

MAY 2018

SAFETYZONE MAGAZINE

**Extending the Life of Precision
Components in Demanding
Applications**



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Industrial Dust
Explosion Protection**

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Extending the Life of Precision Components in Demanding Applications



Specialized PVD coatings increase surface hardness and durability of precision components such as bearings, gears and rollers to significantly increase lifespan under high load conditions

Although bearings, gears, rollers and other precision components are generally made of hardened steel or metal alloys, those utilized in high load applications still can fail due to excessive wear, surface fatigue, pitting, galling and corrosion.

This is exacerbated in applications with metal-to-metal interaction, repetitive friction at high speeds or where little to no lubrication is present. Other factors include the presence of contaminants, the prevailing service temperatures, the loads applied, and loading modes such as sliding, rolling, oscillating and pulsating.

To address this problem, product engineers and component manufacturers often turn to specialized PVD (physical vapor deposition) coatings that can be applied in thicknesses of 0.5 to 4 micrometers to further harden the surface of these parts.

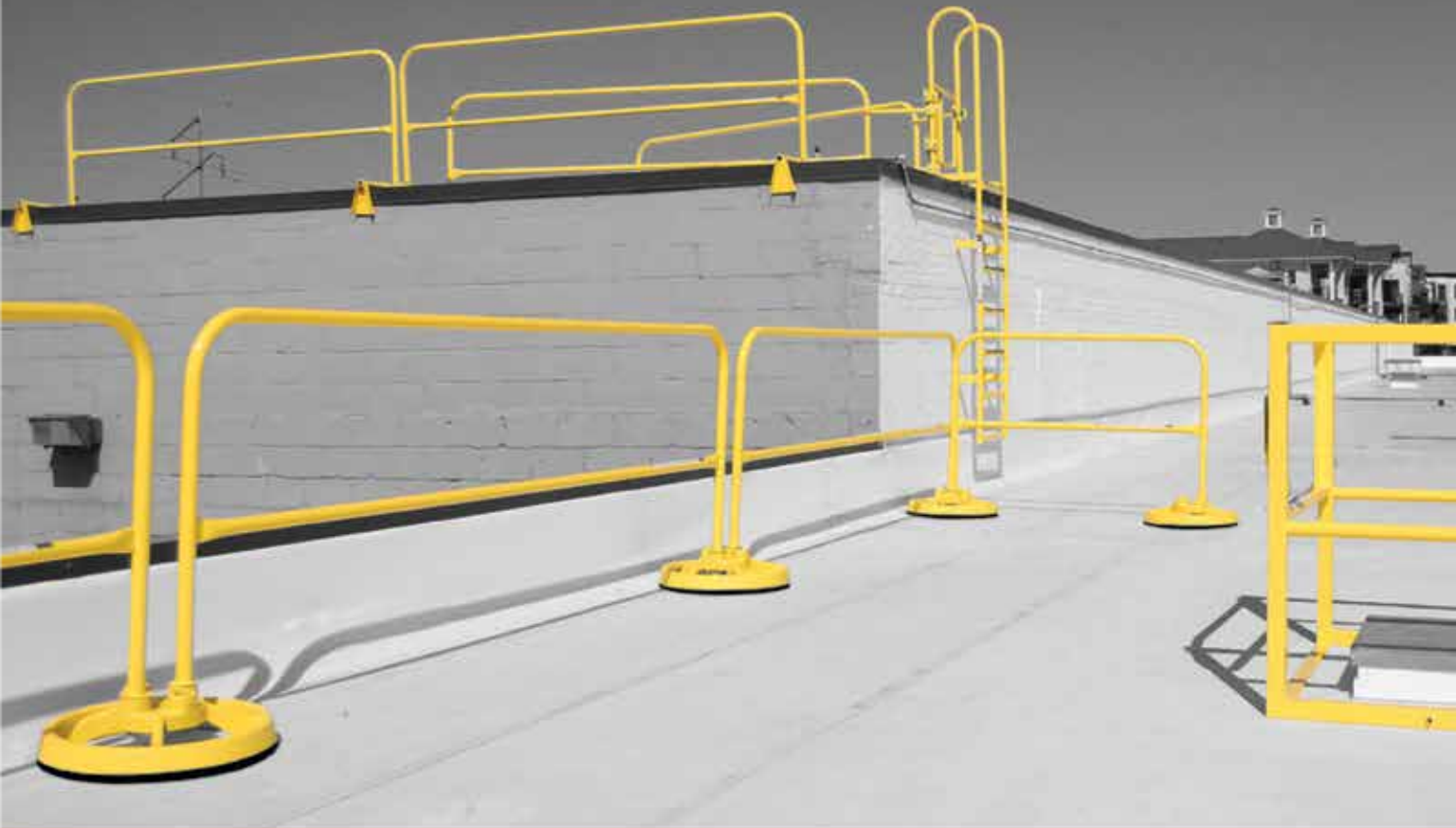
By applying coatings optimized for these types of punishing environments, components benefit from increased surface hardness and a much lower coefficient of friction. As a result, these critical parts do not have to be replaced as frequently, if at all, reducing maintenance and unplanned downtime while improving machinery performance.

Today, these coated components are utilized for a variety of applications from performance automotive and racing to wind turbine shaft bearings and planetary gears; stainless steel cutting blades and piston pumps for food processing; and sliding components in filling and bottling operations. The coatings are also a proven technique for upgrading critical rotating parts in hydraulic drives, pumps and valves.



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Hardened Components

Many components are not coated at all. Instead, these parts are often made of heat-treated, nitrided or case-hardened steels, along with durable high performance materials such as titanium or nickel based alloys.

Even those used in high load, high wear applications are subject to wear and premature failure under poor lubrication. Some industries allow no lubrication at

all, such as cryogenic and vacuum systems, clean rooms, food and pharmaceutical equipment.

When this is the case, engineers often turn to a variety of coating, plating or nitriding options to modify the surface to improve wear and corrosion resistance.

Examples include coating the parts with black oxide. Black oxide is a coating produced by a chemical reaction between the iron on the surface of a ferrous metal

and oxidizing salts. After a post-treatment with oil, the surface provides protection against corrosion, improved lubricity and prevents galling during metal-to-metal interactions.

However, black oxide is not very durable and can be worn away quickly in repetitive, high load applications.

PTFE, another popular coating alternative, is known for its low coefficient of friction but is not recommended for high load applications where it, too, can wear away.

Hard chrome and chemical nickel plating are often specified, as well, to provide protection against wear and corrosion.

Although hard chrome is suitable for components that experience abrasive wear, microcracking inherent to the process limits its use against corrosion. Although this can be addressed with thin coatings that increase surface hardness, these solutions only offer limited wear resistance.

Chemical nickel can be applied over a range of hardnesses. However, the maximum is only 600 HV (Vickers Pyramid Number).

Concerns over polluting compounds, emissions or residues are also associated with these plating techniques.

Specialized PVD Coatings

Physical vapor deposition (PVD) describes a variety of vacuum deposition methods that can be used to produce thin coatings. PVD is typically used to coat components at relatively low coating temperatures of 200-500 °C. These temperatures are ideal because they are below the tempering temperature of steels so as to avoid altering the fundamental material properties.

Fortunately there are several carbon-based coatings available that provide a unique combination of extreme surface hardness, low friction coefficient and anti-corrosion properties like those provided by global coating provider Oerlikon Balzers.

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According to Manfred Berger, Market Segment Manager General Engineering Components for Oerlikon Balzers, the company's BALINIT C coating is a WC/C ductile carbide carbon coating that is highly resistant to adhesive wear (scuffing) in particular. It has a high load-bearing capacity even under conditions of deficient lubrication or dry contact. Due to its low friction coefficient, it acts to reduce pitting and fretting corrosion.

Another example is the BALINIT DLC coating, a metal-free, carbon based coating that is even more durable. Applied through Plasma-Assisted Chemical Vapor Deposition (PACVD), this coating is designed for more severe wear conditions and high relative sliding speeds to protect against abrasion, scuffing and cold welding.

These and other coatings within the BALINIT family that are tailored to specific requirements can be applied to a

variety of case-hardened or tempered steels, austenitic stainless steel as well as nickel, titanium, copper, magnesium and aluminum alloys.

"These materials provide an excellent combination of low coefficient of friction like PTFE, but with the hardness of a ceramic," explains Berger.

The coatings also have the advantage of being thin, typically 0.5-4 µm. This feature, in conjunction with close tolerancing, means that the component retains its form, fit and dimensions after coating without the need for re-machining.

Potential Applications

Bearings

Bearings often suffer from severe and disproportionately distributed abrasive wear. A coating such as BALINIT C is particularly suitable for case-hardening as well as ball- and roller-bearing steels because it can be applied at temperatures under 200 °C.

The PVD coating can be applied not only to inner and outer races and cylinders but also to the balls in ball bearings in a highly uniform coating thickness of 0.5-1 µm. The slight increase in roughness is offset by the good burnishing qualities of the coating, which smoothes the raceway of the inner and outer rings, providing additional protection against scuffing and pitting.

Bearings in the soft calendar rolls of paper machines frequently experience smearing. Not only does PVD coating reduce the possibility of smearing, but by making the bearings harder with coating, it has been shown that the life of these parts can be increased by a factor of three or four. As a result, paper mills are able to hold off on bearing replacement until the calendar roll needs regrinding, significantly reducing costly production downtime.

Similarly, cylindrical roller bearings in compressors are often exposed to low loads and vibrations, causing potential smearing. Applying PVD coating to the bearings removes any such possibility.



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Gears

Gears experience similar wear conditions. The PVD coating significantly reduces scuffing and pitting in gear as well. In fact, BALINIT C has been shown to quadruple the service life of high-speed gears.

The standard FZG C test shows that the fatigue strength is increased by 10-15% over case-hardened but uncoated gears. In the test, the failure criterion for gear service life was defined as single-tooth wear of 4% due to pitting.

The main factors in these improved figures were the lower local surface pressure (Hertzian pressure), which resulted from reduced friction in the rolling contact, and the superior running-in behavior of BALINIT C.

Coatings can also benefit worm gears, where lubrication is not always enough to protect helical-gear transmissions against friction and wear.

The sliding motion and the force between

the worm and gear faces make it difficult for a lubricant film to form. For this reason, the gear is most often made of bronze in order to avoid scuffing.

In service, however, the teeth of the bronze gear wear away quickly and the gear must be realigned or replaced. Coating the steel worm with a carbon-based coating can improve reliability and performance by reducing wear on both the worm and the bronze gear.

Pumps, compressors

Screw spindle-, vane-, gear-, lobe- and centrifugal pumps often function in abrasive and poorly lubricating media. This may be cooling media in grinding machines such as screw pumps and internal gear pumps. BALINIT coated screws provide the ideal combination of hardness and low friction for preventing wear in such poorly lubricated conditions.

Similarly, industrial compressor components, such as reciprocating pistons, screws or valve plates can undergo

extensive wear when oil-free operation, dry gases, refrigerants, high or low temperature limit the use of lubricants.

Customized Solutions

In addition to designing and manufacturing PVD coating equipment, Oerlikon Balzers offers coating services at more than 140 coating centers worldwide, including 16 locations throughout the United States.

According to Dr. Florian Rovere, Director of Sales for Precision Components in North America, companies like Oerlikon Balzers also have the R&D capabilities to tailor coating solutions to meet unique requirements. In addition to coating thickness and hardness, properties such as structure, chemical and temperature resistance, and adhesion can be precisely controlled.

In most cases, no alteration of the formula for the coatings is required, as it is already optimized for high load, high friction environments.

"I find engineers are most surprised about two factors when learning about these specialized PVD coatings," says Berger. First, that the coating can be applied in a thickness as low as .5 or 1 micrometers. The other is that these coatings can last the lifetime of the machine or systems it is in, despite the difficult operating conditions."

For more information about coating solutions for components with Oerlikon Balzers, call (408) 375-4408, e-mail: balzers.components@oerlikon.com; or visit www.oerlikon.com/balzers •



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2	OFFICE: ALARM SYSTEMS OFF-130.1.U.S	1. Does the facility have an employee alarm system? Cite: 29 CFR 1910.395(c), 29 CFR 1910.155	An employer must have and maintain an employee alarm system that is able to be heard, seen, or otherwise perceived by everyone in the workplace. The employee alarm system must be distinctive and recognized by all employees as a signal to evacuate the work area or perform actions identified in the ERP/SAP.
3	OFFICE: ALARM SYSTEMS OFF-130.2.U.S	2. Is the employee alarm system tested annually? Cite: 29 CFR 1910.155(d)(6)	Employee alarm systems must be tested at least annually for reliability and adequacy.

G. AUDIT QUESTIONS						
Date: _____						
Facility: _____						
Auditor: _____						
Question ID	Audit Questions	Auditor Guidance And Notes-Audit Questions	Y E S	N O	N A	Comments
ERGONOMICS						
OFF-140.1.U.S	1. Are workstations configured so that employees can achieve ergonomically correct working postures?	Workstations should be configured to prevent common ergonomic problems. The computer keyboard and mouse should be within easy reach and at a comfortable height (elbow high), the keyboard and monitor should be aligned, and the screen should be at or slightly below eye level. There should be no under the desk storage.				
OFF-140.2.U.S	2. Are chairs used at workstations adjustable and in good condition?	Chairs should be so that employees can work in a comfortable seated position, with good body support. Chair height should allow feet to rest flat on the ground with thighs parallel to the ground.				

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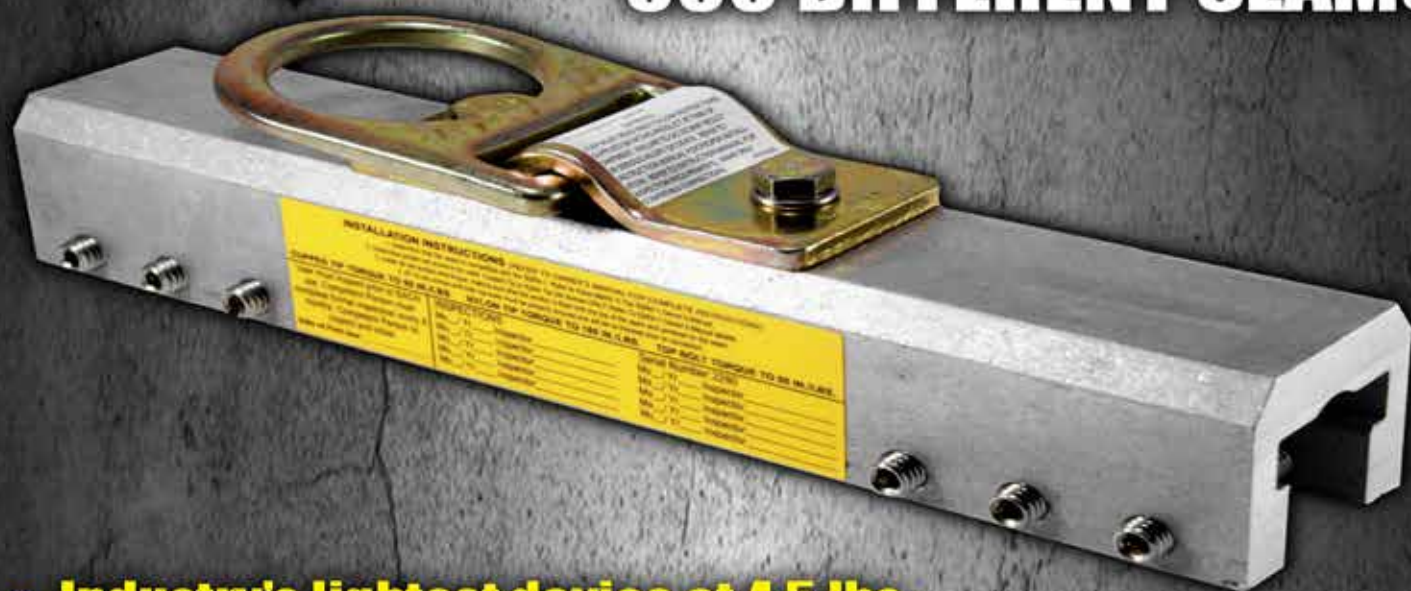
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The Next Phase in Industrial Dust Explosion Protection

Among its directives, NFPA 652 outlines deadlines for sampling and analysis to identify potential risk areas for dust explosions in industrial facilities. Spotlight now turns to mitigation equipment

For a wide range of facilities that manufacture, process, blend, convey, repackage, generate or handle items that could be categorized as combustible dusts or particulate solids, new NFPA Standards and even the first deadline to conduct a dust hazard analysis are now on the books adding to the responsibilities of owners and operators of such facilities.

Explosions can result from an ignition of a combustible gas, mist or dust when mixed with air during processing, handling or storage operations. A rapid rise in pressure occurs in the containing structure, and if it is not of adequate strength to withstand the pressure, extensive damage and injury to personnel can occur.

After a string of incidents in the early 2000s, organizations such as OSHA stepped up the requirements, as with the Combustible Dust National Emphasis Program of 2008, which is still in effect today.

The NFPA (National Fire Protection Association), which has been issuing Standards and guidelines for decades, is

doing the same with publication of NFPA 652 – Standard on the Fundamentals of Combustible Dust, in 2016. This new Standard consolidates best engineering practice and provides reference to all of the existing combustible dust standards in a single, overarching document that applies to all facilities that handle potentially explosive dusts.

While the new Standard does an admirable job of unifying the various existing equipment and industry specific codes, NFPA 652 goes a step further by specifying – for the first time – a deadline for owners and operators of at-risk facilities to conduct a dust hazard analysis.

“Perhaps the most important aspect of the introduction of NFPA 652, is that it requires all owners and operators of a dusty industrial process to do a dust hazard analysis,” says Geof Brazier, president of BS&B Pressure Safety Management, a manufacturer of a broad range of dust explosion prevention and protection technologies.

According to Brazier, NFPA 652 specifies facilities must complete this dust hazard analysis within 3 years. However, recent revisions to NFPA 654 and 61 that additionally apply to many facilities have extended that deadline to 5 years.

While a significant step in the right direction, NFPA 652 is essentially requiring owners and operators of at-risk facilities to confront and address an issue that many may not fully understand in terms of both the potential for such an event and what steps must be taken to mitigate those risks.

The NFPA Standards, for example, outline requirements that can range from improved housekeeping to installing dust-collection equipment and offering protective equipment for personnel.



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In addition, protection or hazard mitigation devices may also be required. Because these typically represent some capital expenditure, many owners and operators are seeking out information on the available technologies on the market.

Explosion Protection Devices

To protect process equipment and personnel, a hybrid of technical measures is often required. Among the options are passive devices like vents or containment systems along with active devices such as explosion suppression or spark detection and extinguishing systems.

In addition, chemical or mechanical isolation devices are required to protect connected equipment and piping from propagating to a secondary event, which can often be more dangerous and destructive than the initial event.

Explosion Vents

During the early stages of a dust or gas explosion, explosion vents open rapidly at a predetermined burst pressure, allowing the combustion process to escape to the atmosphere and limiting the pressure generated inside the process equipment to calculated safe limits.

Venting is the most popular and widely adopted protection mechanism, in part because it is economical and requires little attention or maintenance once installed.

“In the US, there are well over 20,000 vents applied every year on equipment,” says Brazier, adding that a single piece of equipment might require multiple vents according to the NFPA 68 design calculations that assess both dust reactivity and the volume as well as shape of the equipment to be protected.

For decades, explosion vents have traditionally been designed using a “composite” approach that sandwiches plastic film between more resistant stainless steel sheets with holes, or slots, cut into it. These vents are designed to “open” at typically 1 to 1.5 PSI set pressure, a result of the slot and hole pattern placed into the sheet metal.

Over time, however, this type of vent is prone to tears in the plastic film, which is the seal between the process conditions and the atmosphere.

With this type of technology, the holes and slots in the stainless steel sheets can admit particulates and debris over time. In addition to being unsanitary, particularly for food processors, the build-up can eventually affect the functionality of the vent.

“A vent that becomes heavier in weight due to build-up will open slowly and less efficiently, and ultimately the pressure in the equipment will be higher than expected which is a safety concern,” explains Brazier.

In 1990, BS&B Systems patented the first single-section explosion vent, comprised of a solitary sheet of stainless steel in a domed configuration. Perforations around the perimeter to aid opening at the desired low set pressure are protected with gasket materials.

The single-section domed design produces a vent that is more robust, lighter in weight and also largely eliminates the potential for build-up or contamination.

In 2010, the company improved on the design by altering the shape of the dome to a unique compound geometry that delivers even greater rigidity for high vacuum or vibration applications.

Despite its popularity, explosion vents will not work for every application. With venting, the combustion process will release a large ball of flame into the atmosphere that might be 10 times the size of the protected equipment for a few milliseconds.

While this might be an acceptable consequence for equipment that is outdoors at a remote location, for applications within a plant compound or inside a building

it could endanger personnel or equipment, and even lead to a secondary explosion external to the protected equipment.

In cases where a flameball must be avoided, flame arrestors can be deployed. These devices are designed to absorb the pressure wave, flame and at least some of the dust that would normally be ejected by a vented explosion.

The 3 dimensional flame arrestors applied downstream of explosion vents are heavy and when installed directly on top of a vent damage can result.

To address this concern, companies like BS&B Pressure Safety Management provide a flameless system designed with the vent installed inside the flame arrestor. In doing so, the heavier flame arrestor is mechanically mounted directly to the equipment, reducing the weight load transmitted through the more sensitive vent and eliminating the risk of damaging the vent.

It also serves the dual purpose of allowing for easy inspection of the vent and arrestor while installed. NFPA Standards require periodic inspection of explosion safety equipment.

Suppression Equipment

For processes where an explosion would ideally be prevented altogether, suppression systems are the best alternative.

Explosion suppression equipment detects a dust explosion in the first milliseconds of the event and then signals extinguishing modules to release a flame quenching medium into the process equipment. This effectively stops the explosion in its infancy and only low pressure is produced that is safe for the protected equipment.

“Suppression can be preferable for indoor equipment, simply because the explosion doesn’t really propagate; it starts, but it never evolves into a full blown event,” says Brazier.

For a 24/7 process, a suppression system can be very

desirable, because the speed of clean up and refit allows for a quick return to production.

“If you use venting or flameless venting, you are allowing the explosion to fully develop in process equipment, so you have cleanup to deal with, you may have fire-related damages and other consequences that take time to get the process back into operation,” adds Brazier.

A typical suppression system consists of sensors and several explosion suppression “cannons,” which propel an extinguishing agent, such as sodium bicarbonate, into the process equipment. Nitrogen is often used to provide the motive power.

Although some available systems combine nitrogen and extinguishing agent in a single canister, this means the cannon must be oriented vertically downward to discharge properly. If not, the extinguishing powder could be left behind.

In the BS&B suppression system the nitrogen and extinguishing chemical are kept separate until the instant of activation. For this reason, discharge cannons can be installed facing vertically down, horizontal, or even upwards.

For installation purposes, this provides tremendous flexibility for placing cannons in the ideal location.

Separating the extinguishing agent and providing it in an easily replaced canister also means that on-site personnel can refit the system in case of an event. This can be a significant advantage given that some systems require a service technician to travel to the facility to re-set the system.

Containment Systems

To “contain” an explosion, process equipment is built strong enough to resist the pressures generated by the combustion occurring inside a sealed container.

With this type of system, there is a high cost of construction since the design pressure has to be typically over 100 psig, and sometimes over 150 psig, which is far above the



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normal, required operating pressure conditions of the equipment.

As a consequence, containment is only economically viable for processes that are small volumes and / or high added value, such as some pharmaceutical manufacturing and for industries handling toxic materials that cannot be released to the environment.

In this type of system, the isolation devices play a critical role in preventing damage to connected equipment and piping. For this, fast activating knife gate or pinch valve device can be used, as well as chemical isolation systems.

With containment systems, however, isolation equipment must also be able to withstand greater pressures, up to 150 psig, unlike similar equipment required with vents or suppression devices that must survive only 3-10 psig.

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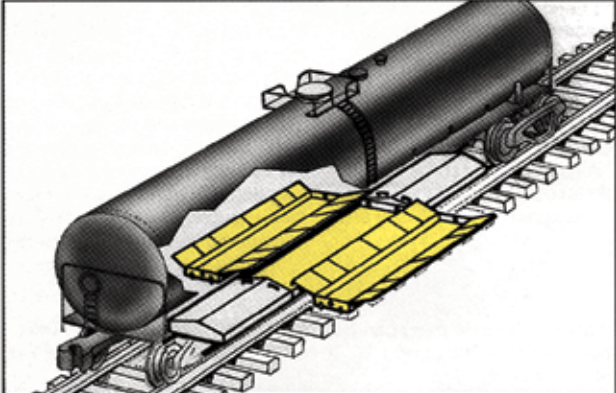
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installed, the appropriate solution for each application is a hands-on, collaborative endeavor.

"There is always more than one way to achieve combustible dust safety," says Brazier. "The expertise is in reviewing each option for a particular industrial process and arriving at a combination of technologies that is technically effective, as well as cost effective in meeting the owner / operator's responsibilities under NFPA Standards."

For more information, contact BS&B Safety Systems at 7455 East 46th Street, Tulsa, OK 74145-6379, (918) 622-5950, e-mail: sales@bsbsystems.com or visit www.bsbsystems.com •



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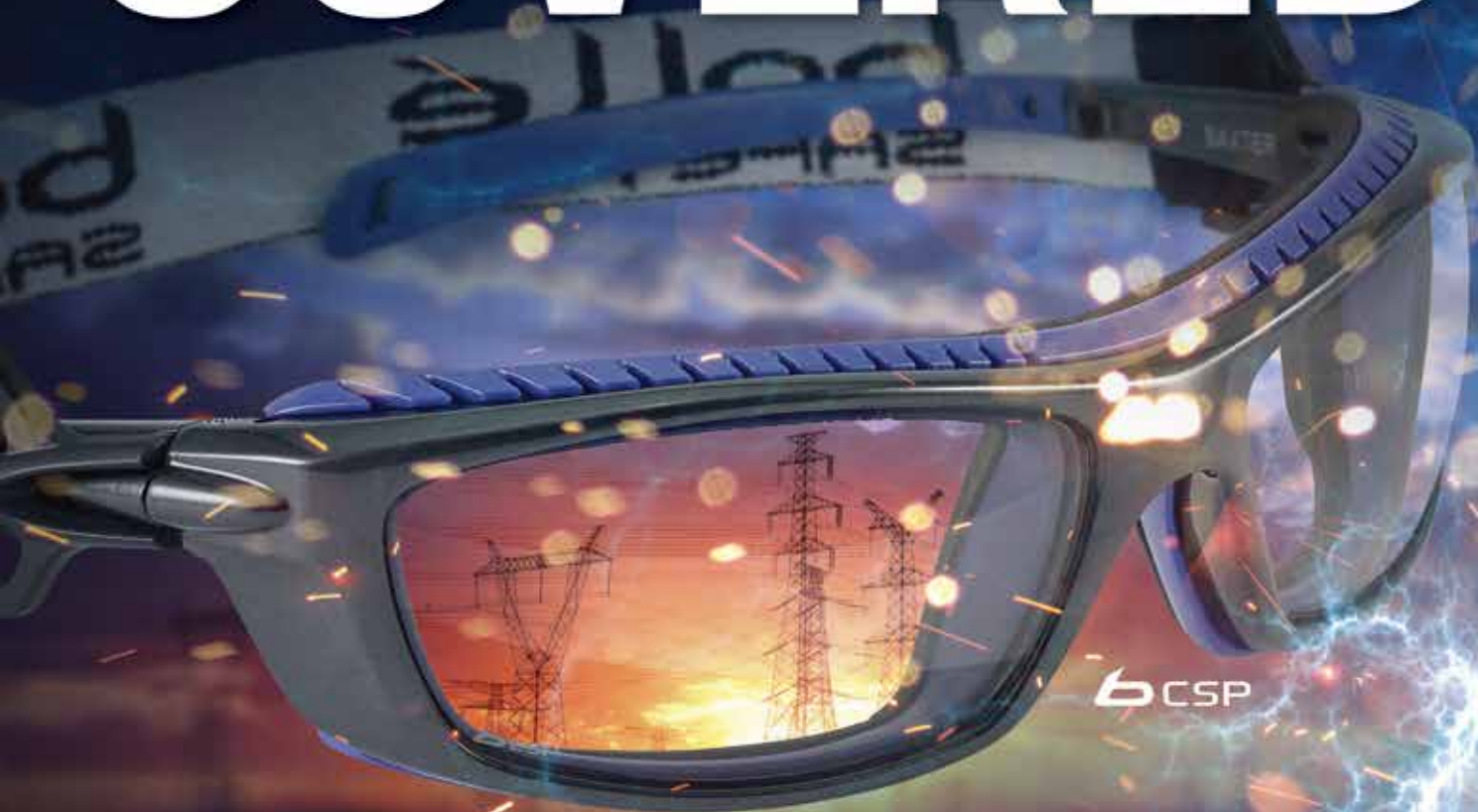
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Educational Resources

Webinars

RegScan understands that staying in compliance is critical. But it doesn't have to be complicated. That is why we host webinars several times throughout the year that help our clients tackle ever-evolving problems in the EHS industry. Prior topics covered included regulatory overviews, the Changing Role of the EHS Manager, and ISO 14001:2015. Such topics specifically address the newest industry standards while banishing compliance confusion, provide necessary tools to manage today's EHS challenges and reduce time and money spent on compliance activities.

Tutorials

RegScan also produces a number of helpful videos for our users. They answer most commonly asked questions on using the RegScan One interface. You may wish to visit our Informational & Tutorial Videos Page prior to submitting a ticket to see if your question can be answered with the assistance of one of these videos.

Quality Suite

RegScan has introduced audit protocols and checklists geared to quality management in healthcare.

They cover the basic ISO 9001 and Quality Systems, Medical Devices (United States and the European Union), and Pharmaceuticals.

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tion.

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Strikethrough allows you to effortlessly see the amendment history of a regulation by comparing the current regulation with an earlier or future version. Changes are easily identified by color-coding. Anything that has been added will appear in green, while anything that has been deleted will appear in red.

My WatchList

My WatchList is a custom regulatory change management tool that allows you to monitor change at various levels of detail. It gives you quick access to only the information you need, while providing a clear record of what you have and haven't reviewed. My WatchList is the easiest way for a Web Services user to build a custom regulatory register, which RegScan will automatically export to your online environmental management system.

LookOut Email Alert

By defining specific keywords or phrases, LookOut allows you receive daily Email alerts on State or Federal regulatory changes.

RegScan Customer Support

As part of our ongoing commitment to improve the RegScan user experience, we use a ticketing system for customer support inquiries. This allows us to streamline requests and better serve you. Available 24/7, the ticketing system

allows you to immediately report an issue and track the support team's response to it. Every support request is assigned a unique ticket number. For your reference, we provide complete archives and history of all your support requests. A valid email address is required to submit a ticket.

Schedule a Demonstration

The RegScan team will gladly demonstrate any of our products or services for free. Our online demonstration sessions can accommodate up to 25 people, and we will schedule a meeting whenever it's convenient for you. During these interactive demonstrations, our experienced staff will go through whatever products or services interest you. You'll also have the opportunity to ask questions, and discuss licensing options that are tailored to your needs. If you decide to purchase, we can take of your training and support needs too. We frequently update our library of training videos, and we'll be happy to arrange online or in-person training sessions. Furthermore, our in-house technical support team is always available on weekdays (except for holidays) between 8 a.m. and 8 p.m. Eastern time, and online 24/7.

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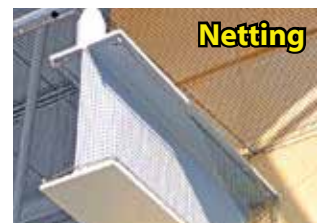
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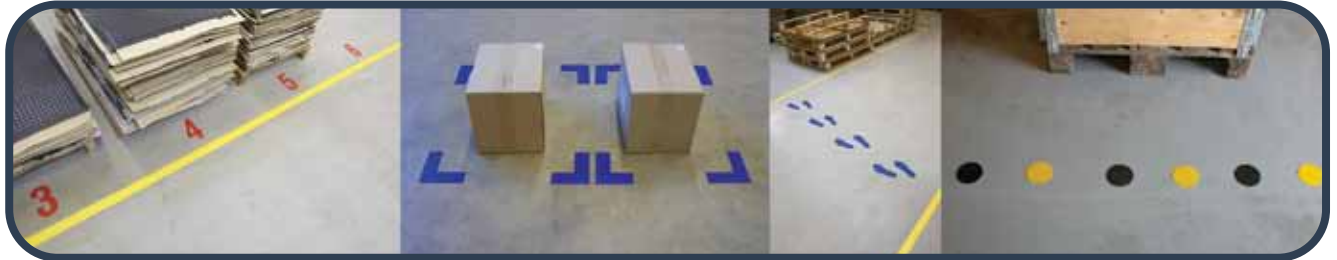
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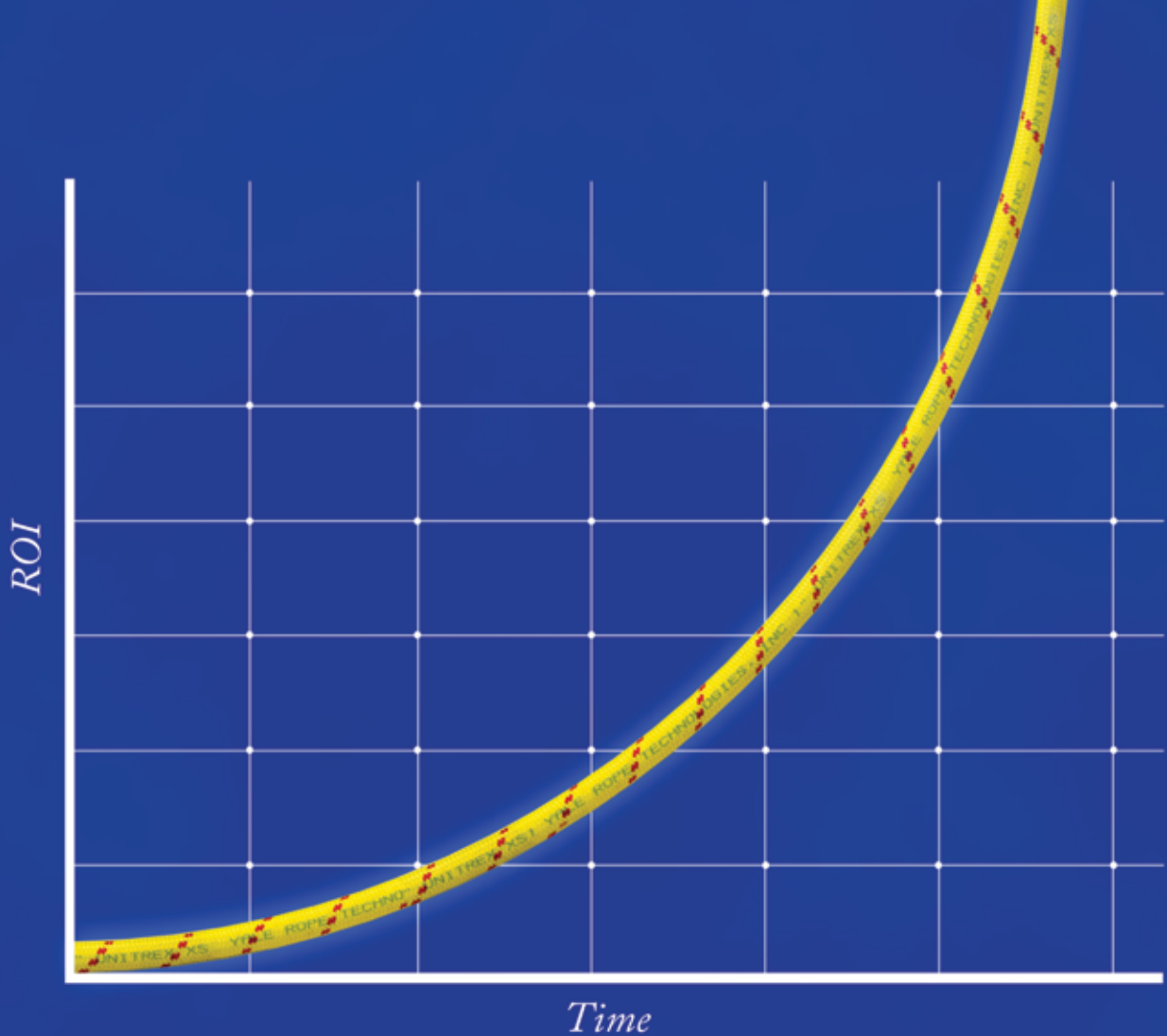
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