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Architectural coatings account for a significant percentage of the volume and value of the overall paint and coatings market. The global exterior architectural coatings market alone is predicted to reach \$39.04 billion by 2024, according to U.S.-based market research and consulting firm Grand View Research. North America accounted for 22.6% of the global volume share in 2015 and is expected to witness significant gains in light of rising reconstruction activities in the United States coupled with infrastructure development in Canada and Mexico. Latin America is projected to witness substantial revenue growth at a CAGR of 6.4% over the reporting period. Primers are expected to witness revenue gains at a CAGR of 6.4% from 2016 to 2024, while alkyd resins may see volume growth at a CAGR of 5.3% during these same years.

Climate change is a global issue impacting weather in all regions of the world. High levels of pollution in some large cities in developed economies and many municipalities in emerging markets continue to cause concern as well. Both issues directly impact the performance of exterior architectural coatings. Do changing weather patterns influence the development of coatings raw materials and final formulations? How are members of the paint and coatings value chain responding to the need for coatings with long-term performance despite exposure to high levels of pollutants? Are there other large-scale issues that the industry is addressing?

CoatingsTech surveyed coating formulators and resin, additive, and pigment manufacturers regarding their perspectives on these challenging questions. Below is a roundup of their insights.

Participants in this round-table discussion included:

- **Kristen Blankenship**—business development manager, LUMIFLON® FEVE Resins, AGC Chemicals Americas;
- **Chris Miller**—senior global research director, Arkema Coating Resins;
- **Camilo Quiñones-Rozo**—market segment manager Architectural Coatings, BASF Corporation;
- **Ed Edrosa**—product manager, BEHR;
- **Mike Mundwiller**—field integration manager, Benjamin Moore;
- **Steven Reinstadtler**—construction market manager, Coatings, Adhesives & Specialties, Covestro LLC;
- **Arnold Nienhuis**—global marketing manager, and **Shandi Ramirez**, industry manager, both for Architectural Coatings, DSM Coating Resins;
- **Alan Fream**—global technical manager, OMNOVA Solutions;
- **Scott W. Moffat**—architectural sales manager, Industrial Coatings, PPG;
- **Michael T. Venturini**—marketing director for Coatings, Sun Chemical Performance Pigments; and
- **Laura Betzen**—group leader, Tnemec Company.

Q. With the weather becoming hotter and wetter in many parts of the world today, is there a need to reformulate exterior architectural coatings? If so, what is being done or what might be done? Does the fact that most exterior architectural coatings today are low- to no-VOC and often waterborne cause challenges? Are there other challenges?

Miller, Arkema Coating Resins: Market needs have always differed significantly from region to region due to many factors, most significantly climate and available building materials. For the most part, that has not changed, and there are no real trends dictating major formulation changes in any specific region. That said, we are seeing formulators working on new and better ways to address those longstanding issues from region to region, including:

- Extending the painting season in colder climates through the formulation of paints that can be applied in colder temperatures.
- Improving surfactant leaching in high-humidity climates.
- Balancing surface hardness with flexibility for warm climates.

At the same time, there is a continued push toward zero-VOC formulations across all regions, a trend that often overlaps with the drive for improved performance. Interestingly, formulating for low-VOC coatings has had a significant impact on resin design for exterior paints. It is more difficult to balance low temperature cure and hardness with zero-VOC coalescents, especially in exterior coatings. Advances in polymer design were needed to improve hardness to acceptable levels and achieve block and film formation at low temperatures when zero-VOC coalescents are used. To achieve this, formulators are employing new techniques such as ambient crosslinking, structured particles, and new additive development.

Edrosa, BEHR: As the weather becomes more extreme, reformulation of exterior architectural coatings has been necessary to not only preserve the products' existing features, but also expand the means under which they can perform. Paint manufacturers have responded to this need by continually exploring new technologies, which in part involves working with different raw material suppliers to develop exterior paints that offer optimal performance in different climatic conditions. We are already seeing products on the market today that have been created as specific responses to ongoing weather changes. The biggest challenge brought about by low- to no-VOC paints is related to application—specifically, open time and wet edge. Removal of solvents makes the paints low VOC, but does so at the expense of workability. Another challenge is in-can preservation, as the reduction of VOCs makes paint more susceptible to microbial contamination. The formulations from BEHR are optimized to address these challenges.

Quiñones-Rozo, BASF: BASF's global footprint provides us with an understanding of the specific requirements that different weather regimes pose on formulation and raw materials. For example, we can tailor binders and additives so that when formulated, they can successfully withstand radically different weather scenarios: from high humidity/high temperature conditions in Southeast Asia to freeze/thaw cycles in the northern United States and Canada. We can leverage this versatility to help our customers adapt to changes in weather regimes. The trend towards low-VOC formulations requires the use of softer binders and/or permanent-coalescing agents. These changes negatively impact dirt pick-up resistance, which is a key performance attribute for exterior coatings. BASF brings a holistic can-of-paint approach to help paint manufacturers address this challenge, leveraging synergies between polymers/binders, formulation additives, and extenders/pigments.

Mundwiler, Benjamin Moore: Research and development for all products including exterior architectural coatings is dynamic. Being mindful of the changing weather patterns creates a renewed focus in developing formulas that provide optimum application characteristics resulting in maximum protection and performance. Low- to no-VOC waterborne coatings can be challenged by hotter and wetter weather, so it is vital to provide technical information on the product so that an applicator can be in a position of being an informed "product mechanic," making the necessary adjustments to control the environment.

Fream, OMNOVA Solutions: Beyond the heat impact, rising temperatures are altering weather patterns and creating weather extremes. Weather is becoming more unpredictable, which poses a problem for waterborne coatings. Commercial painters and DIYers alike are being challenged by shorter application windows due to abrupt changes in temperature and/or precipitation. Providing waterborne products that have early rain shower resistance and film formation in unfavorable climatic conditions benefits the productivity and profitability of commercial painters and simplifies DIY projects. Additionally, there is an increasing trend toward bright colors for building exteriors. With in-store tinting using low-VOC colorants that contain high levels of surfactants, brighter paint colors can give rise to surfactant leaching or exudation, which will spoil the appearance of freshly coated surfaces. Surfactant exudation happens if unfavorable conditions prevail during drying of the paint. OMNOVA has developed technology specifically to address this issue and keep buildings looking good for longer.

Reinstadler, Covestro: Many of the current coatings technologies that find utility in certain traditional climate zones where they must withstand high solar radiation or wet environments are being re-tasked into regions where recent weather patterns have necessitated the need for these key attributes. Exterior coating technologies that resist degradation due to their inherent chemistry, such as polyurethane, are becoming more prevalent in the market due to their longer service life. For example, multiple acrylic-based exterior coatings are now available that are enhanced with the addition of waterborne polyurethane dispersions to increase the longevity of the surface when exposed to sunlight and wind-driven rain. There is also an added benefit in long-term adhesion to the painted substrate with the addition of the polyurethane dispersion.

Betzen, Tnemec: The demands on architectural coatings have changed and become more severe. However, many companies offer coatings that span many types of climates, and sometimes it is just a matter of switching the coating type to match the new climate experienced in an area and the expected climate change in the future to ensure longevity of the coating. Use of existing coatings requires less lab work and allows companies to focus on technologies for which they have field experience. Fluoropolymer and siloxane are examples of technologies that are growing because of higher performance requirements. The only need for reformulation is when a climate is more extreme than what the current product offerings are able to handle. To allow for hotter and wetter climates, the coatings must be formulated to be more hydrophobic and use a high T_g or crosslinking resin. Formulating low- to no-VOC coatings that are able to handle more extreme climates is definitely a challenge. When removing VOC components, a formulation may not have good application properties (for example, less flow and leveling and reduced open time), which have to be dialed in using additives and solvents that are VOC exempt. In order to lower VOC components, often a lower T_g resin must be used, which results in a softer film.



Blankenship, AGC Chemicals Americas: Acrylic and polyester chemistries are widely used for less severe conditions,

but their performance is limited in very hot and humid climates. Polyurethanes and polysiloxanes offer improved durability to meet the rigors of severe environments. Fluoropolymers offer the highest performance for organic coatings and are used on superstructures in tropical and desert environments today. As our climate changes, they will likely be sought after more to offer the extreme protection that architectural structures will need. Waterborne and low-VOC coatings are known to have significant application challenges. If these coatings become the norm, more time and effort will be needed to pinpoint their use to specific climates. However, waterborne and low-VOC coatings technology is always evolving, so the challenges we face today with these coatings may be solved tomorrow. Fluoroethylene vinyl ether (FEVE) water-based resins are unique in that they weather as well as solvent-based FEVE coatings. As VOC regulations tighten, it will be critical that formulators adjust to more environmentally friendly coatings. Water-based FEVE resins are tools the formulator can use to create coatings that match the performance of current solvent-based technology without the VOCs.

Nienhuis, DSM Coating Resins: Climate change and the increase in severe weather conditions are forcing the paint industry to develop more durable and more functional coatings that meet end-user needs. Examples are increased durability and longer maintenance intervals, early rain guard systems, extreme waterproof systems, heat reflective/absorbing systems, and isolating systems. With respect to water-based paints, research studies show that painters prefer to use solvent-based coatings in countries where they are still allowed to use them outdoors. Despite various VOC legislations around the world, painters were not satisfied with the performance of water-based coatings in the past. In the meantime, the paint industry has overcome most of the challenges and positioned waterborne systems with different and improved claims, leading to their increasing adoption by painters. The paint industry is definitely focusing on waterborne systems, and in the do-it-yourself sector there is increasing demand for these coatings.

Venturini, Sun Chemical Performance Pigments: One approach that has been taken is to use coating and pigment technology to manage the heat-island effect in urban environments. Metallic coatings containing aluminum pigments are strong IR reflectors and are used directly as topcoats and as IR reflective "primers" under IR transparent pigments. These techniques can be applied to roofing and building cladding and have also been discussed for automotive coatings.

Moffatt, PPG: PPG's premium 70% polyvinylidene fluoride (PVDF) and FEVE fluoropolymer factory-applied coatings have always been formulated to provide decades of colorfastness and gloss retention in difficult seacoast and industrial environments. Therefore, climate change has not really impacted our formulation strategy beyond the work we are continuously doing to improve our products to maintain their durability in harsh weather conditions, or to enhance the "best practices" we employ. For

example, for structural steel, metal roofing, and other pre-coated metal building products, for optimal protection in hot, humid environments, we typically recommend a chrome pretreatment with a three-coat liquid coating system, comprising a chrome primer for resistance to corrosion, salt, and moisture; a color basecoat; and a clear topcoat for additional UV protection. PPG and other coatings manufacturers continue to research and test ways to eliminate chrome, lead, and other heavy metals from factory-applied primer and pretreatment formulations while improving corrosion resistance to support sustainability initiatives, such as the Living Building Challenge, and increase transparency related to the “Red List” of worst-in-class chemicals. That said, chrome pretreatment remains essentially unchallenged when it comes to delivering the ultimate in corrosion protection.

Regarding the environmental advantages of factory-applied spray powder coatings, we have two schools of thought. First, powder coatings are the only bona fide low-VOC/no-VOC products because they are manufactured without solvents. In addition, because they can be recycled and reused, powder coatings are very efficient and sustainable, whereas the overspray from liquid coatings must be disposed, creating an additional cost. It is important to note that powder coatings are used only in the aluminum extrusion spray building markets. There are no coil-applied powder systems in the United States, and only a few worldwide. However, because powders are typically one-coat systems that can be applied directly to metal substrates without a primer layer, there is a trade-off between perceived better environmental performance and the increased likelihood of corrosion failure. In short, although factory-applied powder coatings provide significant environmental advantages because they do not generate solvent-related VOC emissions, they ultimately provide less corrosion protection than two-coat liquid and powder coatings systems featuring a primer.

Some of the most important ongoing research trends in the industry today center around self-cleaning coatings and in particular architectural coatings that are inherently resistant to dirt pick-up.

Second, most large liquid coatings manufacturers mitigate the environmental advantages associated with powder coatings by incinerating the solvents produced during the manufacturing process; consequently, solvent-related VOC emissions are virtually eliminated. Powder’s environmental benefits are further lessened by most liquid coatings manufacturers because they use the energy generated through incineration to run other processes in their plants. As a result, for large coatings manufacturers, liquid and powder coatings produce virtually the same volume of VOCs at the stack. Environmental compliance for smaller liquid coatings manufacturers that do not incinerate solvents, however, is more challenging. Overall, though, for pre-coated metal substrates, waterborne factory-applied coatings are rarely used in the building industry. For liquid, most applicators use very high-VOC solvent coatings and incinerate the solvents to comply with environmental laws and regulations. Low-VOC powder is becoming more prevalent in spray coatings, but the use of waterborne coatings for exterior building applications is virtually non-existent.

Q. In parts of the world where pollution is a real issue, how are ingredient suppliers and paint formulators addressing the need for self-cleaning coatings that are able to maintain their appearance over a reasonable lifetime? What are the challenges? What are the gaps? What else might be done?

Quiñones-Rozo, BASF: The challenges introduced by pollution can be addressed by facilitating cyclical removal by the elements (i.e., rain) or by preventing dirt from adhering to exterior surfaces altogether. BASF’s most recent binders for the exterior market rely on the latter approach to deliver superior performance. Using novel polymer synthesis design concepts, we have been able to introduce to the market solutions that deliver excellent dirt pick-up resistance without compromising other critical attributes, such as tannin blocking, efflorescence resistance, leaching resistance, and corrosion resistance.

Betzen, Tnemec: To achieve self-cleaning properties in high pollution regions, a number of techniques are used. The use of fluoro or silicone technology, superhydrophobic or superhydrophilic additives, oleophobic additives, and components with catalytic action to break down the pollution are common approaches to address this issue. One of the challenges is that the self-cleaning performance will decrease over time with degradation of the additives/resins. Finding a solution with longevity in performance can sometimes be costly or have environmental drawbacks. Often in areas of high pollution, there are lower VOC requirements that limit what approach can be taken. Lower VOC capable resins typically have a lower T_g , which can sometimes translate into higher dirt pick-up. Balancing the lower VOC requirements with performance is critical when formulating a product that can meet market demands and be a profitable product.

Miller, Arkema Coating Resins: Some of the most important ongoing research trends in the industry today center around self-cleaning coatings and in particular architectural coatings that are inherently resistant to dirt pick-up. This property can be achieved through binder selection, formulation, and in some cases, by imparting specific surface properties to the coatings through the use of nanoparticles. Hybrid platforms where micro/nano coating structures can be achieved represent an emerging and important trend in coatings research. These structures enhance wash off of dirt and have been on the forefront of self-cleaning coatings. Another approach we are starting to see more often is self-catalytic systems using nano TiO_2 particles. The challenge with these systems is to achieve this effect over a long period of time. Design of this capability utilizing standard application methods is a high technical hurdle that many in the industry are working on. Of course, price and performance remain important considerations with all of these systems.



Moffatt, PPG: Although useful in some applications, self-cleaning coatings have a limited market. They are most effective when applied over lower-end coatings and white/light color coatings. When exposed to sunlight for prolonged periods of time, lower-end, and therefore, less-robust, coatings tend to get soft and “reflow,” which can cause them to trap dirt and become less washable. For these types of value-driven products, a self-cleaning surface layer can be a viable solution for improving the coating’s longevity and performance. On the other hand, even though a self-cleaning coating would enhance premium factory-applied fluoropolymer coatings, these products do not readily attract dirt to begin with and shed the dirt that does accumulate when exposed to rainfall. This combination makes the coatings inherently self-cleaning, even if they are not marketed as such. A similar dynamic takes place when a clear topcoat is applied to a color coat. Because the pigments in a color coat produce a jagged, rough surface that tends to absorb dirt, there are benefits to using a clear topcoat—the surface is smoother, gloss and color fade resistance improves, and dirt generally washes off more easily when it rains.

Blankenship, AGC Chemicals Americas: The phrase “self-cleaning coating” has been used in the coatings industry for more than a decade. The challenge to the paint formulator has been understanding what self-cleaning actually means to different markets. Chemistry is complex, and likewise the coating technologies offering this property are quite varied. For example, a self-cleaning coating might need to be superhydrophobic in order for water to roll off of the coating quickly, bringing dirt and

debris with it. This may be appropriate for certain applications, but on tall buildings with good sun exposure, coatings with this feature often leave streaking. The water simply evaporates before it is able to carry all the dirt and debris off the building. For these applications, some systems are formulated to be superhydrophilic to eliminate the visible streaking. Of course, certain chemistries are sensitive to water and degrade easily from exposure. Here is where fluoropolymers have an advantage. Fluoropolymer chemistry is resilient to photochemical degradation. Superhydrophilic coatings based on fluoropolymers allow for the use of water-“loving” additives to afford self-cleaning properties while maintaining the integrity of the coating.

Reinstadler, Covestro: To facilitate less dirt pick-up from natural and man-made sources, scientists have studied the surface characteristics of a coating film both initially as well as after exposure to the elements. While many coatings can exhibit decent resistance to dirt pick-up initially, some coatings begin to degrade over time and lose their self-cleaning ability. Formulators have new choices they can turn to in order to create coatings that shrug off environmental dirt for a longer period of time, thus extending their service life between renovations. For example, Covestro offers an oxidatively-curing polyester-polyurethane dispersion that is used in several commercial higher performing exterior coatings and exhibits tight surface properties that resist dirt long-term. It weathers very well, which means it retains these properties longer than other traditional coatings.

Venturini, Sun Chemical Performance Pigments: Self-cleaning coatings pose several challenges for coatings formulators. One in particular is to combine the ultra-durability needed for structures like building exteriors and iron bridges with self-cleaning properties that last their lifetime of 20+ years. Hybrid polysiloxane-acrylic polymerization technology developed by our parent company, DIC, produces exceptionally durable, stain resistant, and self-cleaning coatings by grafting high levels of silica into the polymer backbone. The self-cleaning properties are the result of hydrophilic groups orienting with the coating surface during cure. Notably, the technology has demonstrated weather resistance that surpasses fluoropolymers and shown a self-cleaning effect that washes off dirt with the action of simple rain water.

Mundwiler, Benjamin Moore: Advancements have been made in coatings that provide maximum dirt and stain resistance/release. Advances in resin technology along with sheen optimization can be the foundation for providing exterior coatings that not only provide protection, but also contribute to aesthetics durability. Challenges can be faced, however, with the recoatability of certain coatings that have been formulated for strictly self-cleaning properties.

Nienhuis, DSM Coating Resins: Increased pollution does take a toll on exterior coatings by reducing their durability. In addition, health has become a key driver in the purchase intent for professionals (e.g., builders) and consumers. As a result, washout of undesired coating components is also of concern. Industry is responding by making exterior coatings that reduce the impact of external factors, as well as by eliminating the use of potential pollutants in coating formulations well beyond legislated requirements. However, the paint industry will never compromise on the application, appearance, and quality performance of coatings. It should also be mentioned that increasing access to plant-based and sustainable raw materials for the formulation of paints, stains, and varnishes with improved performance is providing additional opportunities for coating manufacturers.

Edrosa, BEHR: Close collaboration between paint manufacturers and raw material suppliers has accelerated the development of exterior paints that resist dirt buildup. This requires examining every ingredient in the formula—resin, additive, etc.—which has a direct impact on this extremely important property. Ultimately, the main challenge is ensuring that dirt pick-up resistance is achieved without sacrificing other dry film performance properties, such as flexibility and fade resistance.

Q. What other interesting trends/issues that do not typically get discussed are driving the development of exterior architectural coatings?

Blankenship, AGC Chemicals Americas: In the past, architects have been very conservative when it comes to the utilization of wood products as exterior components on commercial buildings. Access to fluoropolymer coating technology that can be field applied offers the possibility of wood as an architectural component. Higher performance wood types—those possessing dimensional stability—can have their appearance sustained with this coating technology. Some mid-rise buildings are now being constructed with CLT (cross-laminated timber). Fluoropolymer coatings offer the long-term durability required for these types of buildings.

Miller, Arkema Coating Resins: End users are looking for higher performing exterior paints with better color and gloss retention. They want paints with longer service lifespans and significantly improved dirt pick-up resistance for the life of the coating. We are also seeing greater need for technologies that address the stability of concrete and surfactant leaching in high-humidity environments. This is particularly important when painting tilt-up walls in commercial construction projects. Finally, as construction companies begin using more and different composite materials, it is becoming harder to maintain uniform performance from substrate to substrate. This is an area in which Arkema is taking particular interest. We are currently working with formulators worldwide to identify potential solutions and develop products that meet an increasingly complex world of substrates.

Reinstadler, Covestro: New polyaspartic coating technology is offering an improved solution for exterior concrete balconies and terraces. Traditionally either lower property acrylic paints or moisture-curing polyurethanes have been used on these exterior architectural features. Both solutions have the advantage over traditional floor coatings in that they provide adequate elongation necessary to provide protection despite the movement and micro-crack formation that can occur in this application. However, both require certain ambient conditions to cure and may take quite a bit of time before they are rain-ready.

New polyaspartic coatings formulated with aliphatic hardeners that have flexibility built into the backbone offer the rapid curing and long-term durability of traditional polyaspartics combined with increased elongation of the cured film. These polyaspartic-based balcony coatings provide fast return-to-service and lower temperature cure, but with the added attribute of higher elongation similar to traditional moisture curing polyurethanes.

Covestro has developed a solvent-free, lower viscosity aliphatic prepolymer hardener based on hexamethylene-1,6-diisocyanate (HDI) that can be formulated with polyaspartic resins into a 200% elongation or higher balcony coating with near-zero VOC and excellent long-term durability. The technology is uniquely suited for those applications where there may be movement in the substrate, and traditional concrete floor coatings such as epoxies and polyurethanes would not have adequate flexibility. This technology gives contractors the ability to extend their application season into the cooler spring and fall months as well as have a solution that can be rain-ready much quicker than traditional balcony coatings.

Moffatt, PPG: A couple of trends have emerged for factory-applied exterior architectural coatings that are worth noting. First, FEVE resin-based coatings have become more prominent. Although they match the performance level of PVDF coatings, FEVE-based fluoropolymers have distinct advantages over PVDF:

- High-gloss finishes. Spray powder coating or coil-coating of an FEVE clearcoat over a PVDF color coat produces a range of high-gloss finishes.
- Improved hardness and scratch resistance.
- FEVE coatings also adhere direct-to-metal to provide a durable one-coat finish.

Second, the sparkling effect that is produced when mica flakes are added to clearcoats is becoming increasingly popular. Micas and metallics can get “lost” in color coats, especially in whites or light colors. The addition of mica flakes to clearcoats, on the other hand, produces an impressive “explosion” of sparkle that is especially dramatic when seen in direct sunlight. In addition, because micas are UV-durable, FEVE and PVDF clear coatings can incorporate micas for application over color coats to create metallic effects and maintain the color-retention performance levels required to meet AAMA 2605 specifications.

Venturini, Sun Chemical Performance Pigments: One subsegment of the exterior architectural market is coatings for skyscraper monument buildings. Because of their size and complexity, they may take several years to complete, posing a number of challenges for both coating and pigment producers. During the design phase of the project, architects are influenced by many factors, including current fashion trends and automotive finishes that utilize a wide range of coating techniques and pigments. Bringing those ideas to life in an ultra-durable coating can be a particular challenge for coating manufacturers, especially when effect pigments and complex light interactions are involved.

Once in the production phase, color consistency batch-to-batch and year-to-year are highly critical for monument projects where color variations on a building façade are readily noticeable and expensive to correct. Certain pigments are better suited for these projects than others. For instance, Sun Chemical has pigments for liquid formulations that are flocculation-resistant to prevent color drift on high-shear application lines and uses our “Blitz-Bonding” technology to adhere metallic and pearlescent pigment flakes to the resin particles in powder coatings to improve application and appearance properties.

In exterior architectural house paints, color fastness is an area where pigment selection is crucial to deliver the desired results. Universal machine colorants have evolved over the years to take advantage of pigment developments. For this sub-segment, Sun Chemical has, for instance, developed pigments with specially designed crystal structures that provide significantly improved lightfastness.

Betzen, Tnemec: One challenge facing the industry is the creation of globally accepted formulations. Different countries and regions of the world have very specific requirements (i.e., DSL, REACH, etc.), and designing a formulation that meets all of the requirements is becoming harder. For example, with LEED v4 requirements involving emissions testing and Cradle to Cradle requirements involving socially responsible choices, design of a coating that can meet the requirements of both and still have high performance is a challenge. This requires optimizing every single component of a formulation.

Edrosa, BEHR: Over the last few years, there has been a shift in how environmentally friendly paints are assessed. Previously, compliance to green building standards was determined through VOC emissions. This has now evolved to a more holistic approach, with the focus on greater transparency in the disclosure of health and environmental impacts of the paint. Today, the two most recognized building product declarations are Environmental Product Declarations (EPDs) and Health Product Declarations (HPDs). An EPD deals with the life-cycle environmental impacts of the paint, while an HPD is related to disclosure of ingredients and their health effects.

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