



Technical Data

JFE
Enamel Chalkboard
Enamel Whiteboard
Enamel Steel Sheet for Interior

River Enamel

(Dual Coat Enamel)

August 2015

JFE Metal Products Corporation

Introduction

Porcelain enamel is made by fusing glass glaze on a metal base through the process of baking at high temperatures. It has been widely used around the world for accessories, such as *shippouyaki* cloisonné enamels, kitchen products, and other items since long ago.

Porcelain enamel is smooth and hard, and resistant to scratches, chemicals, color fading, and stains. It can also withstand long, heavy use while maintaining a high level of performance. River Enamel from JFE Metal Products Corporation takes advantage of these features and is used as a surface material for chalkboards, whiteboards, and projection screens in schools, public facilities, and offices.

River Enamel is also incombustible and resistant to heat. For these reasons, it is used as an interior material for items such as kitchen panels and toilet booths.

River Enamel is the best porcelain enamel steel sheet in the world, and is produced under the strict quality control measures based on the enameling technologies JFE Metal Products Corporation has developed over more than 40 years.

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1. Manufacturing Process and Processing Techniques of River Enamel

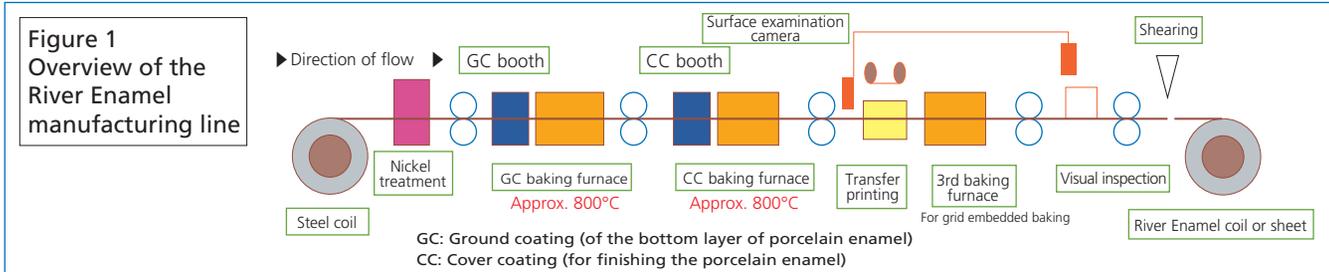
1-1. Manufacturing process

River Enamel is produced in the fully automated line, as shown in Figure 1.

The steel for eusmelting is pre-processed in a nickel treatment tank before it enters the ground-coat booth, where a roll coater evenly applies ground coat glaze to the material. The material is then baked at high temperatures in the ground-coat baking furnace, after which it proceeds to the cover-coat booth. Just as in the ground coating process, here a roll coater or a spraying device applies a finishing glaze, which is selected according to the intended use of the product. The material is then baked in the cover-coat baking furnace.

Grid embedded products are printed with patterns by a transfer printing machine before they are baked in a transfer printing furnace.

Then, after being subjected to strict checks by surface examination cameras and inspectors, River Enamel is cut and processed into coils or sheets which become products.



1-2. Processing techniques

1-2-1. Steel sheet for porcelain enamel

The steel sheet used for River Enamel is a special cold-rolled steel sheet for porcelain enamel (manufactured by JFE Steel Corp.). It contains far less carbon than decarburized steel sheets for porcelain enamel, a JIS-standard SPP material. For this reason, it is free of deformities or enamel defects even when it is baked at high temperatures exceeding 800°C.

1-2-2. Glaze

The ground-coat glaze contains a small amount of oxidized metal to facilitate chemical reactions between the glaze and steel sheet, and enhance the adhesion between them.

In regards to the cover-coat glaze, a titanium glaze-based pigment is added to white glaze (white, ivory, or gray) while a transparent glaze-based pigment is added to a dark-color glaze.

We uniquely blend and control the glaze on our own based on its intended application. This approach enables us to control the quality of our products.

1-2-3. Application of glaze

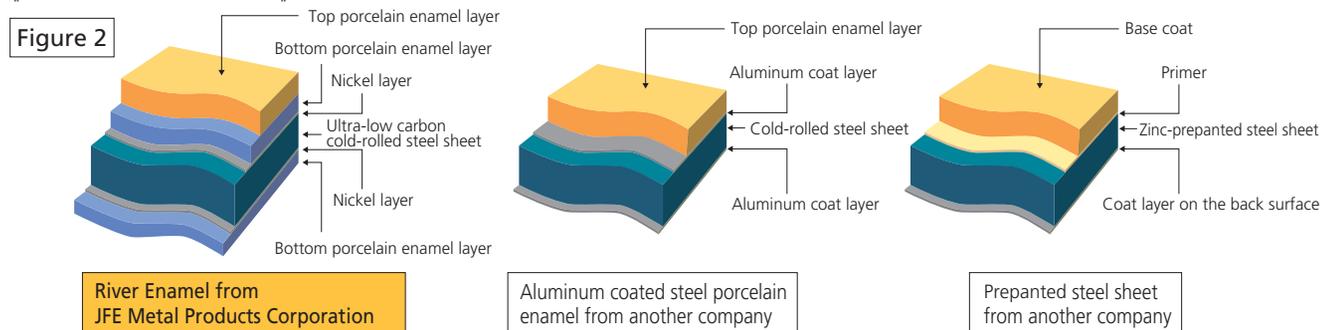
We use a computer-controlled roll coater or an automatic spraying device to apply the glaze, thereby ensuring a uniform coating thickness and creating a smooth surface. In this way, we manufacture products best suited for their intended use.

1-2-4. Baking

River Enamel is made through a double coating process in which the material is ground-coated, baked, cover-coated, and baked again. The double coating process ensures a thick enamel coating, excellent resistance to rust, and superior durability.

In addition, the inner walls of the baking furnaces are made of ceramic fibers and adopt the radiant tube heating system, providing excellent thermal efficiency and uniform temperature distribution.

《Cross-section structure》



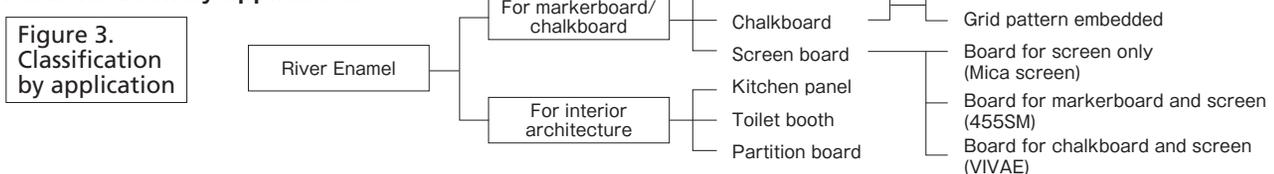
River Enamel is dual coat enamel with two surface porcelain enamel layers.

1-2-5. Inspections

Product inspections of River Enamel include a surface inspection by surface examination cameras installed on the manufacturing line and a subsequent visual inspection by skilled inspectors. In addition, adhesion checks, color tone and gloss level measurements, and appearance and shape measurements, such as measuring the warpage, are carried out off the manufacturing line at intervals of specified number of lots. The results of these checks and measurements are recorded.

2. Product Specifications of River Enamel

2-1. Classification by application



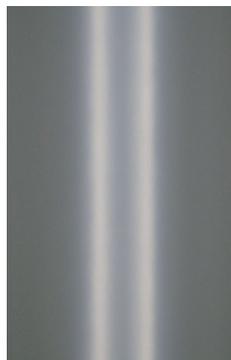
3. Comparison Table of Markerboard Specifications and Performance

Item	JIS S 6052		Reference standard and others	JFE (River Enamel)	Company A (Steel porcelain enamel)	Company B (Aluminum coated steel porcelain enamel)	Company C (Prepainted steel sheet)	Company D (Prepainted steel sheet)
	Standard No.	Standard value						
1 Coat thickness (surface layer)	R 4301	G3133, EN10209:60 ~180 μ m G3314:50 ~ 100 μ m	ISO 2178	110 μ m	110 μ m	60 μ m	30 μ m	30 μ m
2 Coat thickness (back surface layer)	R 4301	—	ISO 2178	30 μ m	50 μ m	0 μ m	8 μ m	8 μ m
3 Steel thickness	G 3133 (steel porcelain enamel product) G 3314 (aluminum coated steel porcelain enamel product)	$t \geq 0.3$ mm		0.3~0.48mm				
4 Color difference from standard (ΔE)	K 5600-4-6	—	ISO7724-3	$\Delta E \leq 1.5$	$\Delta E \leq 1.5$	—	—	—
5 Gloss level (Gs 20)	Z 8741	90% or lower		74%	53%	63%	—	—
	Z 8741	—	ISO 2813 ISO 7668	100%	100%	108%	97%	83%
6 Visibility	—	—		Photograph	Photograph	Photograph	Photograph	Photograph
7 Mohs hardness	—	—	EN 101	5.5	5.5	5.5	2.5	2.5
8 Wear resistance	K5600-5-9 (Taper type wear resistance test)	—	Decrease of mass during a wear resistance test (Wear ring CS-17/ 1kg) (1,000 revolutions)	1.3mg	2.0mg	2.0mg	44.7mg (There were parts where the base material was also worn.)	113.2mg (The base material was also worn.)
9 Impact resistance	R 4301 (Pistol type impact resistance test)	—		> 90N	> 90N	> 90N	> 90N	> 90N
10 Solvent resistance test: Alcohol, acetone, toluene, xylene, and petroleum benzine	—	—	Dip 20°C, 300hr	No change	No change	No change	No change	No change
11 Surface roughness	B 0601	$Rz \leq 14 \mu$ m	ISO 4287	1.2 μ m	1.3 μ m	1.2 μ m	0.9 μ m	1.1 μ m
12 Marker adhesion	S 6052	There must be no unevenness in the lines when the markerboard is viewed from a distance of one meter. The lines must look clear when the markerboard is viewed from a distance of eight meters.		Excellent	Excellent	Excellent	Excellent	Excellent
13 Marker erasability	S 6052	There must be no remaining marker traces or unevenness in erased areas when the markerboard is viewed from a distance of one meter.		Excellent	Excellent	Excellent	Excellent	Excellent
14 Enamel adhesion	K 5600-5-2 (Cupping test)	—	Indentation depth: 3 mm	No cracking/peeling was observed.	Both cracking and peeling were observed.	No cracking/peeling was observed.	No cracking/peeling was observed.	No cracking/peeling was observed.
15 Corrosion resistance	R4301 (Sodium chloride test)	There must not be any rust.		No rust	No rust	No rust	No rust	No rust

Note: Values with no indicated range are typical values, not guaranteed values.
Note: Values from tests we conducted on our own.

◆ Visibility of Markerboard

(Surface reflection and distortion)



〈River Enamel from JFE〉



〈Steel porcelain enamel from Company A〉



〈Aluminum coated steel porcelain enamel from Company B〉



〈Prepainted steel sheet from Company C〉



〈Prepainted steel sheet from Company D〉

The JFE River Enamel Markerboard has an extremely smooth enamel surface, making it easy to write and erase text. The text written on the markerboard is also very easy to see. In addition, it is highly resistant to rust, wear, impact, scratches, and color fading.

◆ Features of River Enamel Markerboard

Ease of writing/visibility	The markerboard has a smooth surface, making it easy to write smoothly with a marker pen. It also ensures sharp contrast between written letters, resulting in even higher legibility.	Resistance to solvents	The surface is able to withstand long-term use due to the blending of glaze which is highly resistant to chemicals. The surface will not exhibit any changes, even when it is exposed to solvents such as toluene and alcohol.
Erasability	The smooth surface allows for marker ink to be erased easily with a dedicated eraser.	Durability	The hard coating film of the enamel, which is formed through the vitrification of the glaze at high temperatures, is highly resistant to wear, impact, and scratches. Mohs hardness: 5.5
Easy to clean	The markerboard can be cleaned properly with the dedicated eraser. Refer to the maintenance instructions on the separate sheet when it becomes dirty. (Usually, the board becomes sufficiently clean by wiping it with wet dust cloth and then with dry cloth.)	Surface roughness	The smooth surface is created by blending the glaze and special glaze coating techniques. This results in higher performance in both ease of writing and erasability.
Resistance to rust (corrosion)	River Enamel has a thick coat and is free of rust, thanks to the dual layer structure of the ground coat and cover coat.	Incombustibility	Incombustibility accreditation number: NM-2744

4. Comparison Table of Chalkboard Specifications and Performance

Item	JIS S 6007		Reference standard and others	JFE (River Enamel)	Company A (Steel porcelain enamel)	Company B (Aluminum coated steel porcelain enamel)	Company C (Prepainted steel sheet)	Company D (Prepainted steel sheet)
	Standard No.	Standard value						
1 Coat thickness (surface layer)	R4301	—	ISO 2178	100 μm	120 μm	50 μm	25 μm	20 μm
2 Coat thickness (back surface layer)	R4301	—	ISO 2178	30 μm	50 μm	0 μm	8 μm	8 μm
3 Steel thickness	G 3133 (steel porcelain enamel product) G 3314 (aluminum coated steel porcelain enamel product)	t ≥ 0.3mm		0.3 ~ 0.48mm				
4 Color difference from standard (ΔE)	K 5600-4-6	—	ISO7724-3	ΔE ≤ 1.5	ΔE ≤ 1.5	—	—	—
5 Gloss level (Gs 75)	Z 8741	≤ 18%	ISO 2813 ISO 7668	16%	19%	19%	5%	11%
6 Chalk adhesiveness and contrast	—	—		Photograph	Photograph	Photograph	Photograph	Photograph
7 Mohs hardness	—	—	EN 101	3.5	3.5	3.5	2.5	2.5
8 Wear resistance	K5600-5-9 (Taper type wear resistance test)	—	Decrease of mass during a wear resistance test (Wear ring CS-17/ 1 kg) (1,000 revolutions)	7.2mg	6.7mg	8.0mg	40.1mg (There were parts where the base material was also worn.)	37.2mg
9 Impact resistance	R 4301 (Pistol type impact resistance test)	—		> 90N	> 90N	> 90N	> 90N	> 90N
10 Solvent resistance test: Alcohol, acetone, toluene, xylene, and petroleum benzine	—	—	Dip 20°C, 300hr	No change	No change	No change	No change	No change
11 Surface roughness	B 0601	Rz ≤ 19 μm	ISO 4287	13.4 μm	14.2 μm	13.2 μm	14.7 μm	11.1 μm
12 Chalk adhesion	S 6007	There must be no unevenness in the lines when the chalkboard is viewed from a distance of one meter. The lines must look clear when the chalkboard is viewed from a distance of eight meters.		Excellent	Excellent	Excellent	Excellent	Excellent
13 Chalk erasability	S 6007	There must be no remaining chalk traces or unevenness in erased areas when the chalkboard is viewed from a distance of one meter.		Excellent	Excellent	Excellent	Excellent	Excellent
14 Enamel adhesion	K 5600-5-2 (Cupping test)	—	Indentation depth: 3 mm	No cracking/peeling was observed.	Both cracking and peeling were observed.	No cracking/peeling was observed.	No cracking/peeling was observed.	No cracking/peeling was observed.
15 Corrosion resistance	R4301 (Sodium chloride test)	There must not be any rust.		No rust	No rust	No rust	No rust	No rust

Note: Values with no indicated range are typical values, not guaranteed values.

Note: Values are from tests we conducted on our own.

◆ Chalk adhesiveness and contrast



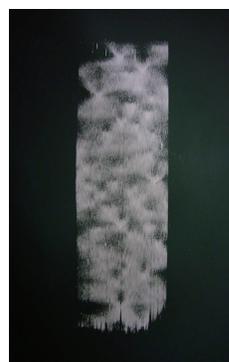
《River Enamel from JFE》



《Steel porcelain enamel from Company A》



《Aluminum coated steel porcelain enamel from Company B》



《Prepainted steel sheet from Company C》



《Prepainted steel sheet from Company D》

The JFE River Enamel Chalkboard has an extremely fine-textured enamel surface, making it easy to write and erase text. The text written on the chalkboard is also very easy to see. The surface is very hard and boasts superior durability.

◆ Features of River Enamel Chalkboard

Ease of writing/visibility	The chalkboard has a smooth, fine-textured surface, making it easy to write smoothly. It also ensures greater visibility because written letters do not appear faint.	Chalk adhesiveness and contrast	The surface is smooth and fine-textured due to the glaze blending and special glaze coating techniques. This results in superior chalk adhesiveness. It also ensures that written letters never appear faint, and provides for sharp contrast.
Erasability	The smooth, fine-textured surface allows for written letters to be erased easily with a dedicated chalk eraser. (Be sure to keep the chalk eraser clean.)	Durability	The hard coating film of the enamel, which is formed through vitrification of the glaze at high temperatures, is highly resistant to wear, impact, and scratches.
Easy to clean	The chalkboard can be sufficiently cleaned with a dedicated eraser. Refer to the maintenance instructions on the separate sheet when it becomes dirty. (Be sure to keep the chalk eraser clean.)	Surface roughness	The smooth, fine-textured surface is created by blending the glaze and special glaze coating techniques. This results in higher performance in both ease of writing and erasability.
Resistance to rust (corrosion)	River Enamel has a thick coat and is free of rust, thanks to the dual layer structure of the ground coat and cover coat.	Incombustibility	Incombustibility accreditation number: NM-2744

5. Markerboard maintenance

Markerboard

A markerboard may become badly stained or the erasability may deteriorate, depending on the use environment. The possible causes of stains are listed below.

The following section also describes what to do when the markerboard is badly stained or when the erasability has deteriorated.

Causes of noticeable stains

- ① The use of a badly stained eraser will also leave bad stains on the markerboard surface.
- ② If you erase a letter or word written in marker ink immediately after you write it, the marker ink will spread over the board because it has not yet dried.
- ③ If you use a neutral detergent or a dirty dust cloth to clean the surface of the board, the detergent or water stain on the surface may absorb the dirt from the eraser, making the markerboard dirty.
- ④ Air discharged from an air conditioner, tar, dirt left by hands, or finger marks may badly stain the board surface.



Cleaning a badly stained markerboard

- ① Wipe the board surface with a clean, wet dust cloth, and then wipe it with a dry dust cloth to remove all the residual water.
- ② If the stain remains after performing the previous step, use a commercially available ethyl alcohol (99.9%) to clean the board.
Do not use a dirty dust cloth or neutral detergent. Doing so will make the board surface susceptible to stains.
- ③ Be sure to use a clean eraser. If the eraser is extremely dirty, wash it with water, and then let it dry thoroughly before using it.
- ④ A thicker-piled eraser works better.

Causes of deterioration in eraser performance

- ① Letters written with old markers (with faint parts or faded colors) may be hard to erase, even during normal use, because of an imbalance in the ink components.
- ② Letters that are left unerased for a long time and those which have been exposed to sunlight or air from an air conditioner may be hard to erase.
- ③ Letters are hard to erase with an old eraser (with worn or torn fabric) or one with a lot of marker dust on it.
- ④ Letters written with a marker are extremely difficult to erase if you clean the board surface with a chemical such as acid and alkali or a neutral detergent.



What to do when letters written with markers are hard to erase

- ① Replace the marker with a new one when the letters written are faint or their colors appear faded.
- ② Replace the eraser with a new one when the fabric is worn or torn. When an eraser is extremely dirty, clean it by washing it with water, and then let it dry thoroughly before using it.
- ③ Do not clean the board surface with a chemical such as acid and alkali or a neutral detergent.

Ordinary markerboard maintenance

Wipe the markerboard with a clean, wet dust cloth, and then wipe it with a clean dry cloth.

6. Chalkboard maintenance

Chalkboard

Just as with a markerboard, a chalkboard may become badly stained or the erasability may deteriorate, depending on the use environment. The possible causes of stains are listed below.

The following section also describes what to do when the chalkboard is badly stained or when the erasability has deteriorated.

Causes of noticeable stains and deterioration in erasability

- ① A chalkboard that has been used for a long time may become extremely dirty due to the chalk powder deposited on the surface or dirt left by hands.
- ② Cleaning the chalkboard surface with a dirty cloth or neutral detergent may cause stains to remain.
- ③ The use of a chalk eraser with a large amount of chalk powder on it will make the board surface extremely dirty.
- ④ The use of an old chalk eraser with worn or torn fabric will make the board surface extremely dirty.
- ⑤ Letters written with chalk will be extremely difficult to erase if the board surface is cleaned with a chemical such as acid and alkali.



What to do when the chalkboard is extremely dirty and when the letters are hard to erase

- ① Remove the chalk powder from the eraser with an electric chalk eraser cleaner before each use.
- ② We recommend replace chalk erasers with new erasers when they become old and worn down, or when the fabric begins to tear.
- ③ When a chalkboard has been used for a long time and has become dirty, wipe it with a clean, wet dust cloth, and then with a clean dry cloth.
- ④ Do not clean the board surface with a chemical such as acid and alkali.

Ordinary chalkboard maintenance

Clean the board surface with a chalk eraser. Remove chalk powder from the eraser before using it.

Technical Data

River Enamel (Dual Coat Enamel)

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