



PPM01 Understanding Pre-Painted Metal

An introduction to the
composition of pre-painted metal,
its application and performance

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Michelle Vondran
Technical Manager
Steelscape



Presentation Overview

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Contact – Shaun Page, shaun.page@Steelscape.com

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Learning Objectives

LO 1.1 – Understand pre-painted metal fundamentals, the paint application process and the advantages of this process relevant to exterior building applications

LO 1.2 – Identify the three common types of paint systems, their differences and appropriate applications

LO 1.3 – Recognize the enhancement options available for pre-painted metal and how they can be modified specific to project needs

LO 1.4 – Identify pre-painted metal durability issues, their causes and applicable warranty considerations for end building users

What Is Pre-Painted Metal?

Pre-painted metal reflects rolls of steel or aluminum in which paint is baked on.

The term *pre-painted* arises from the metal being painted prior to being formed or shaped into its finished state.

Not all pre-painted metal is the same - selecting the right coating can affect product lifespan, energy efficiency and visual appeal.



Pre-painted metal fundamentals and how paint is applied



Spotlight Question

How is paint applied to metal for the majority of building applications?

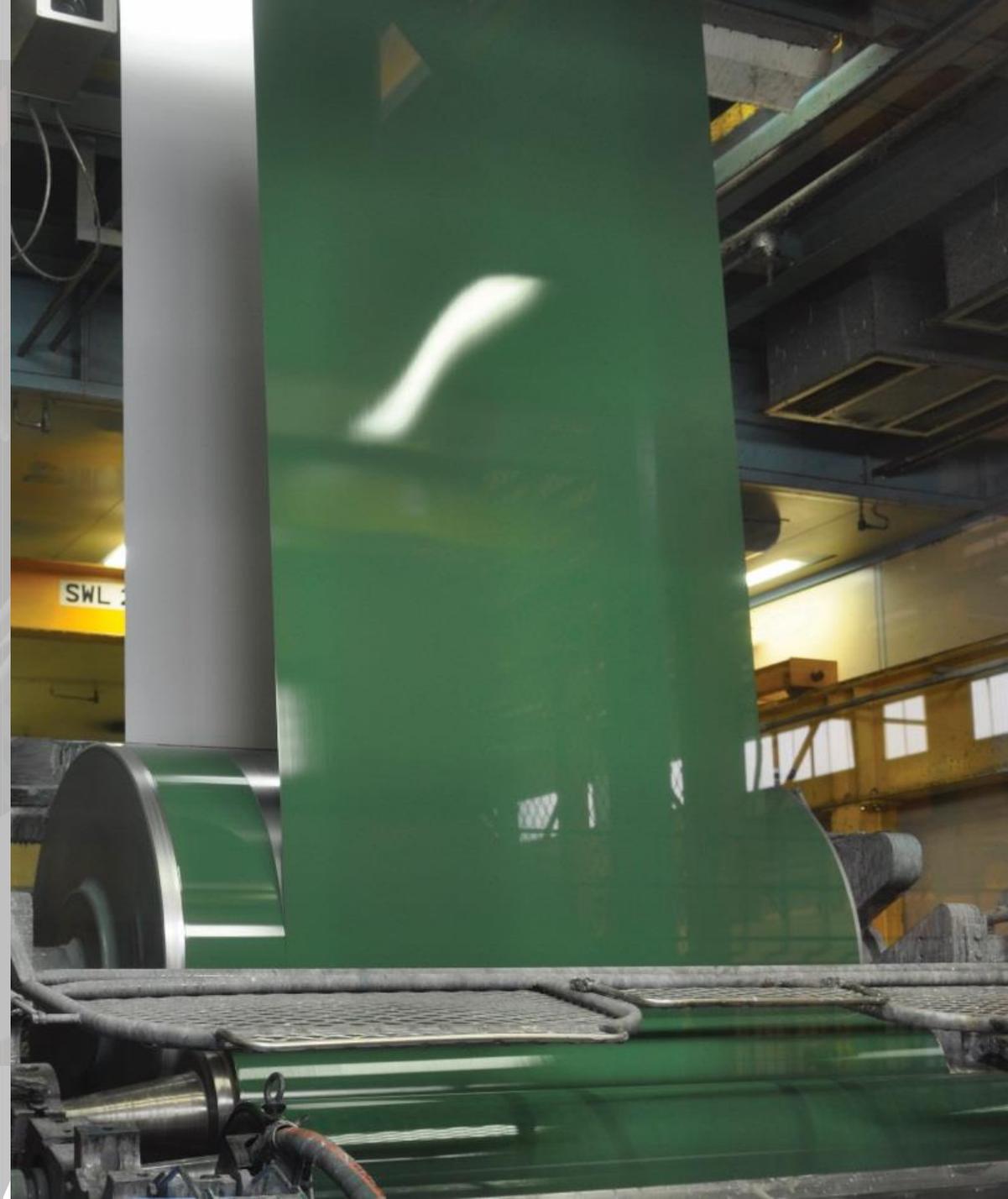
- A) Air-Brush
- B) Dipping
- C) Rolling
- D) Brushing



Spotlight Question

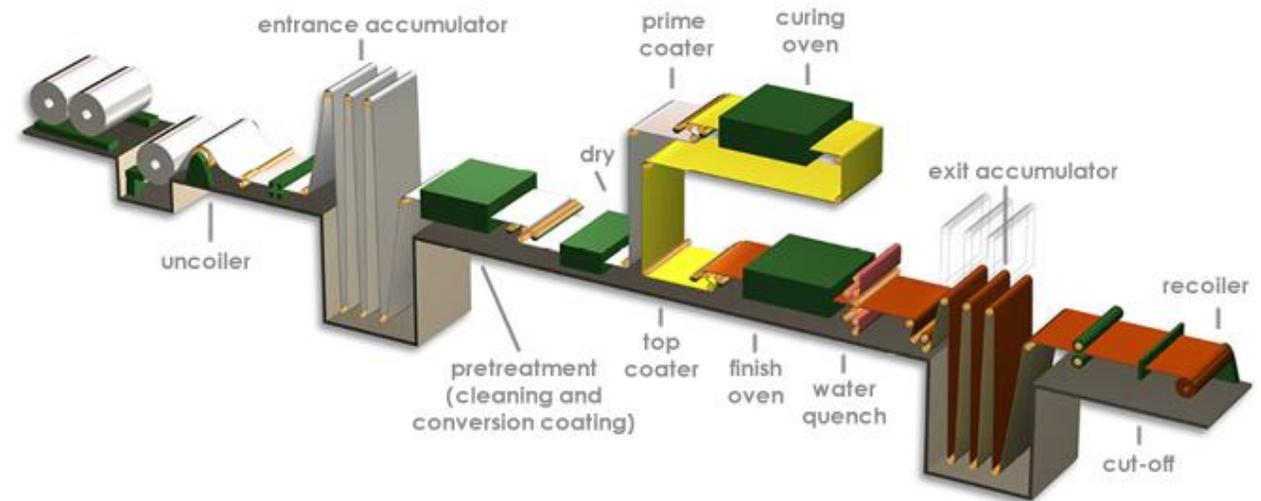
How is paint applied to metal for the majority of building applications?

- A) Air-Brush
- B) Dipping
- C) Rolling**
- D) Brushing



Application of Paint to Metal

- Pre-painting (coil coating) is a method of applying paint to metal
- In a continuous process, the metal is first cleaned before coatings are applied using rollers
- Following coating, paint is baked on
- Painted metal is produced at speeds around 100 feet per minute and up (up to 700 fpm)
- The curing process takes only 15-30 seconds



Source: NCCA

Advantages of Coil Coating

- Surface cleaned and treated prior to painting enabling a tightly bonded finish
- Paint applied in a controlled and autonomous environment enabling high consistency
- Efficient use of paint – A typical paint system is 1.4 mils thick, which includes the backer and primer (Top coat 0.7-1.0 mils)
- By comparison most industrial coatings are 2-5 mils thick
- As metal is painted *before* fabrication, coating must be hard, durable and flexible
- Closed loop system - curing ovens capture and burn harmful VOCs



Source: PPG Industries

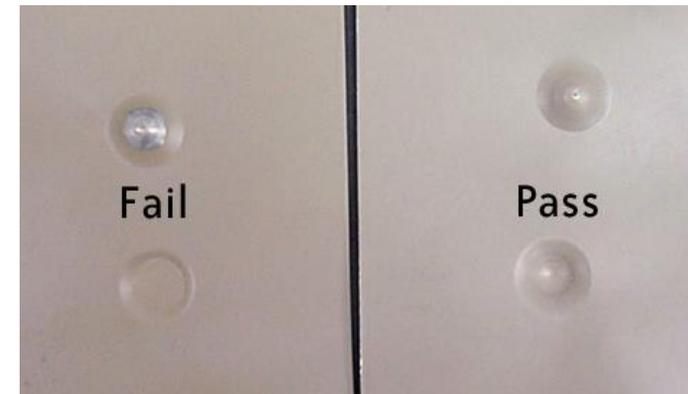
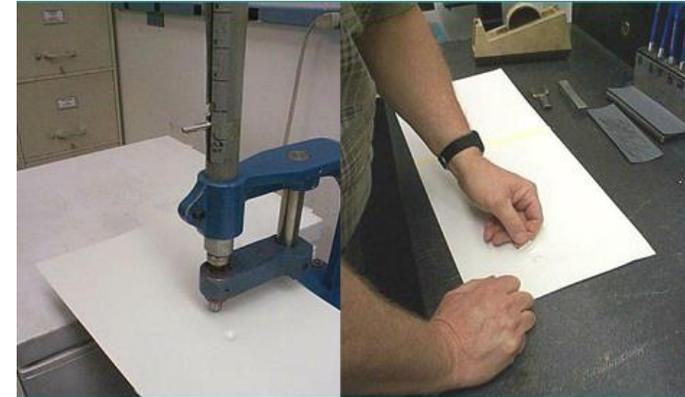
Limitations of Coil Coating

- Process is rapid once running, but can involve significant set up based on properties of paint system
- Process is based on efficiencies of scale, resulting in coaters having large minimum orders for finished product:
 - Can constrict the color palette
 - Make it difficult, expensive or long lead times on custom colors



Quality Control in Coil Coating

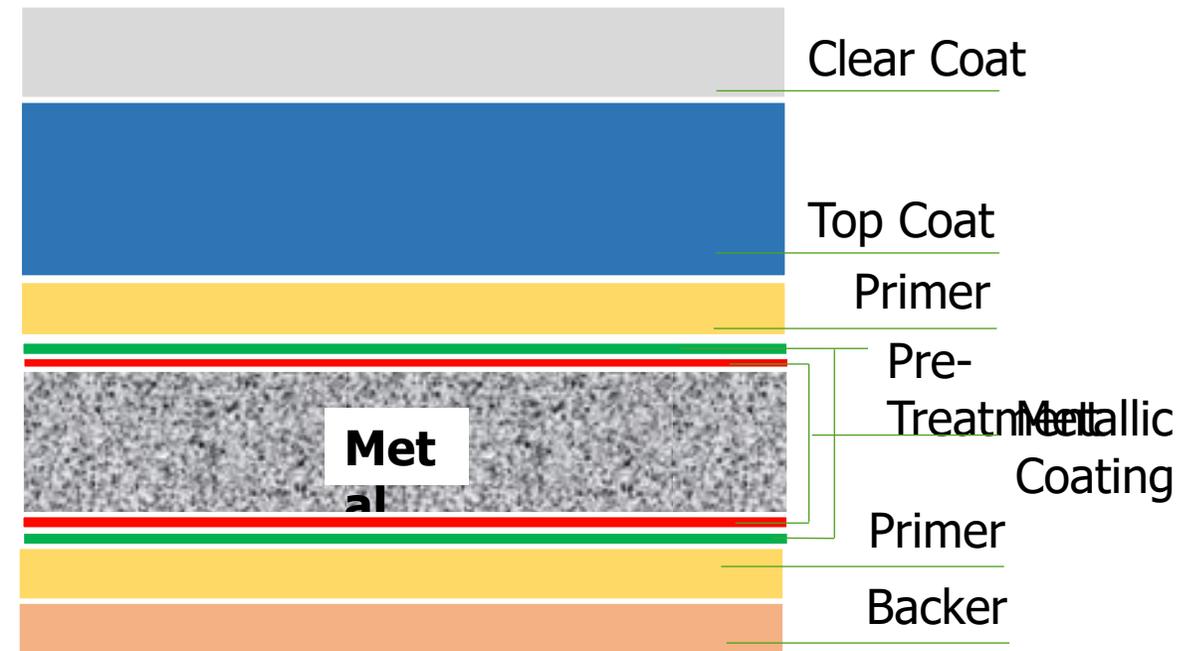
- Tests for suitability:
 - **T bend test**
 - To simulate forming and test for cracking
 - **Reverse impact test**
 - Stress test to identify if adhesion is lost
 - **Color validation** and consistency across strip to standard
 - **Gloss validation** and consistency across strip to standard
 - **Film thickness** – critical for long term performance



Source: NCCA

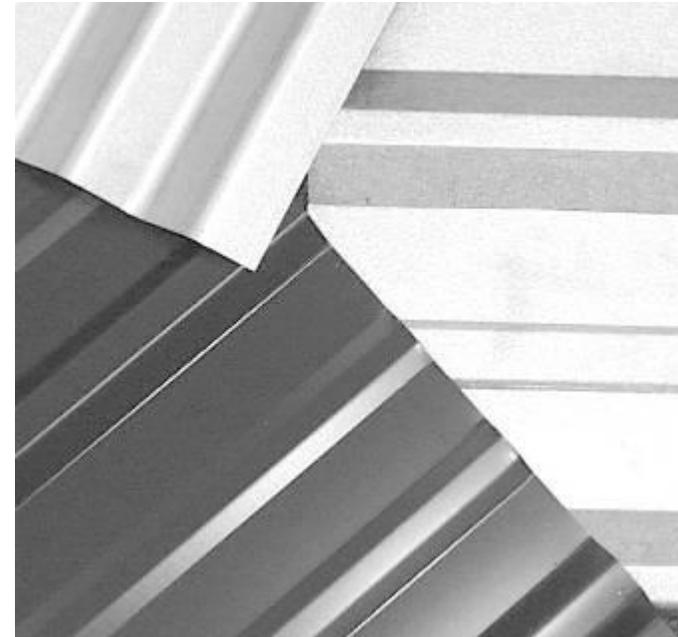
Typical Layers of Painted Steel

- **Backers** – Provide color, some protection and a basis for adhesives
- **Primer** – Prepare the substrate for painting by providing 'bite'
- **Metallic coating** – Corrosion resistance
- **Pre-Treatment** – Paint adhesion
- **Top coats** – Protection from outside elements, color and aesthetic appearance
- **Clear coat (optional)** – Added protection and color depth



Metallic Coating

- Galvanizing and Aluminum-Zinc alloys are the most widely used metallic coating for the corrosion protection of steel
- Hot dipped Galvanizing adds a coating of 100% Zinc
- Galvalume® and ZINCALUME® are two common trade names for 55% Al-Zn
 - Aluminum offers enhanced corrosion protection
 - 55% is the optimal ratio – any difference to this will not be a Galvalume® product



Galvalume® is a registered trademark of BEIC Inc.
ZINCALUME® is a registered trademark of BlueScope Ltd.

Metallic Coating

- Aluminum is inert and provides a protective rather than sacrificial barrier
- The aluminum component (55%) of Al-Zn provides corrosion protection and corrosion warranty, while the zinc component (45%) provides the sacrificial characteristic that protects material edges and cuts
- BIEC licensed metallic coaters of Al-Zn provide a corrosion warranty (20-25 year on average)
- Installation environment considerations can influence metallic coating choice



Galvalume® is a registered trademark of BIEC Inc.

What is Paint?

- A liquid designed for application to a surface in a thin film that cures to a solid film
- Two important attributes:
 - Protection of the surface
 - Creation of the desired aesthetic
- Methods for application include brushing, dipping, spraying, vacuum coating, rolling



Primary Components of Paint

- Primary components are resins, pigments, solvents and additives.
- **Resins** – the binder of the paint, determines physical and chemical properties
- **Pigments** – impart color to paint
- **Solvents** – dissolve resin to a consistency suitable for application
- **Additives** – fine tune or improve performance characteristics

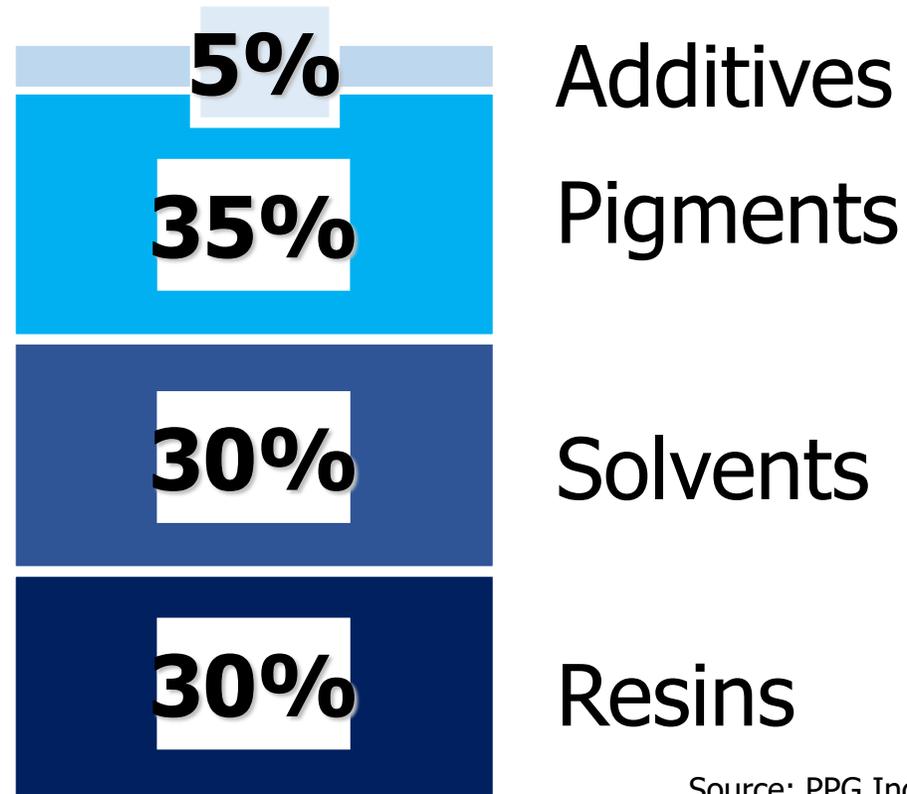


Summary Components of Paint

	Resin	Pigment	Solvent
Component Properties	Physical Properties	Aesthetics	Application
	Durability	Color	Viscosity
	Hardness	Hiding	Levelling
	Flexibility	Corrosion Resistance	Flow
	Adhesion	Film Strength	Stability
	Gloss	Water Resistance	Film Control
	Chemical Resistance		Solvent Popping
	Corrosion Resistance		Compatibility
	Humidity Resistance		
	Abrasion Resistance		
	Impact Resistance		
	Heat Resistance		
	Stain Resistance		

Source: PPG Industries

Typical Composition of Paint

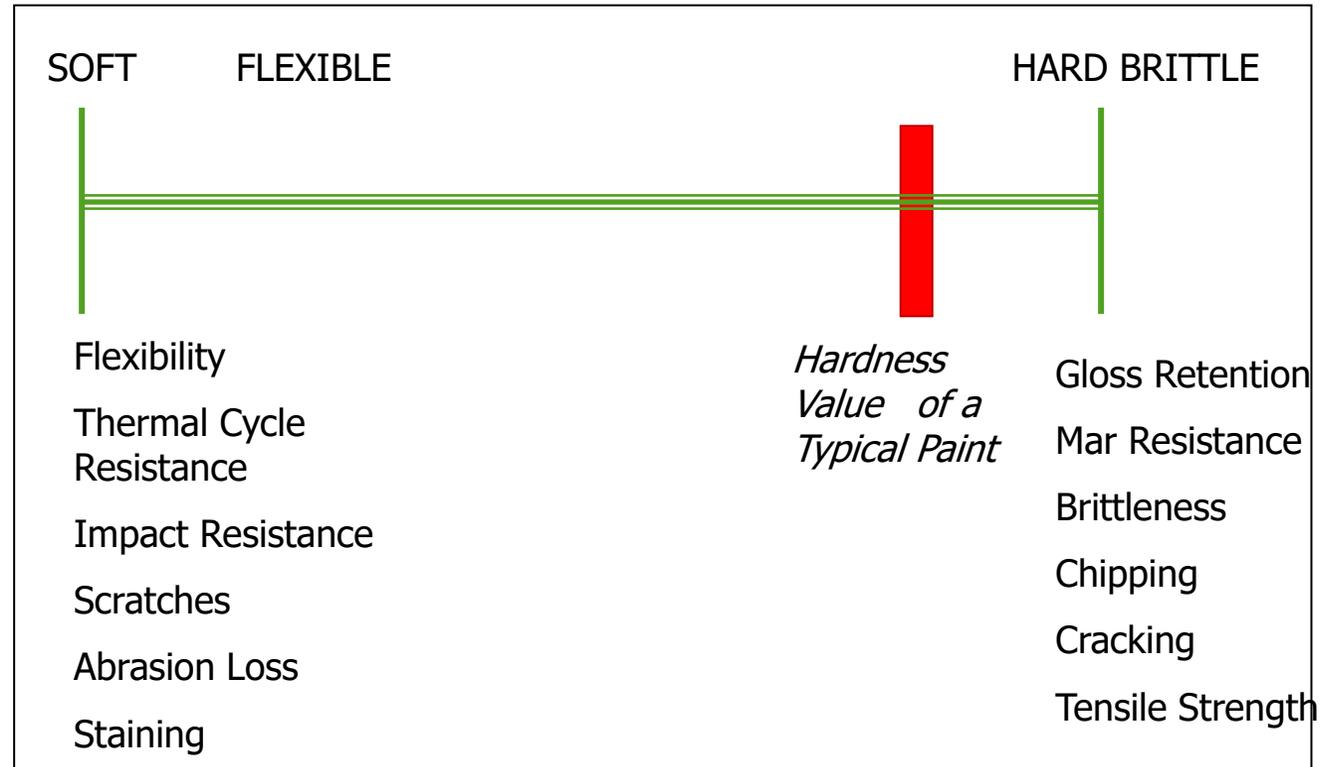


Source: PPG Industries

by weight

How is the Right Paint Selected?

- The right balance of resins, pigments, solvents and additives
- Application process to ensure the right adhesion, the right color and the right gloss
- End use requirements, cost and warranty



Source: PPG Industries

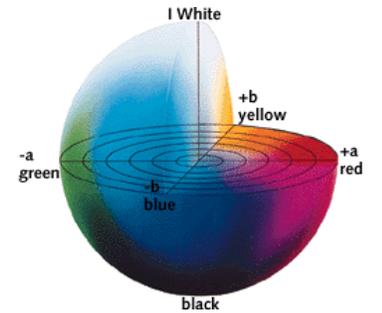
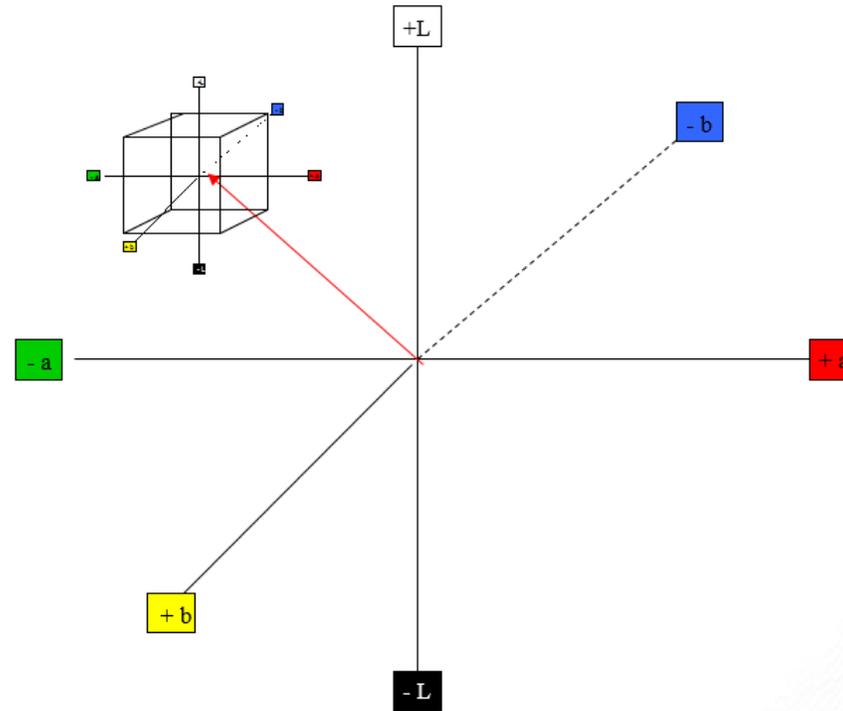
Pigments and Color

- Pigments are insoluble solid particles
- Finely ground and dispersed with resin
- Produced from organic or inorganic pigments
 - Inorganic pigments typically duller yellows, reds, green, brown and black iron oxides
 - Organic pigments typically brighter reds, blues, greens, violets, yellows
- Organic pigments provide a cleaner or distinctive look but are less durable (specifically UV light)



The Application of Color

- Color is the eye's perception of the wavelengths of visible light reflecting from a surface
- Typically represented as LAB number
- Finished product assessed based on variance relative to LAB specification



+L = lighter

-L = darker

+a = redder

-a = greener

+b = more yellow

-b = bluer

Color is most often expressed in terms of deviations relative to a standard.

Common paint systems and their differences



Spotlight Question

Can you name the three common paint systems used in building applications?



Spotlight Question

Can you name the three common paint systems used in building applications?

Polyester, Silicon Modified Polyester (SMP), Flurocarbon (PVDF)



Paint System Types

- Three common paint systems for buildings:
 - 1. Polyesters**
 - 2. Silicone Modified Polyesters** (SMPs or Enhanced Polyesters)
 - 3. Fluorocarbons / PVDF / polyvinylidene fluoride** also known as Kynar 500® or Hylar 5000® systems
- Typically, these range from good (polyester) to best (PVDF)



Kynar 500® is a registered trademark of Arkema, Inc.
Hylar 5000® is a trademark of Solvay Solexis, Inc.

Polyesters

Distinguishing Features

- Cost effective
- Good flexibility and hardness
- Wide range of color and gloss options
- Very versatile and can be formulated in a wide range of performance qualities

Typical Applications

- Gutters, downspouts, agricultural and light commercial, appliance wrappers



Silicon Modified Polyesters (SMP)

Distinguishing Features

- Good exterior weatherability
- Improved resistance to chalk and fade
- Wide range of colors
- Lower cost than PVDF

Typical Applications

- Commercial and residential sidewall and roofs



Fluorocarbons (PVDF)

Fluorocarbons are known by several different names but reflect the same polymer

Distinguishing Features

- Exceptional chalk and fade resistance to aggressive weather elements
- Chemical resistance
- Excellent formability

Typical Applications

- Commercial building panels and roofs where superior weatherability is required

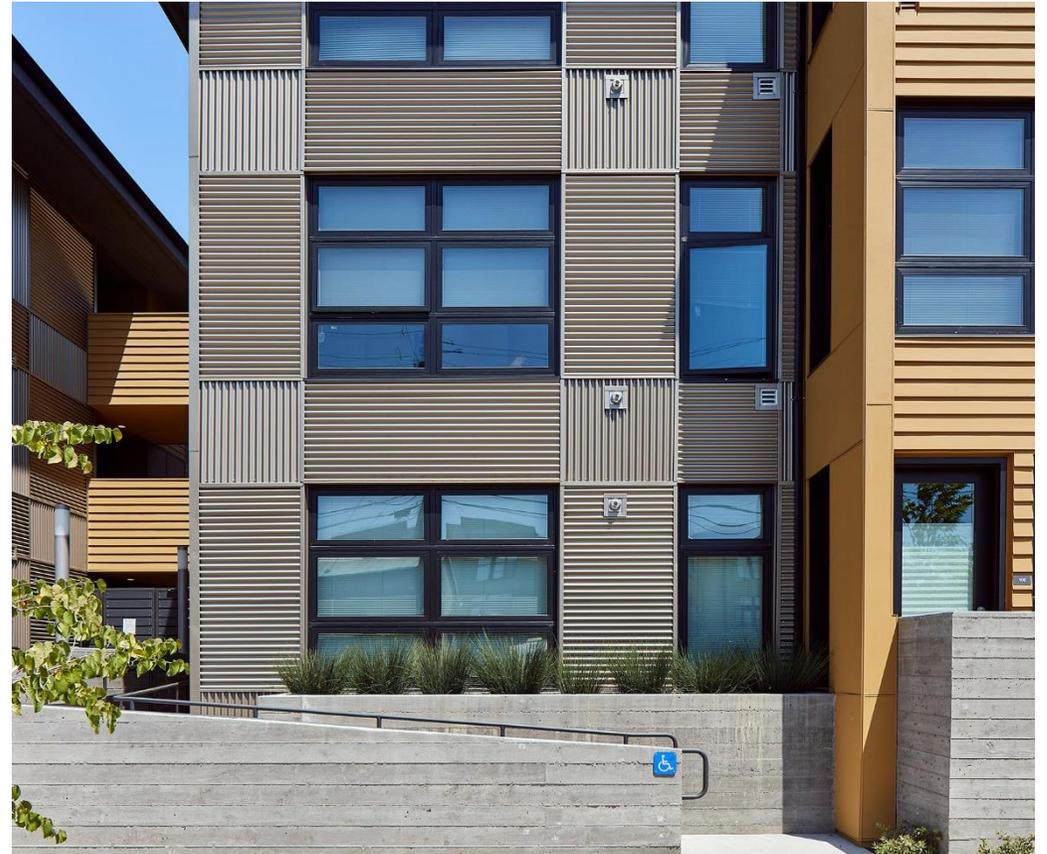


Paint System Summary

Paint System	Polyester	SMP	PVDF
Overall	Good to Better	Better	Best
Price Point	Cost effective	Moderate	Higher
Warranty	None to moderate	Long	Longest
Durability	Limited to good	Medium to High. Improved weatherability	Highest
Application	Versatile, but typically low exposure applications such as agricultural buildings, gutters and downspouts, industrial buildings	Wide range of construction applications including residential and commercial	High end architectural, commercial and high profile projects
Other attributes	Wide range of colors and gloss options	Wide range of colors and gloss options	Excellent chalk and fade resistance and chemical resistance
AAMA specification	2603 or less / 621	2604 or better / 621	2605 / 621

Paint System Considerations

- Not all polyester systems are the same
- Differential between high end polyester and SMP can be marginal
- PVDF still offers the best UV resistance for optimal exterior durability
- Kynar 500® or Hylar 5000® reflect a trade name for a PVDF product
- PVDF systems are most durable when it makes up 70% of the overall resin composition



Kynar 500® is a registered trademark of Arkema, Inc.
Hylar 5000® is a trademark of Solvay Solexis, Inc.

Enhancement options for pre- painted metal



Spotlight Question

What important building considerations can influence the type of pre-painted metal specified?



Spotlight Question

What important building considerations can influence the type of pre-painted metal specified?

Proximity to salt water

Desired building energy efficiency

Desired color to be used

Visibility of roof surface

Desired reflection of roof surface

Mixed use materials

Exposed eaves

And more...



Enhancements Overview

- A wide variety of enhancements are available for pre-painted metal to improve aesthetics or performance characteristics including:
 - Micaceous and metallic pigments
 - Clear coats
 - Marine and industrial enhancements
 - Graffiti resistance
 - Cool roof pigments
 - Texture
 - Prints and imagery



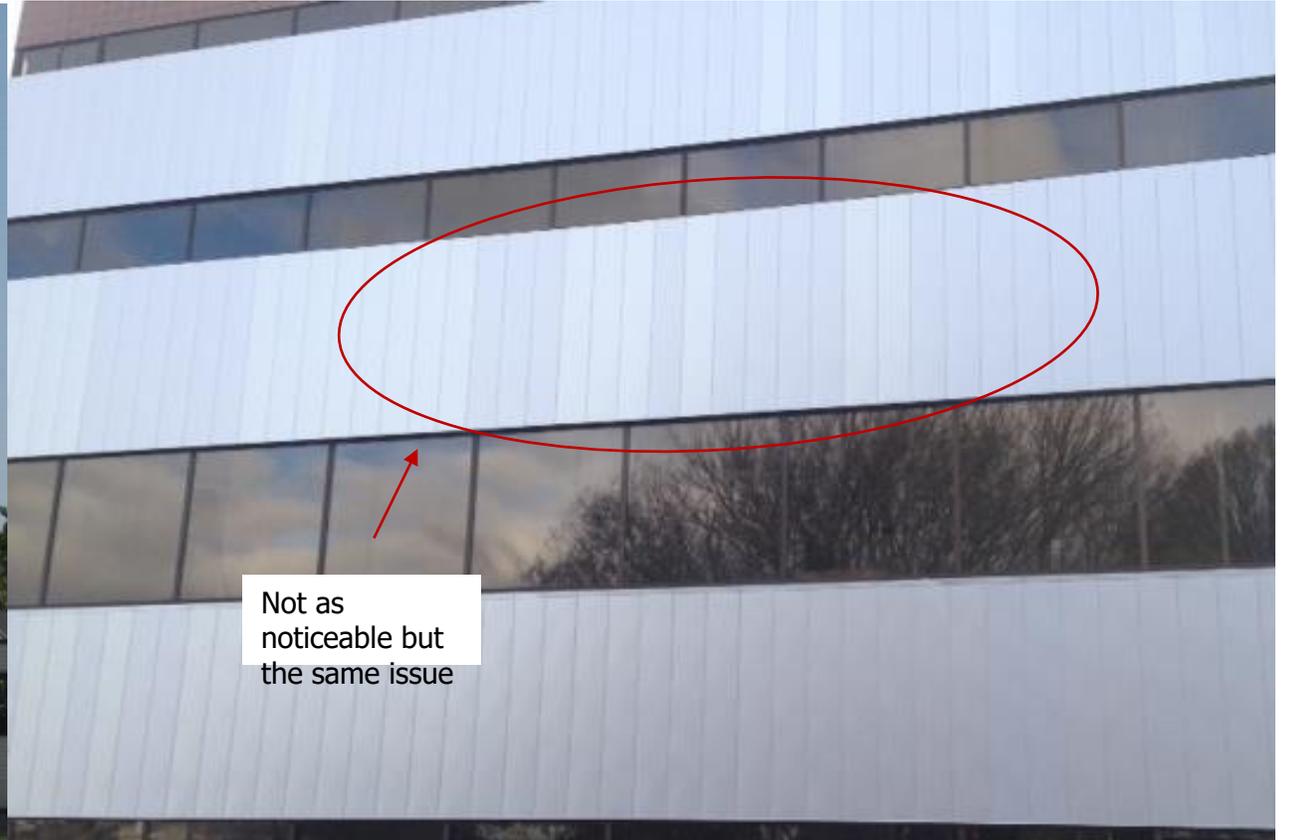
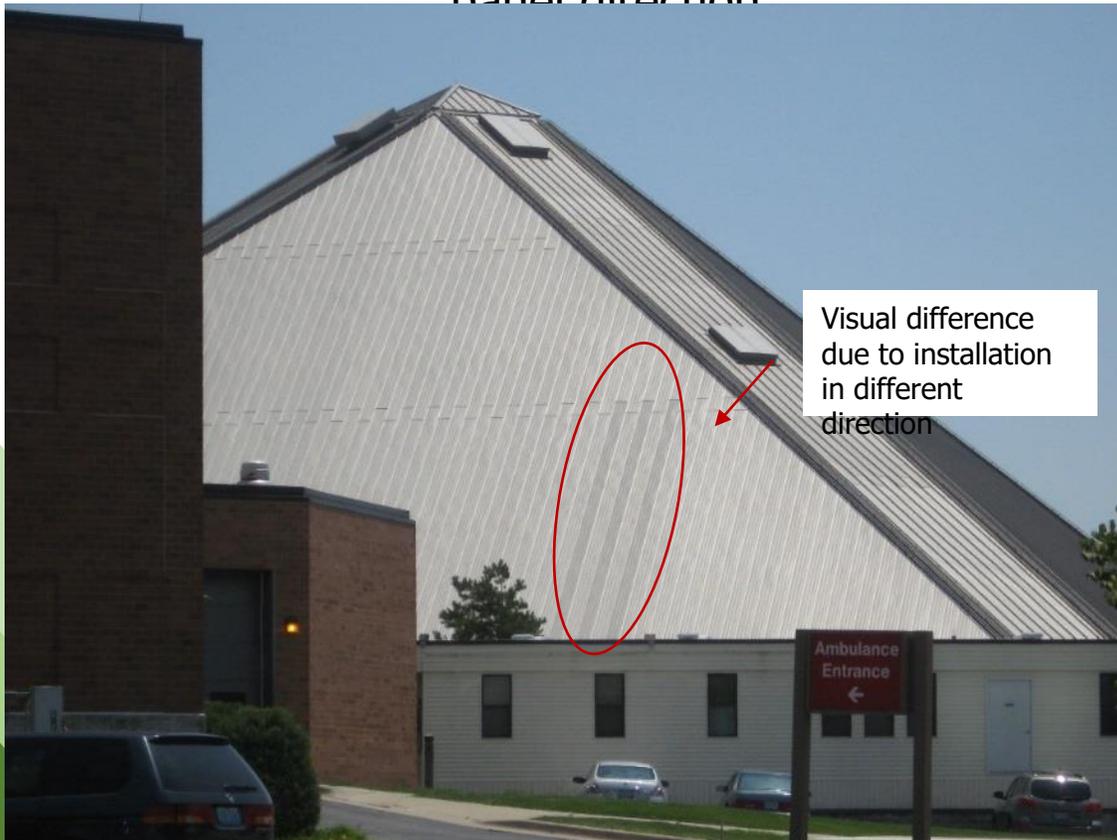
Micas and Metallics

- Mica pigments are added to the paint
- Historically used metal flakes, but mica pigments are more durable
- Often still called 'Metallics'
- Creates a sparkling or light catching effect
- Pearlescent or shifting colors typically use multiple mica pigments



Micas Don't Mix!

- The size and orientation of these pigments cannot be completely controlled which is why installers are urged not to mix batches of these products or alter installed panel direction



Extreme Environment Enhancements

- Pre-painted metal systems can be modified for specific environmental applications
- Includes enhanced durability for coastal or industrial environments
- Product options include high-build primers or applying clear coats
 - Typically include a three or four coat system with a high build primer
- May enable the creation of a warrantable finish despite environmental extremes



Clear Coats and Graffiti Resistance

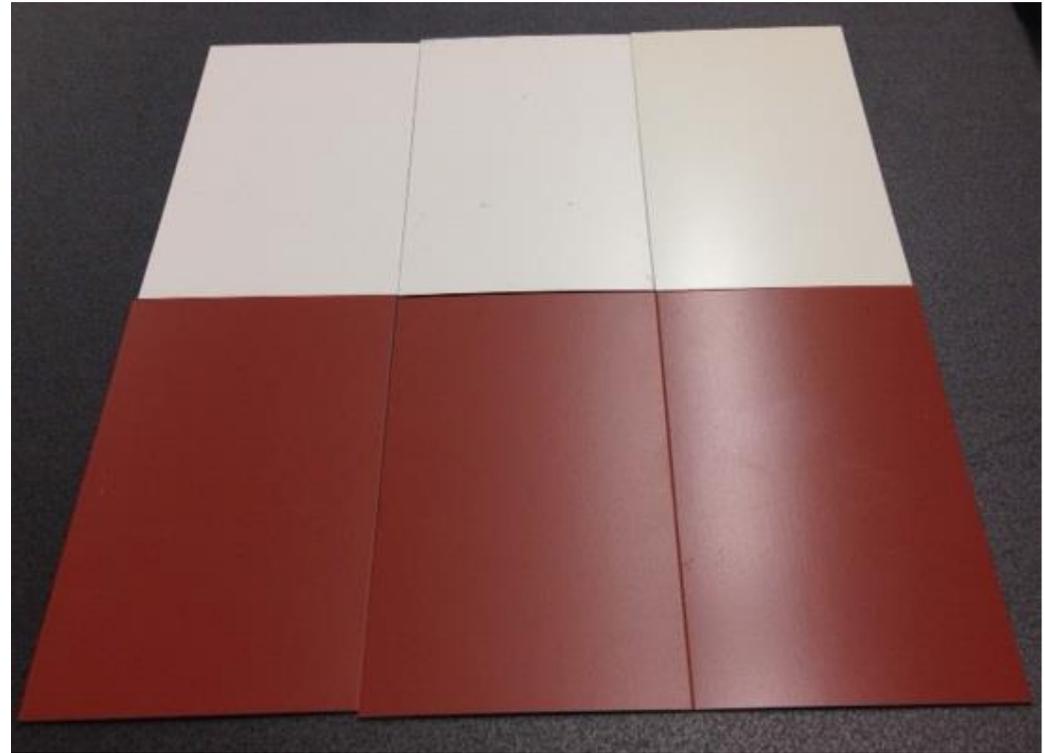
- Clear coat - an additional coating on top of the paint to provide added protection
- Can provide additional UV fade resistance
 - Particularly important for organic pigments
- Clear coats can also add perceived depth to a surface or enhanced gloss
- Clear coat protective properties include:
 - Added hardness and mar resistance
 - Anti-microbial protection
 - Graffiti resistance



Clear Coats and Color Variance

- Base colors that have had a clear coat applied, or are over a thick film primer, often shift slightly in visual color
- More apparent on lighter and brighter colors
- Difference is minor

The panels pictured represent standard, thick film primer, and paint with a clear coat from left to right.



Backers

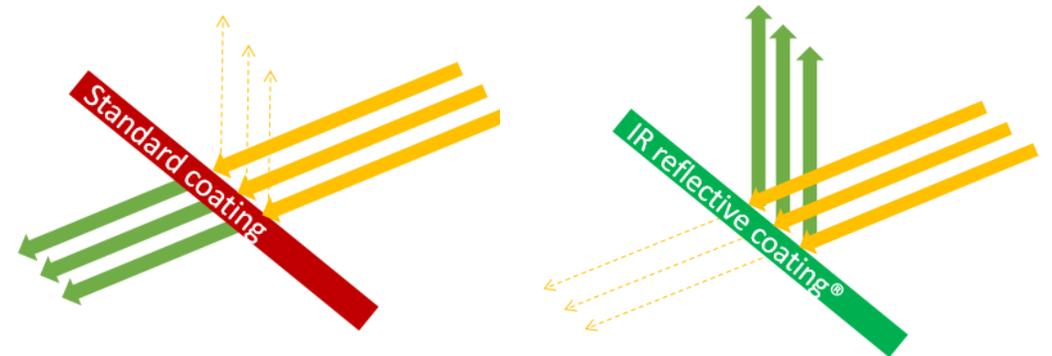
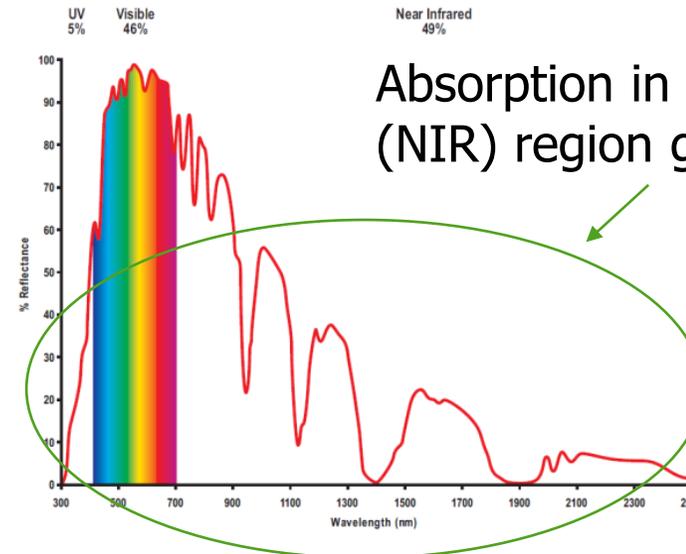
- An overlooked item
- Backers are typically unseen
- Standard backer color painted neutral colors
- Applications such as eaves or overhangs may have an exposed backer
- Most coaters can paint double sided subject to special request



Source: MBCI

Cool Colors

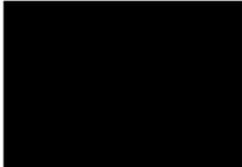
- 'Cool' colors are designed with infrared reflective pigments
- Altered chemically and physically to reflect IR wavelengths
- Enables the creation of dark yet 'cool' colors
- Any paint system not just high end can be modified to be 'cool'
- Minimizes heat build up and reduces cooling costs in hot climates



Cool Pigments Continued

- How is 'cool' defined or measured?
 - **Solar Reflectance** – Amount of solar radiation reflected off a surface
 - **Emissivity** – The amount of heat a surface can dissipate away from itself
 - **Solar Reflectance Index (SRI)** – Value created from solar reflectance and emissivity with factors such as air flow considered.
- Reviewed by Cool Roof Rating Council
- Unlike other materials, metal's aged SRI performance does not deteriorate



 CASCADE GRAY SRI: 58 • LRV: 41	 TAUPE SRI: 53 • LRV: 28	 PATINA STEEL SRI: 38 • LRV: 17
 MATTE BLACK SRI: N/A • LRV: 5	 CANYON RED SRI: 45 • LRV: 16	 RUSTIC RED SRI: 43 • LRV: 13
 WEATHERED COPPER SRI: 32 • LRV: 11	 SLATE GRAY SRI: 32 • LRV: 13	 TAHOE BLUE SRI: 33 • LRV: 14

SRI values as they may appear on a color chart

Cool Colors and Green Building

- Look for paints with a high SRI value that qualify for LEED® and ENERGY STAR® programs
 - Notably the Heat Island Reduction credit
- Typically lighter colors will have a higher SRI value than darker colors, irrespective of 'cool' pigment technology

LEED v4.1 High Reflectance Roof Guidance

	Slope	Initial SRI	Aged SRI
Low-sloped roof	≤ 2:12	82	64
Steep-sloped roof	> 2:12	39	32

SRI guidance as it appears in LEED v4.1 BD+C, SS Credit: Heat Island Reduction

Source: USGBC

Light Reflectance Value (LRV)

- Light Reflectance Value (LRV) or glare, measures the amount of visible or usable light that reflects from a surface
- LRV is expressed as a percentage from 0 to 100
- Typically, lighter colors will have a higher value than dark colors
- Texture can impact LRV as well - rough textures tend to reflect less visible light.



Gloss and Sheen

- Gloss and sheen are two other terms used to describe visible reflection of a surface
- Gloss is the measurement of visible light at a 60° angle from the surface
- Sheen is measured at 85°
- High gloss/sheen results in high glare or shine from a surface, while low gloss/sheen surfaces have a flat or matte appearance.

COLOR	LRV	60° Gloss	85° Sheen
FOREST GREEN 1	9	10	13
FOREST GREEN 2	15	13	28
DARK BRONZE 1	8	11	13
DARK BRONZE 2	7	7	11
PARCHMENT 1	40	11	12
PARCHMENT 2	51	11	20
BLACK 1	5	21	25
BLACK 2	6	19	26

Difference in gloss and sheen between colors and gloss options. Source: ASCBP

Textures

- Paint chemistry available with enhanced textured properties
- Texture can enhance the visual appeal for certain applications and reduced roof glare
- Example applications include where there is a desire for improved integration with traditional building materials



Enhanced Visual Aesthetics

- Pre-painted metal can produce more than solid colors alone
- **Roll printing** - Existing rolls are modified to apply patterns or designs onto metal.
 - Use the same paint systems as solids offering the same durability
 - Development timeline relatively short
 - Limited by repeatability of the roll
 - Applications include exterior roof and wall designs



Enhanced Visual Aesthetics Continued

- **Laminates** – Decorative imagery printed on a film is bonded to the metal substrate
 - Improved design flexibility, reduce repeatability
 - Do not offer the same durability or UV resistance as standard paint systems
 - Film bond is not as strong
 - Applications include faux wood finishes for doors or imagery for interior accents
- **Digital printing** – Paint systems similar to existing norms (such as PVDF) used as ink and applied to steel sheet using large scale version of a traditional digital printer



Source: Globus



Pre-painted metal durability issues and warranty coverage

Spotlight Question

What are the three common elements warranted by pre-painted metal products?



Spotlight Question

What are the three common elements warranted by pre-painted metal products?

Metallic coating corrosion performance (Al-Zn Only)

Film integrity

Chalk and fade



Pre-Painted Metal Durability

- Metal warranty periods can extend from 5 years and up (sometimes up to 40 years)
- Pre-painted typically warrants:
 - Excessive chalking
 - Excessive color fade
 - Delamination of topcoat or primer
- These failures are often due to improper application or installation, poor paint formulation, poor coater quality control or environmental conditions
- Significant difference between paint system types as to warranty coverage



Source: Arkema, Inc.

Excessive Chalking

- Chalking is caused by a degradation of the resin system of the finish
- Resin particles along with imbedded pigment particles lose adhesion and take on a white appearance
- This is predominantly caused by ultraviolet (UV) rays
- High-end paint systems such as PVDFs can offer warranties of 20 years and up against chalking
- Determined based on an ASTM developed 0-10 scale



Excessive Color Fade

- Fading is caused when substances in the environment and UV rays attack paint pigments
- Color change measured by delta E (NBS Units)
 - Delta E is a numerical value that represents total color change
 - The average human eye can detect a change in color between 0.5 and 1 dE
 - PVDF systems warrant the smallest color change of the different paint systems

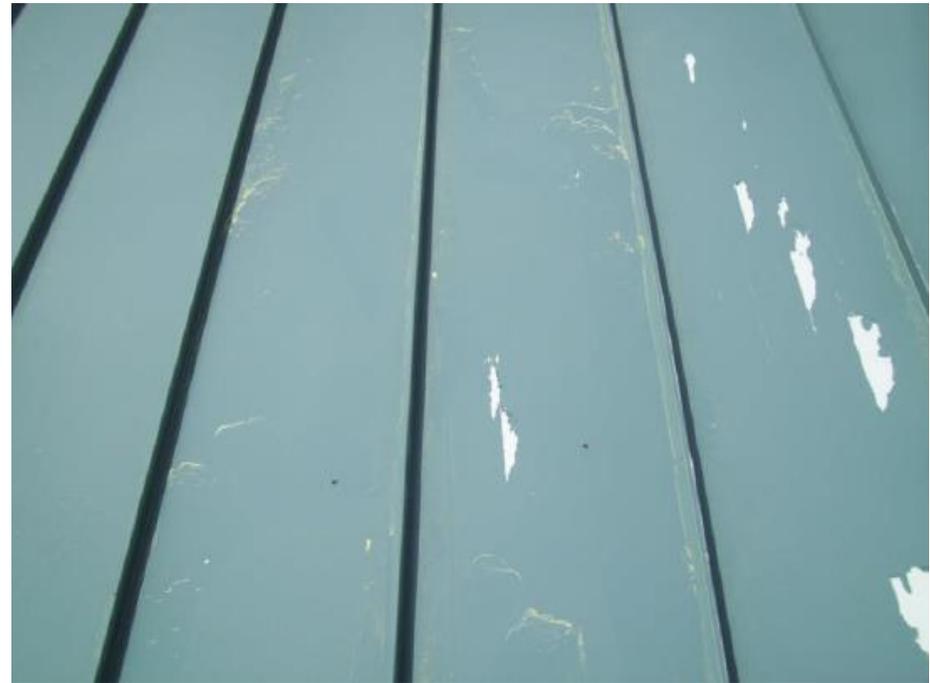


Change in color between 0 and 7 NBS (dE) units for standard blue and red colors



Delamination (Film Integrity)

- Loss of paint film adhesion to either the substrate or between the primer and topcoat
- Creates visible bubbling, peeling, checking, chipping, cracking or complete loss of top coat
- Root causes include:
 - Low film (inadequate coat application)
 - Incorrect pre-treatment
 - Inadequate or extended curing time
 - Incompatibility between top coat – primer
 - Mechanical damage



Other Avoidable Failures

- Pre-painted metal failures can also occur due to a number of controllable factors that arise from improper specification, coater quality control or from installation
- This includes:
 - Dissimilar metals
 - Incompatible materials including sealants
 - Swarf / metal filings
 - Wet stack issues
- Not a failure but important to understand
 - Oil Canning



Dissimilar Metals

- The use of other metals in metal to metal contact with Al/Zn can create galvanic corrosion
- The degree of 'dissimilar' is affected by the surrounding environment
- In proximity to the ocean the galvanic corrosion could be severe
- The further away the two metals are on the list, the greater the potential

More Active



More Noble (less active)

Zinc

Aluminum

Steel

Lead

Copper

Stainless Steel



Stainless steel lighting fixtures were recessed into the Al/Zn panels creating galvanic corrosion in an environment in close proximity to salt water.

Incompatible Materials

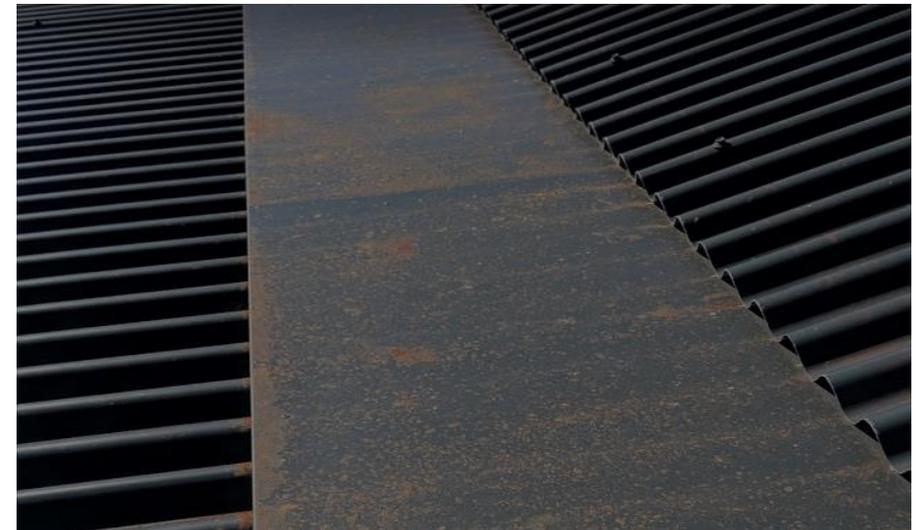
- Al/Zn steel should not ever be in contact with wet concrete mixtures
- Will react with the wet concrete leaving the coating prone to corrosion
- Chemically treated wood can leach out of the lumber and cause corrosion to the steel as well

Painted Al/Zn steel in direct contact with a concrete wall. The steel is corroding under the paint.



Swarf / Metal Filings

- Metal filings are typically created from cutting or piercing when using friction saws, abrasive discs, drills etc, on steel roofing and siding
- These particles, if left on the surface, will corrode and cause rust stains
- This is often mistaken for early deterioration of the roofing or siding itself
- Solutions:
 - Use a power saw with a metal cutting blade
 - Cut sheets on site and on the ground
 - Cover the area around drilling.
 - Carefully sweep the area following installation



Wet Stack Issues

- Oxidation can occur due to transport or storage of steel in a wet environment
- Material will have evidence of water penetration by capillary action
- Store material on racks at least one foot above ground level
- Do not use uncured lumber
- Use under roof storage when possible
- Al-Zn material tends to store better than hot dipped galvanized material



Oil Canning

- Oil canning is not a paint failure
- A wave pattern in metal and created by a number of different factors
- Causes include stresses in base material, improper fastener pressure, misaligned panels, thermal expansion and differential movement between primary structure and metal
- Solutions
 - Specifying tension leveled material
 - Stiffener beads or striations
 - Embossed surfaces
 - Lower gloss coatings



How to Avoid Failures

- Paint system specification appropriate to environmental considerations
- Use of reputable coil coater
- Avoid batch mixing
- Using reputable product manufacturer employing appropriate packaging and paint surface protection prior to installation
- Using reputable installer employing correct storage techniques, installation methodologies and fastener selection
- Frequent roof or wall surface cleaning using coater approved methodologies



Source: Arkema, Inc.

Constructs of a Coating Warranty

- It is always important to understand the details of product warranties
- Warranties are not all the same and headline figures such as 'Lifetime' or '30 years' may mean different things
- Warranties will typically differ in length based on the environment of the installation
- Considerations such as inadequate drainage, improper installation, chemical run off or improper cleaning methods may void warranties

Type of Environment of Installation	Film Integrity (Years)	Color Fade (Years) $\Delta E \leq 5.0$	Chalking Rating (Years) ≥ 8 Rating
Residential, Commercial and School – Buildings used for habitation, Distribution Centers, Hotels, Shopping Malls, Office Buildings, Assembly Factories and Schools located in rural or residential areas.	40	40	40
Industrial – Steel Mills, Power Generating Stations, Oil Fields, Oil Refineries, Ore Mines, Chemical Plants, Paper Mills or other unusual environmental exposure.	10	No Warranty	7
Severe Marine – Less than 1,000 feet from coastline. Requires min 0.7 mils thick film primer over steel, not required over aluminum.	15	15	15
Severe Marine – Less than 1,000 feet from coastline. EXTENDED LIMITED WARRANTY REQUIRES: min 0.7 mils thick film primer and clear coat	20	20	20

Type of Environment of Installation	Film Integrity (Years)	Color Fade (Years) $\Delta E \leq 5.0$ Wall Applications $\Delta E \leq 7.0$ Roof Applications	Chalking Rating (Years) ≥ 8 Rating Wall Applications ≥ 6 Roof Applications
Residential, Commercial and School – Buildings used for habitation, Distribution Centers, Hotels, Shopping Malls, Office Buildings, Assembly Factories and Schools located in rural or residential areas.	40	30	30
Industrial – Steel Mills, Power Generating Stations, Oil Fields, Oil Refineries, Ore Mines, Chemical Plants, Paper Mills or other unusual environmental exposure.	7	No Warranty	5
Severe Marine – Less than 1,000 feet from coastline.	10	10	10

Sample PVDF (top) v SMP (bottom) warranty

Constructs of a Coating Warranty

- When specifying paint, check the warranty carefully and verify the warranty coverage with the installer
- It is also important to review the warranty remedy the manufacturer is willing to provide
- Non-uniform changes in appearance that result from unequal exposure to light is typically not covered
- Marine applications typically have to be pre-approved by the manufacturer

Sheet Metal Roofing

Section 07600

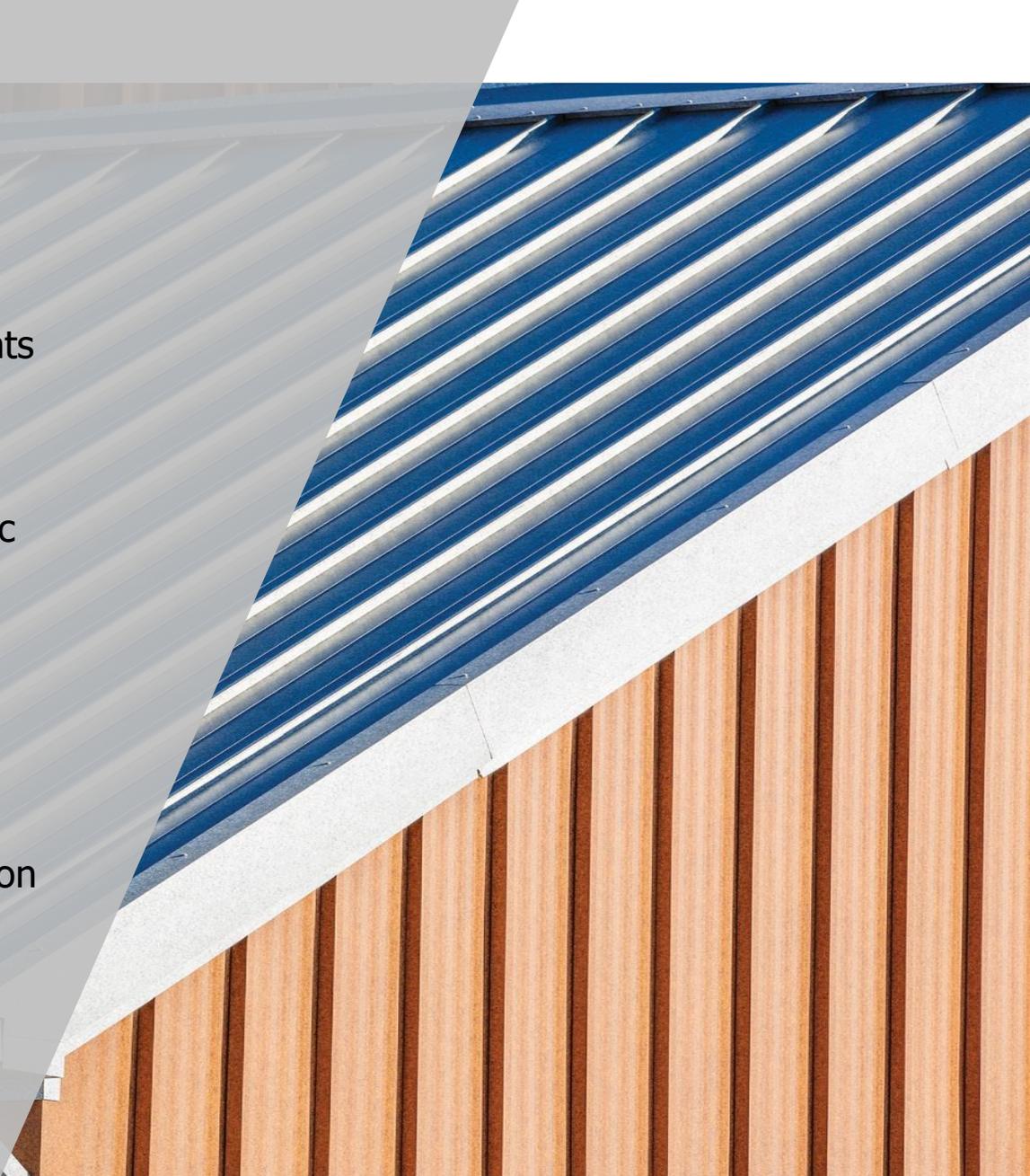
1.06 GUARANTEE

Provide Manufacturer's standard 25-year paint warranty including coverage against cracking, flaking, or peeling (loss of adhesion), change color (fade) more than 5 Hunter delta-E units or chalk in excess of number 8

Sample warranty

Summary

- The three core attributes of paint are resins, pigments and solvents
- Pre-painted metal offers an efficient and consistent paint application process
- Pre-painted metal typically consists of the base metal, the metallic coating, backers, a primer and top coat
- The three broad paint families are polyester, SMP and PVDF
- Paint systems offer a number of enhancements to improve visual appeal, durability and heat retention properties
- Warrantable paint failures include color fade, chalking and film integrity – installation environment and reputable material selection can significantly influence the likelihood of failure
- Pre-painted metal offers lengthy warranties but their coverage should be reviewed in detail specific to the application



Course Review

At the conclusion of the presentation, the audience will be able to:

- Comprehend the constructs of pre-painted metal and its appropriateness for exterior building applications
- Identify the differences between the three primary metal paint families
- Understand the pre-painted metal enhancement options available to the design community to enhance visual appeal or improve product suitability
- Recognize the common causes of paint failure, how they can be prevented and how the building owner can be protected by coating warranties



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Questions?

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