KINECTRICS
a BWXT company

Condition Assessment and Monitoring of Overhead Lines

Enhancing Safety, Reliability, and Longevity Through Stress Analysis and Asset Condition Monitoring

One-stop-shop testing services with experts across multi-professional service backgrounds in **T&D**

Assessing Loads & Stresses

1. Tower Vibration Monitoring
2. Conductor Vibration Monitoring
3. Insulator Pollution Monitoring
4. Thermal Imaging
5. Corona Inspection

Assessing Strength & Integrity

6. Steel Core Inspection using LineVue® & AI Reporting
7. Visual Inspection of Conductors and Hardware
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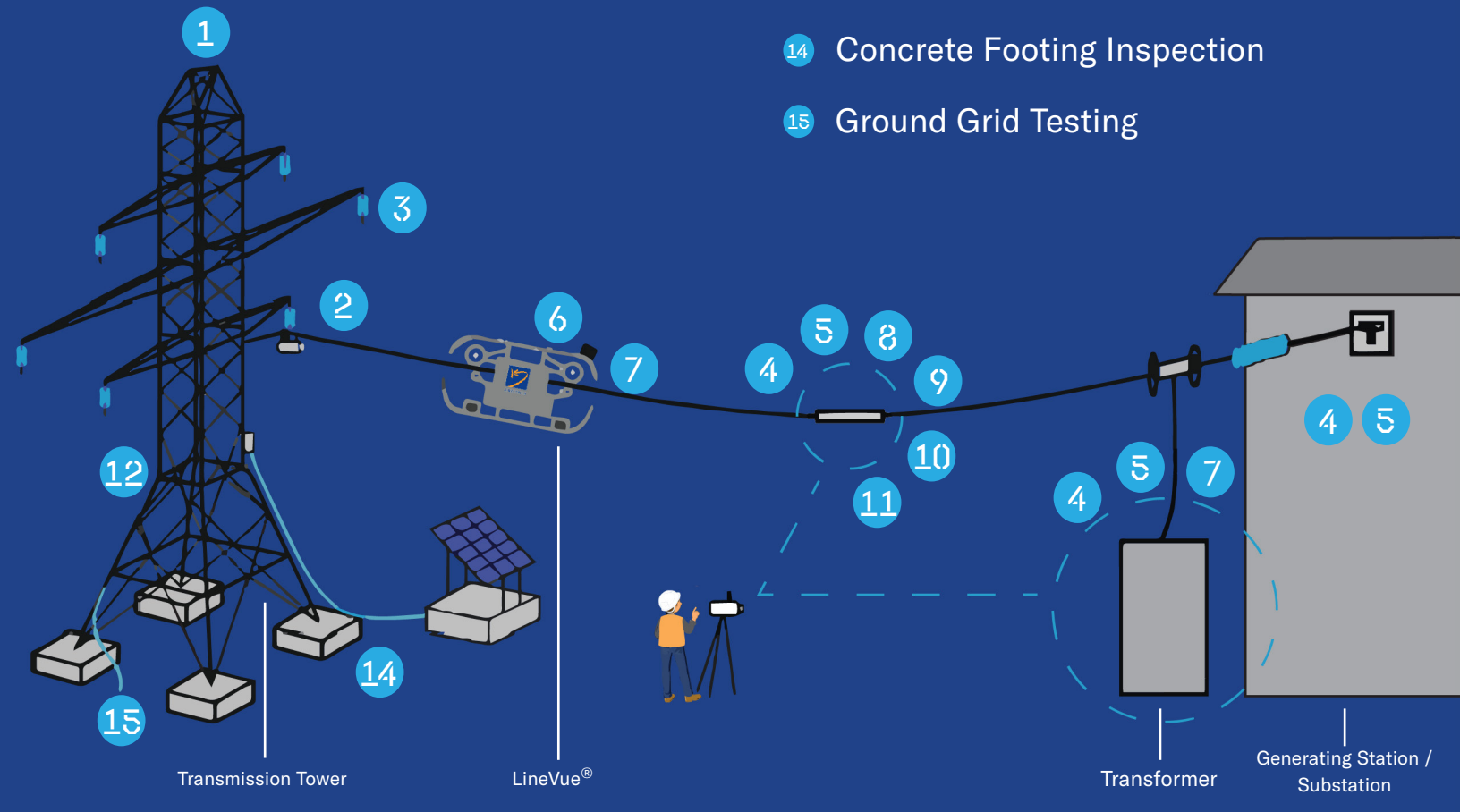
9. Borescope Testing of Connectors
10. X-Ray Imaging
11. Assessment of Electrical Connectors
12. Steel Structure Inspection
13. Wood Pole Inspection
14. Concrete Footing Inspection
15. Ground Grid Testing

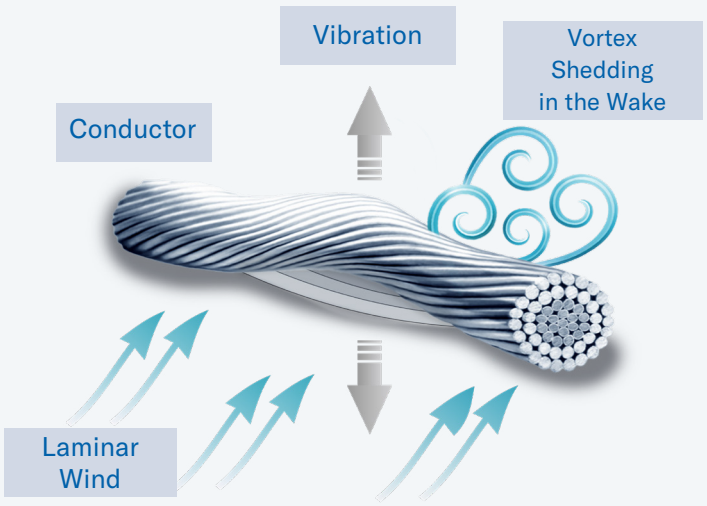


Assessing Loads and Stresses

Vibration Monitoring

Aeolian vibration, a wind-induced phenomenon, occurs when air currents interact with cylindrical structures such as conductors and towers, leading to alternating vortices and resulting in cyclic lateral forces.

These forces cause vibrations that are particularly intense in open, flat terrains, **posing a significant risk to the structural integrity of conductors and towers**.



Why is Vibration Monitoring Essential?

- **Prevents Catastrophic Failures:** Identifies risks like collapsed towers and downed power lines before they lead to blackouts and costly lawsuits
- **Protects the Environment:** Helps avoid environmentally destructive outcomes
- **Saves Costs:** Averts incidents that can cost utility companies millions

1 Tower Vibration Monitoring

Vibration of tower structures causes metal fatigue in the members of the structure, leading to damaged or downed towers, long term power disruption or the inability to energize newly built lines.

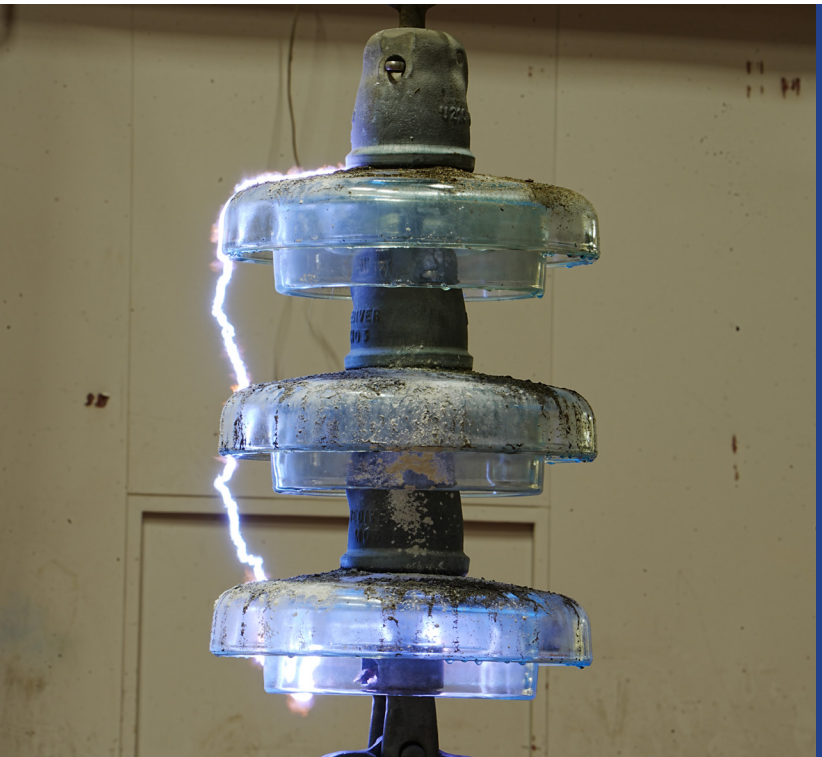
Kinectrics provides an eco-friendly, real-time vibration monitoring system for towers, ensuring safety and reliability by analyzing stress and load in windy conditions.

Operating autonomously in remote locations, our system harnesses wind and solar power to wirelessly transmit data, maintaining stress levels within secure limits through precise model comparisons.

2 Conductor Vibration Monitoring

Vibration-induced fatigue can initiate cracks in aluminum conductors, especially at points of changing bending stiffness, such as clamp locations.

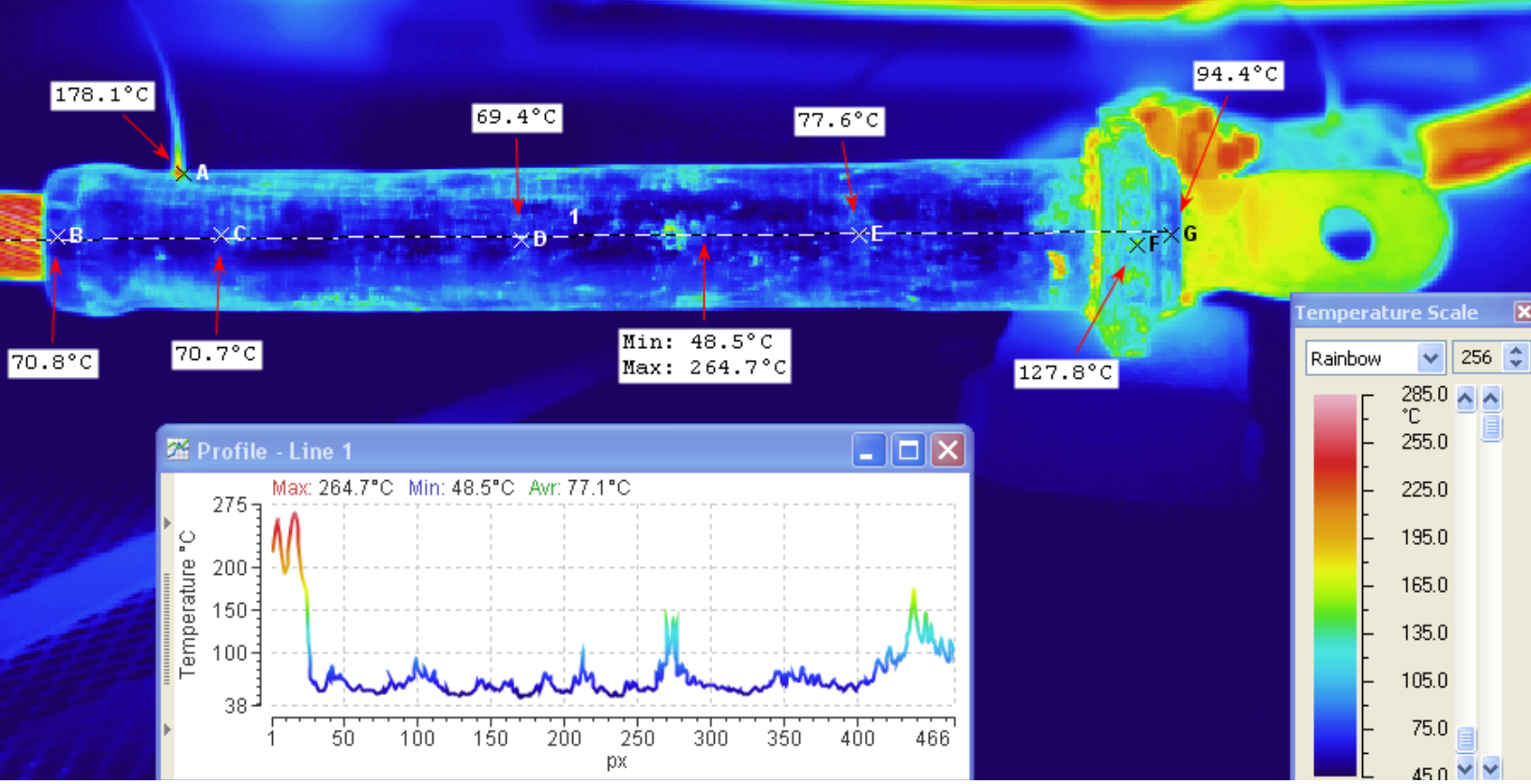
Kinectrics' advanced monitoring assesses conductor stress levels under various wind conditions. By aligning our findings with industry standards, we provide insights into the effectiveness of vibration mitigation devices and advise on necessary actions to maintain conductor integrity.



3 Insulator Pollution Monitoring

Insulators are vulnerable to deposit accumulation due to environmental exposure, which can lead to dangerous arcing incidents.

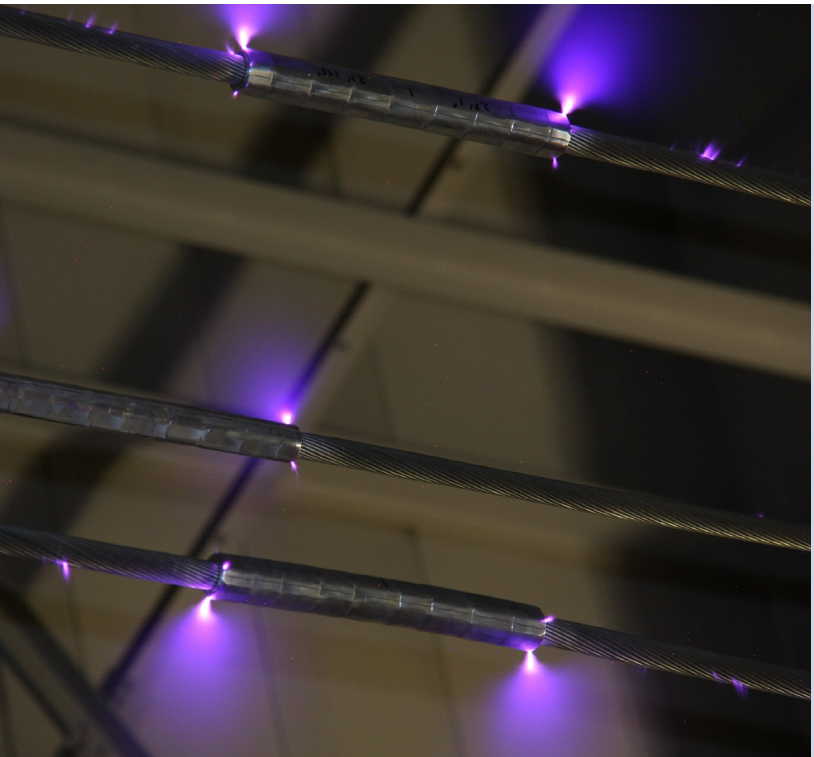
Through meticulous pollution monitoring, **we collect detailed data on various deposit types and environmental factors**, enabling the precise selection of insulators with the necessary specifications to mitigate arcing risks and ensure operational safety.



4 Thermal Imaging

The quality of electrical connections in connectors deteriorates over time, leading to increased resistance and heat loss, which can cause connector failure and pose a danger to substation personnel.

Thermal imaging is an efficient method for measuring the surface temperature of overhead lines and connectors within a substation. **Kinectrics can perform thermal infrared imaging with an accuracy of 1°C, using ground-based equipment, bucket trucks, or helicopters, depending on the accessibility of the connectors.**



5 Corona Inspection

Corona discharge occurs in electrically overstressed regions near high voltage transmission lines, causing issues like audible noise, radio & TV interference, and system losses.

Kinectrics uses corona cameras and other methods to detect this invisible phenomenon in real-time. Our experts analyze the data and recommend repairs, component replacements, or further laboratory tests as needed.

Assessing Strength and Integrity

6 Steel Core Inspection Using LineVue® and AI Reporting

Aging transmission and distribution lines, pose unknown deterioration risks. Assessing their condition is crucial for maintaining power reliability and safety. Kinectrics LineVue® offers an economical way to evaluate the steel core of conductors, aiding utilities in asset management and potentially avoiding costly replacements.

Transmission LineVue®

- **Quickly assesses** the steel core's condition
- Supports electric utilities in creating a reliable health index for **informed capital decisions** and e**nhanced safety**
- **Easily portable** and installable by line crews
- **Non-destructive** tool for inspecting both **energized (up to 500kV)** and de-energized lines

Modular LineVue®

- Inspects **both transmission and distribution** conductors
- Features a **modular system** including drive, sensor, and recovery modules
- **Single operator** can easily lift and install, and **two drive modules** enhance sensor use via leapfrogging
- **Robust recovery system** for guaranteed retrieval of LineVue® during emergencies

LineVue® Recovery Unit

- Designed for **rescuing stranded LineVue®** on hard-to-reach conductors
- Operates manually with **tethered rope** or automatically, ideal for energized line recovery
- Recovery unit **navigates to LineVue®**, attaches via catch mechanism, and disengages brakes for retrieval

Distribution LineVue®

- Utilizes **the same technology** as the transmission LineVue®
- **Smaller and lighter** in design
- **Precision sensor head** tailored for distribution conductors
- Includes an **on-board camera** for inspecting the conductor's exterior

Installation Methods

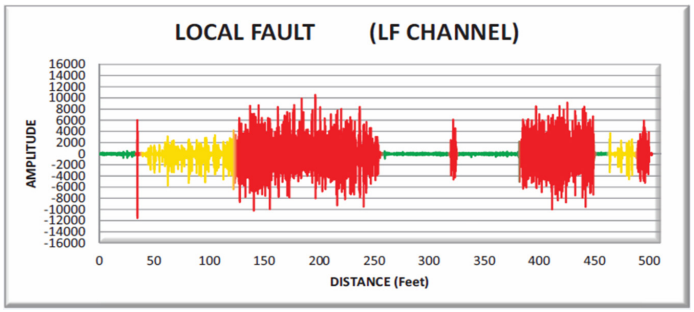
- Bucket Truck
- Helicopter
- Rope and Ladder
- Hot Sticks

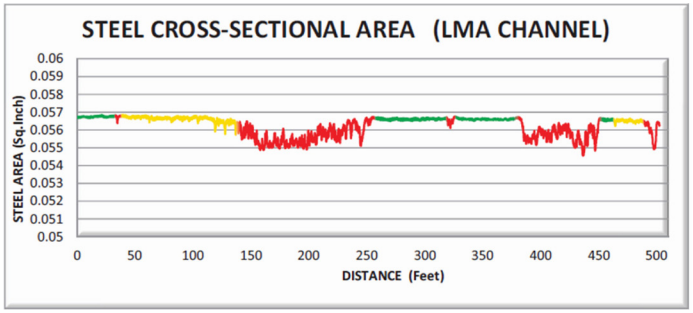
Inspection Results

LineVue® efficiently measures the steel core's cross-section and detects breaks or corrosion in conductors. It works on-site for both energized and de-energized lines.

The graphs included in the report illustrate the conductor condition, with green (good), yellow (moderate corrosion), and red (severe corrosion) shown here for illustration purposes.

Alongside the graphs, the report also provides the remaining Rated Tensile Strength (RTS) of the steel core. This measured RTS value indicates how much mechanical strength remains after accounting for corrosion-related material loss. It is a critical factor in evaluating the conductor's structural integrity and estimating its remaining service life.





AI Reporting

Kinectrics has integrated Artificial Intelligence (AI) and Machine Learning (ML) with its LineVue® device to enhance data analysis. This advanced technology filters out noise, minimizes human oversight, and autonomously selects optimal algorithms for data interpretation. The result is a faster, more reliable, and error-free data reporting process.

7 Visual Inspection of Conductors and Hardware

Visual examinations provide an overall integrity assessment at close proximity. These inspections are performed using a high-resolution camera system combined with AI-based image processing to enhance detection accuracy and consistency. During a visual inspection, several key parameters are assessed, such as:

- Signs of overheating
- Cracking
- Damage
- Wear
- Corrosion
- Discolouration
- Conductor bird caging or popped strands

Table 1 – LineVue® Device Specifications

Parameter	Transmission	Distribution	Modular
Dimensions	L = 90cm, W = 35 cm, H = 53cm (35” x 14” x 21”)	L = 61cm, W = 38 cm, H = 32cm (24” x 15” x 13”)	L = 55cm, W = 34 cm, H = 46cm (22” x 14” x 18”)
Weight	31 kg (68lb)	20 kg (45 lb)	Max 22.6 kg (50lb) (includes drive module and sensor module) Sensor Module: 11.3kg (25lb) Drive Module: 11.3 kg (25 lb)
Diameter of Conductor	15mm-45mm (0.59in-1.77in)	6mm-19mm (0.24in-0.75in)	14mm-29mm (0.55in-1.14in)
Voltage	Designed Voltage – to 765 kV Tested Voltage – to 500 kV	Designed and tested to 120 kV	De-Energized Only
Sensors	Loss of Metallic Area (LMA) – Measures average of the remaining cross-sectional area of all steel core wires over ~0.75m (2-3 ft) length with better than +/- 5% accuracy. Local Flaw (LF) – Indicator which detects local flaws such as pitting or broken steel wires. Sensing head gathers 5 sample readings per inch (one reading every 5.08mm or 0.2 inch)		
Speed	Approximately 40 m/min (130 ft/min)		
Operating Temperature	-20°C to 45°C (-4°F to 113°F)		
Operating Weather Conditions	Up to moderate rain and snow (i.e. 7.6 mm/hr or 1 km of visibility, 0.3 in/hr or 0.62 mi)		
Power Supply	Two (2) 12V nickel metal hydride batteries		
Computer Battery Run Time	Up to moderate rain and snow (i.e. 7.6 mm/hr or 1 km of visibility, 0.3 in/hr or 0.62 mi)		
Motor Battery Run Time	Three (3) ~300 m (1,000 ft) spans on one charge (i.e total of 1,800 m or 6,000 ft as LineVue® travels in forward and reverse). This distance is approximate and depends on the inclination of the spans.		
Data Transmitters	Data and control signals telemetered to ground based laptop in real time. Guaranteed minimum range of 1 kilometer (0.62 miles). Tranceivers are 2.4 GHz.		
On-board Memory	~ 2 Gigabytes (Gb)		
Additional Features	High definition camera and recoverable – Optional recovery system for fail safe operation	High definition camera	High definition camera and recoverable – optional recovery system (with belays) for fail safe operation)

Connector Inspection

In electrical systems, connectors are vital for reliability. However, they are vulnerable to corrosion, improper installation, and manufacturing defects, which can lead to failures or compromised power supply reliability. Since connector issues are not readily apparent, regular inspection and testing are crucial.

8 Borescope Testing of Connectors

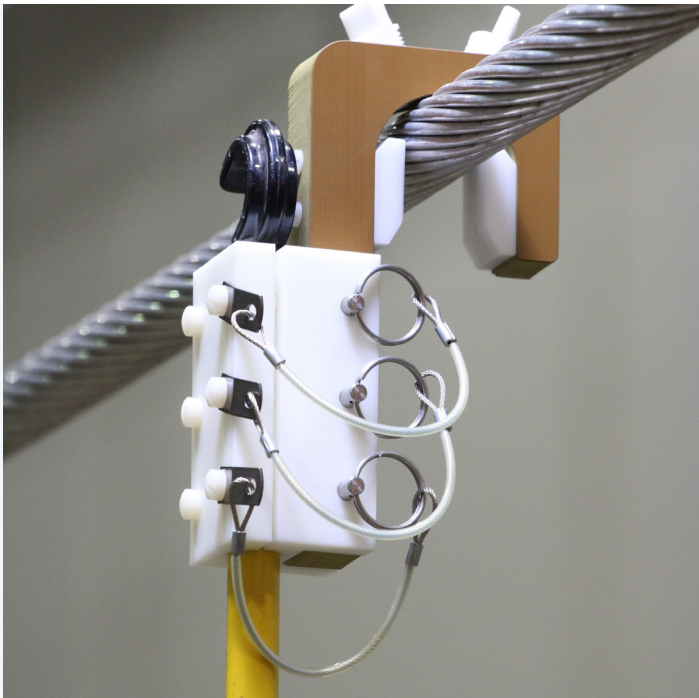
Over time, corrosion can begin to occur inside connectors, and the grease of the connector can begin to deteriorate.

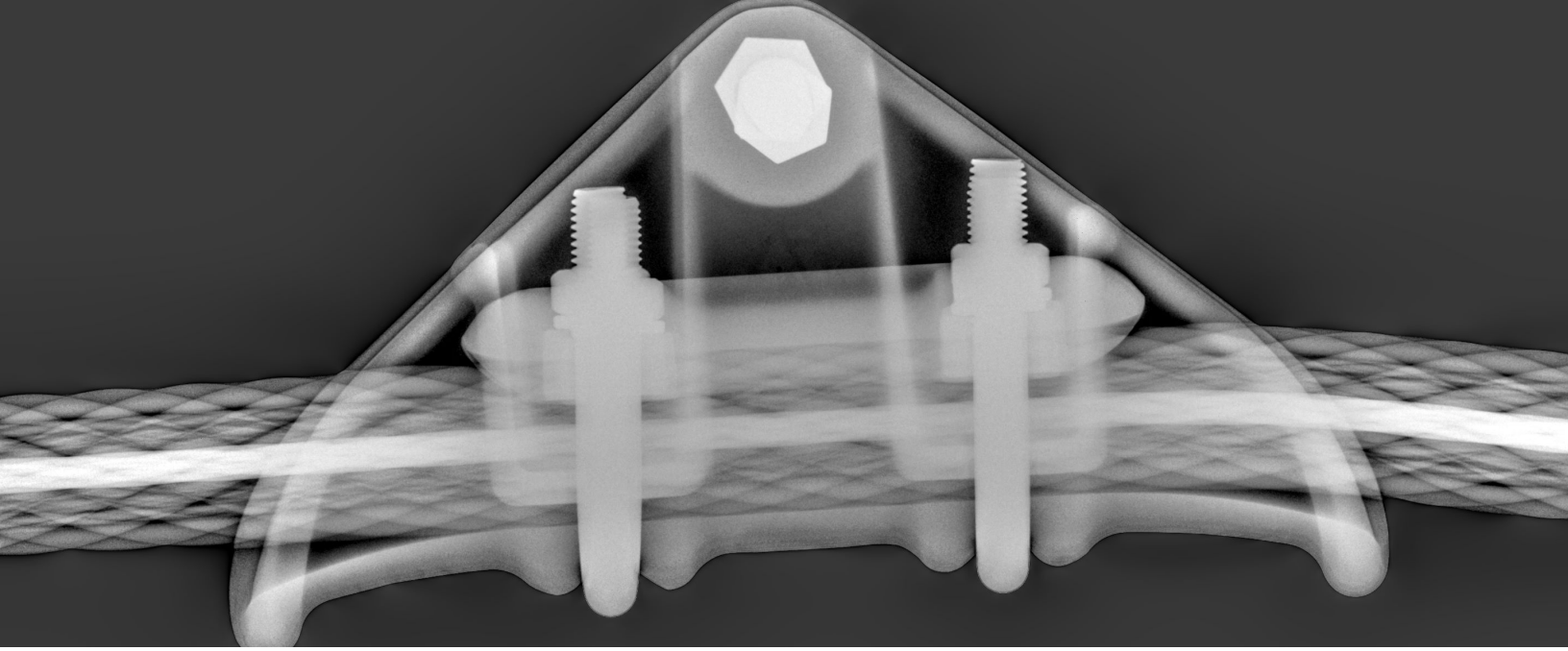
Using a Borescope, **Kinectrics can visually inspect inside the sleeve of the connector** to assess the level of corrosion and condition of the grease. We can perform the test with either a 3.5mm or 8.5mm diameter lens, requiring only a small access hole, making it a minimally invasive procedure.

9 Direct Temperature Measurement of Connectors

Direct temperature measurement is a straightforward and reliable method for assessing the temperature of a connector. This technique involves using a hot stick to place a temperature probe directly on the connector.

Kinectrics' experts analyze the collected temperature data and offer clients recommendations for replacement or remedial actions if necessary.

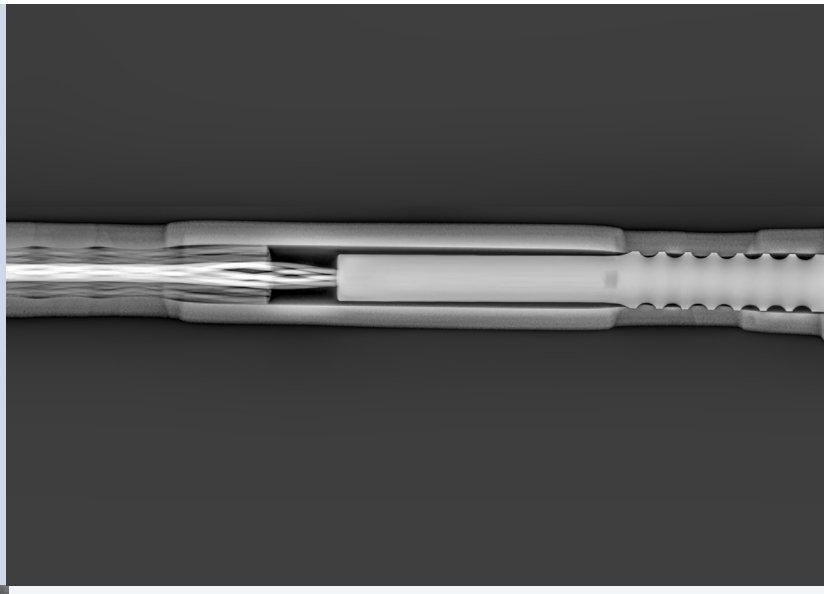




10 X-Ray Imaging

Improper connector installation can increase electrical resistance and lead to energy loss. X-Ray imaging allows utilities to inspect beneath steel and aluminum sleeves to verify installation quality before energizing the line, helping avoid costly mistakes.

Kinectrics' X-Ray system uses a pulsed generator and digital detector, with no radioactive components. It's wireless and can be deployed via helicopter or bucket truck, depending on site accessibility.



X-ray inspections of substation bus ends, suspension clamps and insulators offer a non-invasive way to detect hidden issues such as internal corrosion, cracks, improper installation, voids, or manufacturing defects that are not visible using standard visual inspections.

This techinique enables early problem detection, enhances safety, and supports preventive maintenance with minimal downtime. It also offers visual records to guide repairs and maintain connection integrity.

11 Assessment of Electrical Connections

Electrical connectors can suffer from increased resistance due to corrosion, unclean conductors, and improper installation. This heightened resistance leads to greater energy losses and necessitates verification against industry standards.

Kinectrics offers **AC Resistance Test** and **DC Resistance Test** to ensure that the connectors conform to resistance specifications, thereby maintaining the electrical system's performance and safety.

AC Resistance Test

- Simplest indicator of the condition of a connector at operating temperature
- Performed with a hot stick on a live line
- Does not require an outage
- We perform this test on up to 500kV lines with current values between 100-1400A

DC Resistance Test

- Performed on a de-energized line if readings on an energized line are not possible
- Uses a custom DC micro-ohmmeter
- Provides consistent and accurate results using pass/fail criteria

25+ Unique laboratory and testing facilities worldwide

1,300+ Engineers and technical experts

30+ Years providing lifecycle management services for the electricity industry

12 Steel Structure Inspection

Steel structures, much like conductors, are prone to corrosion over decades. The degradation of the galvanized zinc coating on structural members is a critical issue. Identifying areas with reduced galvanization is essential to prevent the onset of corrosion, which could compromise the structure's integrity.

We address this challenge by:

- Conducting zinc galvanized coating thickness measurements to pinpoint areas at risk.
- Providing detailed images of the structure, enabling clients to undertake necessary repairs.
- Offering drone imaging services for hard-to-reach spots, ensuring a comprehensive assessment of the structure's condition.

In addition to corrosion inspections of steel structures, Kinectrics also inspect structures and hardware for damage or wear, and perform residual torque measurements of tower bolts to identify loose bolts.

13 Wood Pole Inspection

Wood poles in grid systems are susceptible to damage and decay, which can be costly to replace.

Kinectrics helps to extend the life of wood poles through comprehensive inspection services:

- Sounding
- Visual assessment below groundline
- Damage and decay assessment
- Density measurements

14 Concrete Footing Inspection

The stability and strength of tower structures depend on the condition of their concrete footings. Over time, issues such as voids, de-laminations, and degradation can affect the concrete's integrity.

Kinectrics offers a suite of **non-destructive and laboratory tests** to evaluate concrete footings, including:

- Visual examination
- Sounding
- Rebound hammer
- Ultrasonic pulse velocity
- Pull tensile testing
- Carbonation
- Alkali aggregate reaction
- Compressive strength
- Modulus of elasticity
- Splitting tensile

Clients receive a detailed report with ratings, a reassessment timeline, and repair recommendations for each footing.

15 Ground Grid Testing

At Kinectrics, we conduct thorough safety evaluations of grounding systems, including on-site measurements and integrity checks, followed by modeling to inform future upgrades.

Soil Resistivity Testing

- Equipped with powerful instruments, suitable for areas with high resistivity soil
- Capable of performing long soil surveys (up to 1000ft spacing)
- Soil model interpretation by certified and experienced users

Integrity Testing

- Ensuring the integrity of all underground ground conductors
- Checking the integrity of the station fence
- Identifying equipment with broken bonds to the grounding system
- Reporting missing/stolen ground connectors

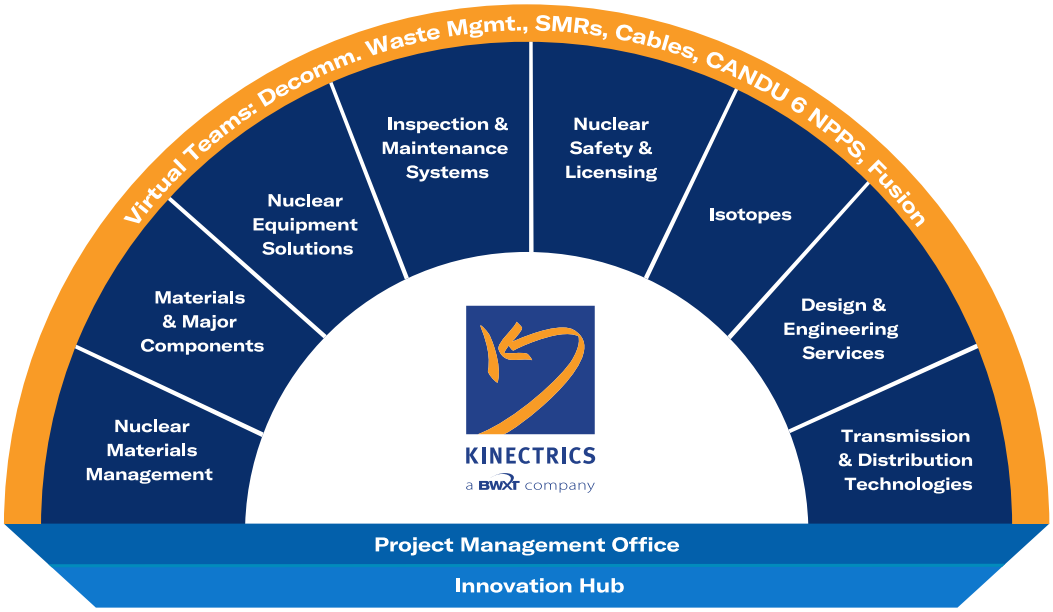
Current Injection Testing

- Simulates fault conditions using off-frequency current injection tests (CIT)
- Measures grounding impedance, current split factors, and station rock resistivity
- Capable of using de-energized phase conductors for high-power injection.
- Estimates ground potential rise (GPR) and zone of influence (ZOI)

Special Studies

- Induction studies for HV cable installations
- Transient
- Pipeline Coordination
- Electric and Magnetic Field (EMF) coordination and measurements
- Stray voltage measurements

We create **innovative and sustainable solutions** that connect our people, facilities, and customers.



At Kinectrics, we're proud to offer top-tier engineering, testing, inspection, and certification services. Our **state-of-the-art laboratory** and **extensive testing facilities** are complemented by a **versatile array of field inspection equipment** and an **exceptional team** recognized for their excellence.

Working hand-in-hand with our clients, we're committed to ensuring your assets deliver **optimal performance, as well as operate safely and reliably throughout their lifespan**.

With our roots firmly planted in Toronto, Canada since 1912, Kinectrics stands out as a beacon of innovation, home to some of the industry's most talented professionals.

Our unparalleled expertise and specialized facilities are dedicated to providing comprehensive condition assessment and asset management services. We're the trusted choice for a growing global network of energy providers and utilities, helping them power the world with confidence.

Let's work together!

Contact us to learn more about our Field Services for Overhead Lines

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