



CHELAN COUNTY

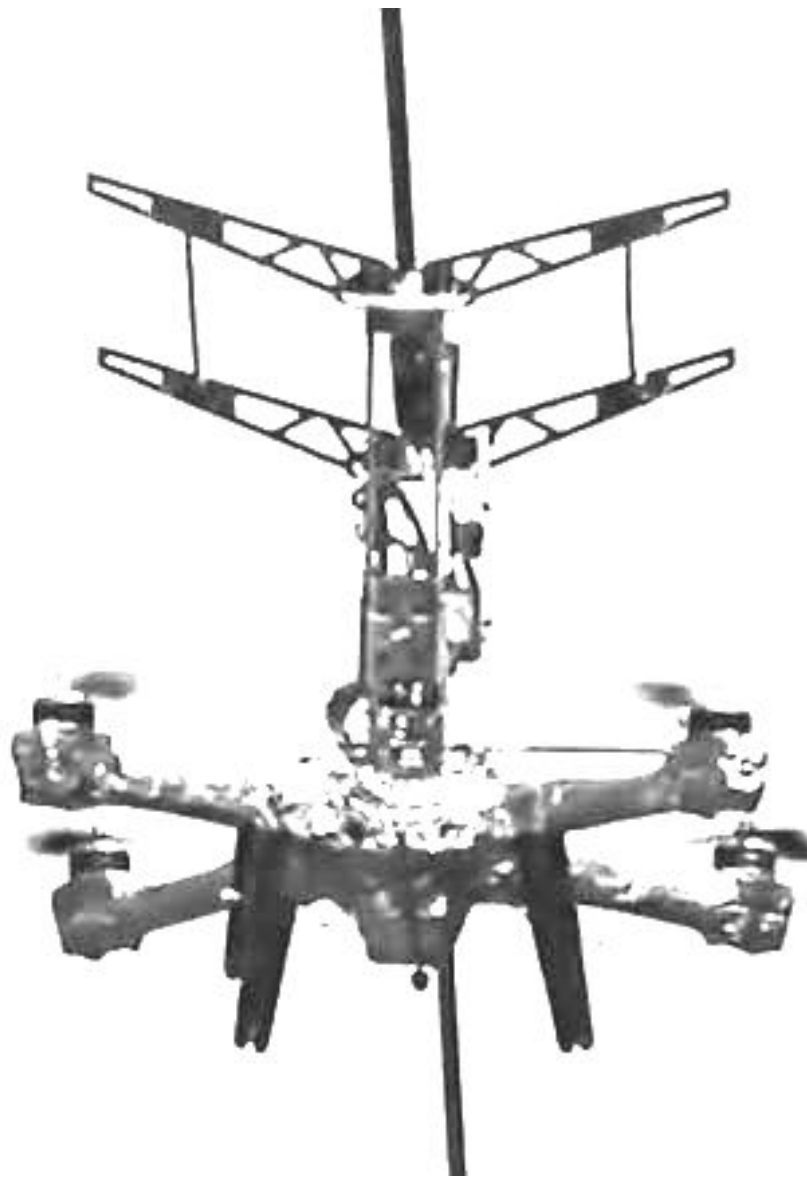
18-Month Pilot Summary

Drone-Installed Wireless Powerline Sensors

Wireless Movement Sensors Successfully Installed and Tested On 115kV Transmission Lines

In a Pilot Project for Chelan County Public Utility District, on July 8, 2020, Recon Dynamics, a Washington company, successfully installed 25 Recon Linebacker™ Powerline Sensor Tags, 4 solar-powered Recon Proxboxes, and a solar-powered weather station (for control purposes) on lines and poles near Wenatchee, Washington. The tags gathered real-time data about line movement and certain performance characteristics, such as temperature. Eighteen months later, all 25 tags were still attached and fully functional.

Recon Dynamics' patented IoT wireless technology and purpose built shielded drone enabled this unprecedented wireless monitoring of wind-based powerline movements in an effort to provide an affordable way to increase safety and to help predict damage to power lines before it's too late.





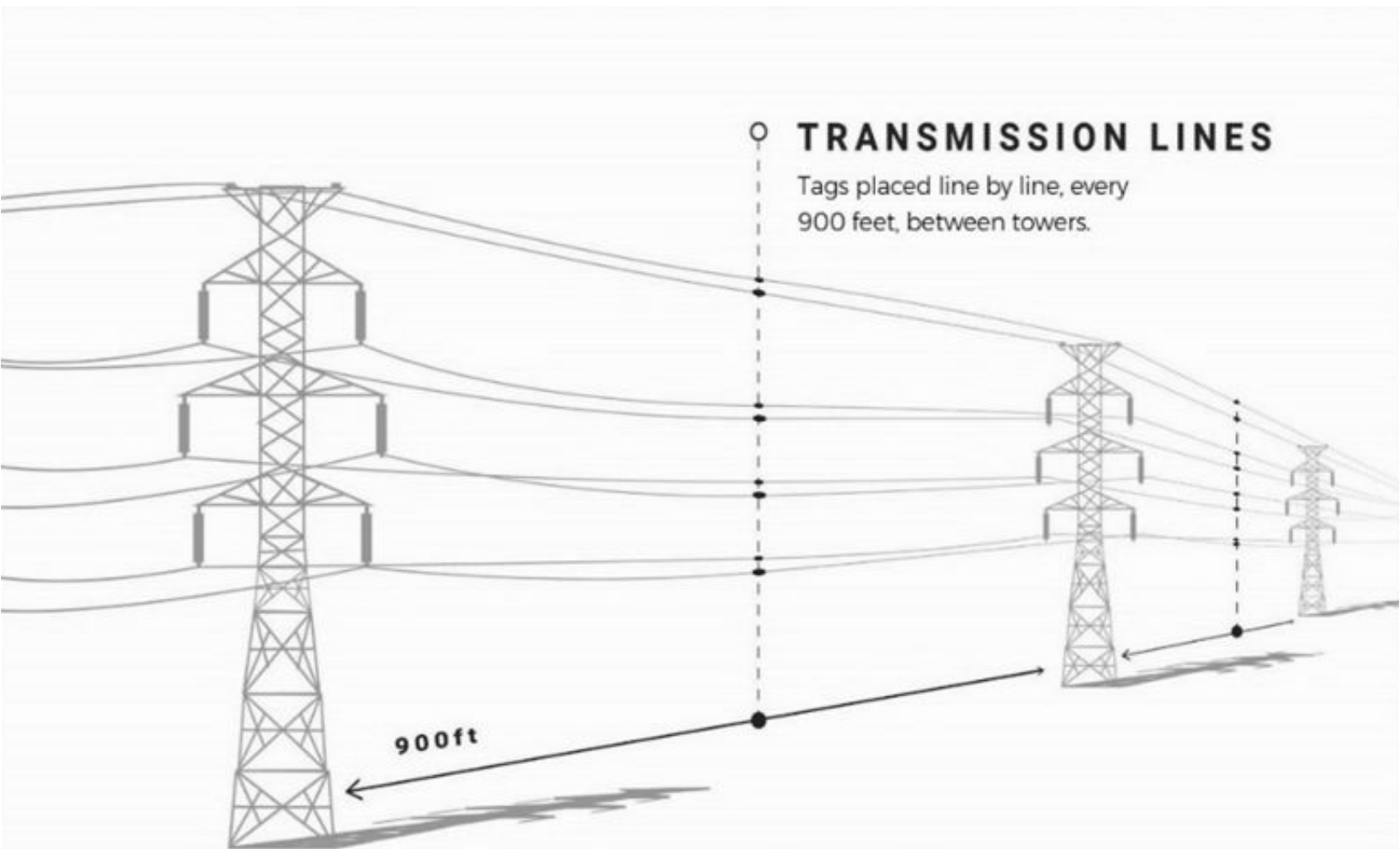
Drone Installs Movement Sensors To Help Predict Line Failure

Recon's Powerline System

Recon's line-installed wireless Linebacker Sensors detect and measure anomalous line movement, from the easiest to detect (line breakage and tree interference) to the more difficult to detect wind movement. Recon's sensors are lithium battery-powered and expected to last 5-10 years. Recon's Proxboxes, which gather data from the sensors and transmit the data to the cloud, are solar powered.

Installation Challenges Met by Shielded Drone Technology

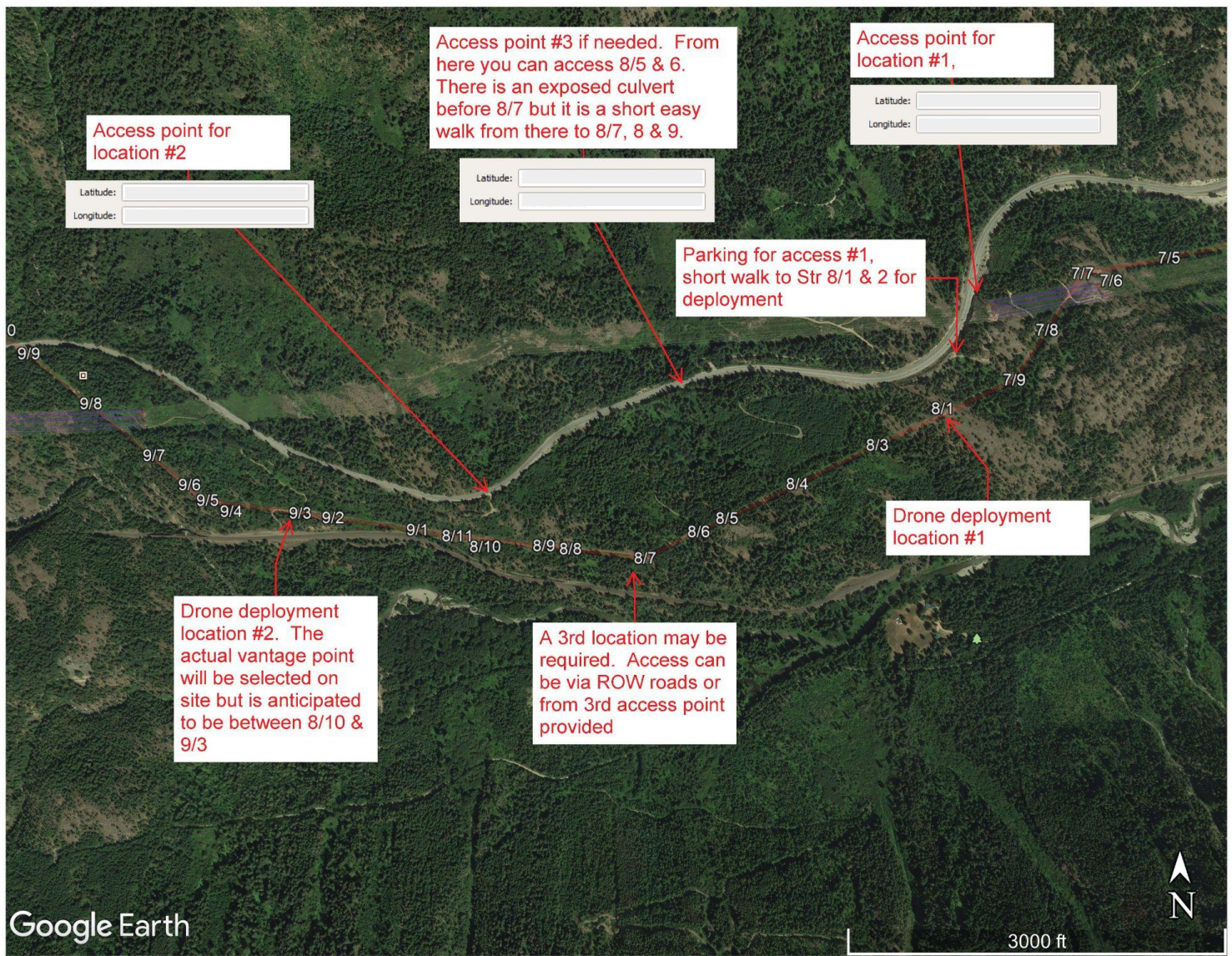
Installation of the Linebacker Sensors presents logistical and scientific challenges. Hand installation, while reliable, may be slow, expensive and comparatively dangerous. In addition, localized electric field near energized components and conductors can produce an electric discharge known as a "Corona." Until now, it was thought that using electronics near the corona was nearly impossible. However, to increase speed and efficiency, Recon has created a shielded drone that successfully operates in the Corona and installs Linebacker tags at an average flight time of only 32 seconds per tag.





July 2020 Pilot Started Near Wenatchee, Washington

Recon Dynamics successfully installed 25 Recon Linebacker™ Powerline Sensor Tags, 4 solar-powered Recon Proxboxes, and a solar-powered weather station on lines and poles near Wenatchee, Washington.. Only Access Point 1 and 2 were used.



QUICK FACTS

- 5-10+ year battery life
- Automatic data transfer
- Motion sensor
- Temperature sensor
- Over-the-air programmable
- Industrial strength
- Location tracking via install location

A cost-effective cloud-based data platform that uses line movement and vibration to detect failures and precursors to failure in electric utility assets, line-by-line and pole-to-pole in real-time.

It uses edge computing and machine learning to provide critical insight into hardware, mechanical and electrical issues on the lines that may or may not be outwardly visible – before and after ignition.

RADIO SPECIFICATION

- Standard: **802.15.4**
- RF Rx Sensitivity: **-97dBm**
- Tx Output Power: **+5.6 dBm**
- Standard Transmit Interval: **5 minutes**
- Transmit Count: **1M+**

BUILT-IN SENSORS

- Motion: **Internal 3-axis accelerometer**
- Temp: **± 3% over operating range**

PHYSICAL AND ENVIRONMENTAL

- Dimensions:
 - 10 x 8.5 x 3.5 in**
 - 243 x 215 x 83 mm**
- Weight: **9.625 oz, 271g**
- Environmental Rating: **IP68**
- Operating Temp Range:
 - 40 to +140°F**
 - 40 to +60°C**

POWER

- Battery: **Non-rechargeable Lithium Thionyl Chloride battery**





Pilot Goals

1. DRONE INSTALLATION

Can the hardware be successfully deployed using a drone? Can it both install and remove the linebacker tags?

2. NO SIGNAL INTERFERENCE

Is the range of the wireless signal near and in the area of the corona of the 115 kV transmission line affected?

Does the hardware have the ability to receive and transmit near and in the corona area of the 115kV transmission?

Can Over-the-Air updates be reliably installed?

3. SENSORS FUNCTION

Can the sensors successfully detect line movement, ambient temperature, and most importantly, wind movement, the most difficult movement to detect?

Can the sensors also detect the easy violations of trees hitting the line, broken insulators, and other abrupt changes?

4. HARDWARE DURABILITY

Does the corona effect of the 115kV transmission line damage or more quickly wear down the electronics inside the linebacker sensor?

Can the sensor can withstand the elements specific to this area of Washington State, ie. harsh winter and very hot summer?



Drone Installation

32 Seconds Per Tag



After 9 months of testing various drone shielding methodologies, on July 8th 2020, Recon successfully installed 25 tags at an average flight time pace of 32 seconds each without incident.





No Signal Interference

Over the air updates executed



Recon engineers successfully completed over-the-air updates to the installed linebacker tags:

- 1) On the day of installation,
- 2) The weeks following installation

In addition, during the weeks following the installation of the linebacker tags, Recon engineers successfully downloaded wind data from the Linebacker tags (the most difficult movement data to observe).. This wind data correlated with a wind station installed at the same site for the purpose of acting as a control.

Signal strength and quality of transmissions were verified to be as predicted for the given range and orientation of the installation.



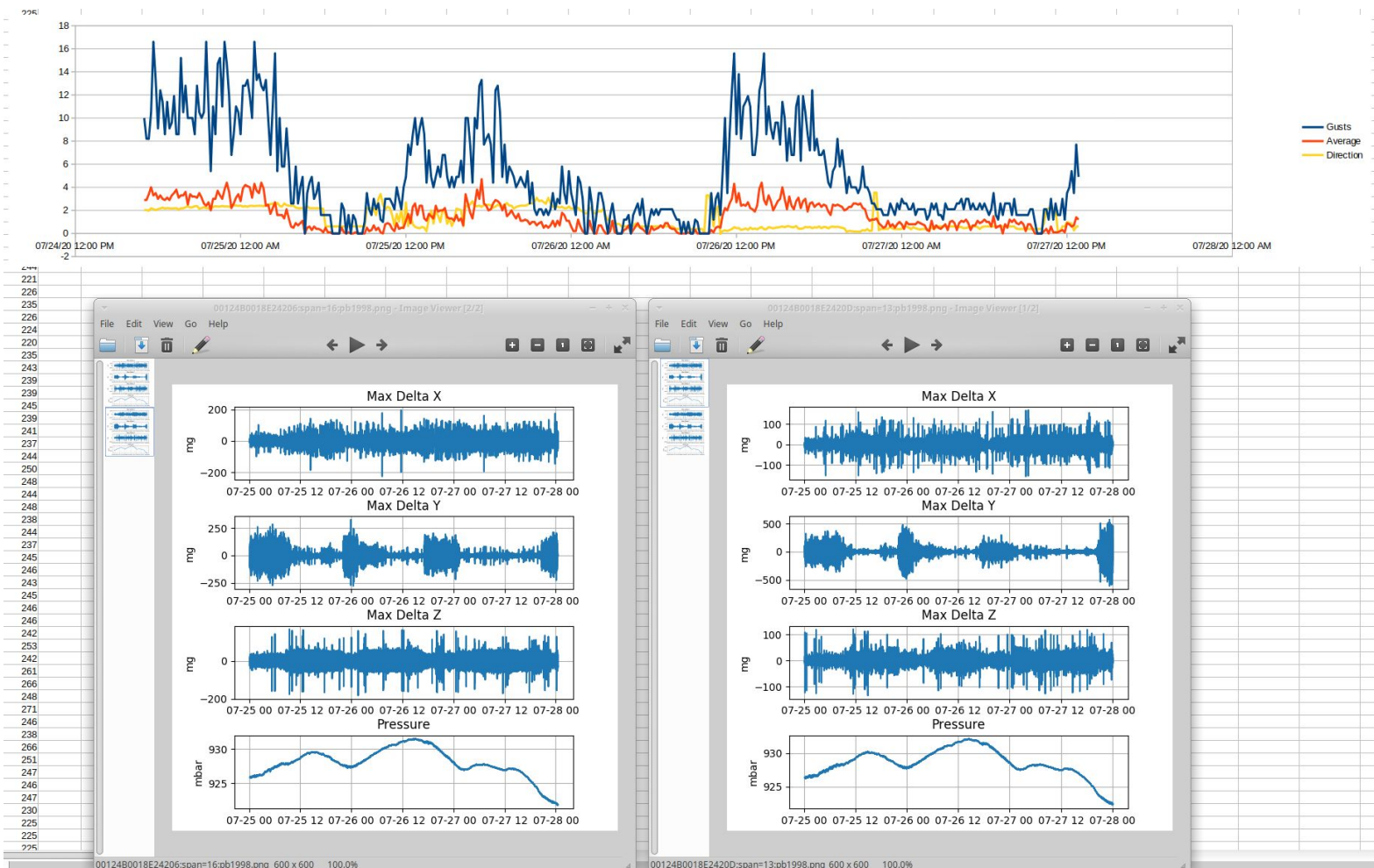
Sensors Function

Wind data matched control



During the weeks following the installation Recon engineers successfully downloaded wind data from the Linebacker tags.

This wind data correlated with a wind station installed at the same site for the purpose of acting as a control.





Hardware Durability

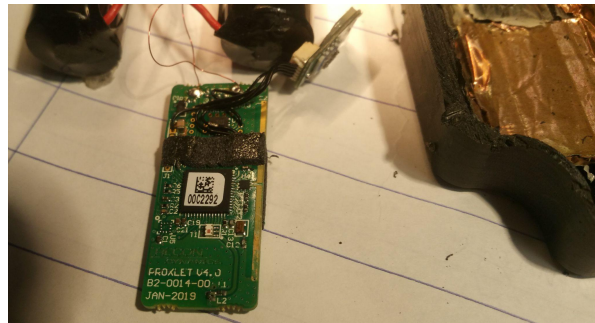
Linebackers™ unfazed



In November 2021, after nearly 18 months, power surging up to 115,000 Volts and temperature swings from -9 degrees F to 109 degrees F. Potelco Inc. employees removed all the linebacker tags from the Chelan PUD 115kV powerlines.

All 25 tags were still installed, and were recovered.

Upon detailed inspection by Recon engineers all 25 tags were still fully operational and showed no signs of any deterioration from the corona of the 115kV transmission line.



SOLAR PANEL CONNECTOR FLAW ADDRESSED

The only equipment that failed was the solar power for the Proxboxes. While the solar panels were adequate, there was a flaw in the solar connection from the panel to the controller, which led to intermittent power loss to the battery powering the Proxboxes. This connection problem was not discovered until a subsequent installation of the same panels for a different installation and different use, and has subsequently been fixed for any further Linebacker installations.



Pilot Results Summary



1. DRONE INSTALLATION - 32 Second per tag

Can the hardware be successfully deployed using a drone?



2. NO SIGNAL INTERFERENCE - Over-the-air update executed

Is the range of the wireless signal near and in the area of the corona of the 115kV transmission line affected?

Does the hardware have the ability to receive and transmit near and in the corona area of the 115kV transmission?

Can Over-the-Air updates be reliably installed?



3. SENSORS FUNCTION - Wind data matched weather station control

Can the sensors successfully detect wind movement, the most difficult movement to detect?

Can the sensors also detect the the easy violations of trees hitting the line, broken insulators, and other abrupt changes?



4. HARDWARE DURABILITY - Unfazed after 18 months

Does the corona effect of the 115kV transmission line damage or more quickly wear down the electronics inside the linebacker sensor?

Can the sensor can withstand the elements specific to this area of Washington State, ie. harsh winter and very hot summer?

