**Recommended Enamel combinations for SunGuard® spandrels**

<table>
<thead>
<tr>
<th>SunGuard® in color area</th>
<th>Marítima Spandrel</th>
<th>Insulating Glass Spandrel</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD Neutral 0.7</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
</tr>
<tr>
<td>HD Neutral 4.6</td>
<td>SGG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
</tr>
<tr>
<td>HD Light Blue 9.2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
</tr>
<tr>
<td>HD Dark Grey 22</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
</tr>
<tr>
<td>HD Royal Blue 20</td>
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<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
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<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
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<td>Neutral 4.6</td>
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</tr>
<tr>
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<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
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<td>Neutral 22</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
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<tr>
<td>Black</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
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<tr>
<td>Dark Grey</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
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<tr>
<td>Royal Blue</td>
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<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
</tr>
<tr>
<td>Silver</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
</tr>
<tr>
<td>SunGuard® Superneutral</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
</tr>
<tr>
<td>SunGuard® High Performance</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
<td>SSG 52 on #2 + Ferro 140 12 4060 on #2</td>
</tr>
</tbody>
</table>

Increased energy absorption in IGU spandrels may result in both lites requiring heat treatment. The air gap should be limited, where possible, to 8 mm.

It must be ensured that SunGuard® spandrels are not exposed to any aggressive media before, during and after installation.

For special applications, please consult Guardian.

These guidelines are for information purpose only and Guardian does not provide any warranty with respect to their content. Guardian provides only a limited warranty for SunGuard® products and not regarding the intended further processing or end product, which remains the full responsibility of the processor.

### Verification

The signature below verifies that the processor has read and understands the full content of the CERAmIC PRInT - SP andREL GlaSS / Product Application Information / SUNGUARD® Spandrel, TM EN, 0216.

**Name/Signature**

**Title**

**Company/Stamp**

**Date**

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SunGuard® products are available at several locations situated throughout Europe. Please contact your local Guardian representative or your local Technical Advisory Center for further information.

- **Guardian United Kingdom**
  - Phone: 0844 030 0313
  - e-mail: sales.uk@guardian.com

- **Guardian Luxembourg**
  - Phone: 00352 2617206
  - e-mail: luxembourg@guardian.com

- **Guardian Spain**
  - Phone: 91 580 8199
  - e-mail: tecnica@guardian.com

- **Guardian Germany**
  - Phone: 00 49 512 99 3999
  - e-mail: info@guardian.de

- **Guardian France**
  - Phone: 01 57 13 32 82
  - e-mail: info@guardian.fr

- **Guardian Portugal**
  - Phone: 351 212 353 353
  - e-mail: tecnica@guardian.pt

- **Guardian Russia (Rostov)**
  - Phone: 00 7 891 258 58 88
  - e-mail: gsr_tac@guardian.com

- **Guardian Russia (Ryazan)**
  - Phone: 00 7 495 619 94 08
  - e-mail: gsr_tac@guardian.com

- **Guardian Hungary**
  - Phone: 36 1 490 75 00
  - e-mail: info.europe@guardian.com

- **Guardian Poland**
  - Phone: 00 48 22 619 81 80
  - e-mail: marketing@guardian.pl

- **Guardian Russia (Moscow)**
  - Phone: 795 111 33 32
  - e-mail: gsr_tac@guardian.com

This document is the only valid one for the application of SunGuard® in spandrel glazing. Please visit www.sunguardglass.com or contact Guardian for its most current version.

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Reference Code: SUNGUARD™ Spandrel, TM EN, 0216
Since there are various ceramic paints that may contain different chemicals, tests must be made in advance. Please check product compatibility before applying glue to the ceramic paint.

Requirements on Enamelling of SunGuard®

After performing extensive internal tests, Guardian recommends the following procedures:

- All enamels must not contain following ingredients: lead, cadmium, graphite, lithium, carbonate.
- Minimum thickness of the wet coating after printing with correctly adjusted processing viscosity:
  - 75 µm by silk-screen printing (e.g. silk-screen type PET 1500/32-100)
- Complete drying through the entire thickness of the enamel has to be ensured before firing.
- The final thickness of the enamel coating after firing should not be less than 30 µm.
- The ceramic frit must melt without bubbling, under normal temper conditions for flat glass, in order to ensure a dense and uniform cover with a minimized porosity.
- Minimum quality control of the final product:
  - All test methods recommended by the enamel manufacturer
  - Scratch resistance and adhesion tests with Erichsen-apparatus
  - Porosity and adhesion (co-proof-test)
  - Melting behavior and surface roughness (glaze test with gloss meter)
  - Uniform and dense coverage (detection of pinholes in transmission – halogen lamp test **)
- The manufacturer must follow specific processing instructions supplied by the enamel producer.

Spandrel glass in the glazed facade system is the glass that conceals structural building components such as columns, curtain wall and structural glazed designs. In the glazed facade system, electrical wiring, plumbing, etc. Spandrel glass is typically located between vision glasses on each floor of a building.

Curtain wall and structurally glazed designs often require the use of spandrel glass to achieve a designer’s vision of the finished project. Spandrel glass applications can be complementary or contrasting in colour when compared to the vision glass appearance. Spandrel glass must be heat treated to avoid thermal stress breakage. Guardian offers an expansion with spandrel glass applications and can help architects and building owners achieve the desired appearance while minimizing the risk of thermal stress breakage.

When vision glass is specified with a high light transmission or low external reflection, an exact colour match between spandrel and vision glass is challenging. Daylight conditions can have a distinctive effect on the perception of vision to spandrel appearance. For example, a clear, bright sunny day provides a higher reflective spandrel glass, which will enhance the vision to spandrel match. A grey, overcast day may allow more visual transmission from the exterior and produce a greater contrast between the vision and spandrel glasses. Guardian recommends that a full-size mock-up be prepared and approved in order to confirm the most desirable spandrel option for a specific project.

Spandrel glass can consist of an opacified uncoated glass, an opacified reflectively coated glass or can be an insulating glass unit composed of a solar control glass as the exterior pane and an opacified insulating interior pane.

SunGuard® Solar and High Durable reflective coated glasses allow for the application of ceramic frit directly to the coated surface for a monolithic spandrel (picture 2). This provides an economical solution that is suitable for many applications. If the desired match cannot be realized with the monolithic spandrel solution an insulation glazing spandrel can be considered (picture 3).

### Ceramic print with FEYRO System 140

The Ferro System 140 includes various types of ceramic paints, composed of partially different chemical components. In relation to the glass products indicated above, Guardian recommends the following types:

- **For spandrel glass:**
  - 14 13 4041 (colour similar to RAL 5007 Brilliant blue)
  - 14 12 4060 (colour similar to RAL 5014 Pigeon blue)
  - 14 11 4060 (colour similar to RAL 4000 Pattini green)
  - 14 15 4001 (colour similar to RAL 7031 Blue grey)
  - 14 14 4001 (colour similar to RAL 9005 Deep black)

- **For edge enamelling**
  - 14 10 4001 (colour similar to RAL 9005 Intensive black – more pigments)

The following table provides guidelines for the use of SunGuard® products in both monolithic and insulating glass spandrel applications. All glass configurations are with the coating on surface #2. On single glasses the first is directly applied to surface #2 and the frit or other opacifier on surface #4 of an insulated glass unit.
Various Guardian SunGuard coatings, equipped with the special Silacoat® layer system, can be printed with ceramic paints.

Glass enamels may react during firing with coatings causing some hazy appearance or even complete destruction of the coating. Therefore it is necessary to test compatibility of enamels with coated glass, under production firing conditions, in order to get optimum results. It is recommended to run preliminary tests with selected ceramic paint/glaze combinations, using the intended production furnace, glass geometries and ceramic coated areas. Unfavorable temper conditions could be the reason to get poor results (low gloss, colour, homogeneity, durability, density, adhesion).

Compatibility and suitability tests are essential for each project. Any printing on a coated glass surface can create colour deviations after firing. Full case project mock-ups are advisable. The processor is responsible for the quality control and quality of the final product.

SunGuard products can be printed with ceramic paint for various purposes:

Drapery print
- Patterns (dots or lines) which are applied to the coating by silk-screen printing
- Must be used facing inside the cavity of insulating glass only
- Patterns (dots or lines) which are applied to the coating by silk-screen printing
- No common approval in combination with SunGuard
- Protects IG sealants against UV radiation
- Covers up construction elements in the edge area
- Ceramic paint needs to cover the SunGuard

Curtain wall glazings / Spandrels (ceramic paint covering the whole coated surface)
- SunGuard® Solar and High Durable coatings only
- Can be used as a single glazing
- Ceramic paint needs to cover the SunGuard® coating in order to ensure an effective protection against any environmental influences

Parapet wall glazings / Spandrels (ceramic paint covering the whole coated surface)
- With SunGuard® Solar and High Durable coatings only
- Can be used as a single glazing
- Ceramic paint needs to cover the SunGuard® coating in order to ensure an effective protection against any environmental influences

Edging enameling
- Covers up construction elements in the edge area
- Protects IG sealants against UV radiation
- No common approval in combination with SunGuard® High Performance. Please contact Guardian!
- Edge enameling of SunGuard® High Performance with a width over 5 cm is not recommended

Picture 1:

Ceramic paint with FEERO System 140

Ferro and Guardian have tested “System 140” colours using recommended solvent “Medium 80 1022” or “Medium 80 1026” on Guardian SunGuard products:

- SunGuard High Performance
- SunGuard Solar
- SunGuard High Durable
- SSG 52

The Ferro System 140 includes various types of ceramic paints, composed of partially different chemical components. In relation to the glass products indicated above, Guardian recommends the following types:

- For enameling glass: 140 13 4041 (colour similar to RAL 8001 deep black)
- 140 12 4060 (colour similar to RAL 5014 Pigeon blue)
- 140 11 4060 (colour similar to RAL 4005 Pating green)
- 140 15 4001 (colour similar to RAL 7023 Blue grey)
- 140 14 4001 (colour similar to RAL 9005 Intensive black – more pigments)

Since there are various ceramic paints that may contain different chemicals, tests must be made in advance. Please check product compatibility before applying glue to the ceramic paint.

Requirements on Enamelling of SunGuard®

After performing extensive internal tests, Guardian recommends the following procedures:

- All enamels must not contain following ingredients: lead, cadmium, graphite, lithium, carbonate.
- Minimum thickness of the wet coating after printing with correct adjusted processing viscosity:
  - 75 µm by silk-screen printing (e.g. silk-screen type PET 1500/32-100)
  - 90 µm by enameling with roller coating
- Complete drying through the entire thickness of the enamel has to be ensured before firing.
- The final thickness of the enamel coating after firing should not be less than 30 µm.
- The ceramic frit must melt without bubbling, under normal temper conditions for flat glass, in order to ensure a dense and uniform cover with a minimized porosity.
- Maximum quality control of the final product
- All test methods recommended by the enamel manufacturer
- Scratch resistance and adhesion test with Erichsen-pen
- Porosity and adhesion (co-proof test)
- Melting behavior and surface roughness (glaze test with glass meter)
- Uniform and dense coverage (detection of pinholes in transmission – halogen lamp test **) 
- The processor must follow specific processing instructions supplied by the enamel producer.

Spandrel glass

Spandrel glass is the glass that conceals structural building components such as columns, curtain wall framing systems, electrical wiring, plumbing, etc. Spandrel glass is typically located between vision glasses on each floor of a building.

Curtain wall and structurally glazed designs often require the use of spandrel glass to achieve a designer’s vision of the finished project. Spandrel glass applications can be complementary or contrasting in colour when compared to the vision glass appearance. Spandrel glass must be heat treated to avoid thermal stress breakage. Guardian’s experience with spandrel glass applications can help architects and building owners achieve the desired appearance while minimizing the risk of thermal stress breakage.

When vision glass is specified with a high light transmission or low external reflection, an exact colour match between spandrel and vision glass is challenging. Daylight conditions can have a distinct impact on the perception of vision to spandrel appearance. For example, a clear, bright sunny day provides a higher reflective appearance. A grey, overcast day may allow more visual transmission from the exterior and produce a greater contrast between the vision and spandrel glass. Guardian recommends that a full size mock-up be prepared and approved in order to confirm the most desirable spandrel option for a specific project.

Spandrel glass can consist of an opacified uncoated glass, an opacified reflectively coated glass or can be an insulating glass unit composed of a solar control glass as an exterior pane and an uncoated insulated interior pane.

SunGuard® Solar and High Durable reflective coated glasses allows for the application of ceramic frit directly to the coated surface for a monolithic spandrel (picture 2).

This provides an economical solution that is suitable for many applications. If the desired match cannot be realized with the monolithic spandrel solution an insulation glazing spandrel can be considered (picture 3).

The following table provides guidelines for the use of SunGuard® products in both monolithic and insulating glass spandrel applications. All glass configurations are with the coating on surface #2. On single glasses the frit is directly applied to surface #2 and the frit or other opacifier on surface #4 of an insulating glass unit.

Picture 2:

Picture 3:
Enamels have been carefully developed for printing and firing on normal soda-lime based float glass. During the re-melting process of the glass, these enamels melt and fuse permanently to the glass surface to form a coloured ceramic layer.

Various Guardian SunGuard coatings, equipped with the special Silacoat® layer system, can be printed with ceramic paint.

Glass enamels may react during firing with coatings causing some hazy appearance or even complete destruction of the coating. Therefore, it is necessary to test the compatibility of enamels with coated glass, under production firing conditions in order to get optimal results. It is recommended to run preliminary tests with selected ceramic paint/glass combinations, using the intended production furnace, glass geometries and ceramic coated areas. Unfavorable temperature conditions could be the reason to get poor results (low gloss, colour, homogeneity, durability, density, adhesion).

Compatibility and suitability tests are essential for each project. Any printing on a coated glass surface can create colour deviations after firing. Full case project mock-ups are advisable. The processor is responsible for the quality control and quality of the final product.

SunGuard products can be printed with ceramic paint for various purposes:

**Decorative print**
- Patterns (dots or lines) which are applied to the coating by silk-screen printing
- No common approval in combination with SunGuard
- Protects IG sealants against UV radiation
- Covers up construction elements in the edge area
- Ceramic paint needs to cover the SunGuard
- Edge enameling of SunGuard

SunGuard® products can be printed with ceramic for various purposes:

**Parapet wall glazings / Spandrels (ceramic paint covering the whole coated surface)**
- With SunGuard® Solar and High Durable coatings only
- Can be used as a single glazing
- Ceramic paint needs to cover the SunGuard® coating in order to ensure an effective protection against any environmental influences.

**Edge enameling**
- Covers up construction elements in the edge area
- Protects IG sealants against UV radiation
- No common approval in combination with SunGuard® High Performance. Please contact Guardian!
- Edge enameling of SunGuard® High Performance with a width over 5 cm is not recommended

**Requirements on Enamelling of SunGuard®**

After performing extensive internal tests, Guardian recommends the following procedures:

- All enamels must not contain following ingredients: lead, cadmium, graphite, lithium, carbonate.
- Minimum thickness of the wet coating after printing with correctly adjusted printing viscosity:
  - 75 µm by silk-screen printing (e.g. silk-screen type PET 1500/32-100)
  - 75 µm by enameling with roller coating
- Complete drying through the entire thickness of the enamel has to be ensured before firing.
- The final thickness of the enamel coating after firing should not be less than 30 µm.
- The ceramic frit must melt without bubbling, under normal temper conditions for flat glass, in order to ensure a dense and uniform cover with a minimized porosity.
- Minimum quality control of the final product:
  - All test methods recommended by the enamel manufacturer
  - Scratch resistance and adhesion tests with Erichsen-probe
  - Porosity and adhesion (cross-probe test)
  - Melting behavior and surface roughness (glaze test with glass meter)
- Uniform and dense coverage (detection of pinholes in transmission – halogen lamp test 1)

- The processor must follow specific processing instructions supplied by the enamel producer.

**Ceramic print with FERRO System 140**

Ferro and Guardian have tested “System 140” colours using recommended solvents: “Medium 80 1022” or “Medium 80 1026” on Guardian SunGuard products:

- SunGuard® High Performance
- SunGuard® Solar
- SunGuard® High Durable
- SSG 52

The Ferro System 140 includes various types of ceramic paints, composed of partially different chemical components. In relation to the glass products indicated above, Guardian recommends the following types:

- For enamelled glass: 140 13 4061 (colour similar to RAL 5007/Deep black)
- For edge enamelling: 140 13 4061 (colour similar to RAL 5007/Deep black)
- For enamelled glass: 140 14 4001 (colour similar to RAL 9003/Sepia brown)

1) Uniform and dense coverage (detection of pinholes in transmission – halogen lamp test 1)

The processor must follow specific processing instructions supplied by the enamel producer.

Since there are various ceramic paints that may contain different chemicals, tests must be made in advance. Please check product compatibility before applying glue to the ceramic paint.

![Table 1](Image_1348x95 to 1546x162)

**Spandrel glass**

Spandrel glass is in the glazes that conceals structural building components such as columns, curtain wall framing, electrical wiring, plumbing, etc. Spandrel glass is typically located between vision glasses on each floor of a building.

Curtain wall and structurally glazed designs often require the use of spandrel glass to achieve a designer’s vision of the finished project. Spandrel glass applications can be complementary or contrasting in colour to calm down the vision glass appearance. Spandrel glass must be heat treated to avoid thermal stress breakage. To facilitate the formulation with spandrel glass applications and to help architects and building owners achieve the desired appearance while minimizing the risk of thermal stress breakage.

When vision glass is specified with a high light transmission or low external reflection, an exact colour match between spandrel and vision glass is challenging. Daytonlight conditions can have a detrimental effect on the perception of vision to spandrel appearance. For example, a clear, bright sunny day provides a higher reflective appearance, which will invive the vision to spandrel match. A grey, overcast day may allow more visual transmision from the exterior and produce a greater contrast between the vision and spandrel glass. Guardian recommends that a full size hand-made mock-up be prepared and approved in order to confirm the most desirable spandrel option for a specific project.

Spandrel glass can consist of an opacified uncoated glass, an opacified reflectively coated glass or can be an insulating unit composed of a solar control glass as an exterior pane and an opacified uncoated interior pane. SunGuard® Solar and High Durable reflective coated glass allows for the application of ceramic frit directly to the coated surface for a monolithic spandrel (picture 2).

This provides an economical solution that is suitable for many applications. If the desired match cannot be realized with the monolithic spandrel solution an insulation glazing spandrel can be considered (picture 3).
**Recommended Enamel combinations for SunGuard® spandrels**

<table>
<thead>
<tr>
<th>SunGuard®</th>
<th>Enamel</th>
<th>Paint Coating</th>
<th>Reference Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD Neutral 0.7</td>
<td>SSG 52 on #2 + Ferro 140 12 4061 on #2</td>
<td>SG Solar Royal Blue 20 on #2 + Ferro 140 12 4060 on #2</td>
<td>HD Neutral 0.7 on #1 + Frit on #6</td>
</tr>
<tr>
<td>HD Neutral 6.7</td>
<td>SSG 52 on #2 + Ferro 140 15 4001 on #2</td>
<td>SG Solar Royal Blue 20 on #2 + Ferro 140 12 4060 on #2</td>
<td>HD Neutral 6.7 on #1 + Frit on #6</td>
</tr>
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<td>HD Quention 44</td>
<td>SSG 52 on #2 + Ferro 140 15 4001 on #2</td>
<td>SG Solar Royal Blue 20 on #2 + Ferro 140 12 4060 on #2</td>
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<tr>
<td>HD Light Blue 9.2</td>
<td>SSG 52 on #2 + Ferro 140 15 4001 on #2</td>
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<tr>
<td>HD Blue Matt 8.2</td>
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<td>SG Solar Royal Blue 20 on #2 + Ferro 140 12 4060 on #2</td>
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<td>SG Royal Blue 20 on #1 + Frit on #4</td>
<td>HD Blue Matt 20 on #1 + Frit on #6</td>
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<tr>
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<td>SG Royal Blue 20 on #1 + Frit on #4</td>
<td>HD Blue 20 on #1 + Frit on #6</td>
</tr>
<tr>
<td>Neutral 0.7</td>
<td>SSG 52 on #2 + Ferro 140 15 4001 on #2</td>
<td>SG Royal Blue 20 on #1 + Frit on #4</td>
<td>Neutral 0.7 on #1 + Frit on #6</td>
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<tr>
<td>Neutral 6.7</td>
<td>SSG 52 on #2 + Ferro 140 15 4001 on #2</td>
<td>SG Royal Blue 20 on #1 + Frit on #4</td>
<td>Neutral 6.7 on #1 + Frit on #6</td>
</tr>
<tr>
<td>Light Blue 9.2</td>
<td>SSG 52 on #2 + Ferro 140 15 4001 on #2</td>
<td>SG Royal Blue 20 on #1 + Frit on #4</td>
<td>Light Blue 9.2 on #1 + Frit on #6</td>
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<td>Light Blue 3.2</td>
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<td>Brown 8.2</td>
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<td>SG Royal Blue 20 on #1 + Frit on #4</td>
<td>Brown 8.2 on #1 + Frit on #6</td>
</tr>
</tbody>
</table>

*Note: For special applications, please consult Guardian.*

**Veriﬁcation**

The signature below veriﬁes that the processor has read and understands the full content of the CERAmIC PRInT - SPAndrel GLASS / Product Application Information / SUNGUARD® Spandrel, T1_EN_0216.

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Recommended Enamel combinations for SunGuard® spandrels

<table>
<thead>
<tr>
<th>SunGuard® in metric area</th>
<th>Maroonic Spandrel</th>
<th>Invincible Glass Spandrel</th>
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<tbody>
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</tbody>
</table>

Increased energy absorption in IGU spandrels may result in both lites requiring heat treatment. The air gap should be limited, where possible, to 8 mm.

It must be ensured that SunGuard® spandrels are not exposed to any aggressive media before, during and after installation.

For special applications, please consult Guardian.

These guidelines are for information purpose only and Guardian does not provide any warranty with respect to their content. Guardian provides only a limited warranty for SunGuard® products and not regarding the intended further processing or end product, which remains the full responsibility of the processor.

Verification

The signature below verifies that the processor has read and understands the full content of the CERAmIC PRInT - SP andREL GlaSS / Product Application Information / SUNGUARD Spandrel, TI_EN_0216.

Please return this page signed via email at info.europe@guardian.com.

SunGuard® Products are available at several locations situated throughout Europe. Please contact your local Guardian representative or your local Technical Advisory Center for further information.

For special applications, please consult Guardian.

This document is only valid for the application of SunGuard in spandrel glazing. Please visit www.sunguardglass.com or contact Guardian for its most current version.

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