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I. LIST OF ACRONYMS & ABBREVIATIONS

EMU	Electric Multiple Unit
EN	European Norm
FAI	First Article Inspection
IEC	International Electrotechnical Commission
ISO	International Organization of Standardization
RAMS	Reliability, Availability, Maintainability and Safety
SI	International System
TBC	To be confirmed
TBD	To be defined
TOR	Top of Rail
UIC	Union International Chemin de Fer

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1 INTRODUCTION

1.1 SUBJECT

This document describes the technical requirements for the preparation and painting of car body and relevant components on the Electrical Multiple Units (hereafter called EMU) produced by Turkish Railway Vehicles Industry Inc. (hereafter called TÜRASAŞ).

A possible deviation from this specification or from other specifications and norms mentioned in this document, shall be validated by written agreements with TÜRASAŞ.

1.2 DOCUMENTS AND STANDARDS

The EMU shall be designed, assembled and tested according to the following international reference standards:

European Standards: TSI, EN;
International standards: UIC; ISO; IEC;
System of units shall be SI.

Table 1 below reports the Applicable Standards for the Scope of Supply.

Standard	Year	Title
EN 50125-1	2014	Railway applications - Environmental conditions for equipment - Part 1: Rolling stock and on-board equipment
ISO 9000	2015	International consensus on good quality management practices.
UIC 580	1990	Inscriptions and markings, route indicators and number plates to be affixed to coaching stock used in international traffic
CEI EN ISO/IEC 17050-1	2010	Conformity assessment - Supplier's declaration of conformity - Part 1: General requirements
EN ISO 4624	2016	Paints and varnishes. Pull-off test for adhesion
EN 13523	2021	General introduction and list of test methods
EN ISO 1519	2011	Paints and varnishes. Bend test (cylindrical mandrel)
EN ISO 1520	2007	Paints and varnishes. Cupping test
EN ISO 2409	2020	Paints and varnishes -- Cross-cut test
EN ISO 2808	2019	Paints and varnishes -- Determination of film thickness
EN ISO 2812-1	2018	Paints and varnishes --

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		Determination of resistance to liquids -- Part 1: Immersion in liquids other than water
EN ISO 2813	2014	Paints and varnishes -- Determination of gloss value at 20 degrees, 60 degrees and 85 degrees
EN ISO 4628-2/3/4/5/6	2-2016 3-2016 4-2016 5-2016 6-2012	Paints and varnishes -- Evaluation of degradation of coatings -- Designation of quantity and size of defects, and of intensity of uniform changes in appearance
EN ISO 4892-1/3	1-2016 3-2016	Paints and varnishes -- Methods of exposure to laboratory light sources
EN ISO 6270	2018	Paints and varnishes -- Determination of resistance to humidity
EN ISO 6272	2012	Paints and varnishes -- Rapid-deformation (impact resistance) tests
EN ISO 8501-1	2008	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
EN ISO 9227	2017	Corrosion tests in artificial atmospheres -- Salt spray tests

Table 1 – Applicable Standards

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2 FUNCTIONAL REQUIREMENTS

2.1 TECHNICAL APPLICATION CONDITIONS

2.1.1 Working Environment

The operating cycle referred to in this specification shall be carried out in an environment free of dust and with the following conditions:

Temperature:

- Minimum recommended: 18°C
- Maximum recommended: 30°C

Relative humidity:

- $35\% \leq RH \leq 75\%$

Should these conditions not be objectively possible, it will be necessary to adapt the execution parameters of the cycle accordingly, but always within the limits specified in the technical data sheets concerning the materials employed.

The temperature of the part to be painted shall always be higher than the dew point by at least 3°C.

2.1.2 Working Equipment

In order to ensure the necessary painting quality, it will be necessary to make sure that the system used is suitable to ensure that the compressed air for spraying is sufficiently dehydrated.

2.1.3 Products To Be Used

The use of products referred to herein is binding in terms of quality and characteristics which are defined, when no specific standards exist, by the technical data sheets of the manufacturers referred to.
Products made by different firms may be used on the basis of a prior written agreement with TŰRASAŞ, provided that they fully meet the quality standards and characteristics specified in the technical data sheets of the products referred to.
The type of paint shall be suitable for application by means of the automatic painting systems in use at the TŰRASAŞ plants.

2.1.4 Application Procedure

The application and drying processes shall be carried out by adhering closely to the instructions given in the technical data sheets of each individual material.
Application to particular details, such as sharp corners, fins, weld spots, shall be carried out with special care.

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2.1.5 Thickness Values

The specified layers, of both primer and enamel, shall be applied to the surfaces to be painted with homogenous thickness and in the specified amount.

The values of the specified thickness of both the primer and the enamel layers refer to dry film. By actual value it is meant the mean of the values observed in 5 measurements over an area of 100x100 mm.

The thickness values of individual coats and of the total of the coats, measured when the film is dry, shall not be lower than the specified values.

For maximum values, higher values may be accepted provided that they are supported by favorable visual examinations (no dripping, etc.) and by satisfactory adhesion tests (cross-cut).

2.1.6 Roughness

The roughness (Ra) of the surfaces to be painted, after the mechanical treatment, shall be within the following values (except where different values are indicated on the drawings):

- Ra 1.6 to 6.3 µm for parts made of steel / stainless steel with thickness < 2 mm
- Ra 1.8 to 2.5 µm for composite materials with resin outer skin
- Ra 3.2 to 12.5 µm for light alloy parts (except where differently indicated)
- Ra 3.2 to 12.5 µm for sheet carbon steel parts with thickness > 2 mm

2.2 FINAL BODY REVIEW

2.2.1 Local Protector

Protect all the parts listed below with suitable methods:

- threaded parts
- machined surfaces not to be painted
- the areas shown in the dedicated drawings (earth points, etc.);
  these parts shall be protected with an epoxy paint with thickness of 15 ÷ 25 µm

The protections applied to these parts shall be maintained throughout the preparation and painting cycles.

2.2.2 Car Body Cleaning

Clean thoroughly all the surfaces of the body through suction, blow molding, or other suitable method.

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2.3 SURFACE PREPARATION FOR PAINTING

2.3.1 Light Alloy Materials Chemical Conversion Surface

Chemical conversion surface shall be made by the pre-treatment described below:

- wash with alkaline cleaner applied by thermal lance steam
- wash thoroughly with cold water until neutral pH of the aqueous phase dripping
- wash with degreasing acid applied by thermal lance steam
- wash thoroughly with cold water until neutral pH of the aqueous phase dripping
- perform the chemical conversion liquid surface with chrome-free conversion applied by thermal lance steam
- rinse with cold deionized water
- dry in oven at 60 ÷ 80 °C for at least 1 hour

N.B. If in the course of chemical pre-treatment and painting there is no continuity, you have to repeat the cycle.

2.3.2 Sandblasting (only for external surface)

The sanding process shall not cause deformations, both of the product that of the parts to be painted.

2.3.2.1 Light Alloy Material

Clean thoroughly, with phosphor-degreasing (for thermal lance / for washes) or organic solvents, all areas of the article, or of the particular presenting conditions of greasiness.

After the process phosphor-degreasing wash thoroughly with cold water and dry.

Sandblast systems and grits steps to prevent pollution of the alloy and obtain a surface with roughness prescribed in paragraph 2.1.6.

Use grits with content of metallic iron ≤ 1%.

N.B. Between the step of sandblasting and subsequent application of the first layer of the bottom shall not spend more than 7 days.
During this time the article or the particular shall be kept in a closed environment at ambient temperature and relative humidity ≤ 75%; in any case there shall be no pollutions and detect triggers oxidation;
If not, those event should repeat partially or totally.

Clean thoroughly with suction, blowing, or another suitable method, the article or the particular for all surfaces (particularly moulded case any semi-open or similar conditions) are completely and surely devoid of grits and related powders.

Clean thoroughly, with phosphor-degreasing (for thermal lance / for washes) or organic solvents, all areas of the article, or of the particular presenting conditions of greasiness.

After the process phosphor-degreasing rinse thoroughly with cold water and dry.

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2.3.2.2 Ferrous And Austenitic Materials

Thoroughly clean all eventual greasy areas of the product or part using organic solvents / degreasing agents.

Sandblast using systems and grains suited for obtaining a surface with a degree of preparation corresponding to grade "A Sa 2 ½" as defined in ISO Standard 8501-1.

N.B. Sandblasting shall be performed immediately before the painting operations. Not more than 8 hours should pass between the end of the sandblasting and the subsequent start application of the first coat and not more than 24 hours should pass between the end of the sandblasting and the end of the first layer application.

During this time the product or part shall be kept in a closed environment at a temperature ≥ 18°C and relative humidity ≤ 75%; in all cases, no starts of oxidisation may be noted.

If the interval between the end of blasting and the first coat application is exceeded the time recommended, a new control of the cleaning shall be done. If the result is not compliant with recommended cleaning level value, it is necessary to start again the blasting.

Clean thoroughly the product or part by suction, blowing or other suitable method so that all the surfaces (in particular any half open boxed sections or similar conditions) are completely and certainly free of grains and dust.

2.3.3 Brushing And / Or Hand Grinding

2.3.3.1 Light Alloy Material

Thoroughly clean all eventual greasy areas of the product or part using organic solvents/degreasing agents.

Brush with stainless steel brushes, and/or hand grind the surfaces to be painted to eliminate the presence of any oxidation and make them suitably rough to improve the adherence of the coats of paint.

N.B. Between the step of brushing/hand grinding and subsequent application of the first layer of the bottom shall not spend more than 7 days.
During this time the article or the particular shall be kept in a closed environment at ambient temperature and relative humidity ≤ 75%; in any case there shall be no pollutions and detect triggers oxidation;
If not, those event should repeat partially or totally.

If the interval between the end of blasting and the first coat application is exceeded the time recommended, a new control of the cleaning shall be done. If the result is not compliant with recommended cleaning level value, it is necessary to start again the brushing / hand grinding.

Clean thoroughly the product or part by suction, blowing or other method so that all the surfaces (in particular any half open boxed sections or similar conditions) are completely and certainly free of grains and dust.

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Thoroughly clean all eventual greasy areas of the product or part using organic solvents/degreasing agents.

2.3.3.2 Ferrous And Austenitic Materials

Thoroughly clean all eventual greasy areas of the product or part using organic solvents / degreasing agents.

Brush with stainless steel brushes, and/or hand grind the surfaces to be painted to eliminate the presence of any oxidation and make them suitably rough to improve the adherence of the coats of paint.

N.B. Brushing/hand grinding shall be carried out immediately before the painting operations. Not more than 8 hours should pass between the end of the brushing/hand grinding and the subsequent start application of the first coat and not more than 32 hours should pass between the end of the brushing/hand grinding and the end of the first layer application During this time the product or part shall be kept in a closed environment at a temperature of $\geq$ 18°C and relative humidity $\leq$ 75%; in all cases, no starts of oxidisation may be noted.

If the interval between the end of blasting and the first coat application is exceeded the time recommended, a new control of the cleaning shall be done. If the result is not compliant with recommended cleaning level value, it is necessary to start again the brushing/hand grinding.

Accurately clean the product or part by suction, blowing or other suitable method so that all the surfaces (in particular any half open boxed sections or similar conditions) are completely and certainly free of grains and dust.

2.3.3.3 Composite Materials With Resin Outer Skin

Hand grind the surfaces to be painted to eliminate the presence of any surface film of anti-adhesive products for dies and make them suitably rough to improve the adherence of the coats of paint.

Any parts displaying a rough/corrugated untreated surface which shall remain as it is shall be hand grinded.

N.B. Brushing/hand grinding operations shall be carried out immediately before the painting operations.
Not more than 72 hours should pass between the end of brushing/hand grinding and the subsequent application of the first coat of primer.
During this time the product or part shall be kept in a closed environment at a temperature of $\geq$ 18°C and relative humidity $\leq$ 75%.

2.3.4 Dry With Phosphor Degreasing

Wash with the use of phosphor degreasing agent for thermal lance to phosphates of iron, mixed in the right proportions, with jets of steam pressure generated by appropriate plant.

Alternatively, in the case of coating with automatic systems, employ phosphor degreasing washings.

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Wash thoroughly with cold water.

Dry in oven at 60 ÷ 80 °C for at least 1 hour, after the swelling of the accumulation zones and box sections.

N.B. The cleaning of the building, or particular, shall be performed on the entire area with great care and with particular attention to surfaces undercut and boxed.
Between the step of degreasing / phosphating and the subsequent application of the first layer of the bottom, they shall not however take longer than 24 hours; in any case you do not have to detect triggers oxidation.
During this time the artefacts, or details, will be preferably kept indoors; if kept in an open environment will surely be protected against the rain.

3 BİLL OF QUANTİTİES

In the table below the approx. surface area for a reference each EMU car

	SKA	OA
	Area [m^2]	Area [m^2]
Cab Structure	6	-
Sidewall	88	43
Roof surface	65	67
End wall surface	7	14
Underframe	67	67
Fairing	75	80
Cab Mask	15	-

Table 2 – Bill of quantity [m^2]

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4 PAINTING

4.1 CAR BODY PAINTING

4.1.1 General

The stock body, roof, floor, chassis and doors shall be fully painted and the dyeing shall guarantee color resistance and brightness of 10 years for red and 15 years for other colors. The painting method of all surfaces shall be submitted to the Administration during the stock design phase

The paint to be used shall be in compliance with the conditions of railway operations and be guaranteed for at least 10 years against cracking, peeling, and leaking due to vibration effect and surface flexures.

The paint to be used shall be anti-graffiti protected paint. The approval of the ADMINISTRATION shall be received during the design process for the characteristics of the paint used regarding protection against microorganisms (algae, bacteria, fungi, etc.), protection against chemicals (acids, alkalis, organic solvents, gases, etc.), protection against mechanical effects (wear, etc.), and protection against flame, and the color and method of application of the paint.

The paintings applied on inner and lower parts for insulation purposes shall have a life span of at least 20 years. There shall be no flows, drips, ripples, or mottles on the paint and it shall be of equal thickness throughout the entire surface.

All depressions, deep slits, notches, roughness and other surface defects or depressions visible on any surface of the stock's exterior painting shall be repaired before painting. The maximum allowable fill thickness during the surface repair process is 2 mm

4.1.2 Side Wall, Fairing and External Doors

- Perform preparation as described in par. 2.3.

- Fill any areas with particular hollows (extruded part joints, localised flaws, weld shrinks) by applying epoxy filler with a spatula.
  Shave the surface with filler.
  Hand grind the filler and repair minor defects with touch-up polyester filler applied with a spatula.
  Total thickness of the filler applied to the outside the body shall be as low as possible.
  Overall filler thickness (after hand grinding): $\leq$ 100 µm. Eventual areas with allowed higher thickness will be indicated on the drawings.
  Dust removal using a pad.

- Application of epoxy primer coat water based
  Dry film thickness = 70 ÷ 80 µm
  Paint yield weight 0.14 kg/m^2
  Verify the minimum thickness of primer coat after grinding; if necessary, because under the minimum accepted or bared areas, restore the coat of primer with primer for touch-up.

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- Application of putty
  Dry film thickness = 200 ÷ 300 µm
  Paint yield weight 0.57 kg/m^2
  Shave and hand Grinding the surface to remove surplus material

- Application of base coat water based
  Dry film thickness = 60 ÷ 80 µm
  Paint yield weight 0.08kg/m^2

- Application of decorative finishing paints with top coat water, according to the colour schemes
  Dry film thickness = 50 ÷ 70 µm
  Paint yield weight 0.07 kg/m^2

4.1.3 Roof, Flat End

- Perform preparation as described in par. 2.3.

- Application of epoxy primer coat water based
  Dry film thickness = 70 ÷ 80 µm
  Paint yield weight 0.14 kg/m^2

- Application of top coat water
  Dry film thickness = 50 ÷ 70 µm
  Paint yield weight 0.07 kg/m^2

4.1.4 Underframe

- Perform preparation as described in par. 2.3

- Application of epoxy primer coat water based
  Dry film thickness = 70 ÷ 80 µm
  Paint yield weight 0.14 kg/m^2

- Application of Sound Damping and Fire resistance material (EN 45545-2, R1-R7 class HL2 min)
  Dry film thickness = 2000 ÷ 4000 µm
  Paint yield weight 2 ÷ 5 kg/m^2

4.1.5 Hollow Parts

Application of a specific anticorrosion protection product, follow indication of the painting Supplier.

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4.2 IDENTIFICATION COLOUR STRIPS AND ENAMEL INSCRIPTIONS

For the color strips, where indicated on the drawing, during the final stage of the painting cycle, apply self-adhesive strips.

As an alternative to enamel inscriptions it is possible to use inscriptions in pre-spaced, punched self-adhesive vinyl film.

4.3 SEALING

Following the application of the epoxy primer or epoxy monolayer, clean with a cleaner and then apply sealant to the edges of all overlapping surfaces jointed by spot welding, follow indications in drawings or in the instruction sheets.

4.4 BOGIE PAINTING

4.4.1 General

Bogies and all equipment on it shall be painted with a dye suitable for working under heavy operating conditions in accordance with EN 12944.

There shall be no rust, corrosion, paint swelling, or spillage on bogies. The paint to be used shall be guaranteed for at least 10 years against cracking, peeling, and leaking.

The paint to be used shall be anti-graffiti protected paint.

The technical specification indicating the painting method of all surfaces and properties of the paint used shall be submitted to the Administration during the stock design phase. Specifically, particular attention shall be given to this issue during paint applications on bogies.

4.4.2 Bogie Frame

Perform preparation as described in paragraph 2.3.2.
Application of epoxy primer coat water based.
Dry film thickness = 60 ÷ 100 µm.

N.B.
Not more than 72 hours (at ambient temperature) should elapse between the application of the epoxy primer and the next coat of paint; if, for any reason whatsoever, painting is carried out after such a length of time, it will be necessary to hand grind the surface and restore the coat of primer on the bared parts of the metal support with primer for touch-up.

Application of acrylic water-based finishing paint.

Dry film thickness = 180 ÷ 240 µm.

4.4.3 Bogie Components

Perform preparation as described in paragraph 2.3.4.
Application of epoxy primer coat water based.
Dry film thickness = 60 ÷ 100 µm.

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N.B.
Not more than 72 hours (at ambient temperature) should elapse between the application of the epoxy primer and the next coat of paint; if, for any reason whatsoever, painting is carried out after such a length of time, it will be necessary to hand grind the surface and restore the coat of primer on the bared parts of the metal support with primer for touch-up.

Application of acrylic water based finishing paint.

Dry film thickness = 180 ÷ 240 µm.

4.5 PARTS MADE OF COMPOSITE MATERIAL

4.5.1 General

Aluminum panels, GRP panels and all steel shall be painted. The painting process shall have a minimum 15 years of resistance in accordance with the EN 12944 standard C4 category.

For the technical properties and quality control tests of the applied paint, EN ISO 2808, EN ISO 2409 and EN ISO 4624 standards shall be taken as references

4.5.2 Exterior and Interior GRP Parts (Cab Mask and Internal Panel)

- Perform as indicated in paragraph 2.3.3.3.

- Application of solv primer Fire Resistance (FR)
  Dry film thickness = 50 ÷ 80 µm
  Paint yield weight 0.11 kg/m^2

- Application of decorative finishing paints with top coat water (anti-graffiti properties), according to the colour schemes (gloss 80%)
  Dry film thickness = 50 ÷ 70 µm
  Paint yield weight 0.07 kg/m^2

4.5.3 Aluminium Internal Panel (Interiors)

- Perform as indicated in paragraph 2.3.3.1

- Application of epoxy primer coat water based
  Dry film thickness = 70 ÷ 80 µm
  Paint yield weight 0.14 kg/m^2

- Application of decorative finishing paints with top coat water (anti-graffiti properties), according to the colour schemes (gloss 80%)
  Dry film thickness = 50 ÷ 70 µm
  Paint yield weight 0.07 kg/m^2

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4.6 PAINTING OF NOT VISIBLE PARTS

4.6.1 General

The equipment, parts or products to be fitted not in view inside and under the body shall be painted as specified in this chapter depending on the type of material.

The surfaces of all corrodible structural members shall be painted in accordance with the relevant UIC vouchers

Aluminum panels, GRP panels and all steel shall be painted. The painting process shall have a minimum 15 years of resistance in accordance with the EN 12944 standard C4 category.

For the technical properties and quality control tests of the applied paint, EN ISO 2808, EN ISO 2409 and EN ISO 4624 standards shall be taken as references.

All metallic surfaces to be painted within the stock shall be coated with a hot-curing epoxy powder coat and shall be submitted to the approval of the Administration. Parts to be covered in this way shall be prepared and cleaned according to the recommendations from the epoxy powder coat supplier.

4.6.2 Equipment And Different Parts

4.6.2.1 Parts In Light Alloy

N.B. For low thickness parts: prepare as described at point 2.3.2.1.

Spray a finishing coat of epoxy-mica based paint according to the indications given in the drawings.

Dry film thickness of layer = 120 to 200 µm.
This clause is not applicable for invisible interior aluminium substructure parts.

4.6.2.2 Parts In Ferrous Material

Prepare as described at point 2.3.2.2.
Spray a finish coat of epoxy-mica based paint according to the indications given in the drawings.
Dry film thickness of layer = 120 to 200 µm..

4.6.2.3 Parts In Composite Material

Perform as indicated in paragraph 2.3.3.3.
Paint as described in paragraph 4.5.

4.6.3 Pipes

4.6.3.1 General

Identification of the fluid crossing inside the pipes shall be by means of self-adhesive strips. The strips shall be 20 mm wide, cover the entire circumference of the pipe and be positioned at a maximum distance of 2 meters apart, and at any rate, there shall be at least one between two unions less than 2 meters apart.

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4.6.3.2 Pipes In Ferrous Material

Prepare as per point 2.3.3.2.

Spray a finish coat of epoxy-mica based paint according to the indications given in the drawings. Dry film thickness of layer = 120 to 200 µm.

Stainless steel and copper pipes remain unpainted.

4.6.3.3 Pipes In Light Alloy

Spray a finish coat of epoxy-mica based paint according to the indications given in the drawings. Dry film thickness of layer = 120 to 200 µm.

Stainless steel and copper pipes remain unpainted.

4.7 PAINTING DUCTS AND BOXES FOR HIGH AND LOW VOLTAGE ELECTRICAL SYSTEMS

Ducts in stainless steel remain unpainted. For the other parts it is essential to respect the styling and functional homogeneity with the application zone.

4.8 PAINTING OF VARIOUS EXTERIOR PARTS WITH APPEARANCE FUNCTIONS

Prepare the support as described in point 2.3.2 and/or 2.3.3 according to the type of support material (The process shall cause no deformation of the pieces).

Application of epoxy primer water based.

Dry film thickness = 50 ÷ 80 µm.

N.B. Not more than 72 hours (at ambient temperature) should elapse between the application of the epoxy primer and the next coat of paint; if, for any reason whatsoever, painting is carried out after such a length of time, it will be necessary to hand grind the surface and restore the coat of primer on the bared parts of the metal support with primer for touch-up.

Fill any areas with particular hollows (extruded part joints, localised flaws, weld shrinks) using epoxy filler with a spatula. Eliminate any ridges and flaws by hand grinding.

N.B. Total thickness of the filler shall be as low as possible.

Application of decorative finishing paints: spray a Polyurethane gloss finishing paint water based in the different colours, according to the colour schemes.
Dry film thickness = 60 ÷ 90 µm.

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4.9 PAINTING OF THE WOODEN PARTS

4.9.1 Wooden Parts Not In View

Paint in accordance with the specifications on the drawing as a function of the specific material/application.

4.9.2 Wooden Parts In View

Paint in accordance with the specifications on the drawing as a function of the specific material/application.

5 PROTECTING THE CAR BODY DURING TRANSPORT

During the transport the car body shall be protect according to the transport specification.

5.1 PAINTING PRODUCTS

Painting products and specific painting colours shall be used according to Company requests.

5.1.1 General Products

N.A.

5.1.2 Specific Colours

The following table illustrate the RAL colours applicable to the train, divided for each component.

Description	Notes	Colours Maps
Carbody shell	Ref. Drawing (TBD)	RAL1015 RAL8022 RAL7043 RAL1000 RAL1036
Equipment on roof/floor	All equipment except components in stainless steel	RAL (TBD)
Air reservoir	N.A.	RAL (TBD)
Bogie	N.A.	RAL (TBD)
Interiors Paneling	Ref Doc. (TBD)	
Drive desk	Ref Doc. (TBD)	

5.1.3 Products For Anti-Graffiti Adhesive Film

Anti-graffiti adhesive film, inscriptions, identifying plates have to be conforming.

It's necessary to verify the compatibility with the painting cycle and the surfaces of application. The Supplier of products for adhesive ant graffiti film, inscriptions and identifying plates has to present the results, conforming to the requirement of the homologation tests, demanding on the technical specification

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6 TEST AND PROTOTYPES

6.1 TYPE TESTS

The Supplier of painting products shall perform the homologation tests described below. In the case of parts or products supplied complete and painted, these tests pertain to their Supplier.

In the case of painting processes performed at the Company, standard tests pertain to the Company.

6.2 HOMOLOGATION TESTS

Test		Documents
a	Appearance	VISUAL
b	Gloss	ISO 2813
c	Colour	ISO 7724/1-3
d	Thickness	ISO 2808
e	Adhesion	ISO 2409
f	Adhesion	EN ISO 4624
g	Pencil hardness	ASTM D3363
h	Bending on cylindrical mandrel	ISO 1519
i	Cupping test	ISO 1520
l	Impact resistance	ISO 6272
m	UV-CON resistance	ISO 4892-1/3
n	Salt spray test	ISO 9227
o	Resistance in thermo-humidistat chamber	ISO 6270
p	Resistance chemical agents	ISO 2812-1
r	Resistance to collision with stones	ASTM D3170

6.3 STANDARD TESTS ON PAINTING CYCLE

The purpose of standard tests on the painting cycle is to make sure that the cycle, over time and on the different parts, meets the characteristics of the products and correct application requirements.

The minimum tests to be carried out are the following:

a) Appearance (colour, traces of sanding defects, orange skin, large fat edges formation, bare spot, cracking, scratches, pinholes, micro blister, dust, etc)
b) Thickness according to ISO 2808
c) Adhesion according to ISO 2409

These test can be integrated from the following added tests if indicate on control documents / test as MFC

d) Gloss according to ISO 2813

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e) Colour according to ISO 11664 series for the basics on colorimetry and the ISO 18314-1 to -4 on analytical colorimetry
f) Adhesion according to EN ISO 4624
g) Resistance to MEK (if necessary) according to EN 13523-11: on epoxy primer to make sure the degree of reticulation obtained is compatible with the application of the next layers

N.B. Non-destructive tests are admitted on specimens produced at the same time as the vehicle. For the main parts of the bodyshell the standard tests (type and frequency) are specified on the relevant routine cards.

6.3.1 Specimens

Unless otherwise specified, the specimens for the tests shall be produced:

- in the actual material and through a complete cycle (preparation and painting)
- according to ISO 1514, where necessary for specific tests, with the type of material most similar to the one actually employed and through a complete cycle (preparation and painting)

6.3.2 Acceptability Criteria

The requirements specified for the individual tests are given below:

a) Appearance: to be checked through visual inspection;
Requirement: conforming to supply/production master

b) Gloss: according to ISO 2813 (angle of incidence: 60°).
Requirement:
- ≥ 85 gloss for finishing enamel, in the absence of other provisions;
- ± 5 gloss if a specific value is required

c) Colour: according to ISO 7724/1/2/3;
Requirement with respect to supply/production master:

- $\Delta E \leq 0.5$ at time of supply,	$\Delta E \leq 1$ at application	for light colours;
- $\Delta E \leq 1$ at time of supply,	$\Delta E \leq 1.5$ at application	for dark colours.
- visual comparison		for metallic colours

d) Thickness: according to ISO 2808.
Requirement: limits given in this specification

e) Adhesion;
Requirement:
- according to ISO 2409;
- degree 0 for anti-corrosive primer or one-layer cycles;
- degree 1 for complete cycle.
- According to EN ISO4624;
- ≥ 3 N/mm2 for antirust primer and one-layer cycles;
- ≥ 2 N/mm2 for complete cycle

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f) Pencil hardness: according to ASTM D3363;
Requirement: ≥ degree F

g) Bending on cylindrical mandrel: according to ISO 1519;
Requirement:
Anticorrosive primer, thickness of 40 ÷ 60 µm: no flaking and detachment with Ø4 mm mandrel.
Finishing paints, the test has to be carried out on a film composed by a layer of 40 ÷ 60 µm of anti-corrosive primer and a layer of 40 ÷ 60 µm of the tested product. No flaking and detachment with Ø5 mm mandrel

h) Cupping test: according to ISO 1520;
Requirement:
single products with thickness of 40 µm: no cracks or detachment at 6mm

i) Impact resistance (Falling-weight) test: according to ISO 6272;
Requirement:
Anticorrosive primer: thickness of 40 ÷ 60 µm: no flaking and detachment with a falling height of 50 cm (direct impact).
Finishing paints: the test has to be carried out on a film composed by a layer of 40-60 µm of anti-corrosive primer and a layer of 40 ÷ 60 µm of the tested product. No flaking and detachment with a falling height of 50cm (direct impact)

l) UV-CON resistance: according to ISO 4892-1/3;
Aspects to be evaluated after 250 h, 500 h, 1000 h, 1500 h, 2000 h;
Requirements:
- Degree of colour variation (according to ISO 7724/1/2/3) after 1500 h and polishing:
- $\Delta E \leq 2.5$ for light colours to be applied to body;
- $\Delta E \leq 3$ for dark colours to be applied to body;
- visual comparison for metallic colours to be applied on body;
- Degree of variation in gloss (according to ISO 2813 (angle of incidence: 60°)) after 1500 h and polishing:
- max 15% of initial value for colours to be applied to body;
- Degree of deep cracking (according to ISO 4628/4):
- no deep cracks;
- Degree of exfoliation (according to ISO 4628/5):
- no exfoliation;
- Degree of chalking (according to ISO 4628/6):
- no chalking for colours to be applied to body

m) Resistance to artificial atmosphere (salt spray test): according to ISO 9227;
Aspects to be evaluated after 250 h, 500 h, 1000 h, 1500 h, 2000 h:
Requirements:
- Degree of blistering (according to ISO 4628/2) after 1500 h:
- no blistering (2 mm along cross);
- Degree of rusting (according to ISO 4628/3) after 1500 h:
- no rusting (2 mm of nicking along cross)

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n) Resistance in thermal humidistat chamber: according to ISO 6270 1-2:
Aspects to be evaluated after 250 h, 500 h, 750 h, 1000 h, 1500 h, 2000 h:
Requirements:
- Degree of blistering (according to ISO 4628/2) after 1500 h:
- no blistering;
- Degree of rusting (according to ISO 4628/3) after 1500 h:
- no rusting.
- Degree of exfoliation (according to ISO 4628/5):
- no exfoliation

o) Resistance to chemical agents: according to ISO 2812-1 method 1.
- oxalic acid (5%) and trisodium phosphate (5%) solution.
Requirement: after 24 h in bath:
- no colour or gloss variation;
- no softening / brittleness.
- Wash detergents.
Requirement: after 120 h in bath:
- no colour or gloss variation;
- no softening / brittleness

p) Resistance to MEK: according to EN 13523:
Requirement: degree to be defined by Supplier or paint products

q) Resistance to stone impact: according to ASTM D3170.
Requirement: degree of chipping ≤ 4a, 5b, 10c, 10d

7 ENVIRONMENTAL CONDITIONS

7.1 CLIMATIC CONDITION

General climatic conditions are reported in the mentioned General Technical Specification TŞ-01.139.

END of DOCUMENT

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