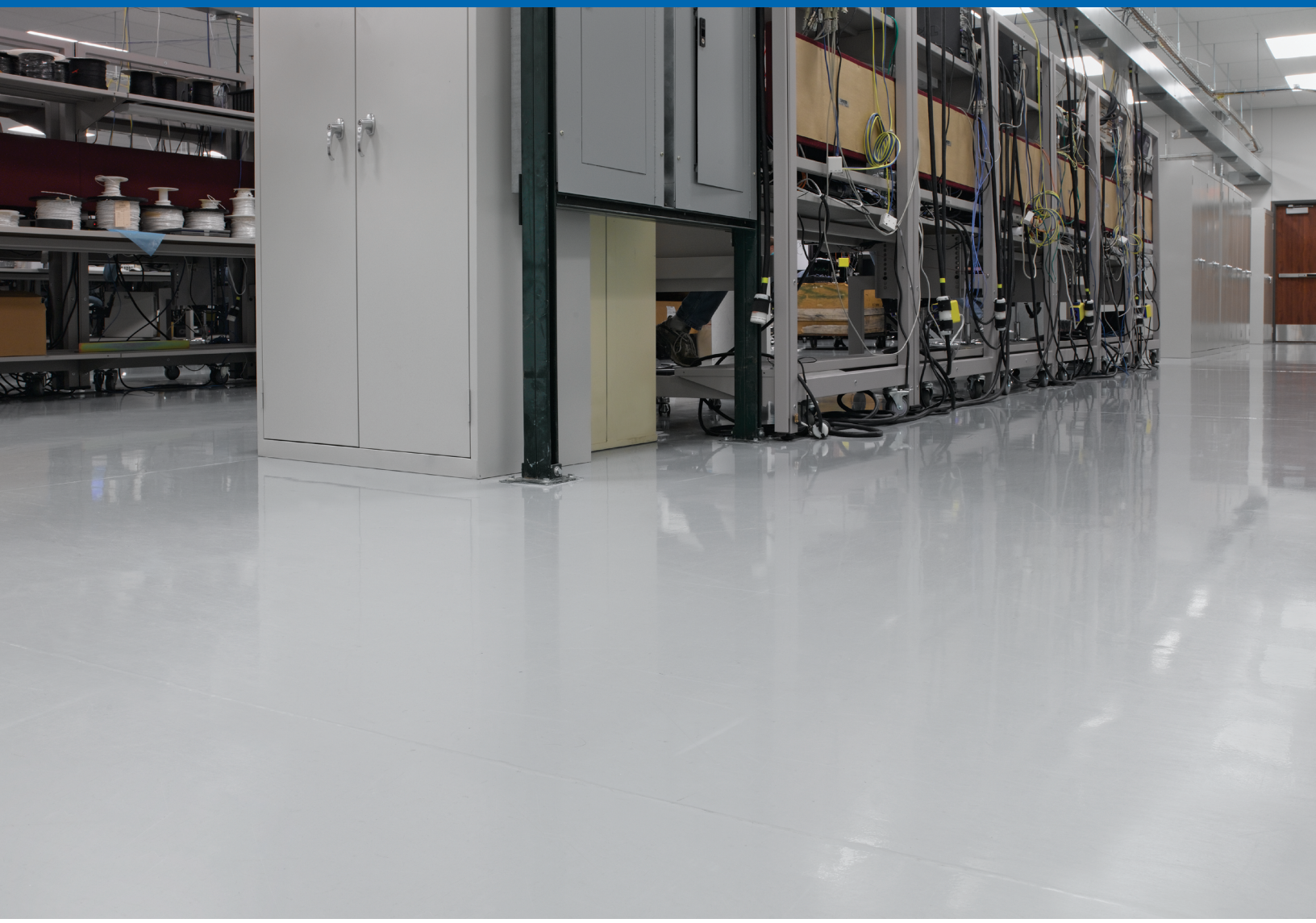

PROTECTING DATA CENTER INTEGRITY FROM TOP TO BOTTOM

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By Ivan Taylor, Project Development Manager, Sherwin-Williams Protective & Marine

With data centers popping up at a rapid pace to meet the immediate and vastly expanding demands of artificial intelligence and cloud computing services, construction efficiency is crucial to keeping new facilities on the fast track to opening their doors.

Any practices that can eliminate time and waste from the construction process are welcome. It's also helpful when those procedures can support sustainability goals. As a bonus, such practices may also deliver cost reductions by default.

One facet of the construction process that's not commonly associated with enabling efficiencies is the use of protective coatings throughout data centers to maintain the integrity and aesthetics of the buildings. Such coatings range from the primers and fireproofing coatings applied to a building's structural steel to the protective coatings that keep critical power and water assets online to the resinous flooring materials poured underfoot. There are also coatings on walls, building infrastructure, roofs and everywhere in between. When carefully specified, each material can be applied in a manner that streamlines construction projects to accelerate project completions.

Those coatings can also extend asset and facility life, providing sustainable benefits as areas that may need to be recoated sooner when using certain materials won't need to be addressed until much later when using high-performance coatings. Any extra service life enabled by a better performing coating pushes maintenance needs further into the future and ultimately results in less overall use of coating materials over the life of a data center – both of which also reduce costs.

Choosing the optimal coatings for efficiency, sustainability and economy requires careful consideration across multiple applications, with high-performance materials offering the best outcomes.

STREAMLINING STRUCTURAL STEEL DELIVERIES

Some construction efficiencies enabled by high-performance protective coatings don't originate at the project site. They may take place miles away at a steel fabrication facility. There, applicators will prepare steel beams and columns for erection by blasting fabricated steel to the appropriate SSPC standard before applying a primer coat to hold the blast and enable transport to construction sites. They may apply additional coatings on top as well.

Fabricators can move steel pieces through a shop incredibly efficiently, especially when using certain types of primers and coatings. For example, single-component alkyd primers with the fastest drying times and MPI 79 approval for corrosive environments may be used when Class A slip capacity is required. Organic zinc-rich primers, such as Zinc Clad® 4100 from Sherwin-Williams, are flexible, easy to apply and fast to handle, curing to handle in as little as one to three hours. Applicators can move to touch-up, fireproofing or topcoating steps thereafter, welcoming fast shop throughput that can save fabrication shops up to two days of staging time for coated assets compared to traditional inorganic primers.

Additional viable organic primers include the Sherwin-Williams Steel Spec® line of alkyd primers, which provide enhanced corrosion protection and application flexibility. These fast-drying shop coat primers meet commonly specified MPI 79 requirements published by the Master Painters Institute for corrosion resistance, adhesion, flexibility, surface prep compatibility, recoatability, VOC ranges and durability.

Inorganic zinc-rich primers, like Zinc Clad® 2500 and Zinc Clad® II Plus from Sherwin-Williams, are also an option and may be needed for specific applications, including ones requiring Class B slip compliance and extended corrosion protection capacity that matches that of galvanized steel. Such applications include solutions for power generation and heavy-industrial areas where steel is exposed within data center campuses. When needed, inorganic zinc primers can be finished with low sheen inorganic films that offer finish color options in an integrally applied coating system.

While Zinc Clad II Plus has a longer curing time and can delay throughput compared to organic primers, Zinc Clad 2500 has a dry-to-handle time that is faster or equivalent to organic primers, accelerating shop throughput. The primer also has a harder, more durable and better long-term anti-corrosion finish than traditional organic zinc primers. Therefore, inorganic primers can also enable the efficient, in-shop installation of protective coating systems – especially compared to the process of galvanizing metal.

The primary reason the hot dip galvanizing process adds significant time to steel coating operations is because it is most often performed at a separate facility. Therefore, steel must be transferred off-site instead of being primed at the fabrication shop, adding an additional step – and cost – to the process flow. Steel primed at the shop can instead move directly from blast to coating to loading for jobsite delivery without an extra transportation step. Steel primed with an inorganic primer also avoids the distortion risks that are inherent to the hot dip galvanizing process, eliminating the potential for steel pieces to warp or buckle. Given that inorganic zinc primers also provide sacrificial protection that's comparable to galvanized coatings, they offer a highly efficient and cost-effective alternative to delivering ready-to-install steel to project sites.

Regardless of whether a shop uses an organic or inorganic primer, the nature of applying these coatings in a shop provides notable efficiencies – and quality control measures – compared to applying them in the field (Figure 1). Shop conditions are controllable, allowing applicators to manage humidity and temperatures compared to the variabilities encountered when applying coatings in the field. Applications are therefore more consistent and reliable, with the option to accelerate curing by increasing temperatures in the shop.

Figure 1. *Applying primers and intumescent fire-resistant materials (IFRMs) in a controlled coatings shop environment offers notable efficiencies that can accelerate construction schedules and minimize on-site coatings activities compared to applying all the coatings in the field.*

Because the applied primers have excellent durability, steel pieces can be loaded, transported, unloaded, stored and erected without suffering significant nicks and abrasions. After the steel is erected – which can happen immediately upon site arrival with shop-applied steel – field applicators should therefore have minimal touch-ups to perform as they apply primers, fireproofing coatings and topcoats to connection points during construction, providing further efficiencies.

With their work limited to certain areas and not entire pieces of steel, on-site applicators can easily avoid other trades. This benefit allows tight project schedules to continue without delay, whereas more extensive on-site coatings activities would likely interfere with other construction activities.

FAST-TRACKING FIRE PROTECTION

Fire protection is a crucial need for nearly any commercial structure to reduce property risk and save lives during a fire event. It carries extra importance for data centers, where fire risk can be elevated due to the amount of high electrical load equipment generating heat and the compact nature of equipment arrangements. The facilities also commonly house battery rooms in which lithium-ion or Valve-Regulated Lead-Acid (VRLA) batteries pose a significant fire hazard. In addition, complex cabling systems with flammable insulation provide a pathway for fire to spread.

Protection from fires is commonly addressed via the use of fireproofing coatings that are designed to keep structural steel from reaching its critical failure temperature (CFT) for a specified period when exposed to the heat of a fire. This commonly 60- to 180-minute span – which depends on the facility owner's and insurer's requirements – is meant to allow sufficient time for building occupants to evacuate the structure, as well as for first responders to enter, clear the building and hopefully extinguish the fire before the CFT is reached.

A variety of fireproofing options exist from spray-applied fire-resistant materials (SFRMs) to intumescent fire-resistant materials (IFRMs). However, for data centers, cementitious SFRMs are not permitted, as this sprayed fibrous material is prone to flaking and producing dust. Any particulates shed could be detrimental to sensitive equipment operating throughout a data center.

Instead, specifications call for the use of non-shedding IFRMs, which don't add particulate matter to a data center's clean room level environments. These coatings are applied to structural steel and react when exposed to fire, keeping the steel from heating too rapidly and extending the time before it can reach its CFT. These extra minutes of protection can make all the difference between people being harmed or escaping the building, as well as between portions of the building collapsing or remaining intact so the structure can be restored.

Importantly, IFRMs, such as epoxy and acrylic FIRETEX® coatings from Sherwin-Williams, can be applied in a shop environment. This could take place immediately following the primer application. In some cases, a primer may not even be needed, as select IFRMs can be applied directly to metal. Regardless, this shop application carries all the same benefits as shop-primed steel in terms of rapidly delivering coated steel to jobsites, minimizing on-site coatings activities and barely disrupting other trades (Figure 2). In addition, IFRMs can be applied efficiently at the shop in high film-build coats, minimizing the number of coats required to meet a facility's specific fire rating.

***Figure 2**. Applying IFRMs at ground level in a shop enables safer and more accurate fireproofing applications, while also minimizing on-site coatings activities so applicators can minimize disruptions to other trades working at the jobsite.*

For aesthetic purposes, data centers may opt to topcoat the fireproofing in areas where structural steel is exposed for design aesthetics or simply practicality. This option gives architects more flexibility in their designs without worry that fireproofing coatings will make the area look unsightly, as they would when using SFRMs.

FINE-TUNING FLOORING

Specifying the right flooring system for data centers can have a major impact on the uptime, safety and cleanliness of these facilities, as they may require abrasion-resistant floor coatings that can withstand heavy equipment and rolling loads. In addition, many areas require the use of coatings with low volatile organic compound (VOC) emissions to maintain air quality, as well as electrostatic discharge-compliant (ESD-compliant) systems to protect sensitive electronics and mitigate fire risks in clean room environments. Moisture control is also a common consideration.

Data centers may include a variety of flooring surfaces, with raised flooring, sealed concrete and seamless resinous systems all being possible. However, the most viable options for meeting efficiency and sustainability goals are poured-in-place resinous floors.

While no longer a standard practice for new construction, some data centers feature raised floors that help to cool densely packed server rooms. However, advances in cooling technology and the increasing density of computing equipment have led most data centers to shift to hard flooring instead.

That hard surface could be a concrete floor that is sealed to mitigate the release of particulates into the continuous airflow of a data center's clean room level environment. This is a highly economical option, and the concrete can be imparted with ESD properties by adding fibers to the concrete mixture. However, those ESD properties can be inconsistent, leading to conductive spikes in some areas or dead spots in others. This disparity could potentially cause any electric charge that's built up to dissipate too slowly, resulting in a static spark harming server equipment. Adding to the case against using concrete sealers is their breathability, which can allow some moisture and air to escape into a room. The sealers are also easily abraded and can contribute to airborne contaminants when bare concrete is exposed. In addition, sealed concrete has a lower life cycle, as it needs to be maintained and resealed regularly.

Poured-in-place high-performance resinous flooring provides a more durable and longer-lasting protective surface compared to sealed concrete. The materials are poured over top of prepared concrete and typically feature multiple layers of different products to build a complete system that's smooth, seamless and impervious to moisture transfer (Figure 3). The impermeability of the flooring also helps to improve airflow efficiency, as air readily bounces off the nonporous flooring.

Figure 3. *Poured-in-place high-performance resinous flooring creates a smooth, seamless surface that doesn't shed particulates, making it ideal for meeting the clean room-level requirements of data centers.*

Flooring durability is key in data centers, as the longer the flooring can last and perform as needed, the fewer tear outs and reinstallations the facility will encounter over its lifetime. That means choosing resinous systems with excellent impact and abrasion resistance to withstand the installation and movement of server racks and other heavy equipment. Systems with superior chemical resistance and cleanability are also required to withstand the rigors of spills and cleaning protocols.

Seamless resinous floors also offer predictable ESD protection and limit conductivity. Such ESD conductive high-performance flooring systems cover both the mitigation of static charges that could otherwise build up within the environment, as well as the dissipation of such charges to minimize harm to sensitive electronic equipment (Figure 4).

Figure 4. *Data center areas housing sensitive microelectronics require ESD flooring to prevent even tiny static shocks from harming equipment.*

In facilities and environments in which high humidity poses a serious threat to electrical equipment, data centers can install advanced moisture mitigative resinous flooring systems. These systems are typically used on concrete that's in contact with the ground underneath, whether in a basement or on a first floor with a slab foundation. Featuring flexible, moisture-mitigation membrane layers, they significantly reduce the amount of moisture that permeates the concrete, ensuring a lower-humidity environment that's safer and more reliable for valuable equipment.

Additional moisture control systems include flexible waterproofing membranes that may be required in mezzanines and mechanical rooms that have sensitive equipment housed below them. These membranes protect against moisture intrusion from above that may be caused by water leaks or water pipe breaks. The systems' flexibility properties help to minimize cracks and maintain a leak-proof seal.

WITHSTANDING WATER SYSTEM CORROSION

The water infrastructure that supports data centers is another area where high-performance protective coatings can contribute to efficiency, sustainability and cost-reduction goals. Such infrastructure may include equipment that stores and moves potable water, treated effluent and/or reclaimed/recycled water throughout a facility. The clean water needs to remain free from contaminants, and the dirty water must stay contained.

High-performance immersion-grade protective linings are the primary solution that help facilities maintain that cleanliness and containment. Such moisture-resistant epoxy, polyurethane or polysiloxane coating materials may be used in water treatment or storage applications made of concrete or steel. They deliver a long service life, which reduces downtime and maintenance cycles.

For applications that support cooling operations, mechanical equipment and backup power infrastructure, protective linings applied to the interiors of various structures prevent gases and chemicals from reaching the substrate beneath the coatings. This protective layer staves off corrosion for potentially decades at a time, allowing assets to remain in operation for the long term with minimal maintenance. Important features to look for in such coatings include low permeability to prevent corrosive liquids from reaching the substrate, as well as excellent resistance to a broad spectrum of acidic and caustic chemicals. In addition, linings with excellent abrasion and impact resistance will survive longer, minimizing the need for frequent field touch-ups or replacements.

Linings may also be used to protect concrete and steel in chemical containment systems to protect not only the structure from corrosive chemicals but also the ground beneath the asset from contamination.

Corrosion-resistant exterior coating systems are also used on water and wastewater assets to protect equipment and maintain aesthetics. Coatings that can effectively protect the surfaces of piping, tanks and mechanical components from corrosive atmospheric environments will deliver the longest expected service life with the least amount of maintenance. That includes when coatings are used in humid, high-heat mechanical rooms. High-performance solutions should provide high UV resistance to deliver exceptional long-term color and gloss retention, excellent resistance to corrosion and weathering, and resistance to chemicals and film attack by mildew. Polysiloxane finishes offer the best-performing resistance to biocides, antiscalants and cooling tower treatment chemicals.

RECTIFYING ROOF ISSUES

In protecting data centers from the top to the bottom, one cannot forget about addressing roofs. Any existing commercial structure faces the potential for leaks to develop as ultraviolet light, wind, rain, snow and even vibrating equipment may wreak havoc on roofing systems. For data centers, such leaks could lead to catastrophic equipment losses, lengthy downtime and expensive repairs.

Rather than perform a costly tear-off and rebuild, roof coating systems offer an economical and fast-track at also delivers sustainability advantages. Adding a seamless, waterproof layer that protects against UV rays, standing water and temperature changes will seal any penetrations and provide significant additional life for the roof. For example, UNIFLEX® roofing systems eliminate joints and seams, the most common sources of roof leaks, with a thick, flexible protective film. The resulting monolithic coating membrane provides lasting, easy-to-maintain waterproof protection.

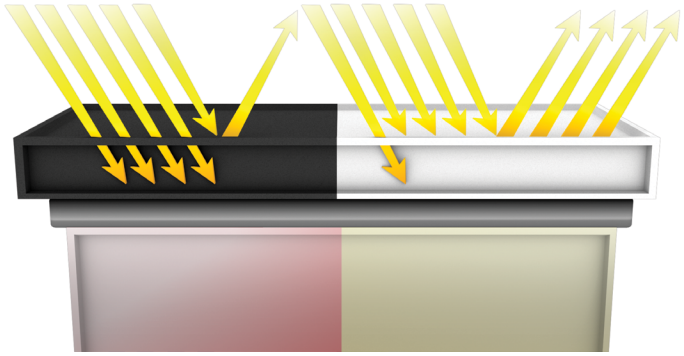

Figure 5. *Applying reflective coatings to restore roof structures and eliminate leaks can help data centers reflect up to 85% of solar heat, significantly lowering their energy demands and cooling costs.*

Avoiding tearing off the current roof offers significant environmental benefits for a facility, as all that material remains functioning on-site and stays out of a landfill. Further sustainability benefits are realized by the reflective nature of the white UNIFLEX roof coatings, which can reflect 85% of solar heat (Figure 5). The building's cooling systems will therefore not need to manage that heat, increasing interior comfort in unconditioned production areas and warehouses while lowering energy demands and cooling costs facility-wide.

DRIVING DATA CENTER CONSTRUCTION EFFICIENCY

High-performance protective coatings play a strategic role in data center construction and long-term reliability. They can accelerate primer and fire protection applications and streamline structural steel deliveries, helping contractors maintain aggressive construction timelines. They also offer long-term durability and optimized performance for flooring, critical water systems and aging roofs. These capabilities reduce maintenance frequency and material consumption over time, supporting both sustainability initiatives and cost-reduction goals. As data centers continue to proliferate in response to accelerating technology demands, the use of high-performance coatings gives architects, specifiers and building owners peace of mind that they can keep aggressive construction schedules on track and also protect their new investments economically over the long term.

ABOUT THE AUTHOR

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Ivan Taylor is a Project Development Manager for Sherwin-Williams Protective & Marine. He has served the coatings industry with Sherwin-Williams for 27 years. His responsibilities with the company have included District Sales Manager, District City Manager, Protective & Marine Coatings Representative, Commercial Branch Manager and other roles within the Paint Stores Group. He is an AMPP-Certified Coating Inspector and an AMPP Concrete Coatings Inspector. Contact: Ivan.G.Taylor@sherwin.com

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