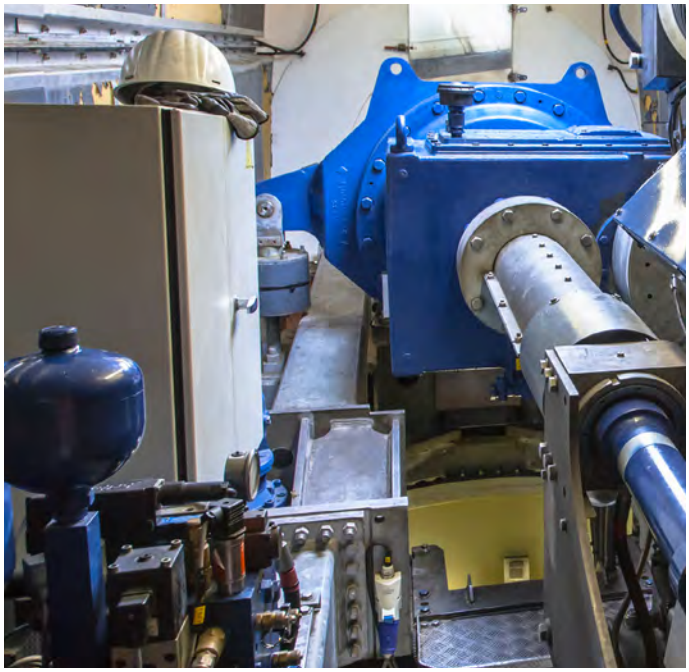
ZERUST® EXCOR®

CORROSION SOLUTIONS FOR THE POWER GENERATION INDUSTRY



ZERUST® is a product of
Northern Technologies
International Corporation

NTI®

WHY CHOOSE ZERUST®?

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

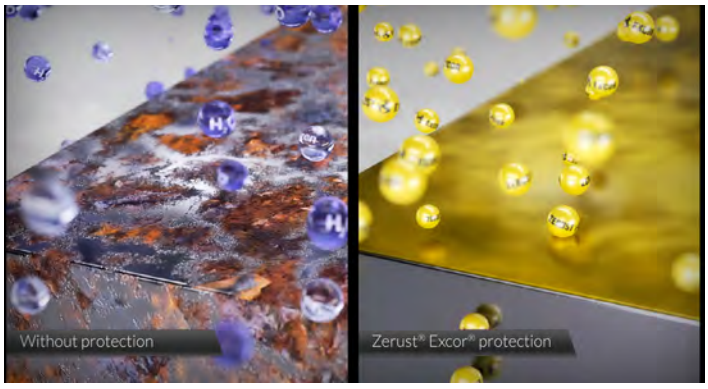
ZERUST® corrosion inhibiting products are a cost-effective way to protect equipment from rust and corrosion in power generation. For over 50 years, ZERUST's proprietary vapor corrosion inhibitor (VCI) technology has been proven safe and effective for protecting metals.An analysis of compatibility using 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 mg/m²/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 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	*Pre-treatment*	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	*Dependent on product*	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.	*Protects sensitive electrical components for up to 2 years‡.*	Neutralizes acidic contaminants
	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

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	*Provides UV and weather-resistant corrosion protection for up to 5 years‡*	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	*Dependent on product*	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.	*Shields metal components from sulfur corrosion and scaling*	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	*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: Fogging, Multimetal compatible Water-based rust preventative liquid designed for fogging and spraying applications	*Up to 5 years‡ in hermetically sealed spaces*	

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 2 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

Component Protected	*Technology*	*Protection Duration*	*Purpose / Risk Addressed*
Gearboxes, Bearings, Engines, Hydraulic Systems, Turbine Housing	**Axxanol™ Z-Maxx:** Heavy-duty anti-corrosion grease	*Up to 1 year‡ outdoors for up to 3 years‡ for indoor assets*	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	*Offers up to 1 year‡ of outdoor protection and up to 2 years‡ indoors*	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	*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: Fogging, Multimetal compatible Water-based rust preventative liquid designed for fogging and spraying applications	*Up to 5 years‡ in hermetically sealed spaces*	
Battery Enclosures, Electrical Enclosures	**Vapor Capsules:** Prevent rust and corrosion in battery storage systems and electrical enclosures.	*Offers up to 1 year‡ of outdoor protection and up to 2 years‡ indoors*	Prevent rust and corrosion in battery storage systems and electrical enclosures.
	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

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 maintanence—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.	*Up to years‡ for indoor assets in ZERUST® packaging*	Replace standard oil in dipping application, compatible with most engine oil lubricants	
Axxanol™ 710C: Corrosion-inhibitor oil additive	*In a closed system it is up to 5 years‡*	Provides corrosion protection of metal surfaces within the void spaces of closed systems	
Axxanol™ 707C: VCI concentrated oil additive	*In a closed system it is up to 2 years‡*	Vapor corrosion inhibitor concentrate specially designed for use with lubricating oils	

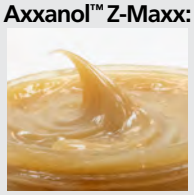
For Rust Removal:

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	

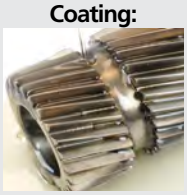
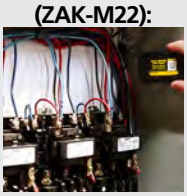
For Storage & Shipping:

Technology	*Protection Duration*	*Purpose*	*QR for TDS*
VCI Packaging Film: Poly packaging film manufactured with added VCI chemistry	*Protects clean metals for years‡ when used correctly*	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: 	Dependent on specific product. Range of technologies, from pH-neutral products to more aggressive products offered.	Dependent on specific product. Range of technologies, from pH-neutral products to more aggressive products offered. For more information, contact us!	
Axxanol™ 707C: 	Closed system‡ Up to 2 years	Compliant with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.	
Axxanol™ 718-ESS: 	Suited for in-service use, and intended for indoor and short-term outdoor protection	See Safety Data Sheet (SDS) section 7 for safe handling recommendations.	
Axxanol™ Spray-G: 	Offers up to 1 year‡ of outdoor protection and up to 2 years‡ indoors	Does not contain solvent, is non-flammable, and complies with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.	
Axxatec™ 85-F: 	Up to 5 years‡ in hermetically sealed spaces	Does not contain solvent, is non-flammable, and complies with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.	
Axxatec™ 87-M: 	Up to 5 years‡ in hermetically sealed spaces	Compliant with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.	
Axxanol™ Z-Maxx: 	Offers up to 1 year‡ of outdoor protection and 3 years‡ indoors.	Compliant with Global Automotive Declarable Substance, TSCA, ECHA SVHC, RoHS, and REACH requirements.	

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.	

For a Custom Corrosion Management Plan Contact ZERUST®

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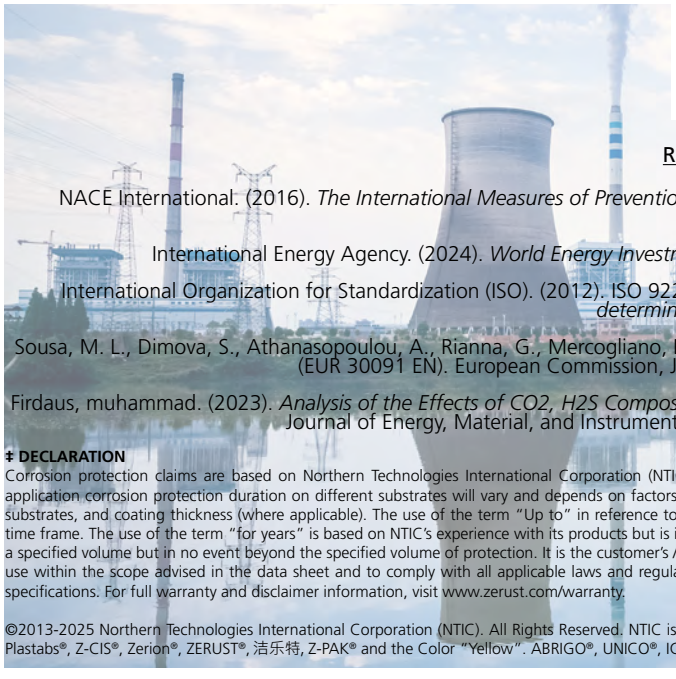

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‡ DECLARATION
Corrosion protection claims are based on Northern Technologies International Corporation (NTIC) internal laboratory testing performed under controlled parameters on contaminate-free substrates. Real-world application corrosion protection 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.