PPG STEELGUARD® 951

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1.0 INTRODUCTION

1.1 Scope

The purpose of these application guidelines is to provide information regarding how to consistently and correctly apply the PPG STEELGUARD 951 Passive Fire Protection (PFP) coating system. These guidelines are not intended as a source for the determination of the STEELGUARD 951 loadings or other specification criteria.

For the safe handling and use of STEELGUARD 951, reference should also be made to the latest versions of both the product data sheets (PDS) and the safety data sheets (SDS) available online.

Only applicators trained or approved by PPG should apply STEELGUARD 951.

The information contained in these guidelines is based upon independent test data, research and field experience, and is believed by PPG to be accurate at the time of publication. However, the contents are not to be construed as warranties to performance or results and will be subject to review and revision from time to time due to our policy of continuously improving our products, processes and service. It is not intended to be exhaustive, there are many factors that can affect the application of the STEELGUARD 951 coating system, which PPG cannot control or account for in these guidelines, such as the quality or condition of the substrate and environmental conditions. Accordingly, the applicator is responsible for ensuring that STEELGUARD 951 is correctly applied given the specific factors affecting the applicator's use of the STEELGUARD 951.

In the event of any doubt or lack of understanding, PPG Field Technical Service (FTS) should be consulted for clarification.

1.2 Field Technical Support

PPG has a global Field Technical Service (FTS) network available to assist with any queries and provide project specific technical advice to aid with the application of STEELGUARD 951, however FTS are not accountable as project inspectors and all application work, quality control and inspection remains the responsibility of the applicator. Please consult the regional PPG FTS in the first instance for technical support.

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2.0 MATERIAL HANDLING AND STORAGE

2.1 Pack Sizes

STEELGUARD 951 is available in the following standard pack sizes: (Note: STEELGUARD 951 is sold and measured by weight not volume).

PPG STEELGUARD 951 Kit	Details
Plural Feed (PF) Kit 	• Supplied in bulk filled containers suitable for machine filling of a heated plural feed spray machine. • Consists of 2 pails of base and 1 pail of hardener = Kits size 60kg (132.3lbs)
Single Feed (SF) Kit 	• Supplied in partial filled containers to allow mixing within the pail for application by single feed airless spray pump with follower plate or trowel application. • Consists of 1 pails of base and 1 pail of hardener = Kits size 18kg (39.7 lbs)

2.2 Storage Environment

STEELGUARD 951 materials should be stored indoors and out of direct sunlight, the following storage temperature ranges should be maintained:

- General Storage: minimum 0°C (32°F) and maximum 30°C (86°F)
- Pre-conditioning of material before application is recommended. Please refer to the relevant application method in Section 5 of this document for more details.

NOTE: where storage conditions deviate from these limits, advice should be sought from PPG's FTS.

To achieve the correct temperatures listed above it may be necessary to use heated or cooled storage units, especially in cold or hot temperate climates. It is recommended that where the material has been stored at low temperatures, i.e., less than 5°C (41°F), that the temperature should be raised gradually to application temperature over a period of 48 hours.

Accelerated methods of heating STEELGUARD 951 pails prior to use, such as electrical heaters in direct contact with the pail or hot water baths are not permitted. Such methods can cause overheating of the outer layers of material in the pail, which may produce undesirable changes to its properties (including a shorter pot life)

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3.0 SUBSTRATES AND SURFACE PREPARATION

3.1 Surface Preparation
All surfaces to be protected by STEELGUARD 951 should be correctly prepared and primed. Surface preparation and coating should be carried out in line with 'best industry practice' as indicated in many publications by organizations such as ISO, NACE, SSPC, ICORR, FROSIO, etc.

The standards of surface preparation contained herein are to be considered minimum requirements. Where other client or project specifications demand a higher level, then the higher level should be adopted.

3.2 Substrate Types
STEELGUARD 951 is suitable for the protection of, and application on, the following substrates:

- Carbon (Mild) Steel
- Galvanized Steel

Please contact PPG regarding other substrates.

3.3 Degreasing and Cleaning
All surfaces to be coated should be clean, dry and free of all oil, grease, dirt, dust and other contaminants; this should be carried out as per SSPC SP1 guidelines.

3.3.1 Abrasive Blast Cleaning
Abrasive blast cleaning is the preferred method of surface preparation prior to the application of the STEELGUARD 951. All used grit blast material and other dust and debris should be removed from the steelwork prior to the application of coating.

3.3.2 Carbon Steel Substrates
Abrasive blast cleaning should be carried out in accordance ISO 8501-1 to a visual standard Sa 2.5 (SSPC SP10/NACE 2) near white metal blast cleaning. The blast profile should be in the range of 50–75µm (2–3 mils) with a sharp angular profile. Preparation to visual standard Sa 2 (SSPC SP6/NACE3) may be possible depending on the project specification – please consult with PPG for more information. Wet abrasive blasting is allowed if that is an accepted method on the primer PDS.

3.3.3 Galvanized steel
Sweep blasting is recommended, in accordance with SSPC SP16. The blast profile shouldbe a minimum of 50µm (2 mils) using non-metallic grit of a fine or medium size with a sharp angular profile. Note: blast profile should be confirmed using portable stylus instruments in accordance with ASTM D-7127, since measurements using composite plastic tapes to ASTM D-4417 methods have produced false positives on galvanized surfaces.

Galvanized substrates are particularly problematic for the application of thick film epoxy intumescent coatings due to great variance in the quality and thickness of galvanizing. Steel that is to be fire protected with PFP should be blasted prior to galvanizing and the galvanizer informed of the intent to apply PFP coating so they make appropriate adjustments to ensure galvanized coating on reactive structural steel (due to silicon content) will not result in a brittle/fragile surface or susceptibility to mechanical damage resulting from subsequent abrasive blast cleaning.

As STEELGUARD 951 provides a full barrier anti-corrosion protection system, the use of galvanizing with it is not regarded as necessary; however, it is normally not possible to differentiate the areas that require PFP early enough so typically all the steel is galvanized up front. Generally, it is considered preferable to blast off the majority of the galvanizing coating leaving only the thin layer of alloyed, tightly adhered, zinc remaining. After blasting of the galvanizing coating an epoxy tie-coat from the STEELGUARD APPROVED PRIMERS guide sheet should be applied immediately (industry guidance recommends within one hour) to prevent the formation of zinc salts.

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3.4 Environmental Conditions

The following conditions are considered the extremes at which STEELGUARD 951 can be applied. Note that the optimum conditions are the preferred application conditions, which are also set out below (all values applicable during application and curing):

- Substrate temperature: Minimum 5°C (40°F) and at least 3°C (5°F) above dew point and not above 60°C (140°F)
- Relative humidity: Maximum 70%
- Environment temperature: Above 10°C (50°F) and not above 45°C (120°F)

The optimum conditions for application & curing of STEELGUARD 951 are (all values applicable during application and curing):

- Substrate temperature: As above
- Relative humidity: Maximum 60%
- Environmental temperature: Above 15°C (59°F) and not above 35°C (86°F)

Environmental conditions must be monitored throughout the working shift, as well as during curing times since weather conditions can vary greatly. Where these optimum conditions cannot be met or maintained, advice should be sought from PPG.

The above parameters are to be observed during the application of different coats of STEELGUARD 951. Once the final coat of the system has been applied, the coated steelwork can be moved to unconditioned areas once the product is dry to handle.

Please refer to PDS for curing times.

4.0 PRIMER SELECTION

4.1 Purpose

The compatibility of the STEELGUARD 951 with the primer should be verified; for this reason, only primer and coating systems satisfactorily tested and qualified by PPG should be used under the STEELGUARD 951. Ideally, the STEELGUARD 951 should be used in conjunction with PPG primers as compatibility of primer and performance are readily verified.

Please refer to the STEELGUARD APPROVED PRIMERS guide sheet for the latest PPG approved primers.

4.2 Primer Condition

It is the applicator's responsibility to ensure that the primed surface and the primer itself are in acceptable condition for overcoating with the STEELGUARD 951. Factors such as ageing of the primer (degradation and surface chalking), contamination, zinc salt formation, rust, bloom, etc. should be considered when determining a surface's suitability before overcoating with the STEELGUARD 951.

In all situations, the surface of the primer should be clean, dry and free of contaminants immediately prior to overcoating with the STEELGUARD 951. Care should be taken to ensure that primer systems have reached sufficient levels of cure prior to overcoating with the STEELGUARD 951, please refer to primer PDS for specific details. Consult the relevant primer PDS for minimum and maximum overcoating times.

4.3 Approved Primers

Only approved primers can be used under STEELGUARD 951. Please consult the STEELGUARD APPROVED PRIMERS guide sheet for the latest list of PPG APPROVED PRIMERS. Zinc salts may occur if epoxy zinc primers are exposed to humid or outdoor conditions prior to application of STEELGUARD 951. These will need to be removed prior to the application of STEELGUARD 951. Typically, this is achieved by high-pressure water washing at a minimum of 170 bar (2500 PSI). If stubborn salts persist, then brushing or another abrasive method will need to be included with the water washing. Industry best practice recommends that zinc epoxy primers should be sealed with a tie-coat to prevent the formation of zinc salts that are detrimental to adhesion of the STEELGUARD 951.

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5.0 STEELGUARD 951 APPLICATION

5.1 Application Methods

STEELGUARD 951 can be applied in several ways including:

- Hopper-fed Plural Spray
- Single leg airless spray
- Heated plural feed airless spray
- Hand application by trowel

Note: It is not possible to apply STEELGUARD 951 by brush or roller. This section of the guidelines explains these four methods of application in detail. Regardless of application method, the material temperature should not be higher than 45°C (120°F) during application.

5.2 Protection of Adjacent Surfaces

Adjacent surfaces that do not require PFP coating, and areas around field joint connections (block-outs) and other design details to be protected by hand application later, should be completely masked off and covered using masking tape and/or paper or plastic sheeting in preparation for application. Once this has been completed, application may begin.

Any masking tape should be removed whilst the product is still wet, and the edge rolled smooth to prevent any lifting of the cured edge leading to potential lifting and corrosion sites.

5.3 Application Tools and Equipment

Hand application tools will be required regardless of whether the STEELGUARD 951 is applied by heated plural feed airless spray, single feed airless spray or by hand. See below for an example of the minimum application tool requirements to correctly apply STEELGUARD 951. Tools should be regularly cleaned to avoid contamination or sub-standard quality application to the final surface finish of the coating.

Figure 1: Minimum tools required:

- Round nose pointing trowel
- Plasterers' finishing trowel
- Bridging gauges (scraper with cut away notch) for measuring WFT
- Hydracone depth gauge (optional)

5.4 Hopper-Fed Plural Spray

STEELGUARD 951 is a two-component epoxy intumescent coating, therefore the most efficient application method of the coating is with plural airless spray equipment, which offers the advantage of not requiring any premixing of the two components, while eliminating any need for introducing solvents and negating pot-life issues.

The equipment used should be purposely designed to spray two-component epoxy PFP coatings, such as STEELGUARD 951, and should be capable of delivering the required ratios, pressures, temperatures and flow rates to correctly apply the product. Pump suppliers will provide their own instructions on machine operation, maintenance and set up required to achieve a high-quality application. The information contained within these application guidelines is given for advice only and the contractor is responsible for determining the suitability of specific pieces of equipment and maintenance of the equipment in good working order according to the manufacturer's recommendations.

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5.4.1 Preconditioning of Material

Prior to application of STEELGUARD 951 coatings using simplified plural feed airless spray equipment, both base and hardener should be stored in a heated storage unit at 20-25°C (68-77°F) for at least 24 hours prior to use. Storage at these temperatures will reduce the viscosity of the product, assisting machine filling and reducing start up time. For ambient conditions consistently higher than this, no pre-conditioning is needed. Base and hardener may be stored for up to 4 days in closed containers under these conditions. The material should be used within this period and not be reheated again.

Prior to filling the machine with material, pre-mix each component using a standard paint mixer until a smooth consistency is achieved.

5.4.2 Machine Operating Parameters

The operating parameters for STEELGUARD 951 depend on several factors including the equipment type and environmental conditions. The below general parameters are provided for guidance purposes; however, applicators should ensure the accuracy of parameters based on the factors influencing their application prior to use of STEELGUARD 951.

Recommended working hose line (containing mixed material) up to 15m (50 ft) of ½" with whip hose ⅜" no longer than 1.5m (5 ft), airless gun type front inlet ⅜". It is also recommended to use two in-line mixing tubes connected, to ensure the material is fully mixed throughout spraying. An example of a pump set-up is as below:

1. Part A to mixer block ¾" hose.
2. Part B to mixer block, ¾" hose from machine to the last length of hose then reduced to ½" hose connecting to mixing block.
3. Maximum length of hoses is 50m (165ft) from the pump to job face.
4. A ¼" water circulation line from machine to mixer block.

Points 1,2,3 Should be insulated and taped all together. The water circulation line circulates hot water from the machine to the mixer block maintaining the heat from the pump. The temperature of the water lines will vary due to ambient conditions.

Note: The water circulation is not used for heating material up, it is only there to maintain the heat.

5. After the block, 1m (3 ft) ½" integration line
6. After the integration line, 2 x ½" inline mixers with a minimum of 12 turns on the worm.
7. 5-7m (16-23 ft) ½" whip line (connects the inline mixer to the spray gun). It can be reduced to ⅜" for maximum 1.5 m (5 ft). A swivel is always recommended.
8. A PFP spray gun

Note: spray tips can be changed to suit sprayer/beams/thicknesses

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Operating Parameter	Value
Material Hoppers	Base: 20-25°C (68-77°F) Hardener: 20-25°C (68-77°F)
In-line Heater Temperatures (optional)	Base: 25-35°C (77-95°F) Hardener: 25-35°C (77-95°F)
Hose Heater Temperatures (optional)	30-40°C (86-104°F)
Gun Exit Temperature	30-40°C (86-104°F)
Displacement Pump Pressure	175-240 bar (3000-4500 PSI)

Thoroughly pre-mix each component using a high-torque hand mixer, then pour components from the drums into the relevant holding hoppers.

The components should be circulated through the material pumps (and in-line heaters) until the base and hardener have reached a minimum temperature of 30°C (86°F). Material temperature **MUST NOT** be any higher than 45°C (120°F) during application.

Switch on the main pump for approximately 10 minutes at an input pressure of 1.4 bar (20 PSI). Empty a minimum of 20l (5 US gallons) of base and 10l (2.5 US gallons) of hardener through the sampling valves. If the equipment does not have sampling valves, then the hoses before the mixing block should be disconnected.

It is important to preheat the lines of the pump to get hot material at the end of the hose when application begins.

5.4.3 Spray Tips and Operating Pressure

Typically, spray tips of 0.533-0.635 mm (0.021-0.025 in.) internal diameter are recommended for application. Where a narrow spray fan pattern is required, such as smaller structural steel sections, a 20-30-degree angle tip should be used. If a wider spray fan pattern is required on larger structures and fire divisions, a 40-60-degree angle tip should be used. An operating pressure of 210-310 bar (3,000-4,500 PSI) is typically recommended for application. The applicator should confirm the correct spray tips and operating pressure before applying STEELGUARD 951.

5.4.4 Ratio checks

No weight ratio checks are required for variable ratio plural feed spray equipment which monitors ratio in real time as application is carried out and where shut off mechanisms are in place, if the equipment deviates outside of the ratio tolerances (±5% variance on the ratio required for STEELGUARD 951). For fixed-ratio pumps, weight ratio checks should be carried out a minimum of twice a day; once at the start of the shift and a second midway through shift; additional ratio checks may be required whenever there has been a significant break in spraying.

The weight ratios should not deviate more than 5% from the target weight ratio of 3.56: 1 (base: hardener).

Weight Ratio Range	Target Ratio (Base : Hardener)	Allowed Range
PPG STEELGUARD 951	3.56 : 1	3.38 : 1 to 3.74 : 1

In addition to the weight ratio checks, the displacement pump pressure gauges should be checked constantly for pressure variations by the machine operator and the colour of the mixed STEELGUARD 951 should be observed by the sprayer. Any colour change would indicate the machine has gone off-ratio and application should cease immediately, and a ratio check performed again.

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Spray application should not be started until the correct weight ratio has been achieved. Results of all ratio checks should be recorded in a daily quality assurance/quality control (QA/QC) log.

Use the following procedure for ratio checks by weight:

1. Weigh clean empty pails for base and hardener and record the respective tare weights of the pails.
2. Fix nozzles (35-43 thousandths of an inch orifice size) to the base and (25-29 thousandths of an inch orifice size) to the hardener dump valves on the mixing block. This is particularly important to maintain the pressure in the system and gain accurate ratio checks.
3. Place the weighed empty pails under the ratio check valves located on the mixing block and open both material valves at the same time and open the flow valve on the pump (take out of circulation)
4. Close both material valves at the same time when the base material pail is at least half full and close the pump flow valve (put pump into circulation)
5. Weigh each pail including dispersed material and record the total weight.
6. Find the net weight of each material dispensed by subtracting the tare weight of the pail from the total weight.
7. Calculate the ratio of base to hardener.

Example Calculation:

Component	Empty Container Weight (kg)	Filled Container Weight (kg)	Nett Weight (kg)	Calculation of Ratio	Ratio
Base	1.800	9.607	7.807	7.807 / 2.193	3.56
Hardener Coating	1.200	3.393	2.193		

5.4.5 Spraying

It is possible to apply STEELGUARD 951 with a coat thickness between 350 microns (14 mils) and typically up to a thickness of 3.5 mm (140 mils) depending on temperature, equipment and operator skill. It is recommended that typically 2-3 mm (79-118 mils) per coat is applied; once the material has gelled sufficiently, subsequent coats can be applied directly without waiting for STEELGUARD 951 to fully cure.

Once the first coat has become tacky the second coat of the STEELGUARD 951 should be sprayed to the final DFT (wet on tacky/wet on gelled). The coating can be applied with a normal spray pattern and does not need a roller to obtain a smooth finish.

5.4.6 Flushing of Equipment

Hot water can be used very effectively for flushing out plural lines and equipment, but care should be taken, as water will not dissolve epoxy resin-based materials. If a true solvent is required for equipment maintenance, the use of THINNER 91-92 is recommended, but this should be done with care with hot equipment.

Particular attention should be paid to the mixing block and inline mixer, as material and fibers can congest here over time. These areas should be thoroughly cleaned and checked to avoid future blockages. Discard the first 2-4 litres (70-140 fl. oz.) of STELGUARD 951 to flush out any solvent between the mixing block and spray gun.

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5.5 Single Leg Airless Spray

For single leg airless spray, it is recommended that a purpose designed epoxy PFP pump is used, this will normally have a minimum ratio of 70:1 and material pump volume minimum 115ccm (7 cu. In.) by cycle. Small pumps are not recommended. Pumps should be equipped with a spring-loaded bottom valve or check valve at pump exit. Recommended working hose line (after mixer) up to 15m (50 ft) of ½" with whip hose ⅜" no longer than 1.5m (5 ft), airless gun type front inlet ⅜".

When beginning single leg application with hopper fixture installed, it is particularly important that all solvent from the previous cleaning process is removed from the hopper and spray lines.

Recommendations:

- Ensure pump is not under pressure and the spray lines are de-pressurised.
- Remove spray gun from spray line.
- Flush out as much cleaning solvent as possible. ****This is particularly important as any solvent left in the hopper may rise to the top of the mixed material due to material density****
- Mix first kit until homogenous (2 – 3 minutes)
- Add two litres (70 fl. oz.) of mixed material to hopper and flush at 1-2 bar (15-30 Psi) pressure, flush all solvent and material until hopper and spray line are clear of any solvent and only mixed material is flowing. ****It may be necessary to add 1-2 more litres (35-70 fl. oz.)****
- Once only mixed material is flowing, de-pressurise the pump and fix spray gun to spray line. Application can begin.
- This process is only required when starting application and after flushing, it is not required with subsequent kits during the same application cycle.

5.5.1 Preconditioning of Material

Both base and hardener should be stored at between 20-25°C (68-77°F) for at least 24 hours prior to use to ease mixing and application. Storage above this temperature will reduce the pot life when mixed. For ambient conditions consistently higher than this, no pre-conditioning is needed. Base and hardener may be stored for up to 4 days in closed containers under these conditions. The material should be used within this period and not be reheated again.

5.5.2 Thinning

Thinning may be required to achieve satisfactory single leg airless spraying. The minimum amount of solvent required should be used, which is normally in the range from 5% to 7% by volume; not exceeding 7%.

Based on an 18kg (40lb.) set, the maximum amount of thinner is 7% on volume = 1.0 liter (34 fl.oz.) Thinner 91-92 or 0.8 kg (1.8lb.).

Note: overcoating and cure times will differ when thinners are used. Use only THINNER 91-92.

5.5.3 Overcoating

Thinning of STEELGUARD 951 will increase the overcoating intervals from that for un-thinned coating. As a guide, the following table has been prepared for:

Overcoating interval for STEELGUARD 951 Overcoating interval for up to a maximum DFT of 2500µm (98 mils) per coat, Thinned 7% 91-92 by volume						
Overcoating with...	Interval	5°C (41°F)	10°C (50°F)	20°C (68°F)	30°C (86°F)	40°C (104°F)
itself	Maximum	3 months	3 months	2 months	2 months	1 month
Sigmadur 541 Steelguard 2458	Minimum Maximum	48 hours 3 weeks	36 hours 3 weeks	24 hours 2 weeks	18 hours 10 days	16 hours 5 days

Note: Only topcoats from the STEELGUARD APPROVED TOPCOATS guide sheet should be used. If a topcoat is not on that list, please refer to your local PPG contact.

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5.5.4 Mixing Ratio
The single feed kits of STEELGUARD 951 come in specific size containers to allow the mixing of a full kit within the base container. Only full kits should be mixed; smaller portions of material should not be used in any circumstances for single leg spraying. This ensures the correct ratio of base and hardener is mixed together.

5.5.5 Spray Tips and Operating Pressures
Nozzle size: 0.533-0.584 mm (21-23 thou)
Fan angle: 20-40 degrees
Inlet pressure: 3-4 bar (45-60 PSI)

The above temperatures, pressures and sizes are given as a guide only and may be adjusted to provide optimum application characteristics. As for the guidance given in Section 5.4.3, the fan angle should be determined depending on the size of the structure being sprayed.

5.5.6 Spraying
It is possible to apply STEELGUARD 951 with a coat thickness between 350 microns (14 mils) and typically up to a thickness of 2.0 mm (80 mils) depending on temperature, equipment and operator skill. The coating can be applied with a normal spray pattern and does not need a roller to obtain a smooth finish.

As with all high-build epoxy coatings using single leg airless spray, it is recommended that the pump be flushed out with THINNER 91-92 after every 5-8 kits dependent on throughput and ambient conditions. Failure to do so can cause cured material to build-up on the pump & line internals, affecting application. Also take care to clean the hopper walls of previously mixed material before adding fresh material. Keeping hoppers that way, you can extend work without flushing to 7-8 kits.

5.5.7 Flushing of Equipment
For single-leg airless application, THINNER 91-92 should be used for flushing. Hot water must not be used.

Particular attention should be paid to the inline mixer, as material and fibers will congest here. These areas should be thoroughly cleaned and checked to avoid future blockages.

Before any spraying is recommenced, all residual solvent left in the lines **MUST** be emptied prior to charging the lines with material – this ensures no thinned product is sprayed onto the project causing potential issues with curing.

5.6 Heated Plural Feed Airless Spray

5.6.1 Preconditioning of Material
Prior to application of PPG STEELGUARD 951 coatings using heated plural feed airless spray equipment, both base and hardener should be stored in a heated storage unit at 20-25°C (68-77°F) for at least 24 hours prior to use. Storage at these temperatures will reduce the viscosity of the product, assisting machine filling and reducing start uptime. For ambient conditions consistently higher than this, no pre-conditioning is needed. Base and hardener may be stored for up to 4 days in closed containers under these conditions. The material should be used within this period and not be reheated again.

5.6.2 Machine Operating Parameters
The operating parameters for STEELGUARD 951 depend on several factors including the equipment type and environmental conditions. The below general parameters are provided for guidance purposes; however,applicators should ensure the accuracy of parameters based on the factors influencing their application prior to use of STEELGUARD 951.

Recommended working hose line (after mixer) up to 15m of ½" with whip hose ⅜" no longer than 1.5m, airless gun type front inlet ⅜". Heated spray lines should not be longer than 50m (165ft). It is also recommended to use two in-line mixing tubes connected together, to ensure the material is fully mixed throughout spraying.

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Operating Parameter	Value
Storage Tank Temperatures	Base: 20-30˚C (68-86˚F) Hardener: 20-30˚C (68-86˚F)
In-line Heater Temperatures	Base: 25-35˚C (77-95˚F) Hardener: 25-35˚C (77-95˚F)
Hose Heater Temperatures	30-40˚C (86-104˚F)
Gun Exit Temperature	30-40˚C (86-104˚F)
Storage Tank Pressures	Base: 3.5 bar (50 psi) Hardener: 3.5 bar (50 psi)
Tank Stirrer Speed	Base: 15-20 rpm Hardener: 15-20 rpm
Displacement Pump Pressure	175-240 bar (3000-4500 psi)

Dispense components from the pails into the relevant holding tanks, ideally using ram-assisted shovel feed pumps.

The components should be circulated through the material pumps (and in-line heaters) until the base and hardener have reached a minimum temperature of 30˚C (86˚F). Material temperature **SHOULD NOT** be higher than 45˚C (120˚F) during application.

Switch on the main pump for approximately 10 minutes at an input pressure of 1.4 bar (20 PSI).

Empty a minimum of 20l (5 US gallons) of base and 10l (2.5 US gallons) of hardener through the sampling valves. If the equipment does not have sampling valves, then the hoses before the mixing block should be disconnected. Material should be kept clean and unmixed so that it can be reused.

It is important to preheat the lines of the pump to get hot material at the end of the hose when application begins.

5.6.3 Spray Tips and Operating Pressure

Typically spray tips of 0.533- 0.635mm (21-25 thou) internal diameters are recommended for application. Where a narrow spray fan pattern is required, such as smaller structural steel sections, a 20-30-degree angle tip should be used. If a wider spray fan pattern is required on larger structures, a 40-60-degree angle tip should be used. An operating pressure of 205-310 bar (3,000-4,500 PSI) is typically recommended for application. The applicator should confirm the correct spray tips and operating pressure for their project, before applying STEELGUARD 951.

5.6.4 Ratio checks

Weight ratio checks should be carried out a minimum of twice a day; once at the start of the shift and a second midway through shift; additional ratio checks may be required whenever there has been a significant break in spraying.

The weight ratios should not deviate more than 5% from the target weight ratio of 3.56: 1 (base: hardener)

Weight Ratio Range	Target Ratio (Base : Hardener)	Allowed Range
PPG STEELGUARD 951 PFP Coating	3.56 : 1	3.38 : 1 to 3.74 : 1

In addition to the weight ratio checks, the displacement pump pressure gauges should be checked constantly for pressure variations by the machine operator and the colour of the mixed STEELGUARD 951 should be observed by the sprayer. Any colour change would indicate the machine has gone off ratio and application should cease immediately, and a ratio check performed again.

Spray application should not be started until the correct weight ratio has been achieved. Results of all ratio checks should be recorded in a daily quality assurance/quality control (QA/QC) log.

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Use the following procedure for ratio checks by weight:

1. Weigh clean empty pails for base and hardener and record the respective tare weights of the pails
2. Fix nozzles (35-43 thousandths of an inch orifice size) to the base and (25-29 thousandths of an inch orifice size) to the hardener dump valves on the mixing block. This is particularly important to maintain the pressure in the system and gain accurate ratio checks
3. Place the weighed empty pails under the ratio check valves located on the mixing block and open both material valves at the same time and open the flow valve on the pump (take out of circulation)
4. Close both material valves at the same time when the base material pail is at least half full and close the pump flow valve (put pump into circulation)
5. Weigh each pail including dispersed material and record the total weight
6. Find the net weight of each material dispensed by subtracting the tare weight of the pail from the total weight
7. Calculate the ratio of base to hardener

Example Calculation:

Component	Empty Container Weight (kg)	Filled Container Weight (kg)	Nett Weight (kg)	Calculation of Ratio	Ratio
Base	1.800	9.607	7.807	7.807 / 2.193	3.56
Hardener Coating	1.200	3.393	2.193		

5.6.5 Spraying

Prior to spraying, ensure all residual solvent from the lines have been removed. This ensures no thinned material is inadvertently sprayed onto the project.

It is possible to apply STEELGUARD 951 with a coat thickness between 350 microns (14 mils) and typically up to a thickness of 3.5 mm (140 mils) depending on temperature, equipment and operator skill. It is recommended that typically 2-3 mm (80 to 120 mils) per coat is applied; once the material has gelled sufficiently, subsequent coats can be applied directly without waiting for STEELGUARD 951 coating system to fully cure. The coating can be applied with a normal spray pattern and does not need a roller to obtain a smooth finish.

5.6.6 Flushing of Equipment

Hot water can be used very effectively for flushing out lines and equipment, but care should be taken, as water will not dissolve epoxy resin-based materials. If a true solvent is required for equipment maintenance, the use of THINNER 91-92 isrecommended, but this should be done with care with hot equipment.

Particular attention should be paid to the mixing block and in-line mixer, as material and fibers will congest here. These areas should be thoroughly cleaned and checked to avoid future blockages.

5.7 Hand Trowel Application

It is also possible to apply the STEELGUARD 951 by trowel, plaster trowel or other similar tools, and then smoothed off using a roller. Hand application is only recommended for small areas such as defects or repair.

5.7.1 Thinning

For hand application, STEELGUARD 951 should not be thinned.

5.7.2 Mixing Ratio

The single feed (18kg/40lb) kits of STEELGUARD 951 PFP coating systems come in specific size containers to allow the mixing of a full kit within the base container. It is recommended that only full kits be mixed to ensure the correct mixing ratio, however smaller portions of material can be mixed if care is taken that the correct ratio is achieved by accurate weighing of the base and hardener before mixing. The mixing ratio should be 3.56:1 by weight (base: hardener) and should not deviate from this by more than 5%. Hand mixing by volume should never be attempted.

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5.7.3 Mixing

Due to the high viscosity of STEELGUARD 951, a high-torque mixer is required. Drills are not suitable and should not be used as they may lead to improper mixing and excessive time taken to mix with resultant shortening of working pot-life. The mixing should begin slowly, and the speed built up gradually.

Mix carefully until a smooth texture and uniform colour is achieved, which should typically take less than 5 minutes.

Consideration should always be given to the relevant pot-life and kits should not be mixed until they are ready to be used. For trowel application, it may be beneficial to spread the material out on a flat board to dissipate heat and extend the workability.

Figure 2: High-torque hand-held mixer

5.8 Application Quality of STEELGUARD 951

5.8.1 Methods of Measurement for Wet Film Thickness

Wet film thickness should be measured regularly during application using a pre-cut bridge gauge, typically made from a scraper; gauge widths of between 40-100mm (1.5-4.0”) have been found to be most appropriate. The gauge is placed into the wet material pressing down to the steel substrate or previous cured layer of PFP and when a line is left in the surface of the wet material the required depth has been achieved. We do not recommend the use of notch or pin gauges as they limit the measurement to one point.

Figure 3: Example of a notch gauge

5.8.2 Final Surface Finish Appearance

Spray application of the STEELGUARD 951 does not need to be smoothed by a roller. However, if desired to remove defects, a trowel should be used to eliminate any voids and then followed by a roller to attain a smooth, uniform finish. The optimum time will depend on the temperature, but for most projects it should be done within approximately 50-60 minutes after spraying; once the material has cured beyond the point it can no longer be worked, it is not possible to reverse this reaction and addition of solvent should not be used to try and achieve “reactivation”.

It is recommended that PPG THINNER 91-92 is used to dampen the rollers, and the quantity used should be kept to a minimum.

Care should be taken to ensure that all residual solvent has evaporated from the film before applying a subsequent layer of the STEELGUARD 951 or a topcoat.

5.8.3 Curing checks for application quality

As an indication that curing is acceptable prior to full cure, the following table of Shore D (ASTM D2240/ISO 868) values can be used as a guide:

	Shore D at Ambient Temperature at 60%RH					
Cure Time	5°C/41°F	10°C/50°F	20°C/68°F	30°C/86°F	40°C/104°F	50°C/122°F
24hr	10	33	56	66	66	66
48hr	53	65	67	69	69	69

5.9 Final PFP Thickness Measurement

One of the most important aspects of quality control in the use of STEELGUARD 951 is the attainment of the correct final DFT to meet the required fire resistance rating. It is imperative that the STEELGUARD 951 is applied to the DFT stated in the project specification documentation/drawings and in accordance with certification issued by the independent certification bodies.

The summary given below is believed by PPG to be accurate; however, it is qualified in its entirety by the certification criteria of the applicable independent certification bodies. Additionally, project specific requirements might exceed these requirements.

5.9.1 Required DFT for a Given Fire Rating

The thickness PFP on fire certification is the minimum average thickness required to achieve the fire rating against whichthe product was tested. Each test standard differs in the method of testing and assessment and the limits on acceptable variance in thickness differ by standard as well. Application of PFP will always result in variation in thickness, typically with a normal distribution about an average thickness; it is essential that this variation is tightly controlled to ensure the fire performance.

5.9.2 Limits on Deviation from Minimum Average

There are two principal methods used to control thickness during fire testing and these limits should be applied to site measurement appropriately:

1. Requirements for UL263 certification

The requirements for testing to UL263, is that the thickness should be within ±20% of the required minimum average thickness. The method requires any areas below 80% of the mean to be made-up with additional material until they comply.Where the thickness is more than 120% of the mean, these are acceptable on a project provided the total thickness does not exceed the maximum allowable thickness; however, the thickness used to calculate the mean is the 120% figure (i.e., local high areas cannot be used to overcompensate for low areas). The maximum allowable thickness should be <24 mm (9.5”).

2. Requirements for ISO, EN, BS and other standards

For standards other than UL263, the acceptance criteria should be as follows, based on the specified DFT being a nominal value:

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The average DFT applied to each element should be greater than or equal to the specified nominal value.

a) The average measured DFT on any face of any member should not be less than 80% of the specified nominal value.
b) DFT values less than 80% of the specified nominal value are acceptable, provided that such values are isolated and that no more than 10% of the readings on a member are less than 80% of the specified nominal value. Where any single thickness reading is found to be less than 80% of the specified nominal value, a further two, or where possible three, readings should be taken within 150 to 300mm (6-12”) of the low reading. The initial reading may be considered isolated if all the additional readings are at least 80% of the specified nominal value. If one or more of the additional readings are less than 80% of the specified nominal value, further readings should be made to determine the extent of the area of under thickness. In such cases, low thickness areas identified should be brought up to the required thickness before proceeding to the next stage.
c) All DFT should be at least 50% of the nominal value.
d) The average measured DFT of any face of any member should not exceed the certified maximum thickness for the particular member shape and orientation.
e) For CE Marked products, refer to specific product Declaration of Performance (DoP) for APPROVED PRIMERS and topcoat thicknesses.

5.9.3 Industry Guidance on Thickness Measurement

There is no industry-specific guidance for the measurement of epoxy intumescent PFP in the construction industry; guidance for thin-film intumescent coatings is sometimes used, this includes:

- AWCI Technical Manual 12-B Standard Practice for the testing and Inspection of Field Applied Thin Film Intumescent Fire Resistive Materials (this method aligns to the UL263 approach of thickness control).
- ASFP Technical Guidance Document – TGD 11 Code of Practice for the specification and on-site installation of intumescent coatings for fire protection of structural steelwork.

It is recommended that an inspection method is agreed upon before the commencement of a project.

5.9.4 Methods of measurement for dry film thickness

For epoxy intumescent PFP, two types of method for DFT measurement are typically employed:

- Non-destructive – the electromagnetic gauge
- Destructive – the drill and pin depth gauge method

Preference should be given to non-destructive methods to minimize the risk of damage to the system.

Figure 4: Electromagnetic Depth Gauge

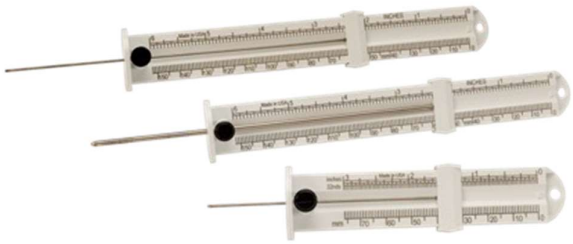

Figure 5: Pin Depth Gauge

5.9.5 Non-Destructive Method

The use of magnetic induction or eddy current gauges for the measurement of the paint DFT has been common for many years. These gauges use interchangeable probes which measure different ranges of thickness. Probes that will measure up to 50mm (2”) thickness of coating on ferrous or non-ferrous substrates are available.

Ensure the correct probe is used for the DFT applied so that an accurate measurement is achieved. In all cases, the manufacturer's instructions should be used to determine the correct method for use and calibration. Where electromagnetic gauges are concerned, particular note should be taken regarding their limited accuracy at edges and corners.

5.9.6 Destructive Method

Drilling of small diameter holes (typically less than 3mm (⅛") and the use of a pin depth gauge to measure thickness at that point is acceptable. Care should be taken not to damage the substrate. All holes should be filled with the STEELGUARD 951 as soon as possible (preferably in the same shift) after measurements have been taken.

5.9.7 Frequency of Measurements

The following information is given for guidance only and does not seek to override any project specific requirement for DFT measurement. Reference should always be made to the client's project specifications or recognized standards such as NACE, SSPC, BS, ISO, etc.

Open Sections (I Sections, Tees, Channels, etc.)

- Webs: two readings per 1m (3ft) length on each face of web
- Flanges: two readings per 1m (3ft) length on the outer face of each flange and one reading per 1m (3ft) length on the inner face of each flange.

Square and Rectangular Hollow Sections and Angles:

- Two readings per 1m (3ft) length on each face.

Pipes and Circular Hollow Sections:

- Eight readings per 1m (3ft) length evenly spread around the section.

Where members are less than 3m (10ft) in length, three sets of readings should be taken, one at each end and another at thecenter of the member. Each set should comprise of the number of readings on each face given above, as appropriate.

6.0 TOP COATING

6.1 Approved Topcoats

STEELGUARD 951 has been extensively tested to industry recognized standards to demonstrate its ability to withstand weather and environmental exposure without topcoats, and as such, the use of a topcoat is generally considered optional and for aesthetic purposes only. However, when a topcoat is to be applied on the STEELGUARD 951, only qualified topcoats should be used.

STEELGUARD 951 can be top coated when it is sufficiently cured (see PDS for overcoating intervals), ensuring the surfaces are clean and dry and free from surface contamination including dust, grease, amine bloom,etc. Recommended minimum overcoating intervals differ depending on topcoat, therefore, refer to PDS for relevant data.

STEELGUARD 951 should only be topcoated with approved PPG topcoats as per the STEELGUARD 951 APPROVED TOPCOATS guide sheet, as compatibility and performance are readily verified. Where non-PPG topcoats are used the topcoat manufacturer should ensure their product is compatible for use with the STEELGUARD 951.

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7.0 TOUCH UP AND REPAIR

7.1 Damage back to bare steel

a) Cut out the coating system using a high-speed cutting tool, to 10-20mm (½”-1”) from the damaged area in all directions.
b) Prepare the steel to ISO 8501-1 St3 / SSPC SP11. The substrate should be dry, sound and free from all contamination and provide a sufficient roughness for the specified primer.
c) Apply the primer to the specified DFT. The primer should be approved for use under STEELGUARD 951 and should be suitable for ISO 8501-1 St3 / SSPC SP11 prepared steel substrates.
d) After curing of the primer, slightly abrade 25-30mm (1-1¼”) of the surrounding sound coating system to remove the existing topcoat.
e) Reinstate the specified DFT of the intumescent coating using the original STEELGUARD 951. Take care not to excessively overlap the existing intumescent coating or topcoat.
f) If the intumescent coating had been top coated, overcoat the repaired areas with the original topcoat to the specified DFT, overlapping the sound finish by 50mm (2”).

7.2 Damage to STEELGUARD 951 only

a) If the STEELGUARD 951 had been topcoated, remove all loosely adhered topcoat and slightly abrade.
b) Ensure the exposed areas of intumescent coating are sound, dry and clean from any contamination.
c) Use a high-speed cutting tool to create a straight edge around the damaged area, if the damage is too irregular.
d) Reinstate the specified DFT of STEELGUARD 951. Take care not to excessively overlap the existing intumescent coating or topcoat.
e) If the intumescent coating had been top coated, overcoat the repaired areas with the original topcoat to the specified DFT, overlapping the sound finish by 50mm (2”).