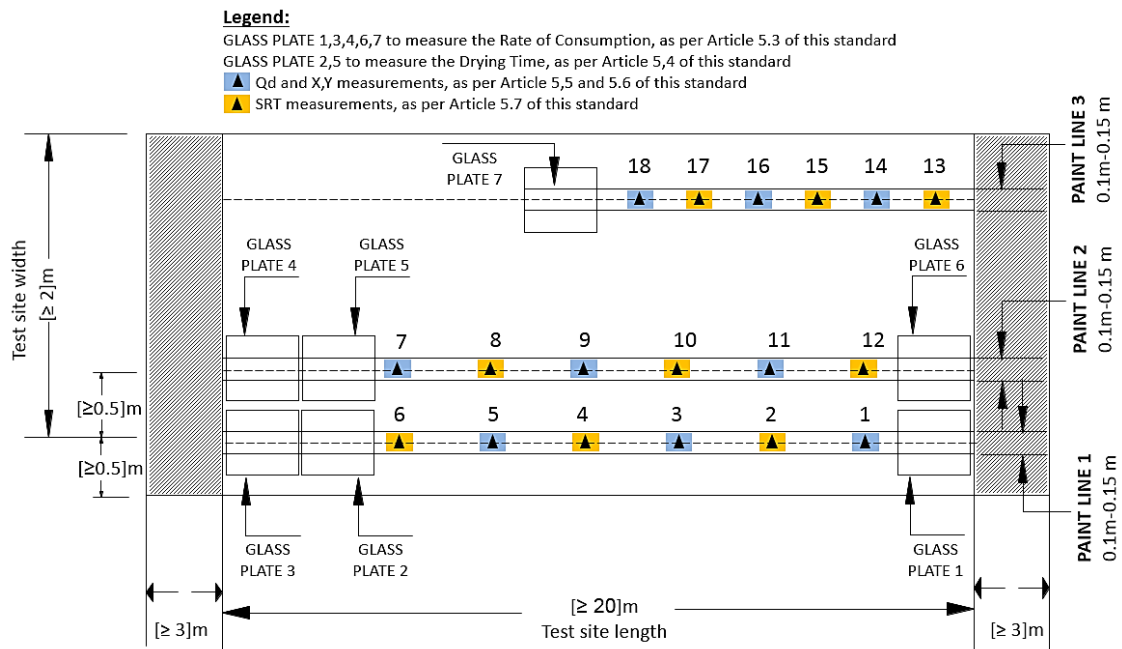


Figure 2. Number and location of measurements points for every line of paint applied ⁽²⁾

⁽²⁾ Paint lines 1 and 2 in Figure 2 above are intended for application with an air-pressurised machine. Paint line 3 in Figure 2 above is intended for application with manual equipment, such as a manual sprayer or roller.