ELECTRIC POWER RESEARCH INSTITUTE

Avian Collision Avoidance System

Testing nocturnal illumination of power lines to reduce avian collision risks

3002010813

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Technical Update, December 2017

EPRI Project Managers

J. Acklen
J. Goodrich-Mahoney

ELECTRIC POWER RESEARCH INSTITUTE
3420 Hillview Avenue, Palo Alto, California 94304-1338 ▪ PO Box 10412, Palo Alto, California 94303-0813 ▪ USA
800.313.3774 ▪ 650.855.2121 ▪ askepri@epri.com ▪ www.epri.com

THE FOLLOWING ORGANIZATION, UNDER CONTRACT TO EPRI, PREPARED THIS REPORT:

EDM International, Inc.

This is an EPRI Technical Update report. A Technical Update report is intended as an informal report of continuing research, a meeting, or a topical study. It is not a final EPRI technical report.

NOTE

ACKNOWLEDGMENTS

The following organization, under contract to the Electric Power Research Institute (EPRI), prepared this report:

EDM International, Inc.
4001 Automation Way
Fort Collins, CO, 80525

Principal Investigator
Dr. James F. Dwyer

This report describes research sponsored by EPRI.

This publication is a corporate document that should be cited in the literature in the following manner:

Avian Collision Avoidance System: Testing nocturnal illumination of power lines to reduce avian collision risks. EPRI, Palo Alto, CA: 2017. 3002010813.

ABSTRACT

Large numbers of birds are killed annually in collisions with power lines. Collision mitigation usually involves installing line markers, devices designed to increase the visibility of power lines to birds in flight. This approach is problematic because it can be dangerous and expensive to install line markers, and because collisions typically persist on marked lines. The purpose of this project is to test an entirely new mechanism for increasing the visibility of power lines to birds. The mechanism to be tested is termed the Avian Collision and Avoidance System (ACAS), which will explore the use of ultraviolet (UV) light to illuminate power lines. EDM International, Inc. (EDM) has completed a conceptual design of the ACAS system, and is now building and refining an ACAS prototype. The prototype uses UV light emitting diodes (LEDs) to create light in a spectrum visible to some birds (370-390 nm), but not to humans. EDM plans to test the ACAS at the Iain Nicolson Audubon Center at Rowe Sanctuary (Rowe) southeast of Kearney, Nebraska, where two transmission power lines cross the Platte River within a major migratory stopover area. Testing will include a study designed with nightly monitoring and quantification of crane collisions with the line, relative to the on/off state or illumination distance of the ACAS system. The test will be conducted in the spring of 2018, with results available in summer 2018.

Keywords

Avian
Bird
Collision
Mortality
Sandhill Crane
Whooping Crane

Deliverable Number: 3002010813

Product Type: Technical Update

Product Title: Avian Collision Avoidance System: Testing nocturnal illumination of power lines to reduce avian collision risks

PRIMARY AUDIENCE: Electric utilities reactively addressing known avian collisions with power lines

SECONDARY AUDIENCE: Electric utilities proactively addressing potential avian collisions with power lines

KEY RESEARCH QUESTION

Avian collisions often persist on marked lines, particularly at night on transmission lines where marking is applied to overhead shield wires. It is also often dangerous and expensive to mark. The purpose of this research is to determine if the nocturnal use of ultraviolet (UV) illumination will serve to mark all wires to better reduce avian collisions, while simultaneously improving safety and reducing marking costs.

RESEARCH OVERVIEW

This research explores whether UV light, which is visible to many bird species but not to people, can be used to mitigate nocturnal avian collisions. If so, then collision mitigation using UV light may be more effective than traditional line marking, may be safer and less expensive to install, easier to maintain, and may not draw attention in the way that line markers sometimes do.

A prototype UV system is under development, and testing of the technology is planned for early 2018 at the Iain Nicolson Audubon Center at Rowe Sanctuary (Rowe) southeast of Kearney, Nebraska, where numerous Sandhill Crane (*Antigone canadensis*) collisions have been reported. Test results will be provided to the Electric Power Research Institute (EPRI) in the summer of 2018.

KEY FINDINGS

- Neither traditional lighting systems, nor lasers exist to illuminate wire spans with UV light.
- LED lights are available which illuminate in the desired UV spectrum.
- Power consumption for LED lights is low, thus advantageous for installation at remote locations.
- Non-filtered lenses must be used in tandem with UV emitting lights.
- A pre-prototype UV emitter array using LEDs with a custom circuit board has been constructed for this project.
- A prototype UV emitter will be constructed based on lessons learned from the pre-prototype.

WHY THIS MATTERS

Avian collisions are a long-term problem for electric utilities, particularly with emerging research indicating that collisions involve many more species and line locations than previously recognized. Traditional collision mitigation via line markers is prohibitively expensive in all but the most important collision sites, and is not consistently effective, often allowing collisions to persist. If UV illumination can be used to provide a more cost effective and flexible alternative to traditional line markers, collision mitigation may rapidly progress world-wide.

HOW TO APPLY RESULTS

If UV illumination is an effective mitigation strategy, electric utilities will be able to contact EPRI to ascertain where and how to secure and install UV emitter arrays.

EPRI CONTACTS: John C. Acklen, Principal Technical Leader, jacklen@epri.com; John Goodrich-Mahoney, Principal Technical Leader, jmahoney@epri.com

PROGRAM: Transmission and Distribution: Environmental Issues, Program 51

IMPLEMENTATION CATEGORY: Reference

Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

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INTRODUCTION

Large numbers of birds are killed annually in the United States by colliding with power lines [1], [2], [3]. Collision mitigation usually involves installing line markers, devices designed to increase the visibility of power lines to birds in flight [4], [5]. This approach is problematic from a conservation perspective because on average, 50% of collisions persist on marked lines [6], though collisions have been lowered by more than half in some cases [1]. Line marking is problematic from an electric utility perspective because it can involve a high level of risk to human safety during installation as line personnel sometimes install markers one-by-one from a helicopter. Line markers also can create costly long-term maintenance obligations for electric utilities [3]. The approach is problematic from a public perception perspective because, in some cases human residents object to the increased visibility of marked lines, and because only the overhead shield wires of most transmission lines can be marked. At higher transmission voltages the energized wires cannot be marked [7], creating the appearance of incomplete marking to some uninformed lay persons.

The purpose of this project is to test an entirely new mechanism of increasing the visibility of power lines to birds. The mechanism does not require the use of helicopters, does not rely on birds learning that the spaced markers that they may see indicates the presence of suspended wires that they may not see, and does not increase the visibility of wires to human residents. The mechanism also marks all wires in a span, regardless of voltage. The device to be tested is termed the Avian Collision and Avoidance System (ACAS).

The ACAS will explore the use of UV light in illuminating power lines via UV emitters mounted on existing power poles, H-frames, or lattice towers. The ACAS system is predicated on information that many birds can see UV light [8], but humans cannot (Figure 1-1).

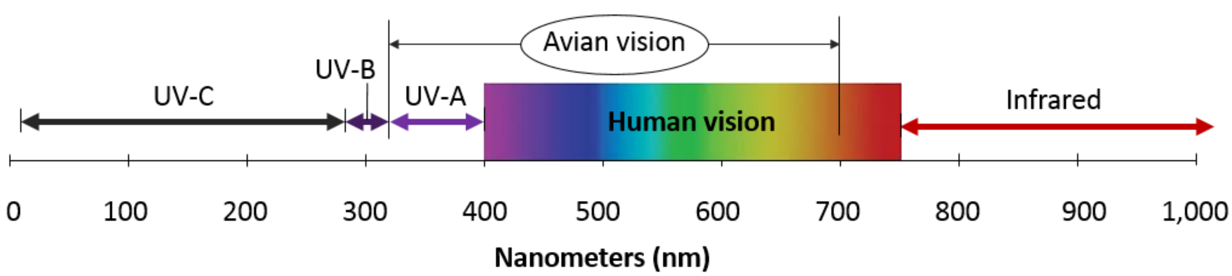

Figure 1-1
Light spectrum visible to humans and birds. Birds can see farther into the ultraviolet spectrum.

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STATUS UPDATE

Task 1. Conceptual Design

EDM has completed Task 1. Conceptual Design (Figure 2-1 and Figure 2-2). This process included exploring the functionality and expense involved in three mechanisms of creating UV light: traditional bulbs, lasers, and light emitting diodes (LEDs). EDM explored and then ruled out options for traditional bulbs because the combination of the large size of the bulbs and the necessity to include many bulbs in the emitter array would have made the emitter prohibitively large, and because traditional bulbs require more power per unit output than other light sources. Power is limited due to the design specification for solar power. EDM explored and then ruled out lasers for the conceptual design because lasers would have had to have been custom manufactured for the wavelength needed, making them prohibitively expensive. If site testing is successful, lasers may be revisited in a production design where economy of scale may reduce the relative financial impact of including lasers.

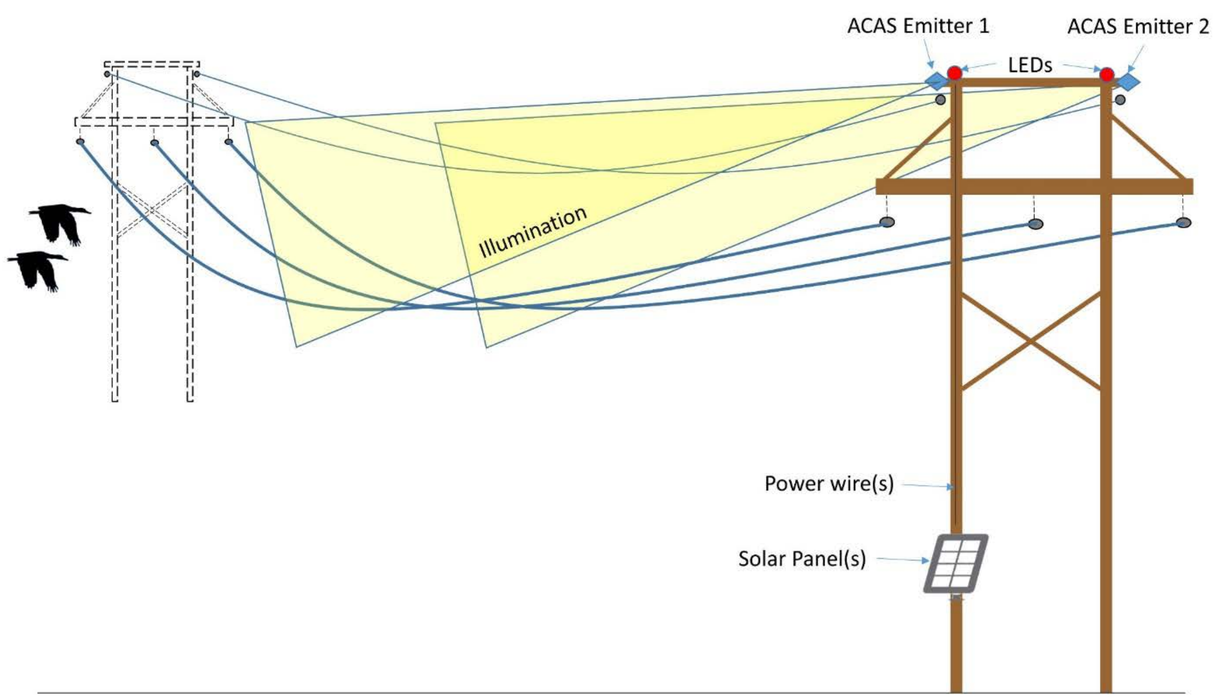

Figure 2-1
Conceptual drawing illustrating illumination of multiple wires in a typical H-frame configuration.

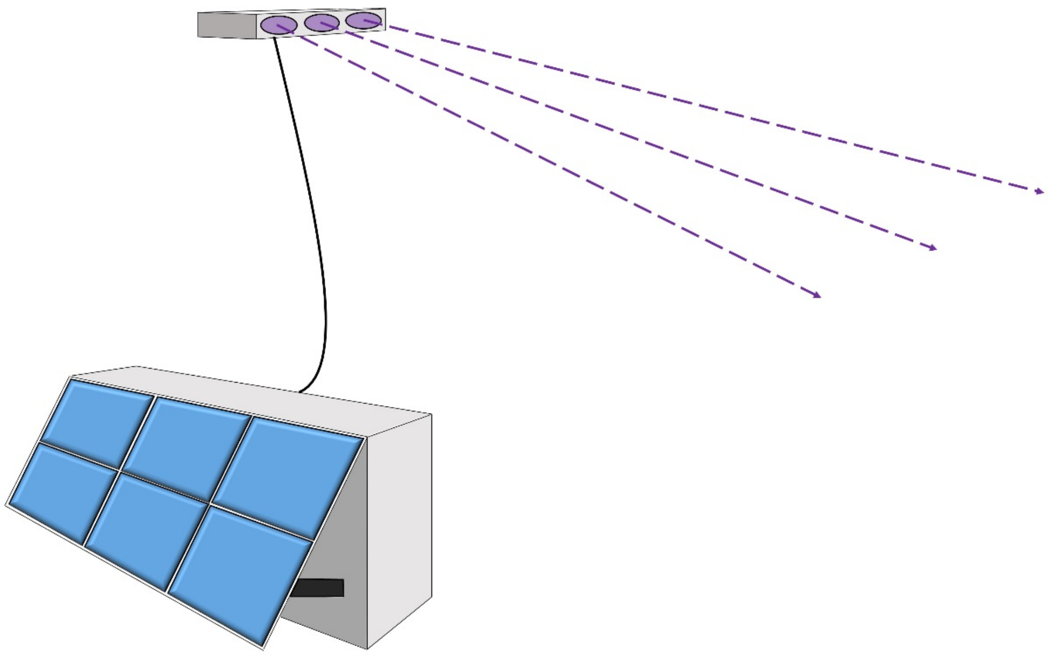

Figure 2-2
Conceptual drawing illustrating separation of UV emitters from solar panel, battery cell, and control box to minimize equipment installed above conductors.

EDM's conceptual design tests with LEDs were the most positive because LEDs generating the wavelengths needed for this project are small, lightweight, and require very low levels of electrical power, allowing multiple LEDs to be incorporated into a single emitter. LEDs producing the wavelengths need for the project (370-390 nm) are also currently mass-produced, reducing costs per unit. EDM explored various mechanisms of powering and enclosing an LED array. Existing off-the-shelf circuit boards were not suitable, and the lenses typically included in off the shelf housings included UV-filtering. Having worked through these challenges, the conceptual design now includes a 50-LED array with a custom circuit board and a non-filtered lens in a tubular housing. EDM is using this prototype to explore projection, attenuation, and focusing of the UV light produced by UV LEDs to identify a suitable arrangement of LEDs within an emitter, emitters within an array, and alignment of the array on a pole or crossarm.

Task 2. Prototype

EDM is now constructing and testing multiple iterations of an ACAS prototype (Figure 2-3 and Figure 2-4) using LED bulbs (Figure 2-5). Once constructed, EDM will continue to refine the solar panel, battery cell, and control box to meet additional technical specifications. These specifications include assembling an array of UV emitters designed to illuminate different portions of the study span.

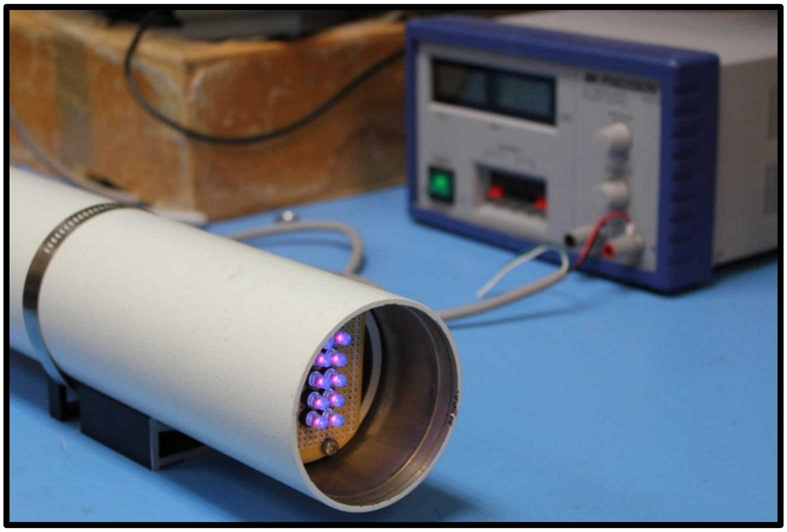

Figure 2-3
ACAS prototype. Violet-colored LEDs within the cylindrical housing produce the UV light reflected from the test panel in Figure 2-4.

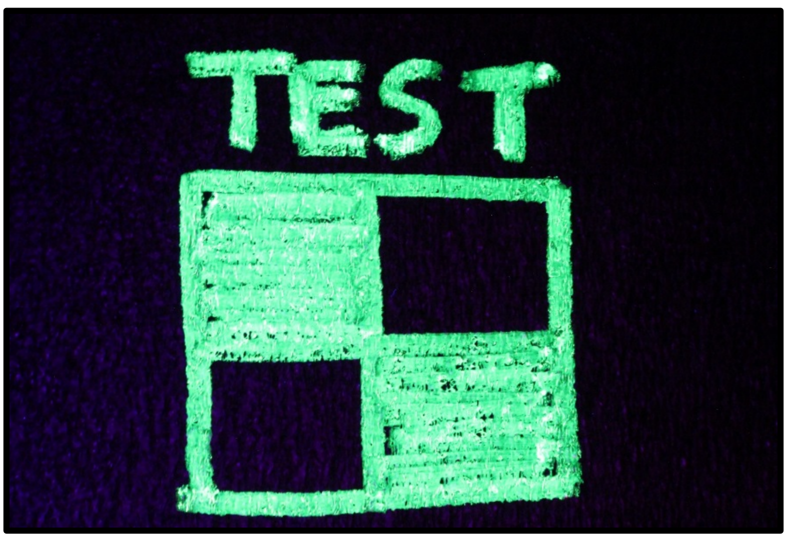

Figure 2-4
Test panel used to visually observe reflectivity of UV light. EDM also is using a UVA/UVB light meter to quantify emitter attenuation.

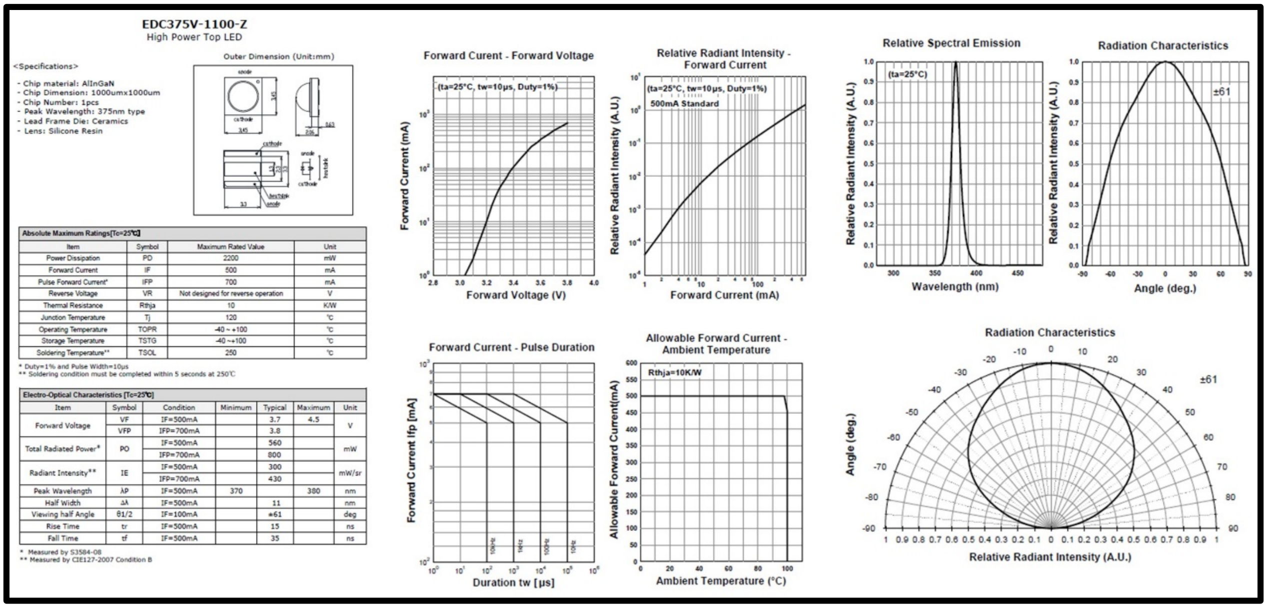

Figure 2-5
Example of technical specifications describing UV bulbs.

Additional technical specifications include:

- Multiple UV emitters arranged to light as much as possible of a 260 m (850 ft) span.
- UV-bulbs to have peak illumination in the 370-390 nm range.
- Power to be provided by solar panel.
- Manual on-off control to be enabled.
- Confirmation of on-off status to be provided via a small LED visible through binoculars.
- Solar panel, battery cell, and control box to be installed below conductors to facilitate access.
- Equipment to be mounted via bands or clamps to avoid damaging poles or crossarms.

Task 3. Site Testing

Collisions involving migrating Sandhill Cranes (*Antigone canadensis*, formerly *Grus canadensis*) occur annually at Iain Nicolson Audubon Center at Rowe Sanctuary (Rowe) southeast of Kearney, Nebraska where two transmission power lines cross the Platte River (Figure 2-6 [6], [9]. Migrating endangered Whooping Cranes (*Grus Americana* [10]) also use Rowe. Though no collisions involving Whooping Cranes are known at the site, concern persists because the behaviors and activities of Whooping Cranes and Sandhill Cranes are similar enough that Sandhill Crane collisions are taken to indicate Whooping Crane risk. This combination of ongoing Sandhill Crane collisions and potential Whooping Crane collisions have triggered the installation of multiple types of line markers at Rowe (Figure 2-7 and Figure 2-8), and multiple studies to understand the effectiveness of these line markers [6], [9]. Despite nearly a decade of effort, collisions persist.

Figure 2-6
Migrating Sandhill Cranes (*Antigone canadensis*; foreground) roosting near a transmission power line (background) on the Platte River at Rowe.

Figure 2-7
Wide view of existing markers on a transmission H-frame crossing the Platte River at Rowe.

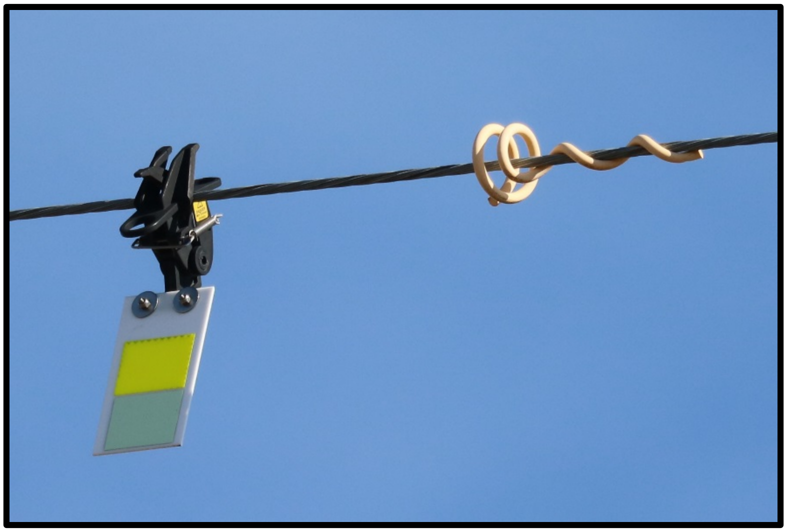

Figure 2-8
Close view of existing markers on a transmission H-frame crossing the Platte River at Rowe.

EDM plans to test the ACAS device at Rowe, anticipating that focusing testing in an area where known collisions occur within a known time frame (spring migration), and within a context where collision monitoring is already ongoing will enable EDM to identify as efficiently as possible whether the ACAS is effective. If the ACAS is effective, testing at Rowe will immediately provide a solution to mitigating collisions there, at least during the test duration. EDM has secured a verbal agreement with Rowe, a written statement of participation from Dawson Public Power (Dawson; the owner of the line), and a written statement of support from the United States Fish and Wildlife Service (USFWS). EDM is currently working with Rowe to develop a Memorandum of Understanding to clearly delineate EDM's and Rowe's responsibilities in completing the project.

EDM plans for the ACAS to be mounted on the south H-frame transmission structure of the east 69 kV transmission power line crossing the Platte River within Rowe (Table 2-1, Figure 2-9, and Figure 2-10). This line is owned and operated by Dawson, which will use a bucket truck to install the ACAS on the H-frame during February 2018, and to remove the ACAS system during May 2018. The ACAS will be tested from approximately 01 March through 18 April. If the ACAS prototype reaches entirely across the Platte River, then each evening during testing, prior to sunset the ACAS will be turned on, or not, by field personnel based on a randomized study design. If the ACAS prototype reaches only partially across the river, then the system may be turned on each night. Field personnel will then use night vision optics to identify collisions, if collisions occur, so that the occurrence of collisions can be compared to the on/off state of the ACAS, or the distance from the ACAS source, respectively. Data to be recorded include date, time, collision species, ACAS status, and estimated distance from ACAS H-frame to collision location. Field personnel will visit the study span daily to 1) turn off the ACAS system if it was left on overnight, 2) search for carcasses, and 3) identify the ages, of any carcasses found. The timing of diurnal visits and carcass searches will be dictated by the presence of roosting cranes, such that surveys will avoid disturbance.

Table 2-1
Location of H-frame structure to support the ACAS system

Coordinate System	Datum/Zone	Latitude/Easting	Longitude/Northing
UTM	14 T	511054	4502881
Decimal degrees	WGS84	40.676728°	-98.869212°
Degrees, minutes, seconds	WGS84	40°40'36.22"N	98°52'9.16"W

Figure 2-9
Overview of the two 69kV transmission power lines crossing Rowe. Black dashed lines: 69 kV transmission lines not included in this study. White dashed line: 69 kV transmission span to be included in this study. Black circle: Rowe Headquarters buildings. Black box: Inset of close view (Figure 2-10).

Figure 2-10
Close view of study span. Black dashed lines: 69 kV transmission line not included in the study. White dashed line: 69 kV transmission line to be included in the study. White arrows: generalized indication of the ACAS system's effective direction. White circle: candidate location of observation blind.

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3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 • USA
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