



CORROSION SOLUTIONS FOR THE POWER GENERATION INDUSTRY

ZERUST® is a product of
Northern Technologies
International Corporation



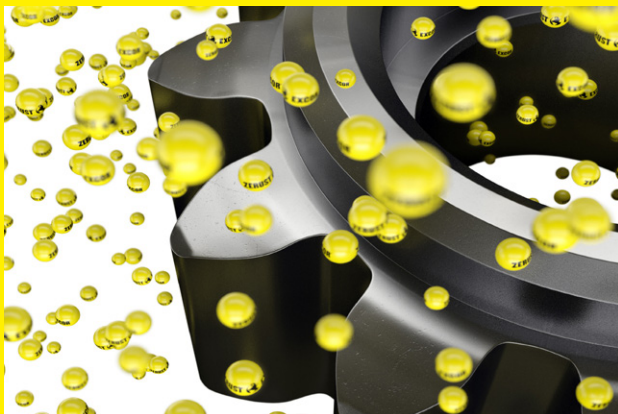
WHY CHOOSE ZERUST®?

PROVEN SAFE, RELIABLE, AND EFFECTIVE CORROSION SOLUTIONS FOR OUTDOOR STORAGE

ZERUST® corrosion inhibiting products are a cost-effective way to protect equipment from rust and corrosion in power generation. For over 50 years, ZERUST's proprietary vapor corrosion inhibitor (VCI) technology has been proven safe and effective for protecting metals. An analysis of compatibility using recognized test procedures can be arranged with a local ZERUST® representative to identify the best corrosion management solution for power generation facilities unique environmental stressors and operational opportunities.



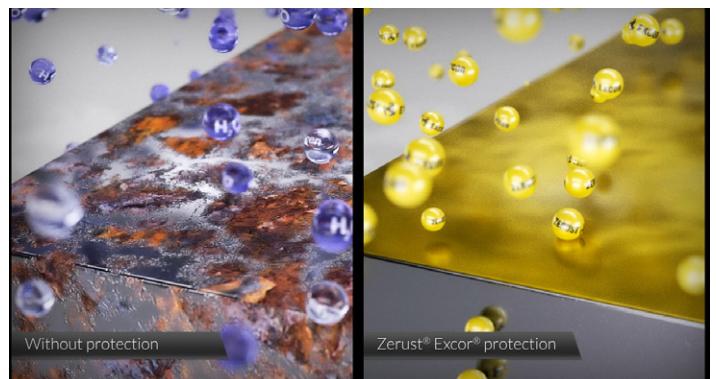
HOW ZERUST® VAPOR CORROSION INHIBITORS (VCIs) WORK



VCI molecules inhibit corrosion by preventing moisture and environmental elements from reacting with the metal surface. Since VCI molecules are transported through the air, they must be trapped around the metal surface using a poly bag or other enclosure. Later, when the enclosure or package is opened, the ZERUST® corrosion inhibiting layer dissipates, leaving clean, dry, and residue-free metals.

SAFE FOR METALS, TOUGH ON HUMIDITY AND CONTAMINANTS

Reduce downtime due to corrosion with ZERUST® protection. Equipment stored outdoors is exposed to corrosive atmospheres with high humidity and condensation, which is typically found in extreme environments. ZERUST® corrosion inhibitor technologies work to combat these causes of corrosion, even acid gases and moisture. By creating an invisible shield on the metal surface, ZERUST® products provide long-lasting protection. Additionally, ZERUST® solutions are easy to apply and remove, ensuring maintenance is straightforward and efficient.



PROTECTING CRITICAL COMPONENTS ACROSS POWER GENERATION SYSTEMS

Corrosion is a persistent and costly challenge in the power generation sector, occurring across a wide range of geographies, facility types, and operating conditions. According to the International Energy Agency, \$3.3 trillion in energy investment is projected for 2025, with \$2.2 trillion dedicated to clean energy technologies, including solar, wind, hydro, and storage infrastructure (IEA, 2024). As these systems scale globally, often in climatically and chemically aggressive environments, corrosion becomes a critical component the operation. The annual global cost of corrosion was estimated at \$2.5 trillion, or 3.4% of global GDP, reflecting both direct asset loss and indirect impacts like downtime, reduced efficiency, and premature replacement (NACE International, 2013). Facilities located in certain environments face heightened corrosion risk due to combinations of the following factors:

Marine and coastal exposure:

- High chloride deposition rates ($>300 \text{ mg/m}^2/\text{day}$), salt spray, and humidity drive aggressive pitting and crevice corrosion particularly on exposed components of wind farms, solar arrays, and offshore substations (ISO, 2012; Sousa et al 2020).
- High humidity and time of wetness (TOW $>2,500 \text{ hours/year}$): These conditions contribute to flash rust and oxide scale formation on carbon steel and aluminum frequently seen in hydroelectric turbines, biomass piping systems, and electrical enclosures.

Industrial zones with high SO_2/NO_x emissions:

- Acid rain and pollutant-driven corrosion affect thermal plants, grid infrastructure, and urban solar installations and increase metal corrosion.
- Facilities in regions with elevated H_2S and CO_2 levels significantly affect the corrosion rate of steam lines and heat exchangers (Firdaus, 2023)

These environmental stressors often align with the placement of modern power assets, for instance:

- Wind and solar farms are frequently installed near coastlines or in semi-arid environments with large temperature swings, exposing structural and fastener elements to salt spray, UV, and condensation cycling.
- Hydroelectric stations inherently operate with high moisture exposure, turbulent flow, and sediment, leading to erosion and corrosion.
- Biomass facilities often emit corrosive byproducts like sulfuric and acetic acid, increasing the risk of internal pipe and vessel corrosion.

Corrosion affects both active and standby systems. Vulnerable stages include:

- Commissioning and hydrostatic testing, where water-borne contaminants initiate internal corrosion
- Long-term layup, where condensation and residual contaminants lead to hidden damage

- Routine operation in harsh conditions, where surface exposure accelerates mechanical and chemical wear



To address these challenges, ZERUST®/EXCOR® offers a suite of engineered corrosion mitigation technologies that include VCI solutions designed to perform under real-world operating environments and help extend the service life of power generation assets by facilitating the management of corrosion and protecting critical infrastructure across power generation systems.

PRODUCT SOLUTION HIGHLIGHTS

Protecting Critical Components Across Power Generation Systems

Biomass Energy Facility



Component Protected	Technology	Protection Duration	Purpose / Risk Addressed
Boilers, Heat exchangers, Feedwater Pipes	AxxaVis™ HST-10: Water-soluble powder additive corrosion inhibitor that treats water and deactivates ionic contaminants	<i>Pre-treatment</i>	Shield biomass energy plant components from acidic corrosion and high-heat exposure.
Boiler exteriors, Flue Gas Ductwork	Rust Preventative Coatings: Wide range of rust inhibitor coatings ranging from oil-based, solvent-based, water-based, and grease-based to oil additives	<i>Dependent on product</i>	Shield biomass energy plant components from acidic corrosion and high-heat exposure.
Electrical panels, PLC cabinets	Vapor Capsules (ZAK-M22): Self-contained VCI diffusers emit corrosion-inhibiting vapors.	<i>Protects sensitive electrical components for up to 2 years*.</i>	Neutralizes acidic contaminants
	Axxanol™ 718-ESS: Electrical corrosion inhibitor spray	<i>Indoor and short-term outdoor protection</i>	Solvent completely evaporates, leaving a protective film that does not modify the conductivity of electronic components

Geothermal Power Plant



Component Protected	Technology	Protection Duration	Purpose / Risk Addressed
Condensers, separators	ICT®510-OPS Shrink Film: High-strength shrink film integrated with ZERUST® Vapor Corrosion Inhibitor Technology (VCI) and UV stabilizers	<i>Provides UV and weather-resistant corrosion protection for up to 5 years*</i>	Protects geothermal well casings and pipelines during hydrostatic pressure tests.
Steam Lines, Heat Exchangers, Well Casings, High-Pressure Pipes	AxxaVis™ HST-10: Water-soluble powder additive hydrostatic testing corrosion inhibitor that treats water and deactivates ionic contaminants	<i>Dependent on product</i>	Shields turbines, separators, and heat exchangers from corrosion.
Metal joints, Steam Turbines, Separator housings, Brackets, Piping joints	Axxanol™ Spray-G: Sprayable rust preventative that forms a protective grease barrier on steam-exposed surfaces, preventing high-temperature corrosion.	<i>Shields metal components from sulfur corrosion and scaling</i>	Protective grease barrier on steam-exposed surfaces, preventing high-temperature corrosion.
	Axxatec™ 85-F: Fogging, Water-based rust preventative liquid designed for fogging and spraying applications	<i>Up to 5 years* in hermetically sealed spaces</i>	VCI technology to protect hard-to-reach voids within an enclosed space, fogging into complex steel assemblies or components with voids and chambers
	Axxatec™ 87-M: Fogging, Multimetal compatible Water-based rust preventative liquid designed for fogging and spraying applications	<i>Up to 5 years* in hermetically sealed spaces</i>	

PRODUCT SOLUTION HIGHLIGHTS

Hydroelectric Power Facilities



Component Protected	Technology	Protection Duration	Purpose / Risk Addressed
Gearboxes, Bearings, Engines, Hydraulic Systems, Turbine Housing	Axxanol™ 707C: Vapor corrosion inhibitor (VCI) oil additive	Up to 2 years* of corrosion protection in closed, lubricated systems	Prevent internal rust due to high humidity and water ingress in enclosed systems.
Turbine Rotors, Penstocks, Control Valves	AxxaClean™: Chemical rust remover options of all different types, from pH-neutral products to more aggressive products	Pre-treatment	Restore and remove rust buildup and scale to prepare surfaces for protection or reassembly without damaging metal.
Exposed Pipes, Gates, Structural Fasteners	Axxanol™ Z-Maxx: Heavy-duty anti-corrosion grease	Up to 1 year* outdoors and up to 3 years* indoors	Long-term grease-based protection against water spray and high humidity.

Wind Power Systems



Component Protected	Technology	Protection Duration	Purpose / Risk Addressed
Nacelle, Electrical Cabinets, Control panels	Vapor Capsules: Self-contained VCI diffusers emit corrosion-inhibiting vapors	Provides up to 2 years* of corrosion protection in sealed enclosures	VCI diffusers emit corrosion-inhibiting vapors preventing rust on sensitive components.
	Axxanol™ 718-ESS: Electrical corrosion inhibitor spray	Indoor and short-term outdoor protection	Solvent completely evaporates, leaving a protective film that does not modify the conductivity of electronic components
Bearings and exposed fasteners	Axxanol™ Z-Maxx: Heavy-duty anti-corrosion grease	Shields outdoor assets for up to 1 year*	Offers superior corrosion resistance for bearings and exposed fasteners, even in salt-laden air environments.
Bearing housings, Turbine Hub Bolts, Brackets	Axxanol™ Spray-G: Sprayable rust preventative grease	Offers up to 1 year* of outdoor protection and up to 5 years* indoors	Provides an easy-to-apply protective layer for hard-to-reach areas in wind turbines.
	Axxatec™ 85-F: Water-based rust preventative liquid designed for fogging and spraying applications	Up to 5 years* in hermetically sealed spaces	VCI technology to protect hard-to-reach voids within an enclosed space, fogging into complex steel assemblies or components with voids and chambers
	Axxatec™ 87-M: Multimetal compatible Water-based rust preventative liquid designed for fogging and spraying applications	Up to 5 years* in hermetically sealed spaces	
Structure Components, Gearbox Parts, Blades, Fasteners (in storage or transit)	ICT®510-C VCI Film: Film diffuses invisible, odorless, and non-toxic Vapor Corrosion Inhibitor Technology (VCI).	Protects clean metals for years* when used correctly	Versatile, cost-effective corrosion prevention solution for power generation designed for wind turbine components in transit and storage.

PRODUCT SOLUTION HIGHLIGHTS

Solar Power Facilities



<i>Component Protected</i>	<i>Technology</i>	<i>Protection Duration</i>	<i>Purpose / Risk Addressed</i>
Gearboxes, Bearings, Engines, Hydraulic Systems, Turbine Housing	Axxanol™ Z-Maxx: Heavy-duty anti-corrosion grease	<i>Up to 1 year* outdoors for up to 3 years* for indoor assets</i>	Shields solar power panel frames, mounting hardware, and electrical connectors from environmental exposure.
Junction boxes, Connectors, Framing Supports	Axxanol™ Spray-G: Sprayable rust preventative grease	<i>Offers up to 1 year* of outdoor protection and up to 5 years* indoors</i>	Sprayable rust preventative that protects solar panel support structures and fasteners.
	Axxatec™ 85-F: Fogging, Water-based rust preventative liquid designed for fogging and spraying applications	<i>Up to 5 years* in hermetically sealed spaces</i>	VCI technology to protect hard-to-reach voids within an enclosed space, fogging into complex steel assemblies or components with voids and chambers
	Axxatec™ 87-M: Fogging, Multimetal compatible Water-based rust preventative liquid designed for fogging and spraying applications	<i>Up to 5 years* in hermetically sealed spaces</i>	
Battery Enclosures, Electrical Enclosures	Vapor Capsules: Prevent rust and corrosion in battery storage systems and electrical enclosures.	<i>Offers up to 1 year* of outdoor protection and up to 2 years* indoors</i>	Prevent rust and corrosion in battery storage systems and electrical enclosures.
	Axxanol™ 718-ESS: Electrical corrosion inhibitor spray	<i>Indoor and short-term outdoor protection</i>	Solvent completely evaporates, leaving a protective film that does not modify the conductivity of electronic components

These examples demonstrate effective strategies to protect critical power plant components from corrosion during both operational use and periods of shutdown or layup. While specific systems are highlighted, many components and protection methods are relevant across multiple types of power plants.

Broader corrosion management solutions—such as lubrication, rust removal, and storage maintenance—can also be applied across various equipment and power plant types.

For more technical details, consult the Product Resources section starting on page 7, Scan the product QR code to access the appropriate Technical Data Sheet.

ADDITIONAL PROTECTION

With Lubrication:



Technology	Protection Duration	Purpose	QR for TDS
Axxanol™ 758-NV: Oil based, non-staining rust preventative.	<i>Up to years[†] for indoor assets in ZERUST® packaging</i>	Replace standard oil in dipping application, compatible with most engine oil lubricants	
Axxanol™ 710C: Corrosion-inhibitor oil additive	<i>In a closed system it is up to 5 years[†]</i>	Provides corrosion protection of metal surfaces within the void spaces of closed systems	
Axxanol™ 707C: VCI concentrated oil additive	<i>In a closed system it is up to 2 years[†]</i>	Vapor corrosion inhibitor concentrate specially designed for use with lubricating oils	

For Rust Removal:



Technology	Application	Purpose	QR for TDS
AxxaClean™ 2048: Oil based, non-staining rust preventative.	Immersion, Spray-on, Brush-on	Moderate-acting (nonhazardous) safe rust remover designed to eliminate medium rust and tarnish, even in the most hard-to-reach cracks and crevices	
AxxaClean™ 3048: Corrosion-inhibitor oil additive	Immersion, Brush-on	Rapid-acting industrial rust remover designed to eliminate heavy corrosion and tarnish	
AxxaClean™ ICT®625-RR: Chelating rust remover	Immersion	It is pH-neutral, acid-free chelating rust remover recovers mildly to moderately rusted ferrous parts	

For Storage & Shipping:



Technology	Protection Duration	Purpose	QR for TDS
VCI Packaging Film: Poly packaging film manufactured with added VCI chemistry	<i>Protects clean metals for years[†] when used correctly</i>	Vapor Corrosion Inhibitor packaging film interrupts the electrochemical corrosion process. A range of metal protection types are available, as well as acid-gas scavenging technology and additives such as ESD and UV protection can be incorporated	

PRODUCT RESOURCE

Technology	Protection Time	RoHS/REACH compliance	QR for TDS
AxxaClean™ Rust Removers: 	<p>Dependent on specific product.</p> <p>Range of technologies, from pH-neutral products to more aggressive products offered.</p>	<p>Dependent on specific product.</p> <p>Range of technologies, from pH-neutral products to more aggressive products offered.</p> <p>For more information, contact us!</p>	
Axxanol™ 707C: 	<p>Closed system† Up to 2 years</p>	<p>Compliant with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.</p>	
Axxanol™ 718-ESS: 	<p>Suited for in-service use, and intended for indoor and short-term outdoor protection</p>	<p>See Safety Data Sheet (SDS) section 7 for safe handling recommendations.</p>	
Axxanol™ Spray-G: 	<p>Offers up to 1 year† of outdoor protection and up to 5 years† indoors</p>	<p>Does not contain solvent, is non-flammable, and complies with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.</p>	
Axxatec™ 85-F: 	<p>Up to 5 years† in hermetically sealed spaces</p>	<p>Does not contain solvent, is non-flammable, and complies with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.</p>	
Axxatec™ 87-M: 	<p>Up to 5 years† in hermetically sealed spaces</p>	<p>Compliant with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.</p>	
Axxanol™ Z-Maxx: 	<p>Offers up to 1 year† of outdoor protection and 3 years† indoors.</p>	<p>Compliant with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.</p>	

PRODUCT RESOURCE

Technology	Protection Time	RoHS/REACH compliance	QR for TDS
AxxaVis™ HST-10: 	Deactivates ionic contaminants in testing water-Supports the use of hard water, preventing rust and scale	Compliant with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.	
ICT®510-C VCI Film: 	Protects clean metals for years* when used correctly.	Manufactured with at least 10% recycled plastic, helping support environmental compliance requirements and meet global sustainability expectations	
ICT®510-OPS Shrink Film: 	Offers up to 5 years* of UV and corrosion resistance.	Manufactured with at least 10% recycled plastic, helping support environmental compliance requirements and meet global sustainability expectations	
Rust Preventative Coating: 	Varies, dependent on specific product. Protective coating varies from (dry-to-the-touch, oily, semi-hard, or soft) depending on the product used	Dependent on specific product. Axxanol™ Anti-Corrosion Oils or AxxaCoat™ Solvent-Based Outdoor Rust Preventatives For more information, scan the QR or Contact us!	
Vapor Capsules (VC 2-1, 2-2, 6-1, and 6-2) 	1 or 2 years* dependent on model	This product does not pose a health hazard to users due to its classification as an article according to UN GHS, US OSHA HazCom, and CA WHMIS regulations. Check REACH SDS for classification in EU.	
Vapor Capsules (ZAK-M22): 	Protects multiple metal types from rust and tarnish for up to 2 years*, depending on the environment, in a sealed enclosure.	This product does not pose a health hazard to users due to its classification as an article according to UN GHS, US OSHA HazCom, and CA WHMIS regulations. Check REACH SDS for classification in EU.	

The Z-CIS® Approach

Corrosion failures in power generation facilities rarely result from a single isolated issue. Instead, they stem from interconnected risks across fabrication, storage, hydrostatic testing, commissioning, outage cycles, layup, and long-term operation.

Applying isolated corrosion products without evaluating the full asset lifecycle often leads to incomplete protection, recurring maintenance issues, forced outages, and premature equipment degradation.

To address this, ZERUST® developed Z-CIS® (ZERUST® Corrosion Inhibiting System), a structured, engineering-driven methodology that identifies corrosion risks and applies the right combination of technologies to eliminate them.

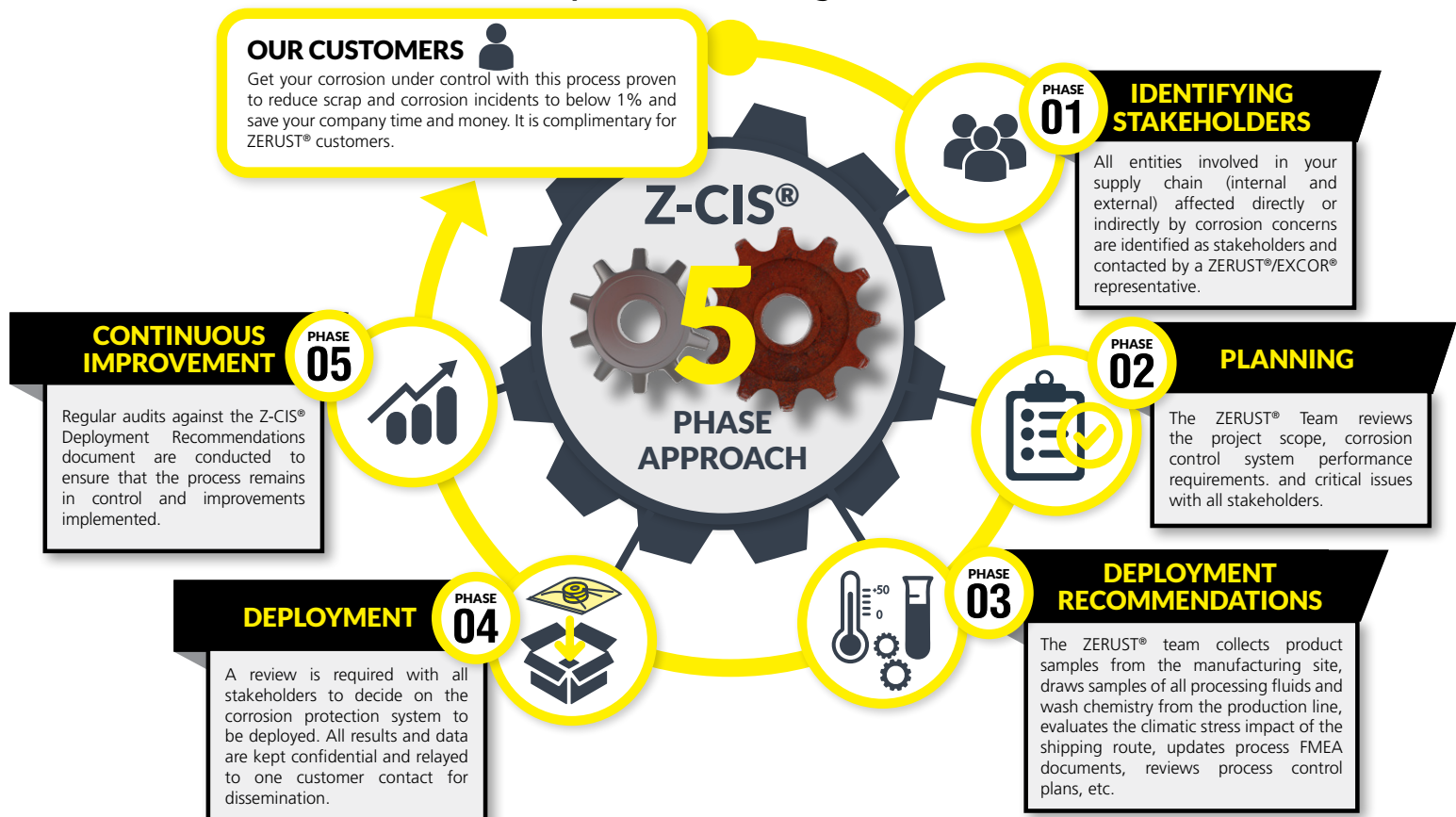
What Is Z-CIS®?

Z-CIS® is a holistic corrosion management framework that integrates:

- Risk assessment
- Product selection
- Process optimization
- Validation and ongoing improvement

Rather than selling a single product, ZERUST® delivers a complete corrosion protection system, customized to your facility type, asset class, and operational environment.

Z-CIS® ensures corrosion protection is designed in, not reacted to later.



Powering Reliability Through Corrosion Control

For over 50 years, ZERUST® has helped power producers protect high-value assets in demanding environments. From turbines and condensers to electrical enclosures and balance-of-plant equipment, our solutions are designed to reduce corrosion-related downtime and extend equipment life.

What Sets ZERUST® Apart

Industry-Proven Technology

ZERUST® VCIs are used worldwide in:

- Thermal and combined-cycle plants
- Hydroelectric facilities
- Wind and solar farms
- Geothermal and biomass operations

Our technologies protect metals at the molecular level, reaching areas that coatings and oils cannot.

Complete Corrosion Solutions

Unlike single-product suppliers, ZERUST® offers:

- VCI films, papers, bags, and shrink wraps
- Fogging powders for voids and tanks
- Water-based inhibitors for testing
- Oil additives and temporary coatings
- Electronics protection systems
- Corrosion management services and trial audits

One supplier. One system. Total corrosion protection.

Environmentally Responsible

ZERUST® products are designed to meet modern environmental standards:

- Nitrite-free options
- RoHS and REACH compliant
- Minimal waste and reduced solvent use

Global Reach, Local Support

With operations and partners in more than 70 countries, ZERUST® provides responsive technical support wherever your power assets operate.

Our experts provide fast, region-specific technical support wherever you operate.

Measurable Cost Savings

ZERUST® customers routinely achieve:

- Reduced forced outages
- Lower maintenance rework
- Faster commissioning after storage or layup
- Extended asset service life

Corrosion prevention isn't a cost, it's an investment!

Certified Quality You Can Trust



Northern Technologies International Corporation (NTIC), the parent company of ZERUST®, is certified to the ISO 9001 Quality Management Standard. This certification reflects our commitment to delivering high-quality corrosion-inhibiting products and services while continuously improving our operations. Through our Quality Management System (QMS), we focus on productivity, innovation, regulatory compliance, and customer satisfaction to support sustainable growth and global excellence.

Global Support

For a Custom Corrosion
Management Plan
Contact ZERUST®



ZERUST.COM
CONTACT PAGE

Algeria	Denmark	Mexico	Spain
Angola	Ecuador	Monaco	Sri Lanka
Argentina	Estonia	Morocco	Sweden
Australia	Finland	Nepal	Switzerland
Austria	France	Netherlands	Taiwan
Bangladesh	Gabon	Nigeria	Thailand
Belarus	Germany	Norway	Tunisia
Belgium	Hungary	Peru	Turkey
Bhutan	India	Philippines	Ukraine
Bolivia	Indonesia	Poland	United Arab
Brazil	Ireland	Portugal	Emirates and
Canada	Italy	Republic of	MENA
Chile	Japan	Congo	(Middle East &
China	Kazakhstan	Romania	North Africa)
Colombia	Korea	Singapore	United
Czech	Latvia	Slovak	Kingdom
Republic	Lithuania	Republic	United States
Democratic	Luxembourg	Slovenia	Uruguay
Republic of	Malaysia	South Africa	Vietnam
the Congo			

Visit www.zerust.com for more
information!

Northern Technologies International Corporation

ZERUST® Business Unit | Corporate Office

4201 Woodland Road, P.O. Box 69

Circle Pines, MN 55014 USA

Toll-Free: 1-800-328-2433 | Phone: 1-763-225-6600

For expert ZERUST® support:

**Call, send email for products, applications, SDS,
pricing, shipping, and other inquiries.**

sales@zerust.com | www.zerust.com

REFERENCES

NACE International. (2016). *The International Measures of Prevention, Application, and Economics of Corrosion Technologies (IMPACT) Report*. NACE International.

International Energy Agency. (2024). *World Energy Investment 2024*. <https://www.iea.org/reports/world-energy-investment-2024>

International Organization for Standardization (ISO). (2012). *ISO 9223: Corrosion of metals and alloys — Corrosivity of atmospheres — Classification, determination, and estimation*.

Sousa, M. L., Dimova, S., Athanasopoulou, A., Rianna, G., Mercogliano, P., et al. (2020). *Expected implications of climate change on the corrosion of structures* (EUR 30091 EN). European Commission, Joint Research Centre. <https://hal.science/hal-04544233>

Firdaus, muhammad. (2023). *Analysis of the Effects of CO₂, H₂S Composition, and Temperature on Steam Towards Corrosion Rate in Geothermal Power Plants*. Journal of Energy, Material, and Instrumentation Technology. 4. 163-168. 10.23960/jemit.v4i4.215.

* DECLARATION

Corrosion protection claims are based on Northern Technologies International Corporation (NTIC) internal laboratory testing performed under controlled parameters on contaminate-free substrates. Real-world application corrosion protection duration on different substrates will vary and depends on factors such as, but not limited to, the application or use, environmental / storage conditions, surface cleanliness, type of substrates, and coating thickness (where applicable). The use of the term "Up to" in reference to time is defined as any time duration from zero up to a specified time frame, but in no event beyond the specified time frame. The use of the term "for years" is based on NTIC's experience with its products but is in no way guaranteed. The use of the term "Up to" in reference to volume is defined as any volume from zero up to a specified volume but in no event beyond the specified volume of protection. It is the customer's / user's obligation to evaluate product performance, corrosion protection duration, safety, and suitability for intended use within the scope advised in the data sheet and to comply with all applicable laws and regulations. **LIMITED WARRANTY/DISCLAIMER** Warranty is limited to the replacement of a product that fails to meet specifications. For full warranty and disclaimer information, visit www.zerust.com/warranty.

©2013-2025 Northern Technologies International Corporation (NTIC). All Rights Reserved. NTIC is the owner of the following trademarks: ActivPak®, Cor Tab®, EXCOR®, Flange Saver®, ICB®, ICT®, Natur-VC®®, NTI®, Plastabs®, Z-CIS®, Zerion®, ZERUST®, 洁乐特, Z-PAK® and the Color "Yellow". ABRIGO®, UNICO®, ICB®, and VALENO® are registered trademarks of EXCOR GmbH, a Joint Venture Partner of NTIC.