

PPG STEELGUARD® 951

Application guidelines

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1. 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 the STEELGUARD 951, reference must also be made to both the product data sheets (PDS) and the safety data sheets (SDS) available online.

These guidelines are subject to the following:

1. Compliance with all applicable standards, regulations and legislation of governmental bodies
2. All equipment used is fully serviced and suitable for use with the STEELGUARD 951 and all health and safety recommendations of the equipment manufacturer followed.
3. All applicators are competent in the application of the STEELGUARD 951 for the type of application being undertaken.

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.

The information provided in these application guidelines is not intended to be exhaustive; any person applying the product, by any method, or in any circumstance other than that specifically recommended in these application guidelines, should first obtain PPG's written confirmation as to the suitability of the proposed method. Additionally, there are many factors that can affect the application of the STEELGUARD 951, which PPG cannot control or account for in these guidelines, such as the quality or condition of the substrate. Accordingly, the applicator is responsible for ensuring that the STEELGUARD 951 is correctly applied given the specific factors affecting the applicator's use of the STEELGUARD 951.

These guidelines are a minimum set of requirements, and additional and/or higher-level requirements may be set in clients' specifications or project specifications; in which case the additional and/or higher-level requirements should be adopted.

In the event of any doubt or lack of understanding, PPG Technical Support should be consulted for clarification.

1.2 Definitions

The following definitions are used throughout this document:

Word	Definition
Must or Shall	Indicates a mandatory requirement
Should	A preferred course of action
May	Indicates one acceptable course of action
Minimum	Indicates a mandatory requirement

International standards (ISO) and metric units (SI Units) are used generally throughout these guidelines; where other standards and units are used these are for guidance purposes only and typically the nearest convenient unit will be used e.g., 1m as a measure of length may be approximated to 3ft where such use is appropriate.



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1.3 Acronyms and Abbreviations

The following acronyms and abbreviations are used throughout these guidelines:

Acronym or Abbreviation	Meaning
DFT	Dry Film Thickness
FTS	Field Technical Service
Mil	One thousandth of an inch
PDS	Product Data Sheet
PF	Plural Feed
PFP	Passive Fire Protection
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control
SDS	Safety Data Sheet
Thou	One thousandth of an inch
WFT	Wet Film Thickness

1.4 Health and Safety

The STEELGUARD 951 requires due care when handling. Warnings presented on PPG product labels, SDS and in this manual must be heeded. This manual is intended to serve as a supplement to SDS and label information. Refer and become familiar with all precautionary information prior to use of these products. Always follow manufacturers' recommendations with respect to spray equipment and any other equipment used.

This system is solvent-free as supplied and is very viscous and non-volatile. Upon repeated and/or prolonged contact with the skin, the material may be irritating and cause dermatitis. Additionally, susceptible individuals may experience an allergic-type reaction known as "sensitization" from very small amounts of material contacting the skin. Caution should be exercised when mixing the two components, see the product SDS for full details.

Although the product is normally applied solvent-free using PFP plural feed spray equipment, for smaller area and repairs, single feed airless spray or trowel application methods may be used and, in these methods, a small amount of solvent may be used for thinning. Solvents are also used for rolling and finishing and cleaning of tools and equipment. Due consideration must be made with regards to health and safety.

1.5 Personal Protective Equipment (PPE)

The tasks and worksite must be evaluated with a risk assessment to determine what hazards are present, or likely to be present, based on the product handling, use and application conditions. All identified hazards should be removed where possible with the use of personal protective equipment (PPE) being a last resort to mitigate the remaining risks. Appropriate PPE, suitable for the work to be performed, should then be selected based on the hazards or potential hazards identified.

Employees should be trained on the proper use and limitations of PPE used. Refer to the SDS for a selection of appropriate PPE for all materials used. Use of eye protection, gloves, respiratory protection and protective clothing must be considered for your particular use conditions when using the STEELGUARD 951.



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1.6 First Aid

Skin and eye contact with STEELGUARD 951 material should be addressed by flushing the affected area(s) with large quantities of clean water as soon as possible. Proper eye wash facilities should be immediately accessible to employees. The location and proper operation of the nearest eyewash and safety shower should be established before any job is started. Please consult the product SDS.

1.7 Environmental

It is important that PPG products be stored and used safely. However, we are especially concerned with the issue of disposal of waste from the use of our products. We believe that all paint-related waste materials should be disposed of properly in a way that poses minimal risks to people and our environment. For this reason, only those quantities necessary for application should be used on the job site. For the disposal of STEELGUARD 951 material refer to applicable laws and regulations and/or seek the advice of specialist waste disposal providers. PPG recommends that unmixed materials are mixed prior to disposal.

1.7 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 the 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

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

PPG STEELGUARD 951 Kit	Details
<p>Plural Feed (PF) Kit</p> 	<ul style="list-style-type: none"> 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)
<p>Single Feed (SF) Kit</p> 	<ul style="list-style-type: none"> 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 6 of this document for more details.

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

In order 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.

Such storage units are typically built from standard site storage containers. The container will generally be lined with thermal insulation and should be suitably ventilated.

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 the STEELGUARD 951 must 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

The 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 Environmental Conditions

In addition to other specified environmental parameters, coating should only take place in the following conditions:

- Substrate temperature: Minimum 5°C (40°F) and at least 3°C (37.4°F) above dew point during application and curing
- Relative humidity: Maximum 85%
- Environment temperature: During application and curing should be above 10°C (50°F)

Environmental conditions must be monitored through the working shift as weather conditions can vary greatly. Where these environmental conditions cannot be met or maintained advice must be sought from PPG.

Curing time will be significantly extended if the environment drops below 10°C (50°F) and will effectively cease below 5°C (40°F); however, curing will recommence when temperature rises again. Conversely, curing time will be reduced at temperatures above 10°C (50°F). Please refer to PDS for curing times.

3.4 Surface Defect Repair

Before the application of any paint or PFP to the surface, it shall be inspected for any defects in accordance with ISO 8501-3.

All surface defects, including weld spatter, cracks, surface delamination and deep pitting which are likely to be detrimental to the protective paint system must be removed.

All fins at saw cuts, burrs and sharp edges shall be removed by grinding to a minimum radius of 2 mm (0.08"). Welds must be inspected for their condition, as these are often a source of corrosion. Undercut welds, blow holes, discontinuous seams and other defects must be rectified. As uneven welds are likely to be the source of corrosion, they will need to be ground smooth, it is not necessary to grind flush.

Due to the criticality of PFP it is recommended that level ISO 8501-P3 (Very Thorough Preparation) is achieved; any deviation from this should be in agreement with the client and PPG.



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3.5 Degreasing and Cleaning

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

3.5.1 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 must be removed from the steelwork prior to the application of coating.

3.5.2 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.

3.5.3 Galvanized steel

Sweep blasting is recommended, in accordance with SSPC SP16. The blast profile should be 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 instrument 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 brittle, fragile or susceptibility to mechanical damage resulting from subsequent abrasive blast cleaning.

As the 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 an epoxy tie-coat should be applied immediately (industry guidance recommends within one hour) to prevent the formation of zinc salts.

3.5.4 Wet blasting (Vapor blasting)

This is a technique of wet abrasive blasting using a relatively low volume of water, grit and air pressure. The technique is very controllable with little interference to 'other trades', not producing sparks and therefore can be used in zoned environments and provides a blast profile similar to that obtained with dry grit blasting. Where wet blasting is used for surface preparation a suitable wet blast/surface tolerant primer from the STEELGUARD APPROVED PRIMERS guide sheet must be used.

3.5.5 Hydro blasting (UHP water jetting)

This method of surface preparation uses water at pressures typically in excess of 2,400 bar (35,000 PSI). As it cannot produce a blast profile, it is not suitable for new, previously un-blasted steel. This method is commonly used in maintenance situations to remove old paint or PFP coatings prior to the application of the STEELGUARD 951, in such circumstances the surface profile should be inspected after removal of the old coating and if necessary, a sweep blast undertaken to achieve the required surface profile. Where hydro blasting is used for surface preparation a suitable wet blast/surface tolerant primer from the STEELGUARD APPROVED PRIMERS guide sheet must be used.



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3.5.6 Dry ice blasting

Dry ice blasting is an alternative to hydro blasting and likewise does not produce a blast profile and has the same requirements as Section 3.5.5 above.

3.5.7 Power tool cleaning

Power tool cleaning is suitable for small areas of repair/touch-up where blast cleaning is not possible. It is recommended that power tool cleaning is carried out in accordance with ISO 8501-1 to a visual standard St3 (SSPC SP11) to achieve a surface profile of a minimum of 25µm (1 mil). Where power tool cleaning is used for surface preparation, a suitable surface-tolerant primer from the STEELGUARD APPROVED PRIMERS guide sheet must be used.

Suitable power tools should be used, but wire brushes are not recommended as they can cause surface polishing.

3.6 Residual Chloride Salt Contamination

The chloride salt level shall be assessed in accordance with ISO 8502-6 and ISO 8502-9. The maximum total allowable residual soluble salts level on the surface should be determined from the project specification. Where no specific level is provided, PPG recommends that the following maximum values should be used:

Substrate	New Construction	Maintenance
Carbon Steel	100 mg/m ²	120 mg/m ²

3.7 Zinc Salts Formation on Surface

The formation of zinc salts may be detrimental to adhesion of the STEELGUARD 951 to the substrate; these may occur if zinc primers are exposed to humid or outdoor conditions prior to application of the STEELGUARD 951. These will need to be removed prior to application of the 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 other abrasive methods will need to be included with the water washing.

Where zinc-rich primers are used, best industry practice recommends the use of an epoxy tie-coat to prevent salts forming. Please refer to the STEELGUARD 951 APPROVED PRIMERS guide sheet for details.



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4.0 PRIMER SELECTION

4.1 Purpose

The selection of suitable primer system for use with the STEELGUARD 951 is critical for both the fire performance and the long-term life and corrosion protection of the system. The choice of which primer system to use will be dependent on many factors, including substrate material and condition, preparation techniques employed, environmental conditions, application conditions, local regulations, project specification and individual client preferences.

The compatibility of the STEELGUARD 951 with the primer must be verified; for this reason, only primer and coating systems satisfactorily tested and qualified by PPG shall 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 APPROVED PRIMERS.

4.2 Primer Condition

It is the applicator's responsibility to ensure that the primed surface and the primer itself are in an 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. shall be considered when determining a surface's suitability before overcoating with the STEELGUARD 951.

In all situations, the surface of the primer must be clean, dry and free of all 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 Primer Types

4.3.1 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 application of the 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.

4.4 Primer Thickness

Prior to overcoating the applied primer with STEELGUARD 951, the DFT should be checked to ensure that the required thickness has been achieved and the maximum allowable DFT has not been exceeded. The maximum primer thickness is dependent on the specific primer system used and reference should be made to the STEELGUARD APPROVED PRIMERS guide sheet. The thicknesses in the guide sheet take precedence over the thickness on the primer PDS and careful monitoring and measurement of primer thickness is required.

DFT measurement should be carried out in accordance with a recognized standard such as ISO 2808, SSPC PA2 or ASTM D1186. The method, frequency of measurement and number of measurements per spot should be agreed between applicator and client and confirmed prior to commencement of the contract.



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4.5 Reduction of Excessive Primer Thickness

Excessive primer thickness should be reduced to within that allowable DFT range in accordance with the STEELGUARD APPROVED PRIMERS guide sheet. The preferred method to be used is abrasive sweep blasting followed by thorough vacuuming to remove contaminants from the surface. Sanding with P80-P100 grade aluminum oxide abrasive paper or proprietary abrasive padsmay be suitable for small areas. Care should be taken to prevent polishing of the surface which would lead to inadequate adhesion of the STEELGUARD 951; frequent changes of the abrasive should be made.

After primer reduction, surfaces should be cleaned of dust and contaminants in accordance with SSPC-SP1 and shall be washed with potable water and thoroughly dried, prior to the application of STEELGUARD 951.

The primer manufacturer's application instructions should be followed where third-party primers are used.

4.6 Thermally Sprayed Aluminum and Zinc (TSA/TSZ)

The use of thick film coatings such as epoxies has been shown to be problematic when applied over TSA/TSZ and is therefore not recommended.

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. Material temperature **MUST 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 must be removed whilst the product is still wet, and the edge rolled smooth to prevent any lifting of the cured edge leading to potential delamination 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.



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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

The 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 negates pot-life issues.

The equipment used must be purposely designed to spray thick film two-component PFP coatings, such as STEELGUARD 951, and must be capable of delivering the required ratios, pressures, temperatures and flow rates to correctly apply the product. They 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. PPG's advice may be sought on suitable equipment and suppliers where necessary.

5.4.1 Preconditioning of Material

Prior to application of STEELGUARD 951 coatings using simplified plural feed airless spray equipment, both base and hardener must be stored in a heated storage unit at 20-25°C (68-77°F) for 24 hours prior to use. Storage at these temperatures will reduce the viscosity of the product, assisting machine filling and reducing start up time.

Base and hardener may be stored for up to 4 days in closed containers under these conditions. The material should be used after 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 a number of factors including the equipment type and environmental conditions. The below general parameters are provided for guidance purposes; however, applicators must 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 ¾" no longer than 1.5m, airless gun type front inlet ¾". It is also recommended to use two in-line mixing tubes connected together, to ensure material is fully mixed throughout spraying. An example of a pump set-up is as below:



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1. Part A to mixer block ¾ inch hose.
2. Part B to mixer block, ¾ inch 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. ¼ Inch 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 ½ inch integration line
6. After the integration line, 2 x ½ inch static mixers with a minimum of 12 turns on the worm.
8. 5-7m ½ inch whip line (connects the static mixer to the spray gun). Can reduce to 3/8 for maximum 1.5 metres, swivel is always recommended.
9. A PFP SPRAY GUN

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

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 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 (21-25 thou) 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.



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5.4.4 Ratio checks

No weight ratio checks are required for 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 ($\pm 5\%$ 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 shall 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.

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 exactly 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 the 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. The coating can be applied with a normal spray pattern and does not need a roller to obtain a smooth finish.



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5.4.6 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 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 will congest here. These areas should be thoroughly cleaned and checked to avoid future blockages.

5.5 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. Pump should be equipped with spring loaded bottom valve or check valve at pump exit. 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”.

When beginning single application with hopper fixture installed, it is very 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 very 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 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

It is recommended that both base and hardener are 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.

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 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.



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5.5.3 Overcoating

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

Overcoating interval for STEELGUARD 951						
Overcoating interval for up to a maximum DFT of 2500um (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	Minimum	28 hours	19 hours	7 hours	3 hours	1.5 hours
	Maximum	3 months	3 months	2 months	2 months	1 month
Sigmadur 541 Steelguard 2458	Minimum	48 hours	36 hours	24 hours	18 hours	16 hours
	Maximum	3 weeks	3 weeks	2 weeks	10 days	5 days

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 shall be mixed, smaller portions of material must 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 5.6.3, the fan angle should be determined depending on the size of the structure being sprayed.

5.5.6 Spraying

It is possible to apply the 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 5-6 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 hopper walls of previously mixed material before adding the fresh one. 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 must be used for flushing. Hot water must not be used.

Particular attention should be paid to the mixing block and worm, 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 any issues with curing.



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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 must 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.

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 must 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 ¾” no longer than 1.5m, airless gun type front inlet ¾”. Heated spray lines must not be longer than 50m (165ft). It is also recommended to use two in-line mixing tubes connected together, to ensure material is fully mixed throughout spraying.

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 **MUST 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 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 205-310 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.



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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 shall 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.

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 exactly 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 the 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.



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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 is recommended, 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.

5.7.5 Thinning

For hand application, STEELGUARD 951 must not be thinned.

5.7.6 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 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 must not deviate from this by more than 5%. Hand mixing by volume must never be attempted.

5.7.7 Mixing

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

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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 must not be used to try and achieve “reactivation”.

For rolling, a short nap, simulated sheepskin roller has been found to give good results, but other short or medium-naps solvent resistant, synthetic rollers may be suitable. It is recommended that the suitability of roller be established on a small area prior to use. Solvent should be used to lightly dampen the roller (it is recommended that a small spray mist bottle is used for this purpose) to prevent material pick-up on the roller as per normal site practice for application of epoxy PFP, but one must ensure that the roller is suitable for use with strong solvents. It is recommended that PPG THINNER 91-92 is used, and the quantity used should be kept to a minimum.

Care must 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 Adhesion checks for application quality

ASTM D4541 and ISO 4624 are the recommended test methods for checking adhesion and cohesion of STEELGUARD 951 if there are concerns regarding application quality. The system must be scored down to the substrate and the minimum value achieved should be 3 MPa (435 psi/s) once the STEELGUARD 951 has reached full cure.

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

Cure Time	Shore D at Ambient Temperature					
	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

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5.9 Final PFP Thickness Measurement

One of the most important aspects of quality control in the use of the 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 which the 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.

The concept of a minimum average thickness recognizes that variation exists and that local low thicknesses are acceptable as long as there are compensation areas of higher thickness. It should be noted that the thickness stated in fire certification is the thickness of the PFP coating excluding any primer or topcoat.

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 $\pm 20\%$ 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 as long as 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 shall be as follows, based on the specified DFT being a nominal value:

- a) The average DFT applied to each element shall be greater than or equal to the specified nominal value.
- b) The average measured DFT on any face of any member shall not be less than 80% of the specified nominal value.
- c) 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 shall 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 shall 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 application stage.
- d) All DFT shall be at least 50% of the nominal value.



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- e) The average measured DFT of any face of any member should not exceed the certified maximum thickness for the particular member shape and orientation.
- f) 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 FireResistive 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 (1/8")) and the use of a pin depth gauge to measure thickness at that point is acceptable. Care must be taken not to damage the substrate. All holes should be filled with the STEELGUARD 951 as soon as possible (preferably in same shift) after measurements have been taken.

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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 shall be taken, one at each end and another at the center of the member. Each set shall comprise of the number of readings on each face given above, as appropriate.

6.0 TOP COATING

6.1 Qualified Topcoats

The 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 esthetic purposes only. However, when a topcoat is to be applied on the STEELGUARD 951, only qualified topcoats should be used.

The 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 over coating intervals differs depending on topcoat, therefore, refer to PDS for relevant data.

The 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 manufacture must ensure their product is compatible for use with the STEELGUARD 951.

7.0 TOUCH UP AND REPAIR

7.1 Damage back to bare steel

- a) Cut out the coating system to 10-20mm (½"-1") from the damaged area in all directions.
- b) Prepare the steel to ISO 8501-1 St3. The substrate should be dry, sound and free from all contaminations and provide a sufficient roughness for the specified primer.
- c) Apply the primer to the specified DFT. The primer must be approved for use under STEELGUARD 951 and must be suitable for ISO 8501-1 St3 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) Reinstall 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").



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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) Reinstall the specified DFT of STEELGUARD 951. Take care to not excessively overlap the existing intumescent coating or topcoat.
- d) 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”).

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