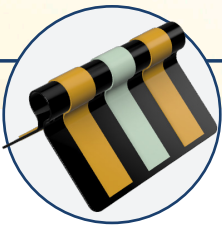




Power Line Sentry
Sicame Group



Hawk Eye™ Bird Flight Diverter Technical Validation

Confidential

PowerLineSentry.com

+1 970 599 1050 | Info@PowerLineSentry.com

8950 Pieper Road | Wellington, Colorado, USA

v.04.30.2025

Table of Contents

Introduction	2 - 4
History	2
Features	3
Variations	4
Hawk Eye™ Bird Flight Diverter Properties	5 - 8
Mechanical/Physical Properties	6
Comparison Reference	7
Installation	8
Contributing Factors to Avian Power Line Collisions	9 - 14
Collision Introduction	10
Detectability Principals for an Optimal Marker	11
Object Detectability by Species	12
Visibility as a Function of Surface Area	13
Visibility as a Function of Contrast	14
Visibility Efficacy in Low Light Conditions	15
Research Projects and Testimonials	16 - 25
Expert Testimonials	17-18
Endangered Wildlife Trust, Eskom	19
Nature Conservation Eygpt, EETC	20
International Crane Foundation, ATC	21
APLIC, US Fish Wildlife, Audubon, NeoEnergia	22
Ameren	23
AEP	24
SSEN	26
Manitoba Hydro	26
Altalink	27 - 28
Montrail-Williams Electric Cooperative	29
Avian and Wildlife Protection	30 - 33
Environmental Conservation Efforts	31
Utility References	32
Avian Power Line Interaction Committee	33
Technical Data	34 - 43
BFD-Series Specifications	35
BFD-050 Technical Drawing	36
BFD-075 Technical Drawing	37
BFD-150 Technical Drawing	38
BFD-AT-050-75 Technical Drawing	39
Line Marker Spacing Guidelines	40
Corona Test Report	41
RIV Test Report	42
PLS CADD Ice-Wind Study	43
BFD-050 IEEE 1656-5.8 120mph Test Report	44
Sources	45-46

The Hawk Eye™ History

We didn't invent the BFD, but we improved it.

Power Line Sentry designed the Hawk Eye™ Bird Flight Diverter to solve the known inherent problems with existing line markers in the industry.

Essential issues include:



- **Spiral designs:** it is widely agreed that this design has a low efficacy. This style does not glow, it does not provide a large contrast, it is difficult to see at night and in low light. This design is time-consuming and difficult to install, and often the incorrect (small) size is utilized.



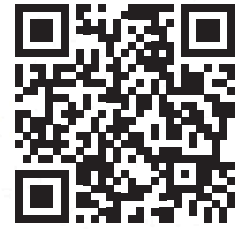
- **Hanging, flapping, spinning designs:** while providing improved visibility over spiral designs, this style is designed to be visible from a horizontal trajectory (it is less visible from ascending and descending angles) and the mechanical issues and weather-induced issues cause frequent clamp/attachment failures leading to line-slippage and potential tag separation.

The Power Line Sentry Hawk Eye™ Bird Flight Diverter was created to solve these problems while enhancing effectiveness and providing best in class durability.

The Hawk Eye™ design is founded upon these principles:

- **High contrast** - highly visible shape and design to enhance detectability in all conditions/ environments
 - 360-degree detectability - so the marker is seen from all potential angles
 - 24-hour visibility - for detection in low light conditions (dawn, dusk, fog, snow, etc.)
- **Durable design** - engineered for longevity
 - Patented retention hose - for position security (no line slippage)
 - No mechanical components - no failure points
 - Light wind and ice loads (low PLS-CADD load)
- **Safe and easy installation** - install options for every and any circumstance
 - Hotstick friendly
 - Robot friendly
 - Drone friendly

Hawk Eye™ Bird Flight Diverter Features



**Watch the
tutorial**

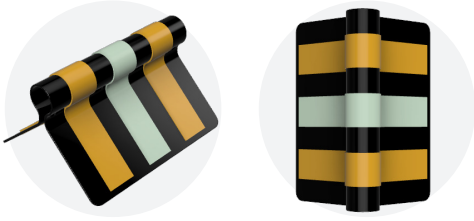
Hawk Eye™ Key Features

- The unique tent-shaped design coupled with a distinctive color combination ensures optimal visibility from all angles, even in low-light environments
- Mirrored fluorescent prismatic yellow bands ensure superior reflectivity from all angles, offering the largest reflective surface area in the industry
- 24-hour glow-in-the-dark bands on all sides of the marker ensure the industry's largest glow surface area
- Only diverter rated for systems up to 345kV with no corona (on direct conductor applications)
- Movement effect without mechanical components to break/fail
- No line slippage
- Retention hose cradles conductor without compressing, pinching, grinding, or causing damage to OPGW or conductor
- UL-94 V-0 flame retardant material
- Withstands position in high winds > 200 kmph for sustained periods
- Compatible with hotsticks, robots, and drones, allowing installation on live lines without causing network downtime
- Easy removal for maintenance or reconductoring
- Safe, automatic, accurate, efficient installation + removal available with FulcrumAir LineFly™

***Technical validation report links in Appendix**

Hawk Eye™ Series Variations

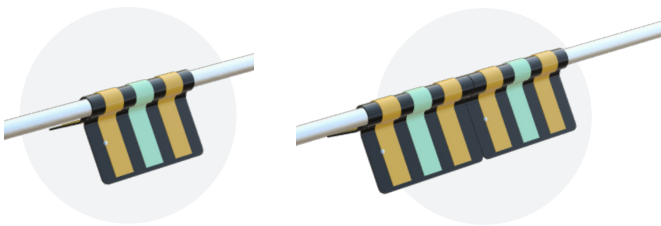
Original Hawk Eye™



Doubled(+) Surface Area Option

Surface area expansion practice

- All Hawk Eye™ variations are designed for seamless side-by-side installation for increased surface area in any given location
- Positioning is always dependent on variety of factors including region, habitat, species, etc.



Hawk Eye™ Bird Flight Diverter Properties

This section highlights the physical properties surrounding the design, materials, and installation.

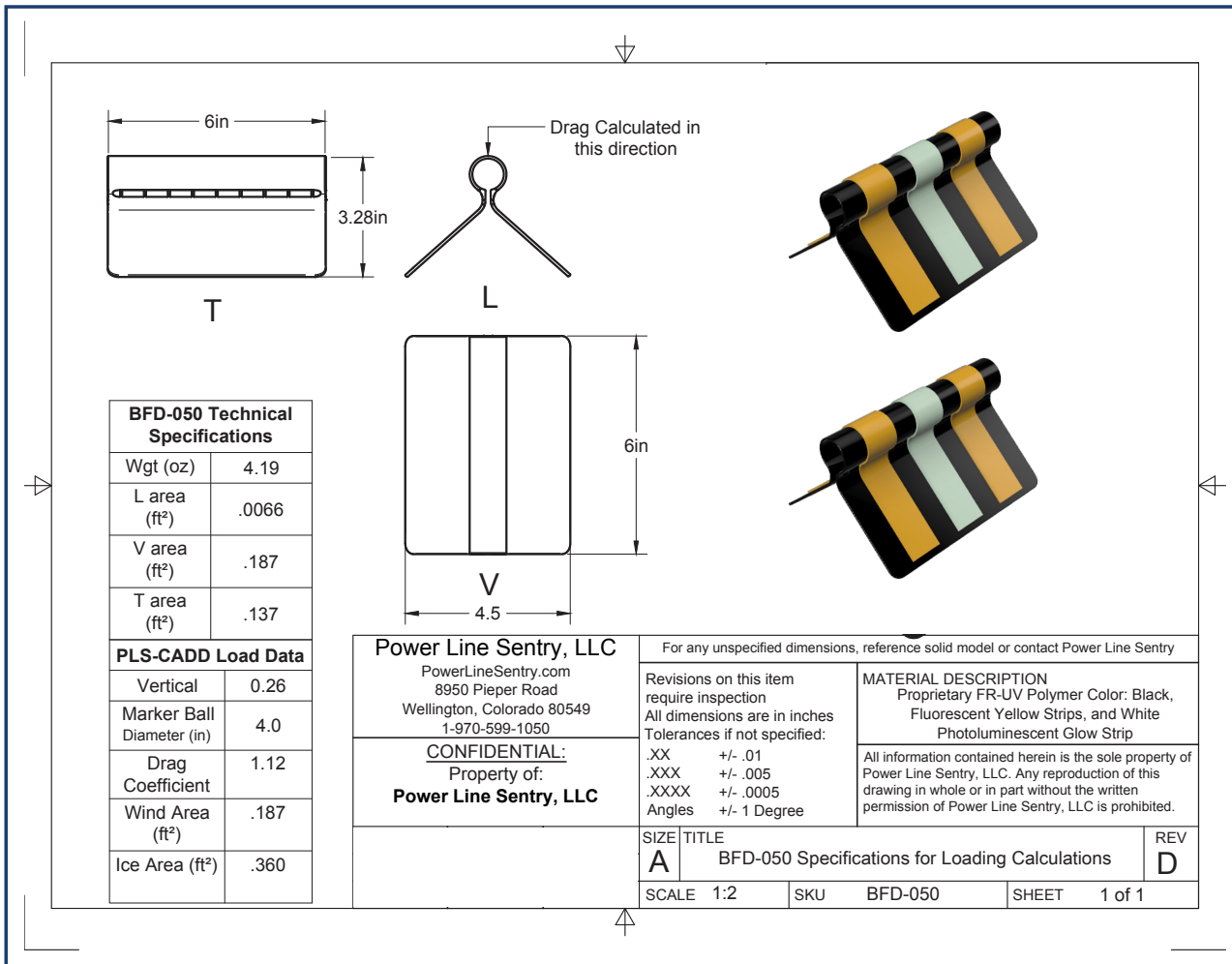
Mechanical/Physical Properties	6
Comparison Reference	7
Installation	8

Mechanical/Physical Properties

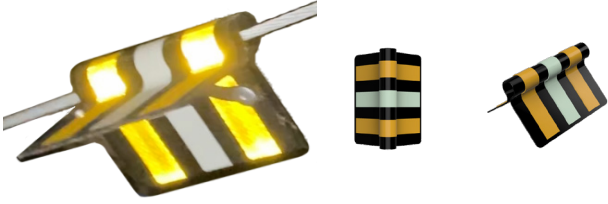
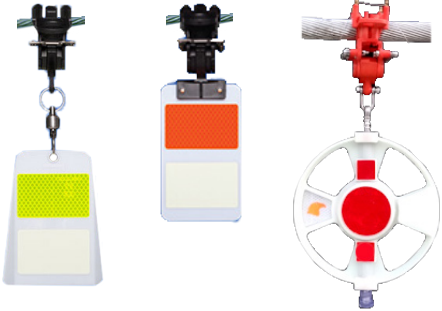
A marker must be built for longevity. To remain effective it must remain in its position on the line and it must continue to provide its designated features for the duration. Additionally, it must not impact the structural integrity of the power line or the reliability of the electrical grid. Effectiveness must also be considered from the point of the line marker's durability and physical composition.

Properties Summary

- Retention hose situated between two wings of an A-frame shape cradles the conductor and provides the optimal combination of resiliency and shore hardness; allowing for the proper amount of both tension and security. A rubber hose cradle does not damage the integrity of the electrical grid.
- Design is rated for systems up to 345kV with no corona (on direct conductor applications).
- The sloped wings of the A-frame shape made from a polycarbonate base minimizes wind, ice, and snow loading.
- The reflective materials and phosphorescent materials are both engineered for longevity and durability in extreme environments.
- The phosphorescent part of the design is rated for 24-hour glow - it absorbs, stores, and converts photons into light throughout the night, and has a 27-year-cycle life expectancy.



Hawk Eye™ Bird Flight Diverter Comparison Reference

Hawk Eye™ Bird Flight Diverter Part # BFD-050 Reference	Flapper/Spinner Style Markers General Examples
	
Rated up to 345kV with no corona	Typically rated up to 115kV
Large surface area (548cm ²)	Typically significantly smaller surface area
Large reflective surface area (174cm ²)	Typically significantly smaller reflective surface area
Large 24-hour glow-in-the-dark surface area (87cm ²)	Typically significantly smaller glowing surface area
360-degree visibility, 3-dimensional	Flat, 2-dimensional shape
Movement/flutter effect without mechanical components to fail	Mechanical components may fail from salt, sand, ice, etc.
No compression clamp that may cause fiber damage	Over-compression can damage fiber
No line slippage	History of line slippage
Effective in all weather conditions	Tag can separate
Quick snap-on installation by hand, hotstick, robot	Slower install
Easily removable	Non-removable
Wide conductor range, options for 6.4mm - 40.6mm diameter wire	Narrow conductor range
20 year minimum maintenance free line life	Visibility reduced in high wind, movement reduced by snow/ice

Installation

Access to overhead conductors for the physical installation of the line markers can present difficulties regarding logistics, liability, and more. Installation conditions involving remote locations, bodies of water, or diverse terrain present additional factors for consideration.

Installation of the Power Line Sentry Hawk Eye™ Bird Flight Diverters can be conducted in various ways: manually or with a hotstick (to provide a greater/safer distance) from a helicopter or bucket truck or robotically with the FulcrumAir LineFly™.

Installation Considerations

- Direct and indirect installation costs from personnel time, logistics, and associated efforts, impact the potential of a line marking project.
- When managing diverse terrain with complexities (i.e., drastic elevation changes, water crossings, land with restrictions, etc.) installing line markers with traditional utility industry methods (i.e., manually with hotsticks, manually with bucket trucks, manually with helicopters) can be tedious, time consuming, and potentially dangerous.
- Corona should be considered when marking high voltage conductor and with an increased focus on transmission and high voltage conductors it has been concluded that line markers should be rated for high voltage systems. Power Line Sentry Hawk Eye™ Bird Flight Diverters are rated for systems up to 345 kV.
- Power Line Sentry Hawk Eye™ Bird Flight Diverters are designed to be installed on live-line energized systems when installed by the LineFly™ Robot or with the hotstick installation tool.

Installations applying robotic technologies are acknowledged as safe, quick, and accurate. Robotic installations are also generally less logistically complex and less carbon-footprint intensive.

FulcrumAir LineFly™ Key Features



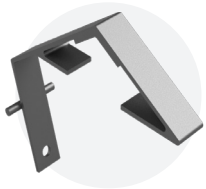
- The most effective robot currently available is the FulcrumAir LineFly™ which has the capacity for 12 Hawk Eye™ Bird Flight Diverters
- Installs approx 500+ Power Line Sentry Hawk Eye™ Bird Flight Diverters per day (per 2 person crew)
- Safe process (no manual installation, no helicopters)
- Drone placement allows for safe access to lines in nearly any environment including wetlands, water crossings, canyons, mountains, etc., and can be controlled from up to a mile away
- Placement is accurate and precise, it is done automatically by the robot to any set specification
- No system down time, can install on live lines
- Minimal environmental impact/land disturbance
- Post installation inspection reports available

BFD-AT-050-075 Hotstick Attachment Tool Key Features

- Durable, reusable hotstick friendly attachment tool
- No system down time, can install on live lines



Watch an
install video



Watch an
install video

Contributing Factors to Avian Power Line Collisions

The following information details some critical factors surrounding avian power line collisions and provides context regarding visibility as a function of surface area and as a function of contrast.

Collision Introduction	10
Detectability Principals for an Optimal Marker	11
Object Detectability by Species	12
Visibility as a Function of Surface Area	13
Visibility as a Function of Contrast	14
Visibility Efficacy in Low Light Conditions	15

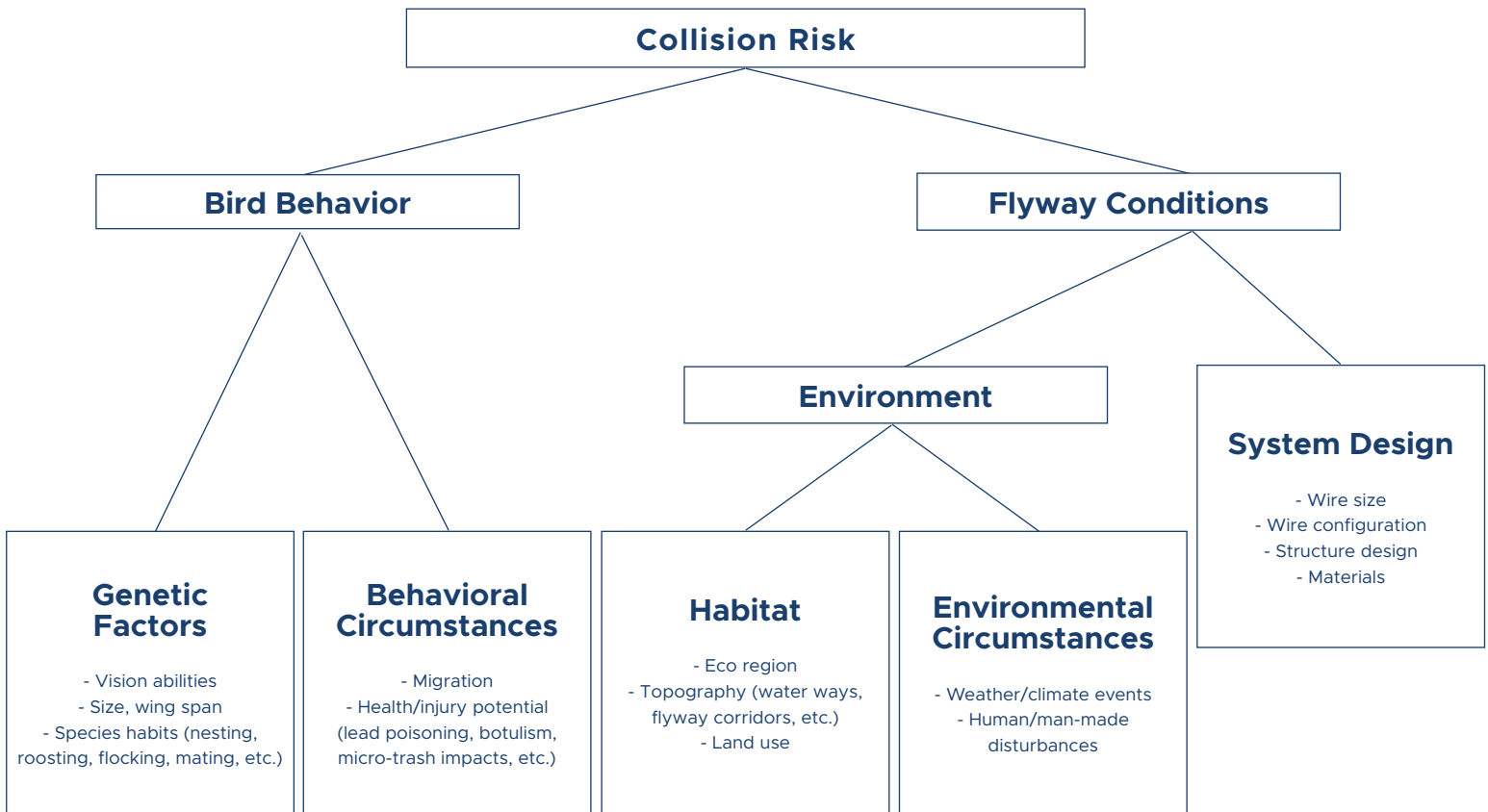
Avian Power Line Collision Introduction

Preventing avian power line collisions can be a challenge for utilities. There are many variables, every circumstance is unique, and conditions are constantly changing. While avian protection is a continuous endeavor to be managed simultaneously with electrical reliability efforts, the information outlined here is based on guidance set forth by the Avian Power Line Interaction Committee (APLIC).

This information outlines the various factors for considering collision potential based on APLIC research and guidance. This outline can be used as a conceptual probability model when updated with values that reflect circumstantial data or specific industry knowledge.

As shown, the potential for avian power line collision is generally cataloged through bird behavior and the bird's flyway conditions. Bird behavior includes genetic factors and behavior circumstances, while flyway conditions include the environment (habitat and environmental circumstances) and the electrical system's design details.

Collision Potential Factors



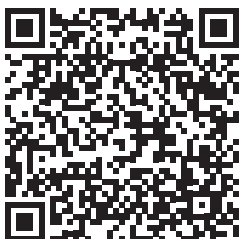
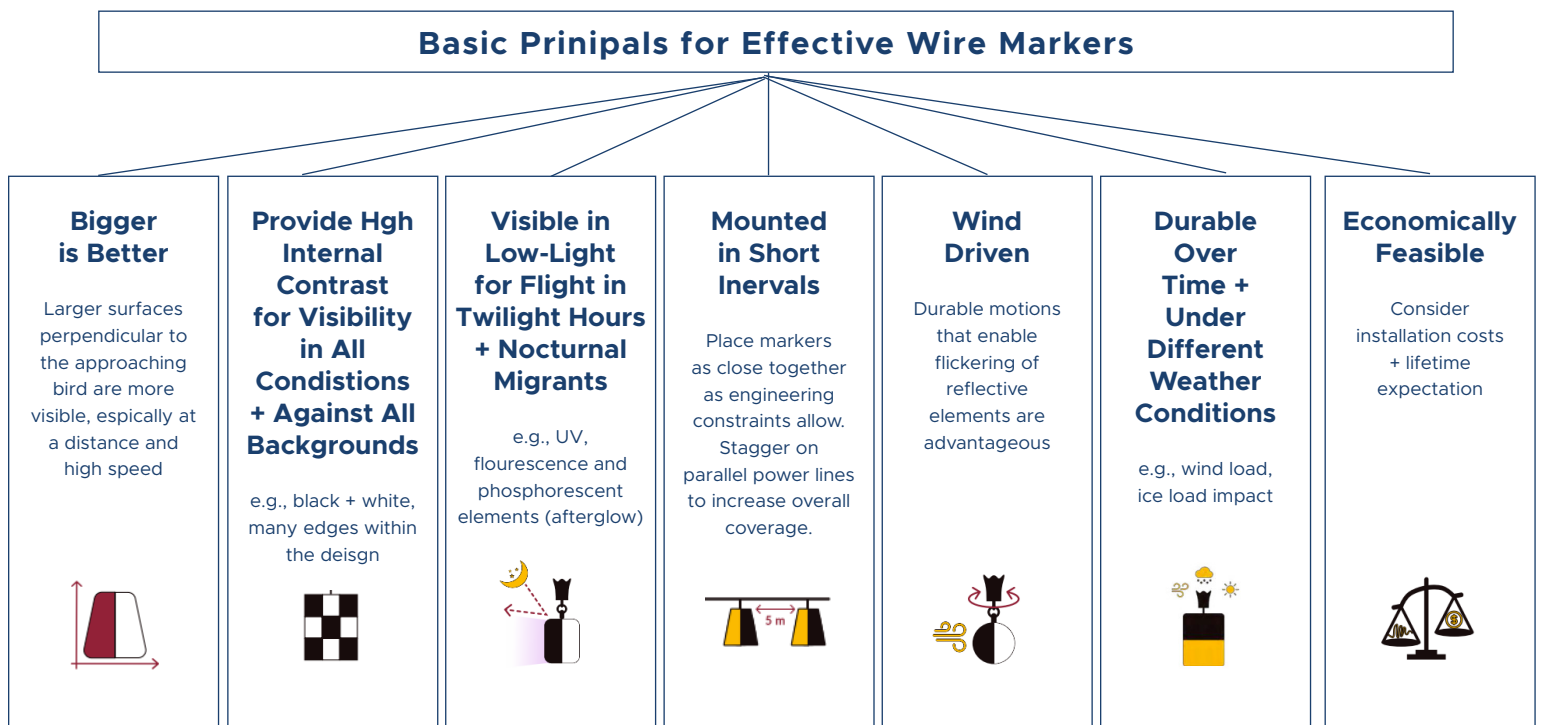
Detectability Principals For an “Optimal Marker”

In accordance with the Nature and Energy report Avian Power Line Collision: Overview of Risk Factors and Effectiveness of Mitigation Measures published by the Renewables Grid Initiative and supported by the European Union BirdLife International, there are 7 major contributing factors to effectiveness.

“Based on current scientific understanding, the following principles contribute to a marker being more effective and usable. While each characteristic is crucial on its own, their combination culminates in an “optimal” marker.”

The Power Line Sentry Hawk Eye™ design complements and exceeds all outlined performance criteria.

Effective Wire Marker Factors



[Read the full report >](#)

Object Detectability by Species

Power lines are often not visible enough for birds in flight to detect and divert away from, and because these collisions are often fatal it has been concluded that power lines should be marked to enhance their detection by birds in flight.

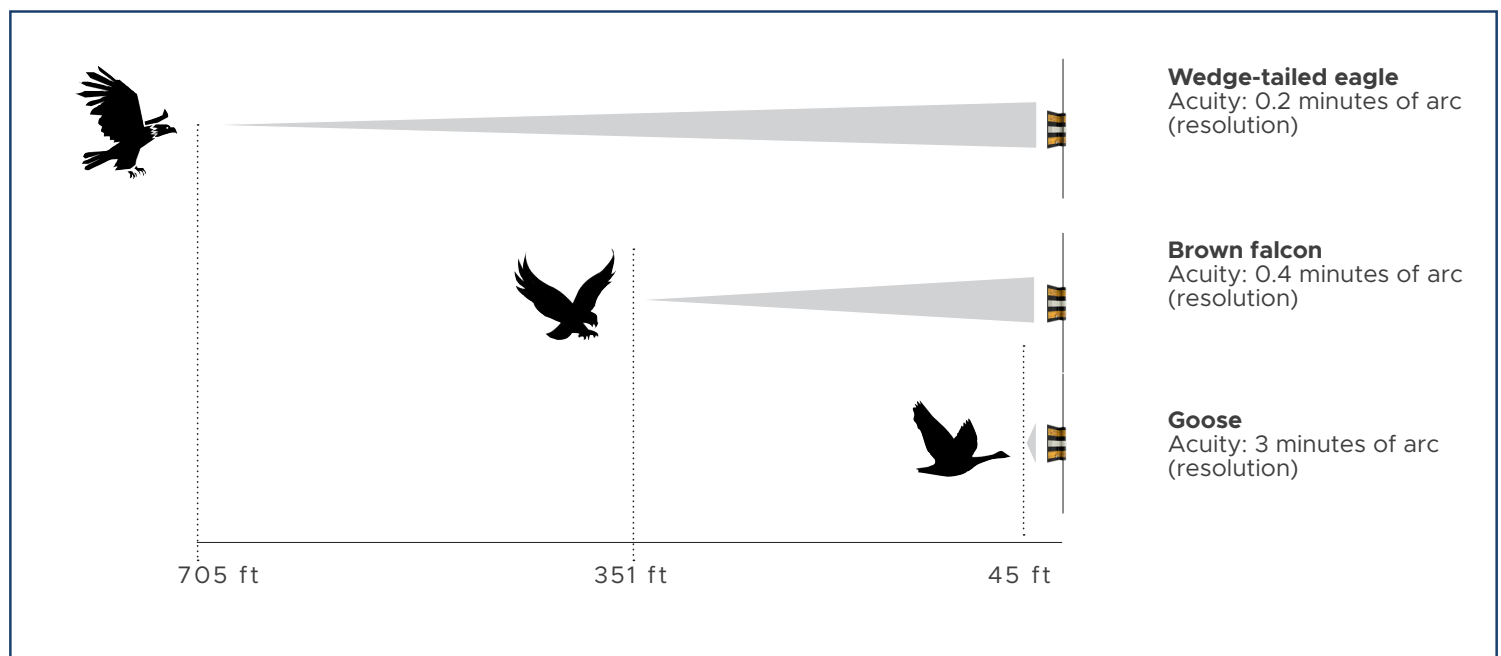
Providing contrast through high visibility line markers provides time and distance for a bird to divert. Power line markers need to contrast well against their background but crucially they need to contrast well within themselves, so that they maintain their detectability under a wide range of background conditions. Enhanced contrast and high detectability can be achieved through a variety of means including surface area, texture, brightness, reflection, glow, motion, and more. Defining the detectable surface area is a quantifiable, unbiased, and fair means of distinction.

The distance of which the Hawk Eye™ Bird Flight Diverter BFD-050 can be first detected varies by species. Calculations shown here are based on the horizontal trajectory of Hawk Eye™ Bird Flight Diverter BFD-050 object size with a surface area of approximately 19.2 in². Power Line Sentry also offers two larger options for larger conductors: BFD-075 has a surface area of approximately 22.5 in² and BFD-150 has a surface area of approximately 29.7 in². The BFD-050 is showcased here because it is the most used, but calculations for the additional sizes are available upon request.

Though vision is essential for a safe flight, visual strengths vary between species. Birds of prey like eagles, hawks, and osprey are known for their accurate judgment of distances; nocturnal species like owls are known for functioning well in poor light; while terns, gulls, and albatrosses are among seabirds that require flight and vision in hazy conditions.

This chart depicts the distance at which various avian species are able to distinguish an object, depicted here is the Power Line Sentry Hawk Eye™ Bird Flight Diverter BFD-050. As shown, birds that hunt to survive have a better ability to resolve a visual cue from a farther distance. Eagles and falcons particularly have powerful long distance vision, while swans, and other large-bodies birds with a limited maneuverability, including geese, cranes and bustards, are known for having poor long distance vision. This example is a visual exercise highlighting how these distances vary for these three bird examples viewing a target under the same, ideal (high daytime light level, good visibility) conditions. As summarized here, the amount of detail that birds can detect from different distances differs between species.

Estimated Distance of BFD-050 Resolution by Species



Visibility as a Function of Surface Area

Line markers are meant to increase the visible surface area of the length of the conductor that they occupy. This data is a comparison of contrasting surface area beyond the wire. The larger an object is the more surface area it has and the greater its impact.

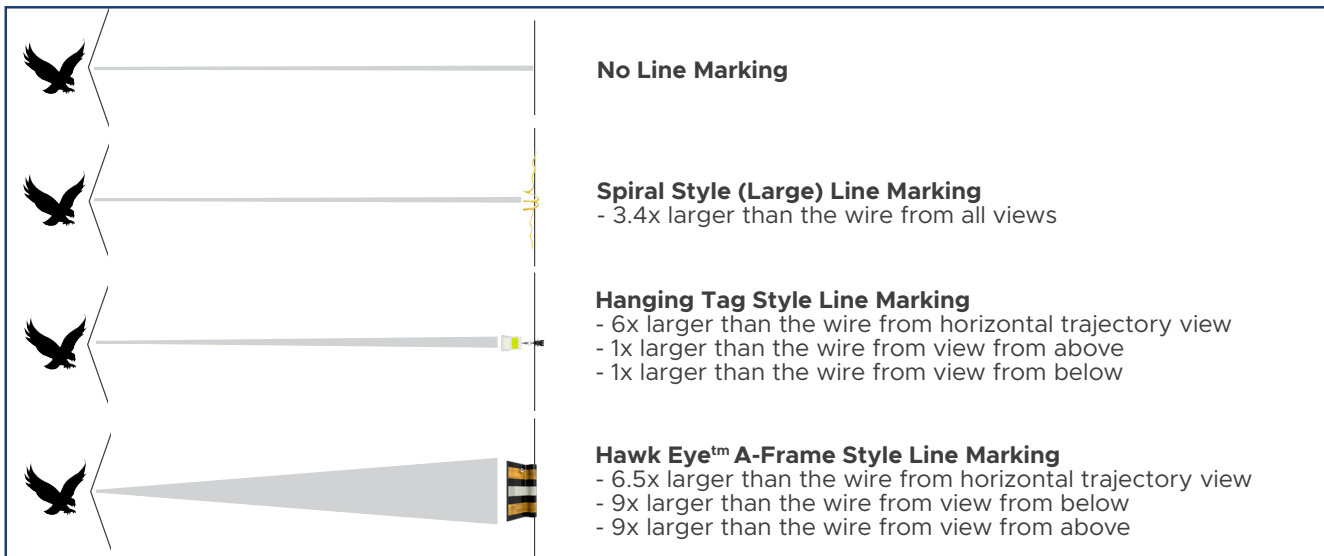
Calculated below are the projected surface areas of the most common line marker design options in the industry. Represented are two helical/spiral-style line markers (the larger swan style spiral as well as the smaller but more common pigtail spiral), a hanging tag-style line marker (one of the largest flapper style markers), and the Power Line Sentry Hawk Eye™ Bird Flight Diverter A-Frame style option (the smallest but most used Power Line Sentry marker; BFD-050). These will be referenced as styles of line markers in this report.

As the calculations for surface area visible in day light explain, the large spiral-style is approximately 3.4x larger than the conductor from every angle, the small spiral-style is approximately 2.1x larger from every angle, the hanging tag-style is approximately 6x larger from the horizontal trajectory but reduced from other angles, and the Hawk Eye™ Bird Flight Diverter is approximately 6x larger from the horizontal trajectory and 9x at its maximum viewing angle.

The size of the wire being marked also plays a role in line marker selection. For example, if comparing the designs for a conductor ranging .250 to .349 inches, then the larger spiral-style would not be included as an option. For the purpose of depicting the largest line markers available in the market, the graphic below represents three commonly used styles with the greatest amount of surface area.

Estimated Line Marker Detectability as a Function of Projected Surface Area in Day Light

Line Markers // Full Surface Area	Dimensions (inches)			Surface Area (square inches)			
	Height	Length	Width	Horizontal Trajectory View	View From Above	View From Below	View from 45 Degree Angle
Power Line Sentry Hawk Eye™ Bird Flight Diverter BFD-050	3.2	6	4.8	19.68	27	27	23.98
Hanging Tag Style Line Marker*	3.75	6	0.05	22.5	0.19	0.19	15.75
Spiral Style Line Marker (Large)	7	0.37 x 4.5	0.37 x 4.5	11.81	11.81	11.81	11.81
Spiral Style Line Marker (Small)	2.25	0.37 x 2.5	0.37 x 2.5	2.11	2.11	2.11	2.11



Calculations Derived with These Formulas

- *Calculations based on marker surface area
- Horizontal trajectory view = height x length
- View from above and below = length x width
- View from 45 degree angle is approximately 70% of surface area, data calculated using CAD
- Exact numbers are dependent on the line marker geometry
- Calculations depicted in graphic assume 0.5 inch wire diameter

Visibility as a Function of Contrast

As stated by APLIC, avian collisions are most common in low light (dawn, dusk, etc.) when they are ascending or descending, though they may also be in level flight. Though species dependent, birds generally have high activity rates at dawn and dusk due to their feeding, roosting, and nesting behaviors. Poor weather conditions that reduce visibility (wind, fog, haze, rain, snow, etc.) increase risk of collision.

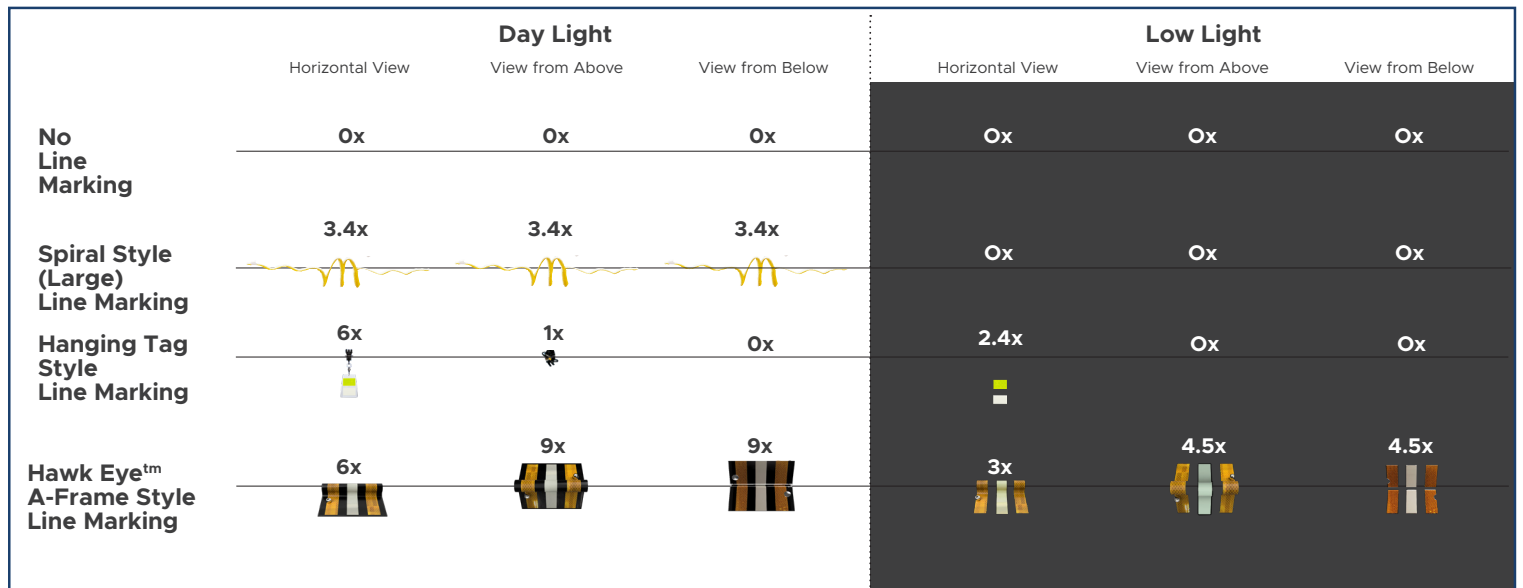
Contrast in low-light or dark conditions is achieved through the use of vibrant colors, varied textures, reflective surfaces, and enhanced brightness. Line markers should provide high visual contrast from all potential approaching angle because a bird's approaching direction and angle depends on many variables including flight patterns, flyway corridors, and structural design. Contrast against the natural background as well as within the marker are both vital. Backgrounds can vary markedly, and hence change contrast of the object against it, but contrast within an object is not affected by the background.

Calculations below explain the surface area visible in low light conditions through surface area of reflective material and glowing material. As shown through the same method of calculations, both spiral-style options provide reduced visibility from all angles, the hanging tag-style is approximately 2.4x larger from the horizontal trajectory but reduced visibility from the other angles, and the Hawk Eye™ Bird Flight Diverter is approximately 3x larger from the horizontal trajectory and 4.5x larger from the other angles. Again, for the purpose of depicting the largest line markers available in the market, the graphic below represents the three designs with the greatest amount of surface area.

Estimated Line Marker Detectability as a Function of Projected Surface Area in Low Light

Line Markers // Reflective Surface Area	Dimensions (inches)			Surface Area (square inches)			
	Height	Length	Width	Horizontal Trajectory View	View From Above	View From Below	View from 45 Degree Angle
Power Line Sentry Hawk Eye™ Bird Flight Diverter BFD-050	3.2	1.98	4	6.16	8.62	7.37	7.73
Hanging Tag Style Line Marker	2.5	1.98	0.05	4.95	0	0	3.47
Spiral Style Line Marker (Large)	0	0	0	0	0	0	0
Spiral Style Line Marker (Small)	0	0	0	0	0	0	0

Line Markers // Glowing Surface Area	Dimensions (inches)			Surface Area (square inches)			
	Height	Length	Width	Horizontal Trajectory View	View From Above	View From Below	View from 45 Degree Angle
Power Line Sentry Hawk Eye™ Bird Flight Diverter BFD-050	3.2	0.1	4	3.01	4.31	3.69	3.87
Hanging Tag Style Line Marker	2.5	1.98	0.05	4.95	0	0	3.47
Spiral Style Line Marker (Large)	0	0	0	0	0	0	0
Spiral Style Line Marker (Small)	0	0	0	0	0	0	0



Visibility/Contrast in Low Light/High Risk Conditions

Enhancing contrast through all potential means (including surface area, texture, reflection, brightness, etc.) is especially important in low light and poor weather conditions. Enhancing contrast of the marker against the background as well as enhancing the internal contrast of the marker through design/pattern are both vital.

In the most distinguishable marker, contrast is enhanced by differences in the reflection of the surfaces and detectability is enhanced by the length of the edges at which reflectivity changes abruptly. The designs with the most pattern edges provide the greatest amount of contrast for the greatest chance of detectability.

One method for defining contrast is the Michelson contrast modulation, which quantifies the relative amount by which the amplitude (or difference) $(f_{max} - f_{min})/2$ of f stands out from the average value (or background) $(f_{max} + f_{min})/2$. In general, mf refers to the contrast of the periodic signal f relative to its average value. If $mf = 0$, then f has no contrast.

Using the Michelson contrast equation, Hawk Eye™ Bird Flight Diverters provide:

- The highest Michelson contrast with a rating of 1.0 (100% contrast)
- The only diverter with a 100% contrast ratio from all 360-degree angles of approach
- The most contrasting edges of any unitary diverter globally
- The longest total length of contrasting edges of any unitary diverter globally

As depicted below, the more surface area of contrasting reflective/textured material, the greater the contrast a line marker provides.

The images represented here were extracted from drone footage of distribution lines in western Washington during a heavy fog event. These snapshots portray how the Hawk Eye™ Bird Flight Diverter provides enhances detectability compared to the lower detectability of the spiral-style marker.

Field of View in Low Light Conditions



Watch the video >



Research Projects + Testimonials

The following industry statements from electrical utilities and wildlife conservation agencies validate the effectiveness of the Power Line Sentry Hawk Eye™ Bird Flight Diverter. These snapshots demonstrate why Hawk Eye™ emerged as the optimal solution for our customers after exploring other industry options.

Expert Opinions	17-18
Endangered Wildlife Trust, Eskom	19
Nature Conservation Egypt, EETC	20
International Crane Foundation, ATC	21
APLIC, US Fish Wildlife, Audubon, Neoenergia	22
Ameren	23
AEP	24
SSEN	25
Manitoba Hydro	26
Altalink	27 - 28
Montrail-Williams Electric Coop	29

Graham Martin, BSc, PhD, DSc: Hawk Eye™ Expert Opinion

Renowned Professor Graham Martin is an Ornithologist with an international reputation built upon his research into the sensory worlds of birds. In recent years he has used his expertise to focus on problems concerned with the functions of vision, especially binocular vision, in foraging behavior, and in understanding why some bird species are particularly vulnerable to collisions with human artefacts, such as power lines.

As included in this testimonial: “Power Line Sentry Hawk Eye Bird Flight Diverter devices are superior to other devices currently on the market.”



Alex Mackewich
8950 Pieper Road
Wellington, CO 80549
United States of America

UNIVERSITY OF
BIRMINGHAM

School of Biosciences

Graham Martin
Emeritus Professor of Avian Sensory Science

Direct Line: 01386 859253

Email: g.r.martin@bham.ac.uk

January 29th 2025

I can only lend support to your devices with respect to my research work on the vision of birds and its part in collision vulnerability across a range of species.

I therefore consider that Power Line Sentry devices should be evaluated on the basis of how far they reach the ideal criteria for the design of vision-based power line bird diverters, which I have described in a number of scientific papers.

Key criteria for effective bird diverters are the presence of high internal contrast incorporating multiple contrast edges, an element of movement, and large absolute size.

On the basis of these criteria I consider that Power Line Sentry Hawk Eye Bird Flight Diverter devices are superior to other devices currently on the market, such as spirals and flapping flags.

Full statement available upon request

Brian McGowan: Hawk Eye™ Expert Opinion

Brian McGowan is a global wildlife and asset protection subject matter expert. He is founder of Sientias Energy and currently active in many industry technical working groups. Highlights from his Sientias Energy Bird Flight Diverter report are below.

Hawk Eye Bird Flight Diverter advantages:

- Movement effect without moving parts that are subject to cyclical fatigue, ensuring weather resilience.
- Utilizes contrasting colors, black, orange and white (yellow when glowing).
- Incorporates high quality 3M engineered reflective & phosphorescent surfaces.
- It can be safely installed up to and including 345kV system voltage corona free.
- This design has been tested up to 190km/hr in wind tunnel testing.
- The design ensures that the unit is equally visible in all vertical directions when a bird is approaching perpendicular to the line.
- A crew of two can install 600 units a day in optimal conditions using a custom robot lifted to the line using either a drone or a bucket truck.

As included in his report: “Based on the positive ongoing trials in and the advantageous features of the Hawk Eye design, I believe it is a suitable diverter for use in bustard protection projects.”

	Common pitfalls, known legacy issues with bird flight diverters.	Opinion: Hawk Eye series
Method of attachment to line	Fixing mechanism or clamp can loosen, resulting in rotation of the BFD around the conductor or linear movement of the diverter clamp. Typical root causes are insufficient clamp forces, environmental degradation of fixing mechanism materials.	Hawk Eye is designed with a large rubber to conductor (substrate) contact area, enabling a robust and stable contact that resists linear movement. While the H-E can rotate around the line it is attached to in high winds, the visible area of the device does not diminish.
Engineered reflective surface	Surface area too small, or pre-mature failure of the adhesive element.	All sizes of Hawk Eye feature a large high quality 3M reflective surface area.
Engineered phosphorescence surface	Surface area too small, or "glow" duration too short and failure of the adhesive element.	All sizes of Hawk Eye features a large high quality 3M phosphorescent surface area.




Full report available upon request

Endangered Wildlife Trust: Hawk Eye™ Eliminates Ludwig Bustard Power Line Collisions in Africa

After an initial research period of 8 years testing the flapper style and the larger swan spiral design with no reduction on Ludwig bustard collisions, it was determined a second phase of research to study different marking options was required.

Since installing the Power Line Sentry Hawk Eye™ Bird Flight Diverters in February of 2022 “there have been no Ludwig bustard, or any other, collision,” even as referenced in the chart above the Hawk Eye diverters were placed in one of the highest mortality rate zones in the research study (0.571).

The results being published through this Endangered Wildlife Trust research on the Ludwig bustard and Eskom’s Karoo transmission lines in South Africa are promising, as the endangered Ludwig bustard is not only in drastic need of protection, but is also one of the most sensitive species to power line collisions (bustards are known for their poor vision). These preliminary results show that the Hawk Eye™ is extremely effective for this species with zero collisions recorded to date. The other markers in this preliminary study, while showing effectiveness, cost 5-10x more, have a higher weight/load, have a lower expected line life, and are more difficult to install.

INEFFECTIVE MITIGATION	 ENDANGERED WILDLIFE TRUST	Collision mortality rate (mortalities/km/year)		Reduction in collision mortality rate (%)	
		Before Marking (41 surveys)	After Marking (8 surveys)		
<ul style="list-style-type: none"> Shaw et al. 2021 72km transmission line experiment 8 years of monitoring BACI study Blue Crane collision rates reduced by 92% No effect on bustards 					
FINDING EFFECTIVE MITIGATION <ul style="list-style-type: none"> Karoo Transmission Line Marking Experiment Droerivier-Hydra 1 400 kV Pre-marking data since 2010 Testing 4 'novel' markers BACI experimental design Encouraging preliminary results 					
		Control	0.471	0.311	34.035
		Rotamarka	0.266	0.000	100.000
		OWL	0.599	0.000	100.000
		Hawk Eye BFD-050	0.571	0.000	100.000
		Avian sphere	0.462	0.197	57.292
		Total/average	0.483	0.219	54.589



Watch the video

Nature Conservation Egypt: Hawk Eye™ Eliminates White Stork, Buzzard, and Common Crane Collisions in Southern Sinai, Egypt

Nature Conservation Egypt (NCE) and the Egyptian Electricity Transmission Company (EETC) installed Power Line Sentry Hawk Eye Bird Flight Diverters along a 20 km high-risk section of a transmission line in Southern Sinai. This area, a known migratory corridor, previously experienced significant bird mortality—particularly among White Storks, which accounted for over 85% of recorded fatalities.

A follow-up survey conducted in April 2025, during the peak migration period, recorded zero bird carcasses on the retrofitted line, suggesting a potentially significant reduction in collisions. While further monitoring is planned, these early results are promising and underscore the impact of this collaborative mitigation effort.



Nature Conservation Egypt
الجمعية المصرية لحماية الطبيعة

Dear PLS Team,

Nature Conservation Egypt (NCE) extends its sincere appreciation for the support and flexibility your esteemed company has demonstrated throughout our collaboration. Your commitment has been instrumental in advancing our conservation efforts in Egypt.

As you are aware, NCE, in partnership with the Egyptian Electricity Transmission Company (EETC), has successfully completed the installation of PLS Hawk Eye diverters along a 20 km section of a high-risk transmission line in Southern Sinai. This transmission line, located between Sharm El-Sheikh and El-Tor, is owned and operated by EETC. The diverters installed are the property of NCE.

A total of 20 km (15 km + 5 km) of the 70 km line identified as high-risk for bird collisions has been retrofitted. Pre-installation data identified White Storks (*Ciconia ciconia*), Buzzards (*Buteo spp.*), and Common Cranes (*Grus grus*) as the most frequently impacted species, with White Storks accounting for over 85% of recorded mortalities.

Installation was completed in January 2025. Upon completion, NCE conducted a systematic carcass removal to establish a clean baseline for post-installation monitoring.

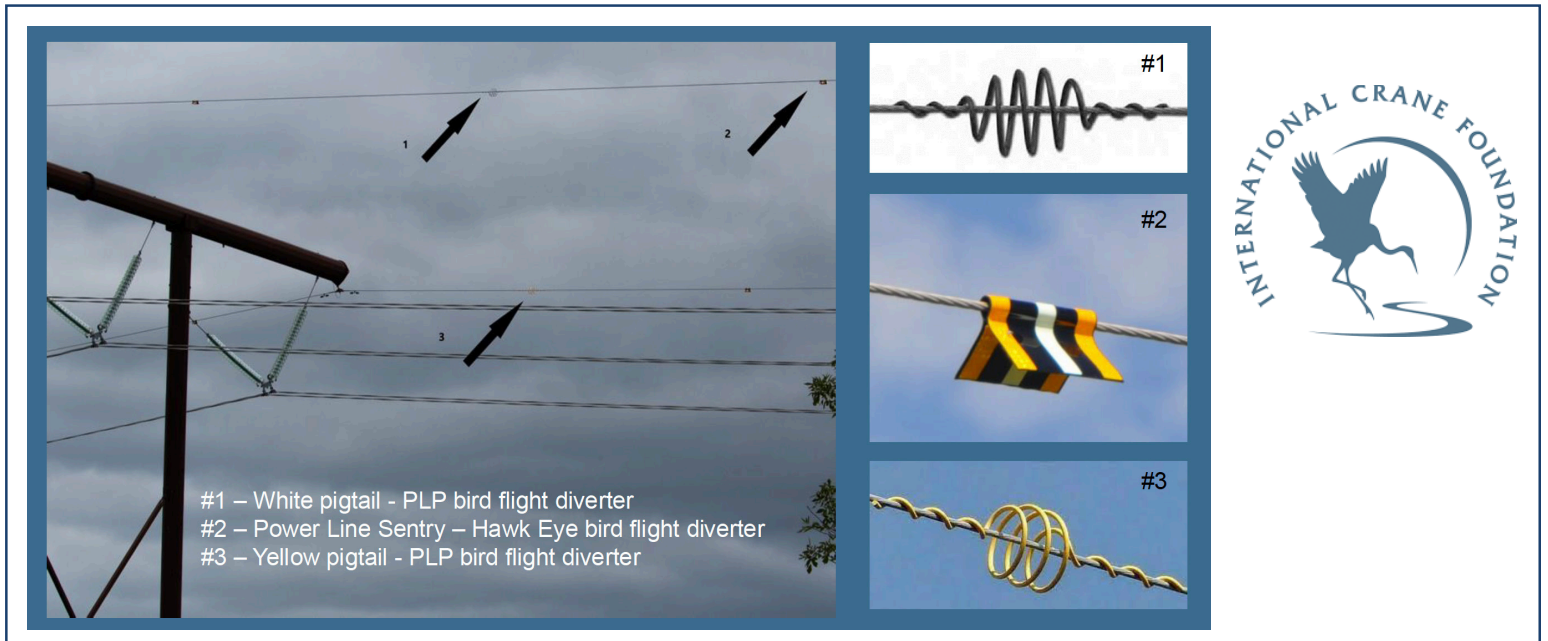
On 9 April 2025, NCE conducted the first post-installation monitoring survey along the entire 20 km retrofitted segment. The survey recorded zero bird carcasses. Given that the peak migration period for White Storks is now concluding, these findings are highly encouraging and may indicate a substantial reduction in collision-related mortality following the installation of the diverters.

Full statement available upon request

International Crane Foundation: Hawk Eye™ Eliminates Avian Collisions

The International Crane Foundation installed and monitored the effectiveness of three different markers: two types of spiral markers and the Power Line Sentry Hawk Eye™ Bird Flight Diverter within the Whooping Crane Migratory Path Wisconsin, USA, and has noted that visibility in low light continues to be the most vital attribute of an effective line marker.

Zero avian collisions were recorded during this study and ATC has since chosen the Hawk Eye™ as their preferred marker.



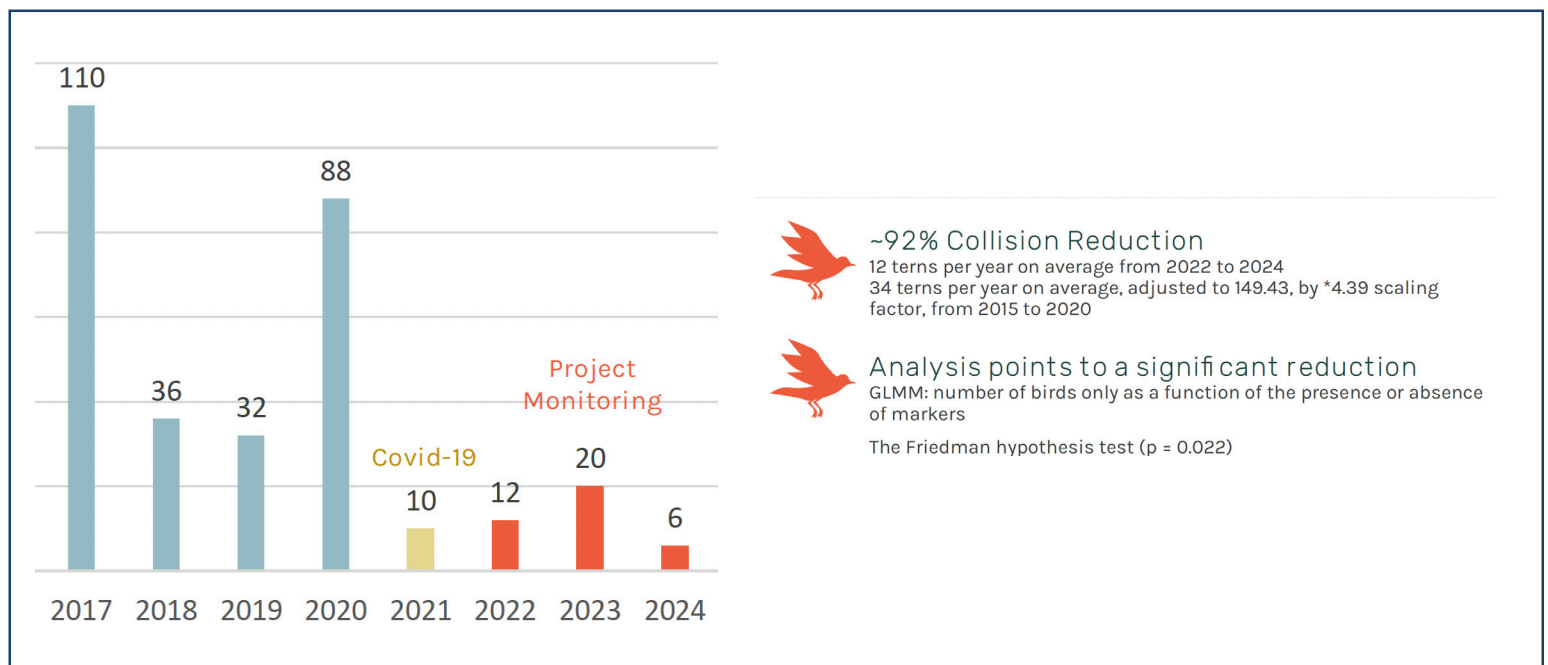
Full report available upon request

South America Tern Protection Project: Hawk Eye™ Reduces Roseate Tern Collisions by Approximately 92%

In this high profile endangered species protection collaboration between Audubon and US Fish and Wildlife, the Avian Power Line Interaction Committee (APLIC) recommended that the Power Line Sentry Hawk Eye™ Bird Flight Diverter be chosen to protect the endangered Roseate Tern from power line collisions in a known highly fatal 3-phase distribution line segment intersecting feeding area (ocean) and nesting grounds (sand dunes) in Galinhos, Brazil.

Since installation in 2021, and even with daily monitoring of an 8x larger increased area and a 4x longer research time period, power line collisions have drastically reduced by approximately 92%, contributing to the protection of this endangered species.

Additionally, NeoEnergia has further extended power line protection to more areas using the Hawk Eye™.

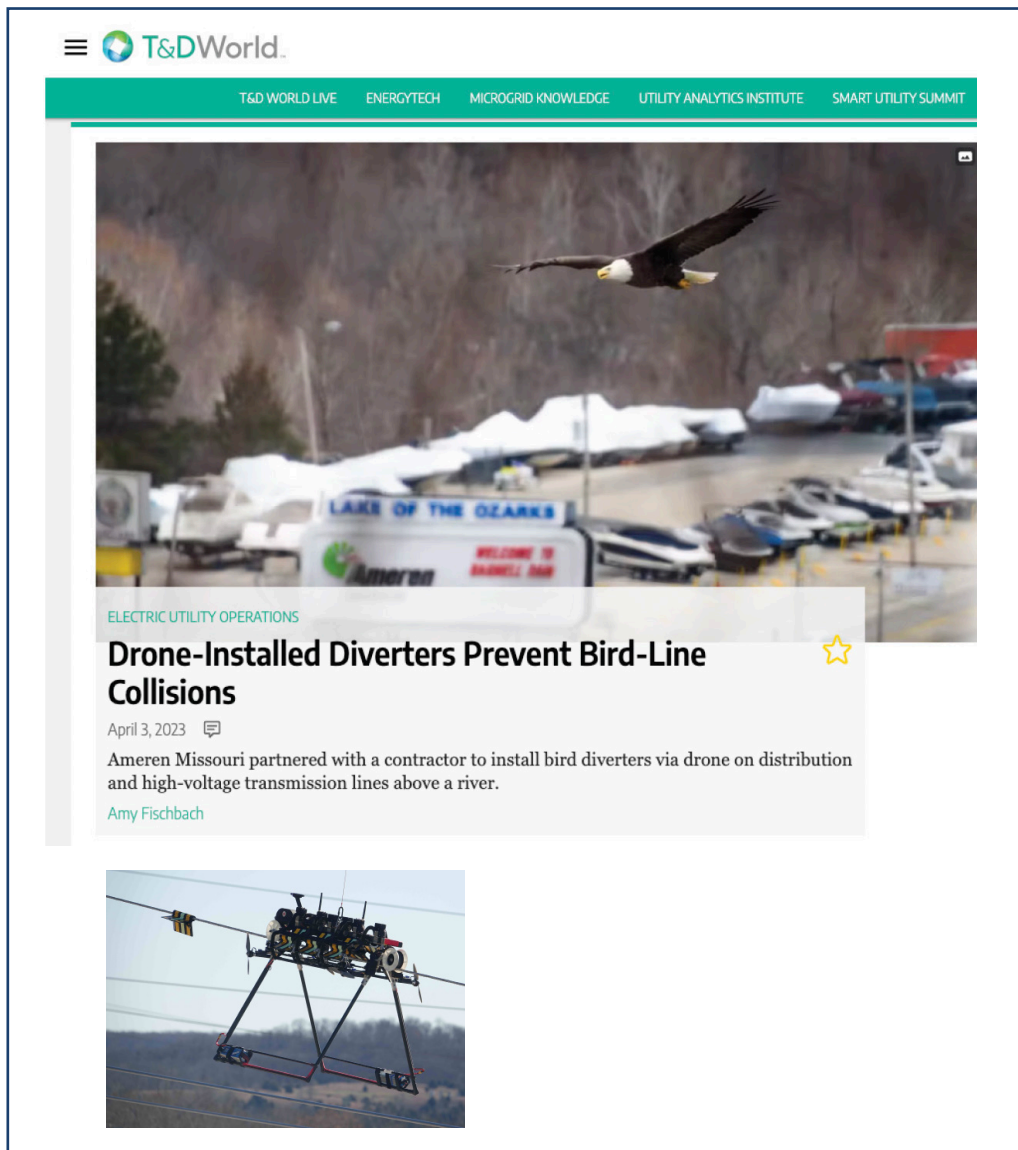


Full report available upon request

Ameren Missouri: Eagle Protection Around Bagnell Dam

The Osage River connects the Bagnell Dam to the Lake of Ozarks and provides a favored feeding and nesting area for Bald Eagles, making it a highly active space for many birds. As the Dam hosts both transmission lines and distribution lines that intersect the flyways and waterways, Ameren uses the Power Line Sentry Hawk Eye™ Bird Flight Diverter to protect these birds from fatal collisions.

Marking lines that cross over water was traditionally a difficult operation, but Ameren chose the LineFly™ robot for this project and the installation was quick, safe, and efficient, and because the LineFly™ can operate on and above live lines, the installation was completed without any network downtime.



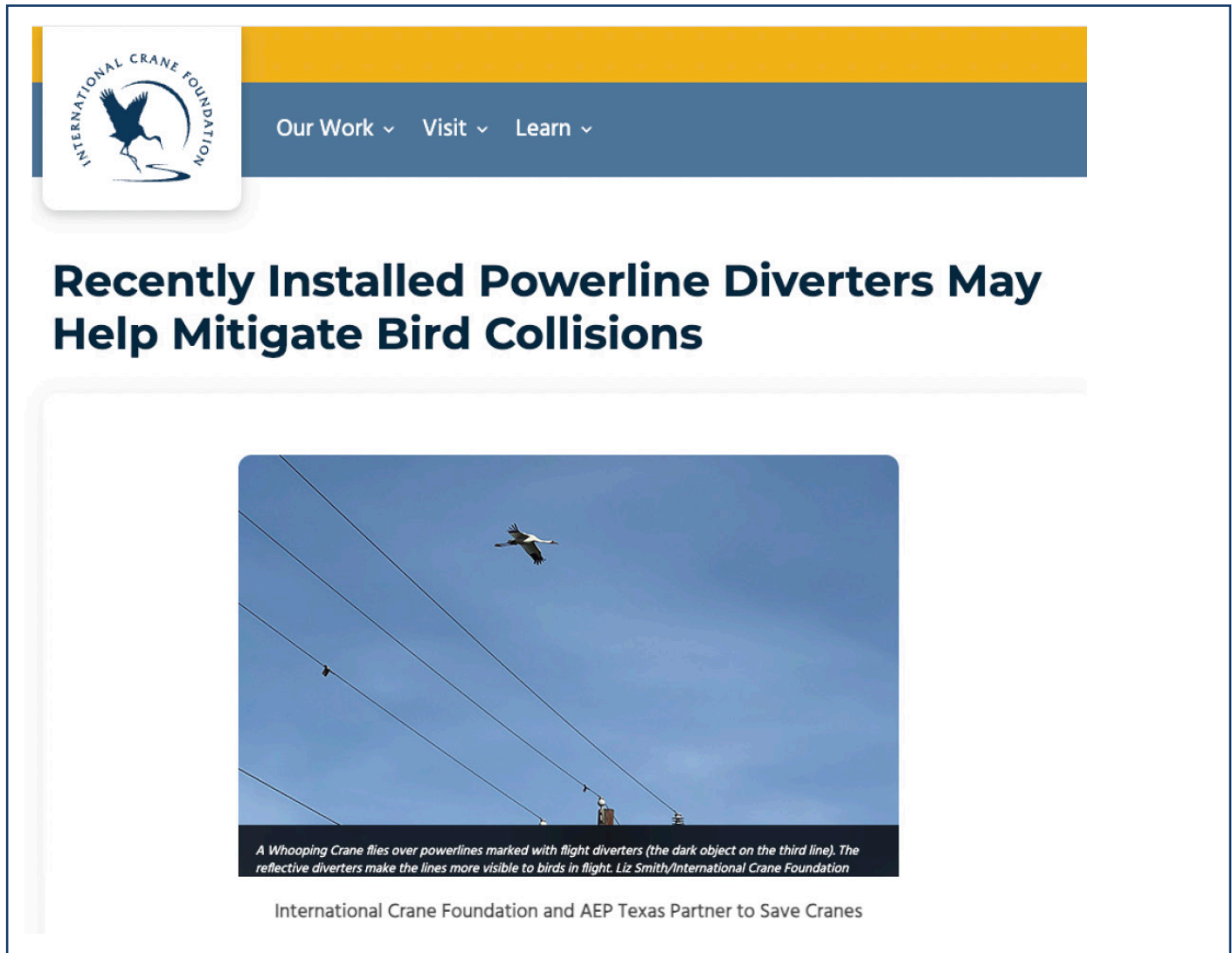
The screenshot shows a webpage from T&D World. The header includes the T&D World logo and navigation links: T&D WORLD LIVE, ENERGYTECH, MICROGRID KNOWLEDGE, UTILITY ANALYTICS INSTITUTE, and SMART UTILITY SUMMIT. The main content area features a large image of a bald eagle in flight over a parking lot with boats. Below the image is the article title "Drone-Installed Diverters Prevent Bird-Line Collisions" with a star icon, the date "April 3, 2023", and a brief summary: "Ameren Missouri partnered with a contractor to install bird diverters via drone on distribution and high-voltage transmission lines above a river." The author's name, "Amy Fischbach", is listed below the summary. At the bottom of the article preview is a smaller image of a drone-mounted diverter being installed on a power line.



Watch the video/read the full report

AEP Texas: International Crane Foundation Praises Whooping Crane Protection


The International Crane Foundation praised AEP Texas for choosing the Power Line Sentry Hawk Eye™ Bird Flight Diverter for “the most effective diverters - that glow in the dark and have a reflective component to ensure birds see them at night”. Protecting the Whooping Crane and other avian species in the high-risk Whooping Crane Migratory Path in Texas, USA, requires a BFD with unique contrasting features that is also built to last.



INTERNATIONAL CRANE FOUNDATION

Our Work ▾ Visit ▾ Learn ▾

Recently Installed Powerline Diverters May Help Mitigate Bird Collisions



A Whooping Crane flies over powerlines marked with flight diverters (the dark object on the third line). The reflective diverters make the lines more visible to birds in flight. Liz Smith/International Crane Foundation

International Crane Foundation and AEP Texas Partner to Save Cranes



Read the full report

Scottish & Southern Electrical Networks (SSEN): UK's First Hawk Eye™ Installation and Removal Demo

In a search for a more effective diverter, after current market offerings had proven to be unsatisfactory, and to complement their commitment to renewable energy while also meeting their goal of a net-zero carbon footprint by 2030, SSEN Transmission conducted extensive research to determine which line marking option is the most effective.

SSEN concluded that the Power Line Sentry Hawk Eye™ Bird Flight Diverter installed by the LineFly™ is the most effective and durable solution to protecting Scotland's power lines. "This innovation is significant in enhancing safety and efficiency across our network, underscoring the importance of collaboration in ensuring the energy transition is a just transition for nature and people."



At SSEN Transmission we recognise the important role innovation has in achieving net zero as we embrace new technologies to become safer, smarter, greener, and faster on the transition to a low-carbon economy.



Watch the video/read the full report

Manitoba Hydro: Hawk Eye™ Chosen to Protect Delta Marsh Migratory Path

Each season, tens of thousands of birds migrate through the Delta Marsh in Manitoba, Canada. Manitoba Hydro chose to have the Power Line Sentry Hawk Eye™ Bird Flight Diverter installed by the LineFly™ to keep birds safe while migrating, including the sensitive Canada Goose.

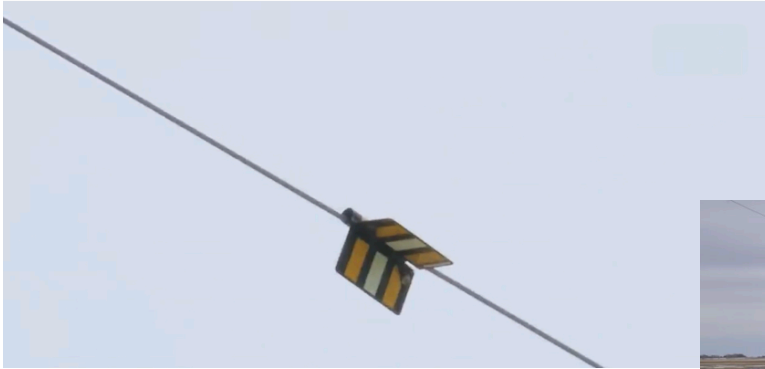
Jeff Laninga, Transmission Live Line & Electrical Effects Section Head, explains how the Hawk Eye™ provides heightened contrast on power lines, allowing birds to divert away from fatal collisions while also improving electrical reliability for the community. Installation with the LineFly™ kept worker safe by eliminating the risk associated with traditional installation methods.



Manitoba Hydro

47,064 followers
1yr · 🌐

May 13 is World Migratory Bird Day. Bird diverters are just one solution Manitoba Hydro has implemented to keep birds — like Canada geese — safe while migrating through areas like Delta Marsh. This is the first time we've used drone technology to install these reflective markers. Watch our video to learn more about how bird diverters work to protect the environment 📌



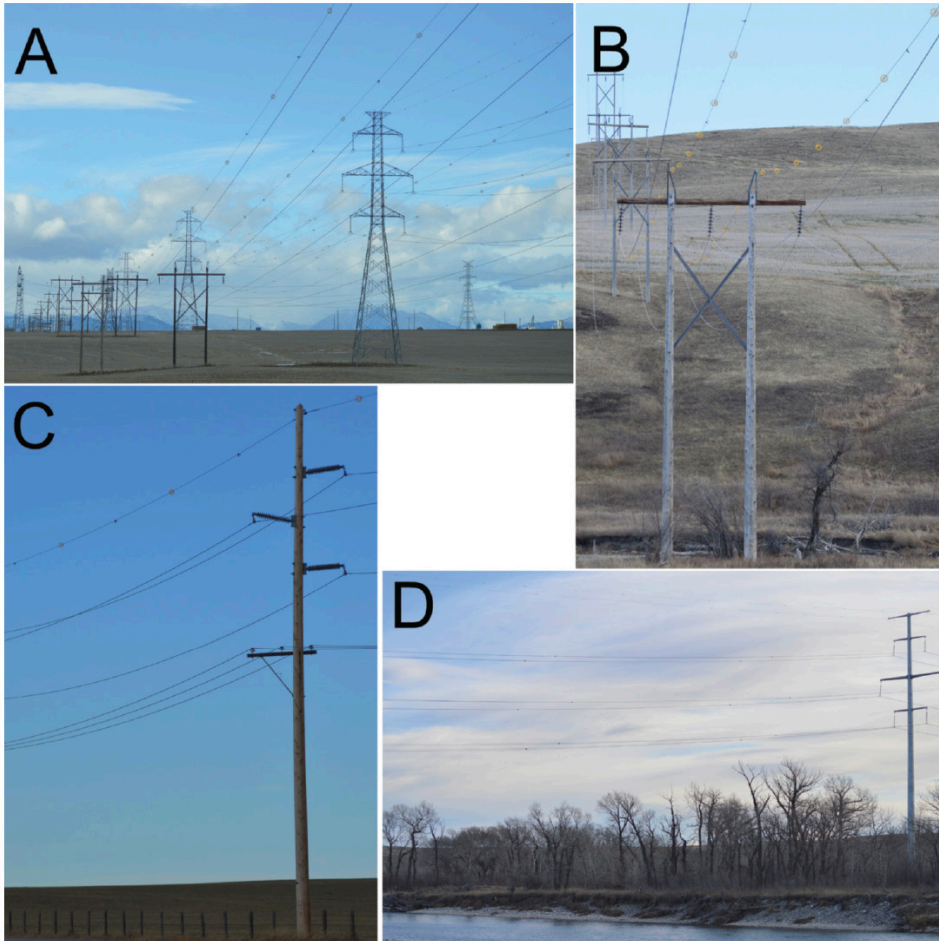
JEFF LANINGA
Transmission Live Line & Electrical Effects Section Head



Watch the video

AltaLink: Hawk Eye™ Praised as Preferred Marker

This 2016 publication by Nikki Heck, M.E.Des., P.Bio. Environmental Advisor at AltaLink Energy quantifies avian collisions with transmission lines in Alberta, Canada, and explains how the Power Line Sentry Hawk Eye™ Bird Flight Diverter is their preferred marking device.

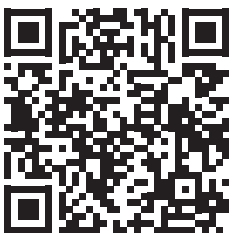


Quantifying and Mitigating Avian Collisions with Transmission Lines in Pincher Creek, Alberta, Canada

Nikki S. Heck, James F. Dwyer, Richard E. Harness, Melissa A. Landon, and Lori A. Nielsen

Keywords: Alberta, avian, bird, collision, line marker, raptor, transmission line, waterbird, waterfowl.

Figure 4. Transmission lines in the Pincher Creek, Alberta, Canada study area following line marking. A) AB-Line, G-Line, and H-Line (from right to left); B) H-Line; C) F-Line; D) AC-Line post-marking.



Read the full report

AltaLink: Hawk Eye™ Letter of Expertise

This Letter of Expertise by Nikki Heck, M.E.Des., P.Bio. Environmental Advisor at AltaLink Energy details that Power Line Sentry Hawk Eye™ Bird Flight Diverter is “AltaLink’s preferred marking device because it provides visibility in low light and from multiple angles, which is an important factor in reducing bird collisions”.



2611 3rd AVE SE, CALGARY, ALBERTA, T2A 7W7
WWW.ALTALINK.CA

September 14, 2022

Eman Ali
Nature Conservation Egypt
eman3abdallah@live.com

Dear Eman Ali:

RE: Power Line Sentry Bird Flight Diverters – Information to Support Bird Protection Program

As requested, I can confirm that AltaLink, Alberta’s largest electric power transmission service provider, has been using the Power Line Sentry Bird Flight Diverter (BFD) for approximately 10 years. The product has not been found to be detrimental to the wires or system functionality. The BFD is AltaLink’s preferred marking device because it provides visibility in low light and from multiple angles, which is an important factor in reducing bird collisions.

For further information on AltaLink’s Avian Protection Program see www.altalink.ca, which has further information you may find beneficial.

All the best with your bird protection program!

Sincerely,

Nikki Copeland (Heck), M.E.Des., P.Biol. Senior Environmental Advisor
T (403) 267-2134 C (403) 990-9968 E nikki.copeland@altalink.ca

AltaLink A Berkshire Hathaway Energy Company
2611 – 3rd Avenue SE, Calgary, AB, T2A 7W7



Montrail-Williams Electrical Cooperative: Hawk Eye™ Protects Whooping Crane in North Dakota

MWEC, who has successfully been using the Hawk Eye™ for over 8 years, recently committed to protecting 230 miles (370 km) of high voltage transmission lines within the Whooping Crane Migratory Path.

Montrail-Williams chose to the Power Line Sentry Hawk Eye™ Bird Flight Diverter, installed by the LineFly™, to prevent fatal power line collisions by whooping cranes and other migratory fowl in North Dakota, USA. The LineFly™ improved the efficiency of this installation project drastically, by installing an average of 500 Hawk Eyes™ per day per crew.

MWEC



Drone Robot Team Is For The Birds

Think of it as mechanical birds helping their feathered friends.

To prevent bird strikes by whooping cranes and other migratory fowl, special drones tethered to robots will place colorful markers – bird flight diverters – on static overhead wires this spring.

“It’s part of our avian protection plan,” said Montrail-Williams Electric Cooperative (MWEC) Civil Engineer Kyle Sorenson. “We are located in the Whooping Crane migratory path. These markers will reduce the probability of unintended bird collisions that at times can result in power outages.”



Read the full report

Avian + Wildlife Protection

Our mission is to eliminate electrical outages caused by wildlife and we are committed to spotlighting the ways in which wildlife protection and network protection overlap.

Environmental Conservation Efforts	30
Utility References	31
Avian Power Line Interaction Committee	32

Environmental Conservation Efforts

Power Line Sentry supports wildlife conservation and environmental stewardship both locally and globally. From our partners at electrical utilities to those with associations founded on avian protection, Hawk Eye™ Bird Flight Diverters are protecting birds from fatal power line collisions around the world.

Avian Protection and Conservation Collaborations



Utility References

The Hawk Eye™ has grown as the preferred bird flight diverter across North America and around the world, and is consistently replacing and out-performing alternative markers. The contacts listed below are available to provide additional insight as needed.

Utility References

Exelon:

Cristina Frank, Principal Environmental Scientist
Cristina.frank@pepcoholdings.com
+1 302-454-4179

Tristate G&T

Diana Leiker
Sr. Transmission Siting/Environmental Planner
Dleiker@tristategt.org
+1 303-254-3565

Altalink:

Nikki Copeland
Environmental Advisor
Nikki.heck@altalink.ca
+1 403-267-2134

ATCO:

Keyra Hawley Yurchi
Environmental Advisor
Keyra.hawleyyurchi@atco.com
+1 780-720-1685

Power Line Sentry Hawk Eye™ Bird Flight Diverter Users List (Partial)

USA CUSTOMERS

Audubon
Ameren
Avangrid
American Electric Power
American Transmission Corporation
Baltimore Gas and Electric
Blatner Energy
Duke Energy
Delmarva power
Delmarva
ENGIE
Entergy
El Paso Electric
Evergy
Exelon
First Energy Corporation
ITC
Invenergy
Jersey City Power and Light
Mississippi Power
NextEra
Oncor
Ohio Edison Company
Puget Sound Energy
Public Service of New Mexico
Pepco
Res
Tristate G&T
Ten West Link
US Fish & Wildlife
XCEL

Atlantic City Electric, New Jersey
City of Yale, Oklahoma
City of Seward, Alaska
City Light and Power, Maryland
Cowlitz County PUD, Washington
Clarke County PUD, WA
City of Farmington, New Mexico
Choptank Electric, Maryland
Cornhusker PP, Nebraska
Dayton Power and Light, Ohio
East Central Energy, Minnesota
High Plains Power, Montana
Idaho County Light & Power, Idaho
Interstate Power and Light, Iowa
Jersey Central Power and Light, New Jersey
Kay Electric, Oklahoma (Whooping Crane Flyway)
KBR Rural Electric, Nebraska (Whooping Crane Flyway)
Lawrence Livermore National Lab, California
Lance Ruffel Oil and Gas, Oklahoma (Whooping Crane Flyway)
Loup Valleys Rural PPD, Nebraska
Matanuska Electric, Alaska
Midwest EC, Nebraska
Midwest Energy, Kansas
Moon Lake Electric Association, Utah
Mountrail-Williams EC, North Dakota (Whooping Crane Flyway)
Niobrara Valley EMA, Nebraska
North Western Energy, Montana
Navajo Tribal Utility Authority, Arizona
Nebraska PPD, Nebraska (Whooping Crane Flyway)
North Plains EC, Texas (Whooping Crane Flyway)
Oakdale EC, Wisconsin
Public Service Enterprise Group, New Jersey, New York

Prairieland EC, Kansas (Whooping Crane Flyway)
Red River Valley REA, Oklahoma
Rolling Hills EC, Kansas (Whooping Crane Flyway)
San Diego Gas and Electric, California
Sacramento Municipal Utility District, California
Snohomish PUD, Washington
Sempra Energy, Minnesota
Sun River EC, Montana
Short Line Power, Wyoming
TRICO Electric, Arizona
Twin Valleys PP, Nebraska
Tillamook PUD, Oregon
Toledo Edison, Ohio
United Power Company, Missouri
White River EC, Colorado
Wells Rural EC, Nevada
Western Farmers Electric Coop, Texas
Yampa Valley Electric Association, Colorado

CANADIAN CUSTOMERS

AltaLink, Alberta
ATCO, Alberta
BC Hydro, British Columbia
Fortis Alberta, Alberta
Manitoba Hydro, Manitoba
Nova Scotia Power, Nova Scotia

INTERNATIONAL CUSTOMERS

Audubon, Brazil
Bird Life International, Egypt
Endangered Wildlife Trust, Africa
ECL, New Zealand
NeoEnergia, Brazil
SAESA, Chile
Transec, Chile

APLIC

The information reviewed throughout this report is based on guidance set forth by the Avian Power Line Interaction Committee (APLIC), an association that incorporates the electrical utility industry with the protection of avian resources.

APLIC's report on Reducing Avian Collisions with Power Lines from 2012 is frequently cited for revealing the importance of marking power lines in order to curtail the detrimental impacts that power lines have on avian populations.

APLIC is also credited for their role in the development of Avian Protection Plans, which were released jointly by APLIC and the USFWS in 2005. Avian Protection Plans are voluntary, utility-specific programs designed to reduce the operational and avian risks that result from avian interactions with electric utilities, and it is within this plan that the avian power line collision prevention efforts discussed here would be showcased.

APLIC members across North America are referenced here. To learn more about Avian Protection Plans and the APLIC mission visit APLIC.org.

APLIC Service Territories



Technical Data

The following reports validate key technical results. Access to the full collection of reports is available upon request.

BFD-Series Specifications	35
BFD-050 Technical Drawing	36
BFD-075 Technical Drawing	37
BFD-150 Technical Drawing	38
BFD-AT-050-75 Technical Drawing	39
Line Marker Spacing Guidelines	40
Corona Test Report	41
RIV Test Report	42
PLS CADD Ice-Wind Load Study	43
BFD-050 IEEE 1656-5.8 120mph Test Report	44
BFD-075 IEEE 1656-5.8 120mph Test Report	
RoHS and REACH Compliance Certificate	
Long Term Observation Field Reference	
Glow Analysis	
Thermal Test Report	
Label Prismatic Markings and Reflective Properties	
Label Weather Testing Results	
Label Material Flammability Test Report	
Retention Hose Data Sheet	
Retention Hose Flammability Test Report	
Retention Hose Weathering Test Report	
Stainless Steel Rivets Salt Spray Report	
Shell Thermal Test Report	
Shell Data Sheet	
Shell UV UL Certification	
Shell UV Aging Report	

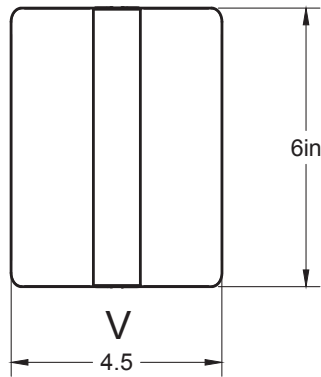
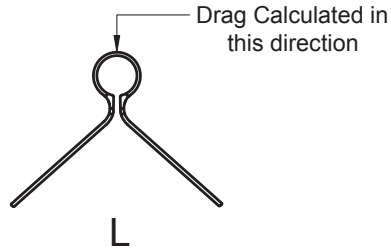
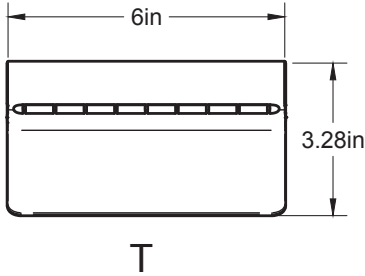
BFD-Series Specifications

SKU	Length	Height	System kV	Conductor range	Conductor diameter	Min qty
BFD-025	6"/15.24 cm	3"/7.62 cm	< 345 kV	#6 - #4	0.18" - 0.26" (4.6 mm - 6.6 mm)	50
BFD-050	6"/15.24 cm	3"/7.62 cm	< 345 kV	#4 - 300 + OPGW	0.25" - 0.68" (6.4 mm - 17.3 mm)	50
BFD-075	6"/15.24 cm	4"/10.16 cm	< 345 kV	336 - 795 MCM	0.69" - 1.09" (17.3 mm - 27.8 mm)	50
BFD-150	6"/15.24 cm	5"/12.7 cm	< 345 kV	850 - 1780 MCM	1.1" - 1.5" (27.9 mm - 38.1 mm)	50
BFD-051/ Guy wire marker *	6"/15.24 cm	3"/7.62 cm	< 345 kV	#4 -300 + OPGW	0.25" - 0.68" (6.4 mm - 17.3 mm)	50
BFD-076/ Guy wire marker *	6"/15.24 cm	4"/10.16 cm	< 345 kV	336 - 795 MCM	0.69" - 1.09" (17.3 mm - 27.8 mm)	50

* Guy wire marker includes retention clip

Tools	
BFD-AT-050-075	Hotstick compatible installation tool for BFD-050 and BFD-075
BFD-AT-150	Hotstick compatible installation tool for BFD-150

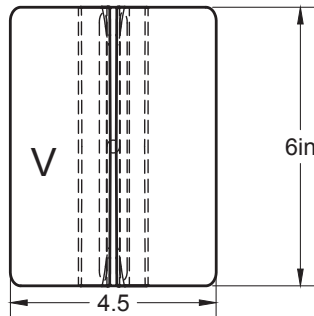
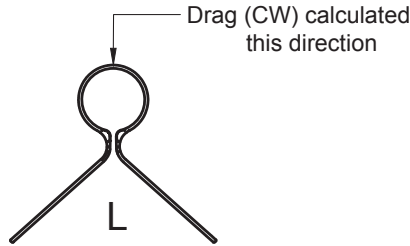
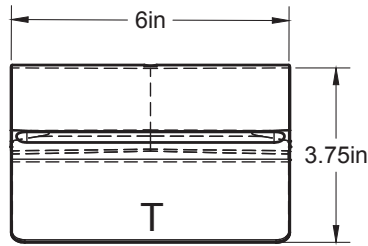
BFD-050 Technical Drawing



BFD-050 Technical Specifications	
Wgt (oz)	4.19
L area (ft ²)	.0066
V area (ft ²)	.187
T area (ft ²)	.137
PLS-CADD Load Data	
Vertical	0.26
Marker Ball Diameter (in)	4.0
Drag Coefficient	1.12
Wind Area (ft ²)	.187
Ice Area (ft ²)	.360

Power Line Sentry, LLC PowerLineSentry.com 8950 Pieper Road Wellington, Colorado 80549 1-970-599-1050		For any unspecified dimensions, reference solid model or contact Power Line Sentry	
<u>CONFIDENTIAL:</u> Property of: Power Line Sentry, LLC		Revisions on this item require inspection All dimensions are in inches Tolerances if not specified: .XX +/- .01 .XXX +/- .005 .XXXX +/- .0005 Angles +/- 1 Degree	MATERIAL DESCRIPTION Proprietary FR-UV Polymer Color: Black, Fluorescent Yellow Strips, and White Photoluminescent Glow Strip All information contained herein is the sole property of Power Line Sentry, LLC. Any reproduction of this drawing in whole or in part without the written permission of Power Line Sentry, LLC is prohibited.
SIZE A	TITLE BFD-050 Specifications for Loading Calculations	REV D	
SCALE 1:2	SKU BFD-050	SHEET 1 of 1	

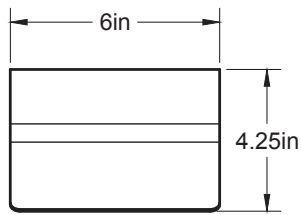
BFD-075 Technical Drawing



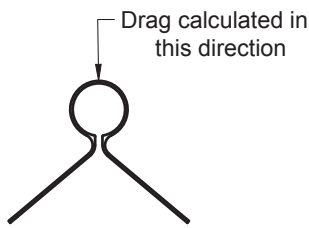
BFD-075 Technical Specifications	
Wgt (oz)	4.43
L area (ft ²)	.007
V area (ft ²)	.187
T area (ft ²)	.156
PLS-CADD Load Data	
Vertical (lbs)	.277
Marker Ball (in)	4
Drag Coefficient	1.12
Wind Area (ft ²)	.187
Ice Area (ft ²)	.365

Power Line Sentry, LLC PowerLineSentry.com 8950 Pieper Road Wellington, Colorado 80549 1-970-599-1050		For any unspecified dimensions, reference solid model or contact Power Line Sentry	
<u>CONFIDENTIAL:</u> Property of: Power Line Sentry, LLC		Revisions on this item require inspection All dimensions are in inches Tolerances if not specified: .XX +/- .01 .XXX +/- .005 .XXXX +/- .0005 Angles +/- 1 Degree	MATERIAL DESCRIPTION Proprietary FR-UV Polymer Color: Black, Fluorescent Yellow Strips, and White Photoluminescent Glow Strip All information contained herein is the sole property of Power Line Sentry, LLC. Any reproduction of this drawing in whole or in part without the written permission of Power Line Sentry, LLC is prohibited.
SIZE A	TITLE BFD-075 Specifications for Loading Calculations	REV D	
SCALE 1:2	SKU BFD-075	SHEET 1 of 1	

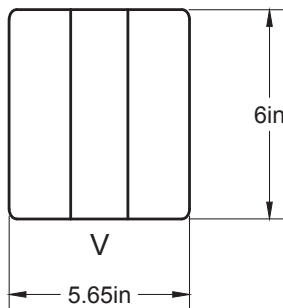
BFD-150 Technical Drawing



T



L



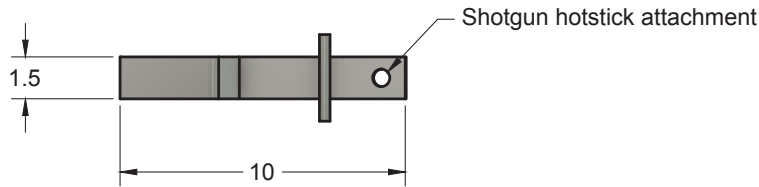
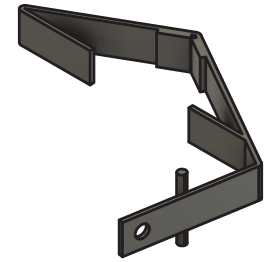
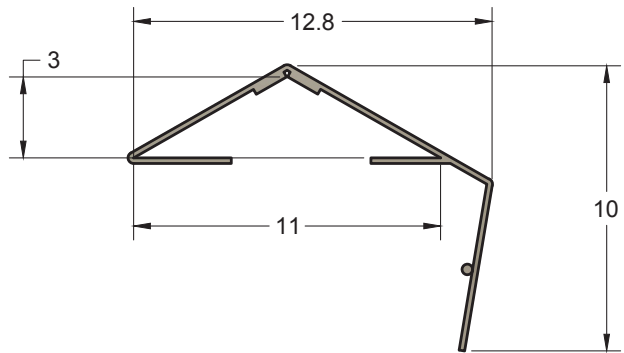
V



BFD-150 Technical Specifications	
Wgt (oz)	5
L area (ft ²)	.005
V area (ft ²)	.235
T area (ft ²)	.177
PLS-CADD Load Data	
Vertical (lb)	.3125
Marker Bal (in)	4.64
Drag Coefficient	1.12
Wind Area (ft ²)	.235
Ice Area (ft ²)	.49

Power Line Sentry, LLC PowerLineSentry.com 8950 Pieper Road Wellington, Colorado 80549 1-970-599-1050		For any unspecified dimensions, reference solid model or contact Power Line Sentry	
CONFIDENTIAL: Property of: Power Line Sentry, LLC		Revisions on this item require inspection All dimensions are in inches Tolerances if not specified: .XX +/- .01 .XXX +/- .005 .XXXX +/- .0005 Angles +/- 1 Degree	MATERIAL DESCRIPTION Proprietary FR-UV Polymer / Color: Black Flourescent Yellow Strips, Photoluminescent Glow Strip All information contained herein is the sole property of Power Line Sentry, LLC. Any reproduction of this drawing in whole or in part without the written permission of Power Line Sentry, LLC is prohibited.
SIZE A	TITLE BFD-150 Specifications for Loading Calculations	REV C	
SCALE	1:4	SKU	BFD-150
SHEET	1 of 1		

BFD-AT-050-075-M Technical Drawing



Power Line Sentry, LLC PowerLineSentry.com 8950 Pieper Road Wellington, Colorado 80549 1-970-599-1050		For any unspecified dimensions, reference solid model or contact Power Line Sentry	
CONFIDENTIAL: Property of: Power Line Sentry, LLC		Revisions on this item require inspection All dimensions are in inches Tolerances if not specified: .XX +/- .01 .XXX +/- .005 .XXXX +/- .0005 Angles +/- 1 Degree	MATERIAL DESCRIPTION Mild Steel Color: Gray All information contained herein is the sole property of Power Line Sentry, LLC. Any reproduction of this drawing in whole or in part without the written permission of Power Line Sentry, LLC is prohibited.
SIZE A	TITLE BFD-050 & 075 Shotgun hotstick installation tool	REV A	
SCALE 1:5	SKU BFD-AT-050-075-M	SHEET 1 of 1	

Line Marker Spacing Guidelines

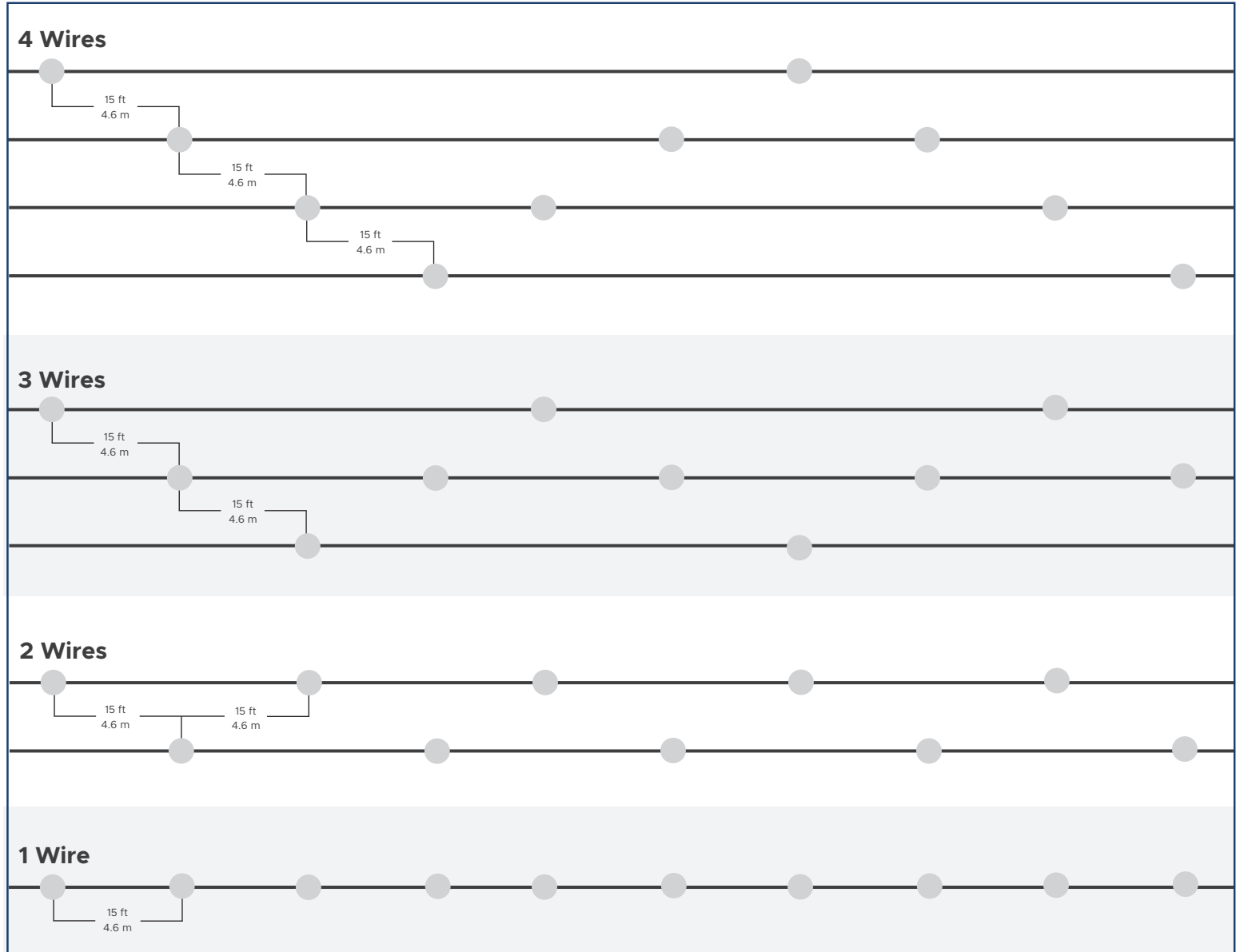
Below is the global recommended practice for spacing, regardless of marker manufacturer. In areas with avian traffic (especially where food, nesting or roosting sources are involved) APLIC guidance customarily supports staggered “W” placement with 15 feet (4.6 m) spacing between line markers. Generally, the 15 feet closest to the power pole does not need to be marked. Rationale for placement should be documented and areas where placement is greater than 15 feet apart should be monitored and modified as needed. If collisions continue these areas should be backfilled with additional diverters to achieve 15 feet spacing.

Spacing recommendations

- Areas with higher avian traffic 15 feet (4.6 m)
- Areas with lower avian traffic Up to 30 feet (9.1 m)
- Systems with multiple lines “W” placement

Examples of “W” placement on systems with multiple lines in the same horizontal plane

● Power Line Sentry Hawk Eye™ Bird Flight Diverter



Corona Report

This report shows that Power Line Sent Hawk Eye™ Bird Flight Diverter is rated for systems up to 345kV on direct conductor applications with no corona.



4 VISUAL CORONA TEST

General Information:

Standard	IEEE 61284:1997, Clause 14
Test Date	2024-10-23
Test Leader	Gaurav Patel

Environmental Conditions:

Ambient temperature	16.4 °C
Humidity	54.8 %
Barometric Pressure	790.9 mmHg

Test Conditions:

Sample numbers:	3776-1C to 3776-4C
Test Frequency:	60 Hz

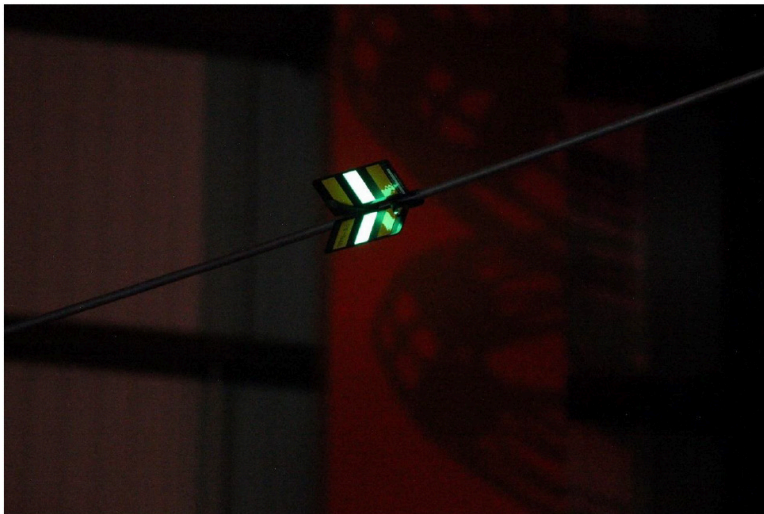


Figure 7. 3776-3C - Corona free at 122 kV

Full report available upon request

RIV Report

RIV (Radio Influence Voltage) tests measure the level of electrical interference or noise generated by a device or material under high-voltage conditions. This RIV report confirms that Power Line Sentry's Hawk Eye™ Bird Flight Diverters successfully passed the test, with all BFD-050 samples recording RIV levels below 30 dB at 80 kV, all BFD-075 samples recording RIV levels below 30 dB at 95 kV, and all BFD-150 samples recording RIV levels below 30 dB at 132.8 kV.



5 RADIO INTERFERENCE VOLTAGE (RIV) TEST

General Information:

Standard	IEEE 61284:1997, Clause 14
Test Date	2024-10-23
Test Leader	Gaurav Patel

Environmental Conditions:

Ambient temperature	16.4 °C
Humidity	54.8 %
Barometric Pressure	790.9 mmHg

Test Conditions:

Sample numbers:	3776-1C to 3776-4C
Test Frequency:	60 Hz
RIV Limit:	$\leq 30 \mu\text{V}$ (30 dB) @ 0.5 MHz,
Minimum Corona extinction voltage:	80 kV

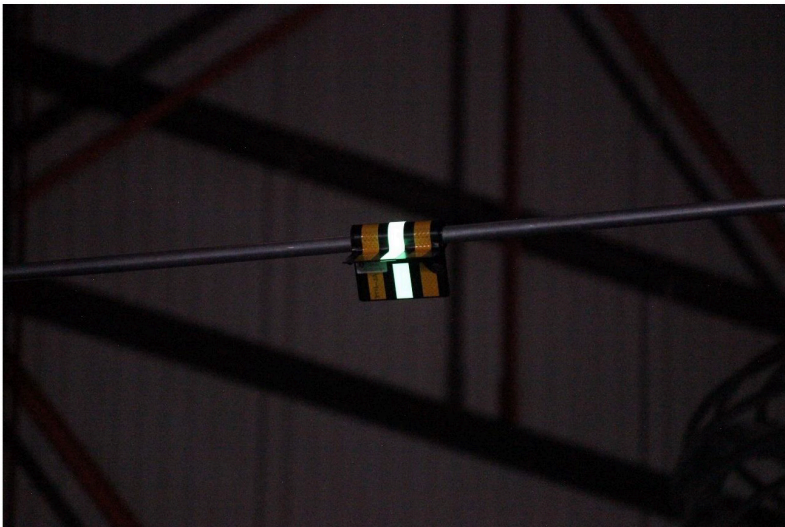


Figure 5. 3776-2A - Corona free at 219 kV

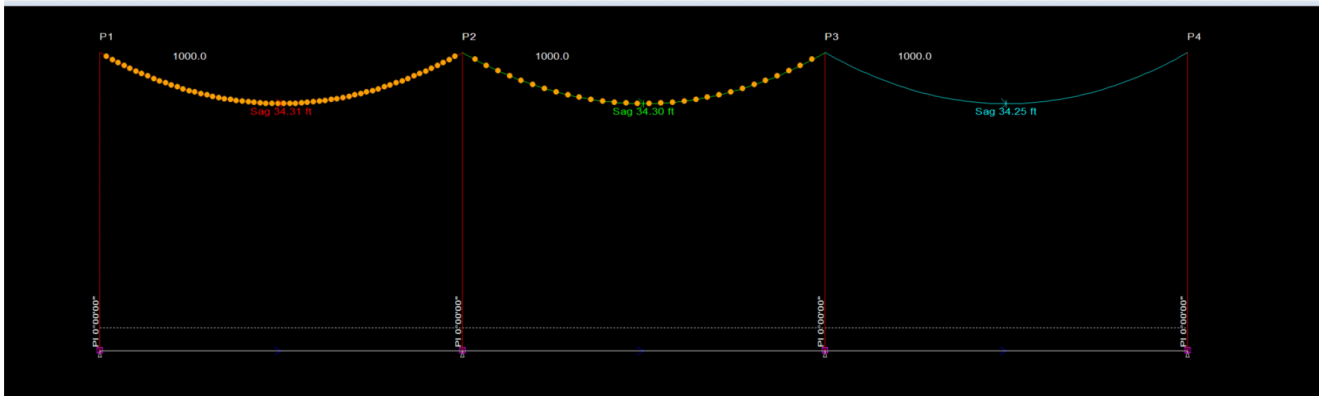
Full report available upon request

PLS-CADD Ice and Wind Loading

This is a study on the wind load effects and ice load effects of the Power Line Sent Hawk Eye™ Bird Flight Diverter BFD-075. This report details the results for 1,000 ft (305 m) OPGW sections with Hawk Eyes™ placed at 16 ft (5m) and 33 ft (10 m).

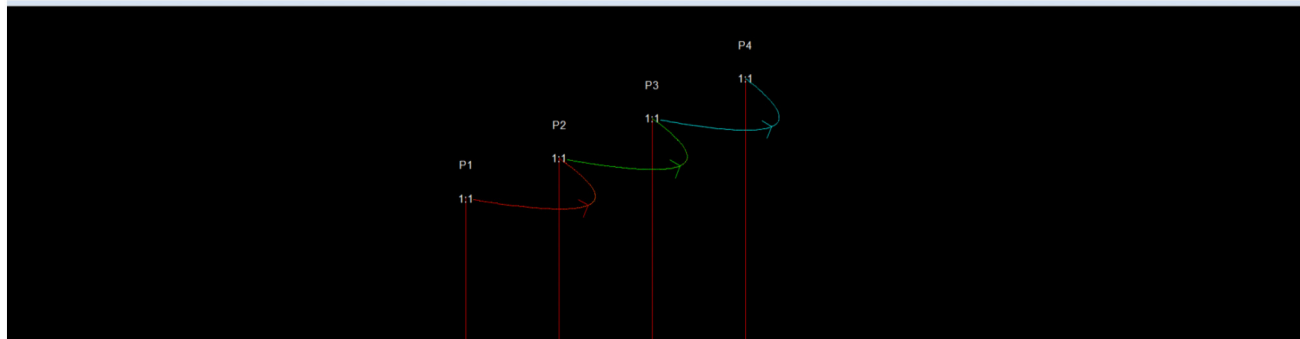
Profile View: NESIC Heavy Ice

Sec #	Start Str # Set #	End Str # Set #	Ruling Span (ft)	Insul. Clipped	Sec Notes	Cable File Name	Voltage (KV)	Current (Amps)	Bundle Shape	Bundle Spacing (in)	Wires Per Phase	Sag Condition	Sag Temp. (deg F)	Sag Horiz. Ten. (lbs)	Display Weather Case	Display Condition	Disp. Wind From	Disp. Phase	Disp. Color	Command To Apply
1	1	P1:1	P2:1	1000	No	OPGW 48 SMF	0.1			NA	1	Initial RS	60.1	3000.0	NESIC Heavy Ice	Creep FE	Left	1	Red	
2	2	P2:1	P3:1	1000	No	OPGW 48 SMF	0.2			NA	1	Initial RS	60.1	3000.0	NESIC Heavy Ice	Creep FE	Left	1	Green	
3	3	P3:1	P4:1	1000	No	OPGW 48 SMF	0.3			NA	1	Initial RS	60.1	3000.0	NESIC Heavy Ice	Creep FE	Left	1	Cyan	



3D View: Creep FE

Sec #	Start Str # Set #	End Str # Set #	Ruling Span (ft)	Insul. Clipped	Sec Notes	Cable File Name	Voltage (KV)	Current (Amps)	Bundle Shape	Bundle Spacing (in)	Wires Per Phase	Sag Condition	Sag Temp. (deg F)	Sag Horiz. Ten. (lbs)	Display Weather Case	Display Condition	Disp. Wind From	Disp. Phase	Disp. Color	Command To Apply
1	1	P1:1	P2:1	1000	No	OPGW 48 SMF	0.1			NA	1	Initial RS	60.1	3000.0	120mph	Creep FE	Left	1	Red	
2	2	P2:1	P3:1	1000	No	OPGW 48 SMF	0.2			NA	1	Initial RS	60.1	3000.0	120mph	Creep FE	Left	1	Green	
3	3	P3:1	P4:1	1000	No	OPGW 48 SMF	0.3			NA	1	Initial RS	60.1	3000.0	120mph	Creep FE	Left	1	Cyan	



Full report available upon request

Wind Retention Testing

This report shows measured results of 120+ mpr (193+ km) conducted on the Power Line Sent Hawk Eye™ Bird Flight Diverter BFD-050.



Element Materials Technology
3922 Delaware Avenue
Des Moines, IA
50313-2542 USA

P 515 266 5101
F 515 262 1910
T 888 786 7566
info.desmoines@element.com
element.com

TEST RESULTS

Sample #1	FPM Required	FPM Measured	MPH Required	MPH Measured	Allowable Requirement
#1 Position	10,560	10,650	120	121.02	Complies
#2 Position	10,560	10,680	120	121.36	Complies
#3 Position	10,560	10,700	120	121.60	Complies
#4 Position	10,560	10,620	120	120.68	Complies

Windload was held for 5 minutes each labeled location

TEST RESULTS

Sample #2	FPM Required	FPM Measured	MPH Required	MPH Measured	Allowable Requirement
#1 Position	10,560	10,640	120	120.91	Complies
#2 Position	10,560	10,630	120	120.80	Complies
#3 Position	10,560	10,730	120	121.93	Complies
#4 Position	10,560	10,670	120	121.25	Complies

Windload was held for 5 minutes each labeled location

Full report available upon request



Sources

In addition to the websites linked throughout this report, sources referenced are listed here.

Sources

Aeroconservation for the Fragmented Skies

Source: Davy, C. M., Ford, A. T., & Fraser, K. C. (2017). Aeroconservation for the Fragmented Skies. *Conservation Letters*, 10(6), 773-780.

Post-collision Impacts and Crippling Bias in Avian Species

Source: Travers, M., et al. (Year). Post-collision impacts, crippling bias, and environmental consequences. Document: Travers et al. - Post-collision impacts, crippling bias, and environmental consequences.

Quantifying and Mitigating Avian Collisions with Transmission Lines

Source: Heck, N. S., Dwyer, J. F., Harness, R. E., Landon, M. A., & Nielsen, L. A. (2016). Quantifying and Mitigating Avian Collisions with Transmission Lines in Pincher Creek, Alberta, Canada. *Environmental Concerns in Rights-of-Way Management*, 353-360.

Reducing Avian Collisions with Power Lines

Source: Avian Power Line Interaction Committee (2012). *Reducing Avian Collisions with Power Lines: The State of the Art in 2012*. Edison Electric Institute and Avian Power Line Interaction Committee .

The Sensory Ecology of Birds

Source: Martin, G. R. (2017). *The Sensory Ecology of Birds*. Oxford University Press, Oxford.

Description: This book by Graham R. Martin explores the sensory adaptations and ecology of birds, providing insight into their interactions with the environment and how these adaptations influence their behavior and vulnerability to collisions with human-made structures.

Wildlife Incident Management Handbook

Source: EWT & USAID. (2022). *Mainstreaming Wildlife Incident Management into Utilities in Southern Africa*. Johannesburg: USAID Southern Africa Energy Program and the Endangered Wildlife Trust.

Wire Marker Effectiveness Review

Source: Renewables Grid Initiative (n.d.). *Wire Marker Effectiveness Review – Nature Conservation and Restoration*. Retrieved from <https://renewables-grid.eu/topics/nature-conservation-and-restoration/wire-marker-effectiveness-review.html>

Summary: Reviews existing scientific studies and field data on the effectiveness of bird flight diverters and wire markers in reducing avian collisions with power lines.

Info@PowerLineSentry.com

+1 970 599 1050



PowerLineSentry.com