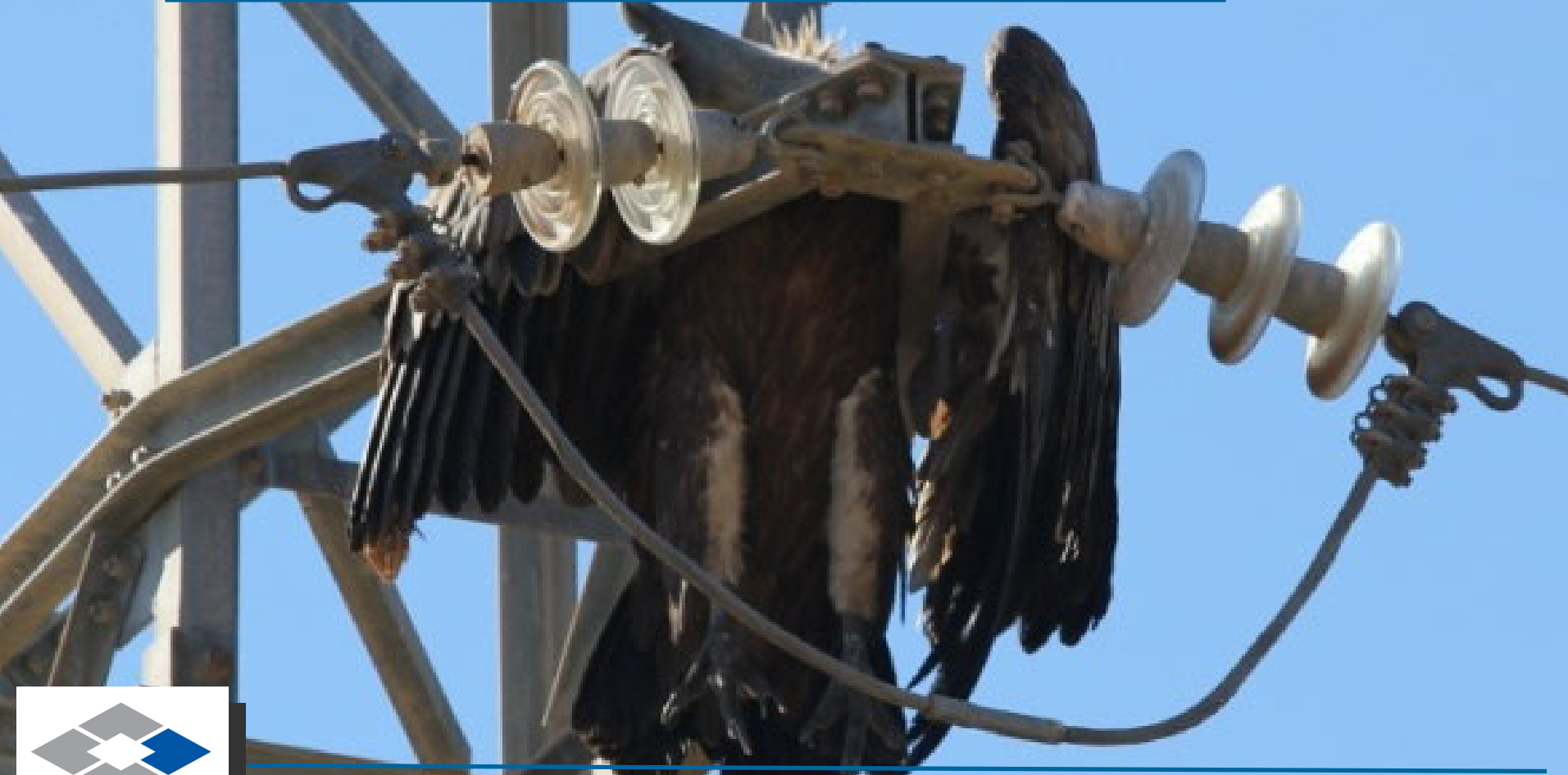


# Preventing Avian Electrocutions and Collisions on Power Lines and in Substations

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**EDM**  
reliability & innovation

JAMES F. DWYER ([jdwyer@edmlink.com](mailto:jdwyer@edmlink.com)), EDM International, Inc., USA



+1 863 464 0272

# Outline

- ❖ **Introduction**
- ❖ Retrofitting Errors
- ❖ Identify Error Types
- ❖ Collisions
- ❖ Collision prevention
  - > UAS line marking
  - > The ACAS
- ❖ Substations
  - > Mitigation



# Introduction

- ❖ Electrocutions occur when birds become part of an electrical circuit
- ❖ The odds of creating a circuit increase with:
  - Biological factors - increasing bird size
  - Engineering factors - decreasing separation
  - Environmental factors - increasing habitat quality





# Outline

- ❖ Introduction
- ❖ **Retrofitting Errors**
- ❖ Identify Error Types
- ❖ Collisions
- ❖ Collision prevention
  - > UAS line marking
  - > The ACAS
- ❖ Substations
  - > Mitigation





# Types of Retrofitting Errors

- ❖ Examples from:
  - Dwyer et al. 2017
  - Dwyer et al. 2019
  - RUS and KAZ

*J. Raptor Res.* 51 (3):293–304  
© 2017 The Raptor Research Foundation, Inc.

## AVIAN ELECTROCUTIONS ON INCORRECTLY RETROFITTED POWER POLES

JAMES F. DWYER,<sup>1</sup> RICHARD E. HARNESS, AND DUNCAN ECCLESTON  
*EDM International Inc., Fort Collins, CO 80525 U.S.A.*

## The Journal of Caribbean Ornithology

RESEARCH ARTICLE

Vol. 32:4–10, 2019

Retrofitting power poles to prevent electrocution of translocated Ridgway's Hawks (*Buteo ridgwayi*)

*Ardeola* 70(1), 2023, 3–27

DOI: 10.13157/arla.70.1.2023.rp1

### Review

## AVIAN ELECTROCUTIONS ON POWER LINES IN KAZAKHSTAN AND RUSSIA

## ELECTROCUCIONES DE AVES EN TENDIDOS ELÉCTRICOS EN KAZAJISTÁN Y RUSIA

James F. DWYER<sup>1</sup>\*, Igor V. KARYAKIN<sup>2</sup>, José Rafael GARRIDO LÓPEZ<sup>3</sup>  
and Elvira G. NIKOLENKO<sup>2</sup>

**SUMMARY.**—Electrocutions involving power lines negatively impact avian populations on six continents. Affected species and mitigation strategies to minimise these effects are well described in parts of North America, Europe and southern Africa and are being developed in Asia, Australia and South America. Probably the most geographically dispersed electric system in the world is in Russia, where avian electrocutions have been documented since the 1970s. Research into avian electrocutions in Kazakhstan and southern Russia is extensive but is largely unknown outside Russia, which limits opportunities to consider cumulative regional effects. This review summarises what is known of avian electrocutions in Kazakhstan and Russia. Avian electrocutions on power lines were first identified in Russia in 1937, with concerns focused on impacts on electric system reliability, not wildlife populations. Electrocutions increased substantially in the 1970s when construction standards transitioned from wooden poles with wooden crossarms, which posed relatively low risk, to concrete pylons with steel crossarms, which posed and continue to pose much higher risks. Impacts to raptor populations are greatest where 6–10kV electric systems traverse vast arid landscapes with few natural tall perches. Birds perching on pylons can simultaneously contact live (energised) conductors and earthed (grounded) crossarms, creating an electrical circuit. Raptors are the bird group most often electrocuted, and this source of non-natural mortality is contributing to declines in Asian raptor populations. For example, Steppe Eagle *Aquila nipalensis* populations have collapsed in the Caspian steppes of Kazakhstan and southern Russia, declining from 20,000 pairs to 1,100 pairs. Fines for electrocutions codified in Russian law are intended to persuade Russian electric utilities to implement mitigation measures, but because fines are rarely enforced either within Russia or within neighbouring countries, mitigation measures are largely omitted even in new construction, and even in places with extensive documentation of electrocutions. Importantly, electric systems are similar across the many countries of the former Soviet Union that now share international boundaries and connected electric systems, probably

# Types of Retrofitting Errors

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## ❖ Product design errors

- Products do not sufficiently cover equipment

## ❖ Mitigation plan errors

- Retrofitting plans do not consider all potentially dangerous locations

## ❖ Application errors

- Appropriate materials or techniques are installed or applied incorrectly

## ❖ Improvisation errors

- Home-made covers do not meet requirements

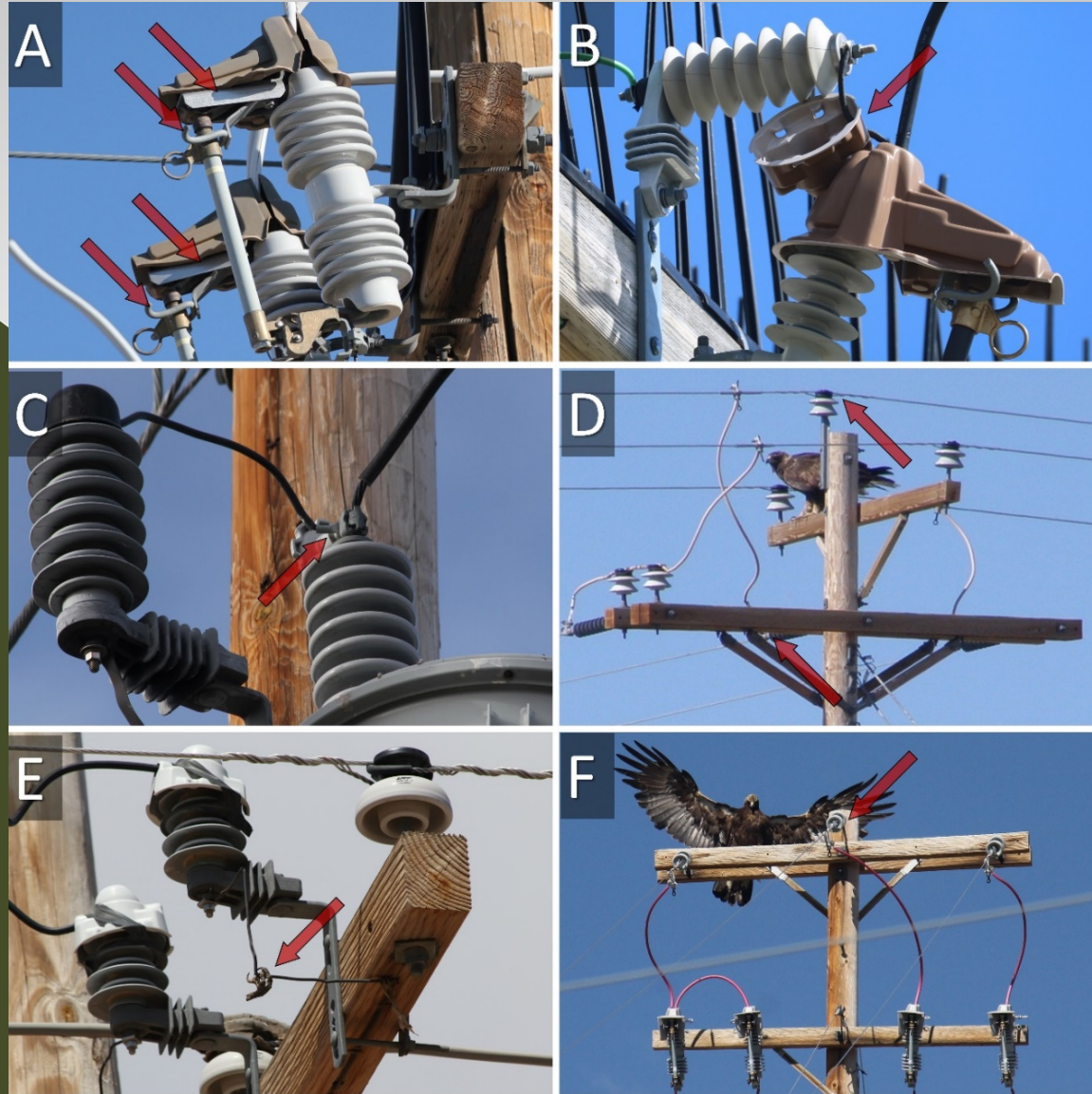
## ❖ Maintenance errors

- Lost or removed covers are not reinstalled



# Types of Retrofitting Errors

- ❖ Product design errors
  - > (A), (B), (C)
  - > Products do not fully cover energized equipment





# Types of Retrofitting Errors

- ❖ Product design errors
  - > Products do not fully cover energized equipment



# Types of Retrofitting Errors

- ❖ Product design errors
  - > Products do not fully cover energized equipment

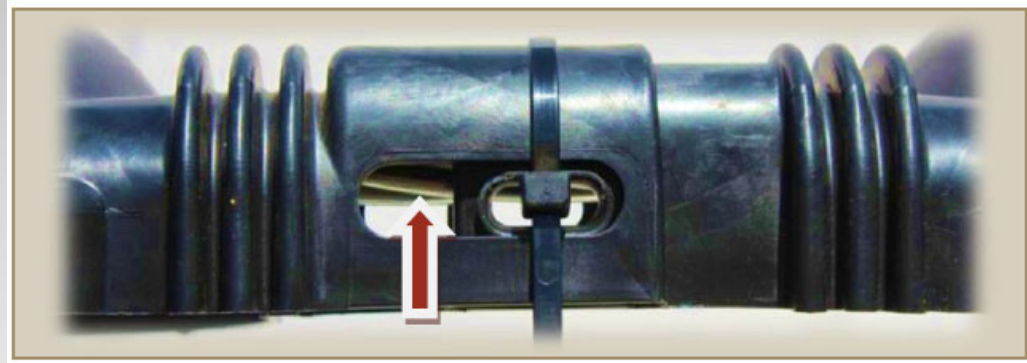
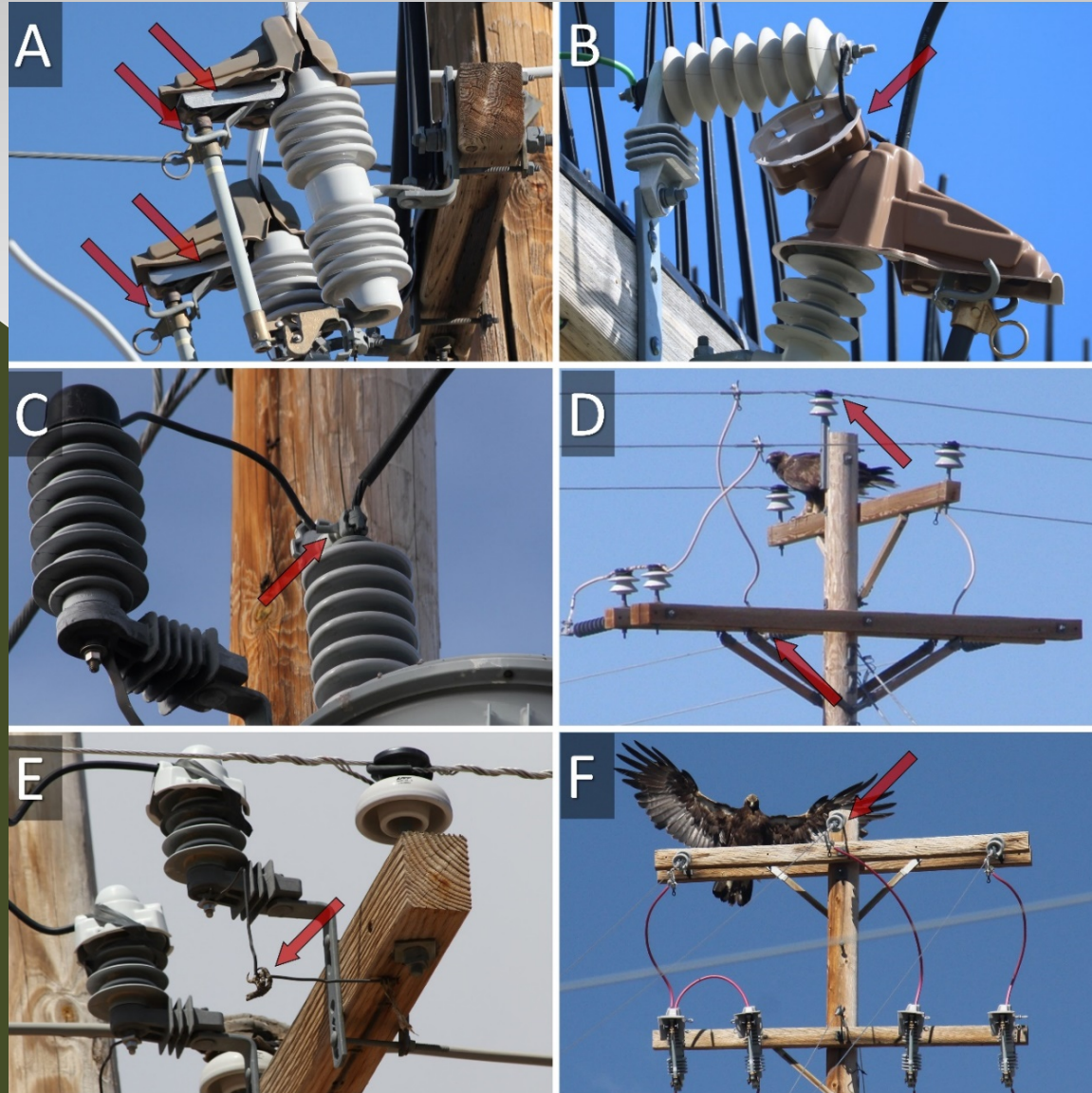


Photo: Elista (2015)



# Types of Retrofitting Errors

- ❖ Mitigation plan errors
  - > (D), (E), (F)
  - > Retrofitting plans do not consider all potentially dangerous locations

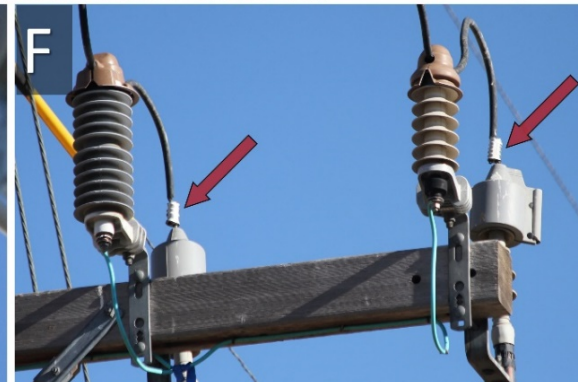
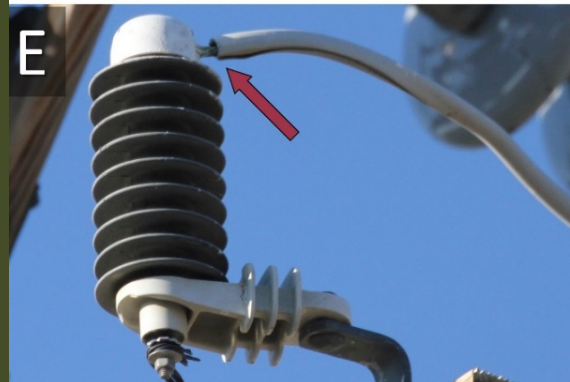
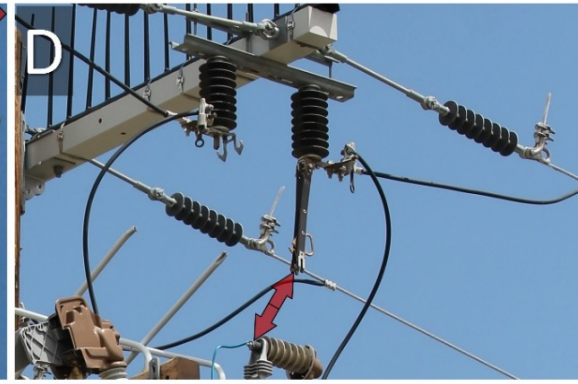
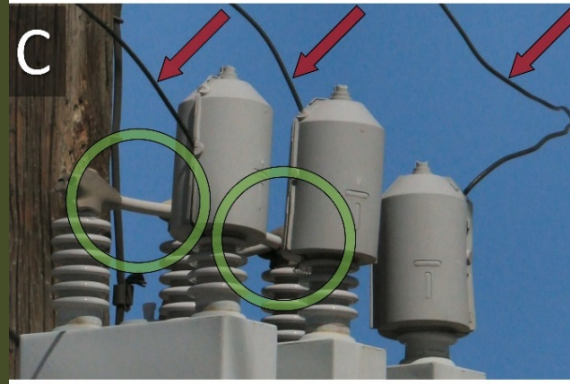




# Types of Retrofitting Errors

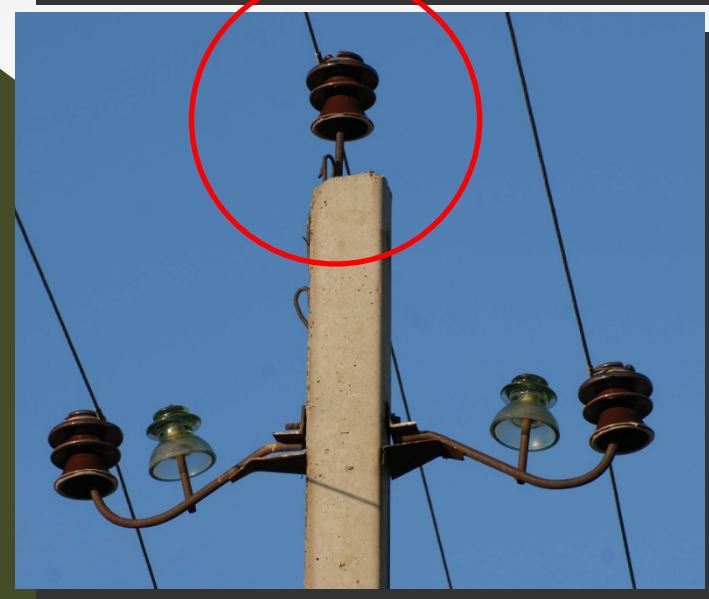
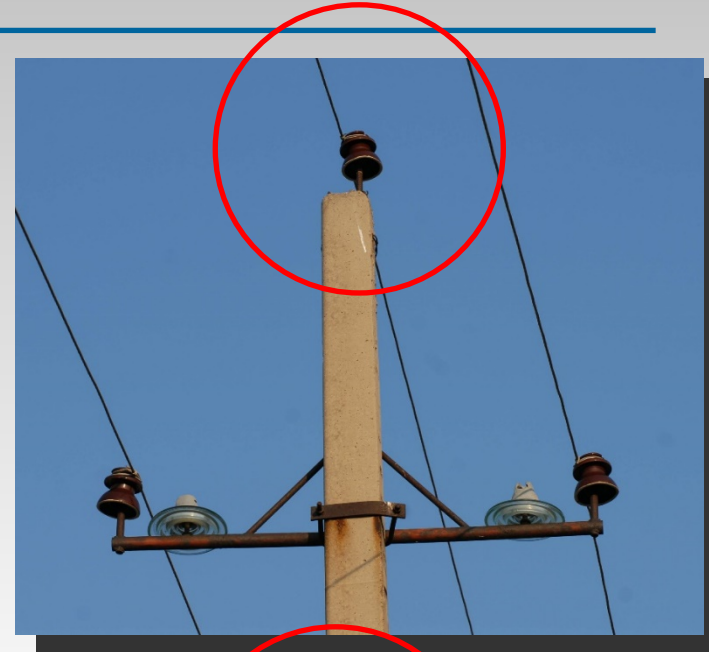
## ❖ Mitigation plan errors

- (A), (B), (C)
- Retrofitting plans do not consider all potentially dangerous locations



# Types of Retrofitting Errors

- ❖ Mitigation plan errors
  - > Retrofitting plans do not consider all potentially dangerous locations

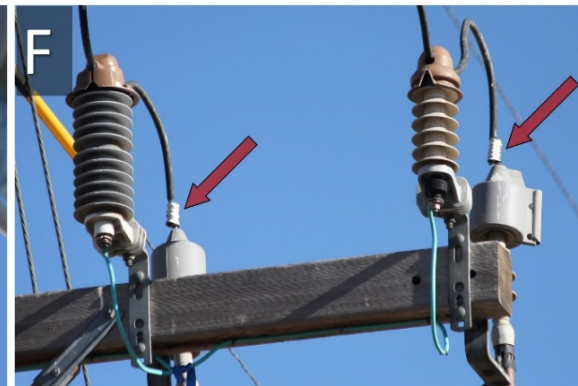
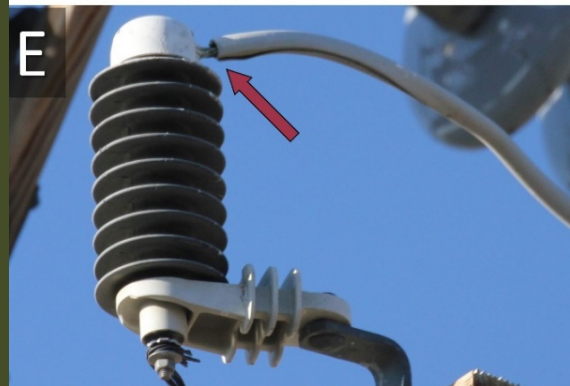
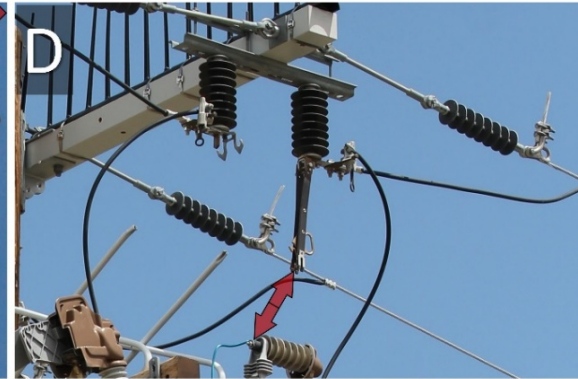
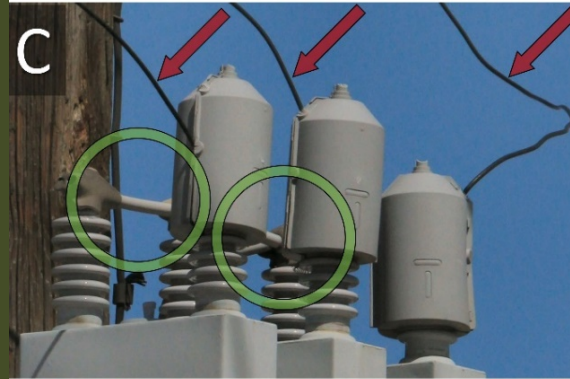
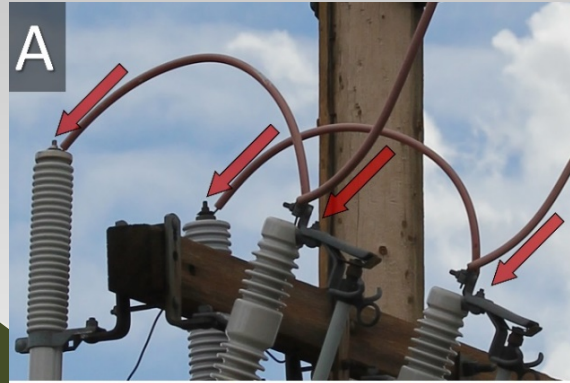


Photos: A. Matsyna



# Types of Retrofitting Errors

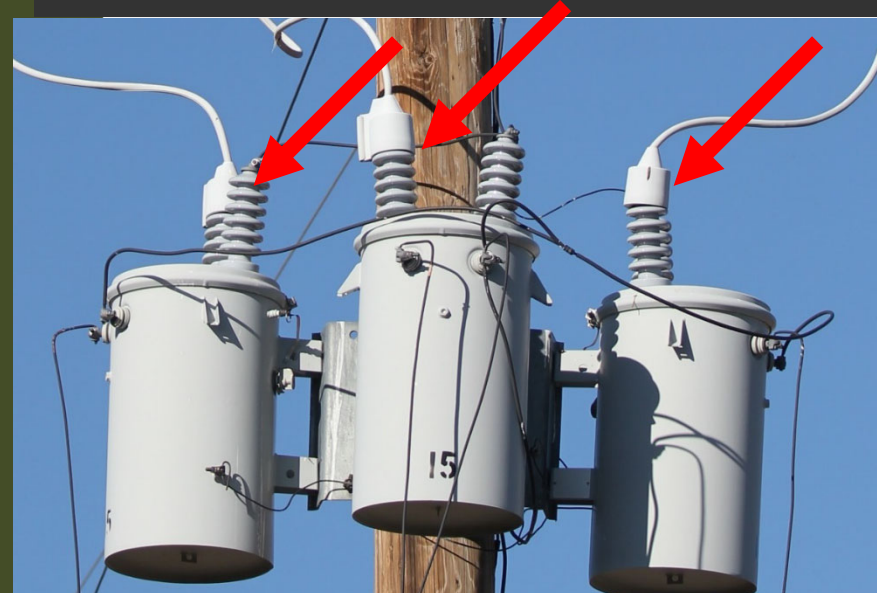
- ❖ Application errors
  - > (D), (E), (F)
  - > Appropriate materials or techniques are installed or applied incorrectly





# Types of Retrofitting Errors

- ❖ Application errors
  - > Appropriate materials or techniques are installed or applied incorrectly



# Types of Retrofitting Errors

- ❖ Application errors
  - > Appropriate materials or techniques are installed or applied incorrectly

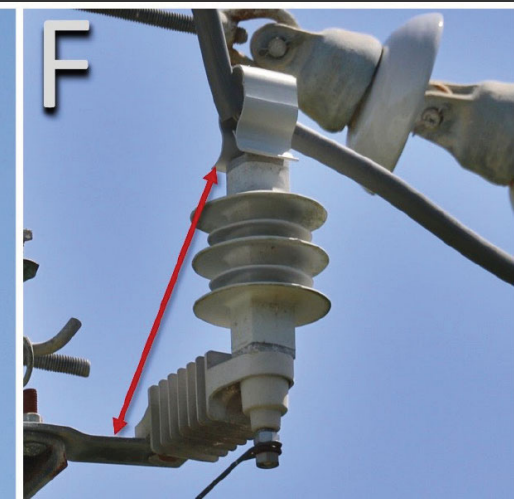
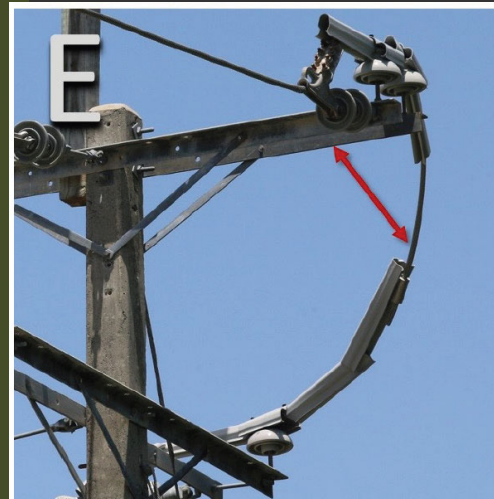


Photo: Elista 2015



# Types of Retrofitting Errors

- ❖ Improvisation errors
  - > home-made covers do not meet requirements for coverage, electrical resistance, environmental conditions, or durability





# Types of Retrofitting Errors

- ❖ Improvisation errors
  - > home-made covers do not meet requirements for coverage, electrical resistance, environmental conditions, or durability



Photo: I. Karyakin



# Types of Retrofitting Errors

- ❖ Maintenance errors
  - Covers removed during maintenance or dislodged and encountered during maintenance are not reinstalled



# Outline

- ❖ Introduction
- ❖ Retrofitting Errors
- ❖ **Identify Error Types**
- ❖ Collisions
- ❖ Collision prevention
  - > UAS line marking
  - > The ACAS
- ❖ Substations
  - > Mitigation



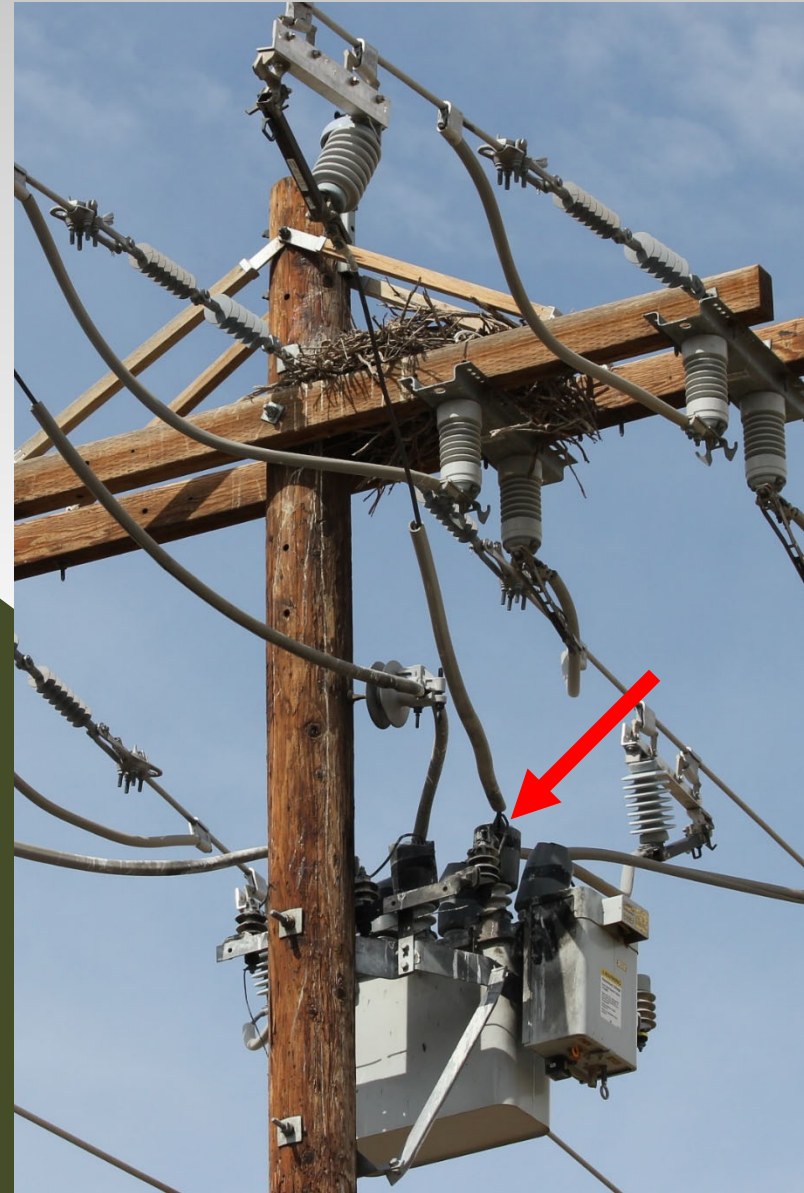


# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:

Ensure field crews are provided with all the materials they need (including training)

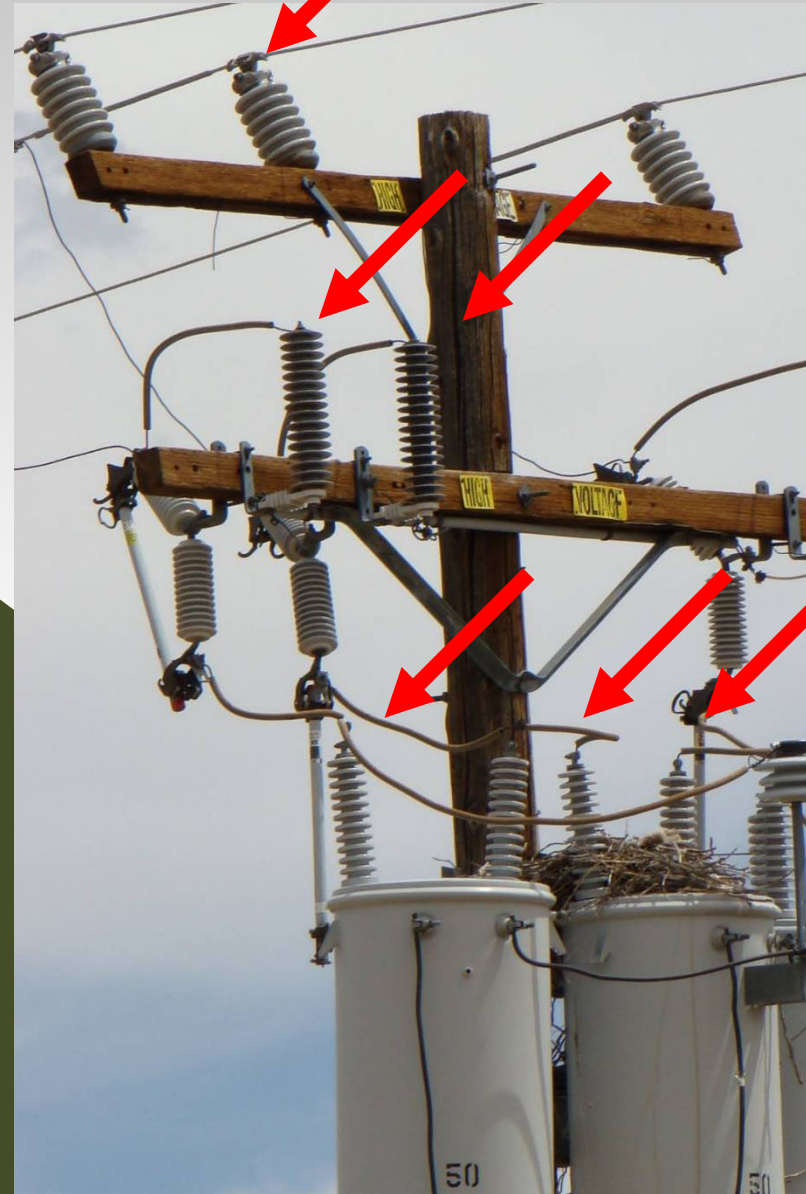


# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:

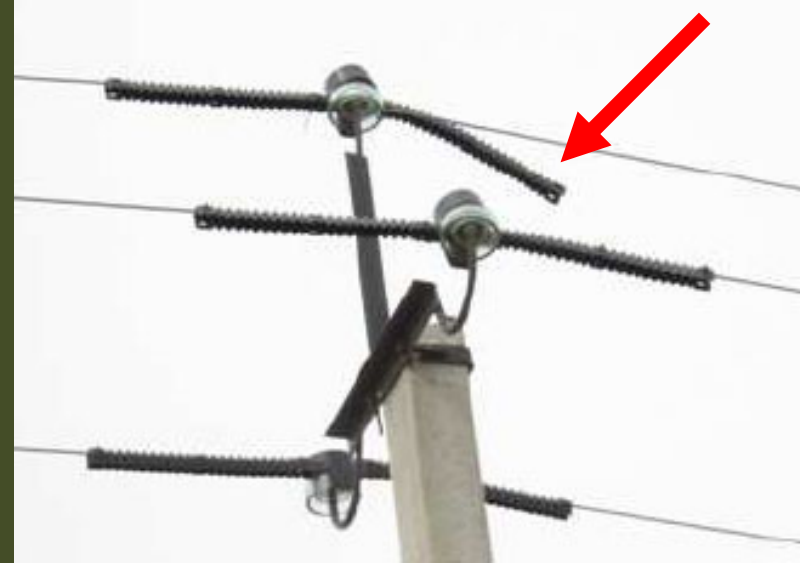
Ensure field crews are provided with all the materials they need (including training)



# Identify the Errors

1. Product design errors?
2. Mitigation plan errors
3. Application errors?
4. Improvisation errors
5. Maintenance errors

Solution:  
Avoid covers that require zip ties to stay in place?



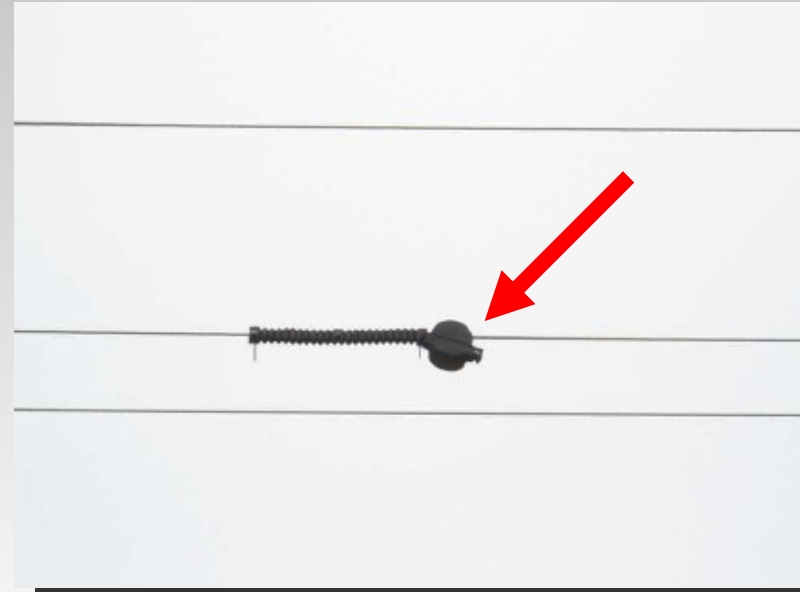
Photos: Goroshko (2016)



# Identify the Errors

1. Product design errors?
2. Mitigation plan errors
3. Application errors?
4. Improvisation errors
5. Maintenance errors

Solution:  
Avoid covers that require  
zip ties to stay in place?



Photos: Goroshko  
(2016)

# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:

Ensure field crews are provided with all the materials they need (including training)



Photos: A. Saltykov,  
R.A Medzhidov

# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:  
Ensure field crews are provided with all the materials they need (including training)

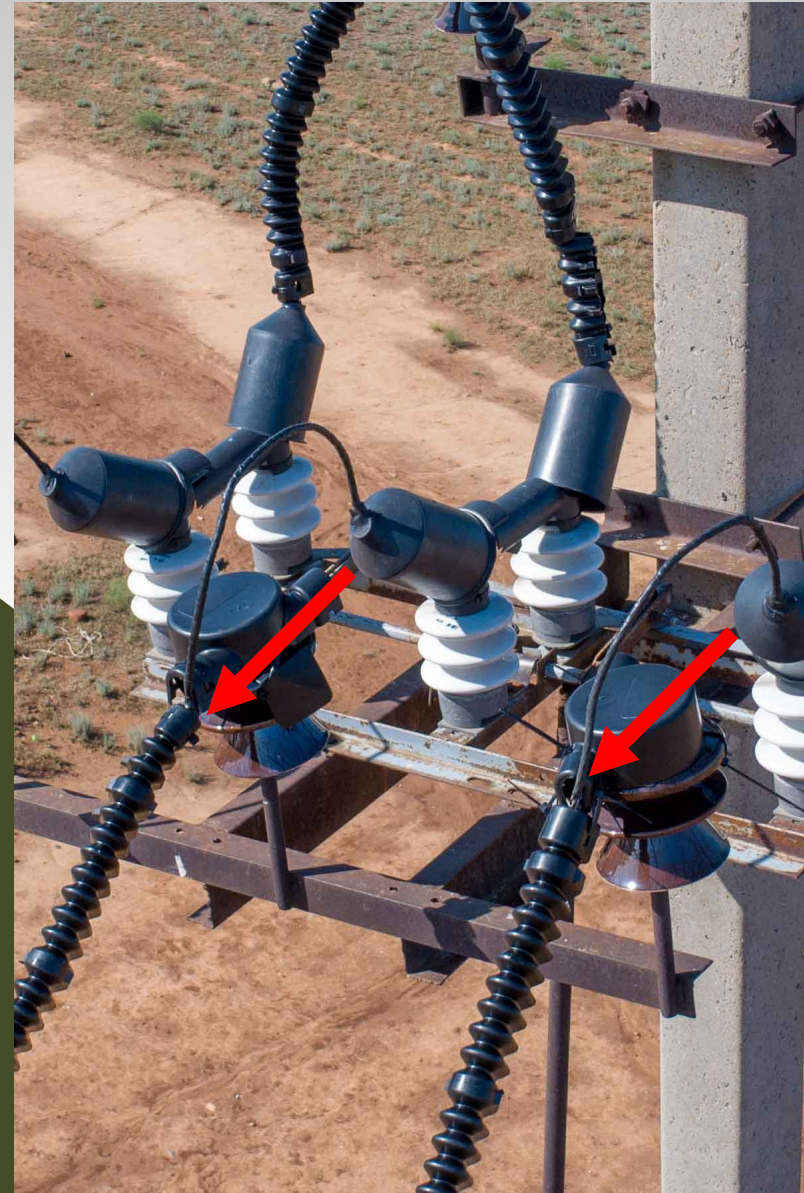


Photo: E. Nikolenko



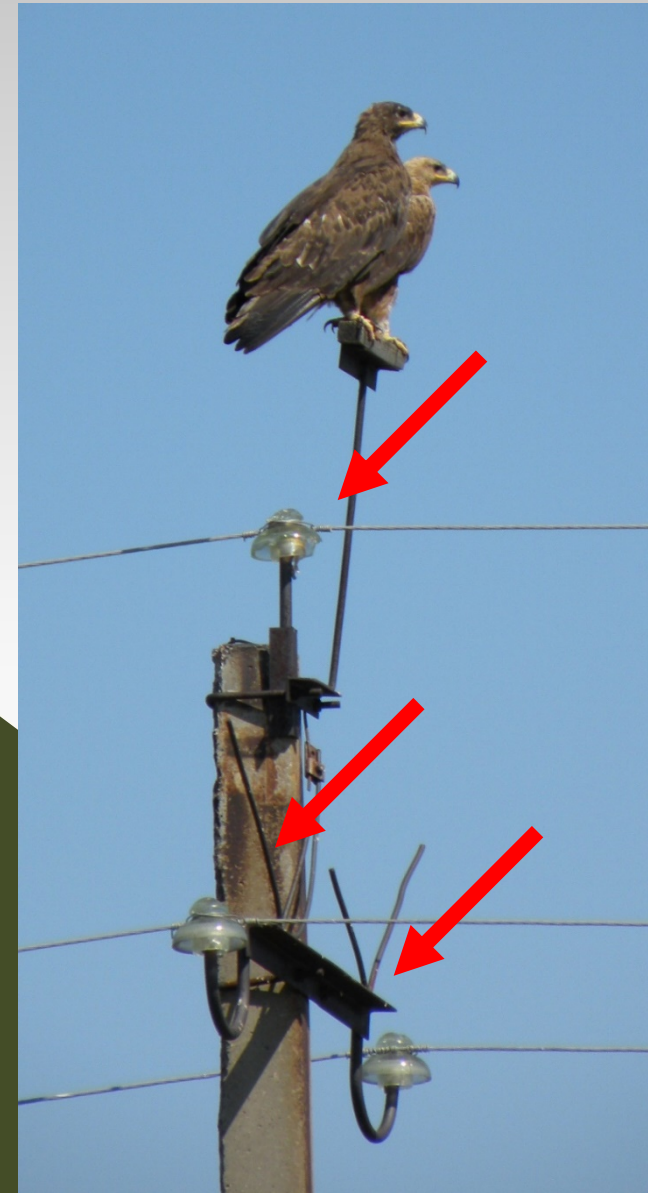
# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:  
Cover energized  
equipment



Photo: I. Smelansk



# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:

Ensure field crews are provided with all the materials they need (including training)

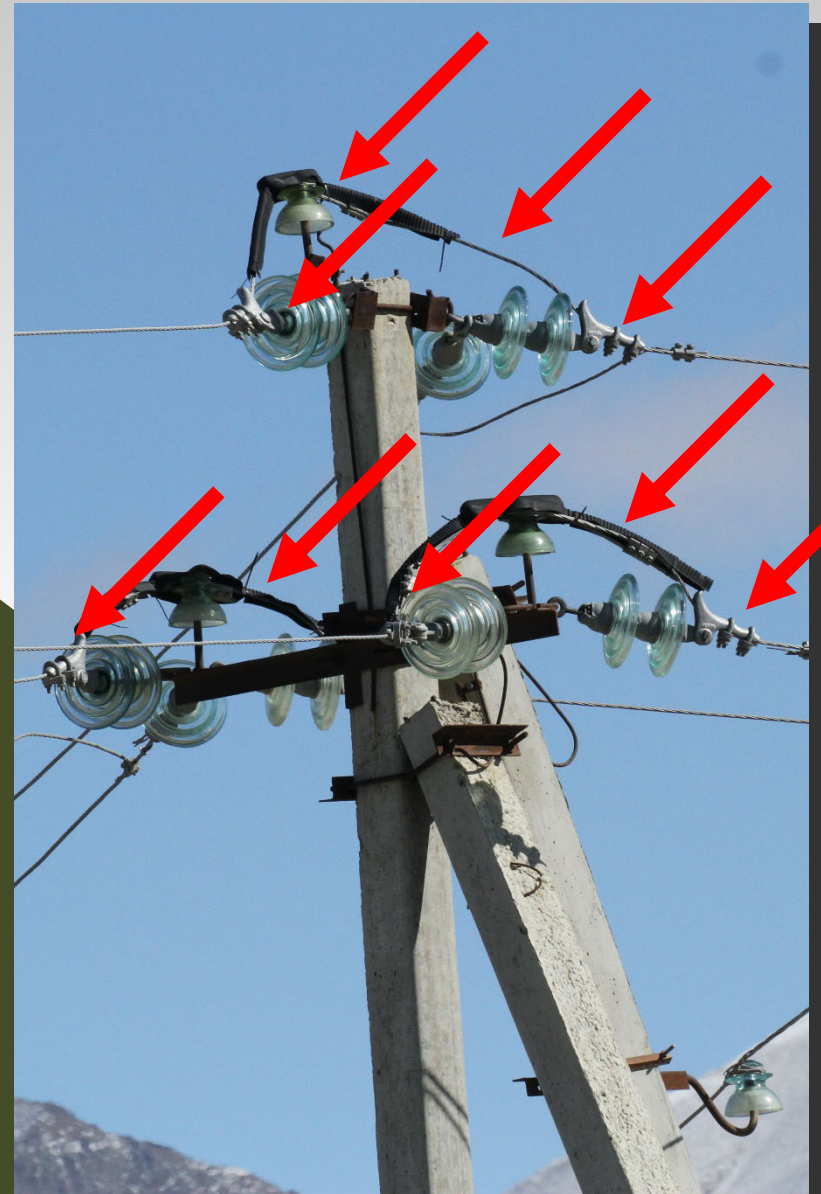


Photo: R. Harness



# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:  
Add insulating disks

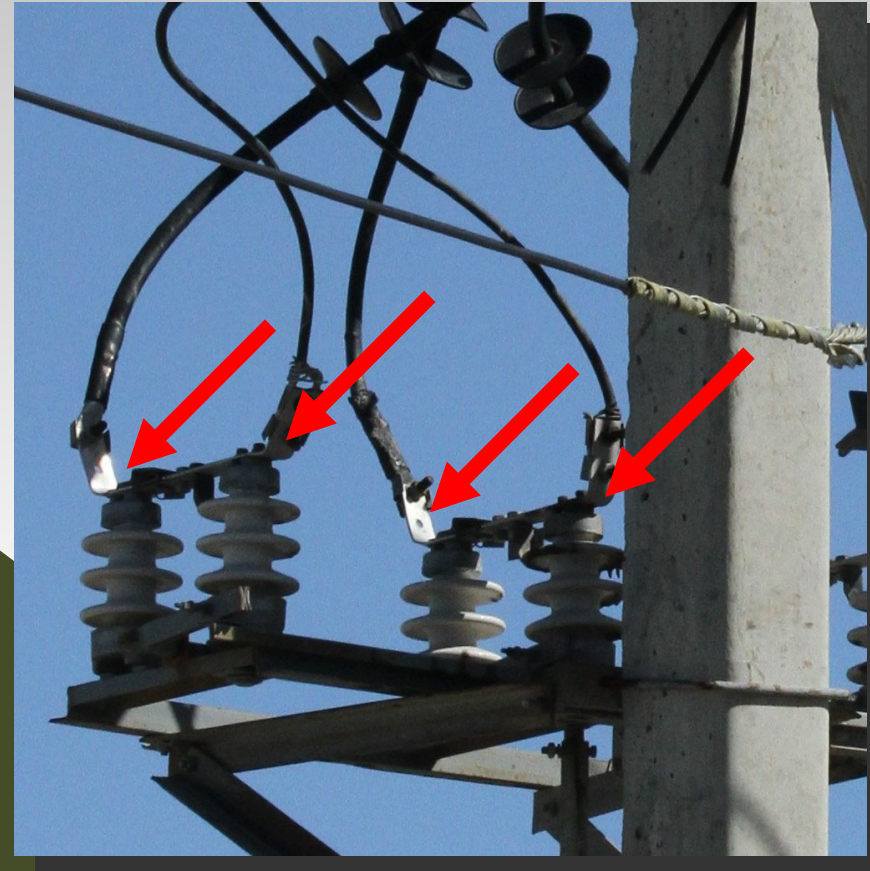


Photo: R. Harness





# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:  
Extend conductor covers  
beyond from crossarms

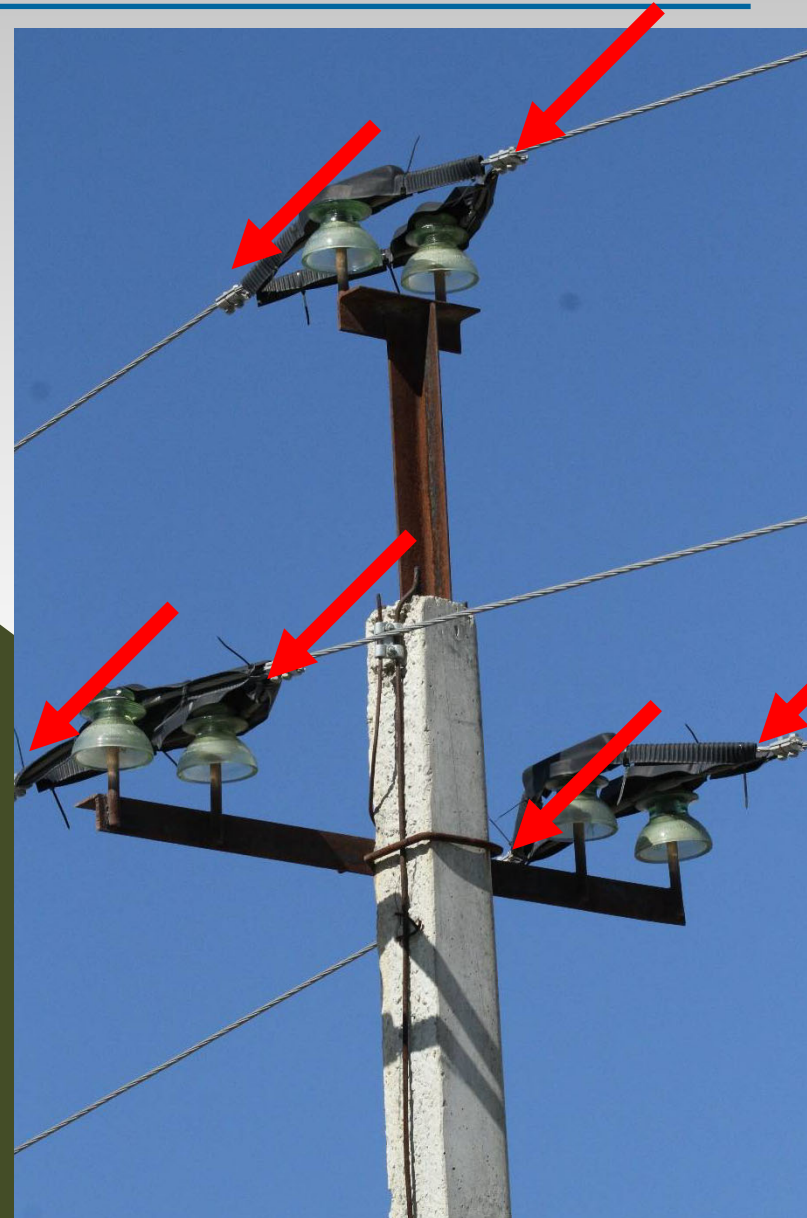


Photo: R. Harness



# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Cover energized equipment



Photo: M. Kolnegari

# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Cover energized equipment



Photo: M. Kolnegari



# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:  
Ensure field crews are provided with all the materials they need (including training)

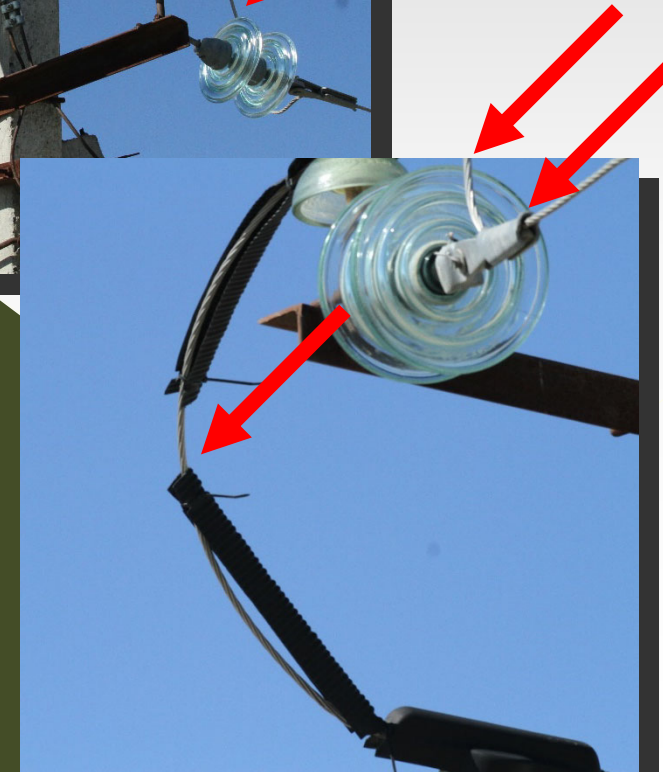


Photo: R. Harness

# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Cover energized equipment

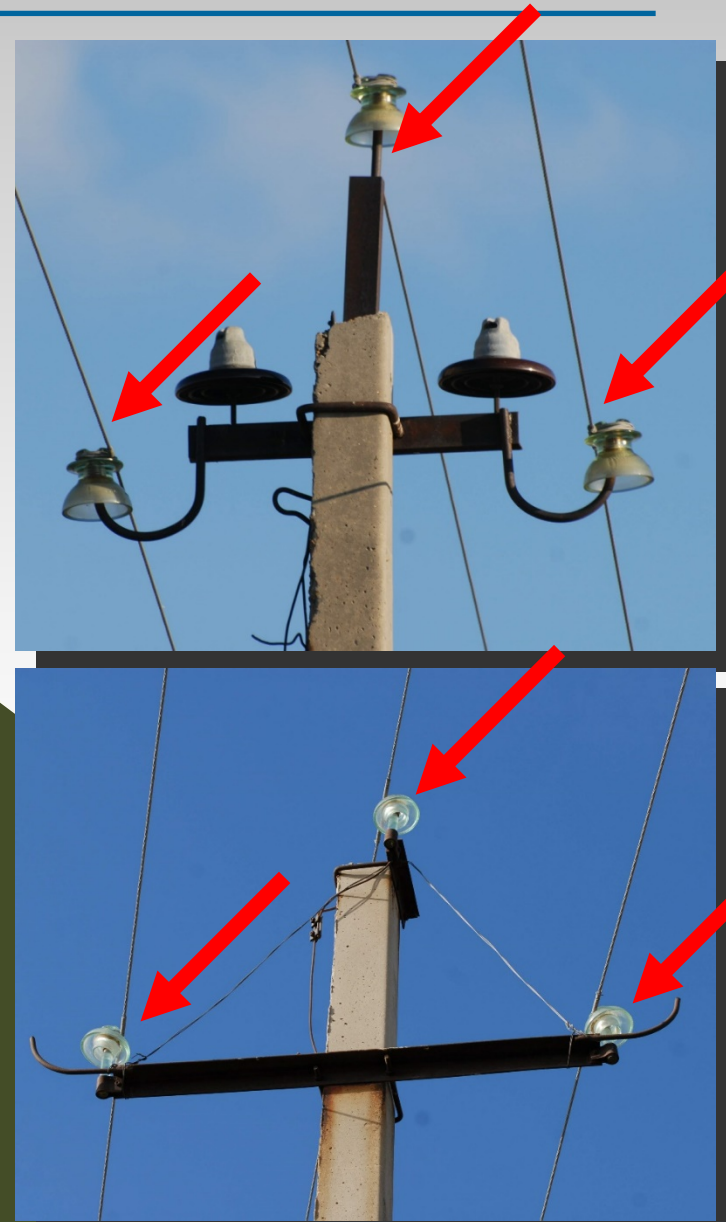


Photo: I. Smelansk

# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Cover energized equipment



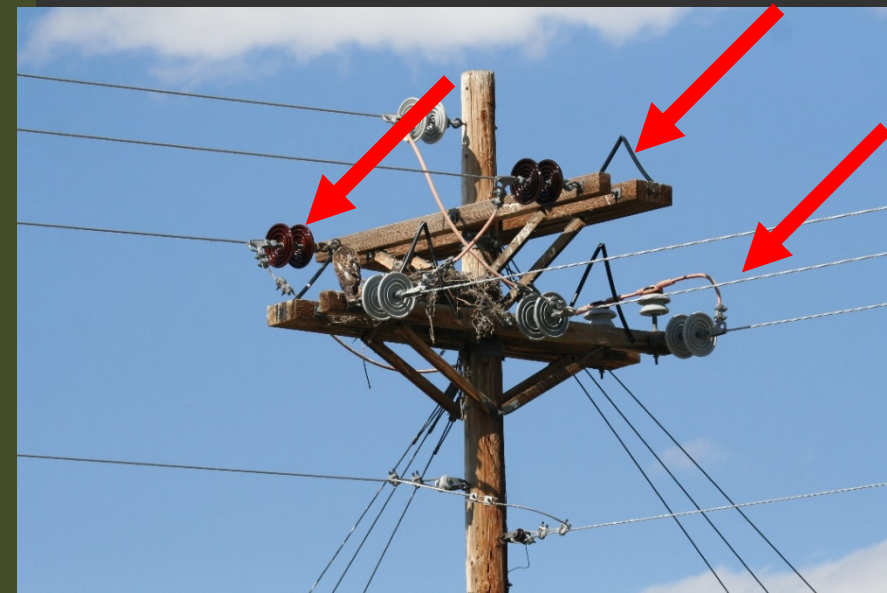
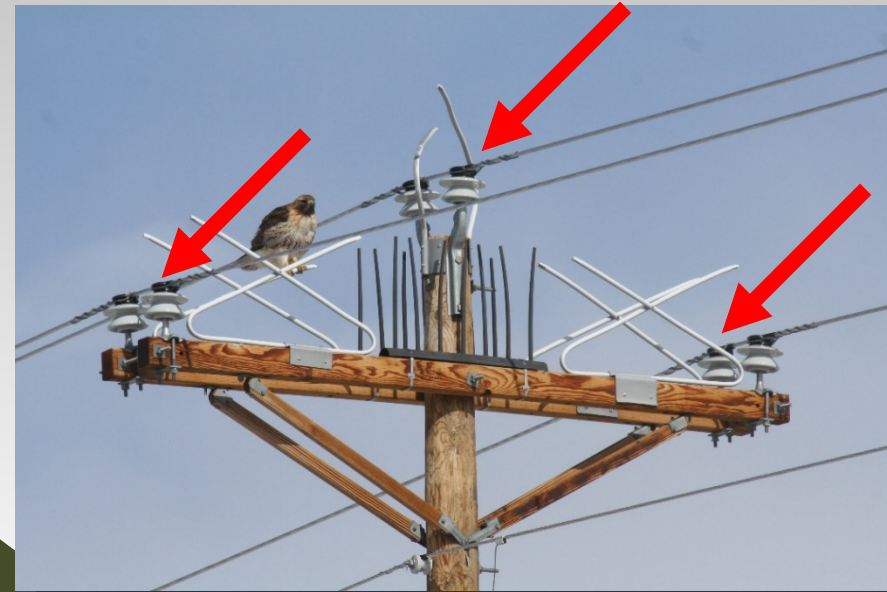
Photos: A. Matsyna



# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors

Solution:  
Cover energized equipment



# Identify the Errors

1. Product design errors
2. Mitigation plan errors
3. Application errors
4. Improvisation errors
5. Maintenance errors



Solution:  
No problems 😊

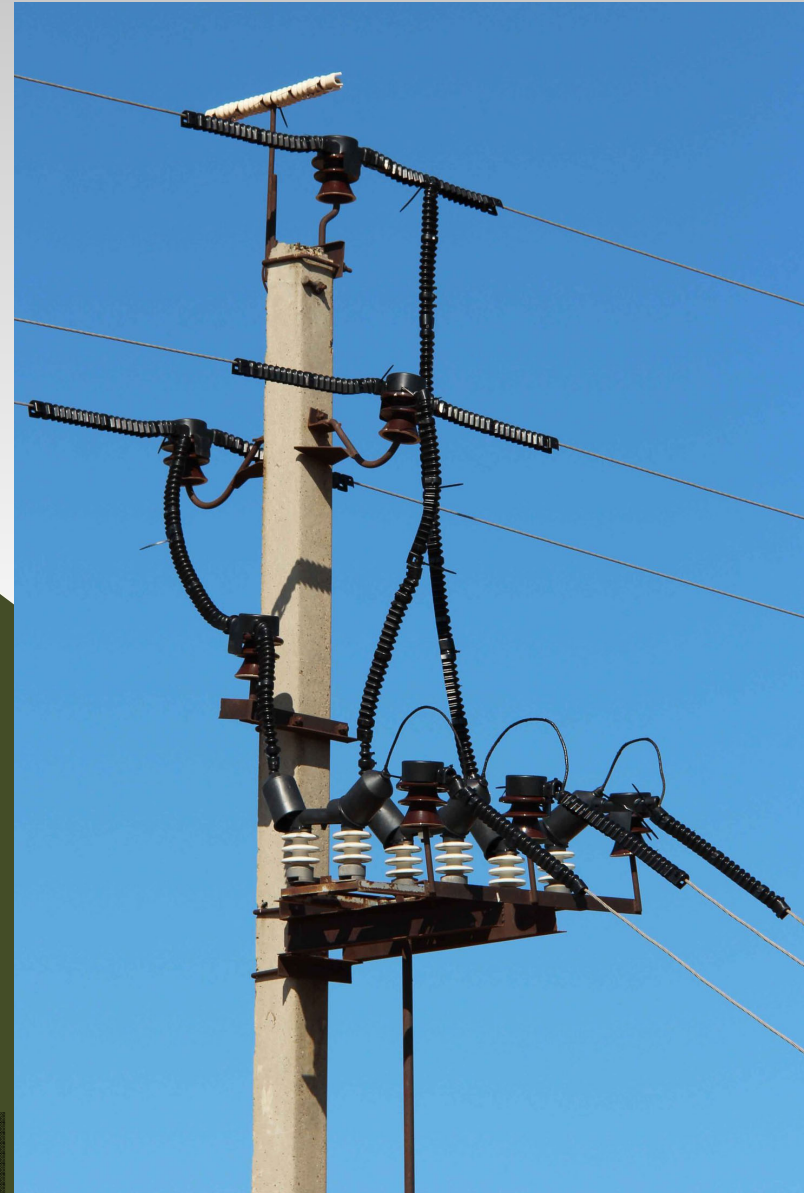


Photo: Unknown

# Outline

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- ❖ Introduction
- ❖ Retrofitting Errors
- ❖ Identify Error Types
- ❖ **Collisions**
- ❖ Collision prevention
  - > UAS line marking
  - > The ACAS
- ❖ Substations
  - > Mitigation





# Avian Collisions

- ❖ Most avian collisions occur at night



# Avian Collisions

---

- ❖ Most avian collisions occur at night
- ❖ Collisions also occur during other periods of low light
- ❖ They also occur to lesser extent during daytime for some species
  - The ACAS is not intended to address daytime collisions





# Avian Collisions

- ❖ Large, heavy-bodied birds flying past transmission lines crossing water bodies are most associated with collisions
- ❖ Other species and distribution lines are also involved





# Avian Collisions

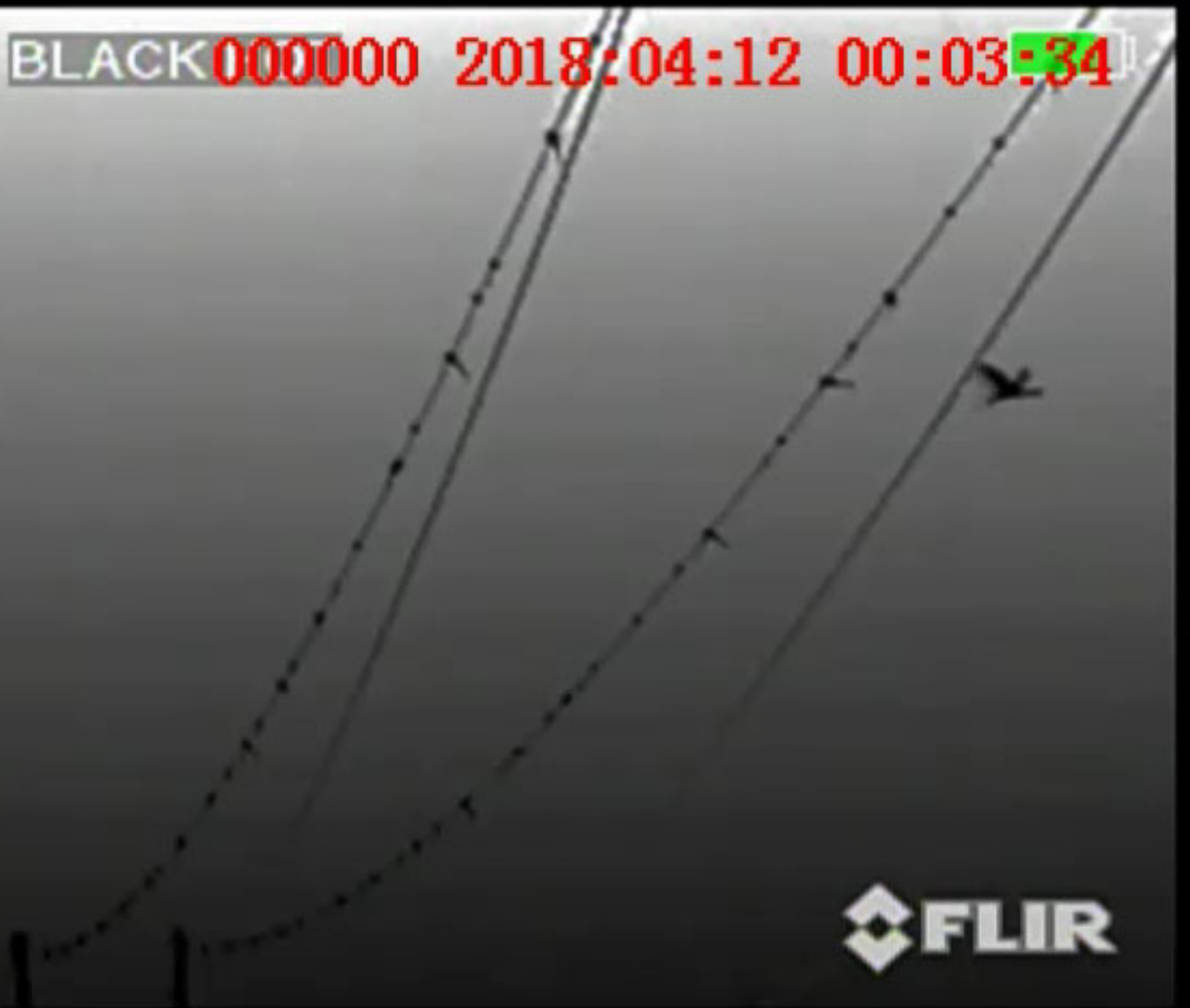
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❖ Collision examples: Video credit: John Gussman



# Avian Collisions

BLACK 000000 2018:04:12 00:03:34





# Collisions in Asia

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Photo: M. Kolnegari



# Collisions in Asia

- ❖ Collision examples:
  - > Flamingos



Photos: M. Kolnegari et al.

# Collisions in Asia

- ❖ Collision examples:
  - > Flamingos, Gulls



Photos: M. Kolnegari et al.





# Collisions in Asia

- ❖ Collision examples:
  - > Flamingos, Gulls, Pelicans





# Collisions in Asia

- ❖ Collision examples:
  - > Flamingos, Gulls, Pelicans, Herons



Photos: M. Kolnegari et al.

# Collisions in Asia

- ❖ Collision examples:
  - Flamingos, Gulls, Pelicans, Herons, others



Photos: M. Kolnegari et al.

# Outline

- ❖ Introduction
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- ❖ **Collision prevention**
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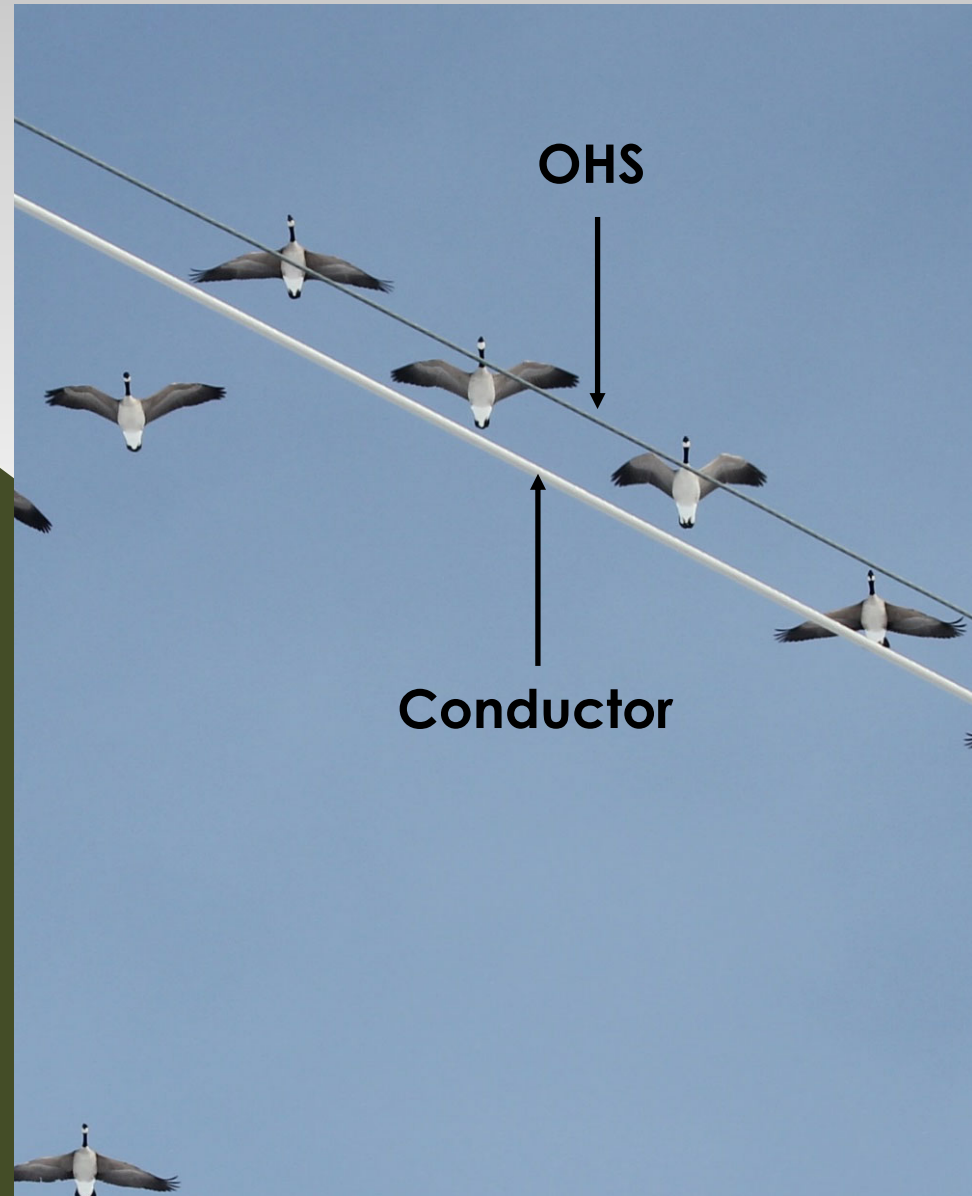
# Collision Prevention

- ❖ Mitigation strategies
  - > Underground
    - Expensive, impractical
  - > Shielding
    - Vegetation, terrain not always available



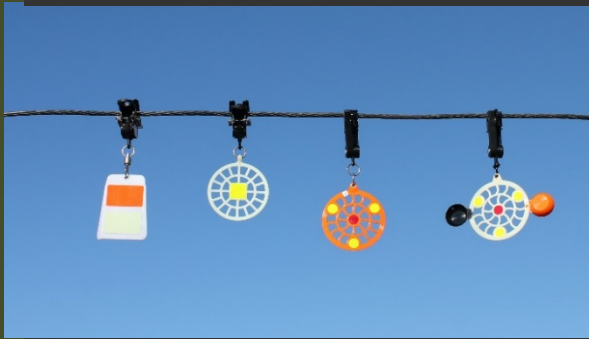
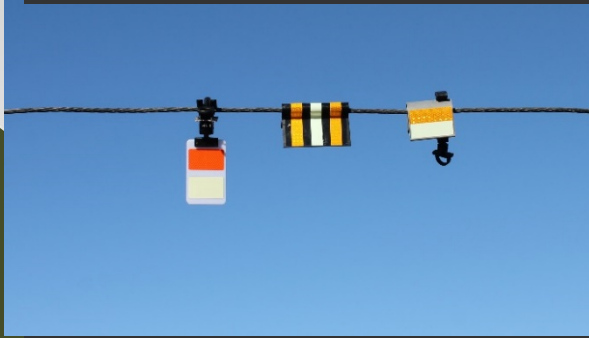
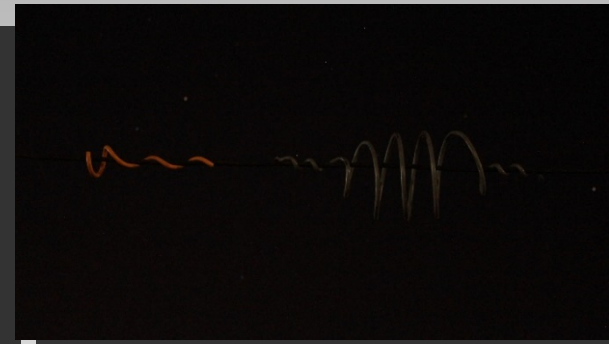
# Collision Prevention

- ❖ Mitigation strategies
  - > Remove OHS
    - Reliability concerns



# Collisio

- ❖ Mitigation strategies
  - > Line marking





# Collision Prevention

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# Collision Prevention

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# Collision Prevention

NAME	WEB SITE	SPONSOR(S)	COVERAGE	USE
Avian Sensitivity Tool for Energy Planning	<a href="https://avistep.birdlife.org/">https://avistep.birdlife.org/</a>	BirdLife International	India, Nepal, Thailand, Vietnam	Maps of avian sensitivity from Low to Very High
Bird Migration Explorer	<a href="https://explorer.audubon.org/home?sidebar=expand&amp;zoom=2&amp;x=-352806.67199999414&amp;y=78981.18294999744">https://explorer.audubon.org/home?sidebar=expand&amp;zoom=2&amp;x=-352806.67199999414&amp;y=78981.18294999744</a>	Audubon	North/South America, Asia, West Africa	Maps and data on migratory birds
Birds of the World	<a href="https://birdsoftheworld.org/bow/home">https://birdsoftheworld.org/bow/home</a>	Cornell Lab of Ornithology	Global	Comprehensives life histories for all bird species
Critical Site Network (CSN)	<a href="https://criticalsites.wetlands.org/en">https://criticalsites.wetlands.org/en</a>	BirdLife International, Wetlands International	Africa and Western Eurasia	Maps and data on sites critical for waterbird species
eBird	<a href="https://ebird.org/home">https://ebird.org/home</a>	Cornell Lab of Ornithology	Global	Maps and data on bird observations collected by bird watchers
European Network of Transmission System Operators	<a href="https://www.entsoe.eu/data/map/">https://www.entsoe.eu/data/map/</a>	European TSOs	Europe and North Africa	Maps of transmission lines 220kV and higher.
Global Biodiversity Information Facility (GBIF)	<a href="https://www.gbif.org/">https://www.gbif.org/</a>	World Governments, Secretariat in Copenhagen	Global	Maps and biodiversity data
iNaturalist	<a href="https://www.inaturalist.org/">https://www.inaturalist.org/</a>	California Academy of Sciences and the National Geographic Society	Global	Maps and species data collected by subscribers.
Integrated Biodiversity Assessment Tool (IBAT)	<a href="https://www.ibat-alliance.org/">https://www.ibat-alliance.org/</a>	BirdLife International, Conservation International, IUCN, UNWCMC Environment Programme	Global	Three global biodiversity datasets (IUCN Red List), protected planet, Key Biodiversity Areas (KBA)
IUCN red List of Threatened Species	<a href="https://www.iucnredlist.org/">https://www.iucnredlist.org/</a>	International Union for Conservation of Nature (IUCN)	Global	Comprehensive information source on the global extinction risk status of birds and other species
Key Biodiversity Areas (KBAs)	<a href="https://www.keybiodiversityareas.org/">https://www.keybiodiversityareas.org/</a>	Partnership with 13 conservation groups	Global	sites contributing significantly to the global persistence of biodiversity
Movebank	<a href="https://www.movebank.org/cms/movebank-main">https://www.movebank.org/cms/movebank-main</a>	Max Planck Institute of Animal Behavior, North Carolina Museum of Natural Sciences, Ohio State University and the University of Konstanz.	Global	Maps and data on animal tracking and other animal-borne sensor data.
Protected Planet	<a href="https://www.protectedplanet.net/en">https://www.protectedplanet.net/en</a>	International Union for Conservation of Nature (IUCN), UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC)	Global	Maps and data on protected areas
Soaring Bird Sensitivity Mapping Tool	<a href="https://maps.birdlife.org/MSBtool/">https://maps.birdlife.org/MSBtool/</a>	BirdLife International	Mediterranean Basin and Middle East	Maps and data on soaring birds



# Outline

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- ❖ Introduction
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  - > Mitigation



# Collision Prevention



❖ Hotstick



❖ Bucket + Hotstick



❖ Bucket only



# Collision Prevention

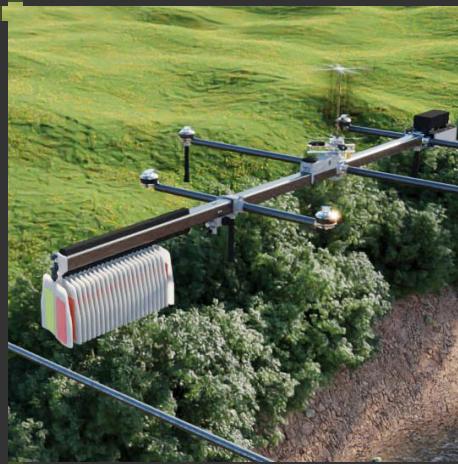


❖ Helicopter

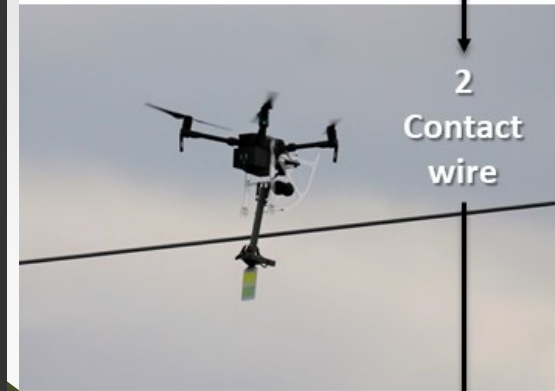
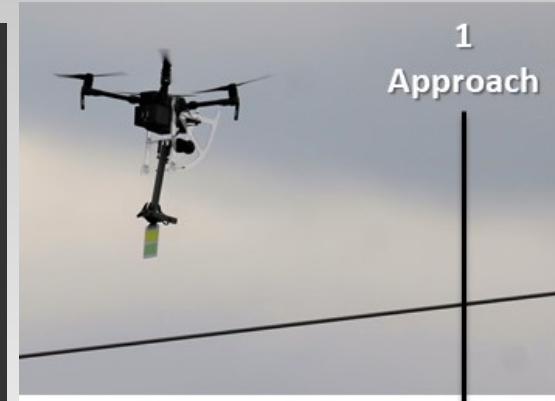




# Collision Prevention



# Collision Prevention





# Outline

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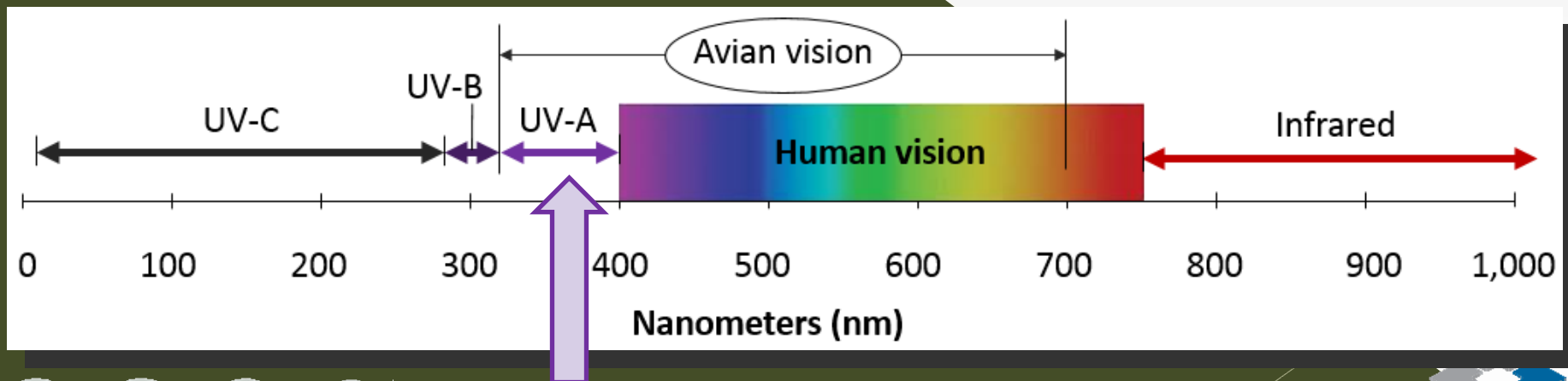
- ❖ Introduction
- ❖ Retrofitting Errors
- ❖ Identify Error Types
- ❖ Collisions
- ❖ Collision prevention
  - > UAS line marking
  - > **The ACAS**
- ❖ Substations
  - > Mitigation



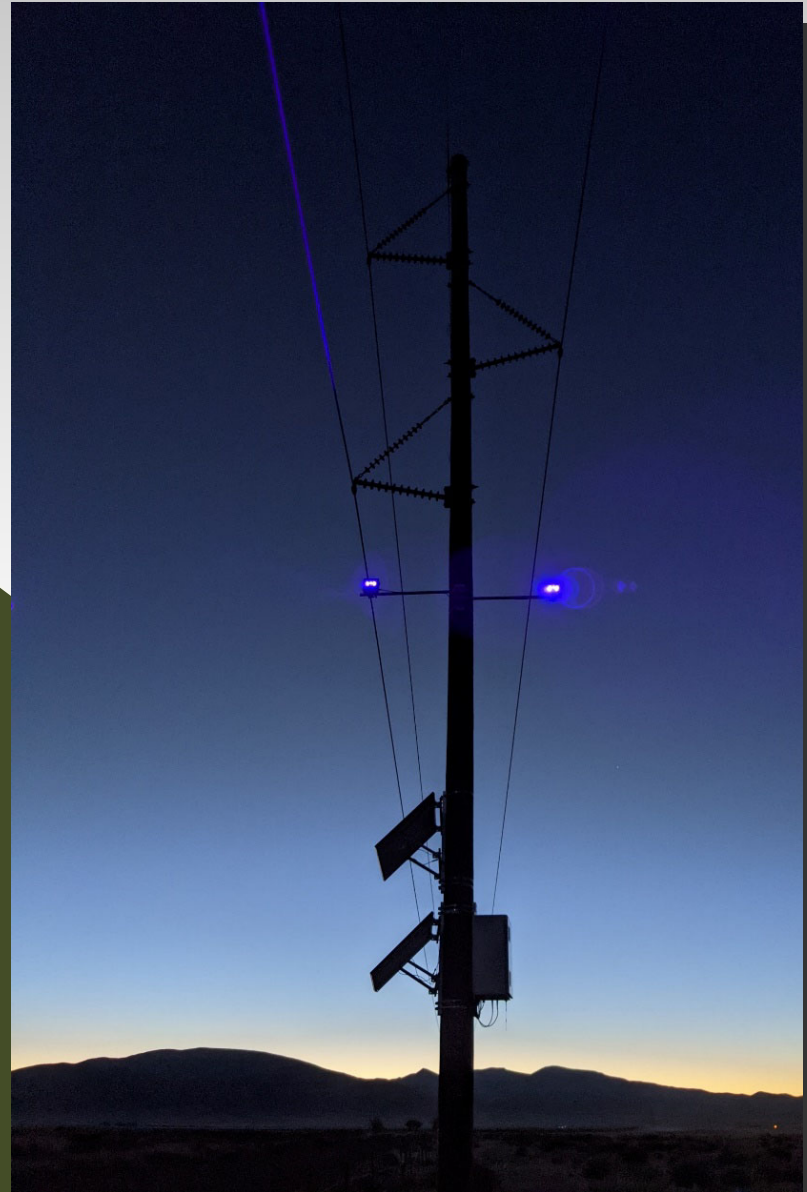


# ACAS

- ❖ ACAS works by illuminating power lines and other collision hazards with UV light
- ❖ The distribution of UV-light sensitivity across bird groups and species suggests ACAS should be effective across a range of spp



# ACAS



# ACAS

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# ACAS





# ACAS

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# ACAS

- ❖ ACAS has:
  - Been tested primarily with cranes
  - Reduced collisions on illuminated spans
  - Reduced collisions on nearby not-illuminated spans
    - On the same line
    - On adjacent lines





# Outline

- ❖ Introduction
- ❖ Retrofitting Errors
- ❖ Identify Errors Types
- ❖ Collisions
- ❖ Collision prevention
  - > UAS line marking
  - > The ACAS
- ❖ **Substations**
  - > **Mitigation**



# Substations

- ❖ Raptors also sometimes enter and nest in substations





# Substations

- ❖ When raptors enter substations, they are often pursuing prey
- ❖ Solution:
  - > Reduce attractiveness to prey
  - > Prevent entry by prey





# Substations

- ❖ Trim vegetation 2-3 m from fence
- ❖ Remove trash
- ❖ Repair fence





# Substations

- ❖ Fill gaps below electric fence



# Substations

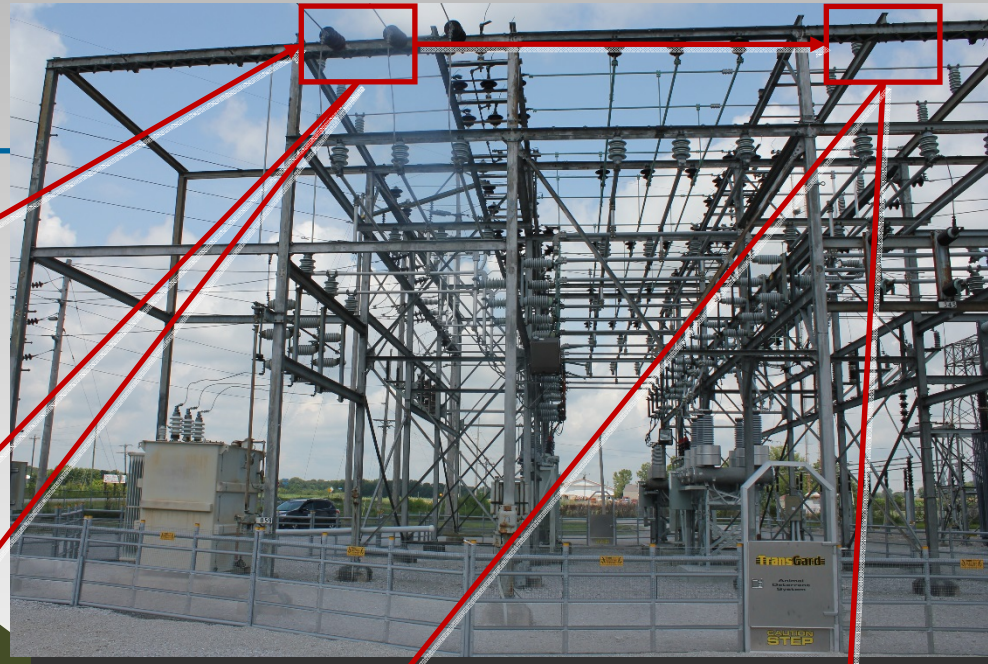
❖ Remove nests





# Substations

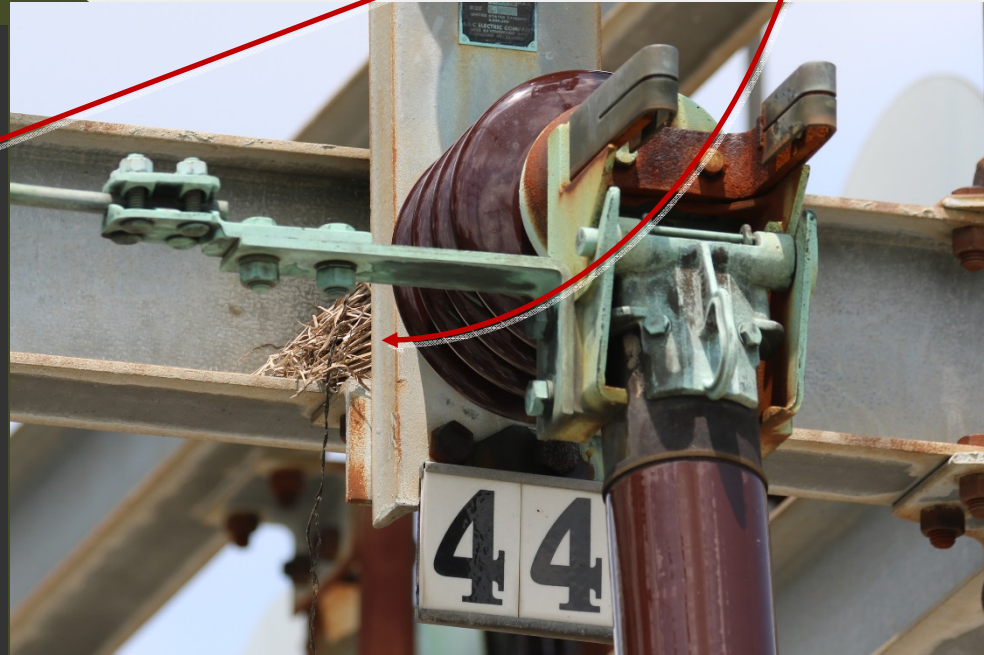
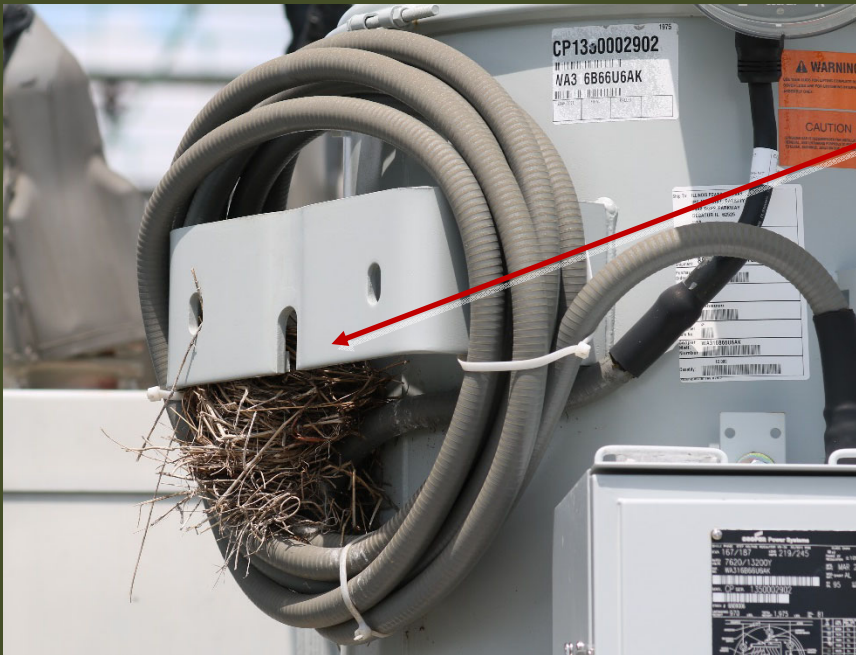
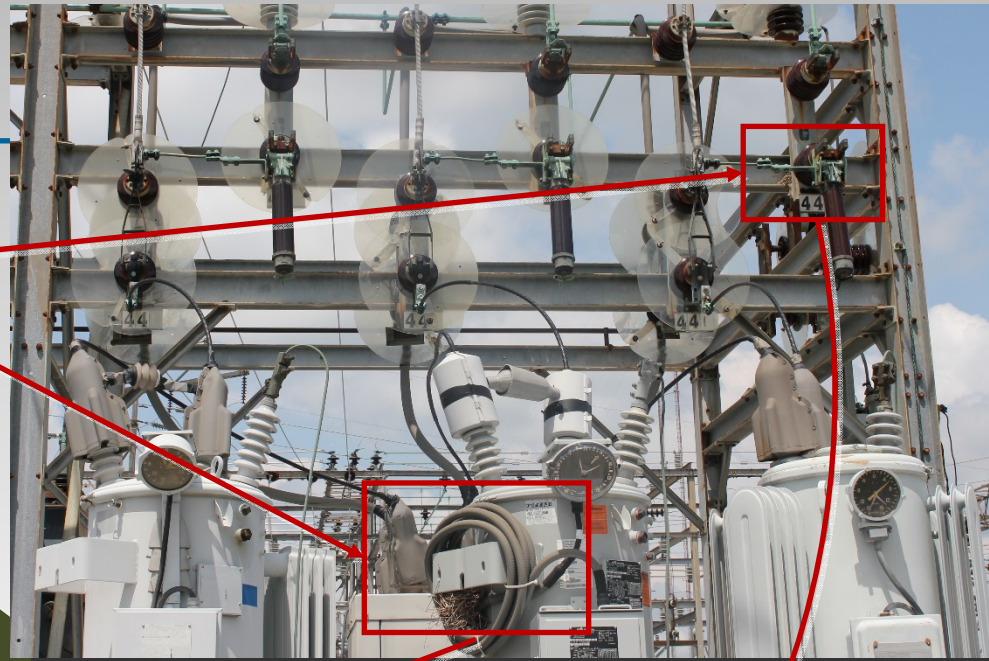
❖ Remove nests





# Substations

❖ Remove nests



# Substations

Transformers

- ❖ Cover jumpers
- ❖ Cover bushings





# Substations

Breakers

❖ Cover jumpers



# Substations

Breakers

❖ Cover bushings

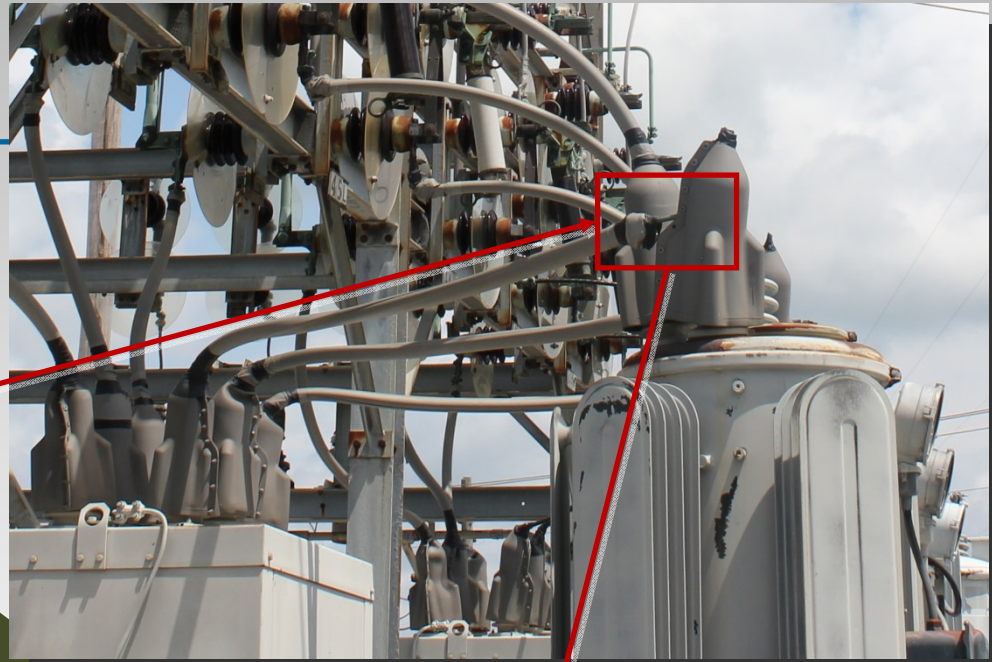




# Substations

## Regulators

- ❖ Insert jumper covers into bushing covers
- ❖ Confirm horizontal bypass arrester is covered





# Substations

- ❖ Install disks on switch bases and bus supports



# Substations

- ❖ Remove lexicon disks
- ❖ Install new disks





# Outline

- ❖ Introduction
- ❖ Retrofitting Errors
- ❖ Identify Error Types
- ❖ Collisions
- ❖ Collision prevention
  - > UAS line marking
  - > The ACAS
- ❖ Substations
  - > Mitigation





# Thank you!



## ❖ Thank you to:

- > I.V. Karyakin
- > E.G. Nikolenko



THE ALTAI PROJECT

## ❖ Want to learn more?

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- > [jdwyer@edmlink.com](mailto:jdwyer@edmlink.com)
- >  +1 863 464 0272
- > Rick Harness
- > [rharness@edmlink.com](mailto:rharness@edmlink.com)



<https://www.youtube.com/watch?v=tJE6ILa9LRw>



# RAPTORS ON THE LINE



# Nest Management

- ❖ Raptors often nest on power lines



Photos: I. Karyakin



# Nest Management

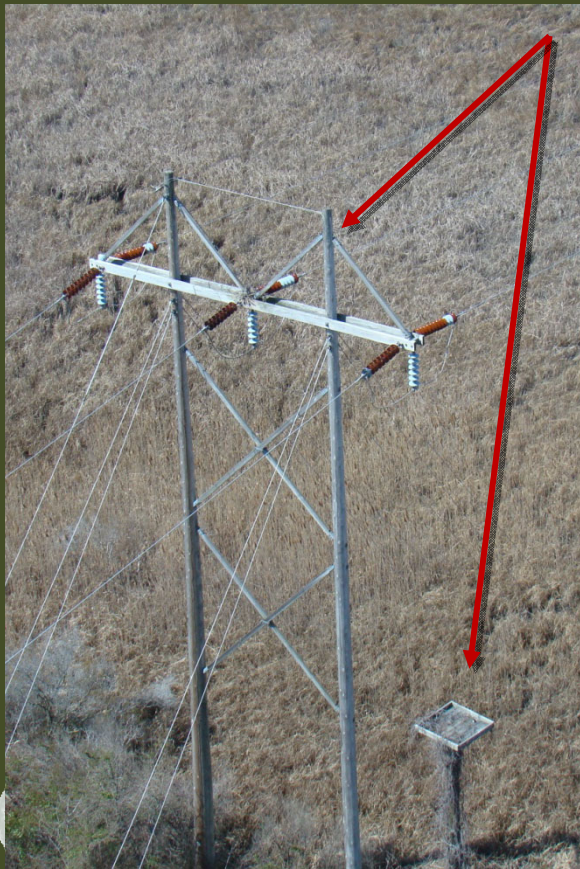
- ❖ Nests can be managed through:
  - Nest platforms below conductors





# Nest Management

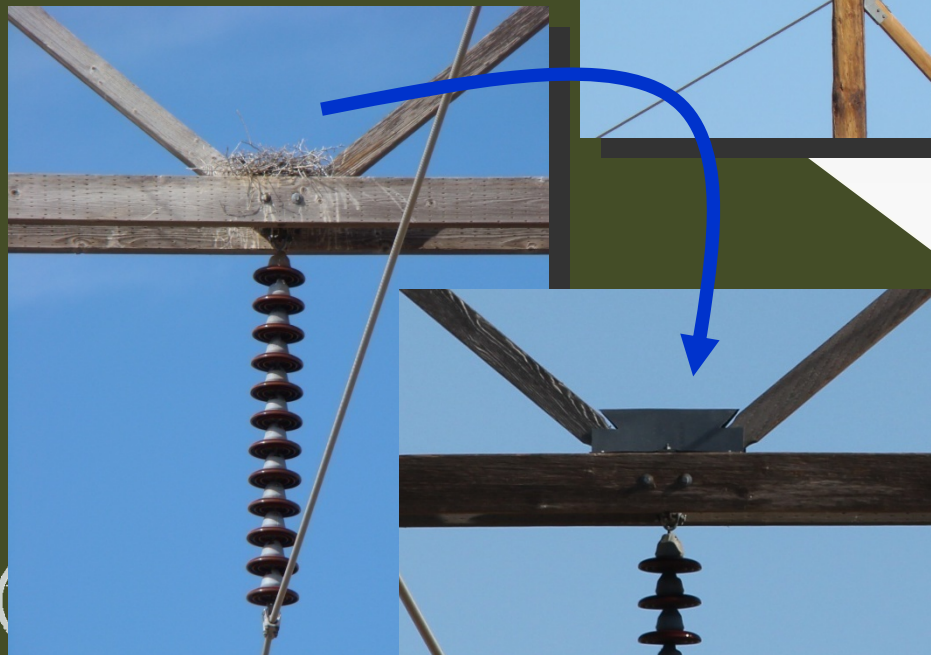
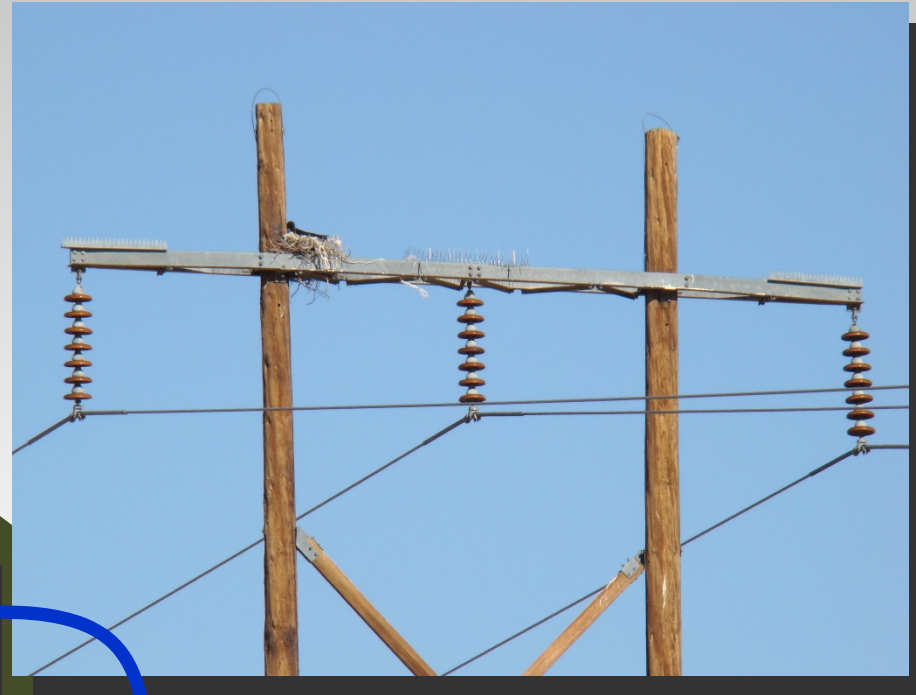
- ❖ Nests can be managed through:
  - Nest platforms separately





# Nest Management

- ❖ Nests can be managed through:
  - > Nest diverters shifting nests to between conductors



# Nest Management

- ❖ Nests can be managed through:
  - > Nest diverters shifting nests to other locations
  - > Works best if a platform is also provided





# Nest Management

- ❖ Nests can be managed through:
  - > Covering energized equipment



# Nest Management

- ❖ Nests can be managed through:
  - De-energizing equipment

