SELECTION AND SPECIFICATIONS FOR ARCHITECTURAL AND INDUSTRIAL MAINTENANCE COATINGS FOR COMMERCIAL ARCHITECTURE

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ABSTRACT

Selection of coating systems for commercial projects may appear to be a simple task, but, to ensure a successful project the Architect or the Engineer needs to perform a thorough and appropriate evaluation of the project to match the right coating systems with the required substrates and environments. Commercial architecture defines more than just simple office buildings; it may include highly complex transportation centers, convention centers, state-of-the-art office structures, sports facilities, and educational facilities at all levels. Each of these building types, while commercial in function, border on high-end industrial facilities because of the variety of spaces and environments that may be encountered.

These building types often require a broad menu of coating systems to provide corrosion resistance and aesthetics. Architecturally exposed structural steel, often used as an accent element, requires a coating system with a high degree of corrosion resistance while providing an aesthetic finished surface; the laboratory in the chemical company's headquarters requires a chemical resistant coating on the floors and walls; the structural steel supporting the canopy over the train yard requires a cleanable and chemical resistant industrial maintenance coating.

This paper will address the challenges - successes and failures - of various systems that have been incorporated into several specific facilities and focus on recommendations for true success.

INTRODUCTION

Many of us in the construction industry constantly seek out ways to minimize issues that have impacts on schedule, price, or constructability. By reducing these risks a project team can move forward with the notion that a successful project is within reach. But, as is often discovered, reality sets in and the well-thought out plan will not work for every element in the project. Contracts for application of coating systems have been considered straightforward and fairly easy to bid and manage, with the one primary challenge of defining the scope of the work. However, there is not a "one size fits all" solution for providing corrosion resistance and aesthetics for the project. It had been a good plan at the start, but once the real scope of painting becomes known, the broad coating needs of the project are much clearer. The simple process to award basic architectural paints to a commercial paint contractor won't work without some tweaking of the bid documents and the required application standards.

The construction industry classifies projects into specific categories which make procurement and construction activities simpler and less time consuming. The US Bureau of Labor Statistics[1] (BLS) and the Census Bureau define various industries within the US. The Construction Sector

[1] North American Industry Classification System (NAICS) 23, Construction.

consists of many elements, including projects that are identified as Commercial and Institutional Buildings, Industrial Buildings, Power and Communications Structures, and Highway and Bridge Structures.

Indeed, these categories do work for many of the projects that are being built in this country. But, there are many more projects that do not fit into any one of these categories due to the broad scope of programmatic and design elements.

At first glance an oil refinery or a coal fired power plant would be considered an industrial project. While that may be true for 85 to 90 percent of the construction activities, there remains a commercial element that must be addressed independently of the industrial, such as operation centers, management spaces, and employee facilities. Likewise, major office buildings are considered commercial structures, but the complexity of the structure and the penchant for expressive design, establishes a strong need for addressing the structure's industrial side. Office structures for specific clients may require research and development laboratories and other spaces that would mimic the client's manufacturing and production facilities. The buildings may be designed with exposed structure.

As the industry places structures into predetermined categories, it also appears that construction companies place themselves into related categories and become specialists in certain types of construction. Architects can also be found who focus on sector specialization. Within the thousands of architectural firms in the US, there are "Starchitects" – the notorious and popular designers that are engaged on iconic edifices that can be found on the covers of design magazines. But, a much larger percentage of architects are focused on the majority of the design projects available. These architectural firms may be small companies with less than 10 employees or major design houses with several thousand employees. They produce a broad range of building designs for all major markets (transportation, justice, healthcare, entertainment, residential, education, office/commercial, retail, hospitality, etc). There are also many architects working in an engineering/industrial environment who provide valuable architectural services by creating interior and exterior spaces that are conducive to productivity and that will support the employees throughout their workday.

Certain building materials are often associated with one particular building type. Architects who specialize will become experts in these building materials within their specializations. But, once the design crosses the line between the commercial and the industrial category, the unique specialization may not always support the total needs of the project.

Each of the four very distinct construction sectors within the US construction industry is served by one specialty trade contractor subsector - the Painting and Wall Covering Contractors. Amazingly, this subsector includes house painters, ship painters, and wall paper hangers. However, just as major construction contractors specialize, painting contractors will also specialize. How many of you would want a house painter responsible for your bridge project?

Building Types

Across the building types defined by the US Census Bureau, many of the same building materials will be used, and each will eventually be exposed to a wide range of environments. Some of the most basic and common building materials which require field painting are structural steel, sheet metals, gypsum board, concrete masonry, and cast-in-place concrete. Depending on the building type and function, these materials need to be protected against degradation within each of the environments in which they exist and they may also need to be coated to maintain a clean environment.

The design profession, whether engineering or architecture, has attempted to qualify certain coating systems for their specific building types. But, as someone who has worked extensively in both engineering and architecture, I understand how widely disparate the understanding is of coating materials that are theoretically designed for engineering projects and those that are designed for architecture.

An element often overlooked in the design of coating systems for architectural construction is the exposure during construction. Lengthy construction durations will contribute to degradation of surfaces that are not properly protected with appropriate coatings.

Coatings for engineering may be assumed to be high performance that protect against extremes in contact and environments but have little aesthetic value. Coatings for architecture may be assumed to be for aesthetics only. While these may well be common thoughts, they are gross misconceptions.

COATING SYSTEM SELECTION AND CRITERIA

When designing coating systems for the various building types within each construction sector, many criteria are considered. Table 1, included at the end of this paper, lists pertinent criteria in no particular order within disparate categories. The categories vary in importance with the building type and function, making final selection somewhat complicated.

In a July 2012 poll, Durability+Design[2] magazine asked about the most important criteria of selection when purchasing or specifying coatings. As an architect, I responded to this poll with "aesthetics." That response was shared by only 6 percent of the respondents; durability was the response from 78 percent. Price and environmental impact were only 2 percent each. An undefined "other" came in with 12 percent. Perhaps the readers of this magazine are primarily industrial-oriented, but this response is indicative of the difficulty in merging industrial design and commercial architecture. Aesthetics draws the short straw and is often ignored. But, as I pondered my response to this question, durability was definitely a strong possibility. Perhaps another choice would have been "aesthetics + durability" to allow for "aesthetic durability."

My experience in the design of coal fired power plants, iconic sports venues, and commercial structures, has forced me to balance durability with aesthetics.

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[2] Durability+Design, Daily Newsletter, week of July 16 to July 22, 2012.

The overriding goal in making coating system selections is finding the right coating systems for the exact environment which produces the most durable and aesthetic finish available for a reasonable price.

Physical Contact and Environmental Exposures

Abrasion and impact of varying degrees are the primary physical risks for applied coating systems. Abrasion and impact differ in the extent of damage caused, but regardless, the results can range from visible surface defects to exposure of the substrate.

Variable air pollutants and weathering impacts are not limited to one building type. Buildings of all types can easily share very similar locations which would logically result in the use of similar exterior protective coatings.

Surfaces that are most subjected to environmental and physical abuse include the following:

- structural steel;
- formed sheet metal;
- concrete and masonry walls;
- plaster;
- concrete floors;
- gypsumboard; and
- handrails and railings - steel and aluminum.

SURFACES FOR PAINTING

Structural Steel

Architecturally Exposed Structural Steel (AESS) is a term given to a segment of the steel industry focused on both aesthetics and structure. AESS has tighter tolerances and allows fewer variations and defects on the surface of the steel. This steel is priced higher than normal structural steel, but is often used diligently in iconic structures or as a design feature within a larger building. AESS may be found in entrance canopies, in expressed structure on a façade, or in the monumental entry and foyer of a Class A speculative office building. As exterior elements, AESS is subjected to exposures that are very similar to the bridge structure crossing the river in front of the structure. These architectural steel elements are not protected by the building enclosure. Not unlike the coating systems for iconic bridge designs, the criteria for the design of coating systems for AESS must include optimum corrosion protection with an even higher degree of aesthetics.

The following depict several conditions that negatively impact a coating system, regardless of the building type or use:

- sun and its UV degradation;
- acid rain and other polluting fallout;
- bird droppings;
- inaccessibility;
- hail and windblown sand; and

- design of structures.[3]

The coating industry has introduced products that provide enhance UV protection. SSPC Paint 36 defines performance for aliphatic urethanes in terms of accelerated and South Florida testing. Polysiloxanes and fluoropolymers will usually outperform the highest quality aliphatic polyurethane. However, higher costs of these two topcoat materials often create capital cost issues.

An often-used shop-applied two-coat system for exterior structural steel has been an organic zinc rich primer with a high build semi-gloss acrylic aliphatic polyurethane topcoat. A similar system with three coats used by many highway departments is shop-applied inorganic zinc with field applied epoxy intermediate coat and polyurethane topcoat.

A system that simplifies maintenance is an organic zinc-rich primer with acrylic topcoats. A system such as this performs well in a benign environment and where an owner requires periodic touchup for aesthetics purposes. The simplicity of touchup and simple repairs are attractive advantages to many owners. However, this system will not perform well in severe exposures. With the increase in production and availability of acrylic and epoxy polysiloxane materials, a two coat system with this as a topcoat over a zinc-rich primer is gaining popularity. Proprietary testing by various manufacturers has resulted in excellent ratings for polysiloxanes in terms of color and gloss retention which are often superior to acrylic polyurethane. Air-dried fluoropolymers are making advances in areas requiring a high degree of chemical resistance and the need for intense, light-stable colors. Costs of fluoropolymers make their use prohibitive except in extreme conditions or when an owner's life cycle cost analysis indicates a long term savings in capital costs. A typical system is three coats with inorganic zinc primer, epoxy intermediate coat and the fluoropolymer topcoat. Thin film fluoropolymers require a high quality substrate such as AESS. Imperfections in the substrate surface will be very visible, especially in the high gloss finish options.

Recoating of these types of systems is not extremely difficult, except for accessing difficult-to-reach elevated surfaces. Cleaning and preparation of intact surfaces is a straightforward process. Brush or roller application of the new materials after spot priming is generally all that is required. However, if the initial finish is spray applied, touchup material will not blend very well and will most likely be visible due to the variance in texture. This will generally not be acceptable in commercial architecture.

Formed Sheet Metal (Doors and Frames)

Although hollow metal doors and frames are steel surfaces, coatings for structural steel are not always the most appropriate for these doors and frames, especially in high traffic areas. Many of the high performance coatings for structural steel are not easy to touchup for two primary reasons: small areas of touchup will be visible and look unsightly and the two-component products are a challenge to produce in small batches.

[3] SSPC Good Painting Practices – Steel Structures Painting Manual Volume 1, Chapter 25, "Design of Corrosion-Safe Structures" and NACE "Standard Recommended Practice Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be lined for Immersion Service."

High gloss coatings are not recommended by the Steel Door Institute for doors with internal stiffeners as the weld marks will be visible and accentuated with the gloss. Hollow metal doors also have a degree of flexibility which could accentuate possible oil canning.

Single component acrylics are generally preferred for interior and exterior doors. Single component alkyds may also be used for interior doors, but are not particularly appropriate for exterior doors due to their likelihood of chalking and fading. These products are easily touched up by an owner's maintenance staff, avoiding the need of hiring professional painters to apply multi-component products.

In areas subject to chemical exposures, waterborne epoxies may be considered for the interior doors. These products are available as either single or two component formulations. For doors, the single component would be preferred for maintenance and touch-up purposes. Epoxies should not be used for exterior faces of doors due to extreme chalking and fading.

Cast-In-Place Concrete, Plaster, and Concrete Masonry Units (CMU) Walls

CMU is often considered the work horse of construction in industrial work. Concrete block is very versatile and utilitarian and it has become the image of what many think of as "industrial." I remember many years ago that CMU was the preferred material for electric substation structures because, regardless of cost, it "looked" cheaper and would be easier to get approved by local authorities. But, CMU also functions to a great extent in high level architecture as backup to aesthetic exterior cladding or as a functional enclosure for utilitarian spaces. Regardless, CMU should be coated with materials consistent with its specific exposure. Due to its robust nature CMU can be used as a structural element; it can provide fire resistance; it is insect and mold resistant; it can control noise transmission; it will resist impact from machines or pedestrians; and is a good alternate to wood framed construction in subtropical regions.

Concrete masonry presents unique problems, as there are generally no specific types of corrosion to prevent. Often aesthetics play a major role in deciding how to coat these surfaces, but other criteria, including mildew resistance, bacteria control, and resistance to moisture and vapor infiltration, may be as important as corrosion protection on steel.

Exterior CMU is often required to protect the interior of the building. CMU surfaces require protection that will provide flexibility and breathability. Elastomeric acrylics have proven to be very effective on plaster, concrete, and concrete masonry units in Florida, the Caribbean, and in the Southwest. Masonry construction eliminates termite issues, but creates construction problems with potential cracking and shrinkage, both of which create water penetration problems. Elastomeric coatings provide the elongation required to bridge minor cracking in the substrates. These products are appropriate for most architectural and industrial environments, except where the surfaces are exposed to potential splash or spillage of caustic or acidic products. To provide protection against these spills, an epoxy would be a better choice, but epoxies will compromise aesthetics due to the chalking and fading caused by UV exposure. The only other criterion that would impact this choice would be VOC's and their limitations by local air quality regulations.

Interior spaces that require a high degree of cleanliness with mold, mildew, and chemical resistance, include kitchens, toilets, showers, and laboratories. Water borne products with low VOC's will generally not provide the same level of protection that tile-like solvent-borne polyamide or polyamine epoxies would. For interior application, these products would still provide a high gloss and aesthetic appearance. However, these types of products with their high VOC's are often considered "Industrial" where the spaces in question would be considered "Architectural." These products may not qualify for LEED credits.

An effective architectural coating system for CMU would be an acrylic-based masonry surfacer with an acrylic topcoat. This system would be acceptable in a benign interior environment that would include offices or storerooms. To improve the durability of this system, perhaps a waterborne epoxy could be considered. This will increase resistance to weak chemicals. Locker rooms often are constructed with CMU due to its resistance to direct contact with sprayed water, as well as its abuse resistance. In these cases, a high performance block filler, often cementitious, can be topcoated with a solvent based polyamide epoxy. This is a highly effective system except for one major characteristic – the finish material will most likely not be VOC compliant for highly regulated areas and may not qualify for LEED credits.

Concrete Floors

Floor coatings are applied to interior concrete slabs to provide aesthetics, cleanability, slip resistance, impermeability, and waterproofing. Unfortunately, the quality of floor coating application can be less than perfect. Surface preparation is often neglected and the coatings are applied to surfaces that have been steel troweled or coated with a floor curing/sealing compound. Several instances have been reported and witnessed where floor coatings have essentially been laying on the smooth concrete surface with no possibility of either mechanical or chemical adhesion. Proper surface preparation is imperative for successful floor coating projects. The International Concrete Restoration Institute (ICRI)[4] provides an excellent document for preparation of concrete surfaces with visual standard chips that can be used for comparing surface profiles with the specification requirements. Testing for moisture and moisture vapor emission is a critical aspect of concrete preparation. Manufacturers' recommendations appear to be moving toward a test defined in ASTM F 2170 that determines relative humidity within concrete slabs, but the calcium chloride test defined by ASTM F 1869-11 is still in regular use.

In an article for Durability+Design, Jayson Helsel[5] provides an excellent overview of floor coating systems and issues. There is no need to repeat his comments here, but I will add to the discussion.

Alternate floor coating systems include economical concrete stains and sealers, which provide aesthetics and protection against stains from normal spills and leaks. Epoxy floor coatings with or without urethane topcoats are common in many applications, whether private airplane hangars, warehouses, or locker rooms. Other materials such as methylmethacrylate

[4] ICRI No. 03732, "Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays."
[5] Durability+Design, "Flooring Formulas: A Primer on Selecting, Using Resinous Systems," December 21, 2011.

(MMA) have quick turn-around times and are common in sport facilities, grocery stores and industrial food handling facilities requiring a high degree of cleanliness. MMA's and epoxies can both be produced in monolithic colors, or in decorative modes with colored vinyl flakes or quartz aggregate. Both of these products are somewhat brittle and may not be effective as waterproofing membranes over a long period of time.

For industrial and production kitchen applications where resistance to thermal shock is necessary, cementitious urethanes are extremely effective, but they can be expensive and are limited in aesthetics.

Gypsumboard

Gypsumboard is common in many different spaces from totally mild and dry to severe with physical abuse and impact. The selection of the correct gypsumboard is a major element of this equation. There are many types of gypsumboard available with different gypsum formulations for water, mold, mildew, and fire resistance. The available facing materials also will provide abuse and impact resistance as well.

The same generic families of coatings recommended for interior CMU can be applied to surfaces of gypsumboard with the same basic results. While installing gypsumboard with only a coated surface in areas subject to moisture or splash and spillage of chemicals may not be good design, it does occur. As mentioned above, the right gypsumboard product needs to be installed and then the right coating system has to be selected. The decision to go with the best protective material or the best low VOC/LEED aesthetic material comes into play for interior applications. Keeping water out of gypsumboard is critical. No matter how good the substrate is at resisting mold and mildew, the material cannot be constantly exposed to excessive moisture. There are limits. The risks associated with ignoring the negative impact on gypsumboard goes beyond replacing the gypsum panels; it goes into excessive mold and mildew and the resulting disruption to operations if abatement is necessary. Installing and painting gypsumboard before the roof is completed may work in fast-track project scheduling, but it doesn't work for long term service from painted gypsumboard partitions.

Steel Railings

Railings offer unique exposure issues. These railings are most often fabricated from steel pipe and miscellaneous metals. Corrosion protection is best offered by hot-dip galvanizing. If required for aesthetic reasons, the rails may be painted. Physical abuse of rails is a primary cause of paint loss, especially from skateboarders who use the top of the rails to impress their friends. Paint on the tops of these rails is generally worn away, and if the rails were not galvanized, the steel is exposed and likely to start to rust.

If the rails were galvanized, the inherent abrasion resistance and cathodic protection of the zinc will resist corrosion and erosion, especially in highly vulnerable exterior installations. According to the American Galvanizer's Association, the corrosion rate of zinc and its life expectancy is a function of the coating thickness and the amount of corrosive elements in the

atmosphere.[6] In rural settings where there is less air pollution and acid rain, galvanized steel may last for 100 to 150 years without major maintenance. Industrial and marine locations contain significantly more aggressive corrosion elements such as chlorides and sulfides and galvanized steel may last for 50 to 100 years in those cases. However, if the rails were not galvanized or coated with a zinc primer, there is no cathodic protection. If only coatings are applied, the corrosion protection is only on the external surfaces. If moisture builds up on the internal surfaces of the rails, the rails may corrode from the inside which will go unnoticed for a considerable amount of time before there could be a failure.

Three fluid applied coating systems may be considered for original coating of galvanized or non-galvanized steel railings. They are as follows with advantages and disadvantages of each:

1. Single-component acrylics for ease of repairing damage: The acrylics have low VOC's and will provide the most cost effective approach for materials, original application, and maintenance, but abrasion resistance is low. Facility maintenance staff can easily re-apply these single component products which, depending on usage, may be often.
2. Two-component epoxy with a two-component polyester polyurethane topcoat: Two-component epoxies and polyurethanes are available in low VOC formulations with an increased level of abrasion resistances. Products require a higher degree of quality in surface preparation, application, and maintenance.
3. Two- or three-component abrasion resistant epoxies: These specialty products would definitely be classified as "industrial." These would have the highest level of abrasion resistance but have no aesthetic value and will generally have high levels of VOC's. If these products are used in an architectural exterior application, such as entrance areas to an iconic skyscraper, an aesthetic topcoat would be required.

Aluminum Railings

Due its inherent corrosion resistance, the only reasons to coat aluminum rails are to protect against severely corrosive elements or for aesthetics. Field painting aluminum can be difficult due to the particular level of surface preparation that is required. Many of the same products used for galvanized steel can be used successfully on aluminum.

In addition, shop applied powder coatings can be very successful, but surface preparation and application quality control in the shop are critical. Peeling and flaking of powder coatings on aluminum rails are very difficult to repair. Field touchup is virtually impossible, resulting in the need to completely strip the powder coatings and starting from bare substrate.

Galvanized Steel

Galvanized surfaces are not difficult to topcoat and there is quite a bit of flexibility in the type of topcoat that can be successful. The environment is the primary criterion because of the wide range of available coatings that work over galvanizing. However, the ubiquitous numbers of failures over galvanized surfaces is more often attributable to poor surface preparation. The oils and grease that are typically on new galvanized surfaces must be removed either with time or with a surface treatment, either solvent rinse or acidic wash. Contaminants left on the surface

[6] American Galvanizer's Association, Technical Information at http://www.galvanizeit.org/

will prevent proper adhesion. Even the best coatings will not adhere to oily and greasy metal surfaces.

Look around in your everyday life at bollards at the grocery store, gutters and downspouts on homes and businesses, or the miscellaneous trim on the commercial building on the corner. Peeling paint is very common and the exposed substrate is miraculously clean and smooth, at least initially.

LEED CERTIFICATION

The conflict between high performance requirements and environmental stewardship is not new, but the urgency of finding solutions will continue to grow. Where is the compromise and when will we finally reach it?

The US Green Building Council established LEED Certification programs to create environmentally sustainable buildings with efficient operating systems. A LEED-Certified building will have minimal impact on the environment as it is constructed and as it operates. Primary focus points of LEED Certification are sustainable sites, efficient use of water, energy efficiency, material sourcing and resources including recycled content of materials incorporated into the building, and indoor environmental or air quality. The materials that are scrutinized for volatile emissions are generally being applied inside the building weather envelope. The concern is the emission of potentially toxic elements during construction and after occupancy. These materials include paints and coatings.

As architects focus on creating buildings that are "green," every effort is made to specify products that have zero or very low VOC's. LEED requirements are often stricter than the EPA Regulations. In many regards, architectural paint manufacturers have been doing an extraordinary job of developing LEED-compliant coatings for interior spaces. These same manufacturers are also continuing to develop new high performance coatings with low VOC's that are comparing favorably to previous generations of high VOC coatings. But even with these innovations, the low VOC high performance coatings may not comply with a designated LEED program. Long term performance of the zero and low VOC coatings is still open to discussion.

In many of the examples I have given there is an opportunity for use of a coatings budget, often used by EPA and LEED to provide offsets for air pollution control. A coatings budget allows the incorporation of high performance and high VOC products in LEED projects by providing a detailed calculation of the total VOC's incorporated into the project. It can be a difficult and tedious task, but it all comes down to a ratio of square footage of painted surfaces, the number of gallons applied, and the VOC's of each gallon. With this type of calculation, that locker room which may comprise only 10 percent of the coated surface can be coated with a higher VOC epoxy which would then be offset by the 90 percent of the surface with an acrylic latex with a VOC well below the maximum allowed for LEED Certification.

This budget concept will allow the building's owners to achieve the LEED Certification desired, but also allow selective use of high performance, higher VOC products to provide the protection required for the substrates in question.

CONCLUSION

Regardless of how a particular structure is classified, design of exterior and interior coating systems must include an evaluation of exposure factors without the bias of whether it is commercial architecture or industrial engineering. The phrase "Architectural and Industrial Maintenance Coatings" may seem to be inclusive; however, there is still a chasm between traditional architectural coatings and industrial coatings. This chasm creates design, supply, and procurement issues for architects, engineers, and general contractors. The preferred method of awarding a single contract for supply and application of all coatings for a project may not always be possible. There are several large global paint companies that can provide a very broad range of products – either through buy-outs or internal development – but the list is not that long. These large companies though, still separate representation and technical support – one group calls on architects; the other call on engineers! There are suppliers that focus solely on architectural coatings, while others focus on high performance industrial coatings with a limited number of commercial coatings.

It is encouraging to see major architectural projects that have incorporated the use of the corrosion resistant and aesthetic industrial products. These projects will maintain a high aesthetic for longer periods due to the use of more sophisticated coating systems, which in turn will reduce maintenance costs for the building owners. Our goal is to educate all members of the design community in effective system design so that they are not relying on generic coating guides that may not provide the complete answer. The education needs will grow as the industry invests more and more into research and development of innovative coating materials designed for a sustainable environment while providing for corrosion protection of the built environment.

COATING SYSTEM SELECTION AND CRITERIA

Table 1

Application Methods and Issues	Durability	Aesthetics	Environmental Concerns	Price	
Brush Roll Spray One part Two or three parts Induction time Drying time Ambient conditions	Resistance to: Abrasion Impact Chemicals Mildew Heat Thermal Shock Permeability Breathability Flexibility Elongation Adhesion Hardness Washability Weathering Salt fog	Application Color choices Opacity Sheen Reflectivity Texture Touchup-ability Resistance to: Chalk Fade Mar	LEED New Construction Healthcare Core & Shell Schools Interiors 0 to low VOC HAPS VOC budgets SCAQMD EPA OTC Odor	Original 1 coat 2 coats 3 coats 4 coats Maintenance	

Environmental Exposures			Physical Contact		
Interior	Exterior	Typical Spaces	Interior	Exterior	Typical Spaces
Normally dry Wet with fresh water Wet with salt water Acidic Neutral Alkaline	Normally dry Wet with fresh water Wet with salt water Acidic Neutral Alkaline Wind-driven rain UV Exposure extremes Temperature extremes	Offices Classrooms Storerooms Pools Saunas Whirlpools Shower rooms Laboratories	Abrasion Impact Public Access Contaminants Floors Heavy Traffic Liquid spills Periodic wetting Thermal Shock	Graffiti Traffic Industrial Pedestrian Hail Wind driven sand	Corridors Cafeterias Clean rooms Operating rooms ICU's Detention facilities Shower rooms