White Paper

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Environmental: Indoor and Washdown

Protecting Control Panels in Indoor and Washdown Environments

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Introduction

Equipment enclosures, electronics, and connections located in indoor environments need more protection than many facility managers realize. Evolving technology, standards, and processes create new risks, hazards and requirements that design/controls engineers must address. Hazards in these environments include, but are not limited to, dust and dripping water, contact from employees, impacts, wear and tear in and around machinery, and contact with liquids from washdown procedures and corrosive cleaning agents. Depending on the nature of the application, control panels may also be located in high temperature environments, encounter or generate electronic interference, and may control equipment that produces high heat-loads. These scenarios also require that engineers and facility managers find solutions to mitigate these issues.

When selecting a control panel infrastructure, it is important to consider all the risks a specific application might encounter. Just one accident or failure can bring a facility's operations to a grinding halt. With this in mind, design/controls engineers should consider additional requirements the enclosure and its components and connections might encounter. These requirements include ingress needs, environmental concerns including ambient temperature and condensation, the presence of chemicals, Electromagnetic Interference (EMI) and other unforeseen factors. Determining these environmental conditions and requirements is critical to selecting the proper enclosure and material for each application.

This white paper is one of three papers that collectively address the environmental protection of control panels. The intent is to provide guidance on the risks involving environmental applications, and offer solutions for indoor and washdown environmental issues. For access to the white papers as they become available, and more information on Panduit or Pentair Equipment Protection (Manufacturers of the Hoffman brand of enclosure), please visit www.Hoffman-Panduit.com.

Back to Basics – Indoor Hazards

Most enclosures protect plant personnel from the internal electrified components, and protect the control devices from their surroundings. The Underwriters Laboratories (UL) rating for enclosures in these applications is UL Type 1. See Appendix II. Light industrial applications use this level of protection when the environment is clean and the air is free of dust, moisture, or chemicals. Since UL approves Type 1 enclosures primarily for indoor use to provide protection against contact with the enclosed equipment and against a limited amount of falling dirt, these enclosures can house everything from programmable logic controls (PLCs), fuses and breakers, wires and Variable Frequency Drives (VFDs). This level of protection is most commonly used in light industrial or commercial environments, such as product packaging for consumer goods, office buildings or warehouses. It is also common for components and connections within or through the enclosure wall to maintain an IEC IP (Ingress Protection) rating, which communicates the level of protection from human interaction. This rating also communicates ingress of dust, dirt, and liquids, to help determine suitability for use. Refer to the *Environmental Protection of Control Panels: Overview and Standards Compliance* white paper for the IP Ratings chart.

Commercial building projects need a significant number of electrical enclosures and junction boxes for their power distribution and cables. Many of these applications are located in walls, ceilings, or utility rooms away from constant human traffic, so these enclosures do not encounter manufacturing or factory operational hazards, water, heat, or other common risks. The building's HVAC system regulates the air and environment in these situations, therefore these enclosures only need general protection and security to keep basic hazards away. Type 1 enclosures are usually the most cost-effective option in these situations and the preferred choice for engineering specification firms to stay within budget after winning a bid.

Internal equipment may subject an enclosure and control panel to an increased thermal load. Smaller, more powerful electronic equipment is becoming the trend so thermal loads are now a primary concern for engineers, even in indoor and non-hazardous locations. When the building regulates the temperature and cycles the air in or around an enclosure, internal heat may not naturally dissipate to desired levels. Increased thermal loads decrease equipment's productivity, reliability and life expectancy (see Figure 1) and are a main source of equipment failure and downtime. Performance plays an integral role in a successful business because compromised equipment can create service outages, decrease equipment life, and cause revenue loss. For engineers and facility managers, understanding thermal requirements is a key component for finding cost effective and reliable solutions to mitigate these issues.

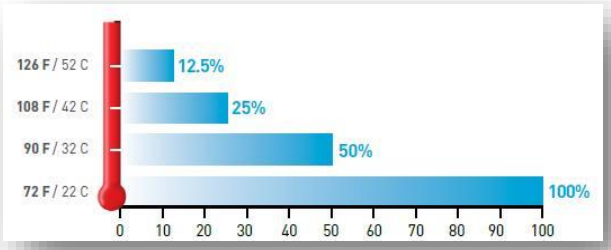


***Figure 1: Electronics life expectancy* percentage (Source: Digital Equipment Corporation).**

Evaluating the Environment

An important factor to consider prior to selecting equipment is to adequately assess the hazards present in and around the work area. Evaluating the environment for climatic conditions can be aided by guidelines and standard references such as TIA (ANSI/TIA-1005-A and TSB-185), the Environmental Classification (M.I.C.E.) Tutorial, and referenced standard IEC 60721-1 - 3, which discusses the classification of groups of environmental parameters and their severities.

Indoor Protection from Dust, Dripping Water, and Oil

UL Type 12 enclosures commonly house PLCs, fuses, wires, and VFDs in environments such as paper mills, automotive, and consumer goods packaging factories. Weather changes can cause the external ambient temperature to vary greatly from the temperature inside a control panel, creating an environment conducive to condensation issues. Without another way to keep condensation from dripping onto or forming on an enclosure, the versatile features of a Type 12 enclosure keep water, dust, and pollen infiltration out while meeting the functional requirements of the equipment inside.

Many paper mill, automotive and consumer goods packaging factories are not air conditioned due to cost and efficiency issues, and instead rely on fans, open doors and circulated airflow to keep the temperature bearable for employees. While this keeps costs down and employees satisfied, it creates an entry point for dust and pollen, along with constant changes in humidity and temperature as the weather fluctuates.

Aside from water infiltration hazards, many industrial applications produce dust and fiber particles or other airborne hazards that can enter an enclosure if it is not properly sealed. If there is cutting, sanding, or grinding involved in the application, a minimum Type 12 rated enclosure should be considered. Human machine interface (HMI) devices are common applications in the middle of these hazards. Many HMI devices are located on a factory floor, running processes, and housing touch screens or other controls. Even though these devices may not face sources of moisture that could damage the controls, they need a seal to keep out other contaminants, because electrical equipment that collects dust or fibers has a greater chance of failure and overheating.

While Type 12 HMI enclosures are designed to keep out these sources of infiltration, sealed enclosure designs can produce the inability to expel heat. Manufacturing, engineering, and laboratory processes need precise timing and measurements, and heat dissipation methods can be just as important as dust and water protection features to keep the controls running optimally. Due to their gasket and dust tight seal, Type 12 enclosures support the use of ACs, fans or other thermal management products, and are suitable for use in areas producing elevated thermal loads. Determining if a site needs thermal solutions, protection from dust, pollen and fibers, along with dripping water or other basic hazards, can help with selecting the correct enclosure upfront. This can save time, money, and resources on future maintenance or repair costs for the facility.

Points of Ingress

The ingress requirement is the level of ability the enclosure has to keep substances and EMI out of the enclosure. Ingress ratings specify the type and amount (if any) of a substance allowed in an enclosure under normal operating conditions. Typical substances include dust/dirt, water/liquids, and human fingers.

Functional ingress is an enclosure requirement to allow control panel access by technicians, wires, or other devices needing entry. There are two types of functional ingress:

- Permanent Functional Ingress – Provides wire or cable access; usually solved with external access ports using solutions such as USB coupler modules
- Temporary Functional Ingress – Provides convenient access to the control panel; easy and reliable enclosure applicable gasketing, hinging, and latching

A potential point of failure with ingress is where accessory devices or cable connections are made through the panel. These components must be selected to match or exceed the enclosure rating to properly seal out dirt, dust, and particles.

When the connected control panel is exposed to water, the cable type used must be compatible with the environment just as the enclosure is compatible. Ingress Protection (IP) ratings were developed to specify the degree of environmental protection of control panels or enclosures, and are also used in other areas, such as cable connections.

For example, when connector systems are used in panel-to-panel EtherNet/IP links for optical fiber, the connection through the enclosure must have an appropriate IP rating (such as IP-67) to seal the connection from dust and water ingress. A suitable solution is the IP rated bulkhead connector in applications where dust and water ingress are a concern.

By design, these types of fiber bulkhead interconnects can also be suited for the more severe categories of Mechanical, Ingress, Climatic/Chemical, and Electromagnetic (M.I.C.E.), typically M3, I3, C3, and E3. These fiber connector systems should also conform to requirements stated in ODVA (ODVA.org) specifications. Refer to the *Environmental Protection of Control Panels: Overview and Standards Compliance* white paper for the IP Ratings chart.

The demand to interface a computer to electronic equipment, such as a network switch, Programmable Automation Controller (PAC) or a Human Machine Interface (HMI) located in the control panel, is increasing on the shop floor. This reduces the necessity to open the enclosure door for maintenance, mitigating ARC flash, and electrical safety risks. A special device is mounted onto the exterior of the control panel, providing electrical connections to the inside of the panel with the ability to permit access to data circuits from the outside of the panel. This removes the need to open the control panel door and risk exposure to high voltages. Two such devices that enable this functionality and maintain IP ratings suitable for dust and water ingress, are a simple bulkhead coupler and a data access port. See Appendix I, #7, #8.

Indoor Protection in Washdown Environments with Corrosive Chemicals

Many indoor enclosures require protection from excessive moisture generated from hose directed or splashing water (otherwise known as “washdown”), ice formation, or corrosive agents. Washdown procedures place control panels at risk of water damage through unsealed openings, backflow through vents, and other places of ingress due to the location of the pressurized water and angles. Enclosures and control panels in processing areas, for instance, food and beverage applications, are subject to these standards and are not immune to the necessary washdown procedures to meet food safety and quality regulations. This requires the enclosure to maintain a completely water tight seal so the controls are safe. There is a Type 4 rating to identify enclosures designed to withstand this harsh treatment.

Food and beverage applications, along with cold storage and meat processing sites, commonly use washdowns since these industries follow a set of sanitary procedures and standards that require strict adherence to keep food safe.

UL Protection from Hose Directed Water and Chemical Cleaning Agents Requirement

UL approves Type 4 enclosures for indoor or outdoor use, indicating these enclosures provide protection against contact, dust, splashing, or hose directed water. It modifies the rating to 4X if the enclosure is corrosion resistant. These enclosures are not protected against water submersion. Enclosures with a 4 or 4X rating are used primarily to protect the contents from damage due to the washdown process or corrosive cleaning agents, and make the environment safe for employees. While used extensively in food and beverage applications, Type 4X enclosures can also be seen in water treatment facilities, pharmaceutical packaging plants, and other manufacturing applications that require sanitary conditions. Often corrosive chemical cleaning agents are used in the washdown process, therefore enclosures located in these environments must also provide corrosion protection. Brewing and beer making applications utilize this type of protection.

With craft beers increasing in popularity, many brewing facilities are sprouting up across the country or are expanding. Cleaning and hose-down procedures occur regularly at these facilities to maintain industry regulated sanitary standards and create a vital need for a watertight seal to protect their controls. Additionally, the constant moisture in the brew house and chemicals used during the cleaning process accelerate corrosion on ferrous metals. With this in mind, control panels and other enclosures require durability so performance and access are not affected during the precise timing needed for a brewing run. A UL Type 4X rating is necessary in these environments.

IP69K is an IP rating that has seen an increase in adoption into the food and pharmaceutical industry due to its stringent high pressure, high temperature washdown requirements. The IP69K test specifies a spray nozzle that is fed with 176°F water at 1160-1450 PSI and a flow rate of 3.7-4.2 gal/min. The nozzle is held 3.9-5.9 inches from the tested device at angles of 0°, 30°, 60°, and 90° for 30 seconds each. The test sample sits on a turntable that rotates the sample once every 12 seconds.

Type 4X enclosures are often used in the food industry, therefore enclosures can be found in refrigerators or low temperature environments and may require heating elements. Food and beverage processing enclosures house PLCs, fuses, wires, and VFDs, and often need cooling or other thermal management products to help the controls perform optimally. Whether it is a heating or cooling element the enclosure needs, these applications demand a watertight enclosure so they can be properly cleaned and sanitized. This requires awareness of the different thermal options and components that can meet both 4X requirements and NSF/ANSI/USDA standards along with IP69K.

Internal Components and Connections

For the internal components and wiring connections within the control panel, moisture and corrosion can affect continuity and the lifespan of the connections. It is essential to select corrosion-resistant materials to maintain continuity where moisture or corrosive chemicals are likely to be present. It is also important to inspect critical electrical connections to the panel, such as power, and grounding and bonding connections for signs of corrosive effects. See Appendix I Indoor Enclosure Solutions for grounding and bonding components and recommendations. See Appendix II NEMA / UL / CSA Type Ratings for indoor and outdoor ratings.

Solution Elements of UL Type 1 and Type 12 Enclosures

To create integrated solutions for Type 1 and Type 12 applications, engineers first look at the enclosure material. Both the type of material and the geometry/shape of the enclosure play a role in the rating the enclosure will receive. Depending on the material used, special finishes may also be needed to satisfy rating requirements. Once materials and finishes are determined suitable, sealing elements such as gaskets, flanges, and latches are added to the design. Without compromising the integrity of the rating, engineers will then integrate thermal solutions and methods of egress or ingress to provide the optimal solution for specific applications.

Material

Type 1 enclosures tend to be constructed from painted mild steel and do not require gaskets to seal openings. However, they can also be made of non-metallic materials to meet a specific need. UL Type 12 rated enclosures are usually constructed from painted mild steel, but are also available in stainless steel and non-metallic versions. See Appendix I, #1.

In addition to the materials that form Type 1 and Type 12 enclosures, there are other components that help determine an enclosure's rating. The shape of the enclosure, along with its door, flange, and openings can help channel water or dust away and protect the equipment. Additionally, how the enclosure is sealed, the type of finish applied, and how its seams are joined create additional layers of protection. See Figure 2.

Figure 2: The methods used by Hoffman include both flat and angled tops, and continuously welded seams ground smooth without overlaps, which create a quality, durable enclosure solution that fits virtually every indoor application.

For internal components, there are product and material choices for panels that run normally at elevated temperatures or in extreme cold. In applications where the normal interior operating temperature exceeds 50ºC (122ºF), alternative wiring duct/wire channel materials are available and specified for such use. Note that wiring and components used within the panel must also be rated for elevated temperatures.

Sealing

The basic components involved in sealing the enclosure are the door, the body flange, the gasket and the handle, or other hardware to secure the door and the components inside. Type 1 and Type 12 enclosures have similarities in all but the body flange and gasket; these differences contribute to the additional protection provided by Type 12 enclosures. These types have similar doors, hinges and handles that provide touch-safe protection. Hinge styles can vary and include lift off, concealed, or continuous hinges. Hardware for securing the door or cover in hinge-less versions include ¼ turn latches, handles, screw covers, and clamps. Most Type 1 enclosures use screw covers or clamps.

Figure 3: There are many options for gasket materials; however, in most Type 12 applications it is primarily urethane or EPDM foam.

Sealing Differences

The gasket and flange components are where Type 1 and Type 12 enclosures generally differ. Type 1 enclosures do not typically feature gaskets, while Type 12 enclosures may have a knife edge or a flat flange to meet with a gasket. A flat flange provides an additional sealing surface with the gasket and helps ensure that the enclosure is sealed properly. The gasket included with Type 12 enclosures can be a manually applied strip or a Foam-in-Place (FIP) gasket that is poured in one continuous path, leaving no gaps. See Figure 3.

Finish

Most Type 1 and Type 12 enclosures are constructed from 16-12 gauge mild steel, but to prevent corrosion, mild steel must have a finish applied. Acceptable finishes include plating, galvanizing, and powder coat or liquid painting. The most typical finish on these enclosures is an ANSI 61 Gray or RAL 7035 light gray powder coat, although many OEM and machine builders have custom colors that they specify. This layer of paint provides a level of corrosion protection and gives the enclosure a finished look because it hides imperfections inherent in the steel and slight surface scratches that can be part of the manufacturing process. See Appendix I, #3.

Thermal Load Mitigation

Many Type 1 and Type 12 enclosures use some form of thermal mitigation device to keep control panels running at optimal temperature. Type 1 does not require a watertight seal, so the options are limitless. However, cost controls are always a main topic, so conduction and ventilation are main components of a thermal management system in a Type 1 enclosure. These systems may also use fans and blowers to circulate and move air from inside or outside an enclosure. In Type 12 enclosures, closed loop systems such as thermoelectric coolers, air-to-air or air-to-water heat exchanges, and air conditioners are used more frequently because the enclosure needs to maintain a water and dust tight seal. For more information on thermal solutions, see Appendix IV: Thermal Solutions Chart – Hoffman Cooling Systems Characteristics.

A Touch-Safe Solution – Wire Management

A micro-processing chip manufacturer needed a clean, easy-to-install solution for managing power/wires at its processing plant. The company needed the wire-way installation with no cutting and minimal installation; additionally there were strict hygienic requirements, down to no labels, due to the outgassing of the ink and zero tolerance of contaminants in the chip manufacturing process. A unique wire-way (utilizing Hoffman's Type 1 lay in wire-way) was created and pre-assembled (without labels to minimize the debris and potential outgassing). All cutting and modifications were completed before the wire-way was shipped to the job-site, eliminating waste and lowering the risk of micro-chip contamination.

Design Evaluation

Evaluating the control panel design is an important step to avoid costly errors. This process can be aided by computational analysis, including summing heat dissipation of components over time, or actually diagramming thermal flows with Computational Fluid Dynamics (CFD) Analysis. See Figure 4. These analysis methods evaluate alternate designs and implement modifications during the design phase.

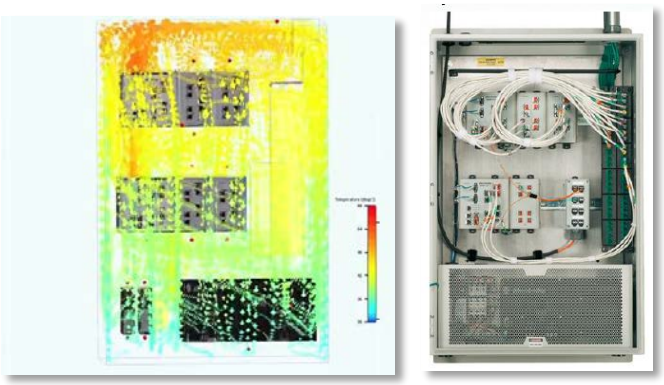


Figure 4: Example of Computational Fluid Dynamics (CFD) used to verify all temperatures below maximum operating temperature, (none in red) over time and under simulated operating conditions.

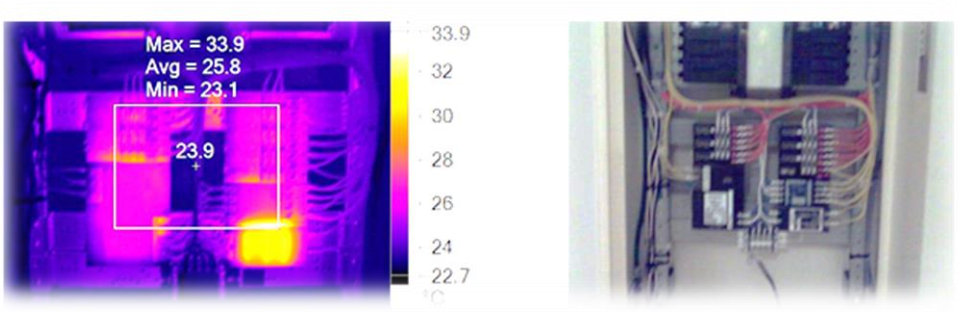


Figure 5: Example of infrared thermal imaging used to evaluate existing panel designs in operation.

For control systems already installed, an assessment of a current design can be performed with infrared thermal imaging to visualize thermal flows under normal operating conditions. See Figure 5. This method is helpful when evaluating additions or modifications to an existing system. To assist design/controls engineers, these types of assessments are available as a service from engineering firms as well as professional services organizations, such as Panduit's Industrial Automation Services.

EMI Management

Electromagnetic compatibility (EMC) is the ability of a machine or other electrical device to operate in an electromagnetic environment to shield or prevent EMI. In sensitive EMI situations, proper EMC shielding around control panel ingress points, and proper enclosure material selection can mitigate EMI/RFI (radio frequency interference) issues.

The enclosure is an EMI barrier protecting internal circuitry from outside sources. However, EMI is also generated by the internal circuitry. The devices within the enclosures can be more at risk because of their sensitivity and close proximity to EMI generating sources. The controls of industrial processes reside within the enclosures, requiring additional protection, even though the devices are already protected from outside EMI.

EMI risks are increasing as a result of competing needs to pack in more networked components and power devices while also attempting to minimize enclosure footprint. Too often, Ethernet switches are added to existing panel designs without proper thought to the harmful effects of exposure to EMI or RFI. These problems can disrupt communications and control functions of the entire automation system and cause industrial Ethernet installations to fail to deliver on their promise of a robust, reliable, and maintainable infrastructure.

A multi-layered approach to mitigate EMI is recommended to maintain operations of critical communications and controls infrastructure including grounding and bonding, proper wire separation, segregation and routing, shielding, filters, and suppressors.

Methods of Access

Type 1 enclosures do not need a full seal, and are able to use vents, knockouts, and openings to create a means of ingress for cables, wires, and equipment. Type 12 enclosures do not have as many features, but engineers have still been able to create solutions that allow entry into the enclosure without de-rating it. By using gland plates, data ports, and swing out panels, engineers have tailored solutions that do not require additional cutting or openings to access the controls. These options maintain the UL rating and keep the enclosure secure from environmental hazards to protect the critical components inside.

A Dust and Dripping Water Solution - Example

In another indoor environment, a drive system manufacturing client was looking for a solution to protect its VFDs. These control systems need protection from dust and occasional dripping water, and in this case, from overhead condensation, equating to a UL Type 12 protection requirement. This client wanted a flexible solution that could easily be modified to meet its diverse drive application requirements. Hoffman created a solution that utilizes the PROLINE® Modular Enclosure platform. See Appendix I, #4. This frame-based system is robust enough for heavy-duty industrial applications and offers the flexibility needed to meet the client's demands. Instead of standard rear covers, the customer received a heavy-duty, 10 gauge rear cover that provided the strength to support the drive and heat sink that protruded beyond the rear cover. The durability allowed the client to vent much of the heat, minimizing the need for additional thermal management. The PROLINE® solution also provides the ability to mechanically join control enclosures together as drive control needs expand for existing lines. Additionally, the PROLINE® solution allows the customer to change from a standard enclosure to a disconnect enclosure by simply changing the door. Appendix III provides an overview of the different indoor hazards and the options available for each enclosure rating.

Solution Elements of Washdown or UL Type 4X Enclosures

Sealing

The basic sealing elements are similar to the Type 12 and Type 4 enclosures because they include the body flange, a gasket, the handle, and other hardware to secure the door and provide protection to both the components and factory personnel. The main difference with Type 4X enclosures is the material used to manufacture the handles, gaskets, and enclosures, along with the water-tight nature that prevents any ingress of water or dust. This water-tight feature prevents enclosures from employing unsealed vents, holes, or other entry and exit points as a means to expel heat or allow access into the enclosure without opening the cover. Although non-metallic materials can be used in this environment, the most common material used in these applications is Stainless Steel, Types 304 and 316L. Additionally, the body flange is occasionally higher or wider and in some products this flange is angled to facilitate liquid run-off to avoid pooling liquids and bacteria growth.

Doors, Covers, and Sealing Hardware

Stainless steel Type 4X enclosures can come with hinged doors or covers. Enclosures with non-hinged covers can be sealed with screws or clamps while the hinged versions can be secured with ¼ turn latches, clamps, or handles. Hinge styles can vary and include lift off, concealed, or continuous hinges.

Body Flange and Gasket

Type 4X enclosures may have a knife edge, or a flat flange to connect with the gasket; however, most enclosures in these applications have a flat flange, or flange trough collar. The flat flange provides an additional sealing surface with the gasket and helps ensure that the enclosure is sealed properly. The gasket included with Type 4X enclosures can be either strip or foam-in-place. There are many options for gasket materials, including urethane, EPDM foam or silicone. Please note that there are industry standards that specify acceptable materials.

Materials and Finish

Enclosures in these environments tend to be constructed from stainless steel, but can also be composed of non-metallic materials such as fiberglass, polyester, or ABS.

Most Type 4X enclosures are constructed from 16-12 gauge stainless steel. The stainless steel is most commonly either Type 304 or 316L. Type 304 is used in less corrosive environments while the 316L version is used in highly corrosive indoor

environments, or in highly corrosive outdoor applications, such as coastal areas. Most enclosures in these applications have a # 4 finish, which is characterized by short, parallel, polished lines using a fine abrasive with the final finish between 120 and 320-grit. A #4 finish has a typical surface roughness of 25 Ra. Occasionally, pharmaceutical, and food and beverage applications require a polished or mirrored surface that a #4 finish will satisfy.

Thermal Solutions

Applications using Type 4X enclosures experience the same thermal management issues as Type 12 enclosures. Type 4X enclosures are subject to washdown procedures. Therefore, the options are more limited, but still provide the same level of protection. Convection systems and fans or blowers that replace the heated internal air with cooler external air would de-rate the enclosure, so closed loop systems such as air conditioners, thermoelectric coolers, and vortex coolers are more widely used. Conduction methods can also be used if the control panels do not emit a significant amount of heat. Hoffman offers a wide variety of thermal management options designed for 4X applications. For more information, please see Appendix IV - Thermal Solutions Chart.

Washdown Solutions - Example

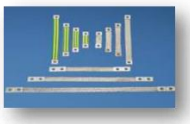
With the rise of foodborne diseases, a US poultry processor was examining ways to mitigate risk. The company wanted a solution that goes beyond FDA requirements regulating food contact surfaces and expands risk mitigation to the entire machine, including areas that do not come in direct contact with the food. The goal was to eliminate as many bacteria harboring locations as possible on the entire processing machine. The Hoffman sales team worked with the company and found a perfect solution using Hoffman’s Watershed enclosures. These enclosures extend protection beyond the food contact zone and comprise the only mass produced enclosure system that meets the NSF 169 requirement. By specifying the Watershed line for all future processing line builds, the customer increased the safety of its processing plants and reduced the risk of food contamination.

Conclusion

Protecting the control panel from environmental elements in indoor touch-safe and washdown environments can present challenging requirements for design/controls engineers. When selecting an enclosure and control panel infrastructure, it is crucial to understand the environment and level of protection that customers require. This includes actual and possible risks, along with current solutions that meet their indoor application needs. Together, Panduit and Pentair leverage their solutions to provide premium control panel protection and optimization best practices that add value to our customers’ organizational needs.

Appendix I – Indoor Enclosure Solutions

#1		**Type 1 and Type 12 Enclosures** Hoffman offers these enclosures in many materials including mild steel, aluminum, polycarbonates, and stainless steel to fit your specific application needs.
#2		**Panduct® Type NE/NS Wiring Duct** This wiring duct from Panduit is made from halogen-free material that will not emit corrosive or harmful toxic gases when burned, and withstands higher continuous-use temperatures than PVC.
#3		**Type 1 Enclosures** These enclosures from Hoffman are offered in both polyester powder paint and galvanized options, with many custom colors available to match your business needs.
#4		**PROLINE® Modular Enclosure Platform** PROLINE® is Hoffman's most versatile enclosure platform. It enables you to easily configure the exact enclosure size, panels, doors, mounting, and components you need to fit your application.
#5		**WeatherFlo™ HD Enclosures** These enclosures from Hoffman are designed to protect and cool 100-500 HP variable frequency drives. Optional impeller packages provide 840 CFM per impeller and use a pagoda top to create an open loop system.
#6		**Type 4X Watershed Enclosures** These enclosures from Hoffman feature provisions to allow direct flushing of the hinge area in addition to 20º sloped tops and door edges, slanted flanged trough collars that prevent the pooling of liquids, gaskets, and a self-grounding latch system with a double seal.
#7		**USB Coupler** The IndustrialNet™ USB Coupler from Panduit is a key component in an overall Industrial data communications application. This industrially rated bulkhead mounted coupler provides a USB A jack on the exterior to a USB Type A jack on the interior side of the control panel.

#8		**IndustrialNet™ Data Access Port** This data access port from Panduit provides data port and electrical outlet access to control panels without the safety hazards of opening the panel in the presence of electrical voltages. The Data Access Port is rated to NEMA 4X and incorporates a weatherproof clear polymer based cover for ease of port identification. The Data Access Port incorporates a locking hasp that accepts Panduit lockout / tagout products, or a padlock to prevent unauthorized access for improved security.
#9	 	**Grounding Bars and Braided Bonding Straps** Consider using these Panduit copper ground bars which are properly designed for grounding purposes. Braided bonding straps should be used to bond the doors with hinges to the rest of the control panel.
#10	 	**Paint Piercing Washers and Bonding Screws** Consider using Panduit paint piercing hardware on painted surfaces to electrically bond the rack for simplified grounding.

Appendix II NEMA / UL / CSA Type Ratings

INDOOR OUTDOOR INDOOR and OUTDOOR

Type	NEMA	UL	CSA
Type 1	Provides a degree of protection against contact with the enclosed equipment, or locations where unusual service conditions do not exist.	Provides protection against contact with the enclosed equipment and against a limited amount of falling dirt.	General purpose enclosure. Protects against accidental contact with live parts.
Type 12	Provides a degree of protection against dust, falling dirt, and dripping noncorrosive liquids.	Provides a degree of protection against dust, dirt, fiber flyings, dripping water and external condensation of noncorrosive liquids.	Provides a degree of protection against circulating dust, lint, fibers and flyings; dripping and light splashing of noncorrosive liquids; not provided with knockouts.
Type 12K	Enclosures with knockouts provide a degree of protection against dust, falling dirt, and dripping noncorrosive liquids.	Provides a degree of protection against dust, dirt, fiber flyings, dripping water, and external condensation of noncorrosive liquids.	Provides a degree of protection against circulating dust, lint, fibers, and flyings; dripping and light splashing on noncorrosive liquids; not provided with knockouts.
Type 13	Provides a degree of protection against dust, spraying of water, oil, and noncorrosive coolant.	Provides a degree of protection against lint, dust seepage, external condensation and spraying of water, oil and noncorrosive liquids.	Provides a degree of protection against circulating dust, lint, fibers, and flyings; seepage and spraying of noncorrosive liquids, including oils and coolants.
Type 3	Provides a degree of protection against windblown dust, rain and sleet; undamaged by the formation of ice on the enclosure.	Provides a degree of protection against windblown dust and windblown rain; undamaged by the formation of ice on the enclosure.	Provides a degree of protection against rain, snow and windblown dust; undamaged by the external formation of ice on the enclosure.
Type 3R	Provides a degree of protection against falling rain and sleet; undamaged by the formation of ice on the enclosure.	Provides a degree of protection against falling rain; undamaged by the formation of ice on the enclosure.	Indoor or outdoor use; a degree of protection against rain and snow; undamaged by the external formation of ice on the enclosure.
Type 3RX	Provides a degree of protection against corrosion, falling rain and sleet; undamaged by the formation of ice on the enclosure.	Not specifically defined.	Not specifically defined.
Type 4	Provides a degree of protection against windblown dust and rain, splashing water and hose directed water; undamaged by the formation of ice on the enclosure.	Provides a degree of protection against falling rain, splashing water and hose-directed water; undamaged by the formation of ice on the enclosure.	Provides a degree of protection against rain, snow, windblown dust, splashing, and hose-directed water; undamaged by the external formation of ice on the enclosure.

Type 4X	Provides a degree of protection against corrosion, windblown dust and rain, splashing water and hose-directed water; undamaged by the formation of ice on the enclosure.	Provides a degree of protection against falling rain, splashing water and hose-directed water; undamaged by the formation of ice on the enclosure; resists corrosion.	Provides a degree of protection against rain, snow, windblown dust, splashing and hose-directed water; undamaged by the external formation of ice on the enclosure; resists corrosion.
Type 6	Occasional submersion is encountered; limited depth; undamaged by the formation of ice on the enclosure.	Provides a degree of protection against entry of water during temporary submersion at a limited depth; undamaged by the external formation of ice on the enclosure.	Provides a degree of protection against the entry of water during temporary submersion at a limited depth. Undamaged by the external formation of ice on the enclosure; resists corrosion.

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- Some enclosures may have multiple ratings.

Appendix III – Challenging Environmental Factors and the Potential Solutions based on Environmental Standards Provided by NEMA, UL, CSA and IEC

		Indoor		
	Environmental Matrix	**People**	**Dust/Dirt/Dripping Fluid**	**Washdown**
SOLUTIONS	Scaling	¼" MAX Holes and Gaps	FIP (Foam-In-Place)	Molded Silicone
	Material for Noncorrosive Environment	Mild Steel	Mild Steel	Stainless Steel
	Material for Corrosive Environment			
	Finish	Polyester Powder Paint	Polyester Powder Paint	#3 Finish (100-120 Grit) #4 Finish (120-320 Grit)
	Features		Drip Shield	Angles, Flange Troughs
	Thermal Management	Natural Convection	Natural Conduction, Heat Exchanger, Air Conditioner	Natural Conduction, Heat Exchanger, Air Conditioner
	EMI	Metallic Braided Gasket	FIP w / Spring Finger	Molded Silicone / with Spring Finger
	Seismic / Shock / Vibration	Seismic Reinforced Design	Seismic Reinforced Design	Seismic Reinforced Design
NEMA / UL RATING		TYPE 1	TYPE 4/4X	TYPE 12

Appendix IV – Thermal Solutions Chart – Hoffman Cooling Systems Characteristics

COOLING SYSTEM TYPE	TECHNOLOGY DESCRIPTION	HEAT REMOVAL RANGE	INDICATIONS FOR USE	TYPICAL APPLICATIONS	Cools Below Ambient	Cools Above Ambient	Closed Loop
Air Conditioners	Forced air Refrigerant-based	High	Hot Environments (typically over 35 (/ 95F) High Heat Load (300W – 17,300W) Dirty or Corrosive Air Harsh/Humid Environments	Indoor or Outdoor Industrial enclosures Telecommunications Wastewater treatment Metal working Oil rig/refinery Foundry	✓		✓

Thermoelectric Coolers	Peltier effect No moving parts or liquids	Law	Small Enclosures Low Heat Load (60-200W) Remote/DC-powered applications	Indoor or Outdoor Telecommunications Battery cabinets Industrial enclosures Security systems	✓		✓
Air-to-Air Heat Exchangers	Closed loop No liquids	Moderate	Cool Air Environment Moderate Heat Load (7-150W/F) Dirty or Corrosive Air	Indoor or Outdoor Telecommunications Light-duty manufacturing		✓	✓
Air-to-Water Heat Exchangers	Close-coupled water cooling No moving parts exposed to environment	Highest	Very Hot Environments High Heat Load (370W to 6700W) Extremely Dirty/Dusty Air	Extreme conditions where air conditioners would be subject to failure Automotive manufacturing Machine tool Packaging Paper mill	✓		✓
Filter Fans, Blowers, Impellers or Direct Air Cooling Systems (DACS)	Forced, fresh air Open loop	Low to Moderate	Cool, Clean Air Environment	Industrial manufacturing Outdoor telecom Data networking		✓	
Vortex Coolers	Requires compressed air source Forced air No liquids or moving parts	Moderate	Hot Environments (typically over 35 (/95 F) Heat Load (up to 1,465W) Dirty or Corrosive Air Harsh/Humid Environments	Heavy manufacturing Metal working Oil rig/refinery Paper mill Foundry Hazardous location models available	✓		✓
Conductive (no cooling unit)	Passive Heat radiates through enclosure walls	Very Low	Cool Air Environment (<78 F/25C) Low Heat Load (50W)	Where enclosed components operate within recommended temperature range		✓	Pre-enclosure rating

Referenced Resources

- Noise Mitigation: Managing Electromagnetic Interference Risks White Paper
- Environmental Protection of Control Panels: Overview and Standards Compliance White Paper
- Outdoor Environmental Control Panel Factors: The Control Panel Infrastructure
- ANSI/TIA-1005-A Telecommunications Infrastructure Standard for Industrial Premises
- TIA TSB-185 Environmental Classification (M.I.C.E.) Tutorial
- IEC 60721-1 - 3, Classification of groups of environmental parameters and their severities
- http://www.odva.org

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About Pentair Equipment Protection

Pentair Equipment Protection, a Pentair global business unit, is the leading provider of worldwide product and service solutions for enclosing, protecting and cooling electrical and electronic systems. Its industry-leading brand—Hoffman—provides a broad variety of standard, modified and engineered solutions to the commercial, communications, energy, general electronics, industrial and infrastructure markets.

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Panduit is a world-class developer and provider of leading-edge solutions that help customers optimize the physical infrastructure through simplification, increased agility and operational efficiency. Panduit solutions give enterprises the capabilities to connect, manage and automate communications, computing, power, control and security systems for a smarter, unified business foundation. Panduit provides flexible, end-to-end solutions tailored by application and industry to drive performance, operational and financial advantages. Panduit global manufacturing, logistics, and e-commerce capabilities along with a global network of distribution partners help customers reduce supply chain risk. Strong technology relationships with industry leading systems vendors and an engaged partner ecosystem of consultants, integrators and contractors together with its global staff and unmatched service and support make Panduit a valuable and trusted partner.