



KINECTRICS

Life Cycle Management Solutions for Fiber Optic Networks

Helping you stay connected longer



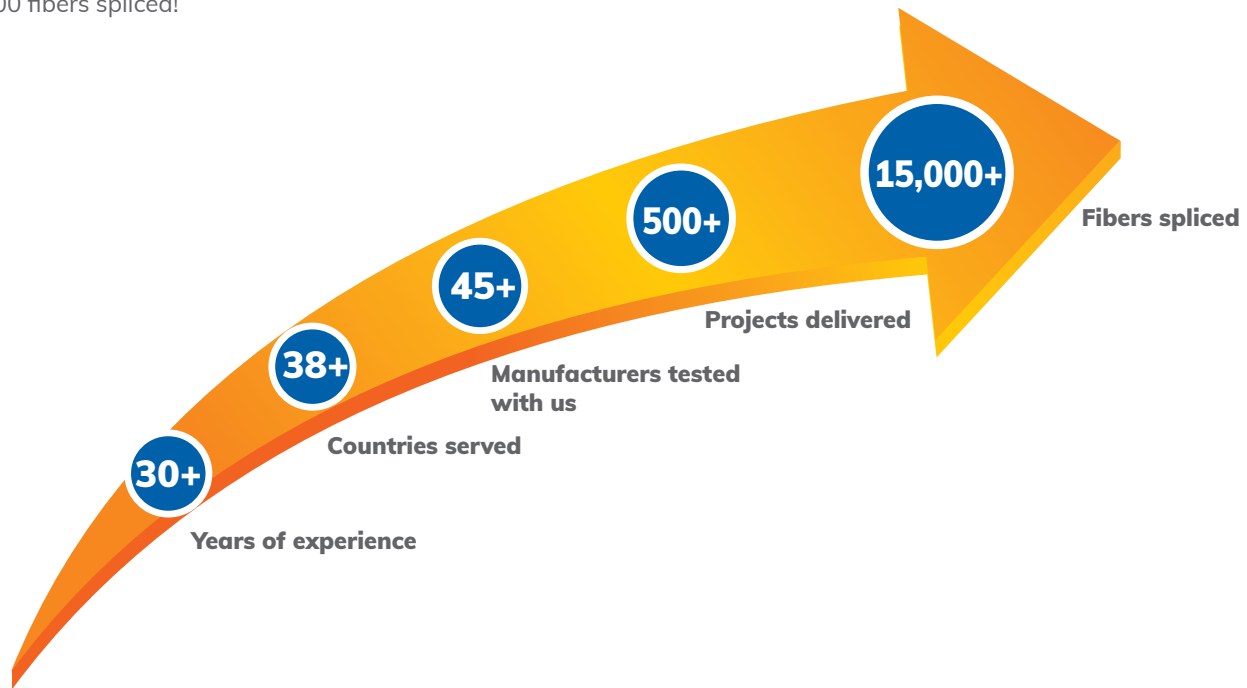
FIBER OPTIC NETWORKS

Fiber optic cable use has experienced tremendous growth worldwide, with installations taking advantage of the existing right-of-ways established by overhead electrical utility transmission lines. Growth has been most notable in regions where long distance, backbone infrastructures are being installed.

Kinectrics is uniquely positioned to provide one-stop-shop testing services for fiber optic cables and hardware.

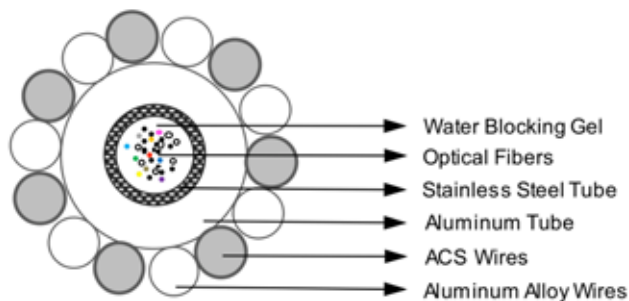
Since the 1990s, Kinectrics has played a key role in the development of industry testing standards for fiber optic cable and hardware and is internationally recognized as a qualified independent authority on laboratory testing.

For over three decades, Kinectrics has been at the forefront of testing fiber optic cables and hardware. We have served over 38 countries and tested with over 45 manufacturers from around the world. We have delivered over 500 projects to qualify high quality products and instill confidence in your fiber optic networks to help you stay connected. This adds up to over 15,000 fibers spliced!



FIBER OPTIC CABLES 101

Fiber optic cable designs are unique and come in various configurations engineered for each application. For electric utilities, the most common fiber optic cables are Optical Ground Wire (OPGW) and All Dielectric Self Supporting (ADSS) cable.



OPGW serves two main systems: power delivery and telecommunications with the following functions:
i) protection to overhead lines against lightning strikes and a return path to short circuit currents during system faults, and ii) a high capacity optical communications network.

Many OPGW designs include metallic wires, aluminum alloy and aluminum-clad steel (ACS) wires, stranded over aluminum and/or stainless steel tubes. The optical fibers are protected inside the tubes and are further protected with a water blocking gel.

ADSS cables are also used by utilities for telecommunications systems. ADSS cables are installed within the electric field of phase conductors using non-conductive elements. ADSS cables are strong enough to support themselves between transmission or distribution structures, often sharing the same support structures as the phase conductors.

Wrap cables are another type of fiber optic cable, offering an all-dielectric design that is helically wrapped around a phase conductor or traditional shieldwire.

Fiber optic cables are considered an integral part of the power network system. To stay connected, designs must survive under normal operating conditions without degradation of their mechanical, electrical or optical properties.

WHY TEST?

Protect your investment

Testing validates that the chosen design of your fiber optic cable is up for the challenge of long term operation. Rigorous Type Test standards exist, detailing tests that simulate transportation, installation or in-service conditions.

By subjecting your cable to various mechanical, electrical or environmental stresses, you can be confident that you have a robust design that will help you stay connected and meet the design life of the line.

Comparison tests may be performed on different designs, to help you select the most suitable and reliable design for your unique application.



Stress-Strain Test

- Cable characteristic test
- Data required for line design



Sheave Test

- Simulates installation
- Verifies mechanical and optical performance



Aeolian Vibration Test

- Simulates laminar wind flow over cable
- 100 million vibration cycles
- Check for damage to cable and hardware



Lightning Arc Test

- Simulates lightning arc strike followed by tension test to determine remaining strength
- Measures relative performance between designs



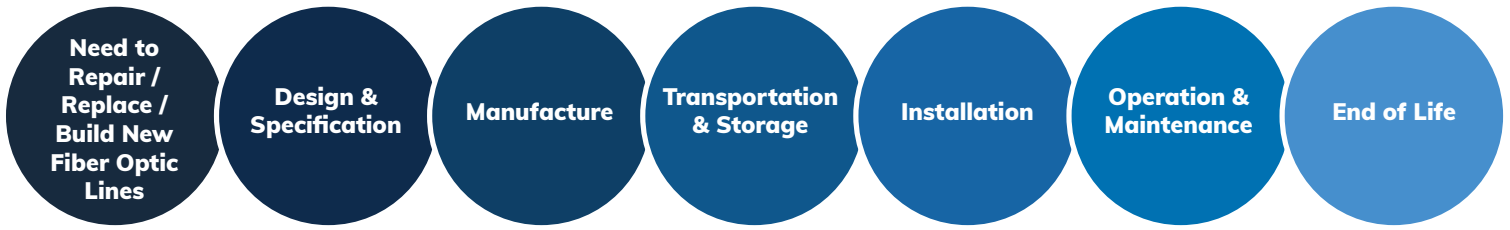
Short Circuit Test

- Simulates fault condition
- Measures maximum temperature in cable
- Verifies optical performance



Galloping Test

- Simulates wind flow over iced cable
- 100,000 vibration cycles
- Check for damage to cable and hardware

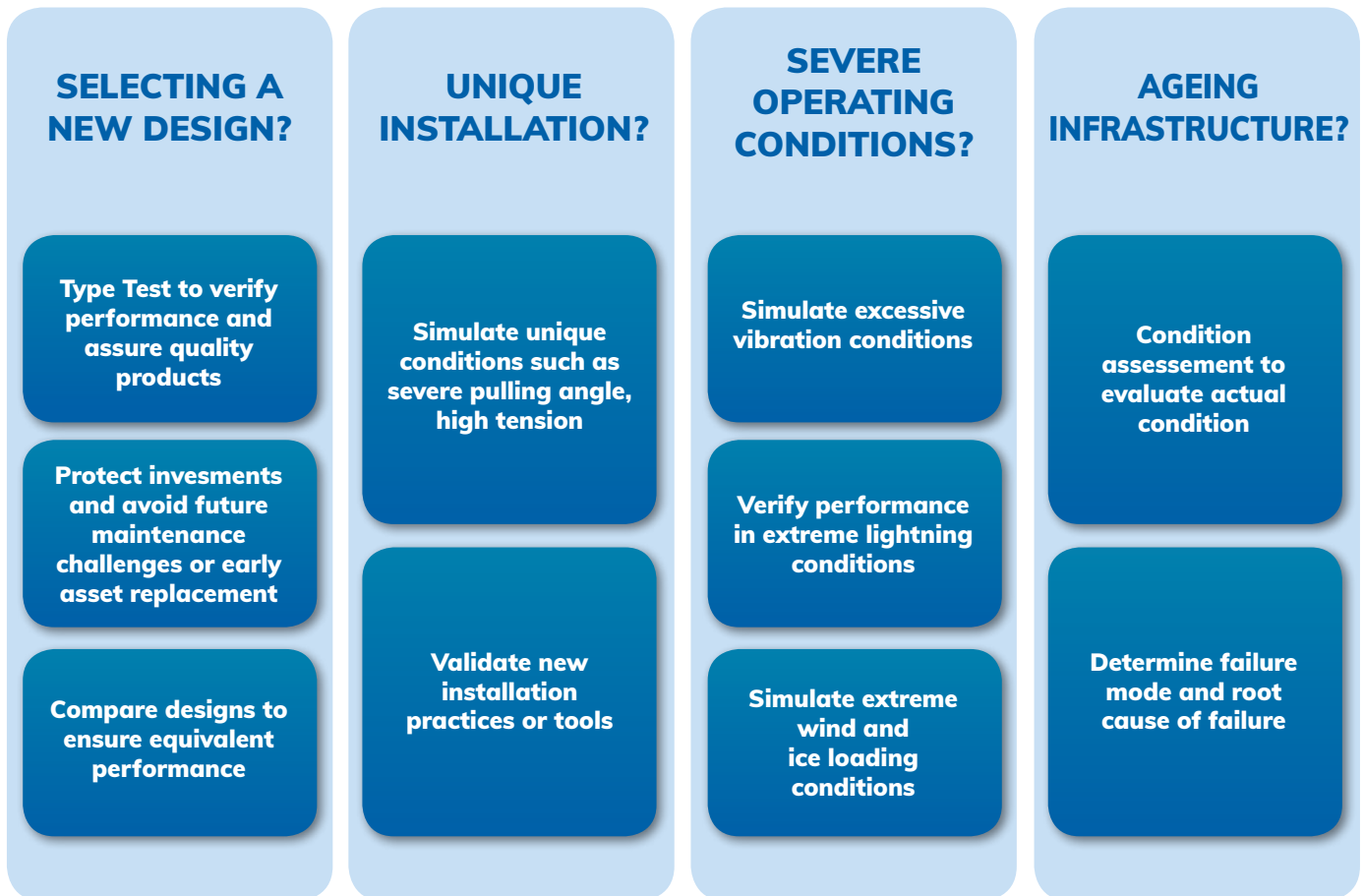


WHEN TO TEST?

Test throughout the life cycle of your fiber optic network

Testing provides real data to verify cable characteristics required for line design and to validate new designs. Testing can determine whether installation or operating conditions may affect the long-term performance of your fiber optic cable and hardware system.

As infrastructure ages, testing samples harvested from the field provides accurate information about the condition of your assets to help you make confident decisions to maintain your networks and extend their useful life.



FINDING THE ONE *Compatibility testing*

Hardware compatibility is critical to successful long-term operation – incompatible materials may lead to accelerated corrosion; or improperly sized dead-ends may lead to increased optical losses.

A systems test subjects the selected cable design and hardware to various conditions to verify their performance.

By testing the cable and hardware as a system, you can be confident your dead-end, suspension assembly, down-lead clamp and other hardware in contact with your fiber optic cable are compatible and will not lead to premature failures.



Turning Angle Test

- Subjects suspension assembly to increasing tensile loads at maximum recommended line angle
- Check for damage to cable or hardware



Short Circuit Test

- Simulates fault condition
- Measures maximum temperature in cable and hardware



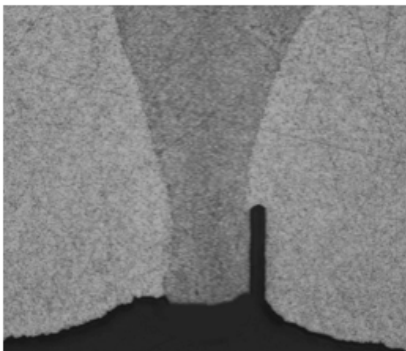
Corrosion Test

- Subjects components to accelerated ageing in a salt fog chamber
- Verify resistance of cable and hardware system to corrosive environment

WHAT CAN GO WRONG?

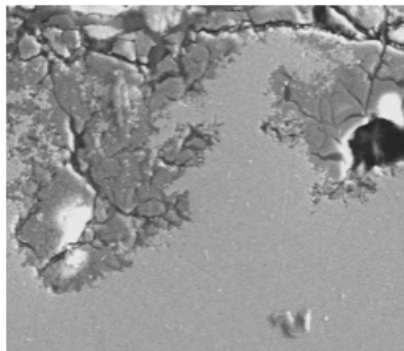
Kinectrics offers comprehensive in-depth failure investigation and metallurgical analysis services. Understanding the failure mode and root cause of failure, manufacturers and utilities can make informed and confident decisions related to their products and assets. Informed decisions may lead to substantial cost savings by eliminating bad processes, or by reducing unnecessary or inadequate repairs or maintenance of ageing infrastructure.

MANUFACTURING & INSTALLATION



- Lack of fusion weld in aluminum tube
- Lead to cracking when OPGW installed
- Through-wall crack developed, inner components became exposed to environment and caused premature failure

CORROSION



- Corrosion of aluminum wires
- Analysis confirmed presence of corrosive elements causing accelerated ageing
- Recommended alloying elements to improve corrosion resistance

LIGHTNING



- Failure due to tensile stress combined with intense localized heating
- Root cause of failure was lightning arc strike
- Recommended actions to improve reliability and future specifications

LABORATORY CAPABILITIES

Kinectrics has comprehensive and multi-purpose laboratories equipped with state-of-the-art equipment, instrumentation and data acquisition systems.

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| Mechanical Testing Laboratory | High Capacity Multi-Purpose Strong Floor | Up to 15 m (50 ft) long horizontal Capacity up to 890 kN (200,000 lb) |
| | Lightning Arc Test | Up to Class 3 test level (200 C) |
| | Sheave Test | Single or triple frame Sheave diameter up to 923 mm (36 in) Breakover angle up to 70 degrees |
| | | Vertical Tensile Machine |
| | Aeolian Vibration Spans | Up to 90 m (295 ft) long spans Capacity up to 225 kN (50,000 lb) |
| Conductor Dynamics Laboratory | Creep Spans | Over 11 test spans Up to 20 m (66 ft) long spans Capacity up to 155 kN (35,000 lb) Ambient and high temperature options |
| | | Galloping Spans |
| | Thermal Chambers | Up to 6 x 5 x 3 m (20 x 16 x 10 ft) Walk-in chamber Temperature range from -50°C to +85°C |
| High Current Laboratory | Indoor Test Cell | Three high-current transformers fed from transmission power system Power frequency up to 60 Hz Maximum test levels: 200 MVA, 20 kV, 100 kA rms |
| Metallurgical Laboratory | Forensic Examination | High resolution digital microscope Scanning Electron Microscope Energy Dispersive X-ray Spectroscopy |
| | | Chemical Analysis |

COMMITMENT TO QUALITY

Kinectrics is accredited to ISO/IEC 17025:2017 by the Standards Council of Canada (SCC).

The SCC is a member of the International Laboratory Accreditation Cooperation (ILAC) and a signatory member of the ILAC's Mutual Recognition Arrangement (MRA).

Kinectrics' accreditation is recognized internationally and demonstrates our unrivalled technical capabilities to provide a full range of engineering and testing services for fiber optic cables.



COMMITMENT TO SAFETY

Kinectrics promotes a safe work environment and empowers all employees to create and maintain a safe and healthy environment. We believe that no task is so important that we cannot make the effort to do it safely.

COMMITMENT TO OUR CUSTOMERS

Our vision is to be the premier technical solutions provider from concept to completion. Our mission is to improve our customers' business by delivering sustainable and innovative life cycle management solutions to nuclear and electricity industries, through our facilities, processes and people.



ABOUT KINECTRICS

Kinectrics' origins can be traced to 1912. With over 100 years of delivering technical excellence, Kinectrics is the category leader in providing life cycle management services for the electricity industry. Trusted by clients worldwide, our experts in engineering, testing, inspection, and certification is backed by our independent laboratory and testing facilities, a diverse fleet of field inspection equipment and an award-winning team of over 1,000 engineers and technical experts.

From initial design and type testing to operational deployment and maintenance services, Kinectrics collaborates closely with customers to ensure that utility assets perform safely, reliably and efficiently throughout their entire life cycle.



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