Welcome to Valspar’s course on Coatings for Cool Metal Roofing. We’re glad you’ve joined us today.

Let’s get started!

We’ve got five learning objectives today:

- First, I’ll talk about the environmental benefits of cool roofing.
- Then, I’ll discuss how cool roofs are evaluated based on industry standards.
- Next, I’ll talk a little about the components of paint.
- From there, we’ll take a look at the coil coating process and its benefits.
- We’ll wrap up by discussing the test methods used for coatings use on cool metal roofing.

Let's start with the first learning objective: discussing the environmental benefits of cool roofing.

The goal of green design is to create high performance buildings.

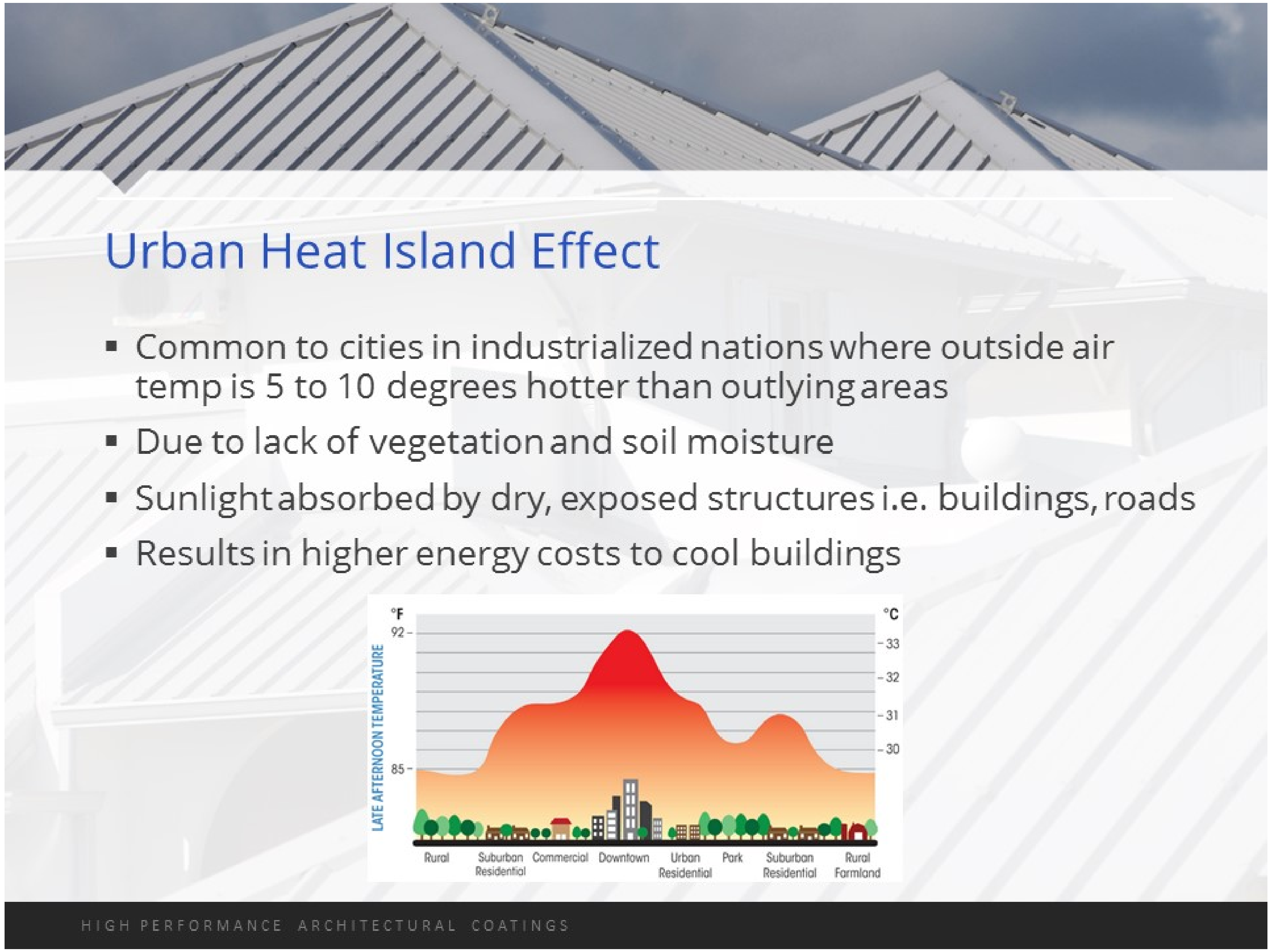
- The 1970s oil crisis led to global awareness of the need for energy efficiency in the design of buildings and consumer goods.
- Recycling efforts during the 1970s became commonplace, and the building industry recognized that it had a significant role to play in reduce, reuse, recycle initiatives.
- In the 1980s, the potential causes of “sick building syndrome” were identified, and concerns for worker health and productivity became an issue for employers, building owners, and the construction industry.
- Also, starting in the 1980s, building projects in water-scarce areas recognized the need to focus on water conservation strategies from site planning to the installation of water efficient plumbing products.

Early green designs usually focused on one issue at a time. However, green building architects in the 1980s and 1990s began to realize that the integration of all the factors mentioned here would produce the best results and, in essence, a “high performance” building.

Design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and their occupants are often called “green design” or “sustainable design.” These practices cover five broad areas:

- sustainable site planning
- safeguarding water and water efficiency
- energy efficiency and renewable energy
- conservation of materials and resources
- indoor environmental quality

Choosing to use green design products and services in a new or retrofit building project has numerous advantages for the individual, the community, and the global environment



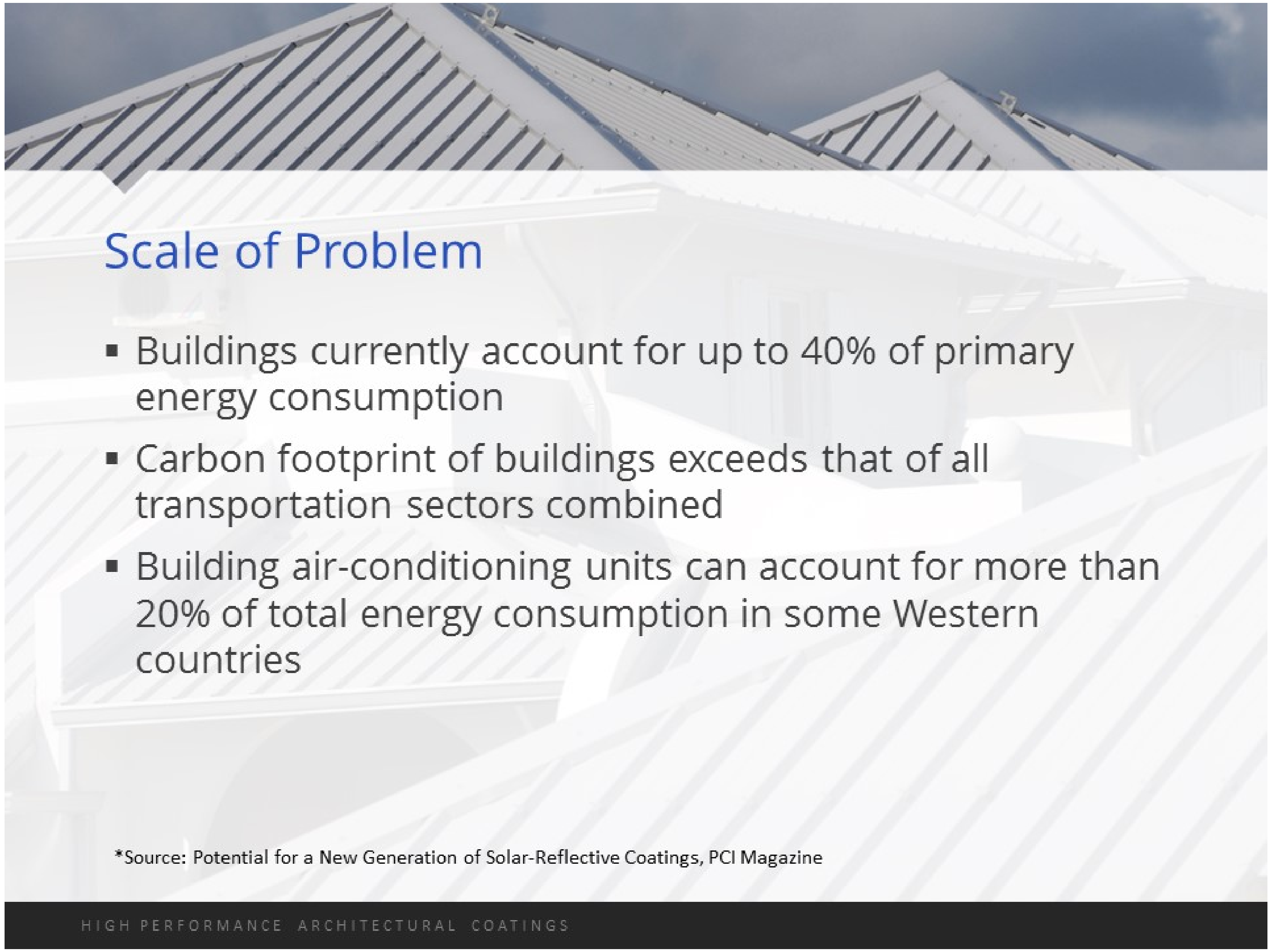
The term “heat island” is used to describe built-up urban areas that are hotter than their surrounding rural areas.

- This effect is common in industrialized nations where the outside air temperatures are 5 to 10 degrees Fahrenheit hotter than outlying areas.
- Due to lack of vegetation and soil moisture in a metropolis, direct sunlight and heat is easily absorbed by dry, exposed man-made structures
- The elevated temperatures result in higher energy costs to cool a building.

This graph illustrates how the spread of homes and buildings has increased the holding of heat in the center of the metropolis, in this case Atlanta, GA. As seen in the diagram, the urban heat island is significantly warmer than its surrounding rural areas.

Resource: U.S. Environmental Protection Agency (EPA), State and Local Climate and Energy Program, Heat Island Effect, www.epa.gov/heatisld/index.htm

The increase in energy costs and focus on sustainability is changing how building materials are selected. With the roof being one of the least-energy-efficient components, coatings manufacturers have created finishes for metal roofs that deliver energy efficiency.

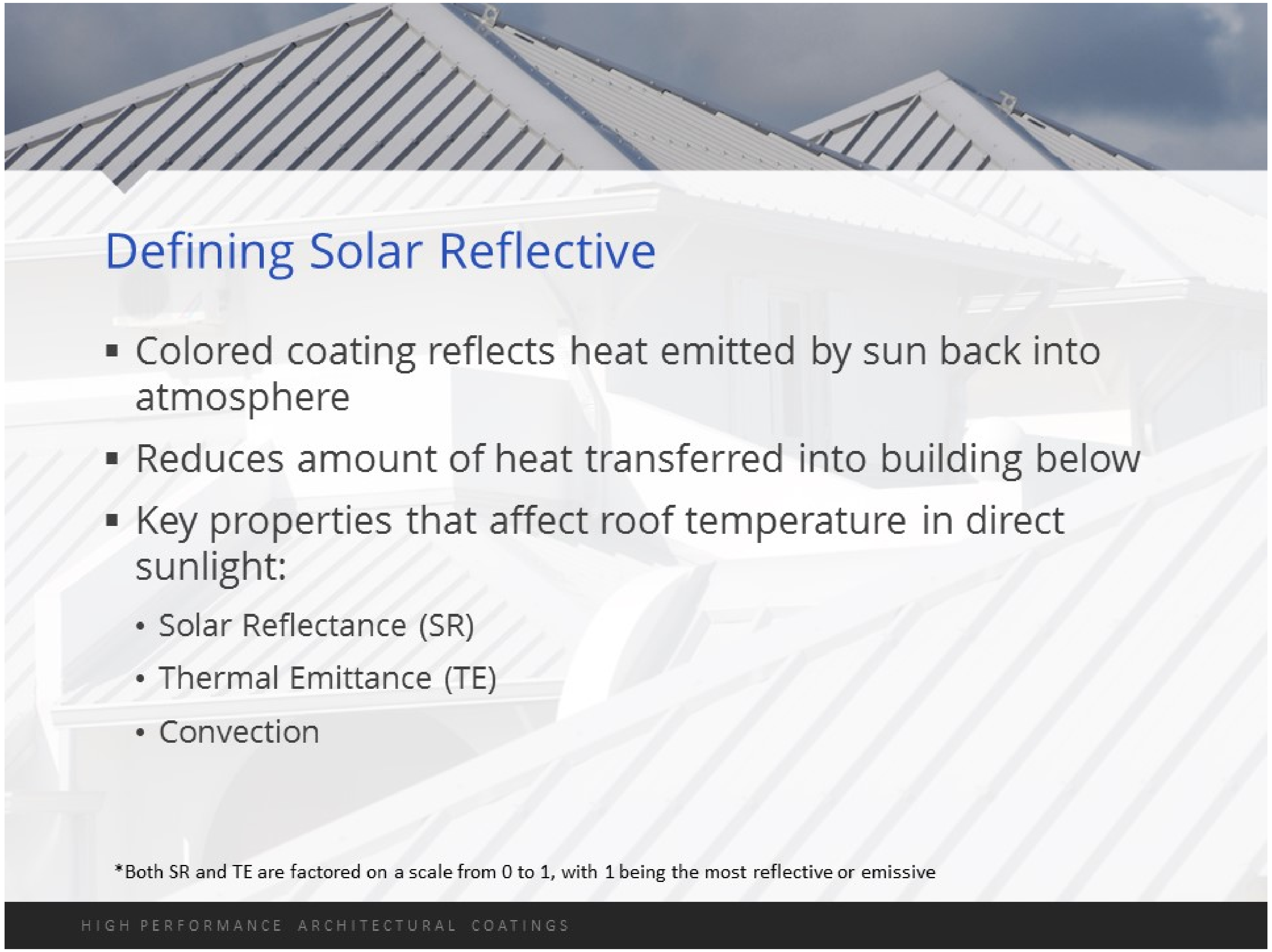


The use of energy by buildings is significant. When you think of all of the vehicles in the transportation sector from cars to trains and airplanes to bulldozers…the carbon footprint of buildings exceeds all of those!

Building air-conditioning units alone can be responsible for more than 20 percent of all energy use in some Western countries.

A cool roof is one that reflects the heat emitted by the sun back into the atmosphere, keeping the temperature of the roof lower and thereby reducing the amount of heat transferred into the building below.

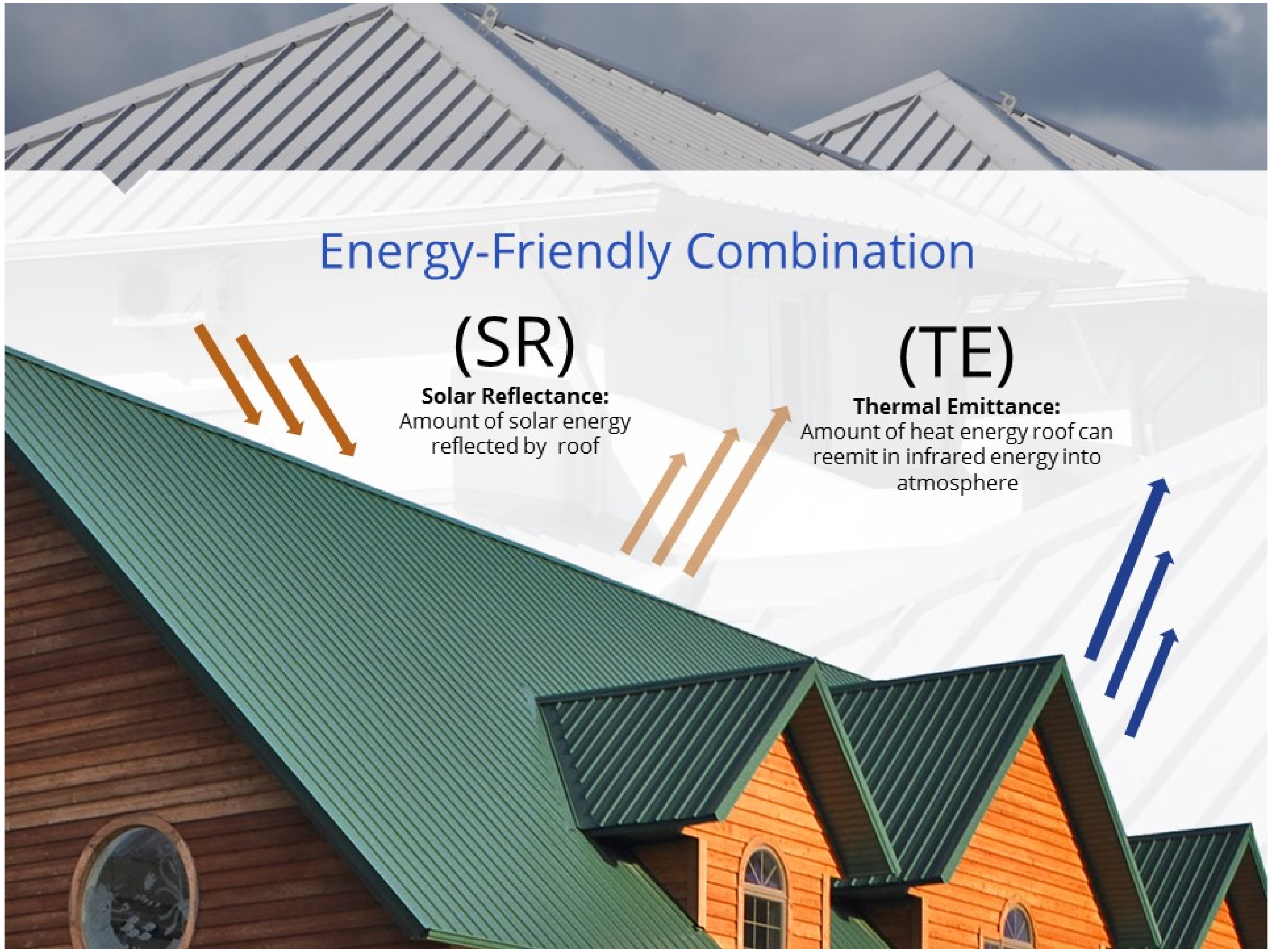
The coolness level of a roof is determined by several factors including geographical location, climate, materials in the building envelope, facility design, and insulation used.



Solar reflective coatings reflect the heat emitted by the sun back into the atmosphere, reducing the amount of heat transferred into the building below.

Key properties important to the temperature that a roof will reach in direct sunlight are:

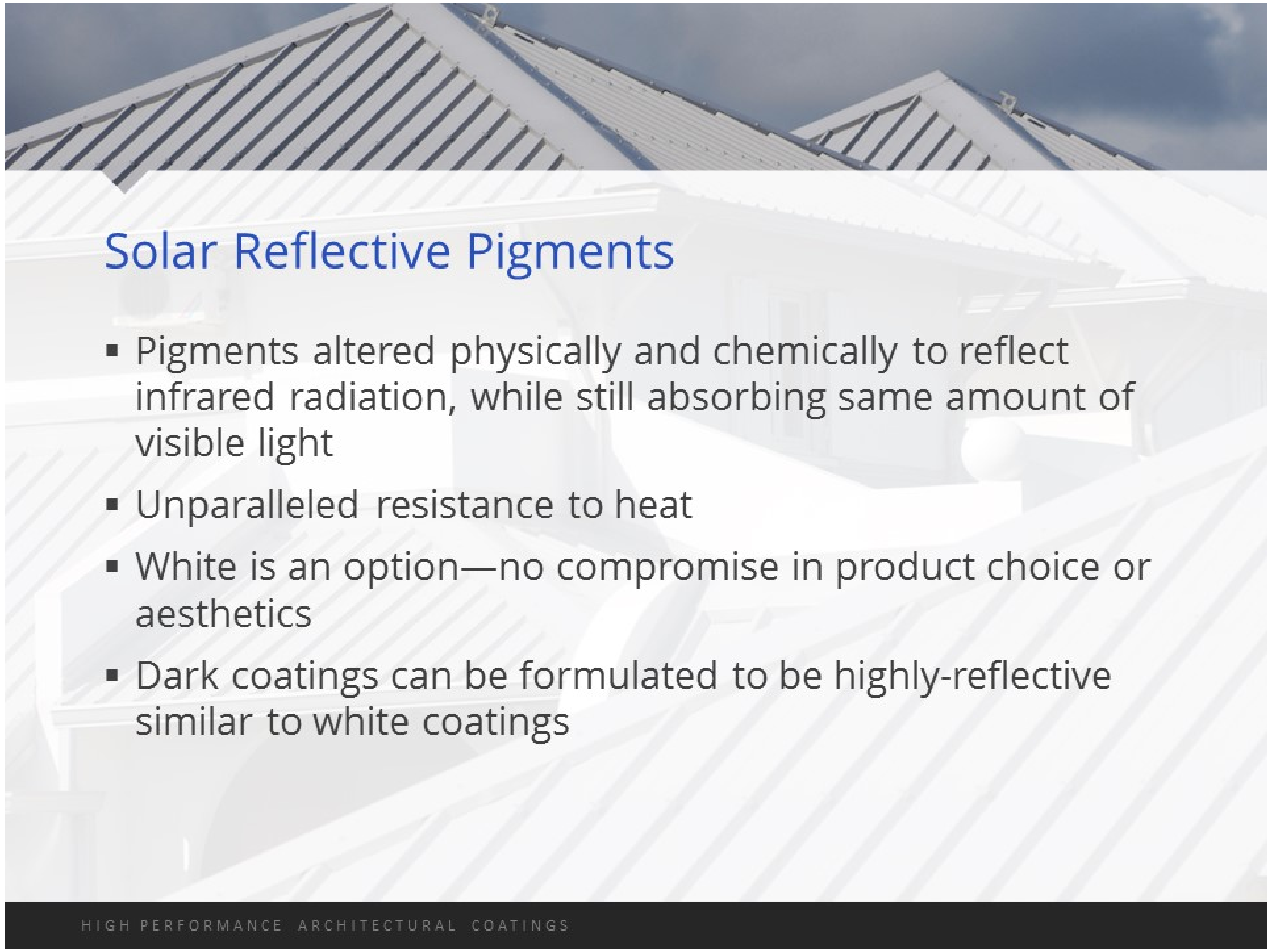
- Solar reflectance (SR), the amount of solar energy that is immediately reflected from a surface.
- Thermal emittance (TE), the amount of heat energy a surface can re-emit in the form of infrared energy into the atmosphere.
- Convection, the amount of heat transferred.



This simple diagram shows the sun hitting the roof and the solar reflective pigments deflecting this thermal energy back to the atmosphere.

A cool roof with a high solar reflectance and a high thermal emittance will have a lower surface temperature compared to that of a roof with a low solar reflectance and a low emittance.

A lower surface temperature translates into less heat gain into the structure below, resulting in a cooler building, which means less energy used and lower energy bills.

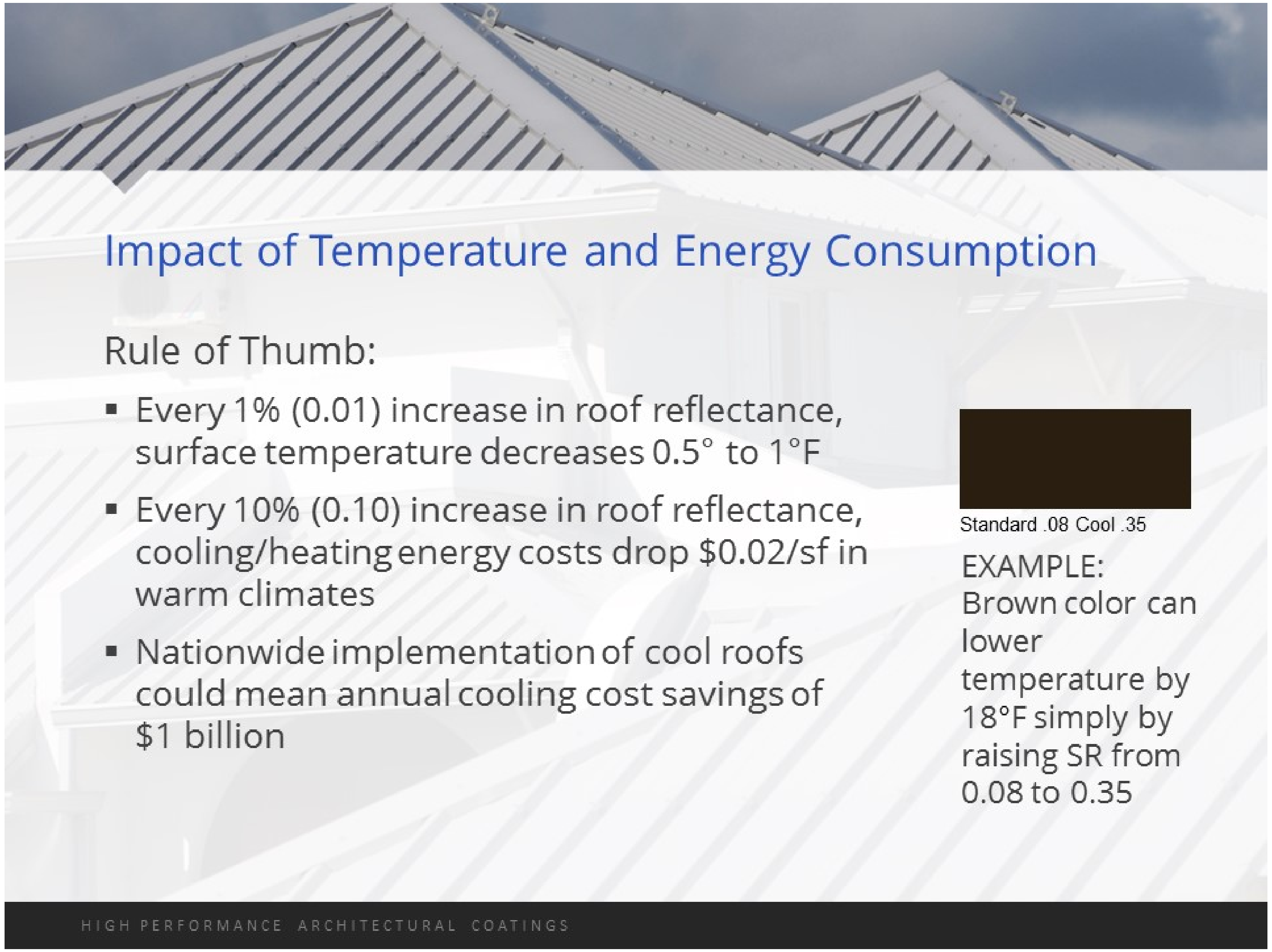


The pigments used in cool coatings are solar reflective. They have been altered both physically and chemically to reflect infrared radiation and have amazing resistance to heat. White is an option, but darker coatings can also be formulated with high-reflectivity.

The more that you can reflect solar energy from the surface of a metal roof or building, the less energy needed to cool the building. Occupants are more comfortable and building owners save on energy cooling costs.

Both the metal roof and metal walls of a building can have Solar-Reflective coatings. Depending on the color of the coating, the pigments in these coatings have different levels of solar reflectance…that's what the numbers represent.

Of course, white has the highest reflectivity, but you can select from a wide range of colors and still achieve the cooling effect needed to meet LEED and Energy Star specifications.



As you increase roof reflectance, surface temperature decreases. Even with 1% more reflectance, that can decrease the temperature up to 1 degree Fahrenheit. And for every 10% increase, you can substantially drop cooling energy costs.

In the example on the right of the screen, a brown roof can lower the temperature by 18 degrees Fahrenheit when the SR is raised.

Nationally, cool roofs could deliver annual cooling cost savings of $1 billion, which is significant.

There are two main cool roof types.

With a low-slope roof, you can only meet the cool roof requirements with a white coating.

However, with steep-slope roofs, many colors are available to help meet Green Design requirements.

With that, we've completed our first learning objective: the environmental benefits of cool roofing.

In our next learning objective, we'll discuss how to evaluate a cool roof relative to industry standards and green building program requirements.

Environmental Regulations

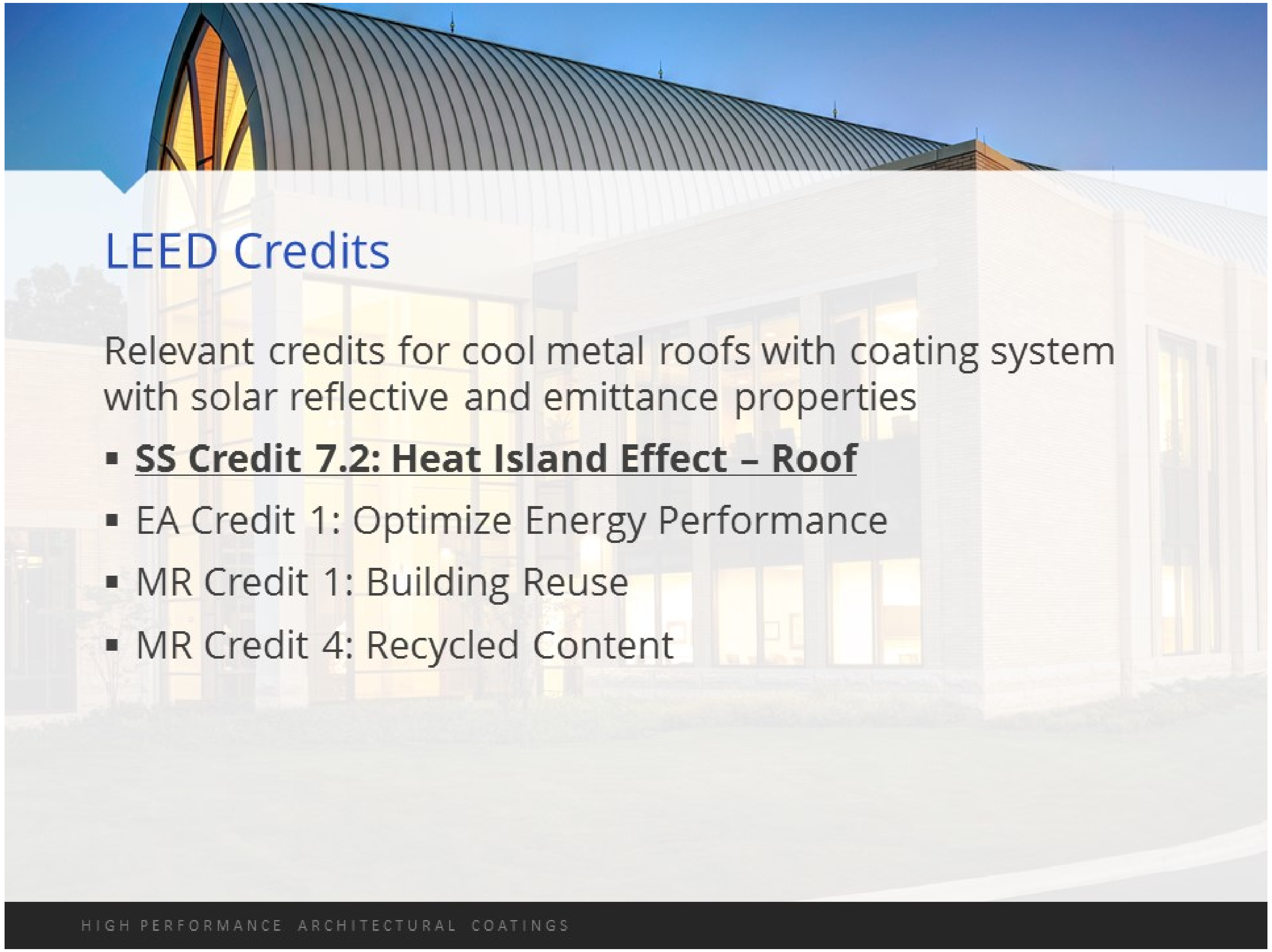
- New standards announced for 2014
- Increased SR and SRI values
- Big impact on coating industry
- SRI combination of initial SR and TE values

ROOF TYPE	SLOPE	ENERGY STAR SR	LEED 2009 SRI	LEED v4 SRI	LEED v4 3 yr SRI	IECC SR / SRI
Low-Slope	≤ 2:12	≥0.65	78	82	64	≥0.70 / 82
Steep-Slope	≥ 2:12	≥ 0.25	29	39	32	

In 2014, new environmental regulations were announced, making SR and SRI values even stricter, which has had a big impact on the coating industry. You can see how these requirements have changed in the chart on the slide.

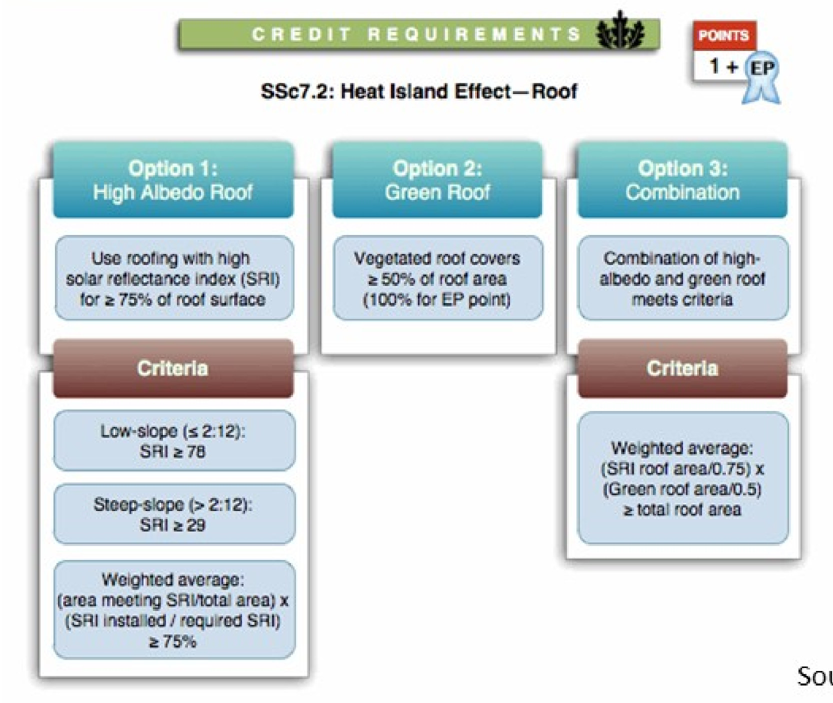
The most relevant category for coatings in the LEED green Building Certification program is Sustainable Sites.

LEED credit requirements cover the performance of materials in aggregate, not the performance of individual products or brands. Therefore, products that meet the LEED performance criteria can only contribute toward earning points needed for LEED certification; they cannot earn points individually toward LEED certification.



The credit you see in bold and underlined is relevant to coatings.

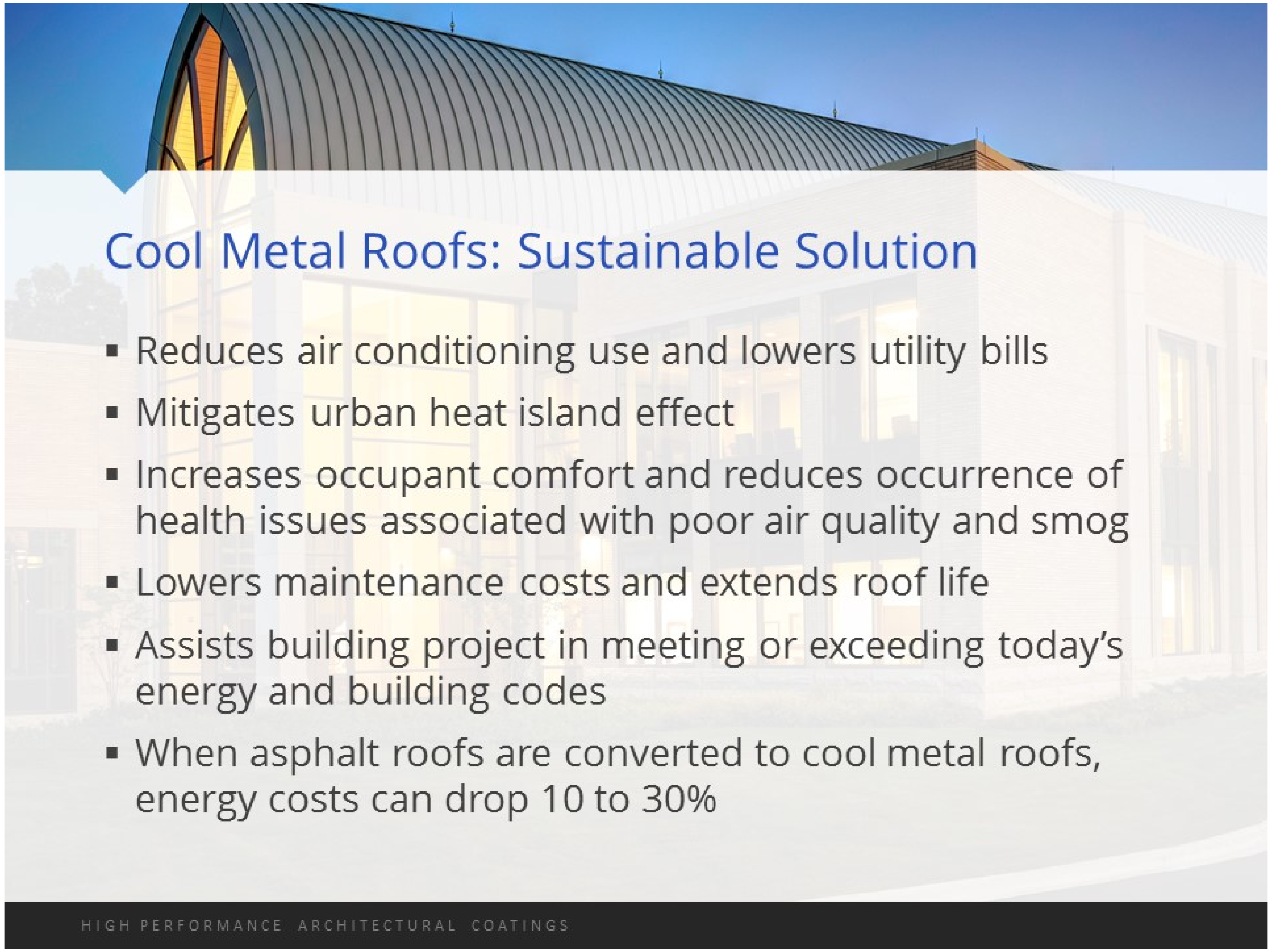
Heat Island Effect - Roofing



Source: leeduser.com

This is an “eye chart” from LEED. The important takeaway is that Option 1 is the relevant category for solar reflective coatings.

More detailed information can be found on LEED’s website.



Metal roofs are recognized as a sustainable, solution and are used on a variety of residential and commercial buildings.

Cool metal roofs, finished with the proper coating system, not only benefit the environment globally and locally, but can also significantly reduce utility bills, mitigate the urban heat island effect, increase building comfort, lower roof maintenance costs, meet energy building codes, and deliver up to 30% energy savings compared to traditional asphalt roofs.

Benefits of Cool Metal Roofing

- Sustainability
- Durability
- Fire and wind resistance
- Lightweight
- Aesthetics
- Retains solar reflectance over time

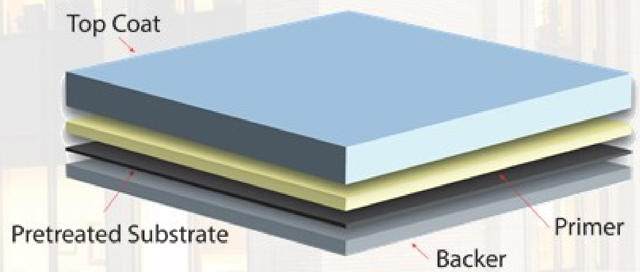
HIGH PERFORMANCE ARCHITECTURAL COATINGS

Cool metal roofs deliver several benefits including sustainability, durability, fire and wind resistance. They are lightweight, beautiful and they retain their solar reflectance over time.

Metal delivers multiple benefits. Pound for pound, it is an economical building material. It is long-lasting and strong. It is the most recycled material in the world with 64% of all steel made from recycled metal.

Components of Metal Roof Panel

- Steel or aluminum substrate
- Top coating system
  - Pretreatment
  - Primer
  - Top coat adds color and SR value
  - Backer
- Coated by coil coating process



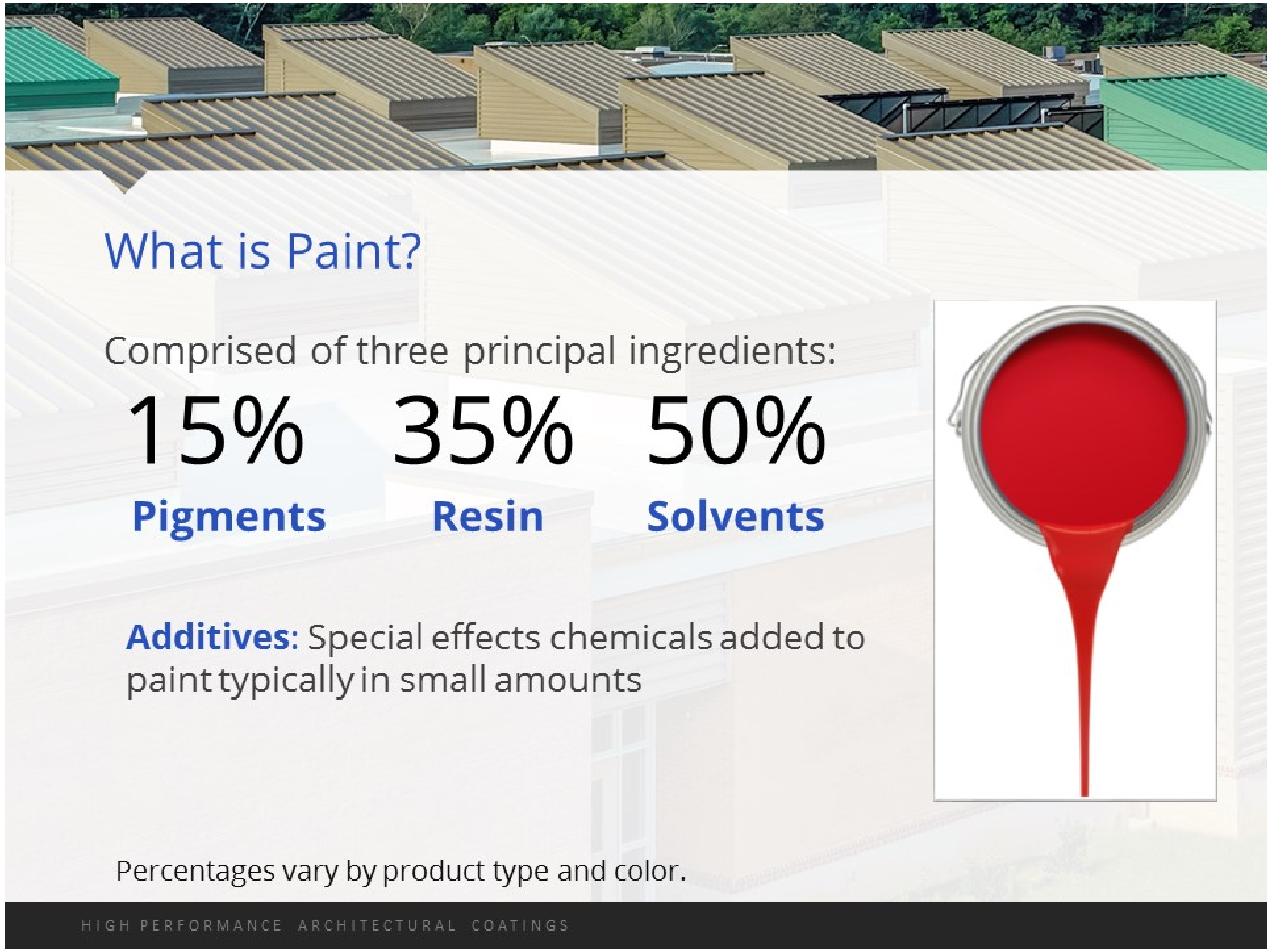
HIGH PERFORMANCE ARCHITECTURAL COATINGS

This illustration provides you with an understanding of the coil coating process.

The metal substrate is pretreated so that it is clean and the coating will properly adhere. The primer is applied along with the top coat, which adds color and the SR reflectivity to keep the roof cool. A backer is also added to protect the back of the metal substrate.

With that, we've completed our second learning objective: Discussing how to evaluate a cool roof relative to industry standards and green building program requirements.

Our third learning objective is to provide more information about the components of paint.



The three main components of paint are:

- resin (the film former and the way we generally refer to the coating)
- pigment (for color and opacity), and
- solvent (diluents that enable us to properly control application).

Additives are formulated into coatings to enhance the performance of paint. Additives are used to control foam, flow, and leveling. Viscosity modifiers are used to improve settling and catalysts are used to accelerate a chemical reaction, but are not consumed.

A typical gallon of liquid paint contains:

- solvents
- pigments
- resin, and
- additives.

Types of Resin

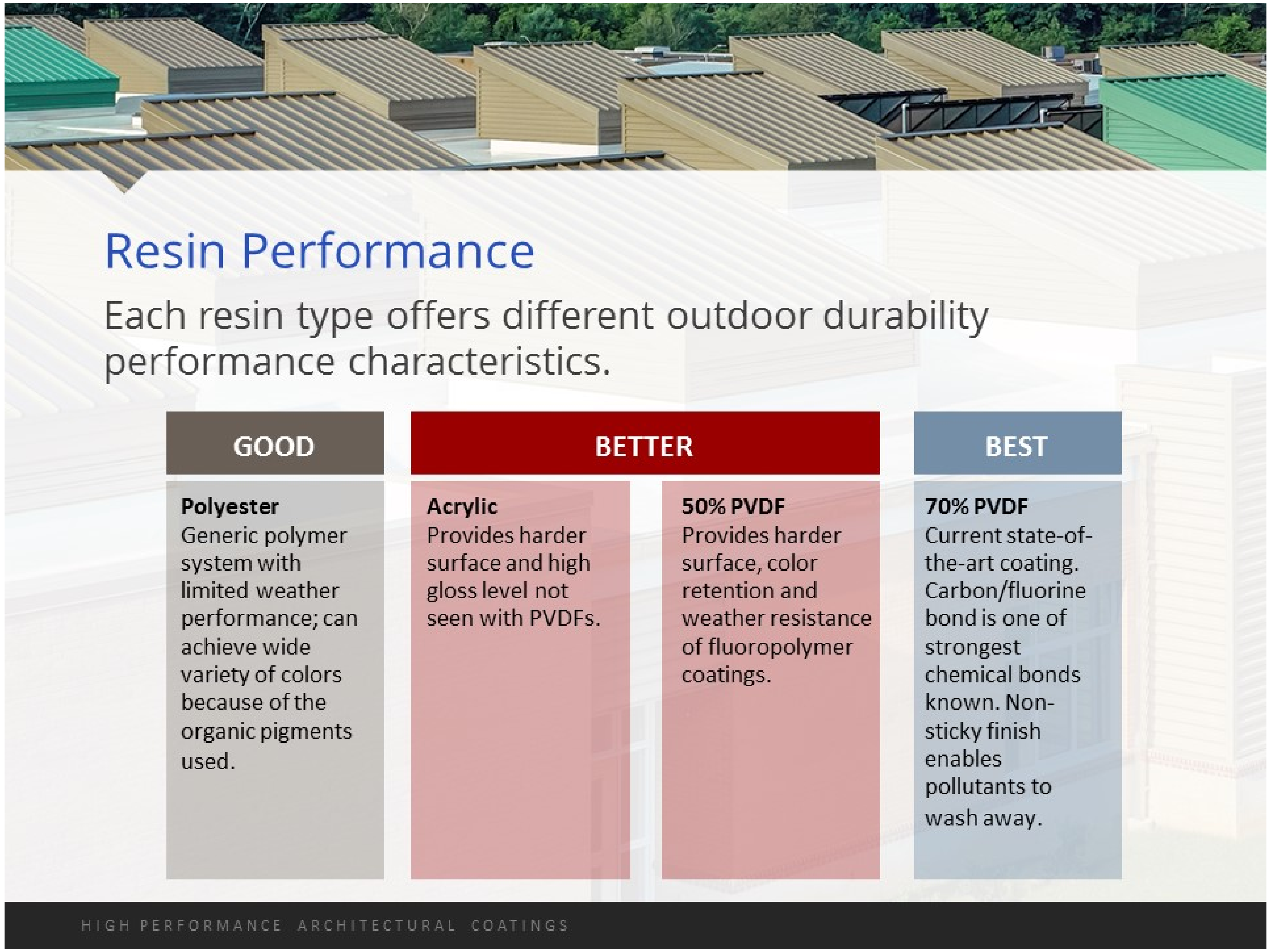
Common resins used in manufacturing metal paint coatings include:

- Fluoropolymer (PVDF)
- Silicone Modified Polyester (SMP)
- Polyester
- FEVE
- Vinyl/Plastisol/PVC
- Acrylic
- Polyurethane

HIGH PERFORMANCE ARCHITECTURAL COATINGS

Here is a list of the common resins used in coatings.

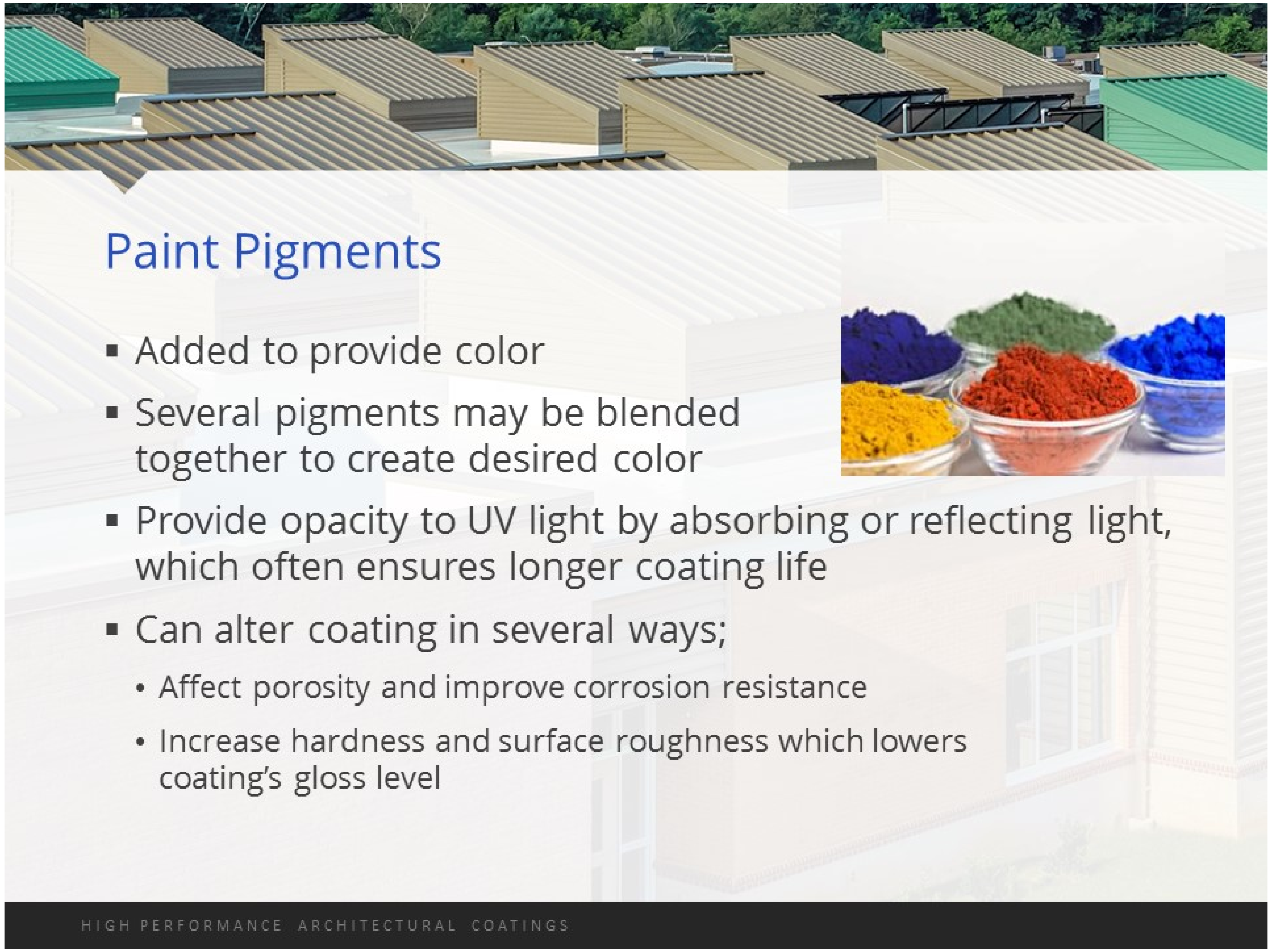
The primary function of resin is to act as the binder in a paint formulation by binding all of the components together. It is the source for a coating's durability and physical properties. It increases the physical strength and chemical resistance of the coating film, and allows for the curing process to occur while paint is drying.



The industry is driven by good, better and best categories—three categories of quality.

- On the left, you see the Good resin category. This consists mainly of polyester coatings. There are a few acrylic resins that fall into that category. Most of these coatings are designed for non-monumental use…more in the residential space on low-rise structures. They are designed to last for five to 10 years.
- In the red section of the slide, we get into the Better category of resins. There are some acrylics and 50% PDVF product. PDVF is an acronym for the resin, which is polyvinylidene chloride. A lot of this is high-end residential, light commercial, and low-rise construction such as strip mall centers.
- Now onto the Best category on the right, you have 70% PVDF resins in your coating system. The other 30% would be a modifying resin, such as an acrylic. These form some of the strongest chemical bonds known—these are the best coatings on the market today.

It's best to consult with a coatings manufacturer on your specific project needs.



Pigments are added to paint to provide color. There are several different pigment types.

In most colors, there is a combination of the different types of pigments blended to create the desired color…organic pigments, inorganic pigments and in some cases, there are some specialty pigments, mica, metallic and color changing effect pigments or even Solar Reflective pigments.

Pigments also offer additional properties such as total coverage or hide, which is the ability of the coating to cover the substrate so you have uniform and consistent color. There are also select pigments, especially pigments that are used in the primer, that offer corrosion resistance. These pigments are especially good to use if you have a project in an aggressive environment where there are industrial chemicals, or there is an ocean-front where there's airborne salt-spray. The coating system will have the ability to resist corrosion with these corrosive-inhibiting pigments. When you increase the hardness of a coating and surface roughness, the coating will not be as glossy.

Colors from organic pigments tend to be more bright and vivid. You'll get brighter reds, greens and blues.

They are carbon-based and are often made from petroleum compounds. They have less hiding power—they are more transparent so there is more show-through due to the smaller particle size of organic pigments. You have to load the formulation with a higher level of organic pigments. Another factor you want to consider is that organic pigments don't weather as well. They allow UV light and oxygen to penetrate, which breaks down the chemical bonds more quickly. They are not as heat resistant. You will see some degradation of color when these types of coatings are used. A lot of residential coatings use these types of pigments…more so than high-performance coatings.

Typically, organic pigments are combined with inorganic pigments when formulating a coating to make sure the right color and durability can be achieved. The pigments used in solar-reflective (SR) coatings are some of the most heat stable, chemically inert, UV and weather resistant pigments known.

Next, moving onto the solvent category. Solvents are mainly used to promote good application properties…thinning the paint to control its viscosity, flow and leveling.

You choose the solvent based on compatibility with the different resins you are using in the coating. Evaporation rate can vary by solvent. So does its ability to disperse the solids in the resin, and the ability to help the film coalesce or form a uniform film. During the oven bake, as solvents are coming out of that wet film, you want them to come out at a certain rate so that the resin and the pigments have time to intermingle and form a good, uniform film across the whole coated substrate.

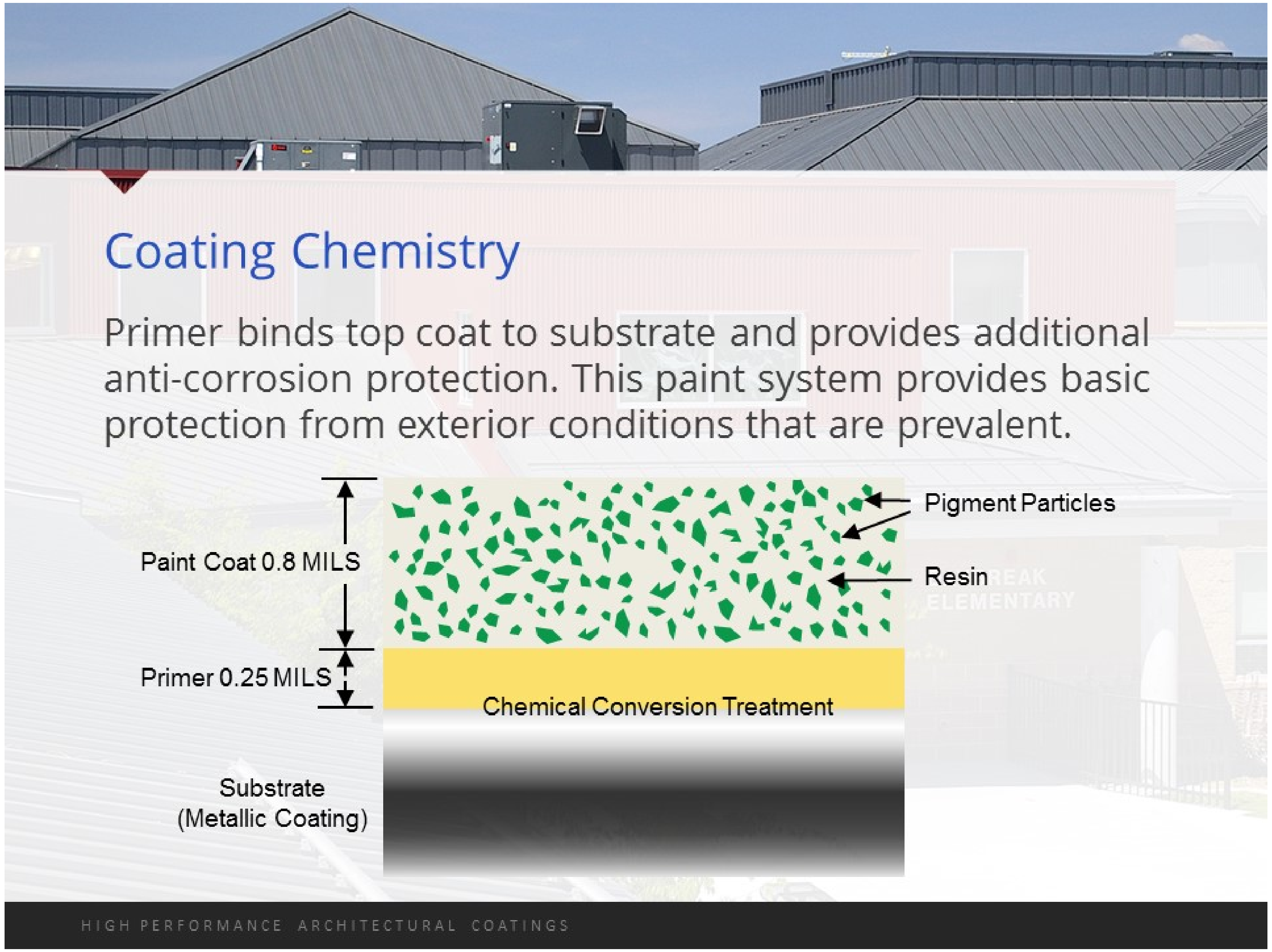
We've now completed our third learning objective to provide more information about the components of paint.

In objective four, let's take a quick look at the continuous coil coating process.

It is called continuous because a large quantity of metal can be coated with paint continuously without stopping.

Here are the basic steps of the coating manufacturing process.

- Dry pigments are combined and added to a container that already contains pre-measured amounts of a specified resin and solvent.
- A high speed disperser (mixer or blender) in which propellers revolve provides the dispersing action required to mix the ingredients.
- The mixture is then pumped over to a second machine, called a media mill. The media contained in the mill may be glass beads, zirconium, steel shot or sand. The hard particles help break up the clumps of pigment into the small sized particles required to produce a homogenous paint solution.
- Finally, the balance of resin and solvent is added to the dispersion to complete the batch of paint.



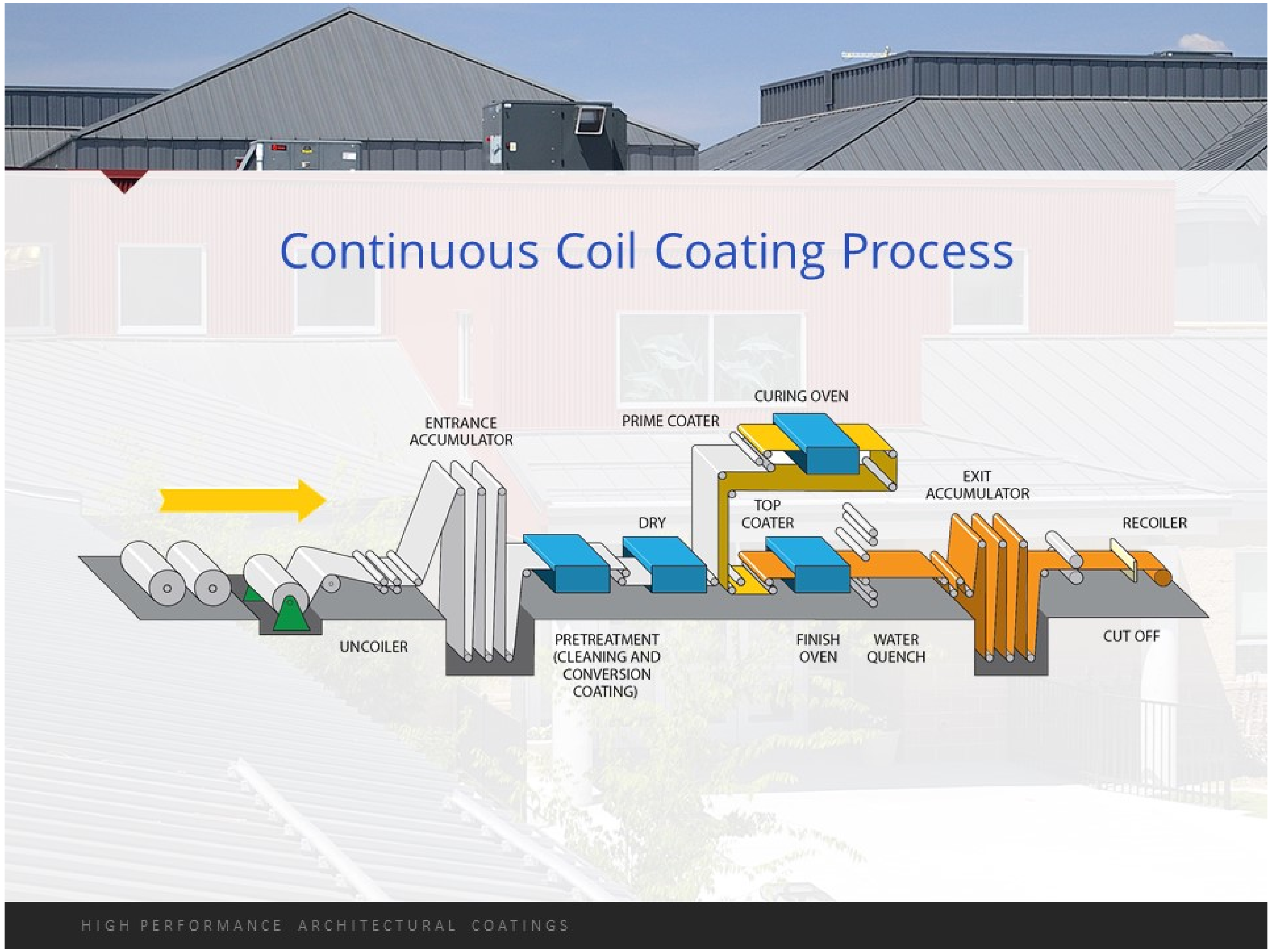
This drawing helps you understand how the coating works to provide protection of the substrate.

- This image shows a cross-section of the coating. Starting at the bottom, the gray layer demonstrates the metallic substrate.
- On top of that is the pretreatment chemical conversion coating. This is applied to the metal to protect against correction and to make it easier for the coating to adhere.
- Next, you'll notice there is .25 mils of primer, which you can see in yellow. Primer is an important base coat that allows the finishing paint to adhere much better. It forms a binding layer that is ready to receive the color paint. The primer binds the top coat to the substrate to provide additional anti-corrosion protection.
- The topcoat depicted in this image is white with green flecks, representing the resin and pigment particles embedded within that resin system. The topcoat is a combination of resin, pigment and other ingredients. It is typically applied in 2 coats. This paint coat layer is up to 0.8 mils thick. There is a lot of innovation that goes into high-performance coatings to make them so thin yet perform so well.

Here’s a snapshot of the continuous coil coating process.

In the picture on the left, you see a very large roll of the bare metal substrate being delivered from the manufacturer’s rolling mill to a coil coating facility.

On the right, you can see the metal being painted.



Coil coating lines represent an investment of tens of millions of dollars. On the left you can see the coil being fed into the machine, where it is **Uncoiled.**

In **Pretreatment,** alkaline cleaners, mechanical brushes and fresh water rinses are used to remove surface contaminants and mill oils that prevent corrosion during transit and storage. Pretreatment also improves surface reactivity of the metal substrate, paint adhesion and corrosion resistance.

Next, **Primers** are applied to both sides of the metal to aid in paint adhesion and corrosion resistance. **Finish Coats or Top Coats** are applied after the prime coat to provide:
- The desired physical appearance and aesthetics;
- Weathering characteristics, like chalk, fade and gloss retention; and
- Physical properties, like hardness and flexibility.

Backers provide corrosion protection, a consistent bottom side appearance and protection against abrasions during transit. Once the coating is cured, the metal is re-coiled and sent to the component manufacturer.

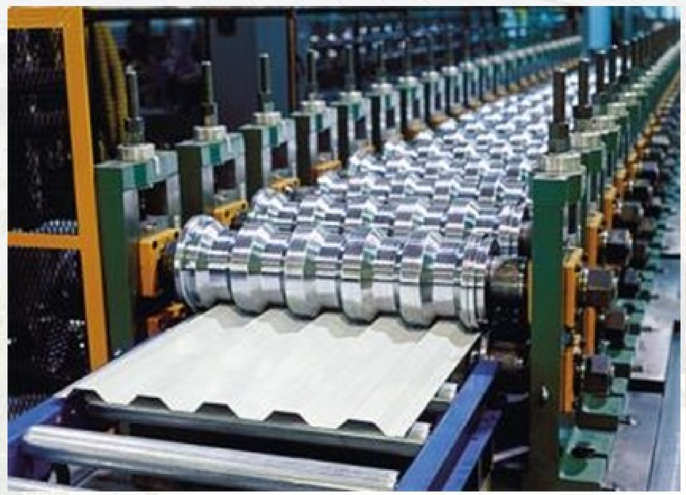
Here’s an image of the continuous coil coating process with the key steps described.

The metal is coated on both sides at the same time moving at speeds of up to 1,000 feet per minute on the coating line. A wide range coating options can be used. This process provides very uniform gloss, color and thickness.

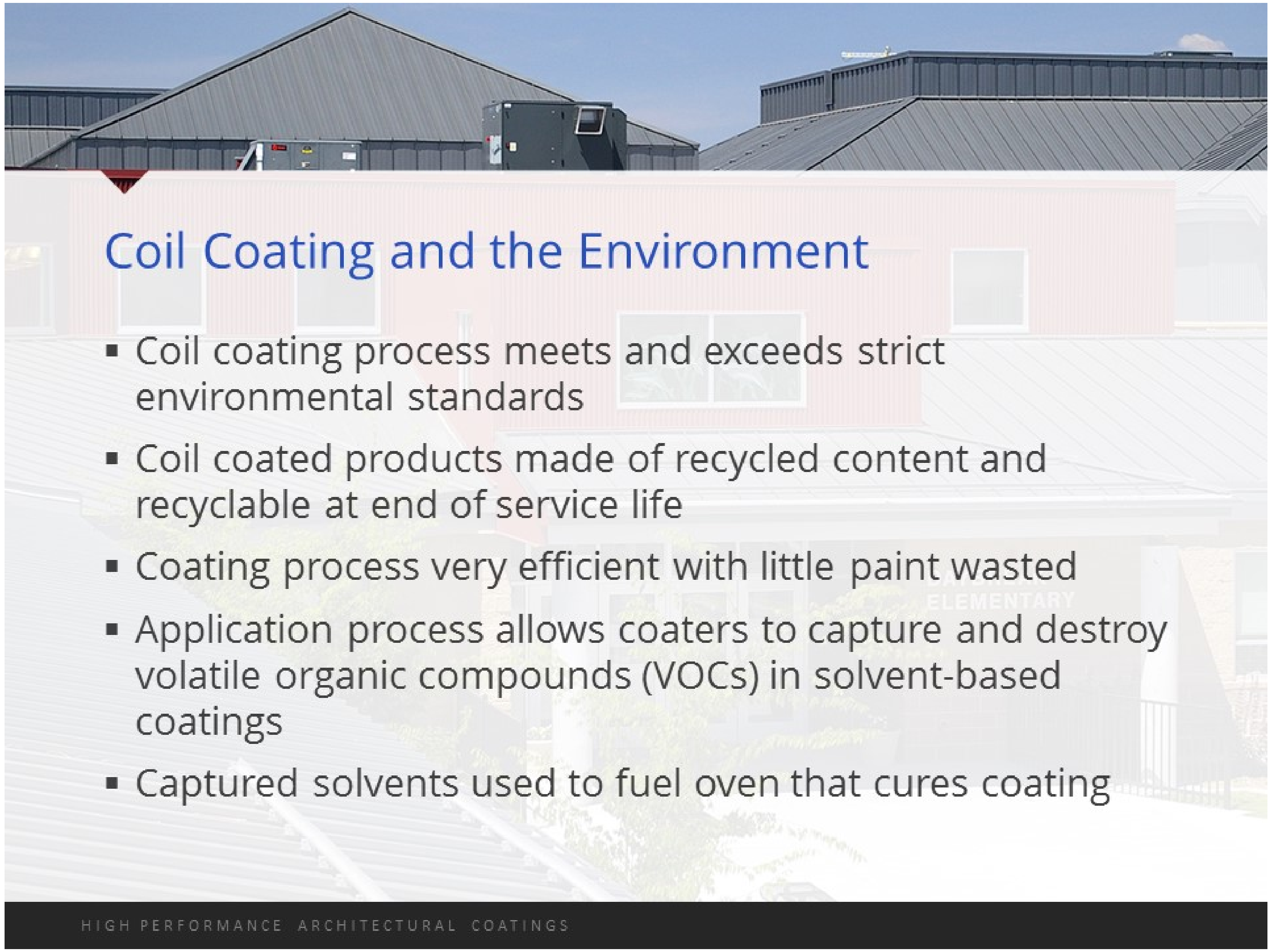
Once coated, the metal is recoiled and sent to the manufacturer to make metal building parts.

What Happens to Coil After it is Coated?

Coil coated metal can be cut, slit, formed, corrugated, profiled and molded into variety of shapes for metal building products and systems



The finished sheets are used in various forms of roofing and cladding, for appliances, furniture and fittings, engineering components, and other finished goods.



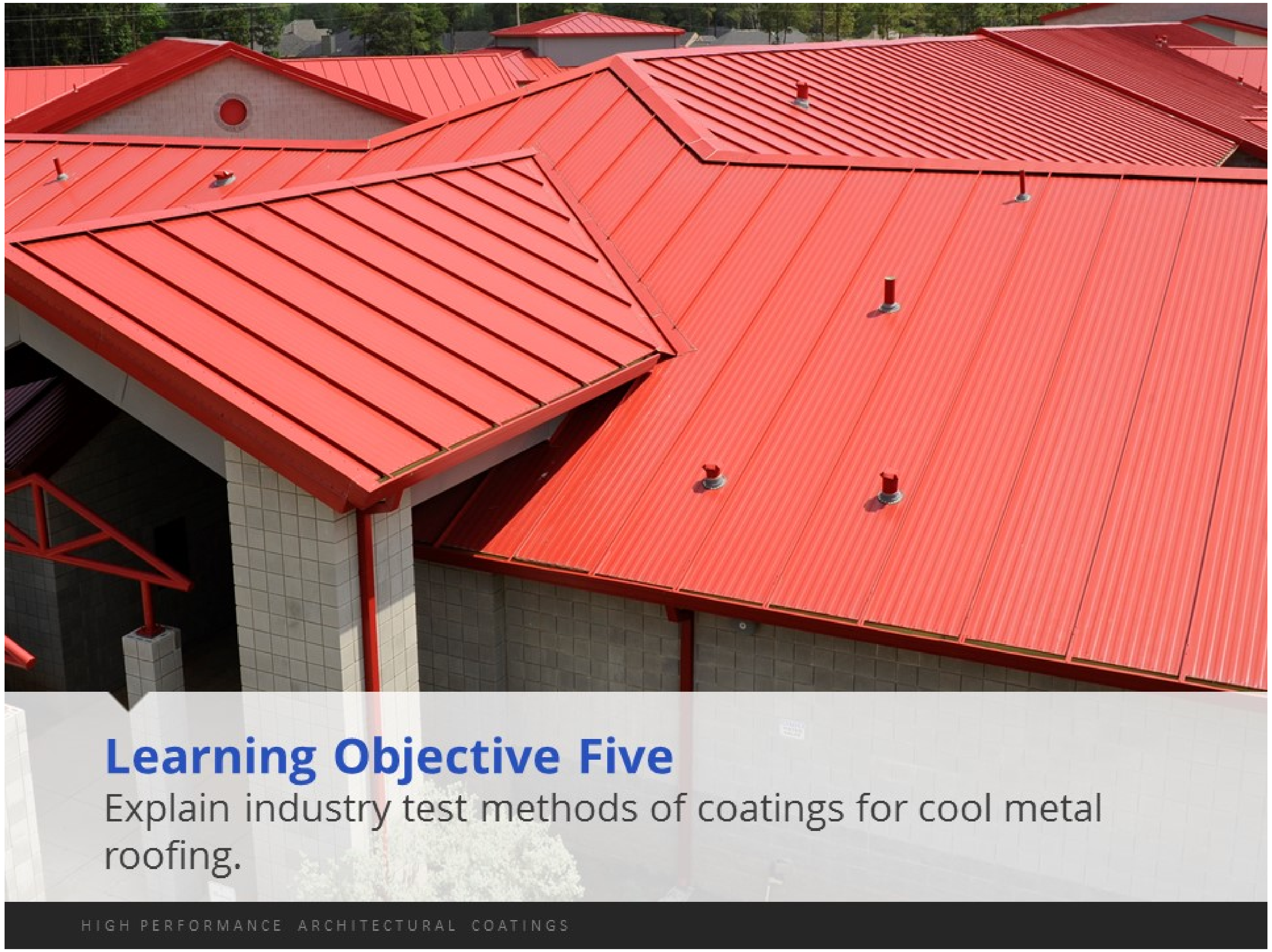
There are numerous benefits that come from the prepaint process.

First, the coating process meets and even exceeds strict environmental standards. The coil coating industry is subject to the highest EPA standards and the prepaint process <u>exceeds</u> these stringent standards.

Coil coating products are not only made of recycled content, they are recyclable. In the efficient coil coating process, environmental issues are concentrated, controlled and even eliminated. In coil coating facilities, 98% of the solvents are captured. The coating curing ovens burn the solvents as fuel, saving energy and eliminating pollutants.

In short, the coil coating prepaint process is the most efficient, effective and environmentally-friendly method to pre-clean, pre-treat, pre-prime and prepaint metal and deliver a beautiful, high quality finish.

With that, we've completed learning objective four: learning more about the continuous coil coating process and the benefits of this pre-paint metal surface treatment.



Let’s now take a look at how paint and coatings are tested so that they meet the strict requirements of the end user.

Can anybody tell me what weathering means, in terms of how it relates to paint?

Factors such as exposure to the sun (UV light), moisture and humidity, high temperatures, and temperature fluctuations can lead to color changes, chalking, blistering, and corrosion to a protective metal roof coating. Knowing the enemy and understanding how it can affect a painted metal product helps a manufacturer develop and deliver products that meet a project's specific performance requirements.

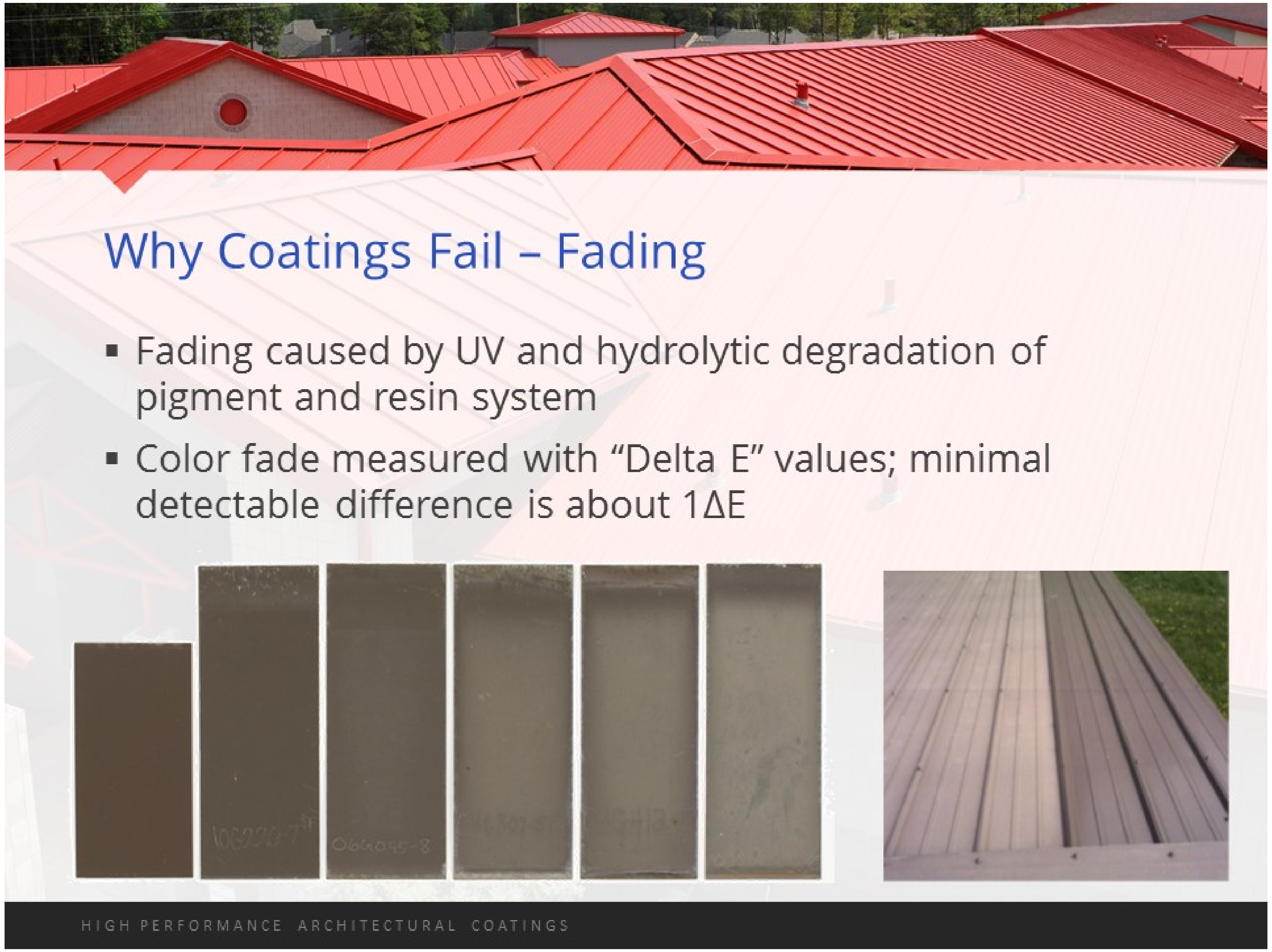
Why Coatings Fail – Chalking

- Chalking caused by degradation of resin system due predominantly to exposure to UV rays
- As resin system breaks down, particles take on white appearance, and embedded pigment particles lose film adhesion

HIGH PERFORMANCE ARCHITECTURAL COATINGS

Chalking is exactly what it sounds like. It is where a white chalky film develops on the surface of the coating that can be rubbed off.

Chalking is caused by degradation of the resin system at the surface of the finish, due predominantly to exposure to UV rays. As the resin system breaks down, resin particles take on a white appearance, and embedded pigment particles lose their adhesion to the film. The durability and performance of the coating decreases.



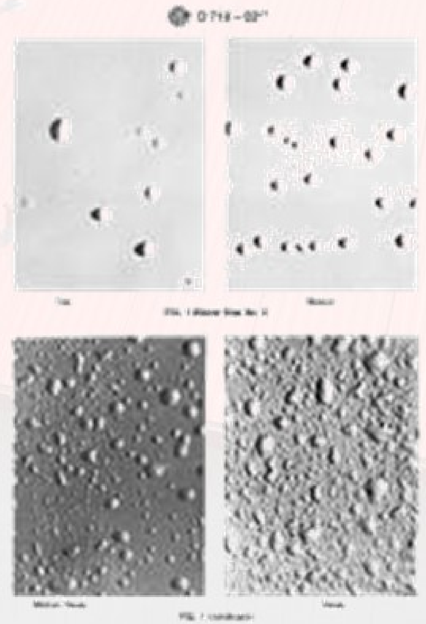
Fading is caused by UV and hydrolytic degradation of the resin system and is measured in Delta E values.

The photos show examples of fading over time.

The series of gray panels in the lower left of the slide represent a fade of about Delta 9 from left to right. The image in the lower right corner shows fading in the field.

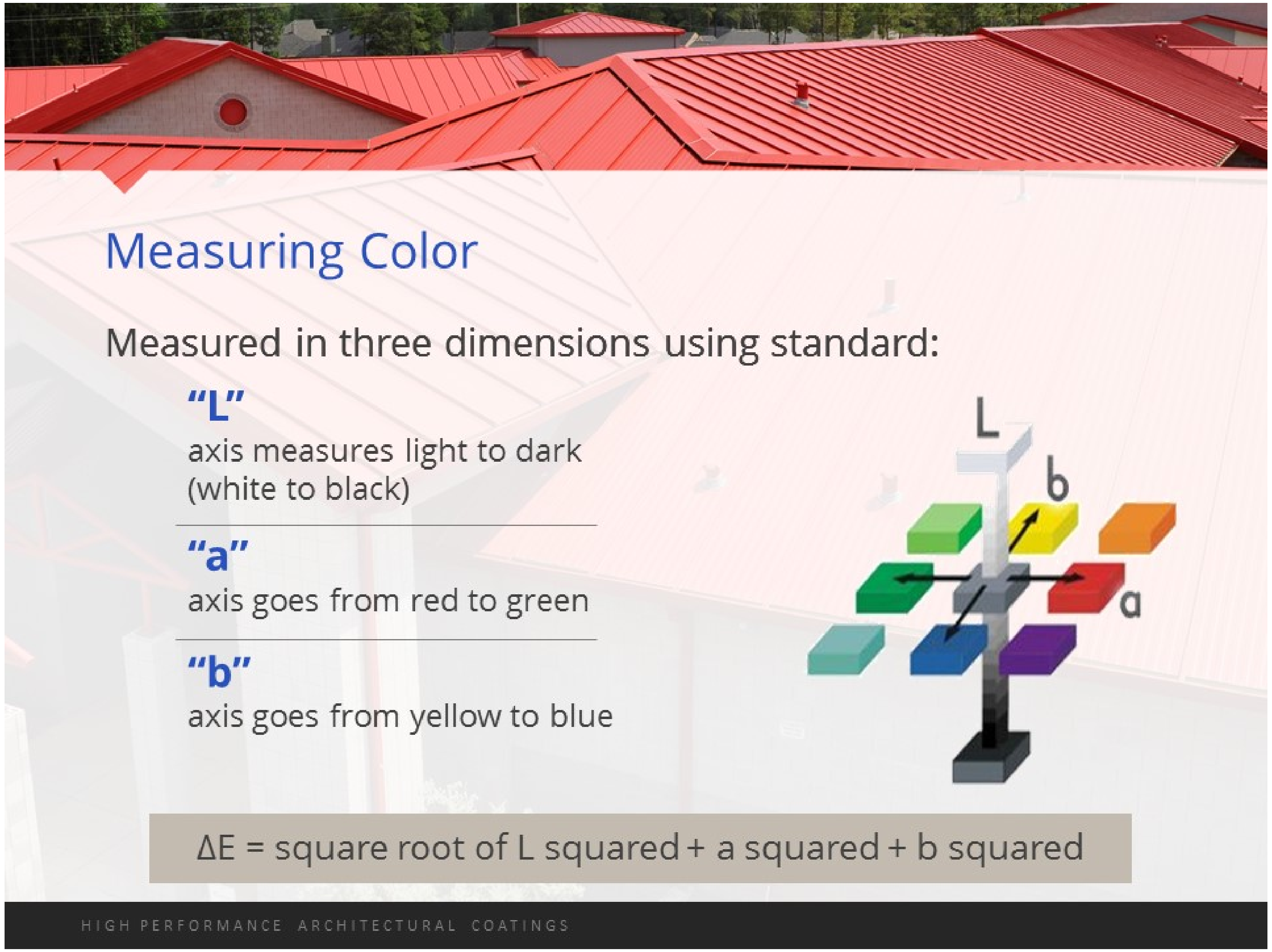
Why Coatings Fail – Blistering

- Blistering can occur in high humidity areas or coastal regions
- Environment important for picking the right project coating
- Use of additives can aid in preventing water absorption



Photos courtesy of ASTM International

Blistering can occur when it’s very humid and the coating was improperly applied or the wrong coating was selected. When the end application is known, the right formulation will provide the required protection with additives used to prevent water absorption.



Color is one of the most important features of a coating, mostly because it is a visual feature.

Everyone sees it and sometimes, different people see the color of the building or roof differently.

Many factors go into creating color and gloss. Reflectance, refractance and surrounding lighting all play a part. Coating manufacturers have developed a mathematical system to designate and describe every color.

The "L" axis measures white to black,
"a" measures red to green, and
"b" measures yellow to blue.

When you, as an architect, specify a color for the roof on your next building, know that the coating supplier can exactly match the color you want by mixing together the different colors of pigments.

The coating industry is constantly testing and evaluating how the weather elements interact with paint. For example, we know that exposure to UV light usually starts to break down the coating's molecules, but it is a combination of the sun, heat and moisture that can accelerate the damage more than any one factor alone.

Tests and evaluations are performed to appropriate industry association standards by technical experts. Technology is key to the weather testing of coatings, the formulation of new materials, or the improvement of old formulas. It allows for coating patch and application performance, resin development, and pigment studies. A coating manufacturer continually develops new products to expand and improve current product lines that prevent field failure, improve quality and durability, meet customer expectations, and comply with government and environmental regulations.

There are a couple of key types of weather testing that are done. The most important and accurate is natural exposure to the elements, which you can see in the photo on the left. This is done at specialty labs in warm climates like Florida, where panels are exposed to high humidity, heat and salt spray…sometimes for decades. This data is crucial to help scientists continue to innovate and improve the performance of coatings.

Coating manufacturers want to have an idea of how well a coating is going to perform once they put it into the market. This helps them develop real-world products that will perform year after year, retaining their color AND quality for a lasting impression.

The second kind of testing is accelerated indoor testing, which you see in the photo on the right. These machines use salt spray, humidity and heat. This testing is most useful in the development stages of coatings to test various ingredients when formulating to see which ones will be the best choice for a particular coating.

In addition to exposure testing, physical tests are performed to gauge a coating's performance. Physical test components are mainly driven by ASTM methods, which is the American Society for Testing and Materials.

- We look at a variety of factors, such as color retention using a color instrument. We can read a reference standard and read the coated substrate in the field to see exactly how much it's changed.
- We can look at film-thickness to ensure the coating will properly cover the substrate and offer protection from corrosion.
- We also have instruments that can read gloss levels. For example, there's a big difference between a matte finish and a medium gloss.
- Resistance to solvents. The basic test for doing that is taking solvent samples and rubbing the coating substrate to see how well the coating fares. That tells us to a degree if the coating will be resistant to certain cleaning methods used.
- And finally, flexibility. There are tools in the laboratory to look at the coated substrate on the post-fabricated part for flexibility properties like adhesion and cracking.

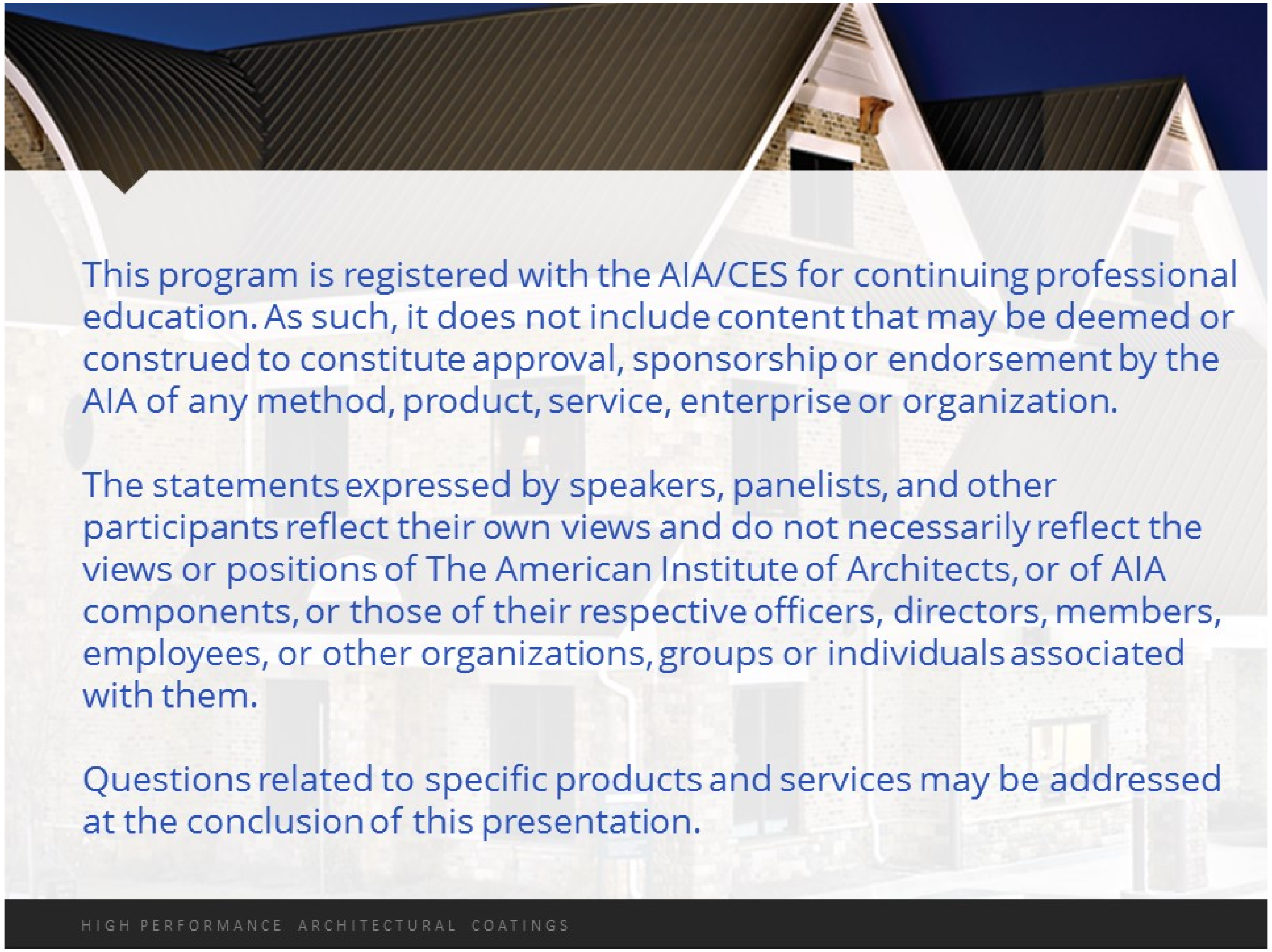
That's the end of learning objective five: explaining industry test methods of coatings for cool metal roofing.

We've complete five learning objectives today:

- First, we talked about the environmental benefits of cool roofing.
- Then, we discussed how cool roofs are evaluated based on industry standards.
- Next, we talked a little about the components of paint.
- From there, we took a look at the coil coating process and its benefits.
- We wrapped up by discussing the test methods used for coatings use on cool metal roofing.

Thanks for joining us today! We hope you have learned some important information about coatings that will help you in your role.

To learn even more, visit valsparcoilextrusion.com or contact us at rommen@valspar.com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