APPENDIX 5.2E

Avian Protection Plan

Avian Protection Plan
Engineering & Operations Administration
Turlock Irrigation District

Submitted to:

Turlock Irrigation District

August 2004

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Avian Protection Plan
Engineering & Operations Administration

1.0 REVISIONS:

1.1	EDM International, Inc.	© August 2004
1.2	Turlock Irrigation District	February 2005

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List of Acronyms and Abbreviations

APLIC	Avian Power Line Interaction Committee
APP	Avian Protection Plan
ATV	all-terrain vehicle
BFD	Bird Flight Diverter
CDFG	California Department of Fish and Game
CFR	Code of Federal Regulations
cm	centimeter
DEMS	Digital Elevation Models
EDM	EDM International, Inc.
E&OA	Engineering & Operations Administration
EPA	Eagle Protection Act
ER	environmental report
ESA	Endangered Species Act
EWT	Endangered Wildlife Trust
GOABS	gang operated air break switch
HCPB	Habitat Conservation Planning Branch of the CDFG
km	kilometer
kV	kilovolts
MBTA	Migratory Bird Treaty Act
mi	mile
MLEA	Moon Lake Electrical Association
MOU	Memorandum of Understanding
NESC	National Electrical Safety Code
NRECA	National Rural Electric Cooperative Association
REA	Rural Electrification Administration
ROW	right-of-way
RsOW	rights-of-way
SFD	Swan Flight Diverter
SVD	Spiral Vibration Damper
TID	Turlock Irrigation District
U.S.	United States
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	ultraviolet
V	volt
WHDAB	Wildlife Habitat Data Analysis Branch of the CDFG

- Bird-friendly standards for new construction.

- Information pertaining to line retrofits to minimize electrocution and collision risk.

The overall goal of collecting these data is to identify potential problem areas for retrofitting, based on survey samples within the service territory. The biological data are necessary to determine how to prioritize the retrofitting. This approach, combined with raptor-safe new construction, will minimize electrocutions and associated outages as E&OA incorporates this plan into their long-term maintenance and operational program.

3.0 LEGAL PROTECTION

3.1 Laws

The MBTA protects the vast majority of birds in the United States (U.S.), with the exception of a few species, such as the introduced house sparrow, European starling, rock pigeon (formerly rock dove or common pigeon), and monk parakeet. The purpose of the MBTA is to afford protection to migratory birds, their parts, nests, and eggs. The list of protected birds is broad. For example, Stanislaus County, California has approximately 294 confirmed species of protected birds. See 50 Code of Federal Regulations (CFR) § 10.13 for a full list of federally covered species.

The MBTA states that, unless permitted by regulation, it is unlawful to pursue, hunt, "take," capture, kill, possess, sell, barter, purchase, ship, export, or import any migratory birds alive or dead, or any part, nests, eggs, or products thereof. Culpability is strict liability (i.e., no degree of knowledge need be proven).

For misdemeanors, the penalties include fines up to $5,000 per individual and $15,000 per organization and up to 6 months imprisonment. Migratory bird electrocutions violate the misdemeanor provisions of the MBTA. The U.S. Fish and Wildlife Service (USFWS) has stated that electrical utilities fall under the provisions of the MBTA, as their utility structures and lines are causing a "take" when electrocutions occur.

Bald and golden eagles, eggs, and their nests are protected under both the MBTA and the EPA. The EPA was first signed into law June 8, 1940, affording protection to bald eagles. On October 24, 1962, the EPA was amended to afford protection to the golden eagle, based on the similarity of appearance of golden eagles to immature bald eagles. The law states no person shall "take," possess, sell, purchase, barter, offer for sale, transport, export, or import any bald or golden eagle alive or dead, or any part, nests or eggs, thereof without a valid permit to do so. The **EPA** expands protection beyond the MBTA to define **molest** or **disturb** as a "take." Culpability for EPA violations is knowingly or with wanton disregard for the consequences of their act. Maximum criminal penalties for misdemeanor violations of the EPA include fines up to $100,000 per individual and $200,000 per organization and up to 1 year of imprisonment. Vehicles and equipment also can be forfeited for violations.

Additional protection is afforded to threatened and endangered bird species under the federal Endangered Species Act (ESA) (50 CFR 17). The ESA was signed into law on December 28, 1973. The law affords protection to fish, wildlife, and plants listed as federally endangered or threatened. The ESA makes it unlawful to import, export, "take," transport, sell, purchase, or receive in interstate or foreign commerce any species listed as endangered or threatened alive or dead. "Take" under the ESA is defined as an act that kills, injures, or harms a listed species. Violations may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or

sheltering. Maximum penalties (misdemeanor) for violations include fines up to $100,000 per individual and $200,000 per organization, as well as up to 1 year of imprisonment. Vehicles and equipment also can be confiscated. The ESA increases protection to habitat and prohibits the harassment of threatened and endangered birds.

3.2 Enforcement Actions

Avian electrocutions have been receiving increased scrutiny by the USFWS in accordance with the MBTA, the EPA, and the ESA. The first electric utility cited for violation of the MBTA was Pacific Gas and Electric of California. In 1993, the utility was fined $1,500 for violations and agreed to retrofit lines to safer standards. In 1998, Sand Point Electric of Alaska was fined $500 and was likewise compelled to retrofit dangerous structures. More recently, however, a plea agreement between the United States Department of Justice and the USFWS with Moon Lake Electrical Association (MLEA) of Utah ushered in an entirely new era of enforcement. Under the agreement, MLEA was given 3 years of probation, ordered to pay $100,000 in fines and restitution, and was required to retrofit electric distribution structures dangerous to migratory birds. MLEA also was required to enter into a Memorandum of Understanding (MOU) with the USFWS and to develop an APP.

On April 16, 2001 the USFWS issued another notice of violation to Pacific Gas and Electric. In a settlement agreement, Pacific Gas and Electric Company agreed to inspect a minimum of 200 line miles each year for 5 years. Raptor electrocution mitigating devices must be placed on a minimum of 2,000 poles annually.

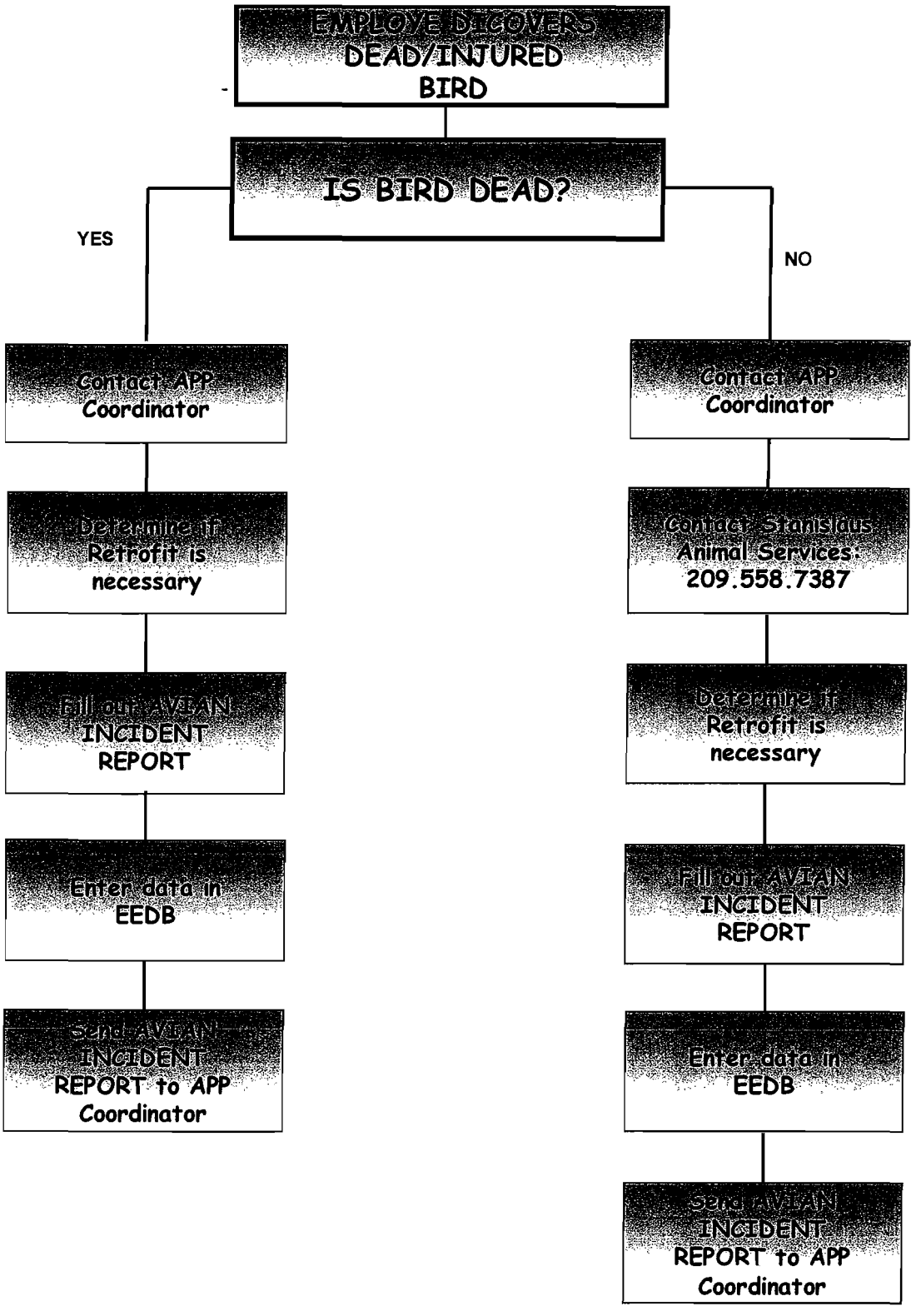


Chart A: Avian Incident Procedure

E&OA personnel will immediately advise the APP Coordinator of the presence of any band, marker, or neck collars.

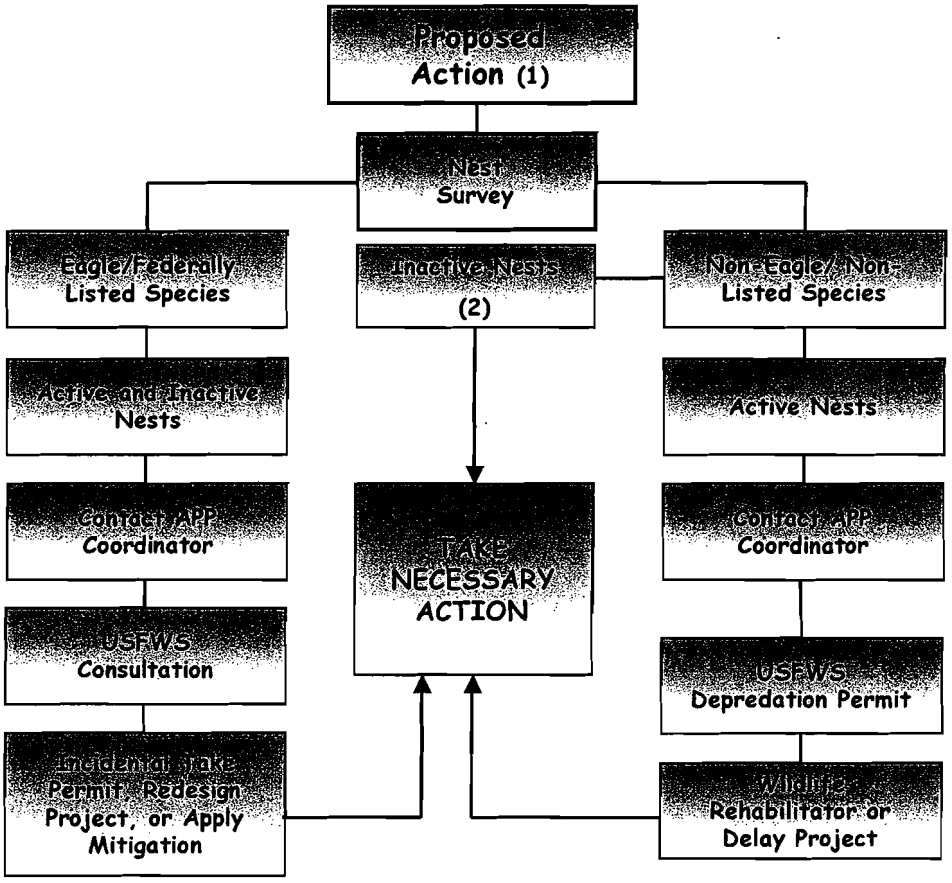
Nest Management. Chart B outlines the procedure for bird nest management on TID facilities. See Appendix A, NEST MANAGEMENT PROCEDURE.

The federal government under the MBTA protects all migratory birds and their nests. A USFWS Depredation Permit (see Section 4.4) is required to authorize the removal of active nests. Employees must not take possession of a nest without first contacting the APP Coordinator for guidance on proper management. An existing Depredation Permit must be amended **before** any active migratory bird nest is removed.

Nests of Eagles and other special protected birds, "listed" as endangered or threatened, are afforded special protection and may not be removed, even if inactive, unless and until the USFWS is consulted and grants special permission.

The USFWS has informed EDM that Crow and Magpie nests that are active and are endangering the safe operation of the line may be removed without a Depredation Permit. **This is not applicable to any "listed" birds.**

Nests of birds protected under the ESA or EPA may not be disturbed even when the nests are under contruction with out USFWS authorization. However, other birds protected under the MBTA only, may have their nests removed continually while the bird is attempting to build the nest. In other words, for these birds, a nest is not considered a nest until it is completed.



(1) If **Imminent Danger** (i.e., threats to human health or safety), contact the APP Coordinator who will attempt to obtain either USFWS or State authorization by phone to take the requested Action. If agency contact is impossible, the APP Coordinator will document all actions, advise on action to take, and contact applicable regulatory agencies as soon as practicable.

(2) Monitor site if project is to be constructed later in the bird breeding season. Check site again 2 weeks prior to construction.

Chart B: Nest Management Procedure

For most bird species (i.e., not federally listed as endangered or threatened), a permit to remove nests can be obtained within 2 weeks. Permits also can be obtained by telephone in special emergency situations.

All inactive nests must be disposed of off-site to discourage birds from re-nesting at the same location. If nests need to be removed during extreme emergency situations threatening human health and safety (which includes potential electric outages), the nest must not be disposed of until the USFWS is properly notified.

As with carcasses, there are many diseases that can be transmitted by contact with nests, and E&OA employees should wear gloves or use an inverted plastic bag to pick up nests. Breathing filters also are recommended because moving nests will often disperse dried bird feces into the air.

Environmental Procedure Summary

- The APP Coordinator will be responsible for making arrangements with the USFWS and the State to obtain necessary permits or guidance. The E&OA APP Coordinator is:

Name:	**Phone:**	
Les Barrigar	Office:	(209) 883-8241
	Cell:	(209) 765-3819

- Any contact with a federal or state officer should be handled as a regulatory inspection; employees should immediately contact their supervisor, and defer any questions until their supervisor arrives. **Do not make any assumptions in the presence of the officer.**

- Employees must not disturb or cause harm, or attempt to harm, any bird, including their nests or eggs.

- Employees should not attempt to identify a migratory bird species to the USFWS or state, or discuss or speculate as to the cause of a bird mortality/injury. **Do not make any assumptions in the presence of the officer.**

- Activities involving possessing bird carcasses, or the unpermitted disturbance of birds are strictly forbidden by law and this APP. The removal of nests must follow the Nest Management Procedure.

- Employees that encounter nests of "listed" birds or active nests to be removed must contact their supervisor and the APP Coordinator before proceeding.

4.4 Recordkeeping

Depredation Permits. A depredation permit allows nest taking under approved situations and must be amended prior to each take, unless in extreme emergency situations (i.e., threat to human health or safety). The permit is effective for 1 year and requires an annual report listing actions taken. The permit is renewable on an annual basis. A copy of this permit must be carried whenever exercising this authority.

The APP Coordinator shall coordinate and oversee record keeping and record maintenance. Record keeping includes the date and location of each nest removed, species, the name of the person who removed the nest, and the permit number under which the specimen was removed.

Mortality. If a dead or injured bird is detected at a TID facility, the APP Coordinator should be notified, an E&OA Avian Incident Report must be completed, the data entered into the designated system, and the Avian Incident Report submitted to the APP Coordinator.

4.5 Sensitive Species

The following lists birds found in the TID service area that are Threatened, Endangered, or are of Special Concern (Stanislaus Audubon Society 2004). The status is indicated by abbreviation: CSC=California Species of Concern, FE=Federal Endangered, FT=Federal Threatened, SE=State Endangered, ST=State Threatened.

- American White Pelican (nesting) CSC
- Western Least Bittern CSC
- White-faced Ibis (nesting) CSC
- Aleutian Canada Goose (wintering) CSC
- Osprey (nesting) CSC
- Bald Eagle (wintering) SE, FT
- Northern Harrier (nesting) CSC
- Swainson's Hawk (nesting) ST
- Ferruginous Hawk (wintering) CSC
- Golden Eagle (nesting/wintering) CSC
- Peregrine Falcon (nesting) SE, FE
- Prairie Falcon (nesting) CSC
- Sandhill Crane (wintering) ST
- Snowy Plover (nesting) FT
- Mountain Plover (winter) CSC
- Caspian Tern (nesting) CSC
- Forster's Tern (nesting) CSC
- Yellow-billed Cuckoo SE
- Burrowing Owl CSC
- Short-eared Owl CSC
- Long-eared Owl CSC

- Loggerhead Shrike CSC
- Yellow-breasted Chat (nesting) CSC
- Bell's Sage Sparrow CSC
- Belding's Savannah Sparrow SE
- Grasshopper Sparrow (nesting) CSC
- Tricolored Blackbird (nesting) CSC

4.6 Definitions

Depredation Permit – A Migratory Bird Depredation Permit authorizes certain management and control activities necessary to provide for human health and safety, protect personal property, or allow resolution of other injury to people or property. A depredation permit is intended to provide short-term relief from migratory bird depredation until long-term measures can be implemented.

Migratory Bird – any bird, whatever its origin and whether or not raised in captivity, which belongs to a species listed in 50 CFR § 10.13, or which is a mutation or a hybrid of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird or any part, nest, or egg thereof. The majority of bird species in the U.S. are considered to be migratory and protected under the Migratory Bird Treaty Act, except for introduced species, such as the house sparrow, European starling, rock pigeon, and monk parakeet and some game species, such as the ring-necked pheasant.

Nest – any readily identifiable structure built, maintained, or occupied for incubating and rearing of protected species offspring. Nests can be found on the ground, in trees, or on structures.

Permittee -Turlock Irrigation District

Possession – detention and control of a protected species. This includes picking up or handling of any migratory bird, as defined above. This may also include moving or transporting.

Protected Species – any bird listed as a federally endangered or threatened species found in 50 CFR § 17.11 and § 17.12 and on the list of migratory birds found in 50 CFR 10.13.

Salvage Permit – a permit issued by the USFWS that authorizes the permittee to retrieve birds found dead in which the permittee had no part in the killing or death thereof.

Take (Migratory Birds) – to pursue, hunt, shoot, wound, kill, trap, capture (alive or dead), or to attempt to engage in such conduct.

- Sandhill crane *(Grus Canadensis)*
- American crow (*Corvus brachyrhynchos*)
- Common raven *(Corvis corax)*
- Yellow-billed magpie (*Pica nuttalli*)

Other raptor species also occur in the service territory (e.g, accipiters, falcons, other owls). However, electrocution incidence of the smaller species, such as the American kestrel *(Falco sparverius)* is not high, based on the size of the bird. Larger raptors, including the Cooper's hawk *(Accipiter cooperii)* occur throughout the region. However, this species is typically a forest dweller that forages on other smaller birds. Based on foraging behavior and flight patterns, it is not highly likely that birds of this type would regularly use distribution poles for perching, thereby minimizing the potential for electrocution.

Of these 17 bird species identified, all have either been documented or could potentially occur at TID, either throughout the year or seasonally. In the absence of natural perch sites, these birds have adapted to using man-made structures such as fence posts, utility poles, and transmission towers from which to hunt or rest.

Although birds are present year-round, some species are more prevalent during the breeding season (i.e., spring/summer), whereas other species occupy this area during the winter period. Both the numbers and diversity of bird species will vary seasonally. The following summary describes the general patterns of these seasonal occurrences on a regional basis.

It is important to note that seasonal migration patterns are dynamic and often vary on a yearly basis due to changes in weather patterns and prey populations; therefore, the data presented in this report should be used as a general guideline to migration periods.

5.1 Osprey

Status and Distribution

The osprey (Photo 1) is protected under the MBTA, and is a Species of Special Concern in California due to removal of nesting trees, degradation of lake and river environment quality, and boating activity near nesting sites (HCPB 2003).

Photo 1 Osprey

Ospreys occur on most of the world's continents. The bulk of the breeding range in North America includes the eastern coast, the northern U.S. states, pockets of the interior U.S., and much of Canada and Alaska (Sibley 2000). Most ospreys are migratory and withdraw from much of the U.S. and Canada in the winter. Ospreys once bred throughout California, but the species is now found mainly in a few areas of northern California (HCPB 2003).

Habitat and Prey

Ospreys inhabit lakes, reservoirs, coasts, estuaries, and riparian corridors that offer adequate nesting sites. This fish-eating raptor will take advantage of most tall structures for nesting, including large living or dead trees, cliffs, channel markers, buoys, utility poles, and other man-made structures near or over water (Terres 1991). Ospreys typically forage for fish on the wing, commonly using prominent perch sites in close proximity to water (Poole 1989).

Seasonal Occurrence

Ospreys are present in northern California during the breeding season (spring and summer) (HCPB 2003). Ospreys are common around Turlock and Dawson Lakes.

5.2 Bald Eagle

Status

The bald eagle is federally listed as threatened under the ESA. It is currently proposed to be delisted; however, this final decision is pending. The MBTA and the EPA also protect bald eagles. Additionally, the California Department of Fish and Game lists it as state-endangered.

Photo 2 Bald Eagle

Distribution

Bald eagles (Photo 2) are widely distributed across Canada and the U.S. Some areas of North America have resident eagle populations, while other areas show seasonal shifts between breeding and wintering populations. The species winters throughout most of California at lakes, reservoirs, river systems, and some rangelands and coastal wetlands. The breeding range is mainly in mountainous habitats near reservoirs, lakes and rivers, mainly in the northern two-thirds of the State, in the Central Coast Range, and on Santa Catalina Island (HCPB 2003).

Habitat

Throughout the year bald eagles frequent the coast, rivers, lakes, reservoirs, and terrestrial habitats adjacent to these water bodies. They primarily feed on fish but also scavenge along roadsides (Stalmaster and Newman 1979).

Seasonal Occurrence

The California breeding season extends from February through July. Birds typically fledge by mid-July. Most lakes and reservoirs in the San Joaquin Valley are frequented by wintering bald eagles. The Central Sierra Audubon Society reports an average of 36.7 bald eagles for the mid-winter counts at Don Pedro Reservoir (Turner 2004). The nesting population in the Central Valley continues to expand. Nesting pairs occur at Don Pedro Reservoir, Chowchilla, and Millerton Lake. Other pairs probably reside in the valley, in preferred habitats associated with lakes and reservoirs. They are particularly attracted to wintering waterfowl concentrations. (Jurek 2004).

Telemetry studies show that the nesting bald eagles leave the area in late summer for the salmon fisheries of Oregon and Washington (Thelander 2004). The resident breeders return in late fall and winter to remain on territory.

5.3 Red-shouldered Hawk

Status and Distribution

The red-shouldered hawk (Photo 3) is protected by the MBTA. Several northern and midwestern states have listed the red-shouldered hawk as endangered, threatened, or of special concern due to declining populations, but no special listing status applies to California birds (Crocoll 1994; HCPB 2003).

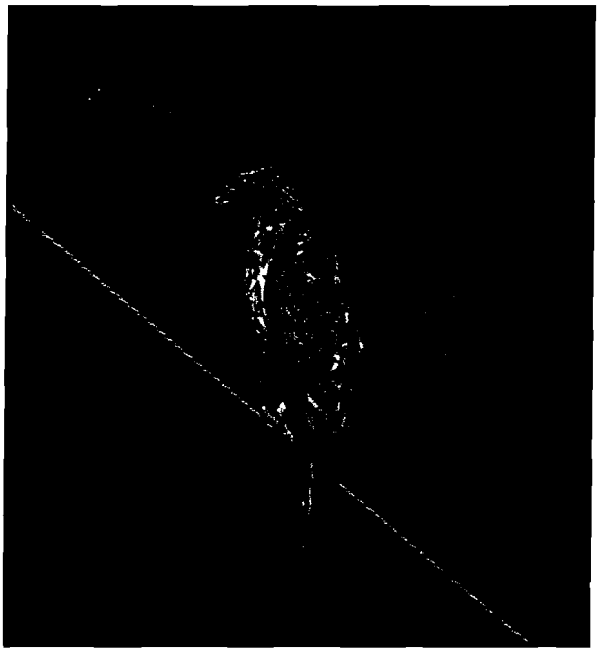


Photo 3 Red-shouldered Hawk

Red-shouldered hawks occupy areas west of the Sierra Nevada range from southwestern Oregon, south through California and into Baja, Mexico. A separate population occurs throughout much of the forested regions of the eastern U.S. (Crocoll 1994). The red-shouldered hawk is a locally uncommon to common year-long resident the length of California along the coast, and in the Central Valley. Uncommon, even in suitable habitat in western Sierra Nevada foothills. Frequents low-elevation riparian woodlands, up to 5000 ft., especially where interspersed with swamps and emergent wetlands (WHDAB 2003).

Habitat and Prey

Forested habitats of many types are used and include riparian areas, bottomland hardwoods, and swampy deciduous forests to more upland deciduous and mixed deciduous-coniferous forests. In western Sierra Nevada foothills, foraging areas are valley foothill hardwood and valley foothill hardwood-conifer habitats (WHDAB 2003).

Red-shouldered hawks frequently hunt from perches, waiting for and swooping down on prey when it presents itself. A variety of perches are used including trees, fences, haystacks, and poles. They are diet generalists and consume small mammals, amphibians, reptiles, occasionally birds, and sometimes insects and crayfish (Crocoll 1994).

Seasonal Occurrence

Red-shouldered hawks are found year-round in California. Some northern populations migrate in winter (WHDAB 2003).

5.4 Swainson's Hawk

Status and Distribution

The Swainson's hawk (Photo 4) is protected under the MBTA and is a Threatened Species in California. The loss of agricultural lands to development is a serious threat to Swainson's hawks throughout California. Other threats include habitat loss due to riverbank protection projects, conversion from agricultural crops that provide good foraging opportunities to crops such as vineyards and orchards which provide fewer foraging opportunities, shooting, pesticide poisoning of prey animals and hawks on wintering grounds, competition from other raptors, and human disturbance at nest sites (HCPB 2003).

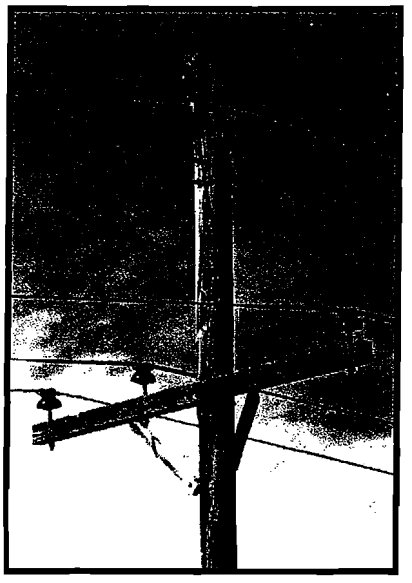


Photo 4 Swainson's Hawk

Swainson's hawks inhabit the Great Plains and desert shrublands of western North America from Canada to northern Mexico. They undertake one of the most remarkable migrations of any raptor species in North America when they vacate their breeding grounds and migrate in large flocks to Central and South America.

Once found throughout lowland California, Swainson's hawks are now restricted to portions of the Central Valley and Great Basin regions where suitable nesting and foraging habitat is still available. Central Valley populations are centered in Sacramento, San Joaquin, and Yolo counties (HCPB 2003).

Habitat and Prey

Preferred territories for Swainson's haws in the Central Valley are riparian systems adjacent to suitable foraging habitats. Foraging areas include native grasslands or lightly grazed pastures, alfalfa and other hay crops, and certain grain and row croplands. Unsuitable foraging habitat includes crops such as vineyards, orchards, certain row crops, rice, corn and cotton crops. Swainson's hawks require large, open grasslands with abundant prey in association with suitable nest trees (HCPB 2003).

The diet of the Swainson's hawk is varied with the California vole being the staple in the Central Valley. A variety of bird and insect species are also taken (HCPB 2003).

Seasonal Occurrence

Migrating individuals move south through the southern and central interior of California in September and October, and north March through May. While the majority of North American Swainson's hawks winter in Argentina, recent studies indicates that Central Valley populations winter in Mexico and Columbia (WHDAB 2003).

5.5 Red-tailed Hawk

Status and Distribution

The red-tailed hawk (Photo 5) is protected under the MBTA. Red-tailed hawks are the most common and widely distributed large raptor in North America. Except for the northern-most populations in Alaska and Canada, they are year-round residents in nearly every state, as well as in Mexico and Central America. Races include the Eastern, Western, Fuertes, Harlan's, and Florida (Wheeler and Clark 1995).

Photo 5 Red-tailed Hawk

Habitat and Prey

Red-tailed hawks are generalists in their habitat preference. During the nesting season, red-tailed hawks may occur from sea level to 9,000 feet in elevation (BLM 2001). They commonly occupy forested lands, open country with scattered trees, edge areas between different habitat types, agricultural lands, and riparian zones. Red-tailed hawks will use large trees, cliffs, and man-made structures for nesting, depending on the substrate and prey availability in nearby areas. This raptor is relatively tolerant of humans and often occurs on the periphery of human-dominated landscapes, such as rural subdivisions and agricultural areas.

Birds typically prefer to nest in a tall tree with good aerial access, nesting in a wide range of habitats. The availability of tall trees for nesting with foraging habitat nearby is important in many areas, but nest sites may not always be in trees. Cliff sites or other elevated locations also may be used for nesting. Perch availability is important for red-tailed hawks, which generally hunt from a perch site. This raptor is an opportunistic forager, commonly preying on small and medium-sized mammals (e.g., rodents, rabbits), birds, and reptiles (including snakes).

Seasonal Occurrence

This species is a permanent resident of California and breeds throughout the state. Red-tailed hawks often migrate down-slope in winter. In summer and fall, some individuals move to open areas at higher elevations (WHDAB 2003).

5.6 Ferruginous Hawk

Status and Distribution

The ferruginous hawk (Photo 6) is protected under the MBTA and is a Species of Special Concern in California. Ferruginous hawks inhabit the Great Plains and Intermountain West from southern Canada to central Mexico.

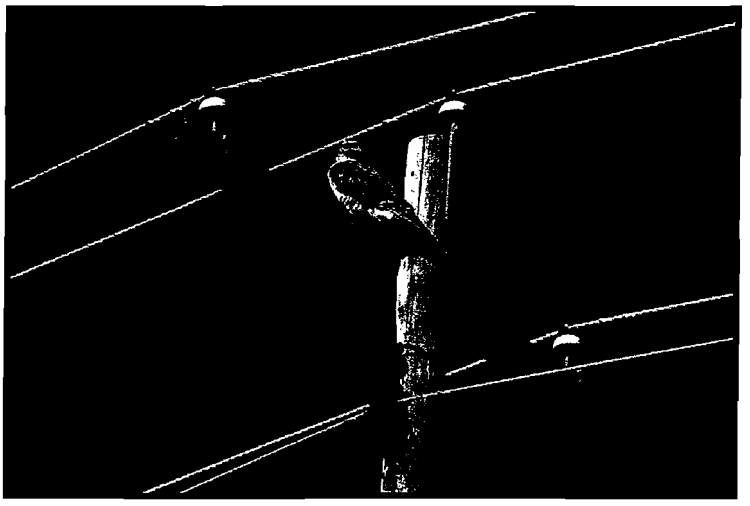


Photo 6 Ferruginous Hawk

In California, the ferruginous hawk is an uncommon winter resident and migrant at lower elevations and open grasslands in the Modoc Plateau, Central Valley, and Coast Ranges. It is fairly common as a winter resident of grasslands and agricultural areas in southwestern California. In the summer, it is occasionally found in the northeast (HCPB 2003).

Habitat and Prey

This large hawk is a bird of open country, inhabiting arid grasslands, semidesert shrublands, and often the interface between pinyon-juniper woodlands and sage basins. They tend to occur in more unbroken or unfragmented landscapes than either Swainson's hawks or red-tailed hawks (Johnsgard 1990), and avoid heavily forested areas, steep canyons, and high elevations (Bechard and Schmutz 1995). There are no records of ferruginous hawks breeding in California (WHDAB 2003). During winter, ferruginous hawks often utilize open farmlands, grasslands, deserts, and other arid regions associated with rabbit species, prairie dogs, and/or other major prey species.

Ferruginous hawk's primary prey items are small mammals. West of the Continental Divide, leporids (i.e., rabbits and hares) and pocket gophers comprise the main food source. East of the Continental Divide, ground squirrels and prairie dogs are generally consumed.

Seasonal Occurrence

Ferruginous Hawks generally arrive in California in September and depart by mid-April (WHDAB 2003).

5.7 Rough-legged Hawk

Status and Distribution

The rough-legged hawk (Photo 7) is protected under the MBTA. Rough-legged hawks breed across northern Canada and Alaska. Only during the winter do they occur in the lower 48 states. They overlap some of the same areas that Swainson's hawks occupy during the breeding season.

Photo 7 Rough-legged Hawk

The rough-legged hawk is a migrant and winter resident in California. It is found a variety of habitats in the Modoc Plateau, northern valleys, throughout the Central Valley, and along the coast from Sonoma to Santa Barbara counties. It also occurs regularly at northern desert areas, Salton Sea, Antelope Valley, and southern California lakes. Abundance varies from year to year; usually common to uncommon. This species tends to concentrate where small mammals are numerous, and food availability appears to determine winter abundance and distribution. Numbers often follow the 3-4 yr cycles of small mammal abundance (WHDAB 2003).

Habitat and Prey

In its winter range, the rough-legged hawk prefers open country at lower elevations. It typically occupies open grasslands, sagebrush flats and basins, agricultural lands, wetlands, wet meadows, dunes, pasture, and river deltas (BLM 2001). Rough-legged hawks are often observed perched along these open areas when foraging. Low rocks and shrubs may be used in the absence of higher sites, but power poles, lone buildings or other structures, fences, and lone trees or snags are all used as resting or hunting perches (BLM 2001).

The primary prey items for rough-legged hawks are rodents. However, it also is known to take birds, insects, and carrion (UDWR 2002a).

Seasonal Occurrence

Rough-legged hawks usually arrive in California in October or November, and begin to depart for nesting grounds in March or April (WHDAB 2003).

5.8 Golden Eagle

Status and Distribution

The golden eagle (Photo 8) is protected under both the MBTA and EPA. Golden eagles are protected under the EPA based on their similarity of appearance to subadult, federally listed bald eagles.

Photo 8 Golden Eagle

Golden eagles occur primarily throughout western North America, from northern Alaska to the Central Plateau of Mexico; a smaller proportion of the population nests in eastern Canada and winters in the eastern United States.

Habitat and Prey

Golden eagles are birds of open habitats and landscapes. Although open grasslands, sagebrush steppe, and broad valleys are the preferred habitats, golden eagles also can be found in higher elevations, along river corridors, and near conifer forests, particularly during migration. Arid, sloping valleys, benches or flatlands bisected by canyons, and gullies or rock outcrops are preferred over flat, featureless terrain (BLM 2001).

In the western United States, the home range of the golden eagle varies from 4.5 to 63 square miles, with habitat types and prey densities ultimately determining the territory size (BLM 2001). Breeding habitat for golden eagles generally consists of lowland and upland desert shrub communities and grasslands, lowland bluffs and cliffs, desert and submontane shrub communities, piñon-juniper, and montane riparian woodlands (Behle 1981). Nests are often located on cliff faces and large rock outcrops, although birds also will use large, ponderosa pines to small junipers or even utility poles (Glinski 1998). Breeding pairs may alternate between nest sites each year (Colorado Atlas 1998). Winter habitats generally include arid, shrub-steppe country and in general are similar in physical appearance to the summer areas (BLM 2001).

Primary prey species for golden eagles consist of small and medium-sized mammals (e.g., ground squirrels, rabbit species), but golden eagles also will forage on insects, snakes, birds, juvenile ungulates, and carrion. Although it is rare, this bird may take large, healthy mammals, hunting cooperatively in pairs (Terres 1991).

Seasonal Occurrence

In the Turlock Irrigation District, golden eagles nest in oak trees within the oak woodland savannas and foothills up to 2,000 feet in elevation. Above 2,000 feet, nesting is mostly restricted to cliffs. A substantial number of golden eagles winter in the area. They do not inhabit the orchards or agricultural areas of the lower valley, but prefer the oak woodland savannas (Thelander 2004).

5.9 Turkey Vulture

Status and Distribution

Turkey vultures (Photo 9) are protected by the MBTA. They are the most widely distributed vulture species in North America. Birds breed from southern Canada, much of the U.S., and south through Mexico, Central America, and South America (Kirk and Mossman 1998).

Turkey vultures are common in breeding season throughout most of California. They are absent to uncommon in most of state in winter, with greatest concentrations in coastal regions, and not found at all in highest elevations of the Sierra Nevada (WHDAB 2003).

Photo 9 Turkey Vulture

Turkey vultures are occasionally electrocuted on power lines. Collisions with power lines are apparently rare since their flight is relatively slow and controlled (Kirk and Mossman 1998).

Habitat and Prey

A variety of habitats are used for foraging, roosting, and breeding. They occur most frequently in open areas that provide adequate cliffs or large trees for nesting, roosting, and resting. Roost sites are often in undisturbed stands of large trees. Preferred breeding habitat includes isolated and undisturbed forested areas that provide rock crevices, logs, stumps, and abandoned buildings for nest sites. Foraging habitats include grasslands, agricultural, and pasture lands, but areas of intensive row-crops appear to be avoided (Kirk and Mossman 1998).

Turkey vultures have a well-developed sense of smell and are adept at detecting concealed carrion. They are almost exclusively scavengers and rarely take live prey. They primarily feed on mammals (wild and domestic) but also consume reptiles, amphibians, birds, fish, crustaceans, and sometimes plant material (Kirk and Mossman 1998).

Seasonal Occurrence

Turkey vultures migrate south or down-slope for winter. Some individuals in coastal regions winter in California. The rest of the population migrates, mostly to Central America, for the winter. Large flocks concentrate along well-defined, traditional migration routes in autumn (WHDAB 2003).

5.10 Barn Owl

Status and Distribution

The barn owl (Photo 10) is protected under the MBTA. This owl is widespread throughout the world, from wilderness to rural locations to urban parks and suburbs (Terres 1991).

Photo 10 Barn Owl

The barn owl is a common, year-long California resident in open habitats including grassland, chaparral, riparian, and other wetlands. Occurs throughout the state from sea level to 5500 ft., avoiding dense forests and open desert habitats. Often found in vicinity of human communities (WHDAB 2003).

Habitat and Prey

Barn owl's prefer open, low-lying areas (below 750-ft. elevation), with an abundant vole population. Although the owl has an extensive range it is uncommon higher in the mountains. Grasslands in areas of milder climates with old buildings or hollow trees for perching and nesting may support large concentrations. The owl also avoids areas with low mean January temperatures, densely forested and intensively cultivated areas (Owling.com 2001a).

The barn owl's diet is dominated by mice, rats, voles, gophers, and shrews. It will also take other prey including larger insects, reptiles, and fish. Small birds, such as blackbirds, are important food in winter (WHDAB 2003). The barn owl hunts following a favorite course or returning to favorite hunting areas. Although it will pounce on prey from a perch also it normally flies low to the ground (less than 10 ft.) and dives onto prey with talons extended. It possesses high auditory acuity and can catch prey in complete darkness. Although the barn owl is highly nocturnal it can be observed hunting in daylight (Owling.com 2001a).

Barn owls usually nest on ledges, crevices, or other sheltered areas of cliffs or human-made structures. They also nest in cavities in trees or snags, burrows, or culverts. Within the TID service territory, barn owls frequently use nest boxes placed for them in agricultural areas.

Seasonal Occurrence

The barn owl resides year-round in California. A mated pair retains roughly the same home range throughout the year (WHDAB 2003).

5.11 Great Horned Owl

Status and Distribution

The great horned owl (Photo 11) is protected under the MBTA. This owl is widespread throughout North America, from wilderness to rural locations to urban parks and suburbs (Terres 1991).

Photo 11 Great Horned Owl

Habitat and Prey

The great horned owl is very adaptable and probably has the most diverse habitat and climatic tolerance of any North American owl species. It inhabits virtually every type of terrain in North America from sea level to 11,000 feet in elevation. If there is a preferred habitat, it would include mature deciduous woods with scattered conifers for maximum roosting concealment that border water with adjacent open habitats for hunting (Owling.com 2001b).

During the day, this nocturnal species often roosts in dense tops of conifers. Great horned owls forage from dusk until dawn; however, individual owls also will forage during the day (Terres 1991).

Great horned owls are highly territorial, and pairs defend their territories year-round. The great horned owl is the earliest nesting owl in North America. Great horned owls do not construct their own nest site, but they customarily adopt the previous year's nest of other bird species, such as red-tailed hawks and crows. Hollow trees are occasionally selected as nest sites, and in rough terrain, particularly where few trees exist, great horned owls will nest on ledges and large, rocky depressions (Owling.com 2001b).

Small mammals compose the bulk of this owl species' diet. However, great horned owls will prey on almost any animal ranging in size from scorpions and grasshoppers to geese, skunks, and small pets.

Seasonal Occurrence

The great horned owl is not migratory, but will move up-slope and down-slope in response to weather conditions (WHDAB 2003).

5.12 Great Blue Heron

Status and Distribution

The great blue heron (Photo 12) is protected under the MBTA. It is the best known and most widely distributed heron in North America, occurring from Alaska to northern South America (Terres 1991). This species is found all year throughout most of California.

Photo 12 Great Blue Heron

Habitat and Prey

This species is typically associated with wet meadows, riparian corridors, suburban ponds, and reservoirs (Terres 1991). It is fairly common in shallow estuaries and fresh and saline emergent wetlands. It is less common along rivers and rocky marine shores, in croplands, pastures, and in mountains above foothills (WHDAB 2003). It typically nests near water sources, and usually in large colonies or heronries. Nests are often built in larger trees near water; however, they also may be constructed on the ground, along rocky ledges, and on man-made structures (Terres 1991).

The heron's diet is comprised of a variety of fish species; however, they also forage on frogs, salamanders, lizards, snakes, shrimp, crabs, crayfish, grasshoppers, dragonflies, and many aquatic insects. Occasionally, this opportunistic feeder may prey on birds and small mammals (Terres 1991).

Seasonal Occurrence

In June or July, after breeding, great blue herons disperse from nesting colonies to outlying areas, but there is little regular migration. Many individuals depart from northeastern California and east of the Sierra Nevada in winter (WHDAB 2003).

5.13 Great Egret

Status and Distribution

Great egrets (Photo 13) are protected by the MBTA. Great egrets have been reported killed in collisions with power lines and other structures (McCrimmon et al. 2001).

Photo 13 Great Egret

This bird is widely distributed around portions the world. In North America it occurs along coasts and adjacent inland areas, pockets of the interior U.S., the West Indies, and south through Mexico, Central America, and South America. Northern and interior U.S. populations are migratory. The great egret is a common year-long resident throughout California, except for high mountains and deserts (WHDAB 2003).

Habitat and Prey

A colonial nester, egrets breed in single-species or mixed-species flocks. Their nests are constructed in shrubs or trees, usually over water or on islands (McCrimmon et al. 2001). Egrets nest in a variety of freshwater or marine wetland types including natural and manmade habitats. Breeding season in California spans from March to July, and from May to July on northeastern plateau (WHDAB 2003).

Great egrets feeds in shallow water and along shores of estuaries, lakes, ditches, and slow-moving streams, in salt ponds and mudflats, and in irrigated croplands and pastures (WHDAB 2003). Egrets eat primarily fish but also will take invertebrates, amphibians, reptiles, small mammals, and birds (McCrimmon et al. 2001). Egrets stand motionless or stalk slowly, then rapidly strike prey with bill.

Seasonal Occurrence

The great egret is resident year-long throughout most of its California range, but leaves the northeastern plateau September to February. From March to July, populations are concentrated near nesting colonies; after nesting, individuals disperse and wander widely (WHDAB 2003).

5.14 Greater Sandhill Crane

Status and Distribution

The greater sandhill crane (Photo 14), the largest of several subspecies of sandhill cranes, is protected by the MTBA and is a Threatened Species in California. This species continues to experience threats on both wintering and breeding grounds by agricultural and residential conversion of habitat, predation, human disturbance and collisions with power lines (HCPB 2003).

Photo 14 Sandhill Crane

The species ranges from as far north as Alaska and the coast of the Arctic Ocean south into the Great Lakes region and westward across Idaho, Nevada and Oregon. Populations also occur in northeastern Siberia, and in the southeastern United States and Cuba.

Habitat and Prey

In California, sandhill cranes establish territories in wet meadows that are often interspersed with emergent marsh. California birds tend to nest in rather open habitat; however, in certain areas, they nest in association with a dense cover of bulrush and burreed (HCPB 2003).

A communal roost site consisting of an open expanse of shallow water is a key feature of wintering habitat. In the Central Valley, preferred wintering grounds of sandhill cranes have favorable roost sites and an abundance of cereal grain crops. Corn and rice are the principal food source at most Central Valley wintering areas. Irrigated pastures are chosen for resting sites throughout the wintering ground. (HCPB 2003).

Seasonal Occurrence

Currently, the estimate for greater sandhill cranes within their Pacific Flyway range is between 5,000 and 6,000 individuals. There are about 25,000 lesser sandhill cranes wintering in California each year. In addition about 6,000 intermediate sandhill cranes, or Canadians as they are also called, also mix with the other two subspecies (HCPB 2003).

Greater sandhill cranes nest in Lassen, Modoc, Plumas, Shasta, Sierra, and Siskiyou Counties. Wintering areas are more restricted due to loss of habitat in the Central Valley wetlands and irrigated pastures of San Joaquin, Sacramento, Butte, Yolo, Merced, Kern, Sutter, and Stanislaus Counties, and in the Imperial Valley of southeast California (HCPB 2003).

5.15 American Crow

Status and Distribution

American crows (Photo 15) are protected by the MBTA, although some states allow regulated hunting. American crows are the most widespread crow species in North America. They breed throughout much of the continental U.S. and lower half of Canada. Northern populations in much of Canada are migratory and breeding birds retreat to the south during the winter months.

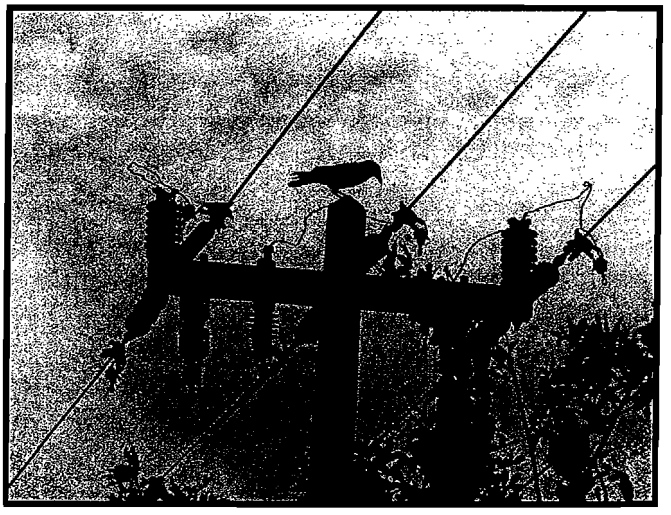


Photo 15 American Crow

Habitat and Prey

A habitat generalist, crows occupy a variety of habitats including urban, rural, agricultural, coastal, riparian, and woodland areas. They avoid dense forests and desert expanses. Their ability to adapt has facilitated large population increases in some areas, especially in cities. Crows can form immense winter roosting flocks of many tens of thousands of birds. Crows are omnivorous and opportunistic foragers; they'll eat almost anything.

Seasonal Occurrence

Crows are common and present year-round in California. The California Department of Fish and Game regulates crow hunting. Season dates generally run from early December to early April (HCPB 2004).

5.16 Common Raven

Status and Distribution

The common raven (Photo 16) is protected under the MBTA. It is one of the most widespread naturally occurring birds in the world, typically a resident of Alaska south through California and east to New Mexico. It is also a resident of Canada from Alaska east through southern Ontario. They occur throughout California, except for areas of the Central Valley, parts of the central coast, and cultivated valleys of the southeast (Small 1994).

Photo 16 Common Raven

Habitat and Prey

The common raven has a broad range from boreal, conifer, deciduous forests; prairies and grasslands; isolated settlements, towns and cities; and deserts. It prefers heavily contoured landscaping (e.g. cliffs) for the thermals, which it uses for foraging. For nesting it will also utilize areas with cliffs, trees, or human structures (Boarman and Heinrich 1999). In California, the common raven occurs throughout the open regions of the state wherever nesting cliffs or trees are available. Preferring to nest in the cliffs they will also use tall trees and power poles.

Ravens are scavengers, frequently feeding on road-killed animals, large dead mammals, and human refuse. They kill and eat prey including rodents, lambs (Larsen and Dietrich 1970), birds, frogs, scorpions, beetles, lizards, and snakes. In the deserts of the southwest they have also been known to prey on young desert tortoises (*Gopherus agassizii*; Berry 1985). They also feed on nuts, grains, fruits, and other plant matter (Knight and Call 1980; Heinrich 1989).

Seasonal Occurrence

Raven migration in California is not known, but they are often seen at the highest elevations in the late summer (Small 1994).

5.17 Yellow-billed Magpie

Status and Distribution

The yellow-billed magpie (Photo 17) is protected under the MBTA. A common, yearlong resident of the Central Valley and coastal mountain ranges south from San Francisco Bay to Santa Barbara County (WHDAB 2003).

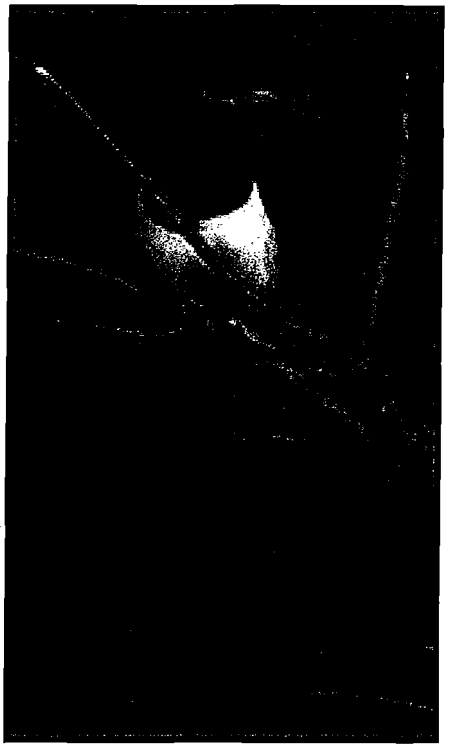


Photo 17 Yellow-billed Magpie

Habitat and Prey

The yellow-billed magpie inhabits valley foothill hardwood, valley foothill hardwood-conifer, valley foothill riparian, orchard vineyard, cropland, pasture, and urban habitats. They prefer open oak and riparian woodland, and farm and ranchland near tall trees, grasslands, pastures, and croplands (WHDAB 2003).

Yellow-billed magpies are opportunistic foragers. About 70% of their diet consists of insects, soil invertebrates, carrion, bird eggs and nestlings. They also eat acorns, seeds and grains, berries and other fruits. They feed by gleaning food from plants, picking at the ground, searching under objects, and catching flying insects.

Mated pairs nest alone or in small, loose colonies. The breeding season is from late February to mid-July with peak activity in May and June. Nest is a large, bulky dome composed of twigs, and lined with mud, rootlets, and grasses (WHDAB 2003).

Seasonal Occurrence

The yellow-billed magpie is a yearlong resident of California. This species sometimes wanders beyond usual range in winter (WHDAB 2003).

6.0 BIRDS AND POWER LINES

6.1 Background

Rural electrification of the U.S. began in the late 1800's and expanded rapidly. As wires began to span rural areas, avian collisions and electrocutions began to occur. Collisions with rural telegraph wires were first documented in 1876 (Coues 1876).

North American electric utilities focused on raptor electrocutions during the winter of 1970-1971 when nearly 1,200 eagle deaths resulting from poisoning (n=30+), shooting from aircraft (n=800+), and electrocution or shooting along power lines (n=300+) were recorded in Wyoming and Colorado (Olendorff et al. 1981). The following year, the U.S. Rural Electrification Administration (REA) published a guide to reduce raptor electrocutions, and several electric companies began testing new, safer power line designs (Olendorff et al. 1981). The new pole-top designs formed the foundation for the first definitive work on raptor electrocutions: *Suggested Practices for Raptor Protection on Power Lines* (APLIC 1996). This document was first published in 1975 and revised in 1981 and 1996. During 1989, nine major electric utilities also joined to form the Avian Power Line Interaction Committee (APLIC) to further study electrocutions and bird collisions (Lewis 1997).

6.2 Contributing Factors to Avian Electrocution

Power lines situated in areas with low vegetation and flat terrain are particularly attractive to raptors because they provide structures from which to hunt and roost (Boeker 1972; Benson 1981). Eagles and buteos (soaring hawks) actively use pole structures, particularly in areas where prey is abundant and few other perch sites exist (Olendorff et al. 1981). Pole perches give raptors a wide range of vision and greater attack speed when hunting. Poles also provide a place for raptors to broadcast territory boundaries and find either sun or shade (Colson and Associates 1995). Twelve North American raptor species have been documented nesting on utility structures (Blue 1996). Some raptors, particularly osprey, frequently nest on utility structures (Nelson and Nelson 1976; Blue 1996). Smith (1985) observed that eagles and hawks often perch on outer and upper utility tower sections during the day and roost on inner and lower sections during the night.

Some raptors, such as the red-tailed hawk, actively seek power line corridors (Ansell and Smith 1980). However, forest dwelling accipiters, such as the Cooper's hawk, and sharp-shinned hawk *(Accipiter striatus)* rarely perch on power poles as they prefer the seclusion and shelter of trees (Olendorff et al. 1981).

Historically, the North American raptor most commonly electrocuted has been the golden eagle (*Aquila chrysaetos*). In general, golden eagles are electrocuted more frequently than bald eagles, and juveniles are more frequently electrocuted than adults (Benson 1981). The most common hawk electrocuted in the U.S. is the red-tailed hawk

and the most-common owl is the great horned owl (Harness 1997). Vultures also are frequently electrocuted.

Bird dimensions are important when considering bird protection. Table 1 provides average bird sizes and weights for common species that occur in the service territory. The Raptor Research Foundation recommends a minimum of 60-inch spacing between phases and phase-to-ground to minimize bird (specifically eagle) electrocutions (APLIC 1996). A large female eagle may have a 90-inch wingspan (54 inches between wrists); however, the 60-inch spacing was selected based on the fleshy wrist-to-wrist distance. The distribution line spacing recommendations also were developed specifically to minimize electrocutions of immature eagles when they begin or terminate a flight, as this is when these younger birds are the most vulnerable to electrocution.

Table 1 Average Size and Weight of Fifteen Bird Species that Occur In and Near the Service Territory

Species	Length (Inches)	Wingspan (Inches)	Weight (Pounds)
Bald Eagle	31	80	9.5
Golden Eagle	30	79	10
Red-shouldered Hawk	17	40	1.4
Swainson's Hawk	19	51	1.9
Red-tailed Hawk	19	49	2.4
Ferruginous Hawk	23	56	3.5
Rough-legged Hawk	21	53	2.2
Turkey Vulture	26	67	4.0
Osprey	22	63	3.5
Barn Owl	16	42	1.0
Great Horned Owl	22	50	5.5
Great Blue Heron	47	84	6.5
Great Egret	39	51	1.9
Sandhill Crane	46	77	10.6
American Crow	18	39	1.0
Common Raven	24	53	2.6

Adapted from Wheeler and Clark 1995, Terres 1991, and Sibley 2000

Numerous factors in addition to bird size and conductor separation contribute to electrocutions. Inclement weather is a major contributing factor to many eagle electrocutions (Benson 1981). Feathers are good insulators unless they become wet. Raptors with wet feathers are 10 times as vulnerable to electrocution above 5,000 volts (Nelson 1979a; Olendorff et al. 1981). Dry birds contacting live wires with their beak and foot, however, can still be killed at voltages below 5,000 (Olendorff et al. 1981). Wet birds also may have greater difficulty navigating around energized conductors when flying to and from poles.

Wind direction relative to utility crossarm orientation affects the probability of electrocution (Boeker 1972; Nelson and Nelson 1976; Nelson 1977; Benson 1981). Crossarms mounted perpendicular to the wind allow raptors to soar away from the structure and attached wires. Raptors taking off from crossarms mounted parallel to

prevailing winds can more easily be blown into energized conductors. Wind orientation presumably places inexperienced fledgling birds at a greater risk than the adults.

Raptor electrocutions often fluctuate seasonally. Increased seasonal precipitation or storm events may increase the electrocution risk accordingly. In the winter, power line poles are valuable sit-and-wait hunting sites, allowing raptors to seek prey without expending energy on active flight hunting (Benson 1981). During the spring, raptors may increase their exposure to electrocution by utilizing pole structures as nesting sites. Seasonal fluctuations of prey abundance also may influence the number of raptors electrocuted in a particular area (Olendorff et al. 1981; Benson 1981).

Age is a significant factor in eagle electrocutions. Adults feed the immature eagles during the first few months after fledging. During this period, the young eagles gain flight experience by short perch-to-perch flights. As these birds begin to hunt for themselves, they generally still rely on stationary perches. The young eagles are inexperienced in takeoffs and landings and less adept at maneuvering than adults (Nelson and Nelson 1976; Nelson 1979a, 1979b). Short flights from perch-to-perch, hunting from the perch and takeoff and landing experience all place young eagles at a high risk for electrocution (Olendorff 1993).

7.0 TID SURVEY METHODS

7.1 Current Approach

E&OA is implementing a number of raptor protection approaches on the TID electrical system. These are discussed in more detail in Chapter 9.0. The E&OA is currently implementing the following to reduce the risk of avian electrocutions:

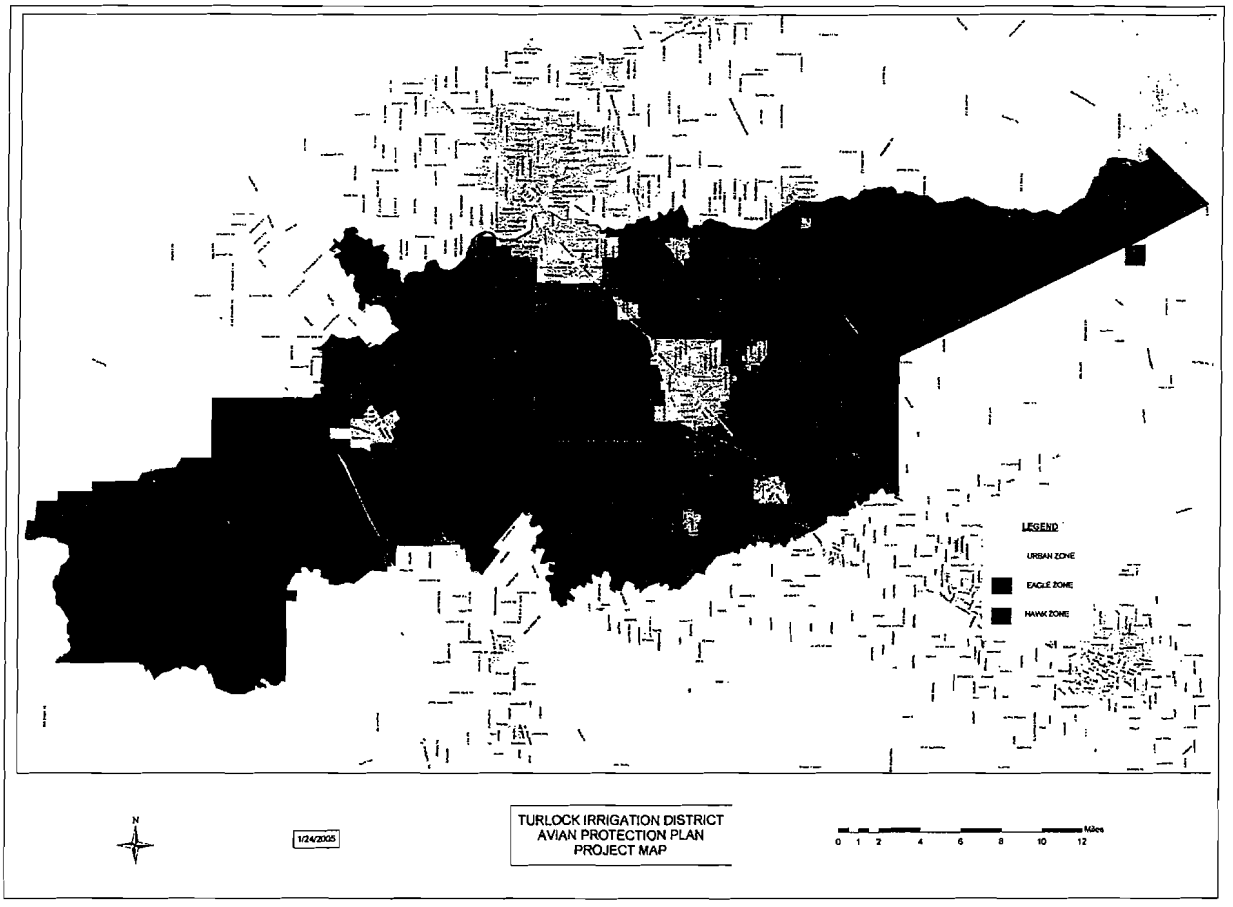
- Using nonconductive wooden crossarms.
- Installing bushing covers on transformer banks.
- Insulating jumper wires to transformers.
- Installing covers on cutouts.
- Installing covers on arresters.

7.2 Project Maps

Maps were created for TID's service area in order to identify high bird use areas in proximity to distribution lines. The purpose of the maps was to compare these biological data to the locations of TID's existing distribution lines and subsequently identify focus areas for the field surveys.

A number of avian species both breed and winter within TID's service area (see Chapter 5.0). Both historical and active nest sites, bird concentration areas, and foraging areas were mapped. The biological information for raptors, wading birds, and other sensitive species added to the maps was obtained from several different sources including the Natural Diversity Database from the Habitat Conservation Division, Wildlife and Habitat Data Analysis Branch, California Department of Fish and Game.

The biological data consisted of two types: 1) point observations for individual occurrences, nests, and roost locations (with appropriate buffers applied) and 2) polygons representing "priority habitats" or wintering, nesting, and breeding concentration areas for species of concern. These data were themed or color-coded by species for easy identification. Effort was made to obtain the best available map data with a reasonable amount of effort, but it should be understood the biological data are not all-inclusive.



Map 1 Bird Use Areas for E&OA Standards application.

7.3 Field Surveys

After the maps were created, EDM initiated field surveys in order to document high-risk structures, examining the specific electrical configuration relative to the pole location, associated habitat types, and relative bird use. Rights-of-way (RsOW) in bird concentration areas were examined and, when applicable, field data were recorded. Sites of historic mortality also were examined, when feasible.

Because it is not feasible to survey every distribution pole within TID's service territory, emphasis was placed on three-phase lines in proximity to bird use areas, although some single- and two-phase lines also were surveyed in specific areas. The intent of this approach was to identify the relative electrocution risk to birds in areas that represent the most optimal habitat, thereby providing E&OA with information for both short- and long-term planning to minimize bird electrocution risks.

When pole access was feasible, field data included:

- TID map/number coordinates of pole
- Photograph number (when applicable)
- Configuration of the primary unit(s)
- Equipment associated with each pole
- Any indications of previous bird mortalities associated with a structure (including species identification and approximate age, if known)
- Sign of bird use (e.g., whitewash, castings, prey remains, feathers, and bones)
- Topography
- Associated habitat type(s)
- Bird species observed in and near the structure, and the behavior of these birds (e.g., perched, flying, foraging)
- Any unusual field observation or anomaly

The resulting field data were recorded on standard data sheets and then transferred into a spreadsheet or matrix (see Appendix B). Applicable photos were taken of pole configurations, representative habitats, and any mortalities observed during the surveys. In some cases, the EDM biologist surveyed poles located outside mapped bird use areas if the habitat and/or topography were favorable for bird use.

When retrofitting measures were recommended, a pole number was recorded, and retrofitting options were identified.

7.4 Habitat Classification

Poles in bird use areas were "sampled" or field checked to identify preferred perches, emphasizing three-phase lines. In fragmented habitat, not all utility poles are at equal risk. Since the purpose of still-hunting is to perch on the highest point to get the best view of the countryside, raptors will select certain poles for perching over others. These "preferred perches" offer the best vantage point and these poles, if unprotected, are more likely involved in electrocutions (APLIC 1996).

An overall habitat ranking of "High," "Medium," or "Low" was calculated in the spreadsheet, based on the variables of habitat, bird use (e.g., whitewash, castings, prey remains, feathers, and bones), and vantage point. Numerical values were assigned relative to these variables to determine a risk value for each pole surveyed. The highest value was given to poles located in rural areas with native vegetation, signs of raptor use, and poles providing a commanding view. The lowest value was given to poles in more disturbed habitats without native vegetation. This strategy to rank habitats was used because geographic location and habitat setting are as important as the technical utility pole design in determining the actual risk of electrocution (Mañosa 2001). This information was combined with the pole configuration risk to prioritize retrofitting, as described below. The results of the field surveys are included in Appendix B.

7.5 Pole Risk Classification

The field surveys recorded pole configurations for those lines examined. Starting at the top of each pole, a unit configuration was recorded for each structure along with the presence of transformers, cutouts, surge arresters, and other equipment.

Research on raptor electrocutions has shown certain structures are more lethal to birds of prey than others. This is especially true when mortality rates are adjusted for structure frequency (Harness 1997). For example, three-phase tangent structures may be responsible for the same number of electrocutions as three-phase transformer banks. However, because three-phase transformer banks occur less frequently in rural areas than tangent structures, their adjusted lethality is significantly higher. Based upon historical problems in the western U.S., the following ranking was used for utility configurations:

High-risk Configuration
- Three-phase transformer banks and other three-phase equipment poles
- Tangent structures with all primary wires supported on a crossarm
- Three-phase deadend and angle poles
- Three-phase riser poles

Medium-risk Configuration
- Single-phase transformer banks and other single-phase equipment poles
- Single-phase risers

Low-risk Configuration
- Three-phase tangent structures with the center phase on the pole top
- Two-phase tangent structures
- Single-phase structures

7.6 Retrofitting

When retrofitting measures were recommended, they were recorded on the field data sheets during the pole inspection. Retrofitting measures and the codes used to record them included:

AC Arrester Cap
BC Bushing Cover
BS Bird Spike
CG Conductor Guard for Primary Conductor
COC Cutout Cover
EP Elevated Perch
IJ Insulated (600v) or Covered Jumper
RG Remove/Gap Pole Top Groundwire
TA Tape
TRI Triangle (Anti-Perching Device or Perch Guard)

When raptor protection devices were already present, they were noted. The proposed retrofitting measures were recorded on standard data sheets and then transferred into a spreadsheet (Appendix B). The proper way to install retrofitting measures is provided in Chapter 8.0.

7.7 Retrofitting Prioritization

A pole retrofitting prioritization list was developed to provide both short-term and long-term plans for bird protection (Table 2). This approach will allow TID to implement a retrofitting program in accordance with the utility's short- and long-term maintenance program. Recommendations were prioritized based on both the habitat and pole risk classification system discussed in the previous paragraphs.

Table 2 Retrofitting Prioritization Determined by Habitat Use and Pole Configuration

Categories of Electrocution Risk			
	Pole Risk Configuration		
Habitat Classification	**Low**	**Medium**	**High**
Low Quality	3	3	2
Medium Quality	3	2	1
High Quality/Preferred Perch	2	1	1

Retrofitting Priority **1** – High-risk Pole
Retrofitting Priority **2** – Medium-risk Pole
Retrofitting Priority **3** – Low-risk Pole

The highest priority was placed on high-risk equipment and deadend poles located in areas with high-quality habitat for birds and their associated prey base or near known raptor roost/nest sites. A retrofitting priority of "High" also was assigned to structures with carcasses/bones (i.e., mortalities) at the pole base or preferred perch poles with inadequate spacing.

Structures with reduced clearances located in lower quality habitat were assigned a "Medium" retrofitting priority. Although these structure types are potentially lethal, they did not show signs of heavy raptor usage and were typically located near roads or other human-related areas. Low-risk structures in high quality habitat also were assigned a medium retrofitting priority due to the potential frequency of bird use.

A "Low" priority was assigned to potential hazardous structure types located in more disturbed areas with low raptor use (e.g., parking lots, urban areas). The retrofitting prioritization is included in the field data spreadsheet located in Appendix B.

The 1981 version of *Suggested Practices for Raptor Protection on Power Lines, The State of the Art in 1981* (Olendorff et al. 1981) states that "correcting 2 percent of all structures can eliminate 95 percent of all eagle electrocutions." Even though the authors of this statement acknowledge this is probably overly optimistic, it does illustrate the importance of a habitat/pole configuration approach to optimize retrofitting. Based

on this overall premise, it is important to note this risk assessment recorded a sampling of poles within TID's service territory and is not all encompassing. In general, raptor populations vary regionally, corresponding directly to prey availability. Raptors are mobile, opportunistic hunters that readily respond to changes in the prey base, which may result in increased bird use in new portions of the utility system not identified in the maps used for this risk assessment.

This APP provides an approach to identify potentially hazardous pole configurations within TID's service territory and can be used by the utility as a tool in operational and facility planning into the future. If additional bird mortalities are recorded, retrofit information should be applied in a holistic, proactive approach. Similar pole configurations in similar habitats associated with any future bird mortalities pose a similar risk. It may, therefore, be prudent to retrofit several structures if a mortality occurs.

8.0 STRUCTURE CONFIGURATIONS AND GENERIC RETROFITTING MEASURES

The following is a generic discussion of typical structure configurations and recommended new construction and retrofitting measures. Chapter 9.0 provides retrofitting measures unique to TID configurations. Retrofitting measures were selected that are both effective and economical to install. An emphasis was placed on specifying products that can be safely installed "hot" to minimize labor costs. The unit drawings shown are 7.2/12.47kV.

8.1 Single-phase Tangent Structures

The most common distribution unit types located in rural areas are tangent structures. Figure 1 illustrates a typical single-phase tangent structure constructed on a wood pole. Single-phase lines are usually constructed without crossarms and support a single energized phase conductor on a pole-top insulator. Single-phase structures without pole-top grounds or pole-mounted equipment generally provide adequate separation for all animals.

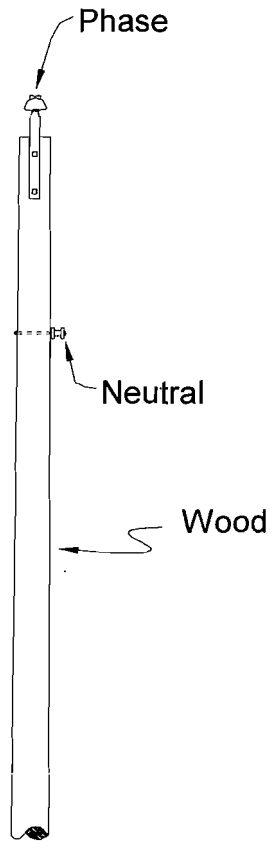


Figure 1 Typical Rural Distribution Single-Phase Pole Configuration, 7.2kV

8.2 Three-phase Tangent Structures

Another common distribution unit located in rural areas is a three-phase tangent structure (Photo 18). Figure 2 illustrates a three-phase tangent structures constructed on a wood pole. Three-phase power lines are usually constructed with an 8-foot crossarm supporting two conductors. A single energized phase conductor typically sits on a pole-top insulator.

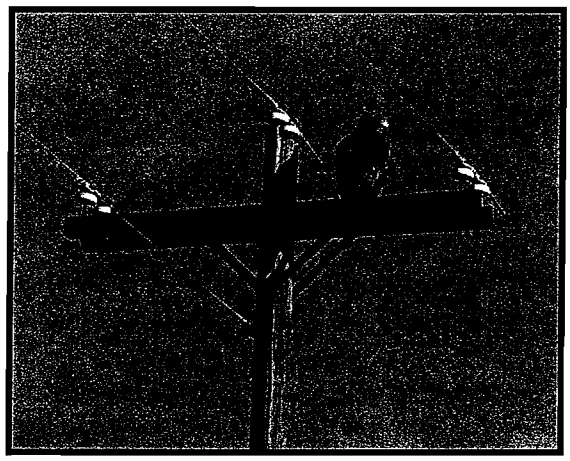
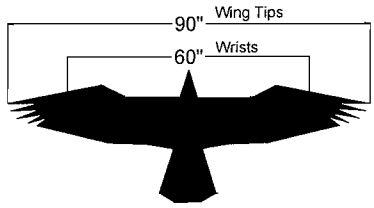


Photo 18 Example of C1 Three-phase Tangent Structure

Distribution three-phase tangent structures, without pole-top grounds or pole-mounted equipment, generally provide adequate separation for all but the largest raptors since 48 inches of phase separation is provided. There also is a 22-degree angle between the outer and center phase wires. This separation is appropriate in areas where large raptors are less likely to occur. In areas where eagles use these poles as preferred perches, additional protection to minimize the electrocution risk is recommended.



Eagle
Measurements

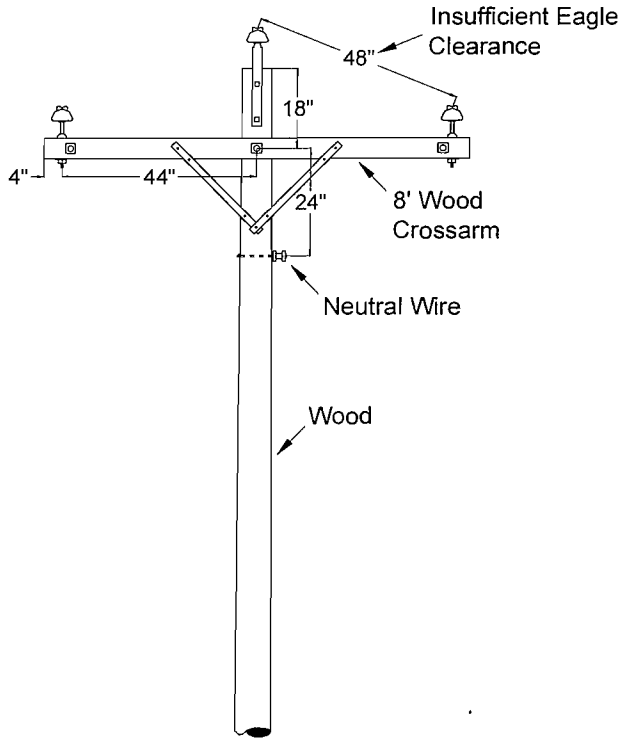


Figure 2 Typical Rural Distribution Three-Phase Pole Configuration, 7.2/12.47kV

In rural areas, new three-phase tangent structures with 8-foot crossarms should be framed to provide additional clearance, bringing the total phase-to-phase separation to 60 inches as recommended in *Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996* (APLIC 1996). This additional clearance required for eagles can be obtained by lowering the crossarm 24 inches on new poles (Figure 3).

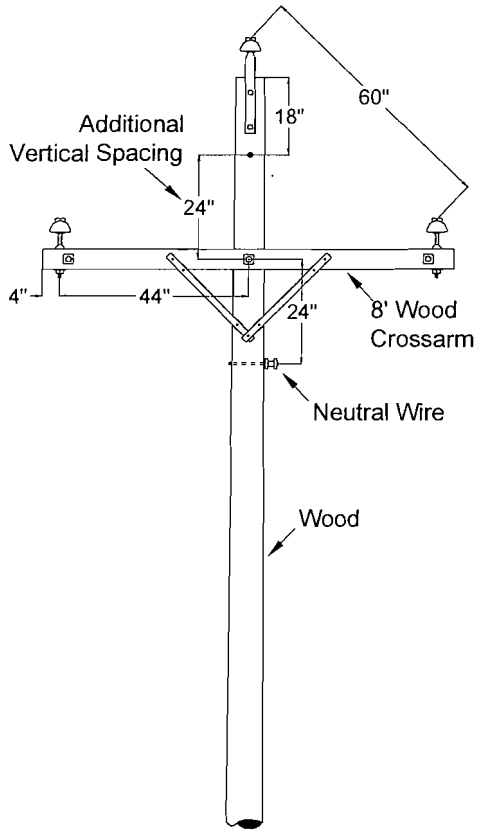


Figure 3 Eagle-Safe Three-Phase Pole Configuration Using an 8-foot Dropped Crossarm, 7.2/12.47kV

If large conductors are used, mounted 8 inches from the crossarm end, the 8-foot crossarm would need to be dropped an additional 6 inches (48 inches from the top of the pole) to maintain 60 inches of separation.

Dropping a crossarm an additional 24 inches may require shorter spans or taller poles to maintain ground clearances, adding to the structure cost. A common alternative to dropping the arm is to use a 10-foot crossarm (Figure 4). This provides the recommended 60 inches of separation without using taller poles and is the most economical method to make a structure raptor-friendly.

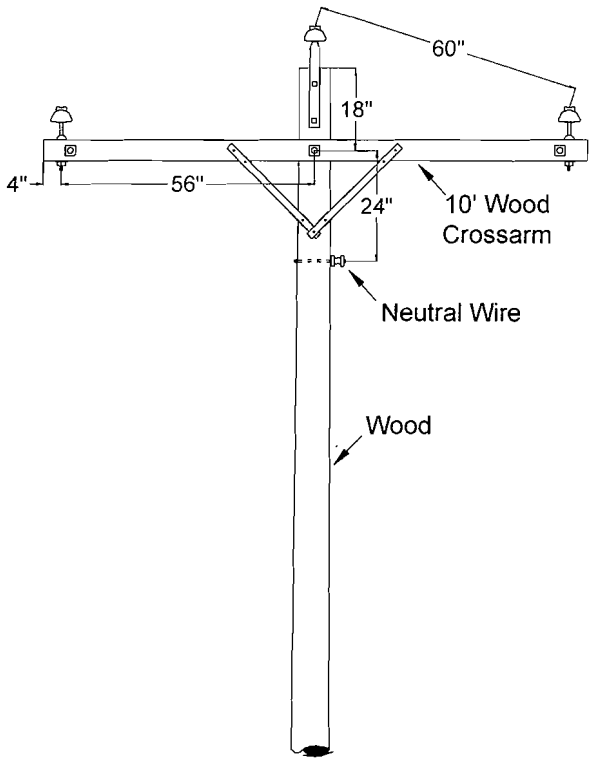


Figure 4 Eagle-Safe Three-Phase Pole Configuration Using a 10-Foot Crossarm, 7.2/12.47kV

If large conductors are used, mounted 8 inches from the crossarm end, the 10-foot crossarm also would need to be dropped an additional 6 inches (24 inches from the top of the pole) to maintain 60 inches of separation.

Retrofitting options applicable to three-phase tangent structures, if warranted, include installing devices to discourage bird perching to covering energized components to prevent a phase-to-phase or phase-to-ground fault. Anti-perching triangles and raptor bird spikes provide suitable retrofitting deterrents to keep large birds from landing on conventional wood crossarms where spacing is less than 60 inches (see Section 8.16, Perch Management). Unfortunately, perch deterrents may simply shift the problem to other structures. At preferred perching sites, a more effective retrofitting solution is to install conductor guards (Photo 19) on exposed tangent phase wires or erect elevated perches, as discussed in detail in Section 8.16.1. Table 3 provides manufacturer options for three different conductor guards. The retrofitting recommendation data in Appendix B use code **CG** to specify conductor guards.

Table 3 Conductor Guards

Manufacturer	Material	Web Site
DMX Industries	Polymer	http://www.dmxind.com
EcoElectrical	PVC w/Silicone Coating	http://www.ecoelectrical.com
Kaddas	ABS Plastic	http://www.kaddas.com
Raychem	Polymer	http://www.Raychem.com

Conductor guards can be installed with hotline sticks and will accommodate small line angles. The most widely used cover is the Kaddas *Bird Guard*. The ends of the Kaddas covers must be trimmed for a proper fit to the conductor. Failure to properly trim the ends may result in the covers coming off in strong winds. Some utilities also fit armor rods over the conductor prior to fitting conductor covers, due to wind abrasion and vibration concerns. In areas where airborne contamination is a concern, a conductor guard with a silicone coating may be preferable.

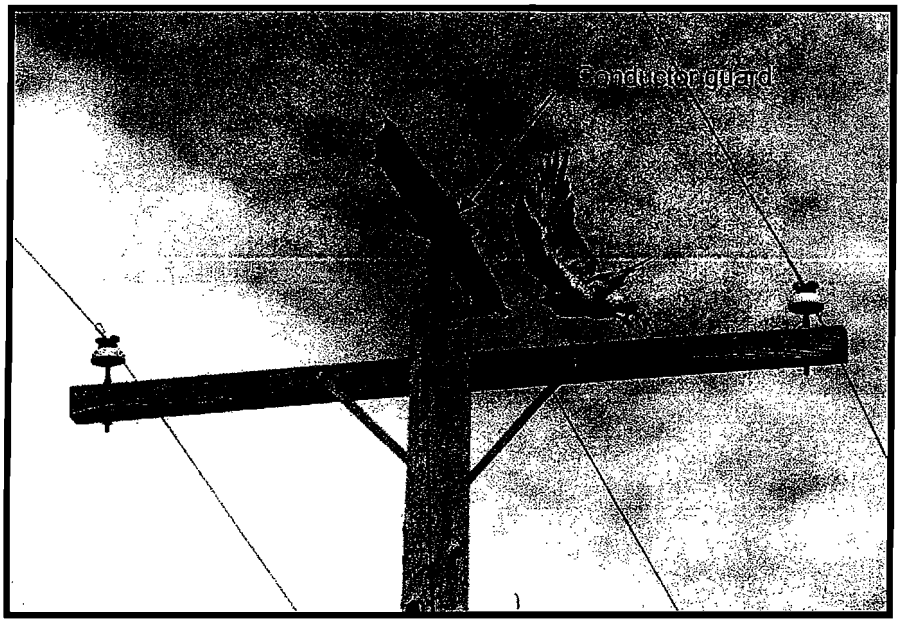


Photo 19 Kaddas Bird Guard Mounted on a Preferred Perch Structure

8.3 Deadend Structures

A deadend is a point on a distribution line where conductors terminate. A double deadend has conductors terminating from two directions. Jumpers are used to connect these two sets of conductors. The arrangement of primary jumpers can be the difference between a safe and lethal structure. For example, a three-phase double deadend structure can either jumper the outer phase jumpers over (Photo 20) or under (Photo 21) the crossarms. Placing jumpers under the arms during new construction precludes large animals from making a phase-to-phase contact with the center phase jumper and is the preferred method. Where safety concerns may prevent the reconfiguration of the jumpers below the crossarm, covering all three primary jumpers with 600V-rated insulation (see Section 8.11, Primary Jumpers) would be a retrofit option.

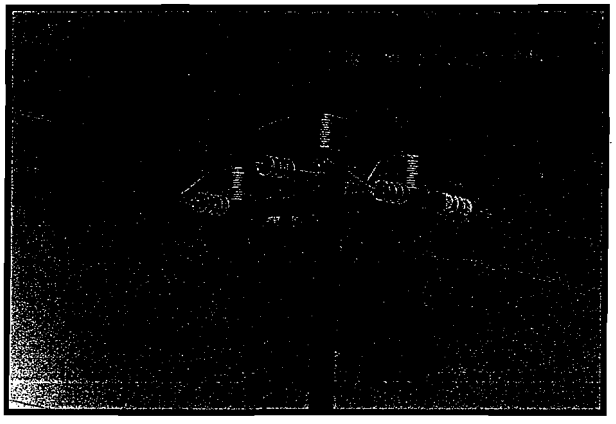


Photo 20 Three-Phase Double Deadend with Exposed Jumpers over the Crossarms

Photo 21 Three-Phase Double Deadend with Jumpers Passing under the Crossarm

Corner or angle structures also can be problematic due to exposed jumper wires. A minimum of 60 inches of separation should be maintained or jumpers should be covered with 600V-rated insulation (see Section 8.11, Primary Jumpers). The center phase also can be fitted with a 26-inch insulated extension clevis to provide additional raptor protection when birds are taking off or landing (Photo 22). Jumpers that are unnecessarily long can increase electrocution problems and should be formed with minimal slack. Placing the neutral on the pole is preferable to terminating it on the crossarm. Vertical construction (Photo 23) is preferred at corners to eliminate jumper issues.

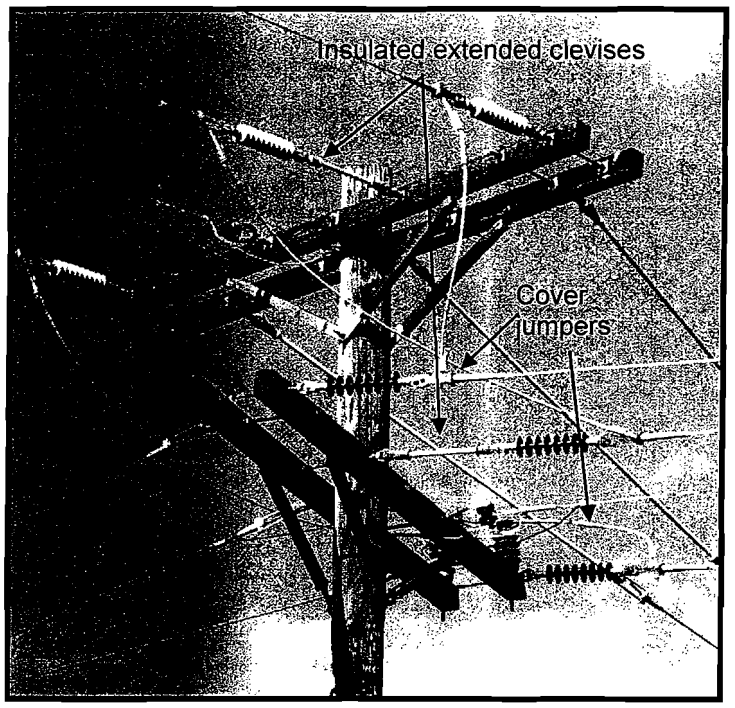


Photo 22 Three-Phase Tap Structure Fitted with Insulated Extended Clevises

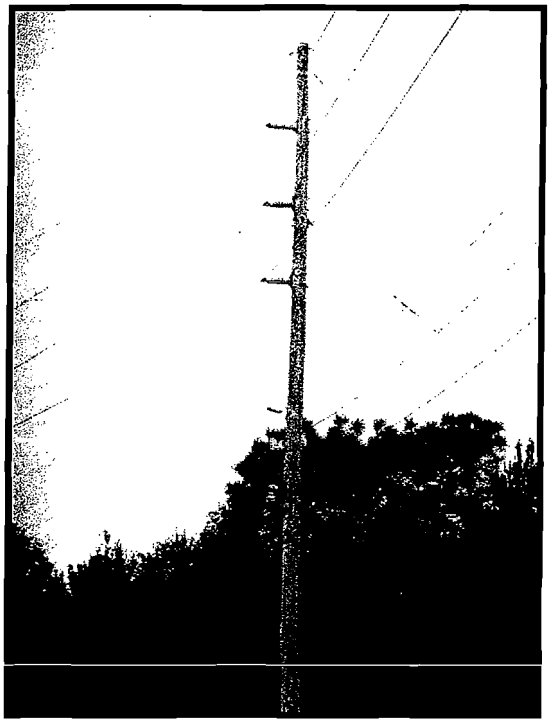


Photo 23 Three-Phase Vertical Angle Structure

Deadend poles require covered jumpers to allow safe perching. Where this is not practical and 60 inches of separation is lacking, perch management is an option (see Section 8.16, Perch Management). However, perch management is most successful when other parts of the structure are still safely accessible to birds.

For single deadend units, anti-perching devices (i.e., perch guards) should be placed on only the front crossarm (Photo 24). This placement allows raptors to continue to utilize a safe portion of the structure.

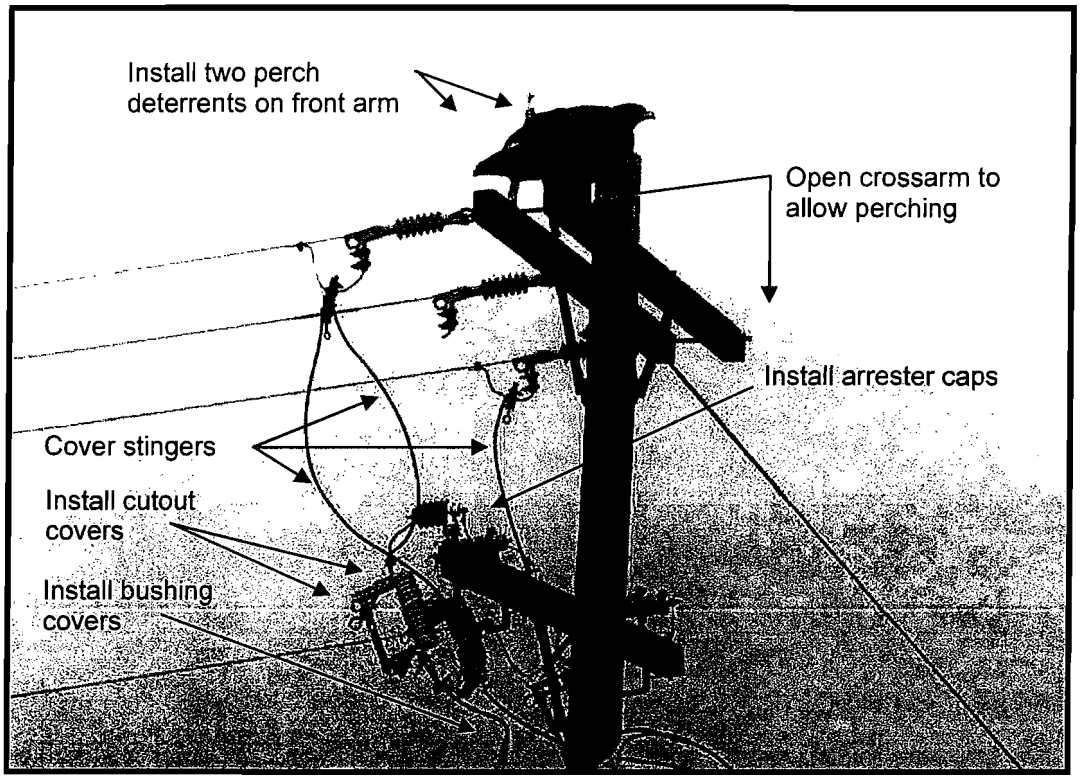


Photo 24 Deadend Structure with Perch Deterrents on the Front of the Structure to Allow Perching on the Safer Portion of the Structure

Retrofitting deadend tap structures may require a combination of perch deterrents and covered jumpers. Where jumpers are in close proximity to other jumpers or grounded hardware, insulation can be used to mitigate problems. Covered jumpers will not, however, address narrow phase separation terminating on deadend crossarms. Perch deterrents are recommended to prevent birds from trying to land between narrowly spaced wires. For example, at angle structures, anti-perching devices should be placed on the top and lower crossarms between exposed phase jumpers (Photo 25). If the neutral wire also terminates on the crossarms, additional perch deterrents should be placed on the front face of each crossarm to prevent phase-to-neutral contacts when birds are either taking off or landing.

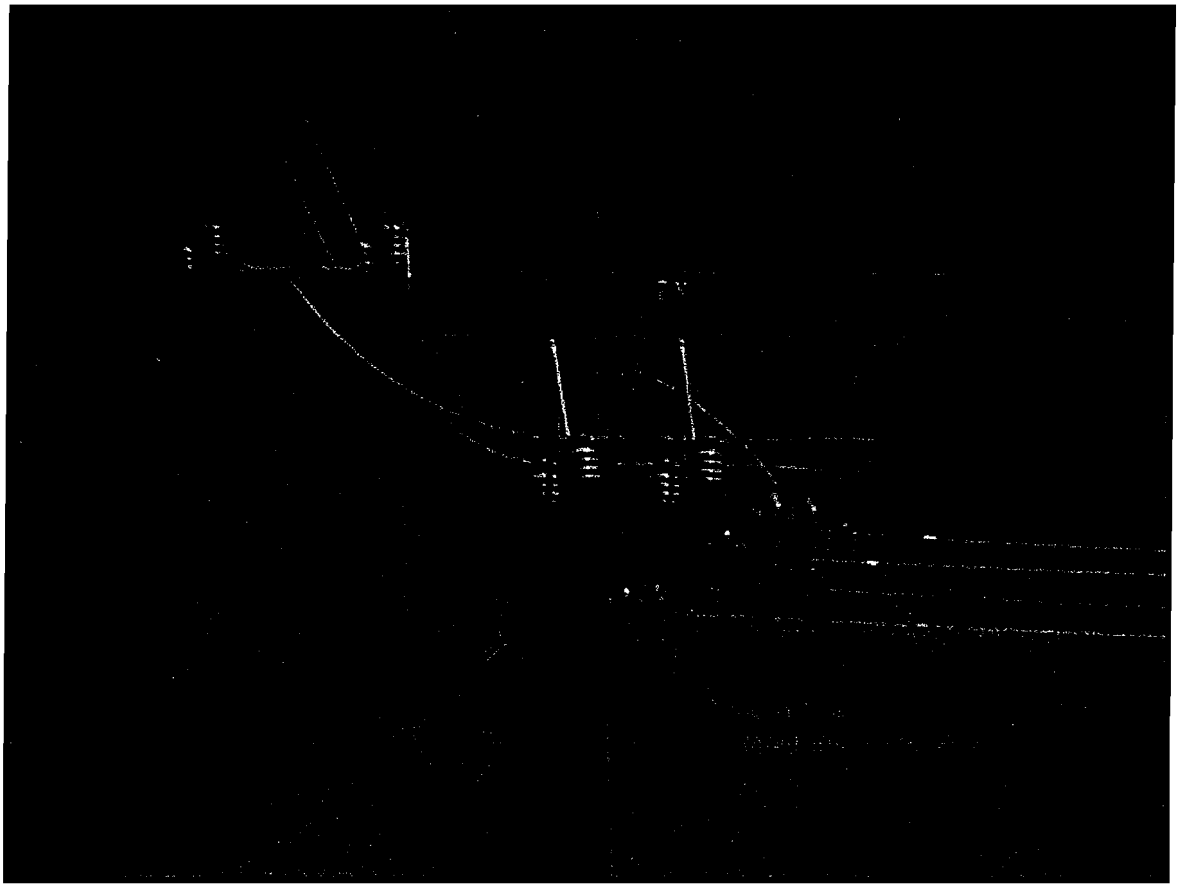


Photo 25 Angle Deadend Structure with Neutral on Crossarm

If the neutral terminates on the pole (below the crossarm) and the center phase is jumpered under the crossarm, perch deterrents are only required on the lower crossarm (Photo 26). This configuration will provide adequate separation for hawks and owls. However, if eagles are present, additional perch deterrents should be placed on the front face of each crossarm to prevent potential phase-to-phase contacts when birds are either taking off or landing.

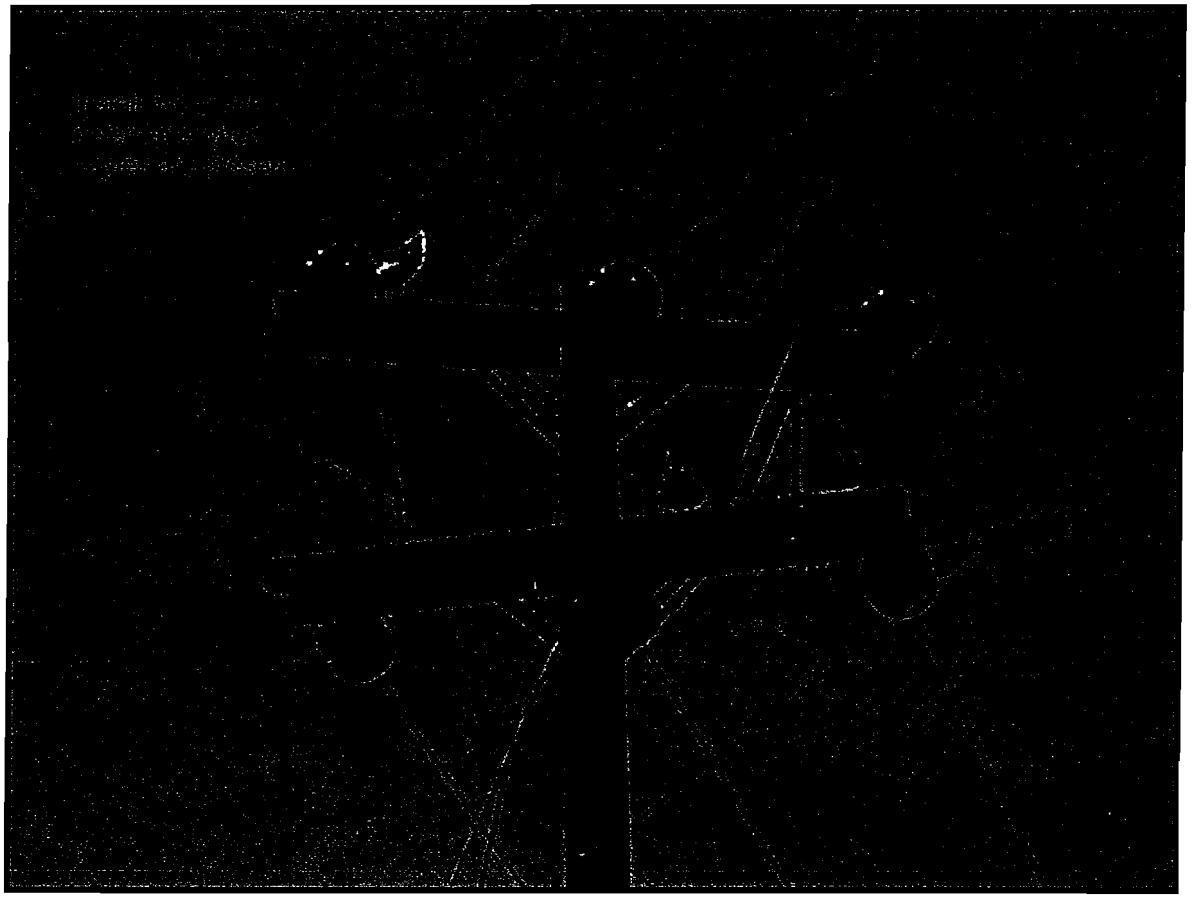


Photo 26 Angle Deadend Structure with Neutral on the Pole

If jumper wires are near groundwires or grounded guying attachments, the grounds also should be covered with protective molding (see Section 8.13, Pole-Top Grounds).

8.4 Crossarms

North American distribution utilities have historically selected wood as the material of choice for poles and crossarms. Accordingly, most animal-proofing techniques are designed for use on wood pole structures. Recently other materials, such as concrete and steel, are being used in distribution line construction. Sometimes non-wood crossarms are used because they are not susceptible to woodpecker damage. In some regions of the U.S., woodpecker damage to wood poles is the most significant cause of pole deterioration. When steel crossarms are substituted for wood, the critical clearance for animals often becomes the phase-to-crossarm separation (i.e., phase-to-ground) (Photo 27). The example shown in Photo 27 also depicts a potential phase-to-phase connection between the narrowly spaced conductors.

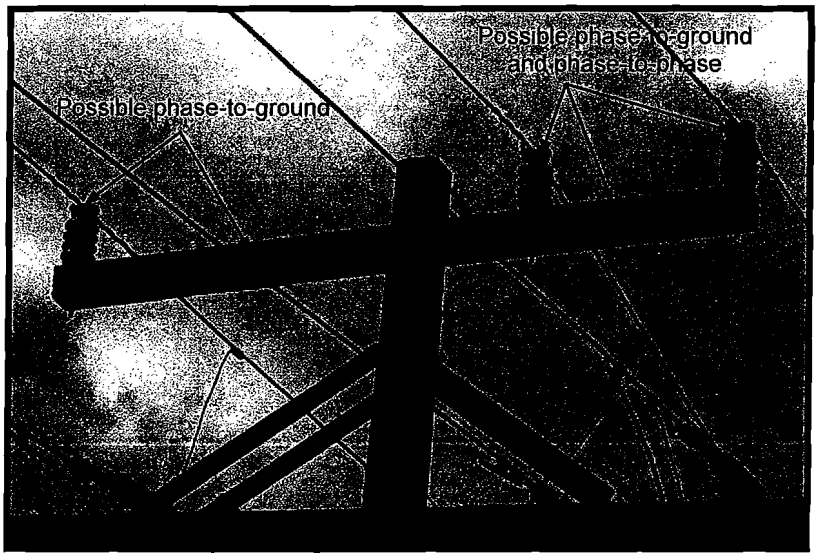


Photo 27 Metal Crossarm Posing a Significant Phase-to-Ground Electrocution Risk

Non-wood crossarms are commonly used in distribution line construction in Europe and other parts of the world and there are differences in electrocution rates of birds on wooden versus metal structures. Sometimes distribution steel crossarms are used in the U.S. as an underbuild on steel transmission poles. If conductive crossarms are employed in the future, alternative framing such as using suspension insulators on distribution lines instead of pin-type insulators or the use of cover-up material should be considered to eliminate potential animal contacts.

8.5 Crossarm Braces

Older power lines sometimes include grounded metal crossarm braces. These braces are attached with lag bolts to the pole and crossarm front (Photo 28). Birds perching on crossarms are able to simultaneously touch one energized conductor and a grounded brace. Metal braces were replaced with nonconductive wood braces.

Photo 28 Hawk Perching on a Crossarm Supported by an Ungrounded Metal Crossarm Brace

8.6 Risers

Risers are poles where an overhead and underground system are connected. Riser poles include protective surge arresters and fused cutouts or switches. The riser pothead is the point where overhead electrical conductors come together and continue down the pole as an underground cable. Potheads are typically supported on either metal brackets or wooden crossarms. The spacing of all of these components can be a risk to perching birds and climbing mammals (Photo 29).

Grounded steel pothead brackets associated with riser poles can be problematic. The brackets are relatively large and in the appropriate habitat, offer an attractive perch platform for birds. Red-shouldered hawks seem to be particularly vulnerable to electrocution on pothead brackets. Normally, this forest hawk perches on low, sheltered branches under the tree canopy and pothead brackets may offer an attractive alternative where natural perches are lacking.

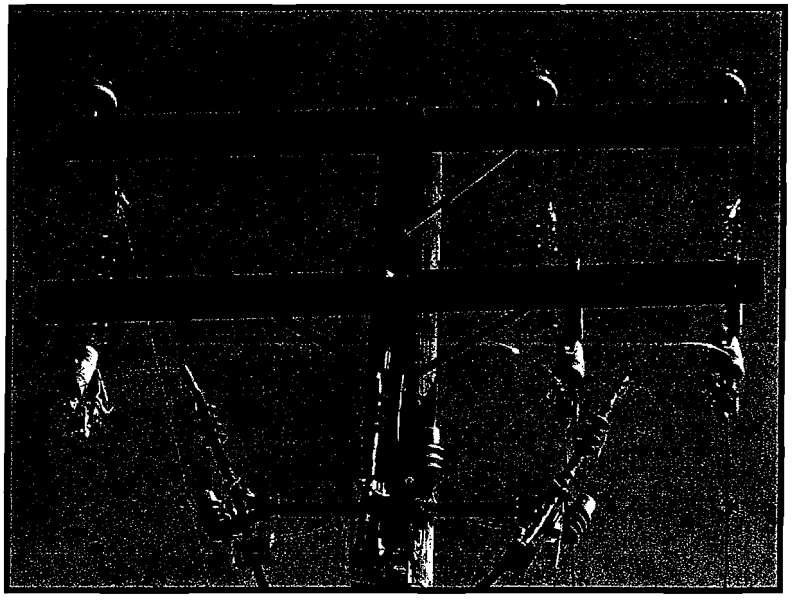


Photo 29 Unprotected Riser Pole

Riser protective equipment and all jumpers should be animal friendly as discussed in Sections 8.9 and 8.11, Cutouts and Stinger Wires, respectively. The riser pothead should be fitted with a snap-on "clamshell" type cover (Figure 5). Any conductors that cannot be covered should be wrapped with insulating tape. No exposed conductor should extend beyond the bushing cover, and leads should be kept as short as possible.

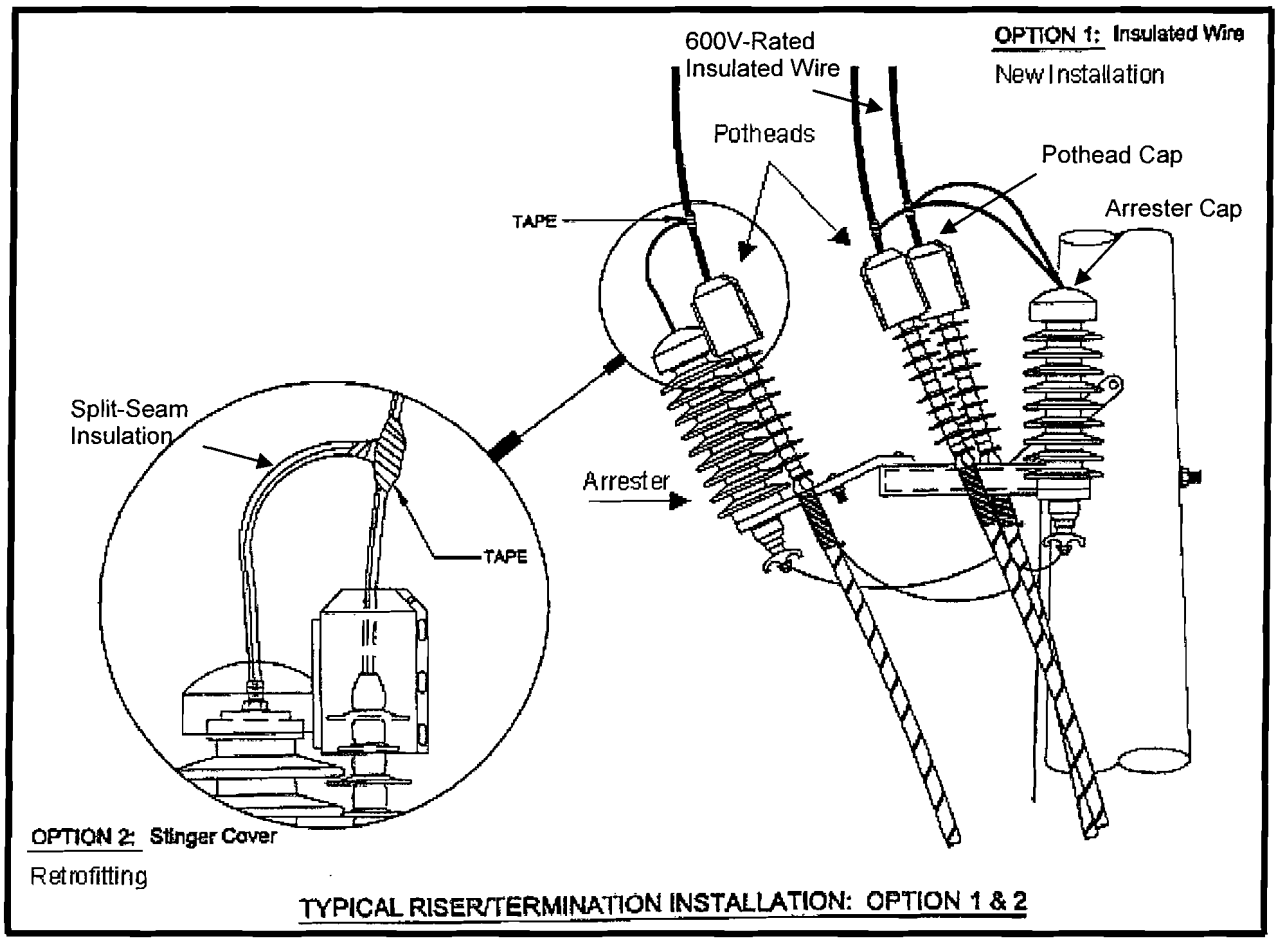


Figure 5 Protected Riser Pole with Pothead Covers

8.7 Transformers

Equipment poles are problematic because of their exposed bushing contacts and because they include other problematic devices such as cutouts, surge arresters, and uninsulated jumper wires. Outages often occur when an animal on a grounded transformer tank touches an energized conductor or bridges the distance between two energized jumper wires.

Bushing covers and 600V-rated insulated covering are a protective system that can provide the necessary insulation level to minimize animal-caused outages. New transformers could be ordered with a "wheel-type" wildlife protector (Photo 30) installed by the transformer manufacturer (Table 4). Porcelain protector models also are available from Porcelain Products Company that will have limited deterioration from exposure to UV rays, moisture, and temperature extremes. The porcelain protectors are available in either a top entry or side-cable entry.

Photo 30 "Wheel-Type" Bushing Cover Delivered with the Transformer

Table 4 "Wheel-Type" Transformer Protector Manufacturers

Manufacturer	Material	Web Site
Central Moloney, Inc.	Polypropylene	http://centralmoloneyinc.com
Cooper Power Systems	Polypropylene	http://www.cooperpower.com
Howard Industries, Inc.	Polymer	http://www.howard-ind.com
Porcelain Products Company	Porcelain	http://www.porcelainproductsco.com

All bushing covers should be installed with 600V-rated insulated stinger wire for additional animal protection (see Section 8.11, Primary Jumpers).

A variety of after-market bushing covers are available for retrofitting (Photo 31). These covers are generally made of track-resistant, high-density polymers that either snap on or slide over bushings. Snap-on covers allow installation without removing the transformer stinger wire. Slide-over units require the stinger wire to be temporarily removed in order to slide the cover over the transformer bushing. For retrofitting purposes the "clamshell" type may be preferable (Table 5). The covers can be ordered with a fire-resistant material. If they are struck by lightning, the material will not burn and drip to the ground.

Photo 31 After-Market Bushing Covers

No uniform standards exist for bushing covers, and some are more resistant to UV and environmental degradation than others. This degradation can lead to tracking problems. When bushing covers are selected, their properties should be thoroughly reviewed and line crews instructed on the proper method of installation. The retrofitting recommendation data in Appendix B use code **BC** to specify bushing covers.

Table 5 "Clamshell-Type" Bushing Cover Manufacturers

Manufacturer	Material	Web Site
Central Moloney, Inc.	Polypropylene	http://centralmoloneyinc.com
DMX Industries	Polymer	http://dmxind.com
H.J. Arnett Industries	Polypropylene	http://www.arnettindustries.com
Hendrix Wire and Cable	Polypropylene	http://www.hendrix-wc.com
Howard Industries, Inc.	Polymer	http://www.howard-ind.com
Hubbell	Polypropylene	http://www.hubbellpowersystems.com
Kaddas	Polymer	http://www.kaddas.com
Preformed Line Products	Plastisol	http://www.preformed.com
Raychem	Polymer	http://www.tyco.com
W.H. Salisbury & Co.	SALCOR	http://www.whsalisbury.com
Warco, Inc.	Ethylene Propylene	http://www.warcoinc.com

It is not uncommon for bushing covers to be installed improperly. Installing bushing covers below the first insulator skirt can eventually result in flashovers. Photo 32 depicts the proper and improper way to install bushing covers.

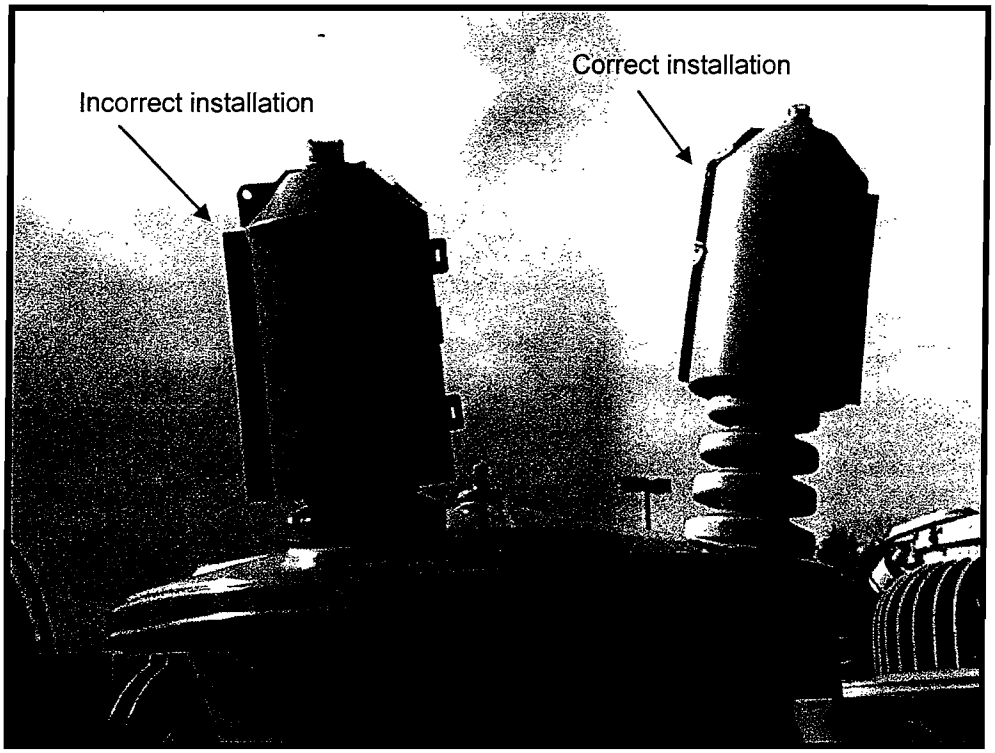


Photo 32 Fargo Bushing Covers Installed Incorrectly (Left) and Correctly (Right) over Transformer Bushings

The Hendrix bushing cover has an internal ridge to ensure the product is correctly installed on the top bushing shed. Covers also can be ordered to cover both the transformer bushing and gapped arrester (Photo 33).

Transformer manufacturers sell pole-type distribution transformers with an optional protective insulated cover (lid) rated at 15kV dielectric strength. It should be noted that these units still have an exposed "captive bolt" holding the arrester bracket that is a potential phase-to-ground contact point for animals.

The quoted insulation values may deteriorate over time due to exposure to UV light, contamination, and other aging factors. However, insulated covers on pole-type distribution transformers will help to mitigate the electrocution of raptors and small animals on the top of transformers.

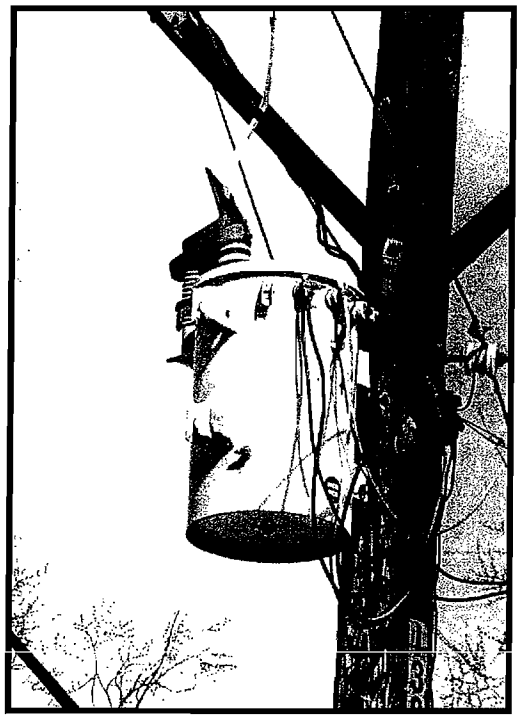


Photo 33 Combination Arrester/ Bushing Cover

Photo 34 provides an example of a bushing cover, which protects small to moderately sized birds from a phase-to-ground connection. However, bushing covers will not provide adequate protection for larger birds, such as eagles, unless the stinger wire also is covered (Photo 35).

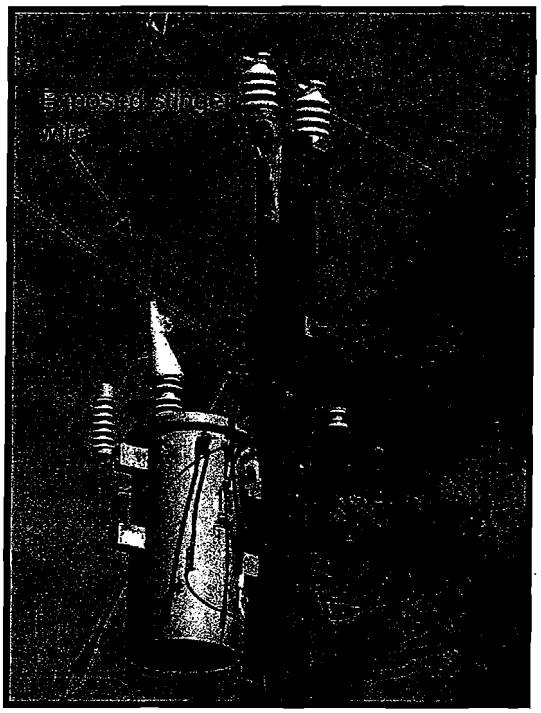


Photo 34 Example of Transformer Protection Inadequate for Eagles

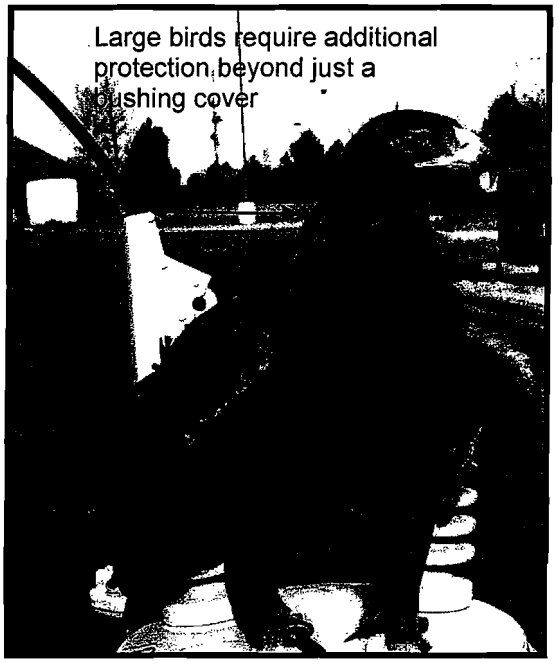


Photo 35 Eagle on a Transformer with a Bushing Cover and Covered Stinger Wire

8.8 Other Equipment

Regulators, reclosers, and capacitors can be lethal to animals due to exposed bushings and jumpers. Regulators maintain the level of voltage within a prescribed range in order to maintain efficient equipment operation or to prevent equipment damage. Reclosers are pole-mounted devices attached to overhead lines sensitive to interruptions of current flow in the overhead wires. When a recloser senses an interruption, it automatically opens and immediately re-closes. If current problems persist after a number of reclosings or "shots," the recloser will remain open; this will cut off power until the recloser is reset manually. Most reclosers are set to remain open after three shots. Reclosers may mask detection of bird electrocutions by clearing an interruption. If a bird is killed in a remote location it may then go undetected.

Reclosers and regulators should include bushing covers and 600V-rated insulated covering (Figure 6) as discussed in Section 8.7, Transformers. Groundwires in proximity to energized items also should be either isolated or insulated. No bare portion of the insulated leads should extend beyond the bushing covers.

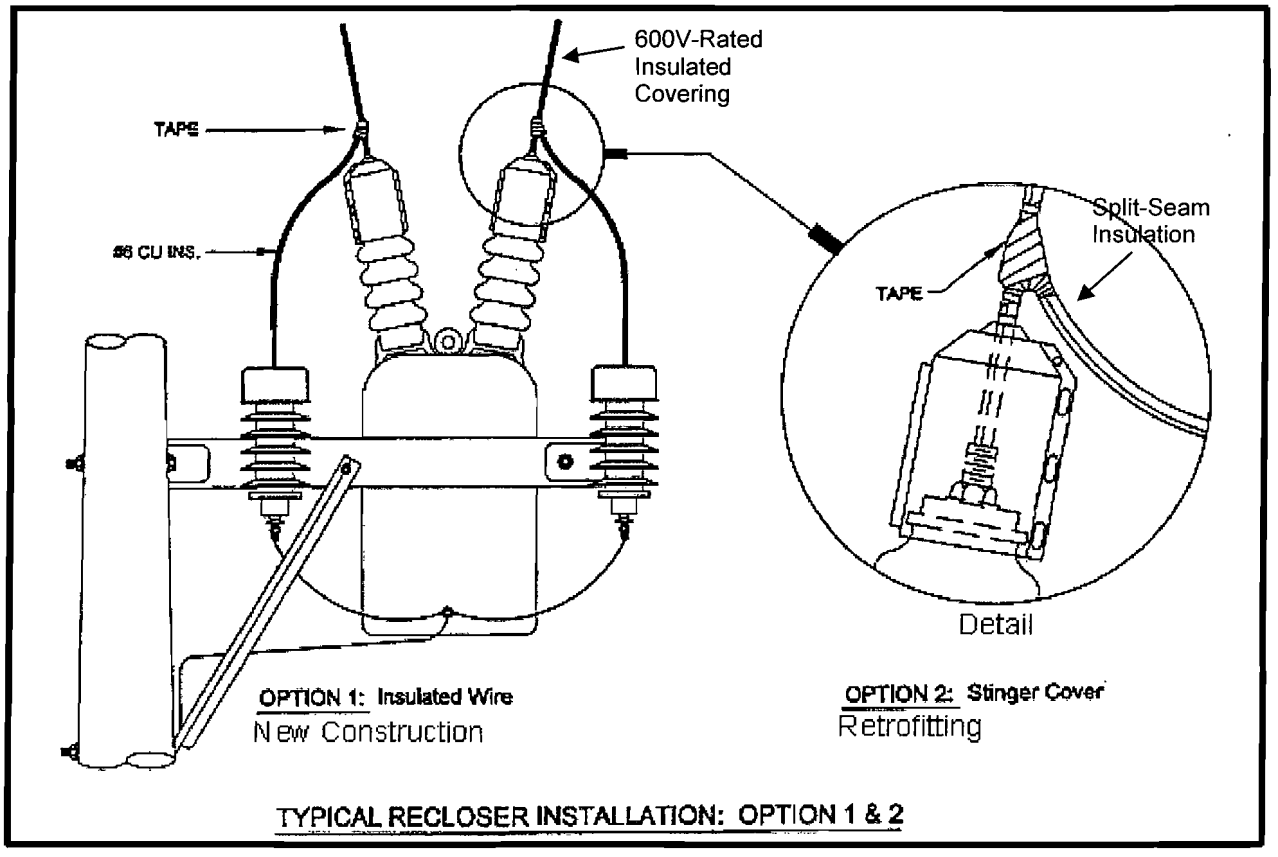


Figure 6 Recloser Fitted with Animal Protection

A capacitor is an electrical device for storing a charge of electricity and returning it to the line. It is used to balance the inductance of a circuit. Capacitors always should be purchased with animal protection already installed (Photo 36). The animal protection consists of custom-fitted bushing covers and covered jumpers. Stinger wires and all capacitor protective devices also should be animal guarded. Capacitors without animal protection can be retrofitted with after-market bushing covers and stinger wire cover.

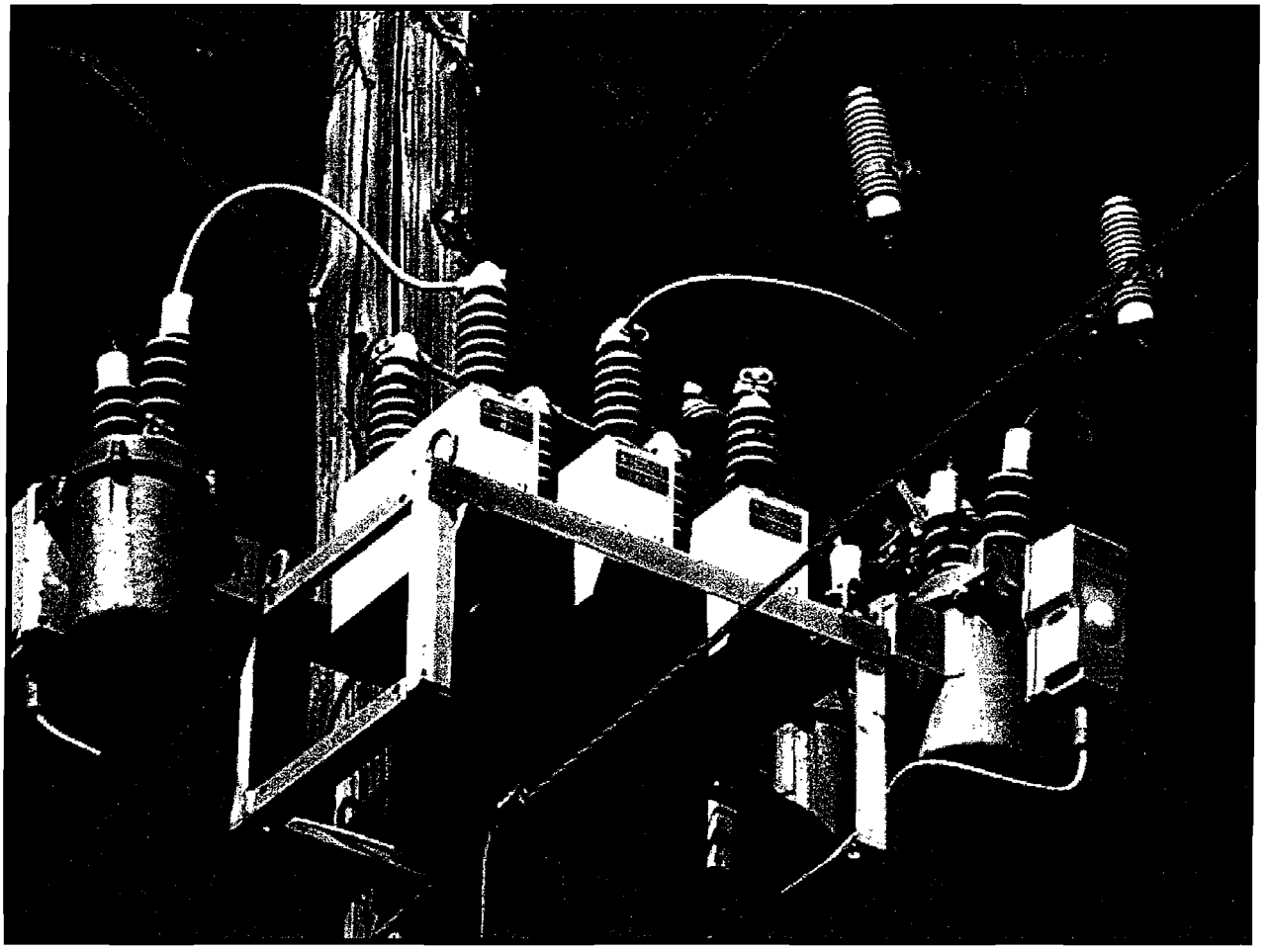


Photo 36 Capacitor Bank Factory-Ordered with Animal Protection

8.9 Cutouts/Switches

8.9.1 Cutouts

A cutout is a device used to install fuses between primary conductors; this device is often called a "fused cutout." If the fuse fails, this mechanism provides a visible open, which can be seen from the ground. The top plate of the cutout is energized and can be problematic to animals if they are mounted near a grounded surface or near other energized equipment. There are two ways to prevent cutout problems: isolation and insulation. Isolation entails mounting cutouts in a manner that makes an animal contact more difficult, such as on insulated fiberglass brackets or by installing perch deterrents to prevent bird access to a certain location on the structure. Insulation requires covering the potential phase-to-phase or phase-to-ground contact points where a bird may perch.

Cutouts are often installed with metal brackets (see Section 8.13, Brackets). If the metal bracket is grounded, it can easily allow for an animal to bridge the distance between a cutout and ground (Photo 37). The potential phase-to-ground connections shown in Photo 37 also would apply to the energized cutout, jumpers, and stinger wires with the metal crossarm.

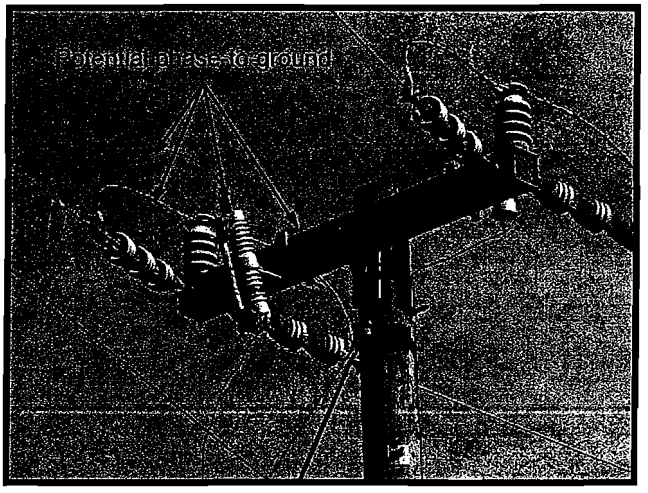


Photo 37 Example of Cutout on Grounded Metal Bracket and Metal Crossarm

If cutouts are in close proximity to each other, perch deterrents can be placed between the devices to minimize the chance of phase-to-phase contact (i.e., isolation) (see Section 8.15, Perch Management). Whenever cutout leads are in proximity to a grounded plane or another phase conductor and the potential exists for an animal to bridge the gap, the cutout jumpers should be insulated with 600V-rated insulation (see Section 8.11, Primary Jumpers).

Cutouts also can be covered if they cannot be effectively isolated. Kaddas and Raychem manufacture several cutout covers (Photo 38) to insulate the top of various cutouts. Cutout covers should always be used in tandem with 600V-rated insulated jumpers. Any conductors that cannot be covered should be wrapped with insulating tape. Presently, covers for load break cutouts have just become available through Kaddas; however, no direct information on their performance is currently available. The retrofitting recommendation data in Appendix B use code **COC** to specify cutout covers.

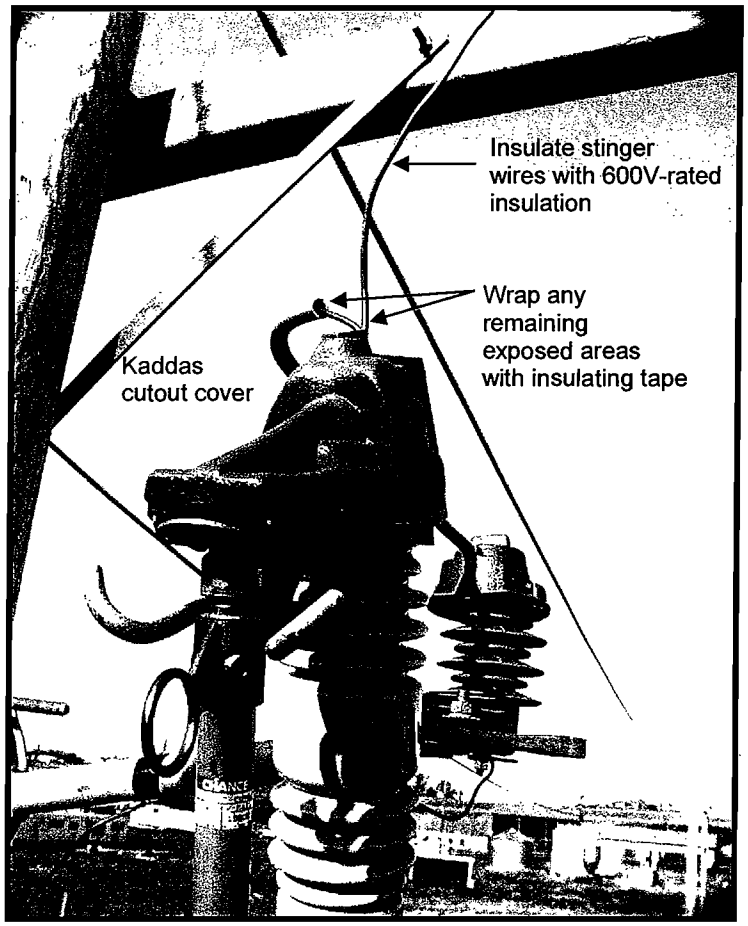


Photo 38 Cutout with an Insulating Cover

8.9.2 Three-Phase Switchgear

Switchgear is used to energize or de-energize three phases at one time. Existing gang operated air break switches (GOABS) are very problematic to animal proof because they typically have minimal separation, and traditional retrofitting measures (e.g., perch guards, spikes) interfere with the operation of the switch. If a switch needs retrofitting, it is best to install an elevated perch above the switch to encourage birds to use the higher location (Refer to Section 8.15.1, Elevated Perches). New switches can be purchased with fiberglass support arms versus steel arms. At least one switch manufacturer, S&C, produces a unit with wildlife protection on the interrupter (Photo 39). It also may be possible to order and mount new switchgear upside-down to prevent animal contacts. However, this would need to be coordinated with the manufacturers.

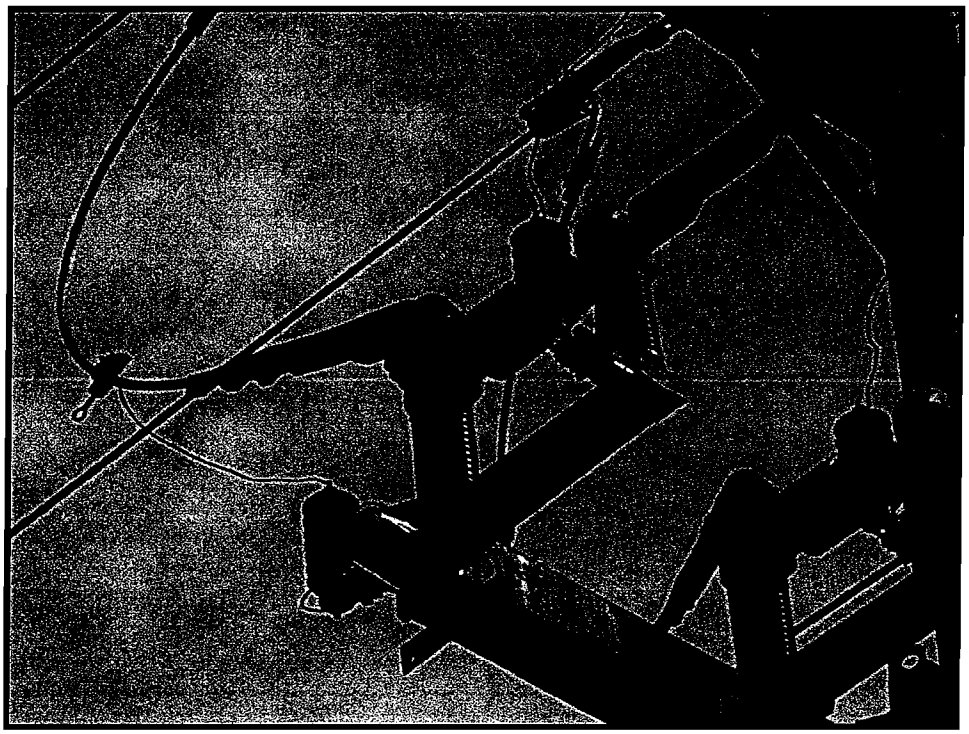


Photo 39 Switch with Built-in Animal Protection

8.10 Surge Arresters

Arresters clear over-voltage problems such as lightning strikes. Arresters have a groundwire attached to one end leading to earth and another end either attached or in proximity (gapped) to an energized wire. Arresters are used on some equipment poles and all underground riser locations and can be mounted on crossarms or directly on a transformer. All new arresters should be ordered and installed with manufacturer-supplied wildlife caps. 600V-rated insulated covering also should be used for arrester hot leads (Figure 7). No exposed wire should extend beyond the wildlife cap, and leads should be kept as short as possible. The retrofitting recommendation data in Appendix B use code **AC** to specify arrester caps.

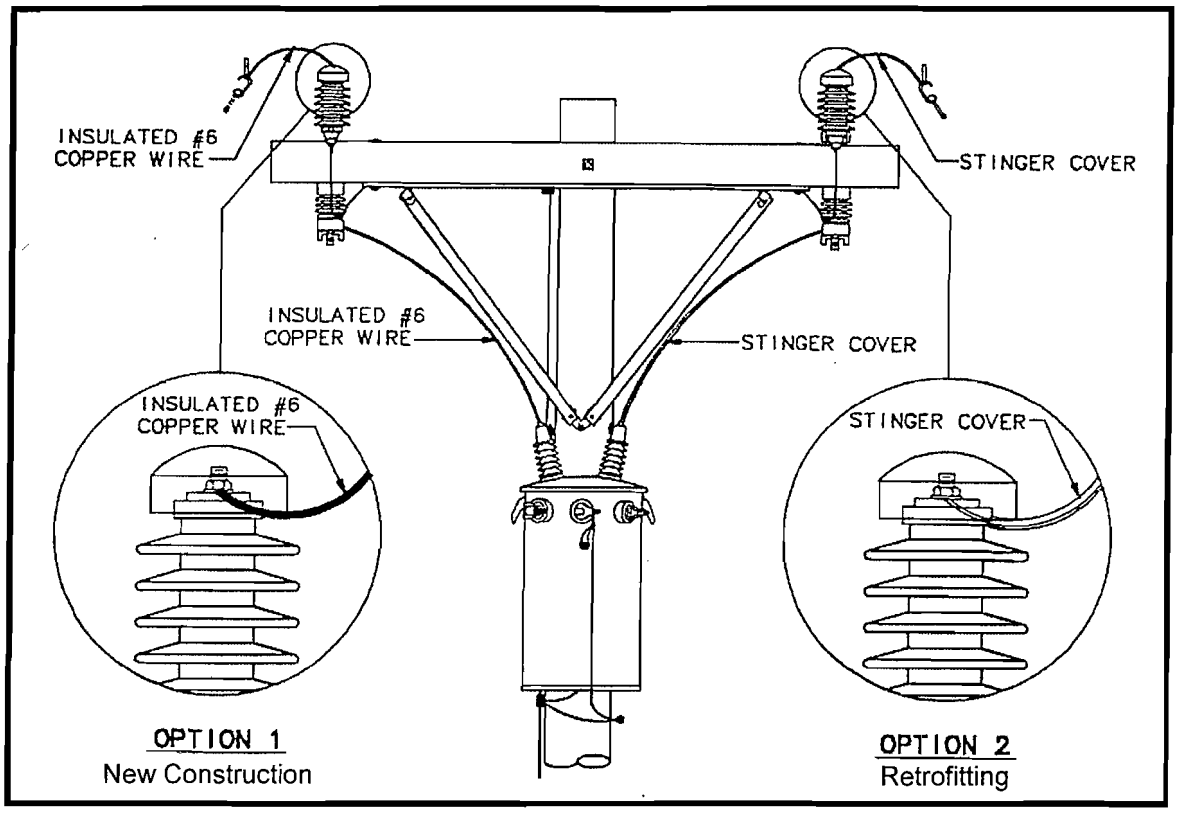


Figure 7 Installing New and Retrofitting Surge Arresters

Transformer-mounted arresters also should be installed with manufacturer supplied wildlife caps and 600V-rated insulated covering ().

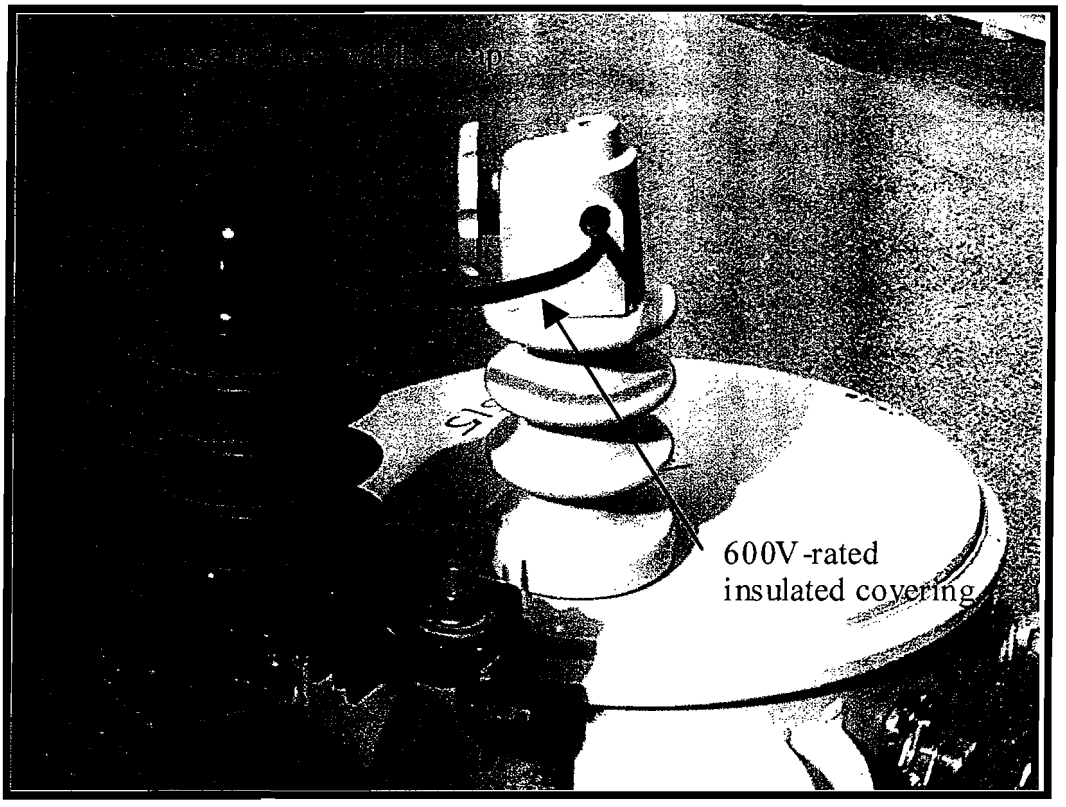


Photo 40 Transformer-mounted Surge Arrester with Wildlife Cap

Older gapped arresters (Photo 41) can cause problems if small birds, climbing animals, or even insects span the open gap. Gapped arresters should continue to be phased out of TID's system. When gapped arresters are used, a transformer bushing cover with a side knockout must be used to provide an adequate opening for the spark gap rod, and the bushing cover opening must be aligned with the spark gap rod. Groundwires associated with surge arresters should be routed to avoid potential phase-to-ground contacts.

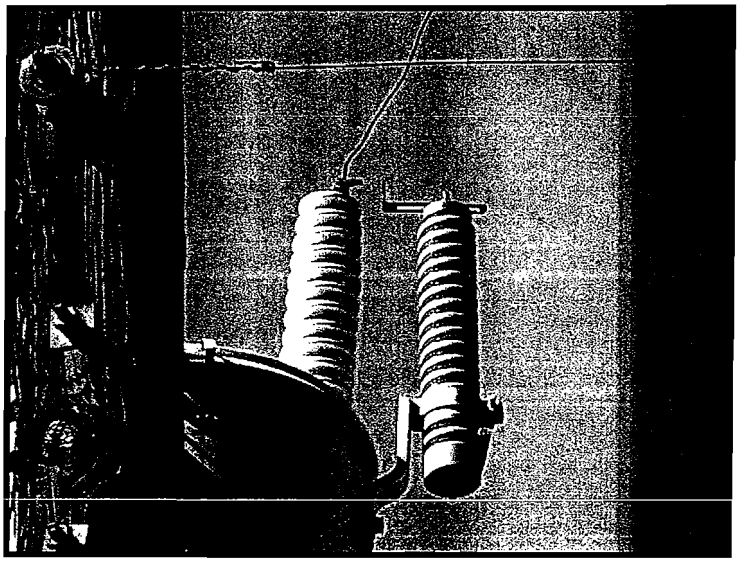


Photo 41 Gapped Surge Arrester

The position of an arrester can be modified to reduce potential contacts. Installing arresters in a horizontal fashion with covered leads also reduces exposure to animals (Photo 42). This installation should include an insulated cap. Attention should be placed on the groundwire exiting the bottom of the arrester. If the groundwire is in proximity to any energized hardware, it too should be covered (Photo 43). Any conductors that cannot be covered should be wrapped with insulating tape.

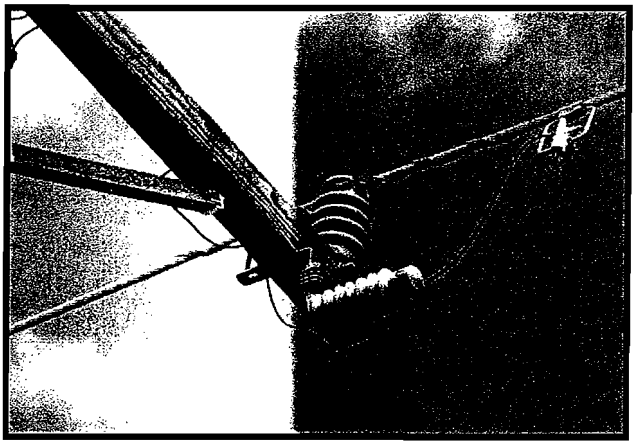


Photo 42 Horizontally-mounted Surge Arrester to Reduce Animal Exposure

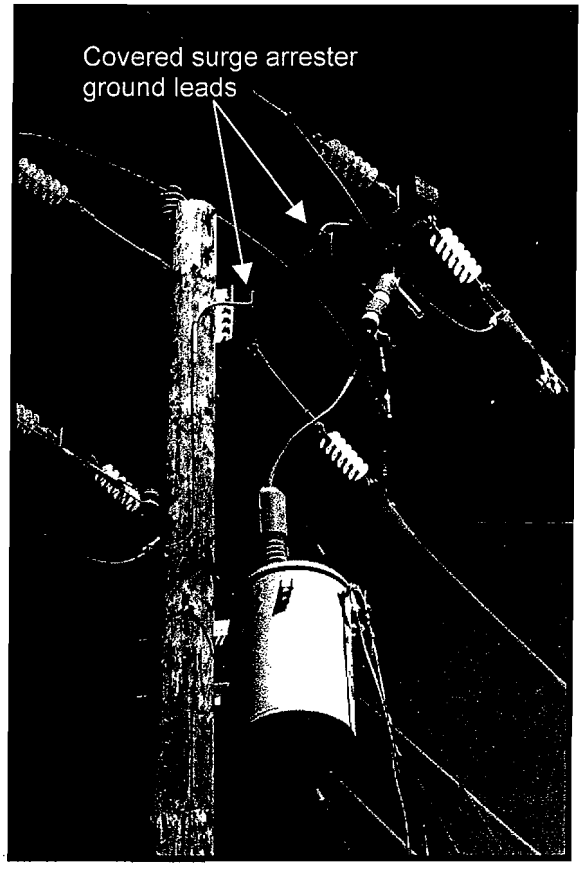


Photo 43 Covered Surge Arrester Ground to Eliminate Phase-to-Ground Animal Contacts

8.11 Primary Jumpers

When an energized primary jumper is in proximity to a grounded plane or another phase conductor and the potential exists for an animal to bridge the gap, the jumper should be covered. New jumper construction should minimally include 600V-rated insulated covering (Photo 44). Although 600V-rated covering does not protect for the full line voltage, it does provide enough insulation to allow brief animal contact without causing a flashover. Prolonged contact with protected parts may still cause insulation failure and allow for a short-circuit.

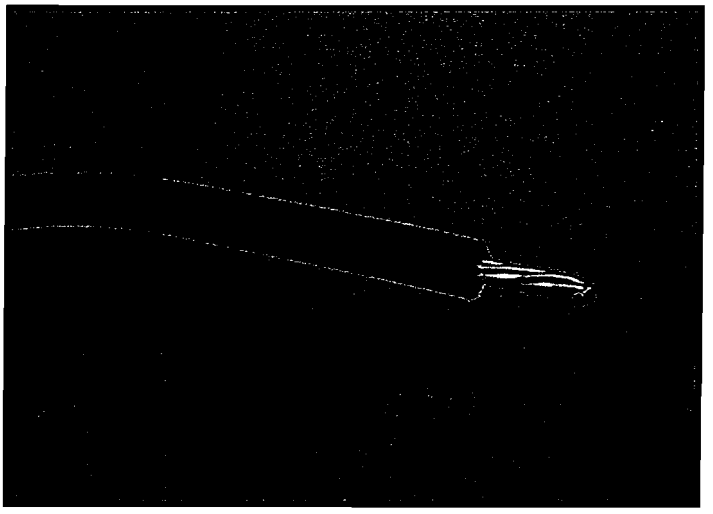


Photo 44 Insulated Jumper Wire for New Installations

When retrofitting it may not be practical to install 600V-rated insulated wire on deadends and tap units. In these situations W.H. Salisbury & Co. insulating SALCOR cover material can be employed. This insulation has a split seam and can be installed over existing wire without disconnecting the lead wire from the bushing, which is very useful when retrofitting (see Section 8.11, Stinger Wires). MidSun also makes a split-seam jumper. The retrofitting recommendation data in Appendix B uses code **IJ** to specify insulated (or covered) jumper pieces.

Primary jumpers are regularly fastened to pin-type insulators for support. Distribution ties manufactured of aluminum-covered steel secure jumpers in the top groove of interchangeable head-style insulators. Distribution ties supplied with a pad, provide superior abrasion protection for the conductor under all types of motion, including low frequency sway oscillation, high frequency aeolian vibration, and galloping. The pad component is recommended because it surrounds bare conductor with a resilient cushion where the conductor would come into contact with the insulator and with the center section of the tie. In the case of distribution ties applied over insulated jumpers, the ties can be furnished without pads because the jacketing itself prevents contact with the bare conductor. PREFORMED™ Plastic Line Ties also are offered as an alternate to metal ties applied over insulated jumpers.

Stinger Wires

Equipment such as transformers, regulators, capacitors, and reclosers are fed with a primary "stinger" wire off the main power line. When an energized transformer stinger is in proximity to a grounded plane or another phase conductor and the potential exists for an animal to bridge the gap, the stinger should be covered. New equipment construction should minimally include 600V-rated insulated stinger wire. As discussed in Section 8.11, Primary Jumpers, 600V-rated covering does not protect for the full-line voltage on distribution class transformers. However, it does provide enough insulation to allow brief animal contact without causing a flashover. Prolonged contact with protected parts may still cause insulation failure, resulting in a line short-circuit.

As stated for jumper wires, when it is not practical to install 600V-rated insulated covering, the W.H. Salisbury & Co. insulating SALCOR cover material or MidSun insulation should be employed. This insulation has a split seam and can be installed over existing wire without disconnecting the lead wire from the bushing (Photo 45). The same recommended sizes for the stinger cover-up material would apply, as presented in Section 8.11, Primary Jumpers.

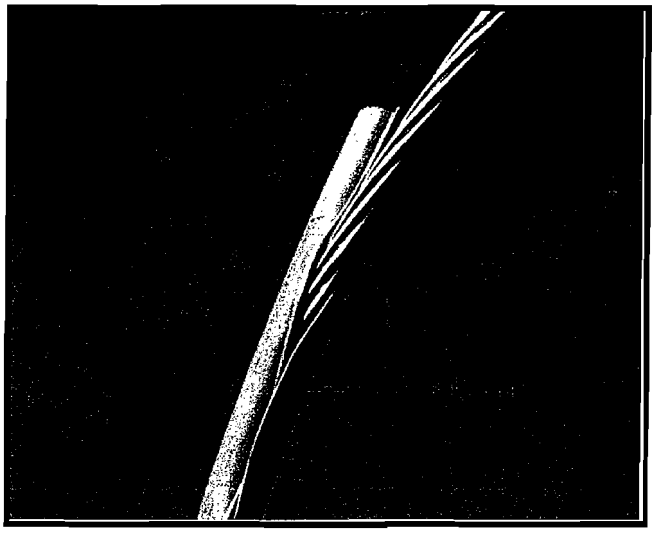


Photo 45 Stinger Retrofitted with W.H. Salisbury & Co. Insulating Salcor Cover Material

A properly animal-protected equipment unit includes 600V-rated insulated stingers and properly mounted bushing covers. No bare portion of the insulated leads should extend beyond the wildlife caps.

8.12 Pole-Top Grounds

Poles located in wide-open areas are attractive to raptors. These same conditions also make utility poles vulnerable to lightning strikes. Lightning can cause extensive damage to utility structures and equipment. Construction practices attempt to limit lightning damage by running groundwires to the pole tops (Photo 46). A copper wire is placed all the way down the pole and bonded to a ground rod or butt plate buried at the pole base. The downwire is tied into the neutral conductor. The groundwires provided a path for lightning strikes allowing lightning to travel down the wire to earth, instead of passing through equipment or traveling down the pole, destroying it in the process.

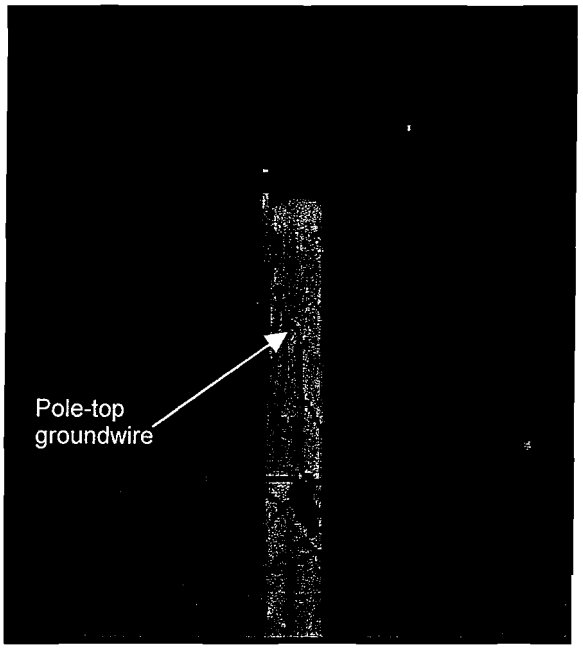


Photo 46 Pole with a Pole-Top Groundwire

Sometimes metal hardware, such as crossarm braces and guy wires, also are bonded to these overhead groundwires. This is done to eliminate leakage currents. Unfortunately, these grounding practices result in reduced phase-to-ground distances for large perching birds and can be lethal. Birds perching on top of the pole can be electrocuted when perching on an insulator and touching their tail to the pole-top groundwire. Pole-top grounds extending above the pole (Photo 47) can be particularly problematic.

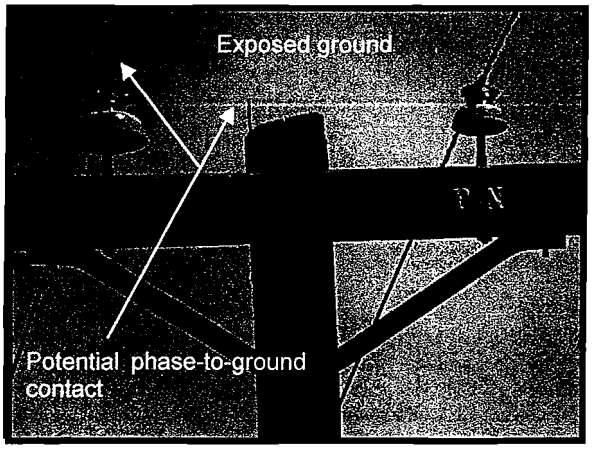


Photo 47 Pole with Groundwire Extending above the Pole Top

Pole-top grounds could be gapped and still provide adequate lightning protection. The gaps break the pathway to earth, thereby reducing the risk for perching birds of prey. This can be accomplished by placing two 4-inch gaps in the pole groundwire (Photo 48). Lightning will spark over the gaps while still allowing raptors to perch safely on the pole top. An alternative solution is to simply remove the pole-top grounds above the neutral.

For structures located with pole-top grounds, the groundwire should either be gapped or the insulator covered with a conductor guard (see Section 8.1, Single-Phase Tangent Structures). At a minimum, the end of the pole groundwire should be at least 12 inches from the pole top, since an eagle's tail feathers can reach 10 inches below a perch. The preferred method of pole protection is to install lightening arresters with proper animal guards and covered jumper wires. The retrofitting recommendation data in Appendix B use code **RG** to specify either using conductor guards or gapping existing pole-top grounds.

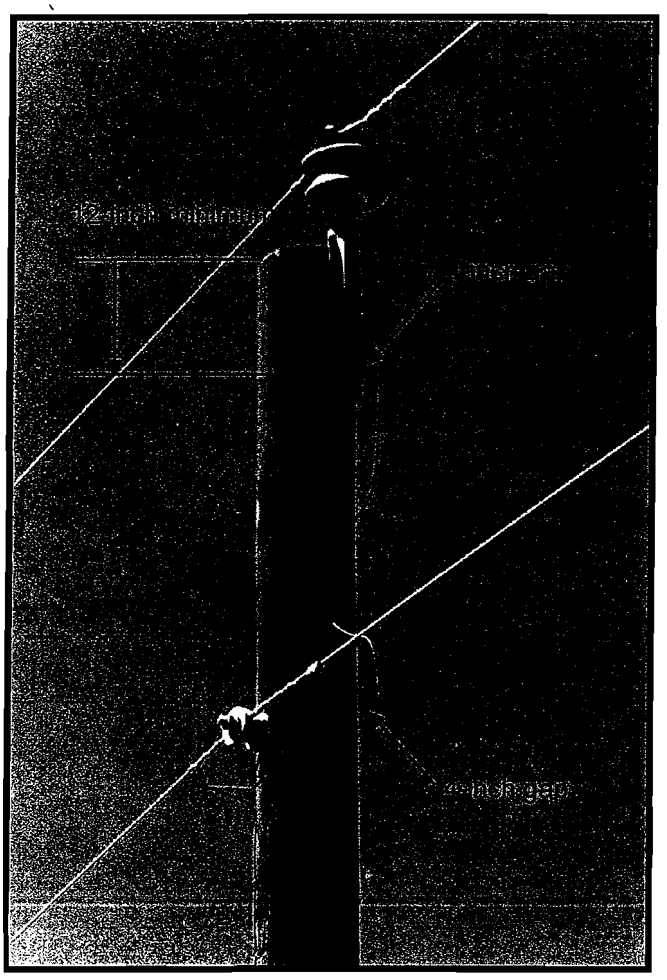


Photo 48 Pole with a Pole-Top Ground Properly Gapped to Prevent Raptor Electrocutions

8.13 Brackets

Metal riser/cutout/arrester brackets can pose a risk to animals when they are bonded to earth through groundwires (Photo 49). An animal on a conductive bracket needs only to touch one energized jumper wire to complete a pathway to ground.

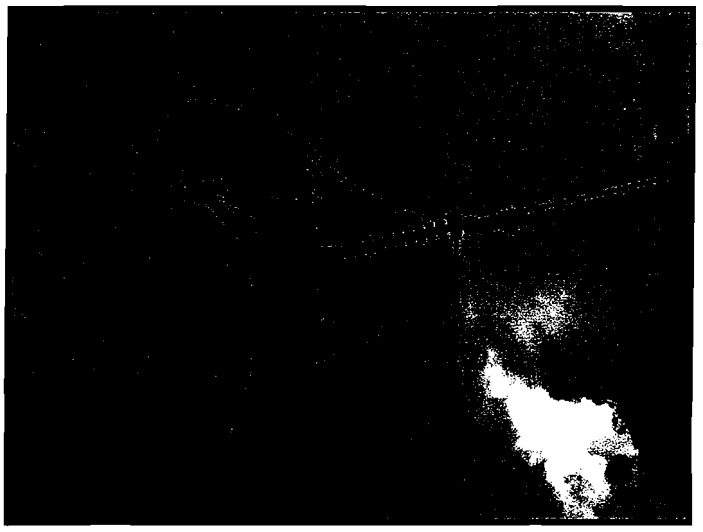


Photo 49 Single-Phase Metal Cutouts/Arrester Bracket

In new construction, metal brackets can either be replaced with nonconductive fiberglass (Photo 50) or wooden (Photo 51) standoff brackets. Either of these brackets is preferable because they are insulated. It is important to note the metal ends of the brackets should not be bonded to ground, if possible.

During retrofitting, it may not be economical to replace brackets. In these situations it may be more practical to cover exposed wires with 600V-rated insulation and install wildlife protectors on exposed cutouts, bushings, potheads, and arresters, as discussed in previous sections. Both conductive and nonconductive brackets supporting multiple phases should still employ insulated jumper wires if there is not adequate separation between jumpers.

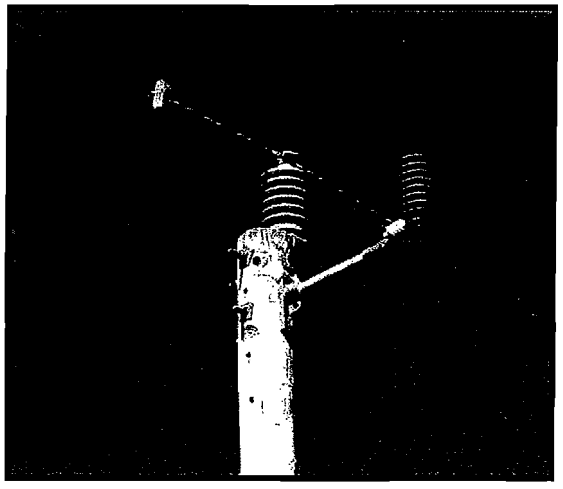


Photo 50 Single-phase Fiberglass Cutout/Arrester Bracket

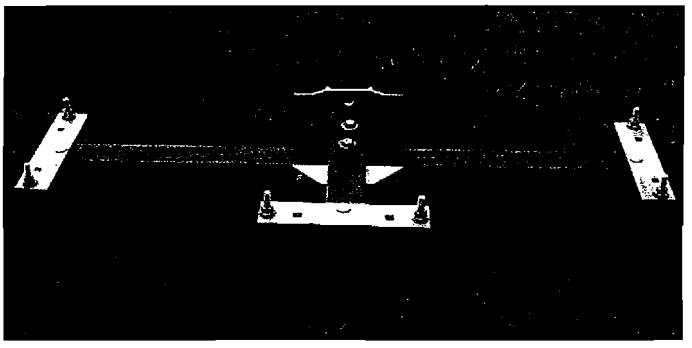


Photo 51 Three-phase Wood Bracket

8.14 Guying

Steel guy wires are typically attached to poles with a thimble eyebolt. Guy wires create a path to earth because they are directly attached to anchors imbedded in earth. This configuration can be problematic if a guy pole attachment is located near energized wires and/or hardware. Grounded guy wires can be particularly problematic on double deadend structures because guy wires tensioning the upper set of crossarms typically pass near energized jumpers on the lower set of crossarms (Photo 52).

Installing fiberglass strain rods (Photo 53) or insulating links (Photo 54) in down guys will provide protection by eliminating a pathway to ground. Insulating links also have the advantage of reducing cathodic anchor rod deterioration.

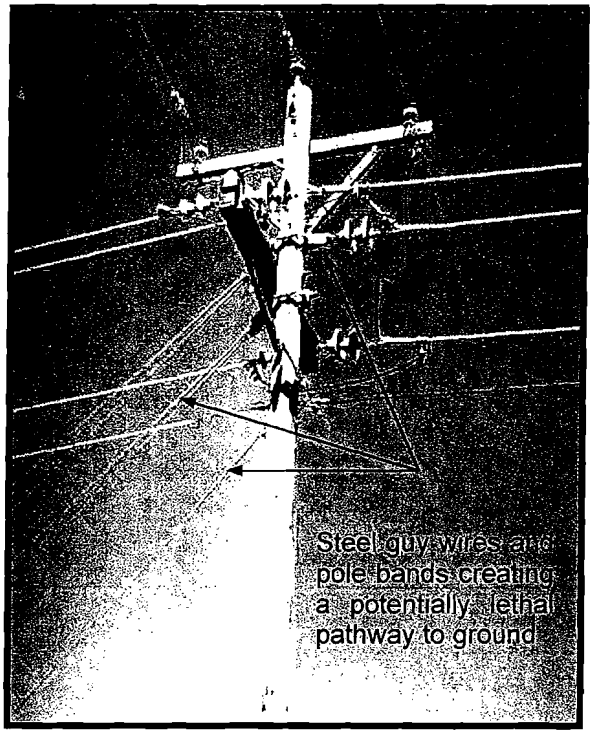


Photo 52 Grounded Guy Wires and Pole Bands in Proximity to Energized Jumpers

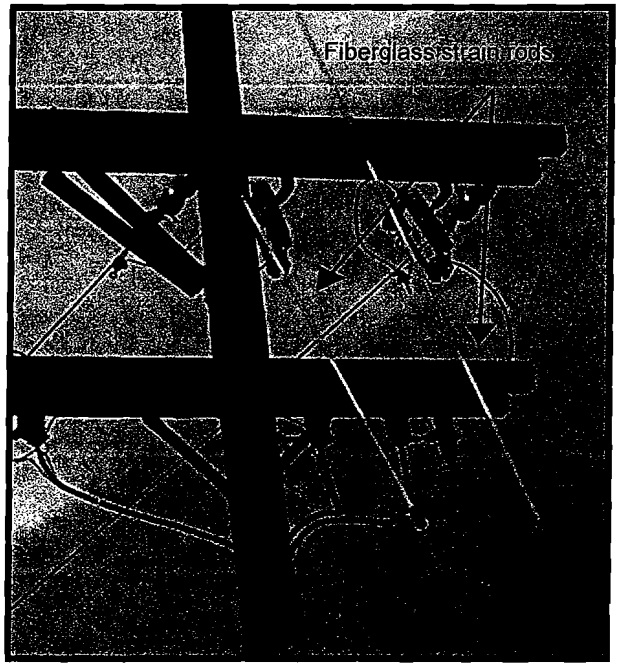


Photo 53 Fiberglass Strain Rods to Prevent a Pathway to Ground

Photo 54 Insulating Link to Prevent a Pathway to Ground

8.15 Perch Management

Perch management is designed to either encourage perching in safer areas of a structure or to deter birds from perching in dangerous or high-risk areas when adequate separation is not provided (Figure 8).

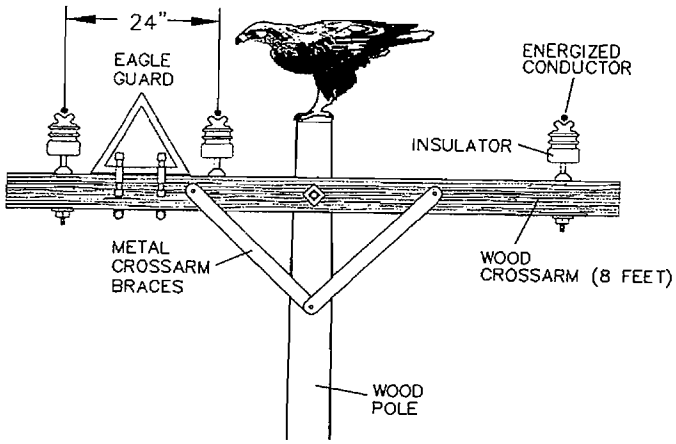


Figure 8 Eagle on a Three-Phase Tangent Structure with Inadequate Separation

8.15.1 Elevated Perches

Perch encouragement is typically achieved with elevated perches designed to attract birds to the highest point on the structure. When elevated perches are constructed, they should be designed so birds cannot get under the perch during the heat of the day or during inclement weather.

Eagle perches should be approximately 8 to 12 inches above a crossarm to prevent birds from sitting under the perch (Photo 55). Installation of perches also must adhere to NESC and all other pertinent safety requirements. Elevated perches are particularly important on structures located at topographical high points near a prey base.

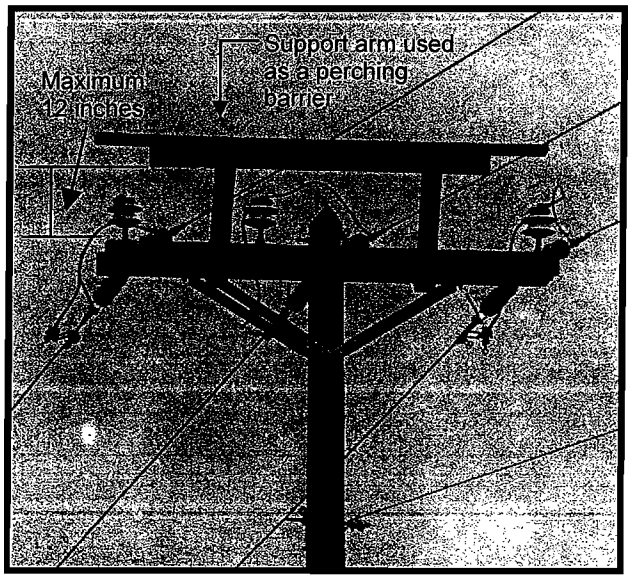


Photo 55 Elevated Perch on a Three-Phase Tangent Structure

Perch deterrents can be successfully used in tandem with elevated perches. As with all devices, they should be installed properly so that they do not create future operational problems. Manufactured perches are available from Aluma-Form and Hughes Brothers.

The retrofitting recommendation data in Appendix B uses code **EP** to specify elevated perches.

8.15.2 Perch Guards

Perch guards are designed to discourage birds from landing at dangerous structure locations. They also may be used to keep birds from defecating on suspension insulators and equipment. A variety of perch guards are commercially available from several manufacturers made out of different materials (Table 6). Some can be installed "hot" with hotline sticks; others must be bolted to the structure. In general, perch guards that can be installed "hot" cost more than guards requiring more labor to install. One unique Kaddas design has a center strut to preclude perching under the perch guard (Photo 56).

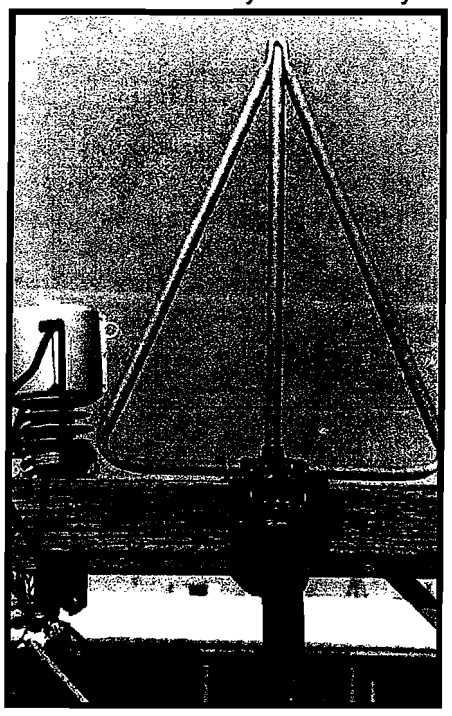


Photo 56 Kaddas Perch Guard with a Center Strut to Prevent Perching within the Triangle

Several guards require the horizontal crossarm surface for mounting. This may not be possible when cutouts, arresters, and other items are present. In those situations a unit that mounts into the vertical crossarm surface is required (Photo 57).

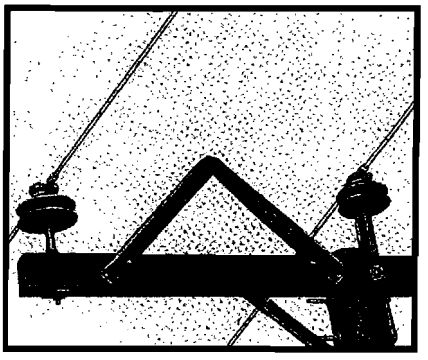


Photo 57 Hendrix Perch Guard that is Adjustable and Mounts on the Vertical Crossarm Surface

Table 6 Perch Guards

Manufacturer	Material	Web Site
Raptor Guard	PVC	None: (970) 878-5041
EcoElectrical	PVC w/Silicone Coating	http://www.ecoelectrical.com
Hendrix Wire and Cable	Polypropylene	http://www.hendrix-wc.com
Hughes Brothers	Fiberglass	http://www.hughesbros.com
Kaddas	PVC	http://www.kaddas.com
Mission Engineering	HDPE	http://www.mission-eng.co.za
Pacer Industries	PVC	None: (208)733-8074

It is important to note that perch guards do not always keep birds off structures (Photo 58). The goal of a perch guard is to discourage a bird from roosting in a certain area. This is most successful if safer portions of the pole are still available to the bird. Perch guards are simply a tool to manage where birds can land on a structure (Photo 59).

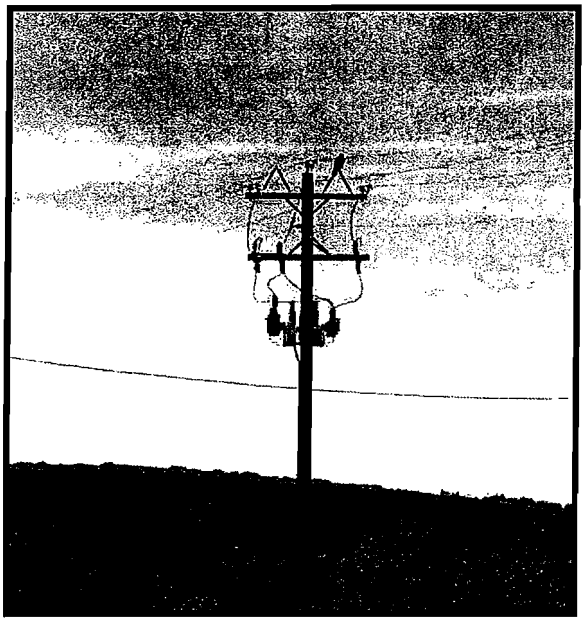


Photo 58 Bird Perching on a Triangle Perch Guard

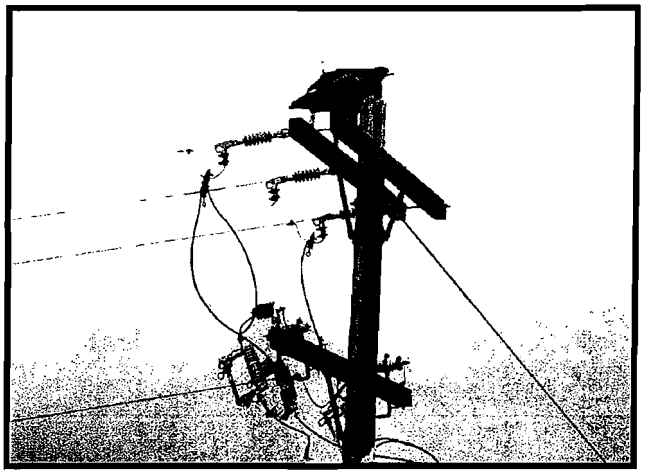


Photo 59 Perch Guard Shifting an Eagle Toward the Safe Side of a Deadend Unit

In new construction it is preferable to provide adequate separation of conductors for birds rather than to use perch guards. Placing perch guards on the top of some poles can even contribute to electrocutions, since birds may choose to roost lower on the pole near energized equipment. Perch guards also can simply shift problems onto other dangerous line segments (Photo 60). The retrofitting recommendation data in Appendix B use code **TRI** to specify perch guards.

Photo 60 Perch Guards may Shift Birds Toward more Problematic Structures

Perch guards should be sized properly to discourage birds from perching under or adjacent to the guards (Photo 61), and purchased with a protective coating to prevent UV deterioration. Home-made guards without UV protection will often prematurely deteriorate, becoming ineffective (Photo 62).

Photo 61 Raptor Perching under a Perch Guard

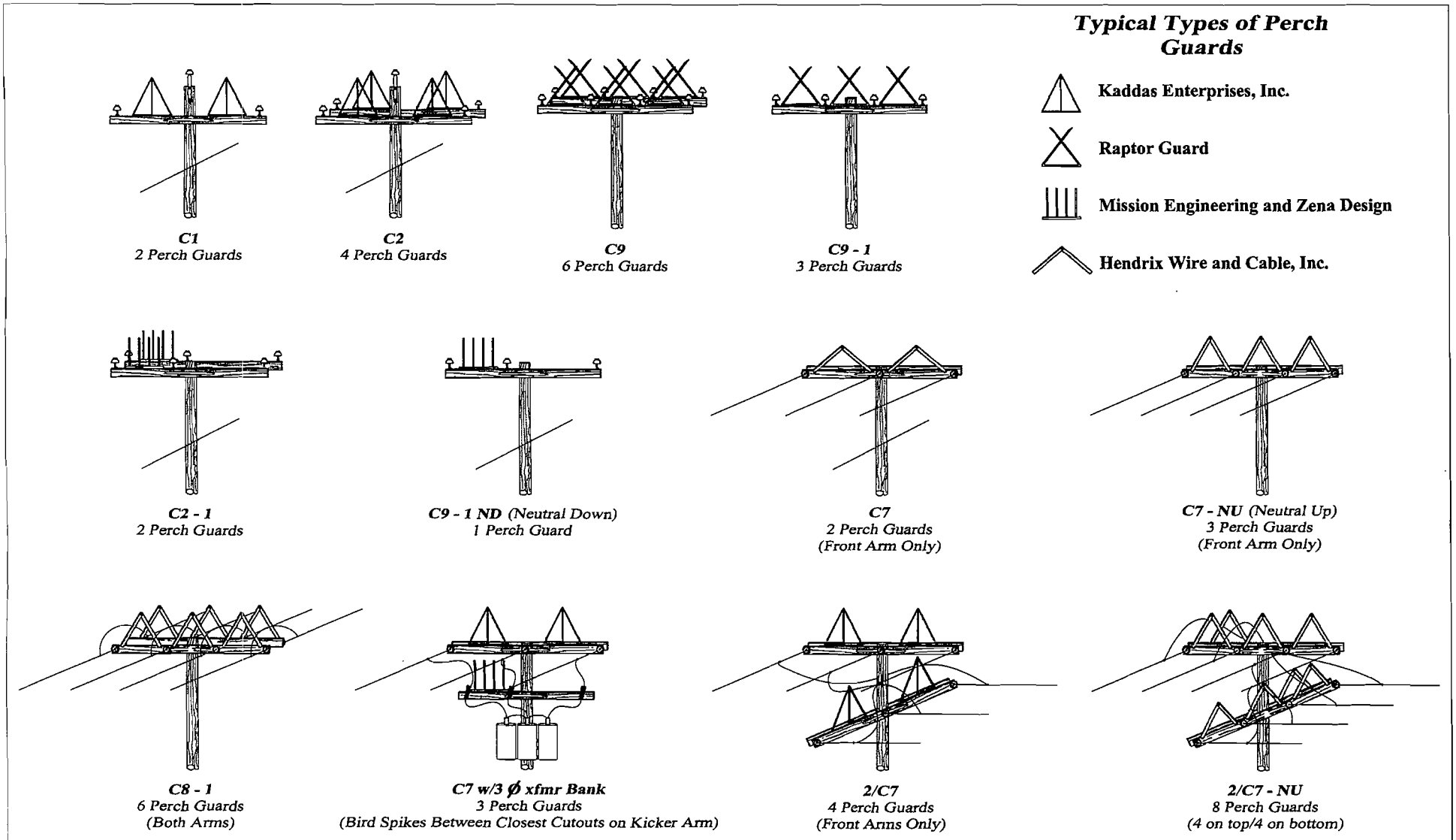
Photo 62 Deteriorated Traffic Cone used as a Perch Guard

Like all utility components, guards should be installed according to the manufacturers' specifications using NESC clearances to avoid potential electrical problems. Guards placed too close to conductors can lead to flashover problems under certain environmental conditions. On the other hand, providing too much separation, may allow birds to land next to guards.

Captive bird tests reveal hawks require 6 inches of separation before they will attempt to land between an insulator and a perch guard (Photo 63). Eagles will attempt to land when there is a minimum of 10 inches between a guard and insulator. Accordingly, utilities should not increase their separation beyond 5 inches, if the goal is to keep eagles and hawks off their structures.

Figure 9 provides specific installation diagrams for a variety of perch guards.

Photo 63 Providing 6 Inches of Separation will allow a Swainson's Hawk to Perch between the Insulator and Guard



Correct Perch Guard Installation For Different Configurations Using a Variety of Products

Figure 9

8.15.3 Bird Spikes

Bird spikes can be an effective perch deterrent. Spikes can be placed in hard to reach areas and come in a variety of materials (e.g., metal, plastic polymers) and sizes to deter a wide range of bird species. However, the spikes must be sized properly and installed in the right location on the structure in order to effectively deter birds. Small spikes will not deter large birds and small birds may nest in them (Photo 64 and Photo 65). Small plastic-type spikes become brittle and break easily, reducing their effectiveness. The potential risks to employees climbing and working around sharp spikes also can be significant.

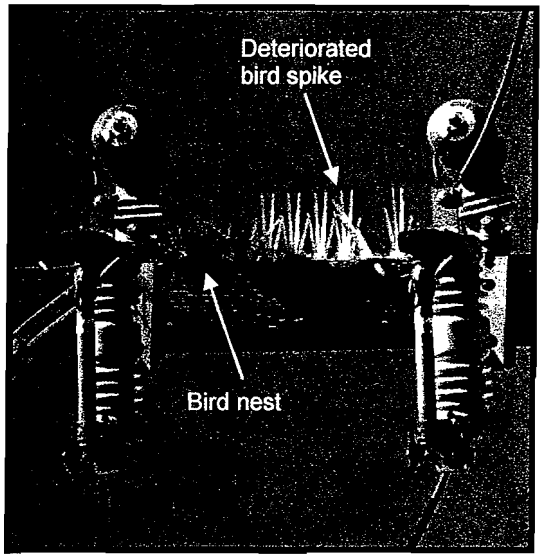


Photo 64 Bird Nesting in Small Plastic Spikes

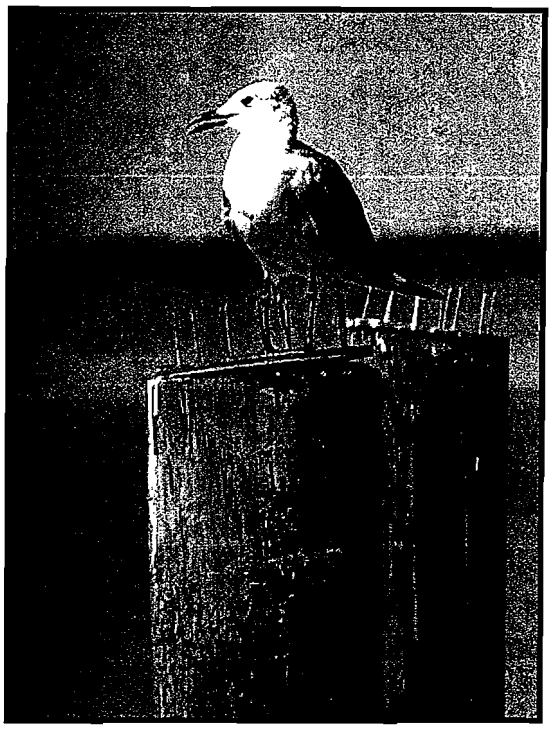


Photo 65 Bird Perching on Bird Spikes

Specialized Mission Engineering HDPE bird guards developed to eliminate bird streamer faults have shown to be useful in deterring raptor perching (Photo 66). In captive testing, the bird guards were successful at all perching attempts and did not harm the birds. These modular guards can be linked together to form chains that can be angled, they are easy to work around during line maintenance activities, and they are furnished with a UV coating to prevent deterioration. These new bird spikes are attached to the pole with either a UV-resistant strap or they may be screwed on the structure. Contact Mission Engineering at **www.mission-eng.co.za** for more information on the bird spikes or email **supern@mission-eng.co.za**. The Zena *Perch Preventer* and *Mini-Zena* are alternative large bird spike products available from Prommel Enterprises, Inc. at **www.zenadesign.com/**. The retrofitting recommendation data in Appendix B use code **BS** to specify bird spikes. See Figure 9 for installation specifics.

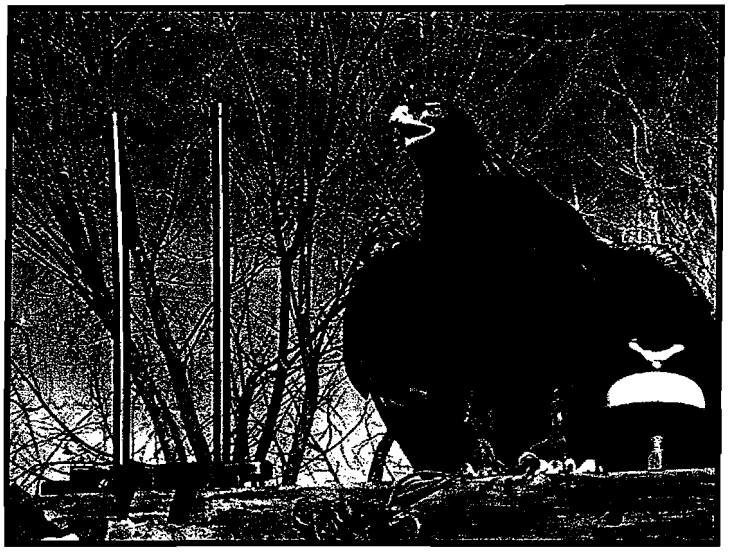


Photo 66 Golden Eagle Perched next to a Mission Engineering Bird Guard

8.16 Collisions

Birds face collision threats from power lines, television towers, radio and cellular telephone towers and related wires, wire fences, wind turbines, cars, aircraft, trains, etc. Although birds often exist near power lines without significant collision risks, problems occur in localized areas where certain factors exist.

The following information on bird collisions is provided to better understand why birds may collide with power lines, and what applicable mitigation may minimize those risks.

8.16.1 Risk

Size and maneuverability are important factors in evaluating species' vulnerability to colliding with overhead wires. Soaring and slow-flying species are less vulnerable to collision hazards than fast, strong flyers (i.e., species with high wing loading). For example, many species of ducks are vulnerable to collisions when flying at low altitudes because of their high flight speed. Flying in flocks also restricts maneuverability and increases collision risk.

Generally, raptors are infrequently involved in collisions although they spend extensive periods of time in the air relative to ground-dwelling species. However, some raptor species such as the peregrine falcon (*Falco peregrinus)* can be vulnerable to collisions because of their hunting behavior (attaining high speeds when following prey near the ground) (Olendorff and Lehman 1985). These collisions usually occur on distribution lines employing small conductors. Raptor collisions with larger transmission conductors are less documented. Some large, heavy-bodied birds such as herons, cranes, swans, and pelicans are frequently reported casualties of transmission line collisions because of their large wingspans and lack of agility.

The probability of collisions occurring is influenced by how birds use habitat near power lines. Collisions with power lines can occur during daily flights within a daily use area. In general, ecologically sensitive areas such as wetlands, where birds congregate to nest, feed, roost, migrate or overwinter, should be avoided if possible. Intermittent wetlands are another good example of habitat that also should be avoided but is not always obvious. A power line located between a feeding area and a roosting site of wetland birds can be problematic, especially when only a short distance separates them, resulting in birds making a short flight at the critical height. Birds crossing power lines at low altitudes several times a day makes them more susceptible to collision.

8.16.2 Overhead Static Wires

Overhead static wires are frequently located above transmission conductors. These wires are grounded and are used to shield lightning from striking the transmission conductors. Overhead static wires are typically smaller than transmission conductors, and several collision reports have stressed that reduced or smaller static wires are

particularly likely to cause bird collisions (APLIC 1994). There are also eyewitness accounts of swans that have managed to avoid phase conductors in time, only to collide with the overhead static wires, which were thinner and less visible.

8.16.3 Wire Marking

One of the most effective ways to reduce avian mortality is to mark wires to make them more visible (Beaulaurier 1981). However, from an engineering point of view, wire marking is not always a good solution. Devices that physically enlarge the wire commonly act as wind-catching objects and increase the risk of wire breaks and power outages due to line tension and stress loads. The attachment of devices also may cause physical damage to the conductors from abrasion. Wire marking also has not proved to be the perfect solution and there is no broad agreement among biologists on the success of line marking. However, the effectiveness of some marking methods that target specific species can hardly be questioned, and marking is justified if spans are determined to be dangerous to endangered and vulnerable species.

Although several products are available to mark power lines, there have been very few rigorous experimental designs to test their effectiveness. Also, very few studies comparing products have been completed. Following is a discussion of the various products available to mark wires and their advantages and disadvantages. Table 7 lists vendor product information.

Table 7 Bird Collision Devices and Manufacturers

Manufacturer	Device	Description	Web Site
Kaddas	Flapper	Swinging Plate	http://www.kaddas.com
P&R	BirdMARK / Firefly	Swinging Plate	http://www.pr-tech.com/products/birds/birdsigns.htm
MidSUN	Collision Guard	Swinging Mat	http://www.midsungroup.com
Mission Engineering	Bird Collision Diverter	Swinging Plate	http://www.mission-eng.co.za
Dulmison	Bird Flight Diverter - BFD	Coiled Solid PVC Wire Marker	http://catalog.tycoelectronics.com
Preformed Line Company	Bird Flight Diverter - BFD	Coiled Solid PVC Wire Marker	http://www.preformed.com
Dulmison	Swan Flight Diverter - SFD	Coiled Solid PVC Wire Marker	http://catalog.tycoelectronics.com
Dulmison	Spiral Vibration Dampers -SVD	Vibration Dampers	http://catalog.tycoelectronics.com

8.16.4 Flapper

The Flapper (Photo 67) was designed in South Africa in partnership with Preformed Line Products, ESKOM, and the Endangered Wildlife Trust (EWT). The Flapper is distributed by Kaddas and is designed to securely grip wires up to a diameter of 0.75 inch with a locking plastic jaw. The Flapper can be installed and removed from the ground (Photo 68); has been UV stabilized; and is available in red, white, and black. Black and white flappers provide maximum contrast.

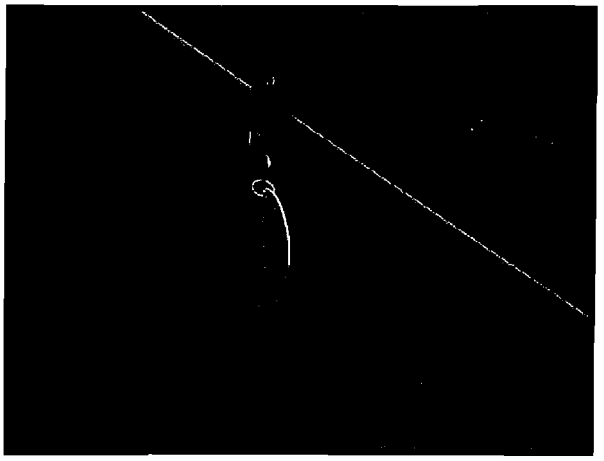


Photo 67 White Flapper

The Flapper is used in Africa and is effective at reducing collisions. However, ESKOM has experienced problems with the device shifting in some the earlier versions (van Rooyen 2000). The EWT recommends two modified ways of attaching the flapper to mitigate this problem:

Photo 68 Flapper Installation

- Attach the flapper disk (not the clip) to a helical holder (basically a metal wire pigtail), which is then wound around the conductor/earthwire. ESKOM has 2 years of experience of his method on very small conductors 0.9 inch diameter with no shifting.
- Attach a spiral onto the conductor and then attach the flapper by its hook to the spiral. This has the advantage of making the line even more visible as the device is now bigger. ESKOM has not experienced spirals shifting since implementing these measures.

The newest Flapper version is attached by a clamp arrangement activated by a (nonmetallic) screw eye, which can be installed using a shotgun stick. According to the distributor, this unit when properly applied, will not shift and move on the line. The manufacturer also recommends using silicone adhesive on the clamp.

There are two versions of the Flapper, one is attached with a ratcheted clamp, and the other is installed with a breakaway composite screw using a hotline stick. The Flapper is available with a luminescent paint that will glow in low light situations. The color of devices plays an important role in reducing collisions (Kreithen 1996).

The advantage of the Flapper is the movement of the swinging plate helps make a line more visible than simply increasing the line profile. The effectiveness of the Flapper has been scientifically tested in South Africa, and preliminary data show that the Flapper is effective in reducing bustard and crane collisions (van Rooyen 2000; Anderson 2001). However, in areas of vandalism to overhead power lines, a marking system resembling a target might create problems. The potential for devices slipping on hard to access overhead transmission static wires also is a significant concern.

8.16.5 BirdMARK Bird Flight Diverter

The BirdMARK (Photo 69) is distributed by P&R Industries and is designed to securely grip wires up to a diameter of 2.5 inches with a strong spring-loaded clamping jaw. The clamping jaw also is used with several other P&R products designed specifically for power lines. The BirdMARK is presently being used in England and Ireland.

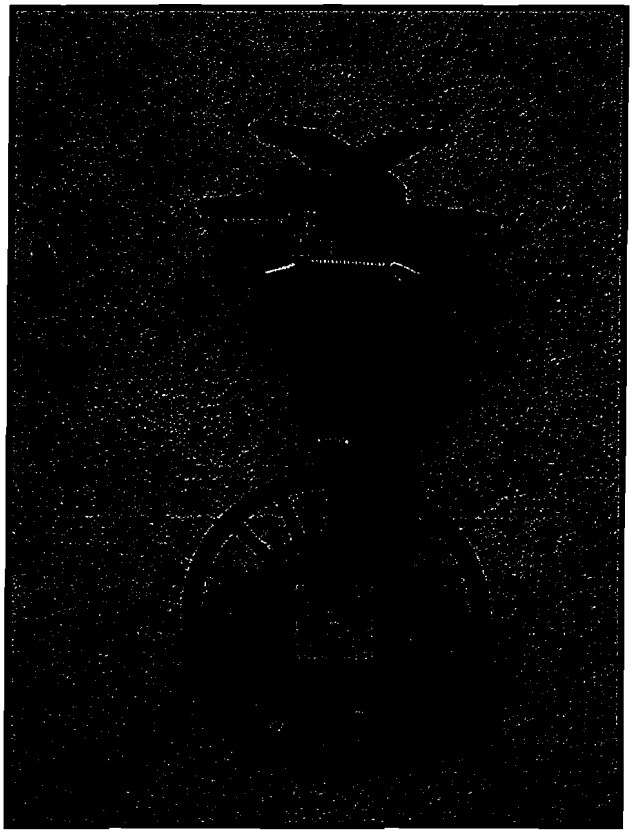


Photo 69 BirdMARK Bird Flight Diverter

The BirdMARK can be installed and removed from the ground without interrupting power. The manufacturer claims the BirdMARK will stay in position even in a Force 8 gale. The swinging roundel is available in either orange or red-and-white.

As discussed for the Flapper, the advantage of the BirdMARK is the movement of the swinging plate makes a line more visible than simply increasing the line profile. However, vandalism can be a problem. Unfortunately, no studies on the effectiveness of the BirdMARK were found in the scientific literature although it would appear the device should be similarly effective as the Flapper.

Recently this product line has been expanded to include the FireFly. The FireFly uses the same clamp but the circular plate has been replaced with a rectangular plate. The rectangular plate includes a reflective and fluorescent reflective plate (Photo 70 and Photo 71).

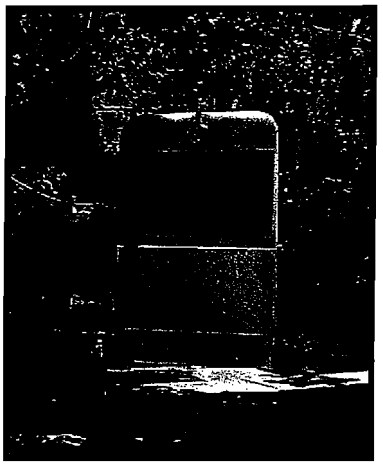


Photo 70 FireFly During the Day

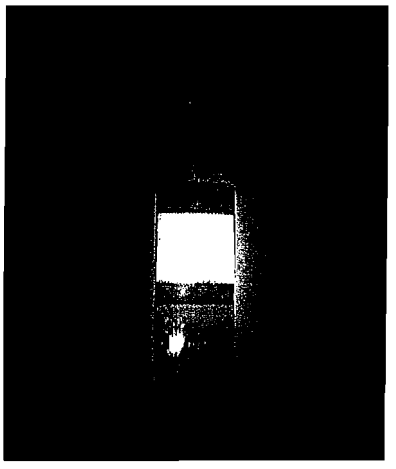


Photo 71 FireFly at Night

Mission Engineering and MIDSUN Company also have recently introduced their own versions of swinging devices to prevent collisions (Photo 72). However, no data are currently available on their effectiveness.

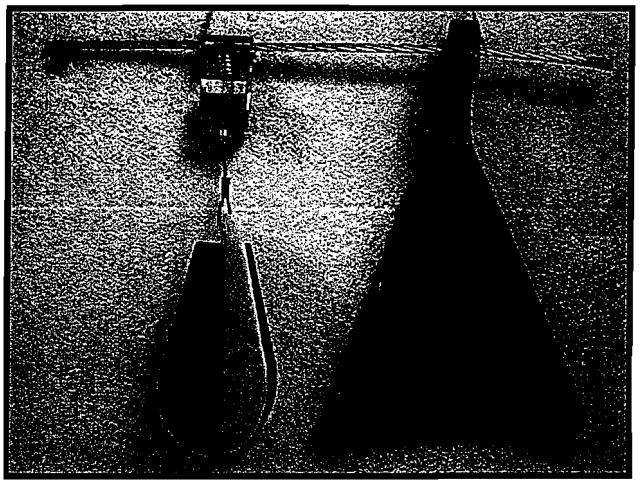


Photo 72 Mission Engineering (left) and MIDSUN (right) Bird Diverters

8.16.6 Bird Flight Diverter

The Bird Flight Diverter (BFD) was developed in Europe during the 1970's (**Figure 10**). The BFD is made from a high-impact, standard gray PVC and is UV stabilized.

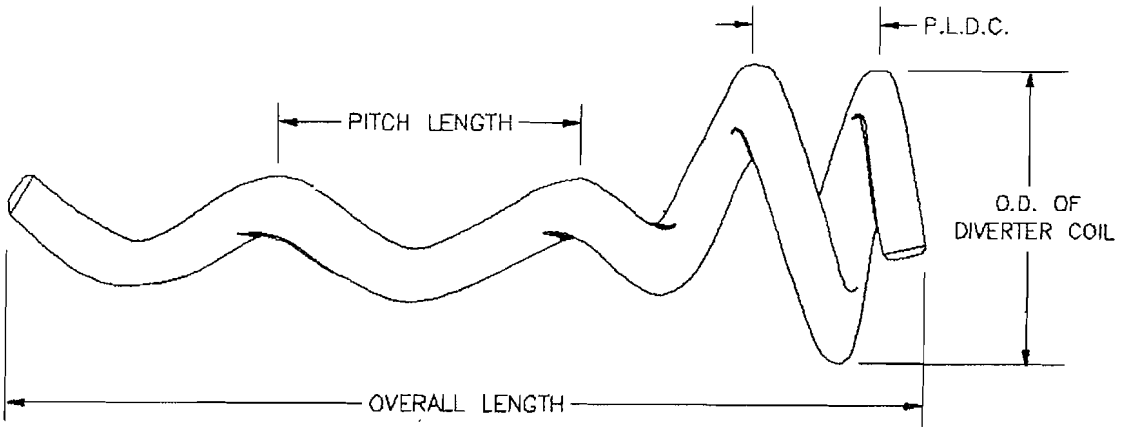


Figure 10 Bird Flight Diverter Manufactured by Dulmison. Made from High Impact PVC and UV Stabilized.

The Dulmison BFD is available in a variety of colors and different sizes to accommodate a conductor ranging from 0.175 to 1.212 inches (Photo 73).

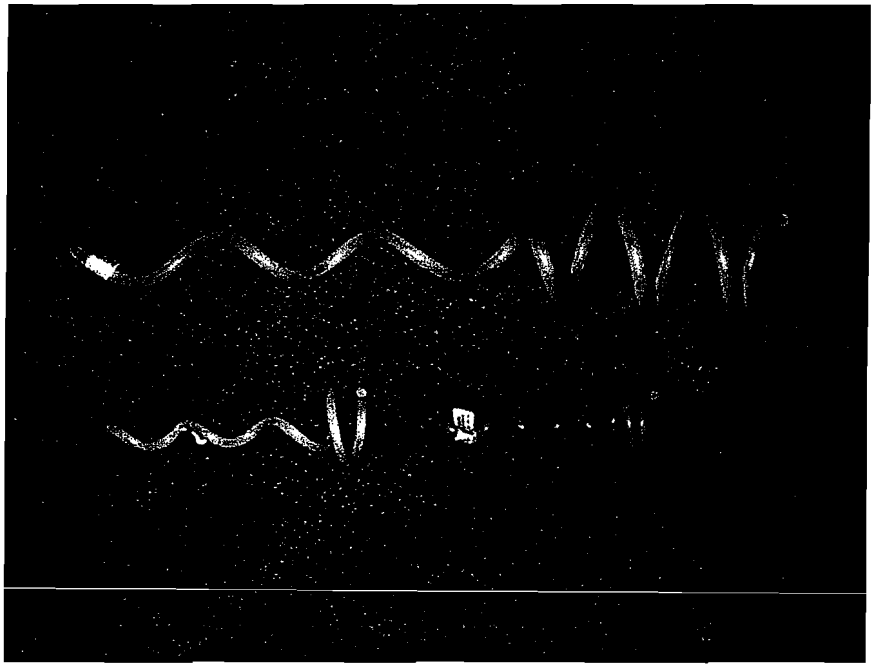


Photo 73 Bird Flight Diverters for Small and Larger Wires

The BFD has been effective when installed on transmission overhead static wires in Europe, where typical spacing ranges from 16 to 33 feet. In North America, the BFD also has shown to be effective in reducing waterfowl collisions with overhead static wires (Crowder 2000). The spacing of the BFDs in Crowder's 1998-2000 study was 20 feet apart. The BFD is believed to be effective because its profile increases line visibility.

However, the BFD cannot be installed on electrically energized conductors with a voltage more than 230kV because of ozone deterioration. The ozone destroys the chemical properties, making the BFD brittle and reducing the service life. BFDs also can create radio and television interference when installed on higher voltage conductors but are appropriate on overhead static wires and on lines below 230kV. The BFD colors may fade after long periods of exposure but should not become brittle or lose their elastic properties. ESKOM has used the Preformed Line Products, BFD in South Africa for years with no reports of mechanical failure (van Rooyen 2000) although some red PVC devices have faded.

8.16.7 Swan Flight Diverter

The Swan Flight Diverter (SFD) is similar to the BFD but includes four 7-inch spirals (Photo 74). The SFD also is made from a high-impact, standard gray PVC and is UV stabilized. The Dulmison SFD is available in a variety of colors and sizes to accommodate conductors ranging from 0.175 to 1.212 inches.

The SFD has been shown to be effective when installed on transmission overhead static wires in North America. In the early 1990's Northern States Power Company addressed a problem where endangered trumpeter swans (*Cygnus buccinator*) were colliding with a power line during the winter months in a small bay on the St. Croix River in Hudson, Wisconsin. Yellow SFDs were installed to increase the shield wires' visibility in low light conditions. The SFDs were installed May of 1996, using a 50-foot spacing staggered on each parallel shield wire, resulting in an appearance of a 25-foot spacing.

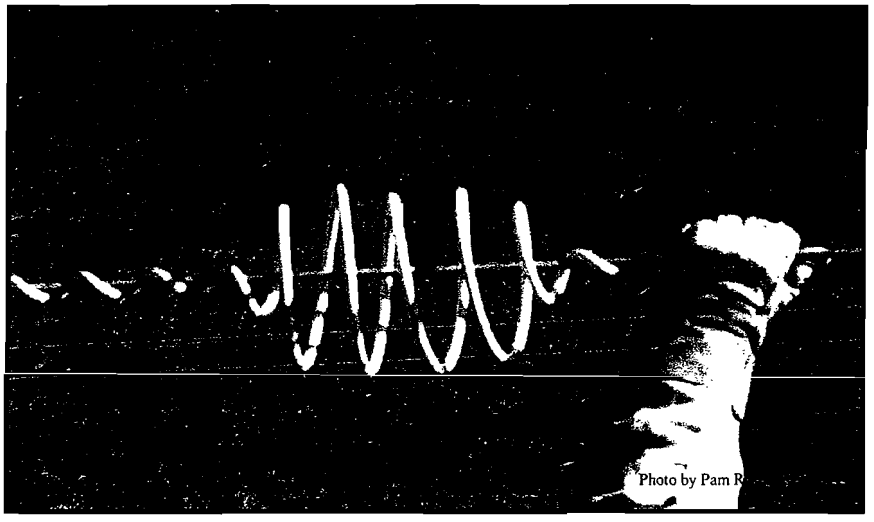


Photo 74 Swan Flight Diverters Being Placed on a Static Wire

In this example, a lineman was placed in a line cart on the shield wire and pulled himself across the shield wire by hand to install the diverters (Photo 75). It took a three-man crew 2 hours of setup time for each wire crossing and 30 minutes for the lineman in the cart to install the SFDs. To date no additional collisions or deaths have been documented (Rasmussen 2001).

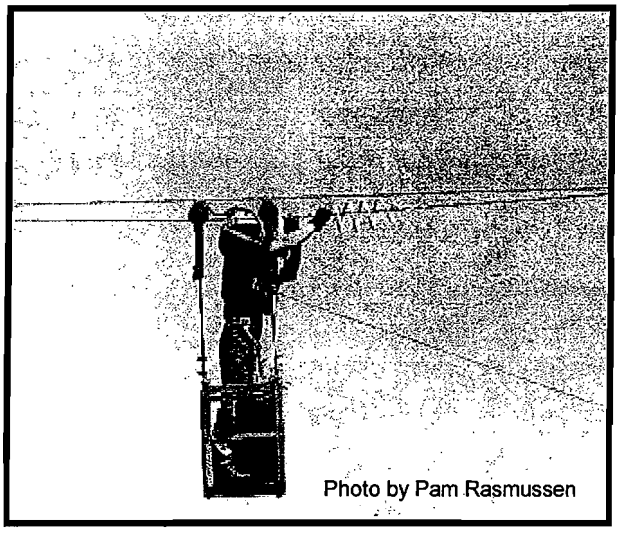


Photo 75 Lineman Installing SFDs from a Suspended Pull Cart

In Indiana, the SFD has also recently shown to be effective in reducing waterfowl collisions with overhead static wires (Crowder 2000). The spacing of the SFDs in Crowder's 1998-2000 study was 20 feet apart (Photo 75). The close spacing was required to compare the effectiveness of the SFD to the BFD.

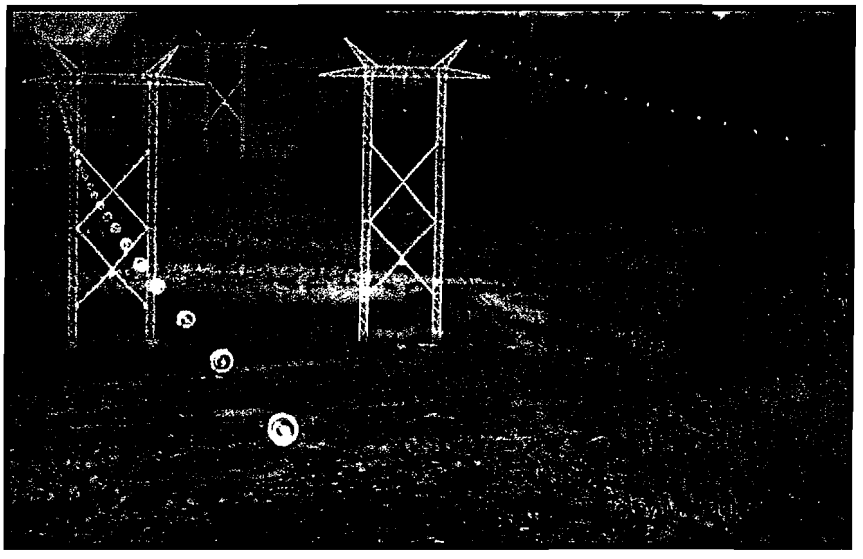


Photo 76 Swan Flight Diverters Installed at a 20-foot Interval in Indiana

Like the BFD, the SFD cannot be installed on electrically energized conductors with a voltage more than 230kV because of ozone deterioration. The ozone destroys the chemical properties and makes the SFD brittle, reducing the service life. SFDs also can create radio and television interference when installed on higher voltage conductors, but these devices are appropriate on overhead static wires and on lines below 230kV. As discussed for BFDs, the SFD colors may fade after long periods of UV exposure but should not become brittle or lose their elastic properties.

8.16.8 Spiral Vibration Damper

Spiral Vibration Dampers (SVDs) are manufactured from solid PVC into a helix (Figure 11). The purpose of the damper is to reduce high-frequency aeolian vibration.

The SVD is designed to provide the action/reaction motion to oppose the natural vibration of cable by gripping a conductor tight at one end; loosely on the opposite end. The vibration is often inducted by low velocity winds of 3 to 8 mph.

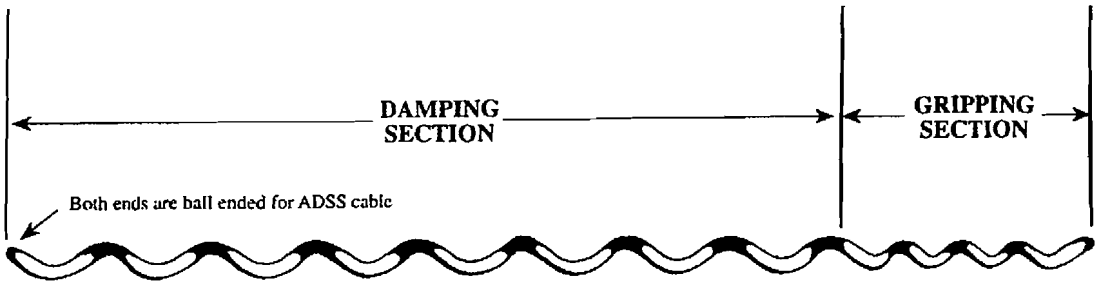


Figure 11 Spiral Vibration Damper

The Dulmison SVD is made from a high-impact, standard UV-stabilized PVC. The SVD also is available in a variety of colors, and there are different sizes available to accommodate a conductor ranging from 0.175 to .76 inch.

SVDs have been used in the San Luis Valley in Colorado to mitigate crane collisions. Coverage of the wires was 27.5 percent per span, reducing collisions by 61 percent. As discussed for BFDs and SFDs, the SVD cannot be installed on electrically energized conductors with a voltage more than 230kV because of ozone deterioration, and radio and television interference can be a problem when installed on higher voltage conductors. The SVD colors also may fade after long periods of UV exposure but should not become brittle or lose their elastic properties, making them appropriate for overhead static wires and lines below 230kV.

Tri-State Generation and Transmission Association has used the Dulmison and Preformed spiral vibration dampers since 1985 without any failures (Dille 2001). The dampers are easy to install; however, after several years they do become brittle and will break if they need to be removed.

8.16.9 Conclusion

8.16.9.1 Marker Type

There are very few comparative studies testing the effectiveness of various marker devices to minimize bird collisions with power lines. One study by Crowder (2000) compared the SFD and BFD in their effectiveness to reduce waterfowl collisions at an Indiana wetland. Another study in South Africa by the EWT (in review) tested the effectiveness of the Flapper and BFD to reduce bustard and crane collisions. Both studies showed all devices to be effective in reducing, but not eliminating collisions. In Crowder's study there was no significant difference between the SFD and BFD based upon the number of dead birds per search. Comparisons between the Flapper and BFD are not yet available from South Africa.

The circumstantial nature of existing data and the lack of analysis of known instances of collisions, compounds the difficulty of selecting appropriate mitigating devices. There are no studies on which marker is most effective for raptors. However it is very likely that swinging plates will show to be more effective than static measures. Unfortunately although an experimental swinging plate used in the San Luis Valley was effective in reducing collisions, the aerodynamic instability of the plate proved to be destructive to conductors. It is important to select mitigating measures that will need minimal maintenance to reduce the potential for future disturbance. Until test data are available demonstrating the Flapper, BirdMARK, Mission Engineering, and MIDSUN plates are aerodynamically stable and that the devices will stay in place during high winds, other passive devices should be used in hard to access areas. Swinging plate systems hold great promise for reducing collisions, but they should be tested on less critical lines with easy access.

Passive marking devices include the SVD, BFD, and SFD have all been demonstrated to reduce collisions with waterfowl, cranes, bustards, and swans. They are all manufactured from a high-impact PVC that possesses excellent strength and durability properties. Although these devices are available in a variety of colors, there is a general consensus that these devices work because they increase the profile of the line, not because of their color. Because the SFD has the largest profile, it is preferred over the SVD and BFD. In areas with heavy ice loading, the larger profile might not be preferable. Passive markers can be ordered in yellow to maximize contrast with the horizon during low-light conditions.

8.16.9.2 Marker Spacing

The space between wire markers varies depending upon a number of factors including the size of marker, bird species, and extent of the concentration areas. The optimal way to install markers is to stagger them to minimize the number of devices required. In the collision studies documented in *Mitigating Bird Collisions with Power Lines: The State of the Art in 1994,*

- The BFD reduced collisions from 86 percent to 89 percent when spaced 16 feet apart and 57 percent to 58 percent when spaced 33 feet apart.

- The larger BFD (Catalog BFD-7) reduced collisions 65 percent to 74 percent when spaced 50 feet apart.

- The SVD reduced collisions 61 percent when 27.5 percent on the span was covered.

In the only published study on the SFD, Northern States Power Company eliminated swan collisions using yellow SFDs at a staggered 50-foot spacing, resulting in an appearance of a 25-foot spacing.

It is important to note the reported collision reduction levels are complied from a variety of sources and are not directly comparable due to varying methodologies, environments, and bird species. Also, none of the studies specifically addressed raptor collisions.

The optimal diverter placement is to stagger the devices midway between each other on alternating lines to reduce the number of markers required. A significant portion of the cost associated with installing any marker is achieving the proper device placement. When stringing the conductors it is important to mark where the diverter is to be placed rather than to perform measurements when the wires are in the air. This is more critical when installing markers with a helicopter or tall crane than when using a pull cart.

Given today's pressures to ensure electrical reliability, it is imperative that utilities exercise due diligence when seeking to implement solutions to such problems. Care must be used in solving potential collision problems to avoid creating additional operational problems that could lead to degradation of facility availability by promoting either forced or scheduled outages. Thus, utilities should exercise caution by using solutions with a proven track record or by thoroughly testing potential solutions before implementing them on critical facilities.

Although active devices have been shown to effectively reduce collisions, passive PVC devices have proven to be effective in the long term. Tri-State has used spiral vibration dampers since 1985 without any failures, and Northern States Power has successfully used the SFDs since 1996 with no maintenance problems. Likewise Montana Power has used the BFD's since 1998 with no shifting or other maintenance problems.

9.0 RESULTS AND CONCLUSIONS

9.1 Survey Results

The following summary information pertains to the field survey results compiled by EDM for E&OA. Chapter 7.0 details the field survey methodology and approach used to develop this APP. As described, these surveys examined the structures in proximity to "bird use areas," focusing on pole configuration and location, associated equipment, habitat types, topography, bird species identified, relative bird sign, and land uses.

As discussed in this APP, there are a number of distribution line structures that present more risk to birds than others. These structures are often equipment poles, particularly transformer units. Other problematic configurations include poles with closely spaced conductors, and deadend units. It should be noted that pole configurations exist on the system (e.g., transformer units near residences) that are not included in the associated data summary matrix presented in Appendix B. This is because the focus of the surveys was to concentrate in areas with favorable bird habitat.

Appendix B delineates pole-specific retrofitting options for structure types recorded in the field. This chapter describes in detail the recommended retrofitting approaches and measures associated with this data summary matrix (i.e., short-term retrofit recommendations) and for future new construction (i.e., long-term planning and design) to minimize avian electrocution and collision risks on the system.

During the field surveys several avian mortalities were observed. These are indicated in the field data spreadsheet in Appendix B.

9.2 Positive Practices

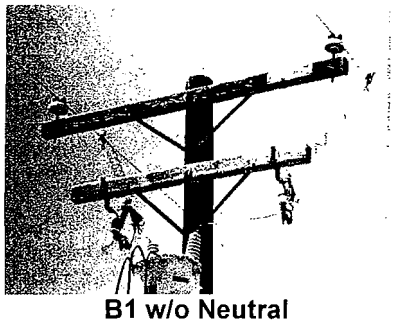
During the field surveys, it became apparent that the E&OA has been proactive in installing insulated jumpers to transformer bushings, and animal protection devices on capacitor banks. Though these practices were not applied in all cases, they have undoubtedly been helpful in reducing the electrocution risk to wildlife.

9.3 Specific Structures and Retrofitting Options

The following information summarizes information regarding specific types of configurations (structures and equipment) currently found in the TID service area. The discussions here are aimed to assist the E&OA in implementing their retrofit program and choosing new construction approaches. Applicable retrofit approaches or options are discussed for each of these configurations observed.

9.3.1 Unit Designations Used

The unit designations used in the field data spreadsheet are derived for TID structures from the Rural Electrification Administration (REA) / Rural Utilities Service (RUS) Bulletin 50-3 (Standard D-804) *Specifications and Drawing for 12.5/7.2 kV line Construction* (REA 1983).



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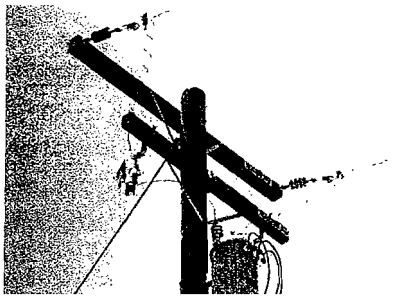
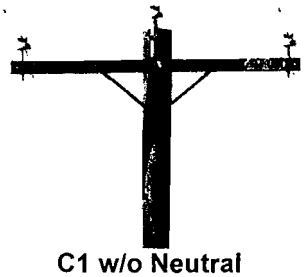
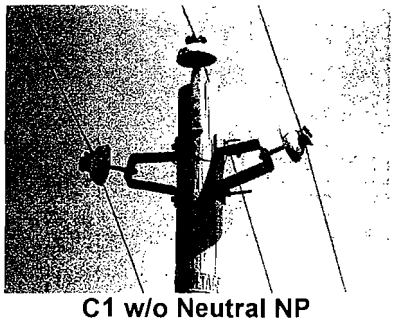


B7 w/o Neutral



C1 w/o Neutral



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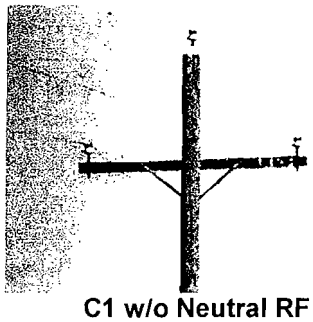
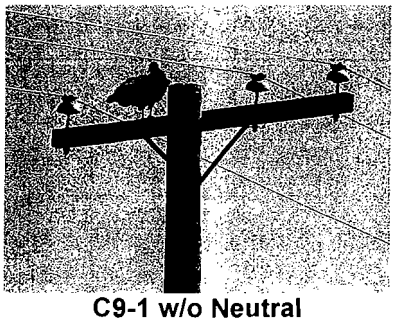
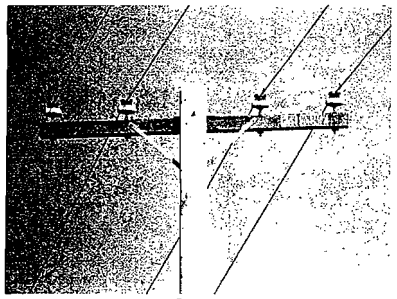


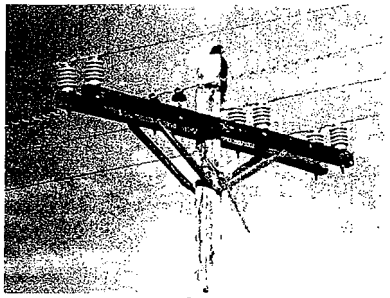
C1 w/o Neutral RF (Raptor Friendly)



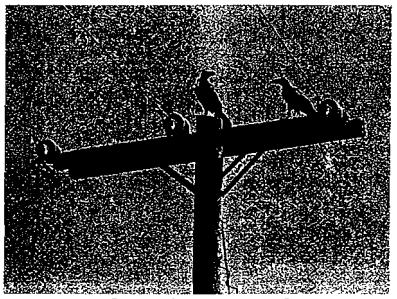
C9-1 w/o Neutral



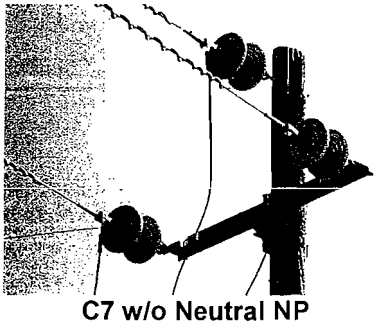
C9-1



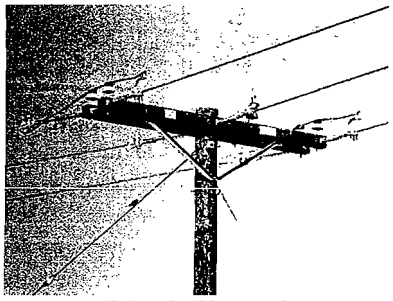
C9



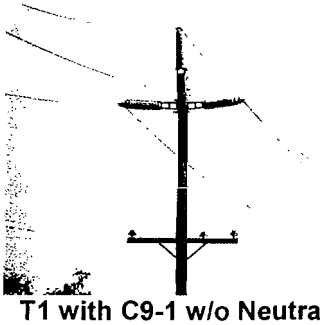
C7 w/o Neutral



C7 w/o Neutral NP (Narrow Profile)



C8 w/o Neutral



T1 with C9-1 w/o Neutral UB (Under Build)

9.3.2 Three-phase 3-wire Single-crossarm Flat-top Tangent Structures

The structure referred to in the field data sheets as "C9-1 w/o N" is probably the most prevalent configuration distribution poles seen in the TID service area. This structure poses some risk to larger birds when they perch on the crossarm side with two wires.

Two options are recommended for this structure, depending on the habitat and intensity of avian use.

Retrofit option 1 (Figure 12) is most appropriate in areas of favorable habitat when birds perch on the structure infrequently, or when alternate perches are available in the area.

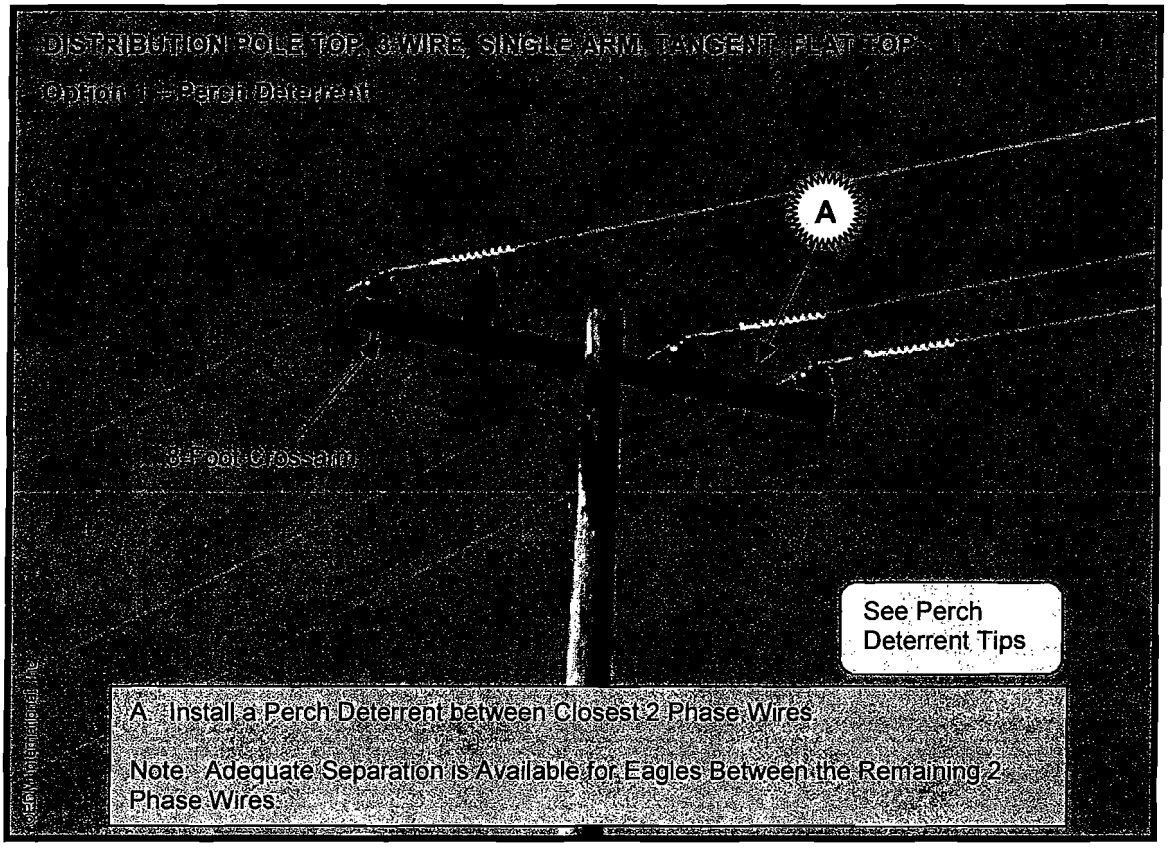


Figure 12 Retrofit Option 1 for C9-1 without Neutral

Retrofit option 2 (Figure 13) is preferred when the structure is used as a perch frequently or by more than one bird at the same time. This situation can occur near an active nest, or adjacent to a preferred hunting area. Note that when the line angles downward or upward significantly on either side of the crossarm, conductor covers will not fit. In these cases, retrofit option 1 should be used.

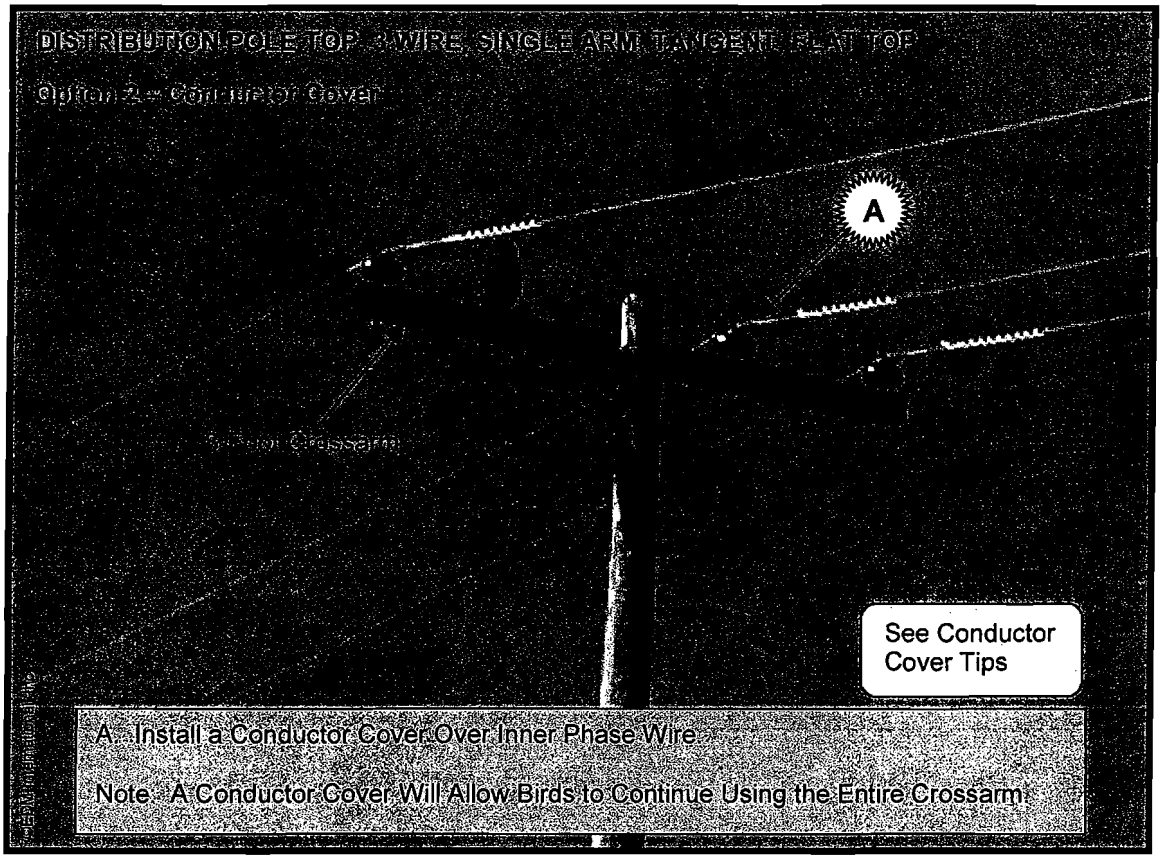


Figure 13 Retrofit Option 2 for C9-1 without Neutral

9.3.3 Three-phase 4-Wire Single-crossarm Flat-top Tangent Structures

The three-phase structure with neutral referred to in the field data sheets as "C9-1" is also used commonly in the TID service area. This structure poses significant electrocution risk to eagles perching anywhere on the structure, and also to other raptors perching between the pins on either side of the crossarm.

Two options are recommended for this structure, depending on the habitat and the species likely to perch on the structure.

Retrofit option 1 (Figure 14) is recommended in areas of favorable habitat when birds perch on the structure infrequently, or when alternate perches are available in the area. Note that a perch guard between the center two phases is required in areas where eagles are found.

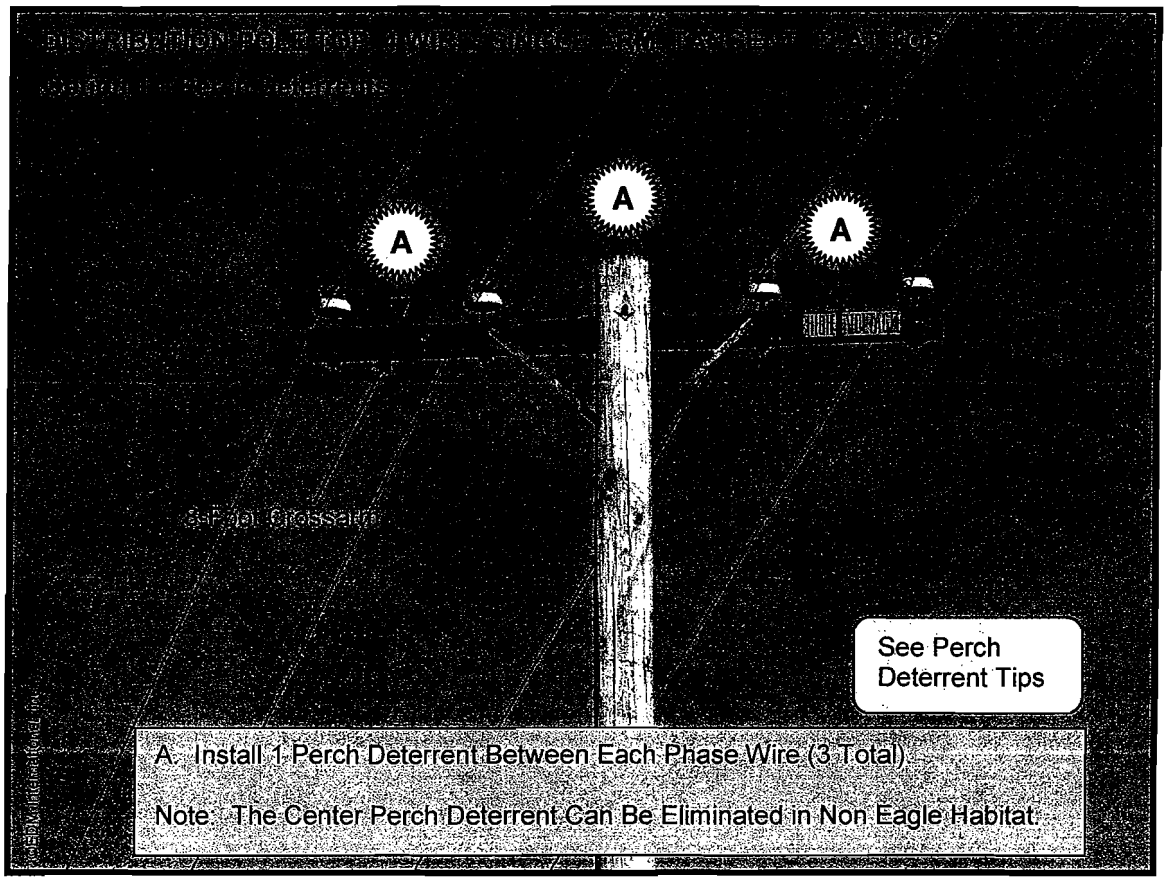


Figure 14 Retroft Option 1 for C9-1

Retrofit option 2 (Figure 15) is preferred when the structure is used as a perch frequently or when no alternate perches are nearby. This retrofit option should be given consideration when the structure is near an active nest, or adjacent to a preferred hunting area. Note that when the line angles downward or upward significantly on either side of the crossarm, conductor covers will not fit. In these cases, retrofit option 1 should be used.

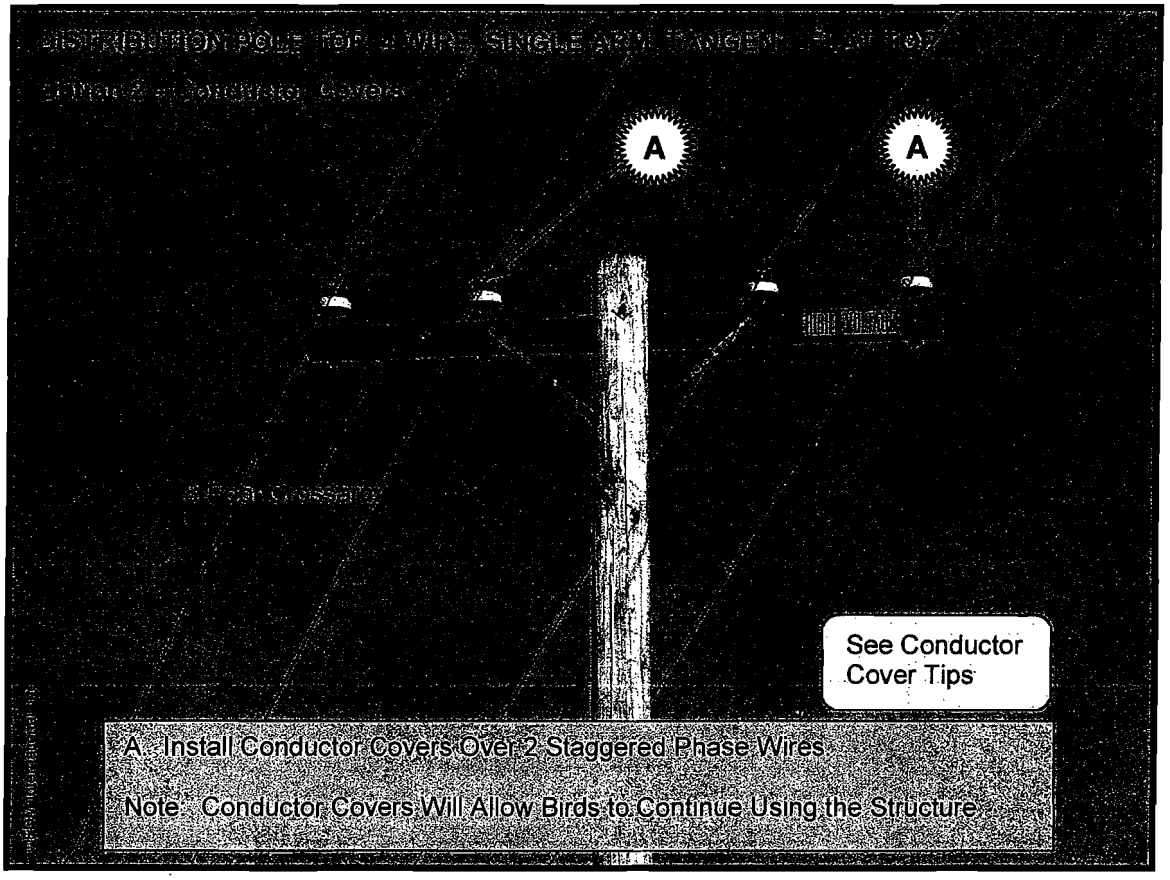


Figure 15 Retrofit Option 2 for C9-1

9.3.4 Three-phase 4-wire Double-crossarm Flat-top Tangent Structure

The structure referred to as "C9" in the field data spreadsheet is not frequently used in the TID service area. The structure is similar to C9-1 and poses similar risks to larger birds. The key difference in retrofitting this structure is that the double crossarm requires twice the number of perch guards.

Retrofit option 1 (Figure 16) is recommended in areas of favorable habitat when birds perch on the structure infrequently, or when alternate perches are available in the area. Because the center two phases are spaced close together, center perch guards are always needed, even in non-eagle areas.

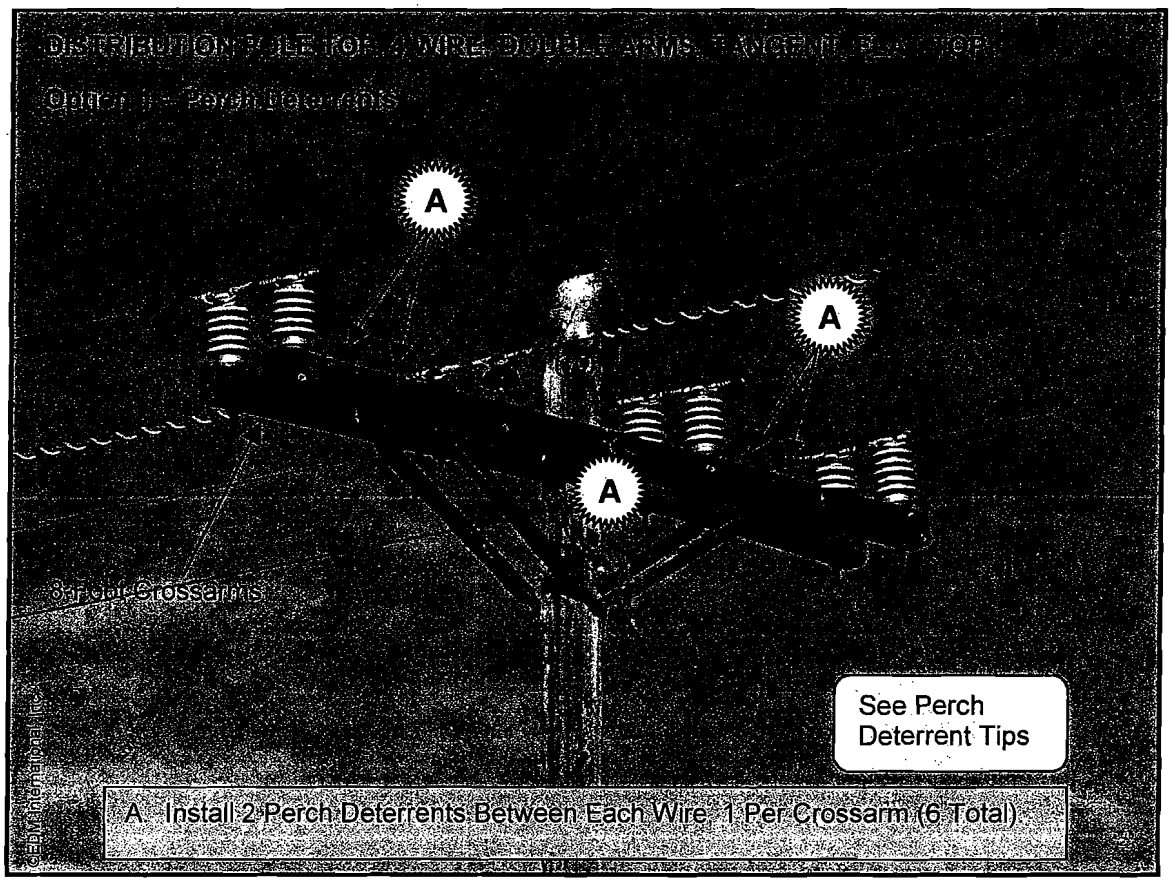


Figure 16 Retrofit Option 1 for C9

Retrofit option 2 (Figure 17) is preferred when the structure is used as a perch frequently or when no alternate perches are nearby. This retrofit option should be given consideration when the structure is near an active nest, or adjacent to a preferred hunting area. For this unit, conductor cover orders must specify double-pin configuration. Note that when the line angles downward or upward significantly on either side of the crossarm, conductor covers will not fit. In these cases, retrofit option 1 should be used.

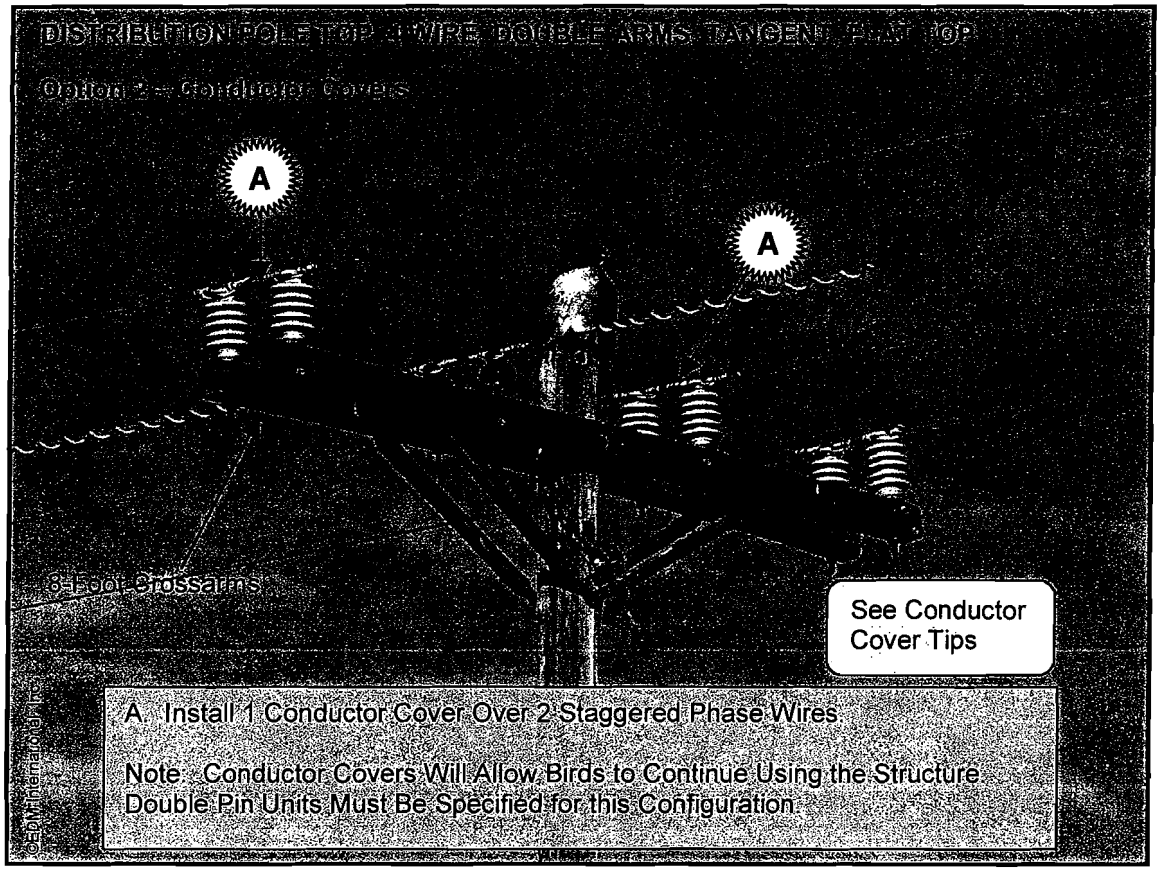


Figure 17 Retrofit Option 2 for C9

9.3.5 Three-phase 3-wire Narrow Profile Structure

This structure referred to in the field data spreadsheet as "C1 NP w/o N." This structure is common in the western portions of the TID service area recently acquired from Pacific Gas and Electric. Since birds perch on the insulator brackets as easily as they do on crossarms, this structure poses some risk. The recommended retrofit calls for the installation of conductor covers, since the brackets will not easily accommodate perch guards.

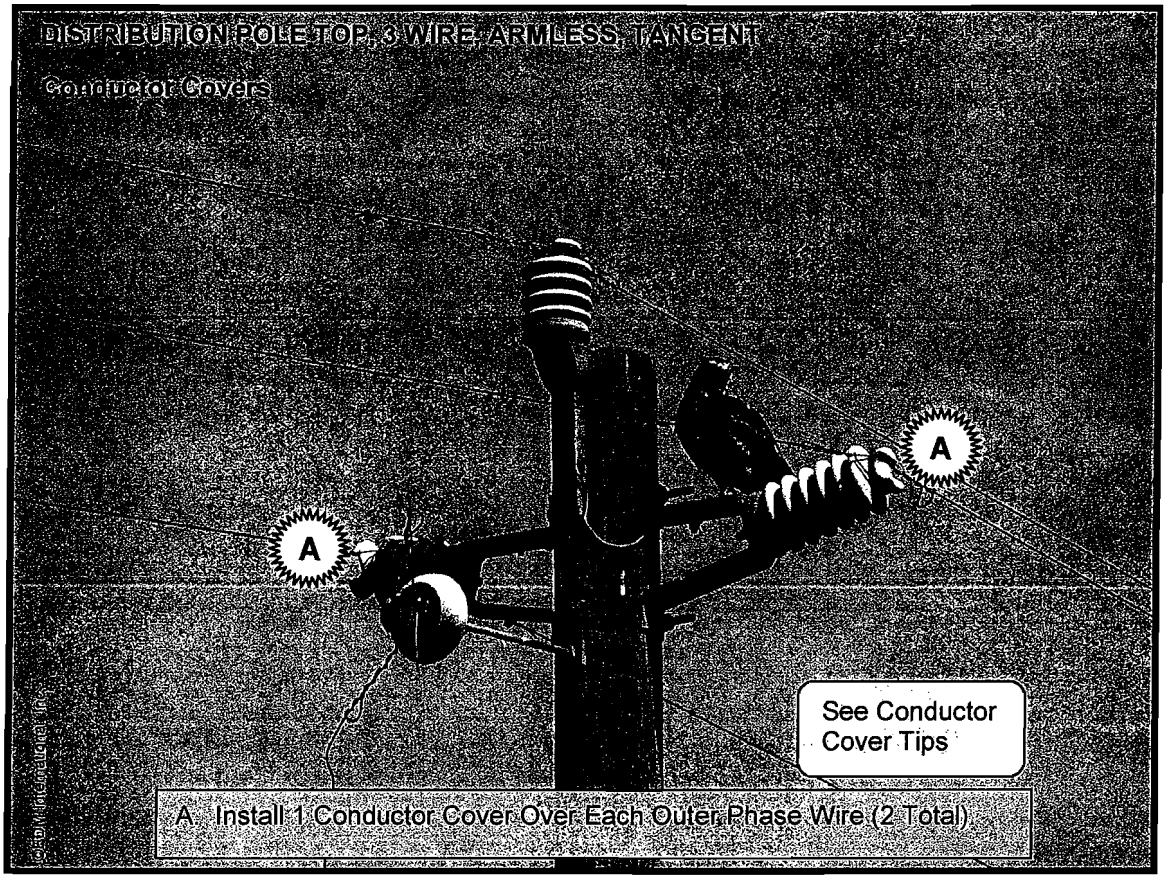


Figure 18 Retrofit for C1 NP without Neutral

9.3.6 Three-phase 4-wire Single-crossarm Triangular Tangent Structures

The structure referred to as "C1" in the field data spreadsheet is seldom used in the TID service area. The structure provides adequate line separation for most perching raptors, but does pose risk to eagles.

Retrofit option 1 (Figure 19) is recommended in areas of favorable habitat when eagles perch on the structure infrequently, or when alternate perches are available in the area.

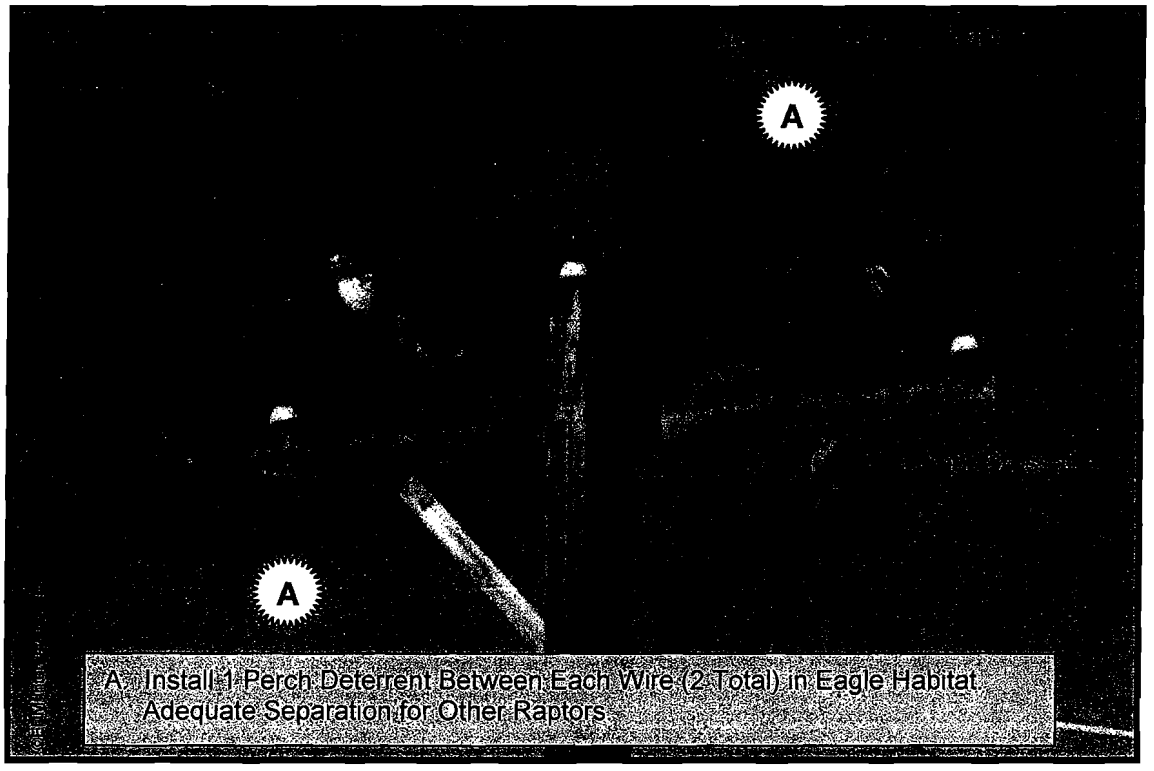


Figure 19 Option 1 Retrofit for C1

Retrofit option 2 (Figure 20) is preferred when the structure is frequently used as a perch by eagles, or when no alternate perches are nearby. This retrofit option should be given consideration when the structure is near an active eagle nest, or adjacent to a hunting area preferred by eagles. Note that when the line angles downward or up ward significantly on either side of the crossarm, conductor covers will not fit. In these cases, retrofit option 1 should be used

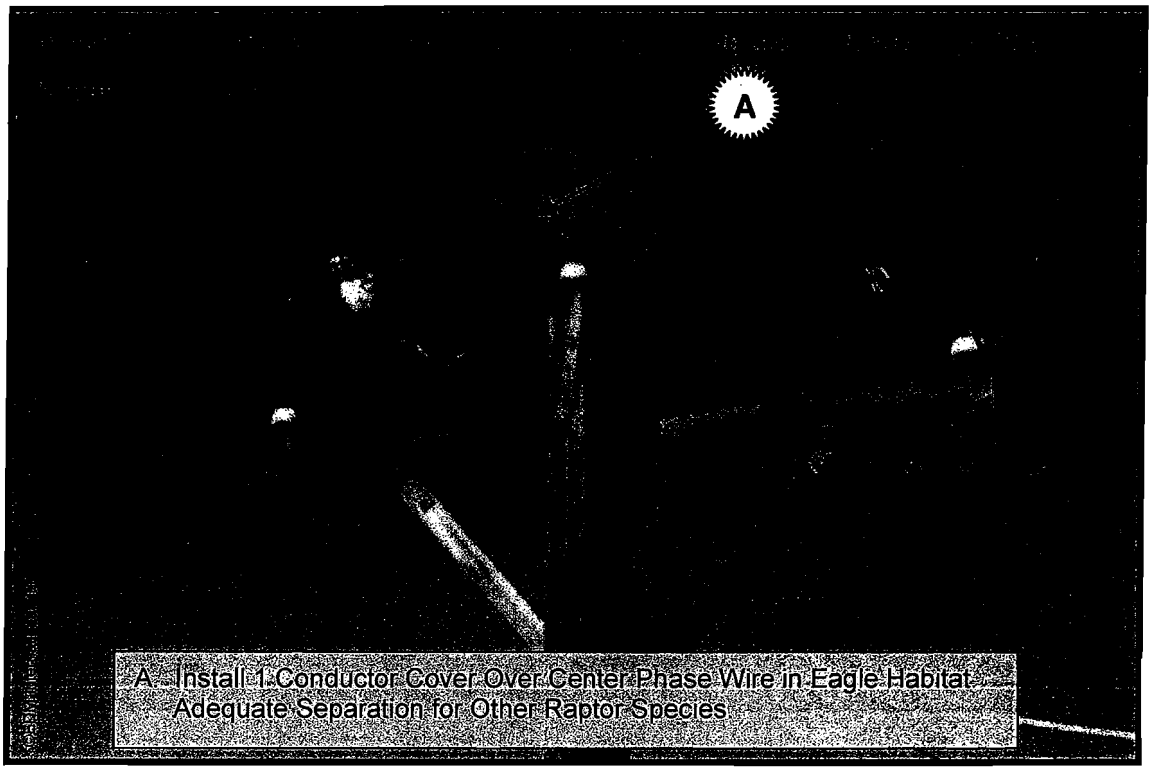


Figure 20 Retrofit Option 2 for C1

Retrofit option 3 (Figure 21) is recommended for new construction in eagle habitat. Dropping the crossarm on the pole provides the the 60 inches of separation required by eagles.

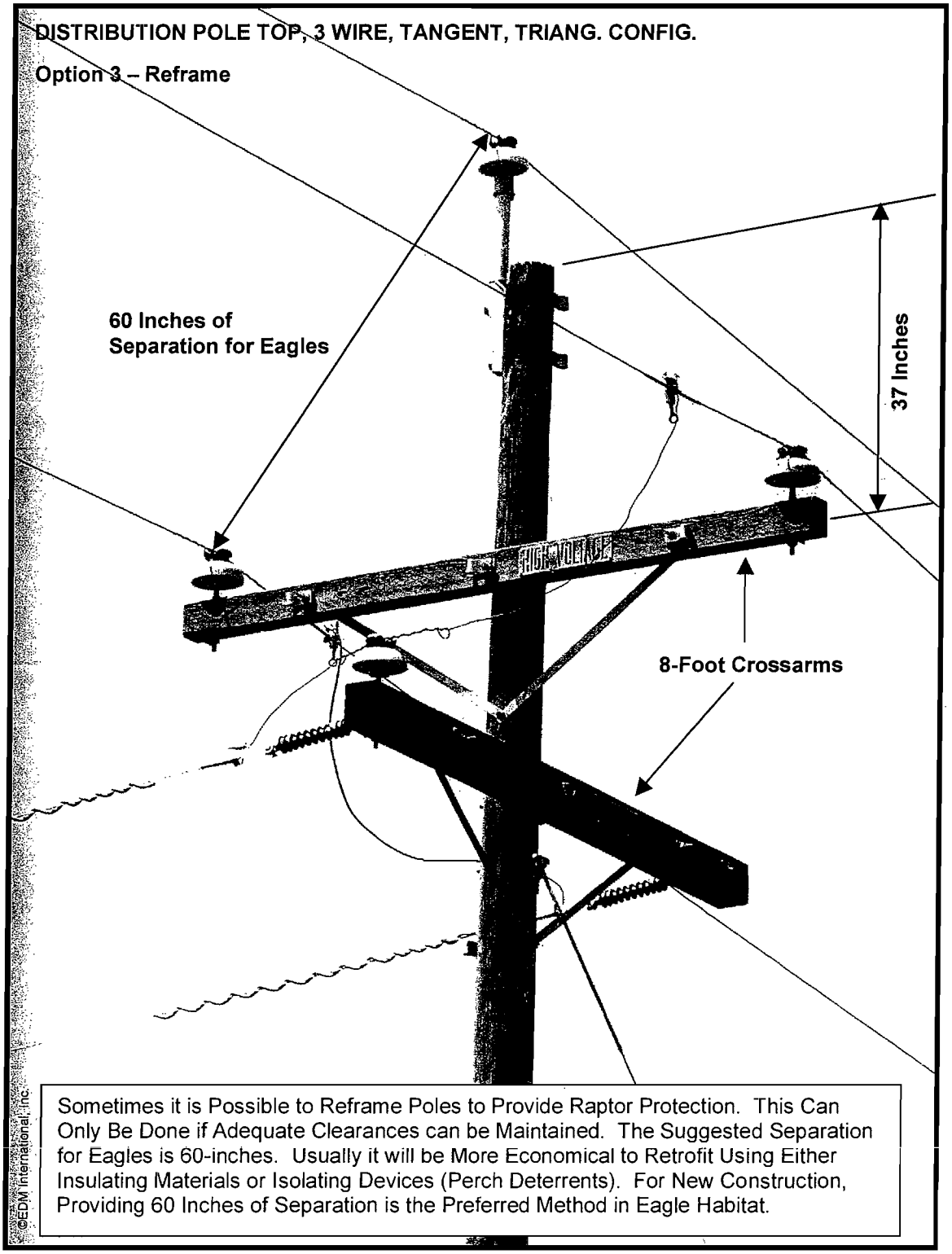


Figure 21 Retrofit Option 3 for C1

9.3.7 Three-phase 4-wire Double-crossarm Triangular Tangent Structures

The structure referred to as "C2" in the field data spreadsheet is not frequently used in the TID service area. The structure is similar to C1 and poses similar risks to larger birds. The key difference in retrofitting this structure is that the double crossarm requires twice the number of perch guards.

Retrofit option 1 (Figure 22) is recommended in areas of favorable habitat when eagles perch on the structure infrequently, or when alternate perches are available in the area.

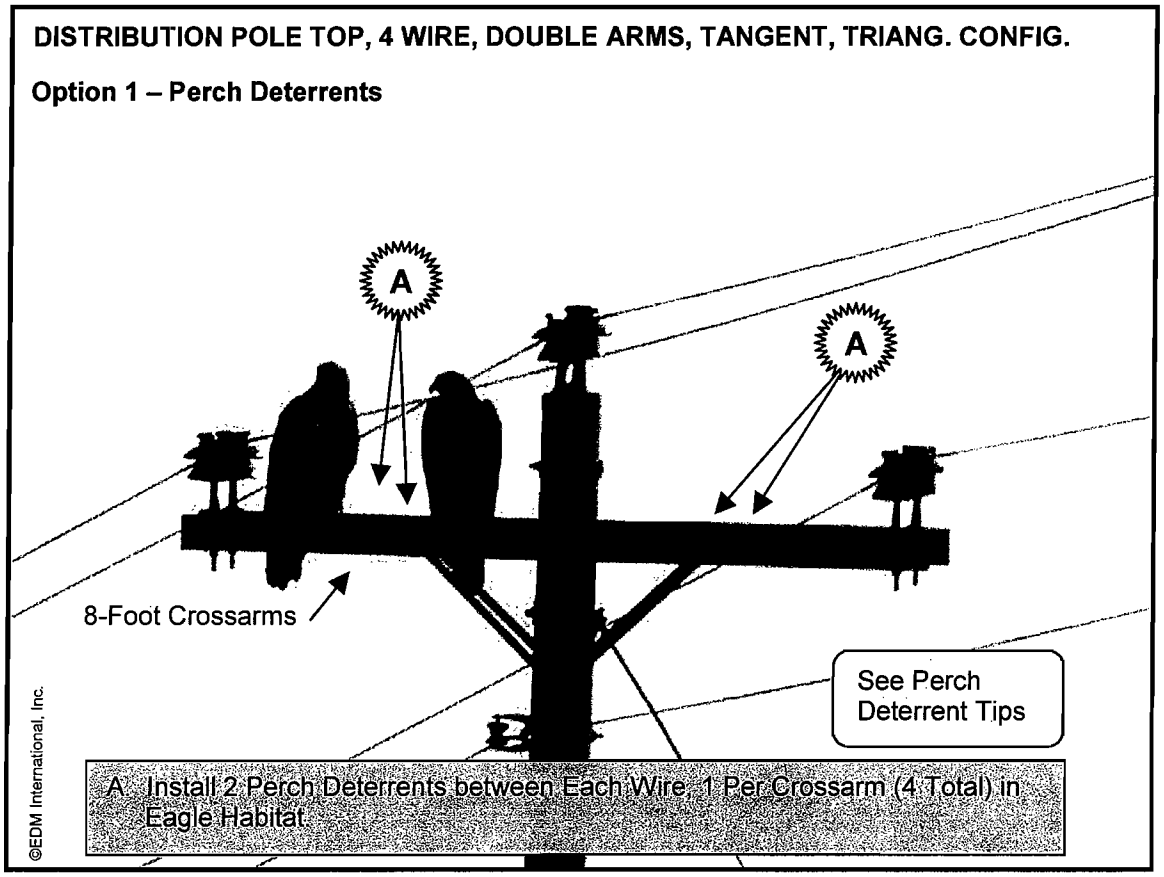


Figure 22 Retrofit Option 1 for C2

Retrofit option 2 (Figure 23) is preferred when the structure is frequently used as a perch by eagles, or when no alternate perches are nearby. This retrofit option should be given consideration when the structure is near an active eagle nest, or adjacent to a hunting area preferred by eagles. Note that when the line angles downward or up ward significantly on either side of the crossarm, conductor covers will not fit. In these cases, retrofit option 1 should be used

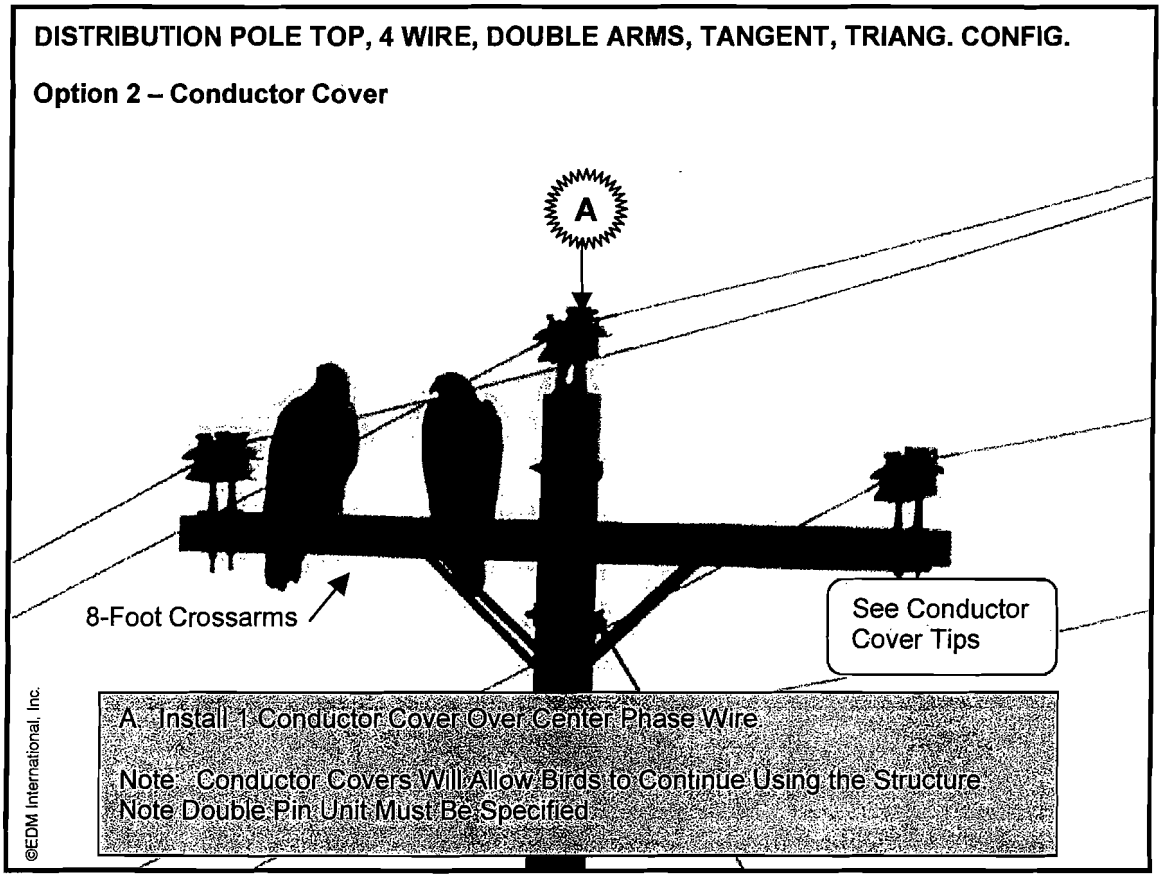


Figure 23 Retrofit Option 2 for C2

9.3.8 Three-phase 3-wire Deadend Structure

The structure referred to as "C7 w/o N" in the field data spreadsheet is very commonly used in the TID service area. A similar structure with a single crossarm is also common. Deadend structures are often preferred as perches because they offer easy access to the crossarm, and because they are often located some distance from roads and other areas human activity.

Retrofit option 1 (Figure 24) is recommended in areas of favorable habitat when birds perch on the structure infrequently, or when alternate perches are available in the area.

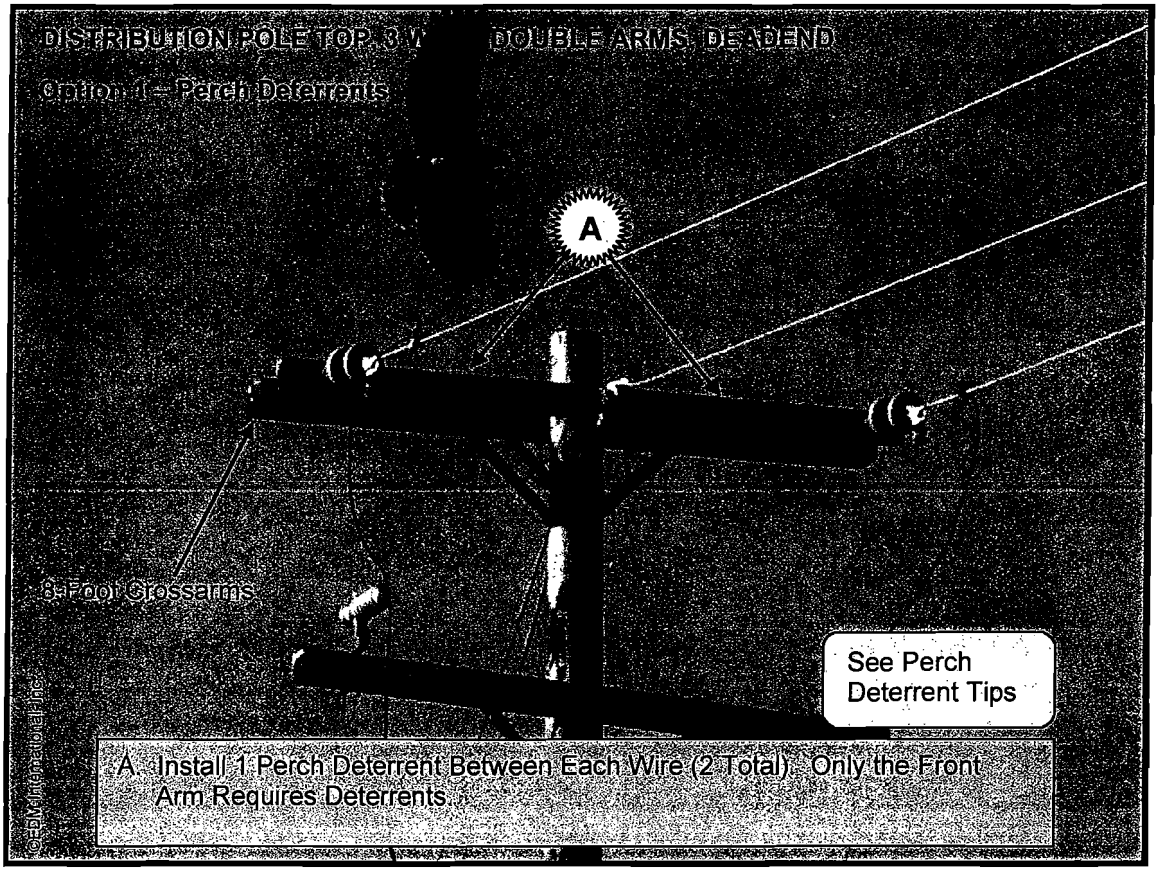


Figure 24 Retrofit Option 1 for C7 without Neutral

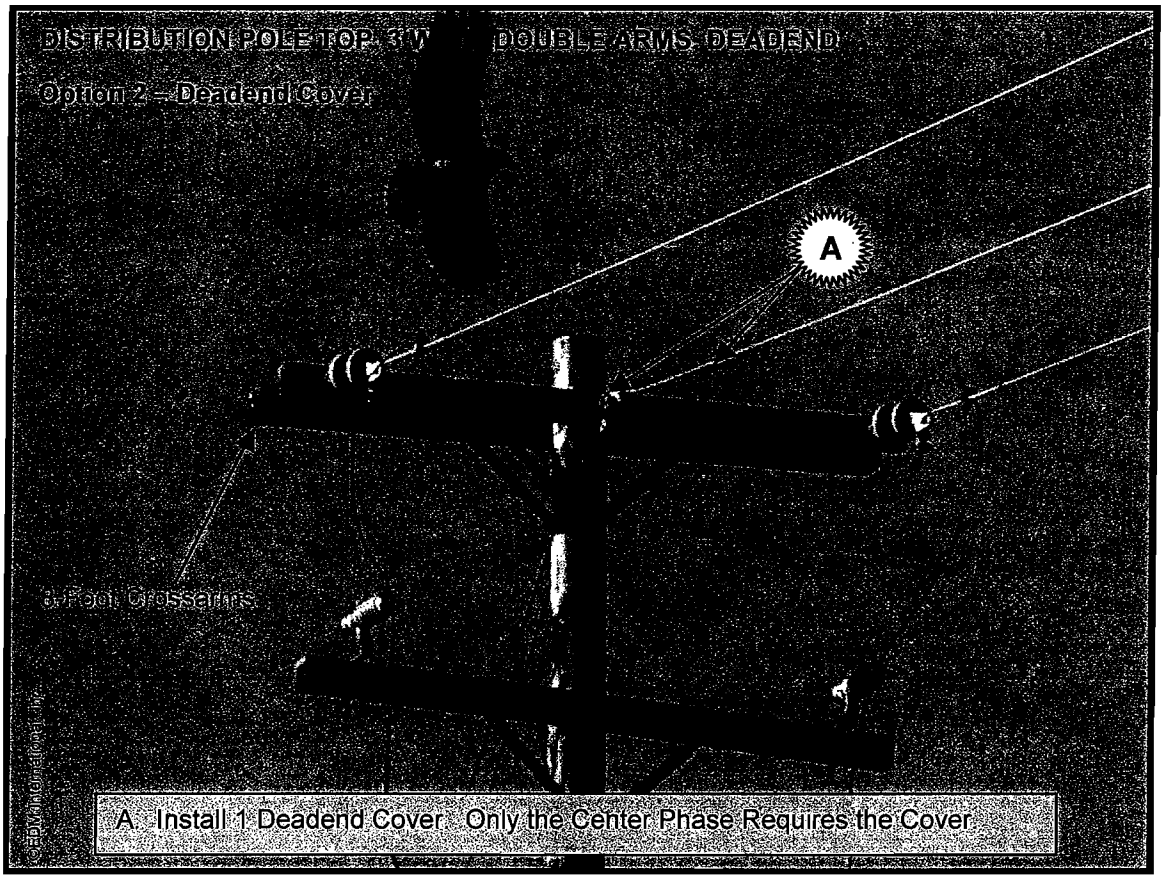


Figure 25 Retrofit Option 2 for C7 without Neutral

Retrofit option 2 (Figure 25) is recommended in areas of favorable habitat when birds perch on the structure frequently, or when no alternate perches are available in the area. This retrofit option should be given consideration when the structure is near an active nest, or adjacent to a preferred hunting area.

9.3.9 Three-phase 3-wire Double-deadend Structure

This structure is referred to as "C8 w/o N" in the field data spreadsheet.

Retrofit option 1 (Figure 26) is recommended in areas of favorable habitat when birds perch on the structure infrequently, or when alternate perches are available in the area.

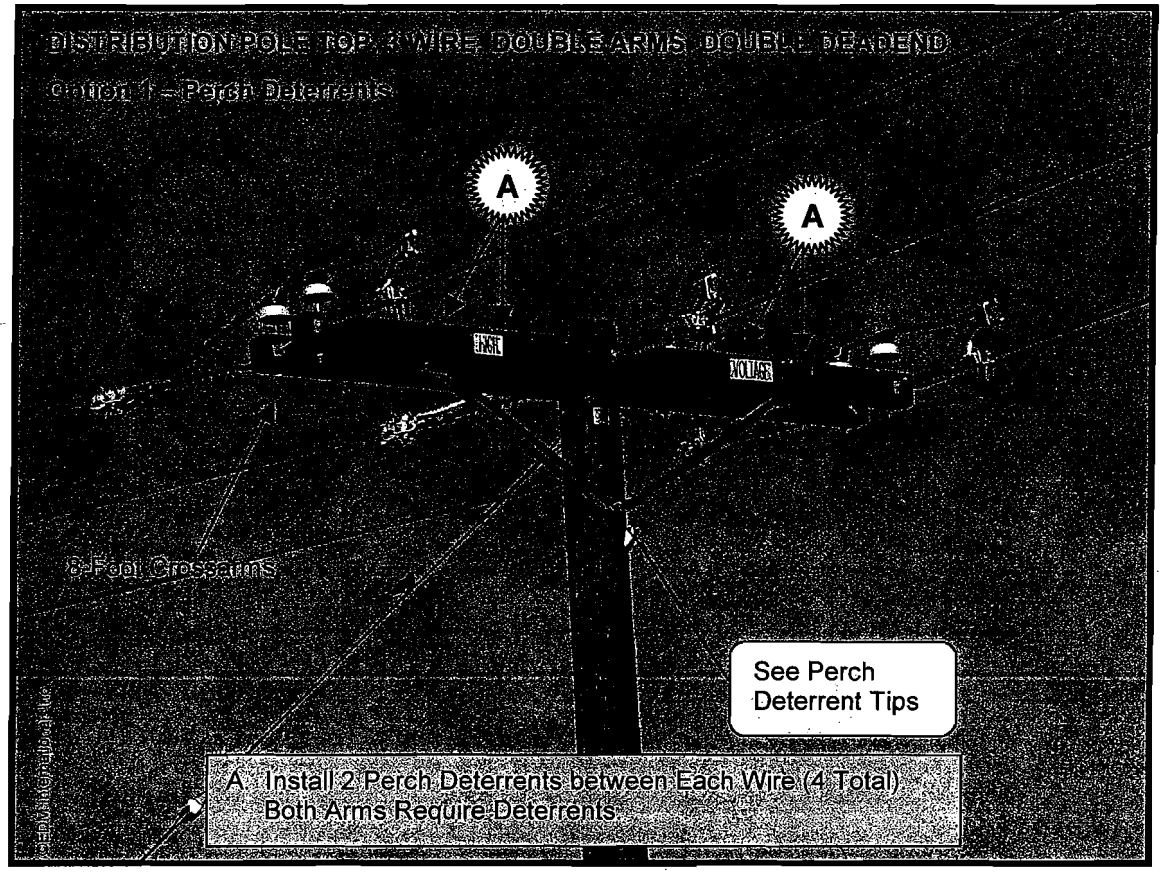


Figure 26 Retrofit Option 1 for C8 without Neutral

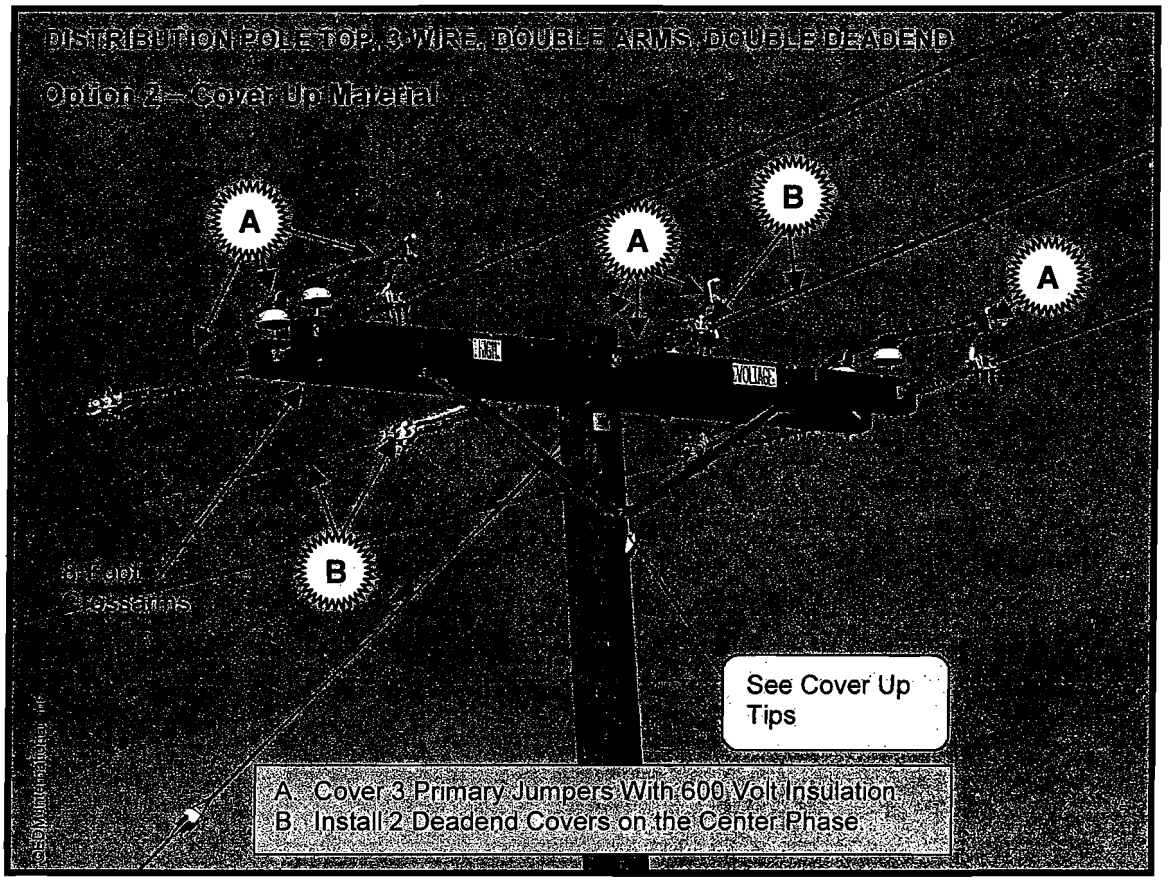


Figure 27 Retrofit Option 2 for C8 without Neutral

Retrofit option 2 (Figure 27) is recommended in areas of favorable habitat when birds perch on the structure frequently, or when no alternate perches are available in the area. This retrofit option should be given consideration when the structure is near an active nest, or adjacent to a preferred hunting area. The retrofit should avoid using metal tie-wraps on the crossarm pins, as they may build up an inductive charge. Insulated or plastic tie-wraps should be used to retrofit these structures.

9.3.10 Three-phase 3-wire Corner Structure

This structure uses two deadend units to turn the direction of the line. Such structures pose considerable risk to larger birds because of the easily accessible perching spots and the hazards posed by the primary jumpers.

Retrofit option 1 (Figure 28) is recommended in areas of favorable habitat when birds perch on the structure infrequently, or when alternate perches are available in the area.

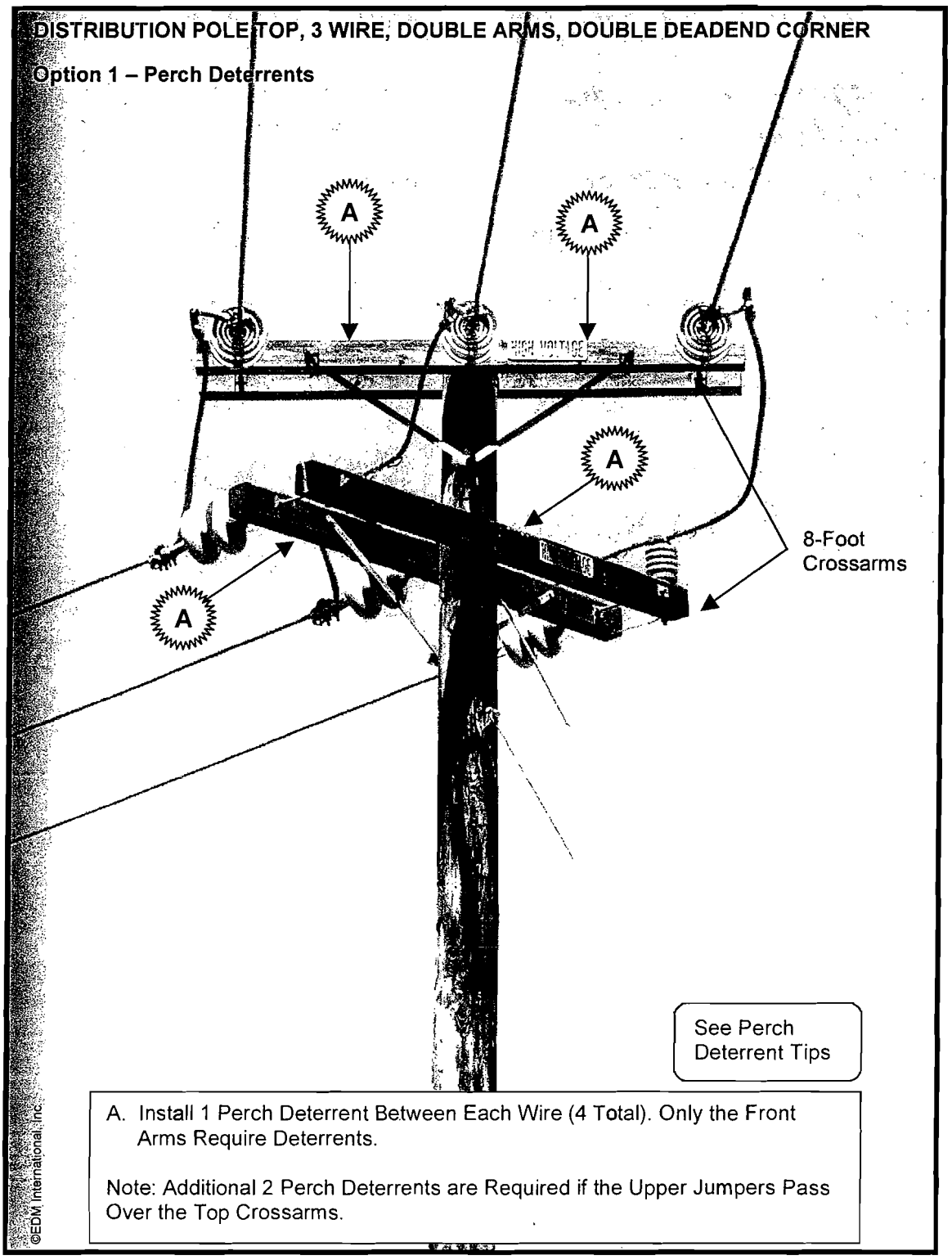


Figure 28 Retrofit Option 1 for C7/C7 Corner Structure (without Neutral)

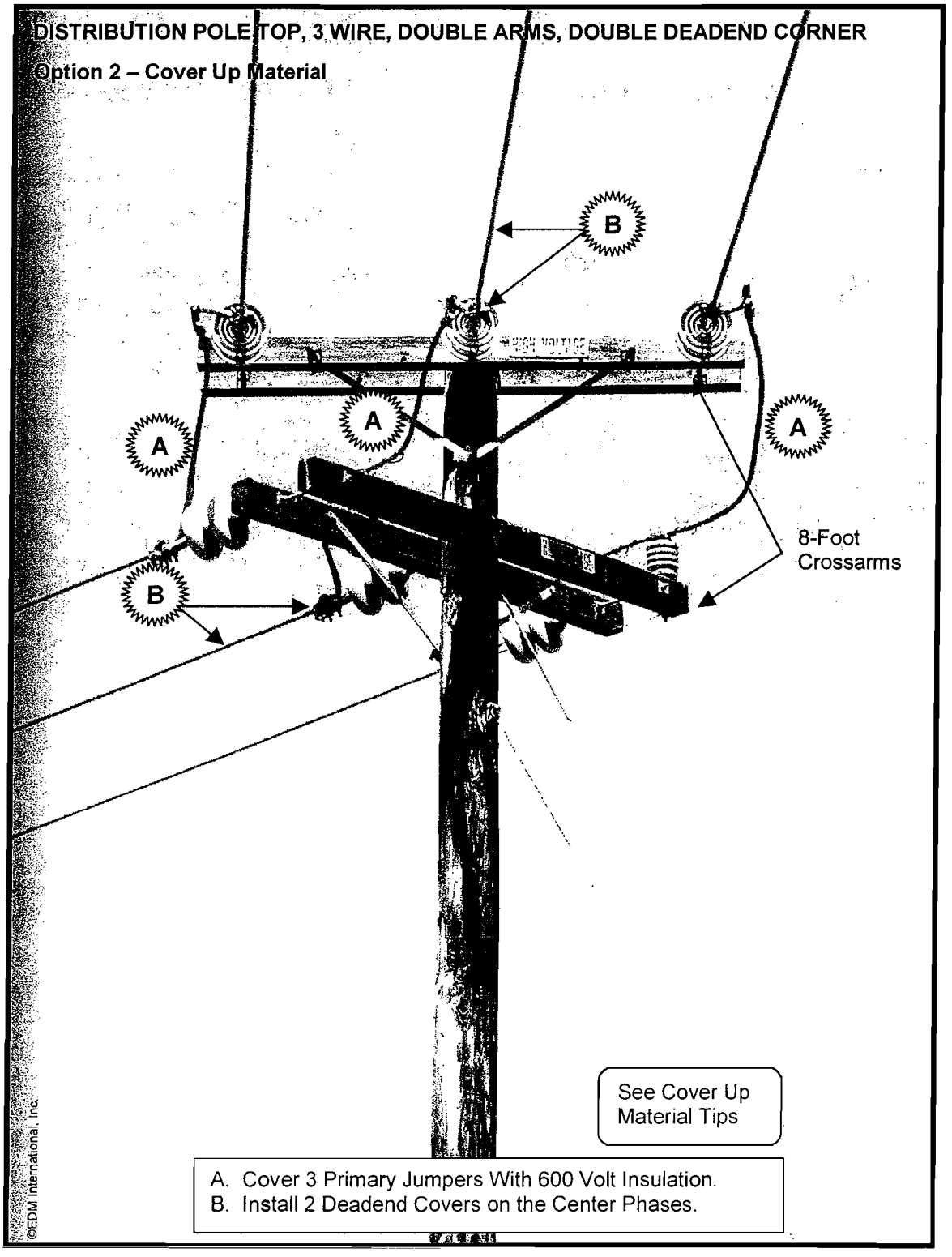


Figure 29 Retrofit Option 2 for C7/C7 Corner Structure (without Neutral)

Retrofit option 2 (Figure 29) is recommended in areas of favorable habitat when birds perch on the structure frequently, or when no alternate perches are available in the area. This retrofit option should be given consideration when the structure is near an

active nest, or adjacent to a preferred hunting area. The retrofit should avoid using metal tie-wraps on the crossarm pins, as they may build up an inductive charge. Plastic tie-wraps should be used.

9.3.11 Three-phase 3-wire Side Tap

This structure consists of a "C9-1 w/o N" and also a "C7 w/o N" crossarm unit which begins a tap off the main line. The risk presented by this structure includes the risks presented by the individual crossarm units, but has the added risk presented by the primary jumpers and their proximity to perching locations.

Retrofit option 1 (Figure 30) is recommended in areas of favorable habitat when birds perch on the structure infrequently, or when alternate perches are available in the area.

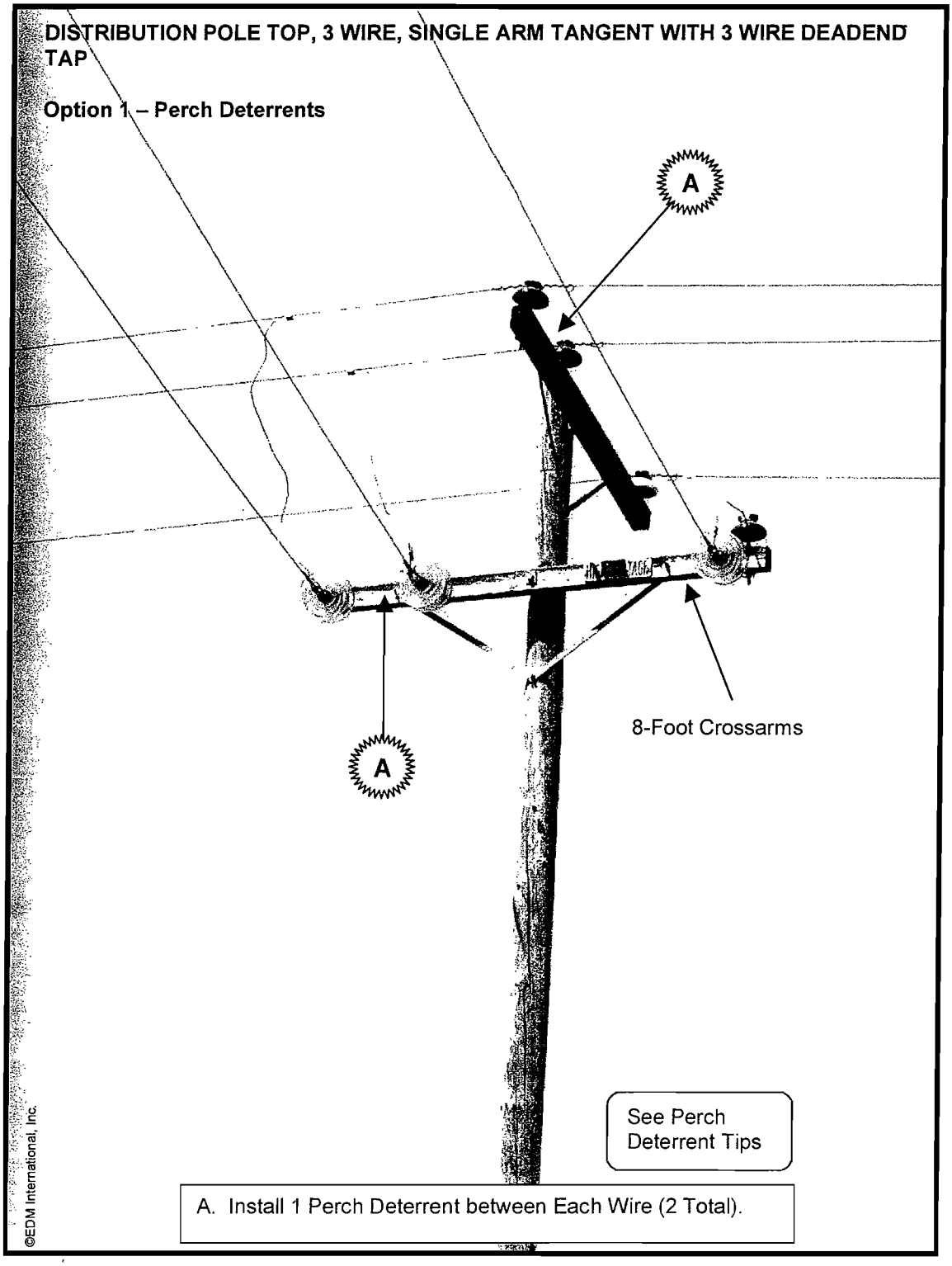


Figure 30 Retrofit Option 1

Retrofit option 2 (Figure 31) is recommended in areas of favorable habitat when birds perch on the structure frequently, or when no alternate perches are available in the area. This retrofit option should be given consideration when the structure is near an active nest, or adjacent to a preferred hunting area.

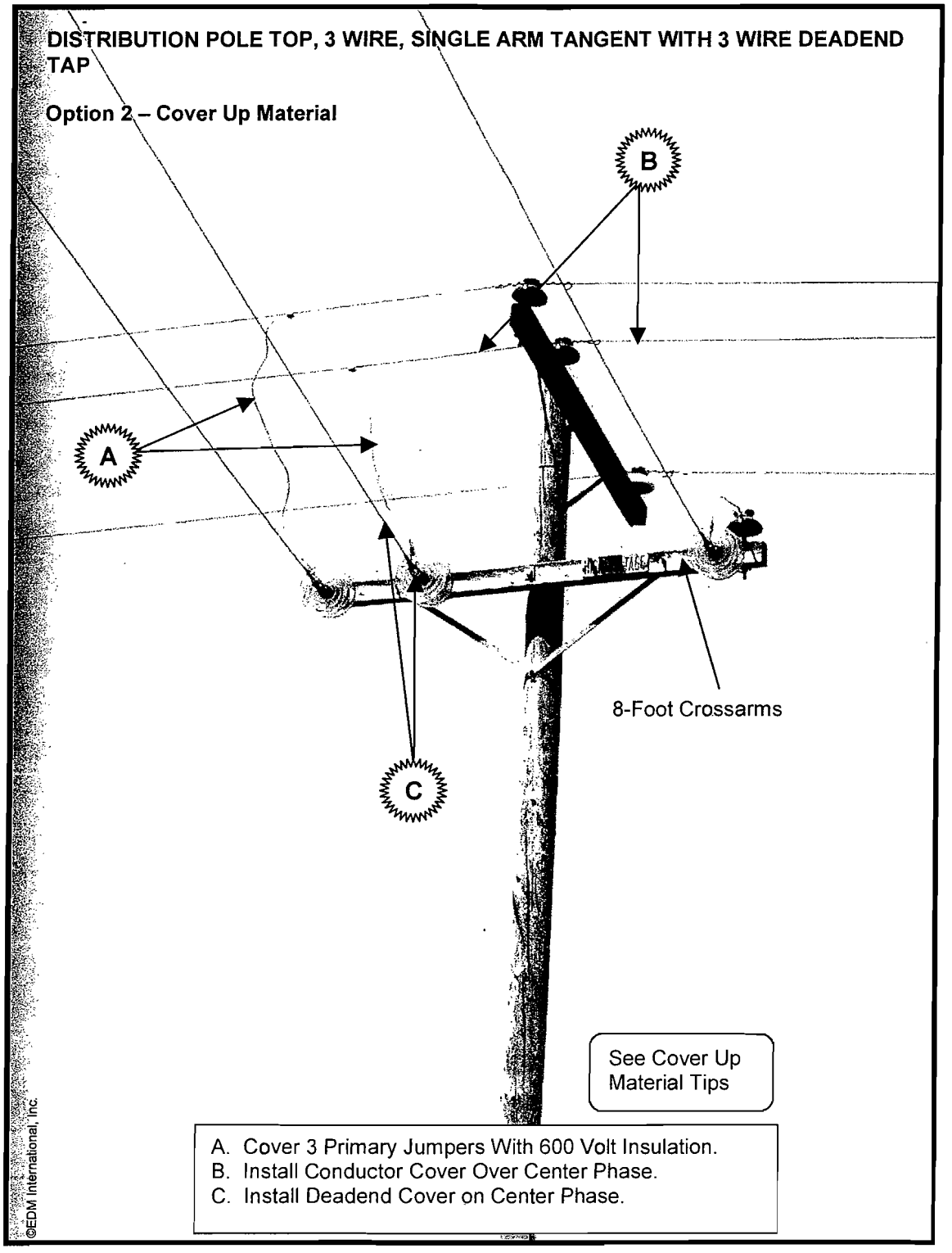


Figure 31 Retrofit Option 2

9.3.12 Dual-bushing Transformer

In the TID service area, dual-bushing transformers are used at residences and other locations receiving single-phase service. The cutout fuses are typically mounted on the transformer bushings (Figure 32). This equipment configuration is difficult to retrofit for wildlife protection because neither the cutouts nor bushings can be covered with products currently available. It recommended that the stinger wires to the cutouts be insulated to provide some protection.

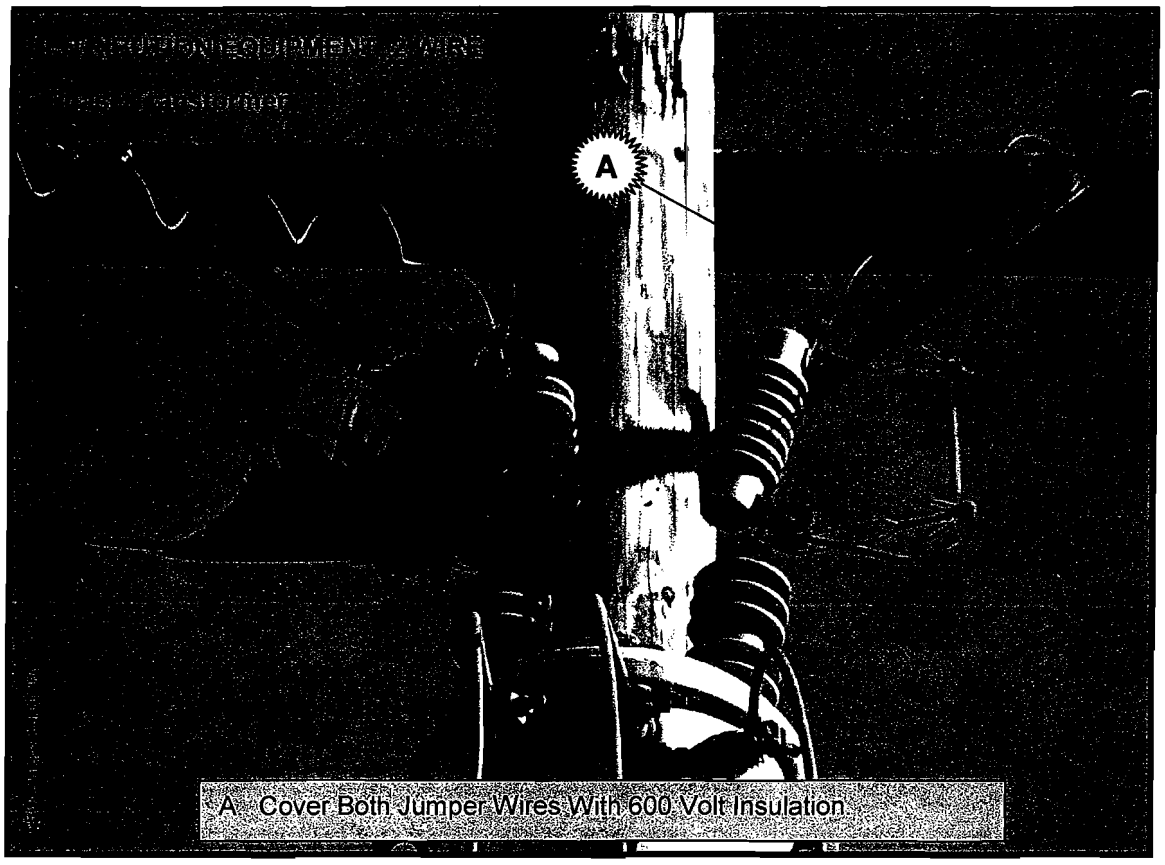


Figure 32 Retrofit for Two-phase Transformer

9.3.13 Three-phase Transformer Bank

Three-phase transformer banks on the TID system typically consist of three separate cans (each with two bushings) (Figure 33), or a single can with three bushings. The cans and brackets are not grounded, but all of the bushings are hot (delta system). These equipment poles pose considerable risk because of the number of exposed contact points.

The recommended retrofit for this equipment configuration calls for all bushings and jumpers to be covered.

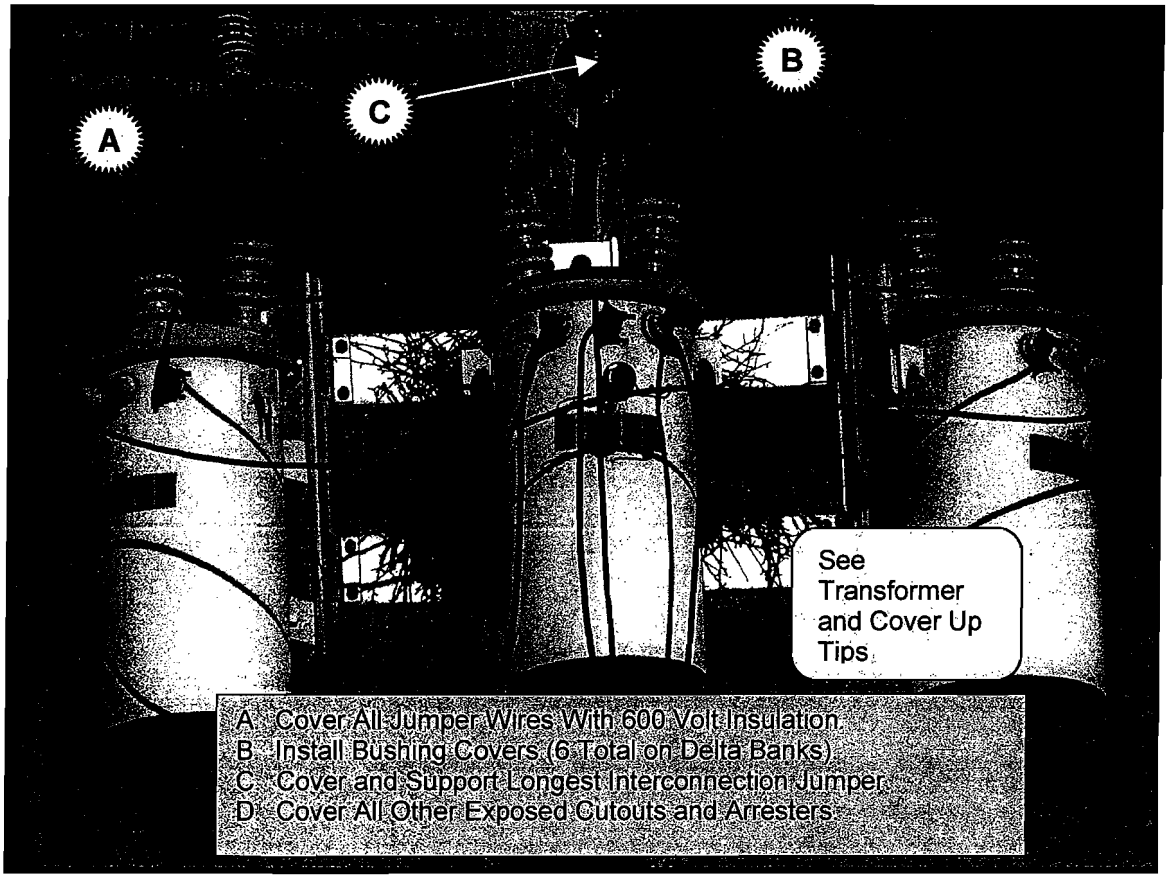


Figure 33 Retrofit for Three-phase Transformer Bank

9.3.14 Three-phase Riser

In the TID system, structures with three-phase risers typically come in two configurations: one with the potheads mounted on a crossarm (Figure 34), and one with potheads mounted under a crossarm (Figure 35). In both configurations, cutouts and lightning arresters are also present. The crossarm supporting the potheads is typically grounded, which poses a particular risk when the nearby contact points and jumpers are not covered.

The recommended retrofit in both cases involves covering the jumpers and connection points. When potheads are mounted below the crossarm, they do not pose a risk and need not be covered. If bolt splices are used to connect jumpers, they should be wrapped with fusing tape.

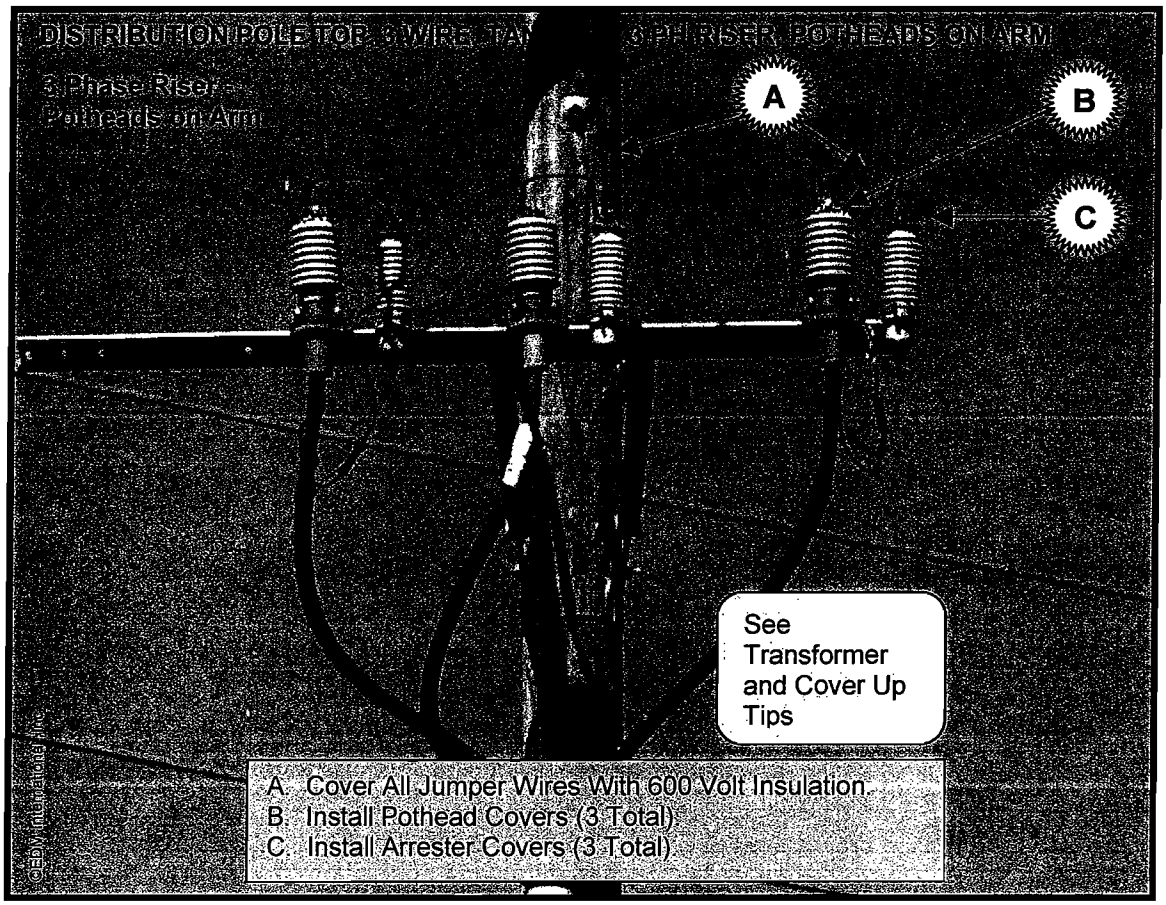


Figure 34 Retrofit for Three-phase Riser with Potheads on Arm

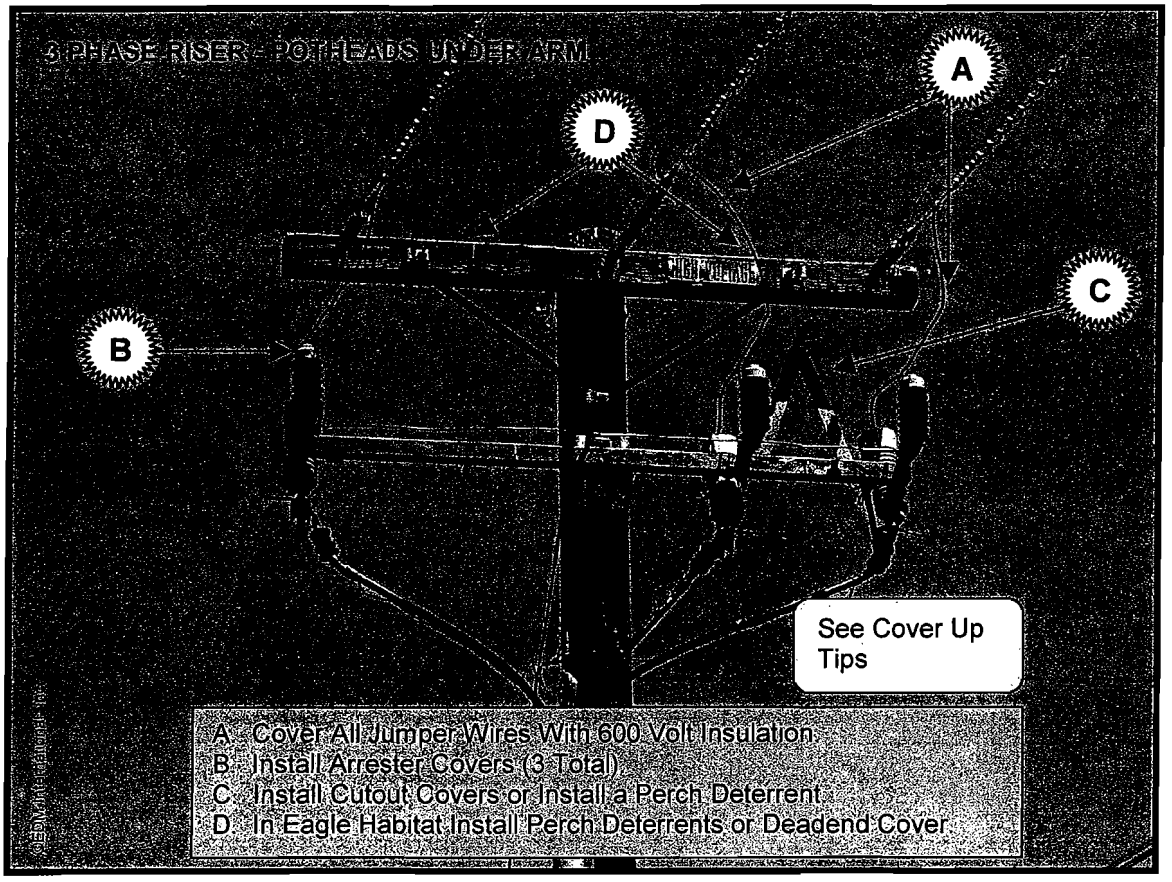


Figure 35 Retrofit for Three-phase Riser with Potheads Under Arm

9.3.15 Three-phase Recloser

Three-phase recloser banks can present significant electrocution risk because of the number of exposed jumpers and contact points.

The retrofit for three-phase reclosers should cover all jumpers and bushings.

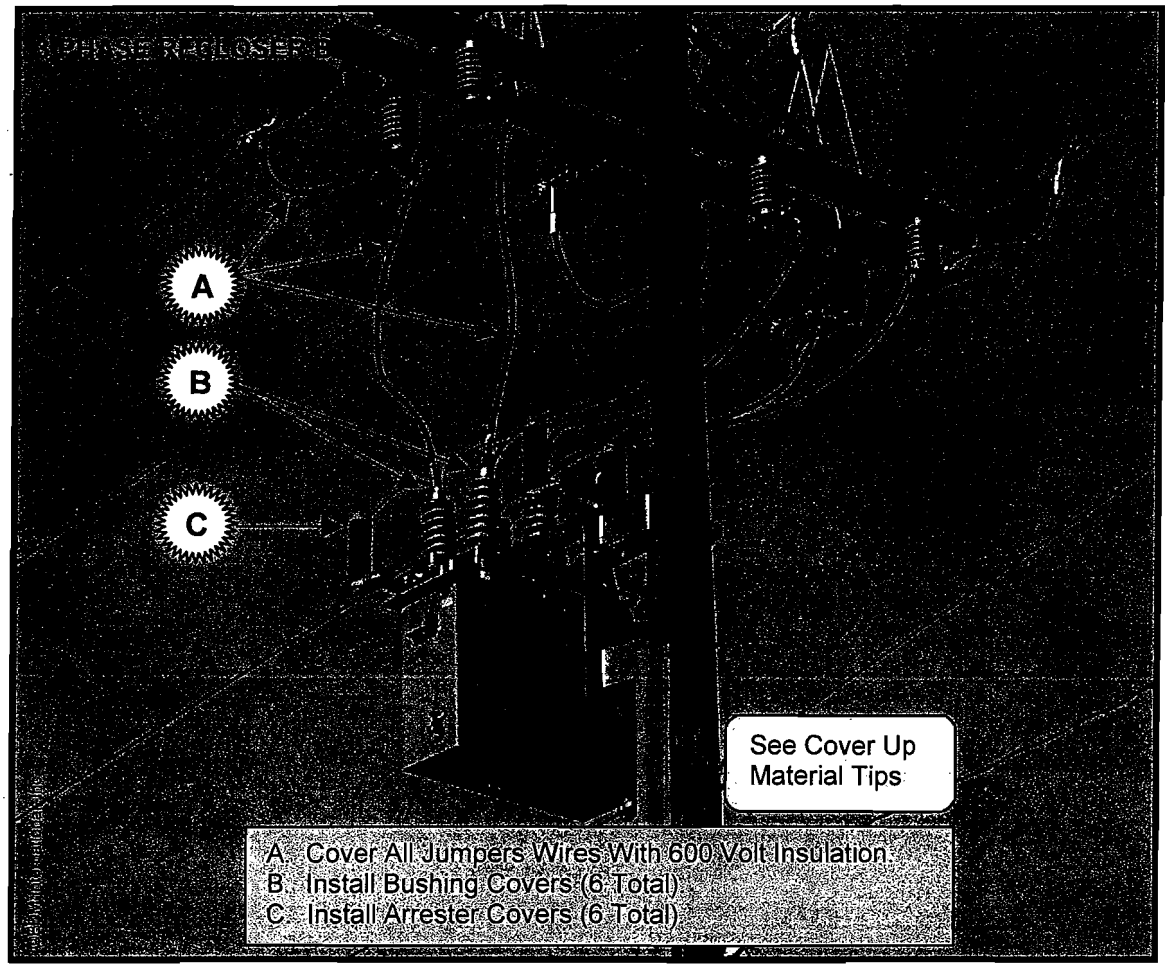


Figure 36 Retrofit for Three-phase Recloser

9.3.16 Three-phase Capacitor Bank

The three-phase capacitor banks observed on the TID system were typically already retrofitted. For those not already equipped with wildlife protection, the following retrofit (Figure 37) is recommended.

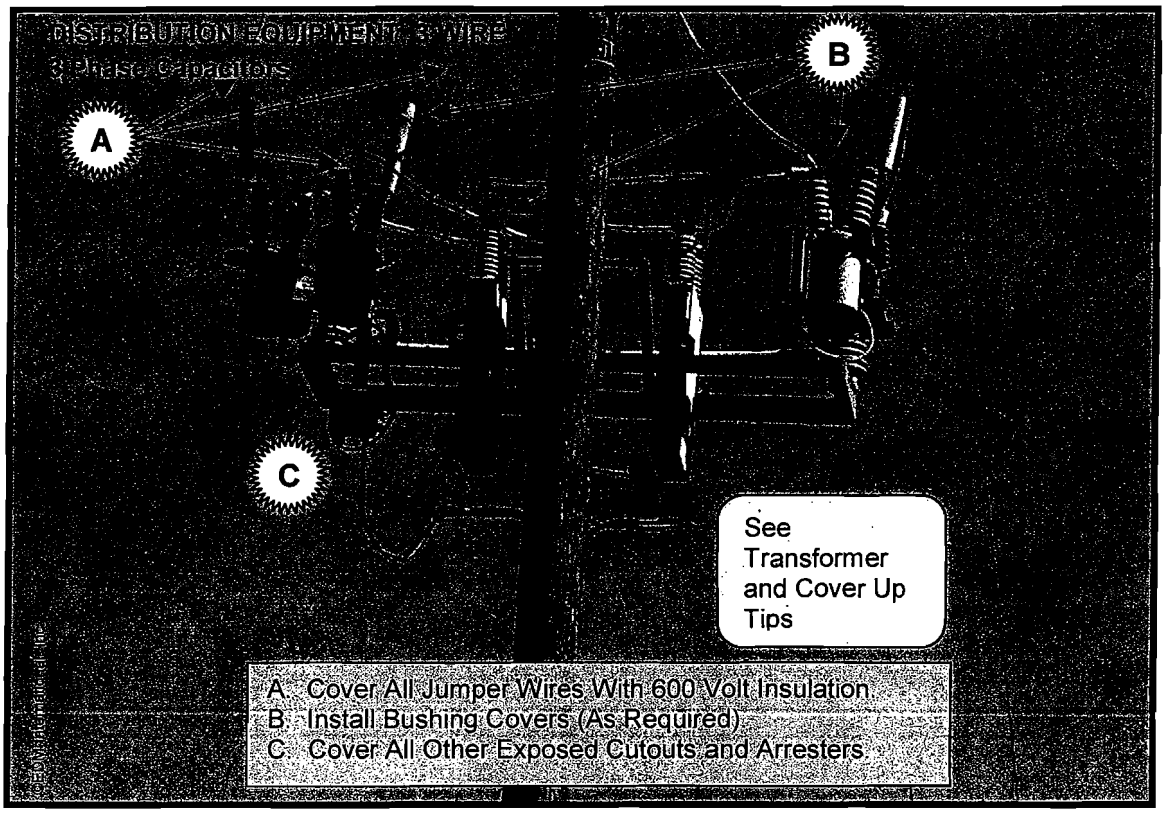


Figure 37 Retrofit for Three-phase Capacitor Bank

9.3.17 Cutouts and Arresters

On equipment poles in the TID system, cutouts are typically mounted on kicker arms. Kicker arms are frequently used as perches, particularly on hot days by raptors seeking a shaded perch.

Retrofit option 1 (Figure 38) is recommended when there are covers available for the cutouts.

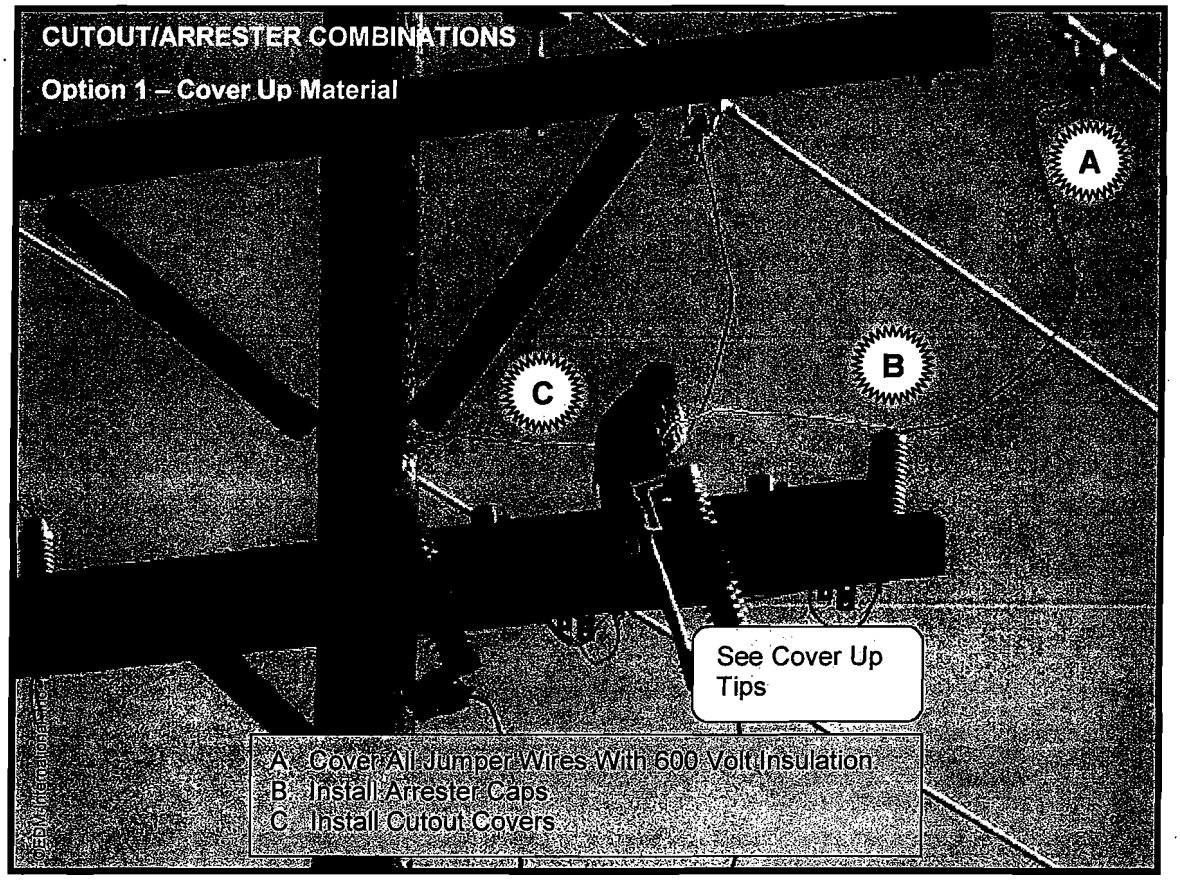


Figure 38 Retrofit Option 1 for Cutouts and Arresters

If the cutouts have 50-amp fuses (grasshopper type), there are no covers available to fit them. In this case, retrofit option 2 (Figure 39) is recommended. In place of cutout covers, a perch guard is installed between the cutouts.

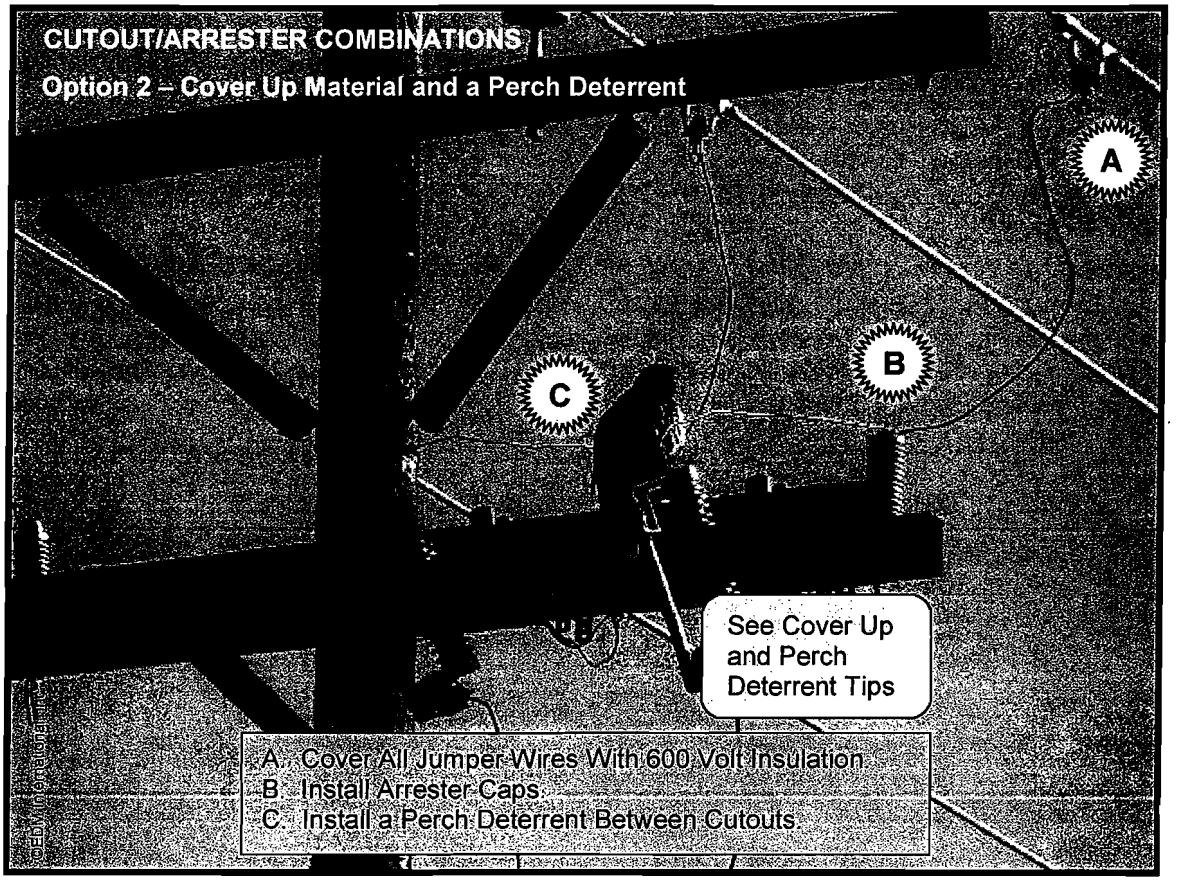


Figure 39 Retrofit Option 2 for Cutouts and Arresters

9.4 Comments on Surveyed Areas

9.4.1 Transmission Lines with Distribution Underbuild

At the time of our survey, a new transmission line was being constructed along west Harding Road (Photo 77). The distribution line underbuild units on these structures use a C9-1 configuration (4 wires on a single crossarm), which do not provide adequate separation for hawks found in the area. Completed transmission lines elsewhere in the TID system also included underbuild units with three or four wires (Photo 78). The distribution crossarms on these structures should be retrofitted as described in Section 8.4. Underbuild units with steel crossarms pose the highest risk to perching raptors.

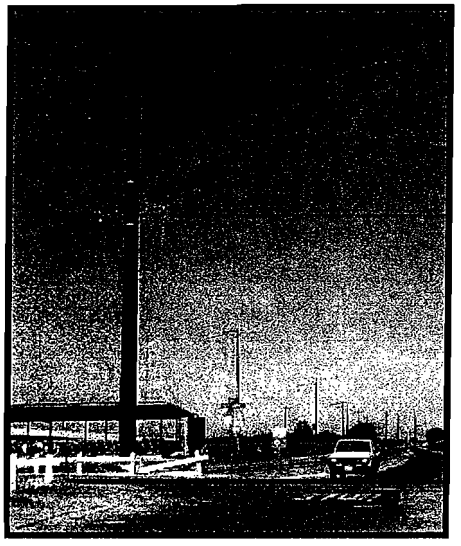


Photo 77 New Transmission Line with C9 Underbuild along Harding Road

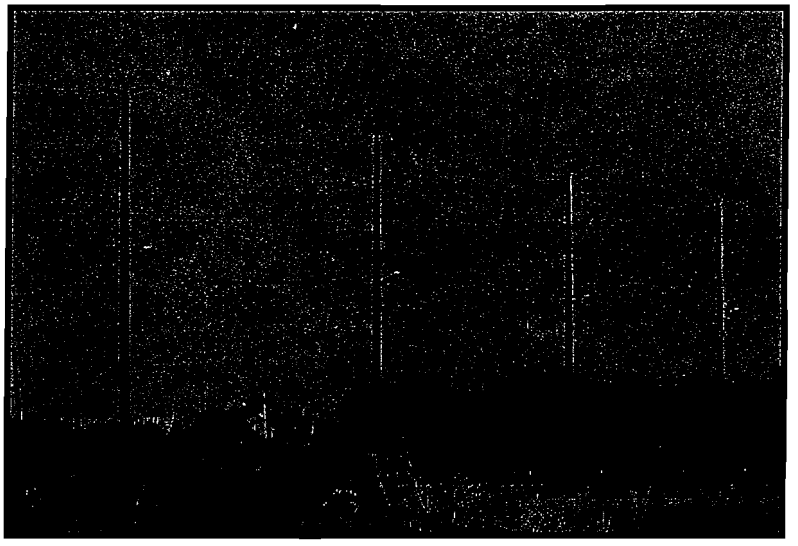


Photo 78 Completed Transmission Line with C9 Underbuild

9.4.2 Foothills / Oak Woodland Savanna Areas

The eastern and western extremes of the TID service territory lie within foothills / oak woodland savanna habitat (Photo 79). These areas are favored by turkey vultures, golden eagles, and other raptors. Retrofitting of structures in these areas should be done with consideration of eagle use.

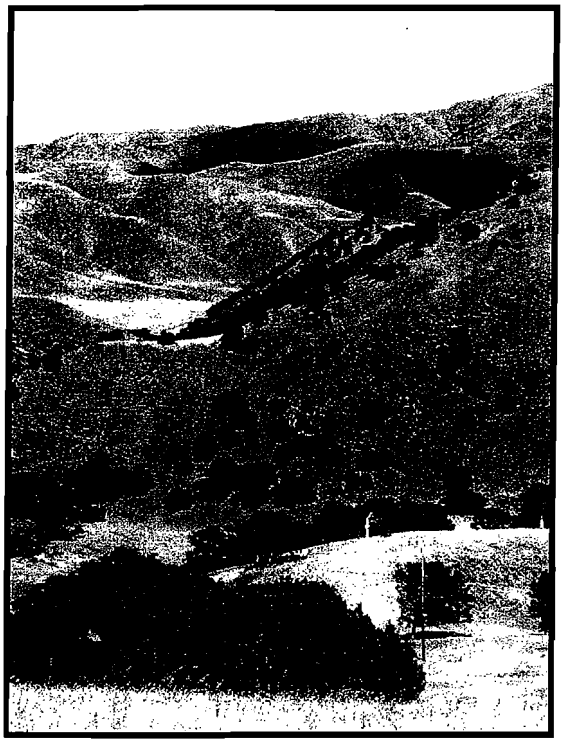


Photo 79 Foothills / Oak-Woodland Savanna

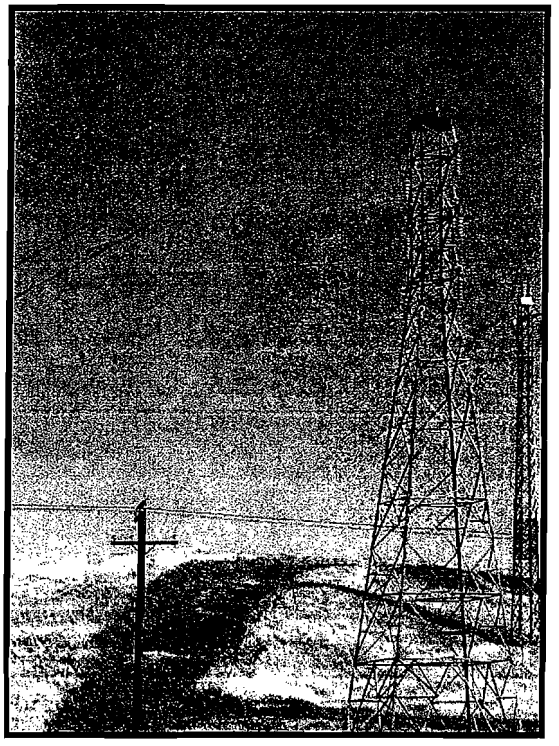


Photo 80 Osprey Nest at Dawson Lake

9.4.3 Don Pedro Reservoir / Dawson Lake / Turlock Lake

The larger reservoirs and lakes in the TID service area should be given special priority in the implementation of the Avian Protection Plan. Don Pedro Reservoir, Dawson Lake, and Turlock Lake are located in golden eagle habitat, and are in areas of concentration for wintering bald eagles. At least one nesting pair of bald eagles has been observed at Don Pedro reservoir. These areas host nesting osprey as well (Photo 80), and osprey were observed perching on distribution poles near their nests on adjacent transmission structures. Red-shouldered, Swainson's, and red-tailed hawks also frequent these areas, in addition to numerous waterfowl and wading birds. The retrofit alternatives chosen for these areas should be appropriate for eagles and for frequent perching.

9.4.4 Sewage Disposal Ponds

Sewage disposal ponds typically attract a variety of waterfowl and raptors. Distribution structures in such areas typically include three-phase transformer banks and riser poles. The sewage treatment ponds at west Zeering road (Photo 81) are particularly attractive to raptors because the ponds are surrounded by open grassy areas near the San Joaquin River. A number of Swainson's hawks, red-tailed hawks, and American crows were observed on the structures at this location. Red-tailed hawks were also observed on the lines adjacent to the Hughson percolation ponds. Lines in similar areas should be assigned a higher retrofit priority.

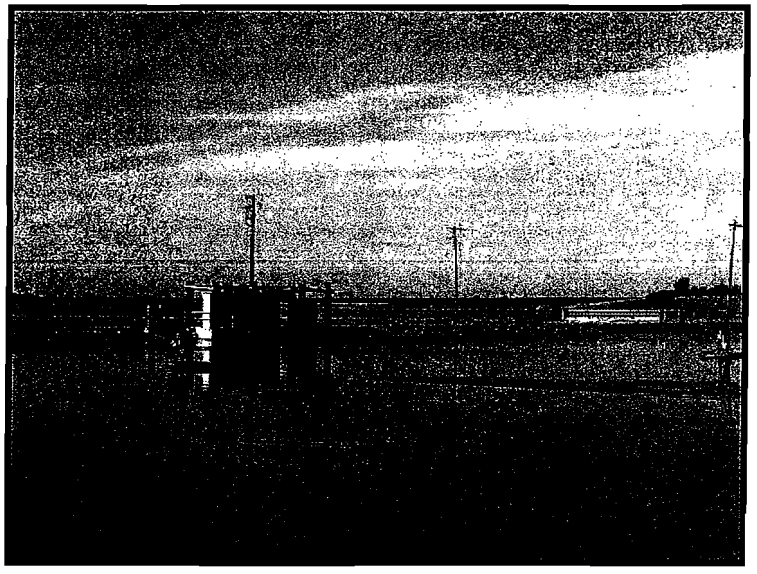


Photo 81 Sewage Disposal Ponds at Zeering Road

Photo 82 Pasture Near Hogin and August Roads

9.4.5 Pastures and Hay Fields

Pastures and hay fields (alfalfa, clover etc.) are favored hunting areas for hawks (Photo 82). The APP survey results presented here include structures in many such areas. Equipment poles in other areas of similar land use should also be assigned a higher retrofit priority.

9.4.6 Cattle Feeding Areas and Chicken Farms

Lines, structures, and equipment located in the vicinity of cattle feeding operations and chicken farms should be targeted for retrofit (Photo 83). These locations host large numbers of birds including American crows, brewer's blackbirds, European starlings, western kingbirds, rock pigeons, and house sparrows. Problems at cattle and chicken operations include electrocution on equipment poles, as well as line slap resulting from numerous birds perching on the line and taking off at the same time (Graham 2004). Line slap may be prevented by installing phase spacers. The Hughes Brothers CF800E 15kV mid-span phase spacer (Figure 40) features a fiberglass rod with polymer insulators. These spacers are available in several lengths and can be installed with hot sticks.

Photo 83 Crows Perched Near Cattle Yard

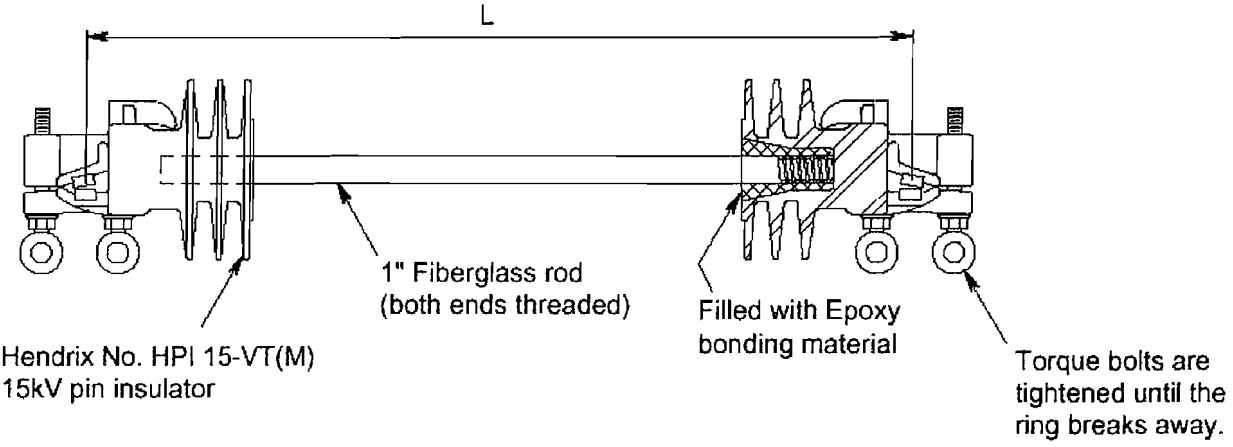


Figure 40 Hughes Brothers CF800E 15kV Mid-span Phase Spacer

9.4.7 Orchards with Nest Boxes

Orchards can provide favorable habitat for raptors, especially when they border open areas such as hay fields, grassy pastures, or ploughed fields (Photo 84). Barn owl nest boxes placed in orchard areas increase the likelihood that these large raptors will habitually use the area.

Orchards also typically have one or more structures with two-phase and three-phase transformer banks. Orchards with both owl nest boxes and unprotected transformer banks offer a high risk of electrocutions and resulting outages. Structures in orchards with nest boxes should therefore be slated for retrofit sooner rather than later.

Photo 84 Nest Box Near Equipment Pole with Two Barn Owl Fatalities

9.5 Comments on Transmission Outages

TID provided EDM with transmission line outage data for analysis and suggestions on what might be causing a large number of outages of unknown cause.

Figure 41 shows the number of outages by hour of occurrence and cause on the Don Pedro/Hawkins transmission line from 1990 through 2004. Figure 42 shows the number of outages by month of occurrence and cause. In both figures, causes are indicated by numbered code (see Figure 43).

The times of the outages associated with causes 15 ("other") and 16 ("unknown") are consistent with outages caused by streams of defecate ejected from birds perching on the structures (Photo 85). As they fall, long "streamers" can bridge phases and cause an outage that leaves little if any visible evidence.

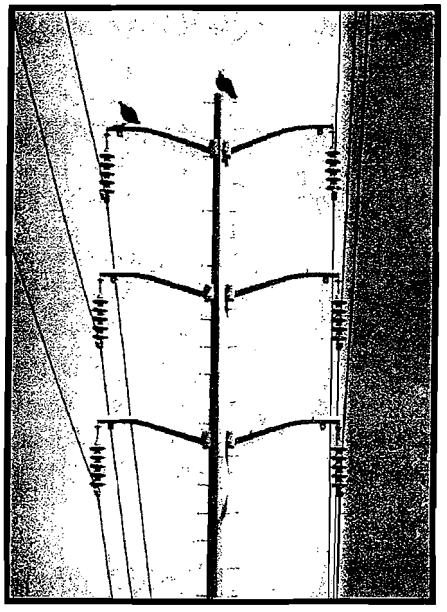


Photo 85 Turkey Vultures Perched on Transmission Line

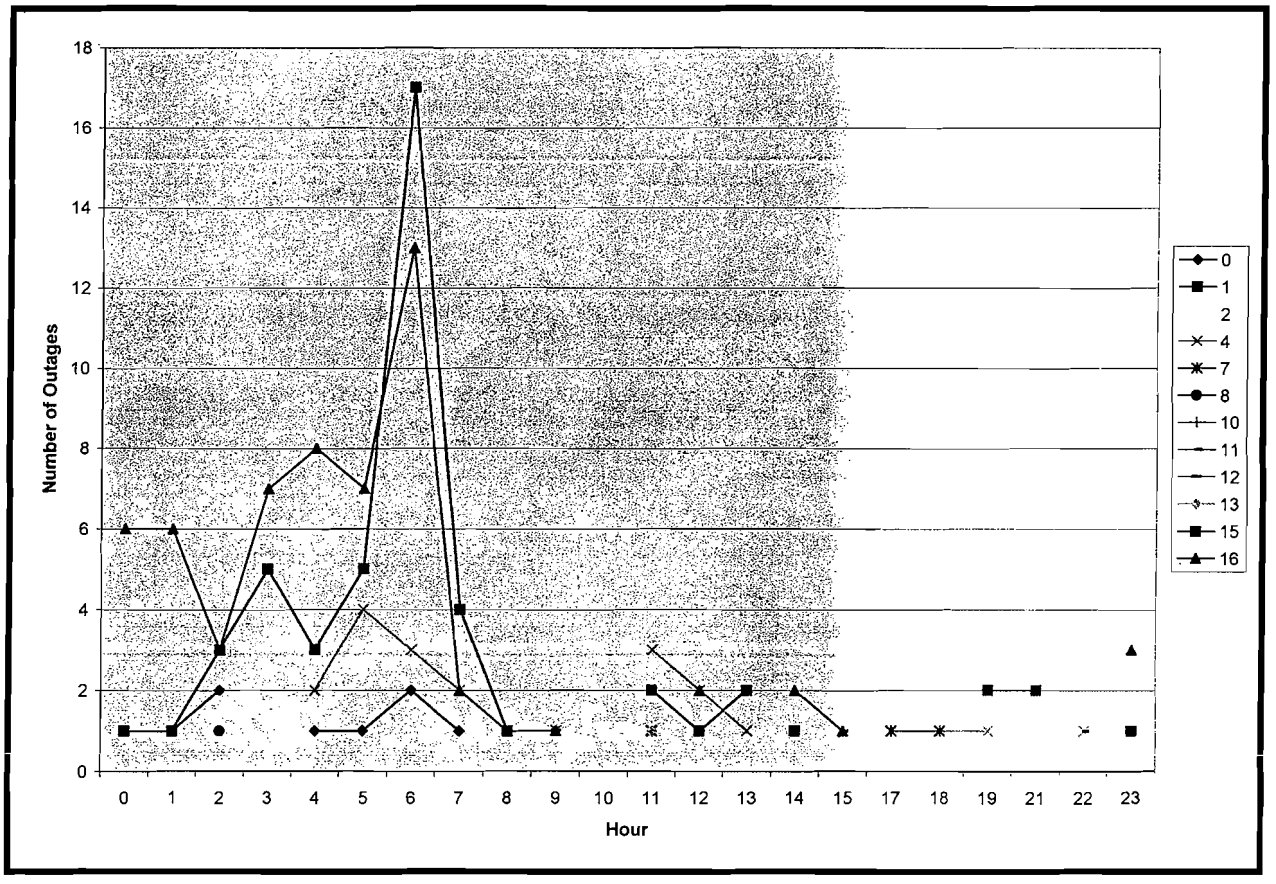


Figure 41 Number of Outages on Don Pedro/Hawkins Transmission Line by Hour of Occurrence and Cause, 1990–2004 (data supplied by TID)

The chart in Figure 41 illustrates that outages due to causes 15 and 16 have pronounced peaks between 5 a.m. and 7 a.m. This is the time of day that raptors would be waking up, defecating, and leaving their overnight roosting perches on the transmission structures. The chart in Figure 42 shows that outages due to causes 15 and 16 are much more numerous in the fall and winter. These are also seasons in which more raptors are migrating through or over-wintering in the TID area.

These observations are not sufficient to determine conclusively that streamers are causing many of these outages, but are enough to warrant further consideration.

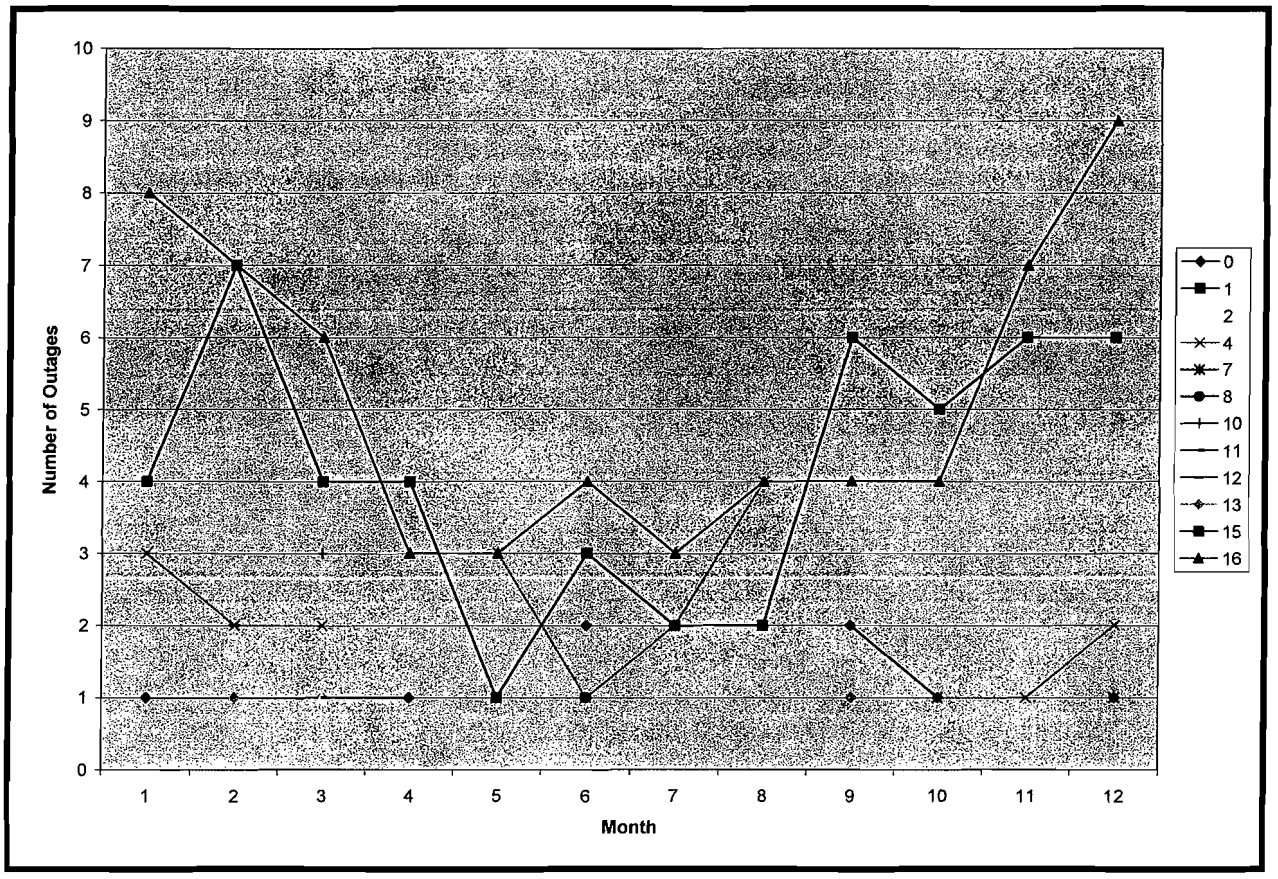


Figure 42 Number of Outages on Don Pedro/Hawkins Transmission Line by Month of Occurrence and Cause, 1990–2004 (data supplied by TID)

1	New Entry	9	Wire Down
2	Scheduled	10	Equipment Failure
3	Emergency	11	Lightning
4	Birds	12	Wind
5	Animals	13	Adverse Weather
6	Trees	14	Overload
7	Vehicle Altercation	15	Other
8	Foreign Interference	16	Unknown

Figure 43 Cause Codes for Don Pedro / Hawkins Outages

9.6 Long-term Considerations

As stated in Section 7.1, survey efforts focused on areas that coincide with bird use areas or high-quality habitat for area birds. These survey results have been described generally in Section 7.3 and are detailed in the data summary matrix in Appendix B. However, a number of pole configurations also occur in areas that may not have been surveyed but still present a risk to birds. Examples of this scenario include single-phase transformer units near residences, three-phase transformer units in agricultural fields, and closely spaced conductor configurations along ridgelines.

To address these concerns and aid in the E&OA's long-term planning program, additional general recommendations to implementing the APP for on-the-ground decisions would include the following:

- Equipment poles (e.g., transformers, risers) at remote locations, such as sites with irrigation pumps, stock tanks, etc. should be targeted with higher priority for retrofitting. Among these locations, highest priority should be given to those near hay fields or pasture areas, since these are more frequently used by raptors.

- Equipment poles (e.g., transformers, reclosers, regulators, capacitors, risers) and high-risk configurations (e.g., C9, C9-1, C8, C7/C7, C2-1) in and near burrowing mammal colonies or other terrestrial foraging areas should receive a higher priority ranking for retrofitting or raptor-safe construction.

- High-risk poles along the following landscape features also should receive a higher priority ranking:

  - Rivers
  - Streams
  - Wetlands
  - Reservoirs
  - Irrigation ditches
  - Ridgelines
  - Hills
  - Pastures and hay fields
  - Cattle yards and chicken operations

- If a pole shows significant signs of bird use (large amounts of whitewash, castings, prey remains), then that pole is considered a "preferred perch." It often is advantageous to maintain that pole as a perch site, to avoid pushing birds on to adjacent, potentially more lethal structures. For a preferred pole site, it is appropriate to install a conductor guard or an elevated perch on the pole, but ensure that perch guards are used beneath the perch to keep birds from perching on the crossarm beneath the elevated perch. Also, installing an elevated perch does not eliminate the need to protect equipment on the pole.

- Staff training is an integral part of an APP. Communications on how to best implement these recommended general and site-specific measures should be communicated to the applicable personnel, including managers, line supervisors, engineering, design, and field staff

- Training and communication may encompass activities such as permit compliance information, nest management, bird mortality reporting, and public interaction, depending on E&OA's future programs and emphasis.

9.7 Retrofit Alternatives

Retrofitting approaches to minimize the risk of bird electrocution typically involve either "isolating" or "insulating" potential contact points on a structure. Appendix B contains the spreadsheet detailing the complete results of the field survey. The retrofitting approaches and associated devices and materials outlined in this matrix were selected based upon effectiveness, ease of installation, and cost.

However, it is important to note that a number of alternatives can be used for mitigating electrocution risk on structures, as long as the basic concepts are followed. A wide variety of companies produce products toward this goal. These devices and materials and their associated manufacturing contacts are provided in Chapter 8.0.

Each of these products has advantages and disadvantages, and it is the individual utility's prerogative to decide which product they choose to install, implementing the guidelines or objectives outlined in Chapter 8.0. and Section 9.3. For example, when perch deterrents are recommended there are several types available. Figure 9 in Chapter 8.0 illustrates installation techniques for four different products. A utility also may choose to replace the proposed type of product recommended in the Data Matrix and select another, such as perch deterrents recommended for a tangent structure. A utility may choose to simply cover the center phase with a conductor guard manufactured by *Kaddas, Raychem, DMX*, or *Eco-Electrical* versus installation of perch deterrent devices on the crossarm. In summary, it may be more economical to install a more costly retrofit device, while minimizing labor installation costs.

Table 8 totals the minimum retrofit materials recommended for each priority level. It is important to note that the information presented in Appendix B is only representative of a portion of TID's service territory. Therefore, Table 8 lists the estimated **minimum** number of retrofit devices or materials recommended, since the risk assessment approach used for the development of this APP cannot be quantified.

Table 8 Estimated Minimum Amount of Retrofit Materials Recommended[1]

	Number of Entries (Poles)	Bushing Covers Normal	Bushing Covers w/ Knockout	Pothead Covers	Arrester Caps	Entries Requiring Insulated Jumpers[2]	Conductor Guards	Perch Guards[3]	Perch Deterrents[4]	Remove or Gap Ground[5]	Cutout Covers	Elevated Perches
Priority 1	77	175	0	14	18	64	68	43	0	3	99	0
Priority 2	274	622	0	40	41	212	12	161	0	0	227	4
Priority 3	131	430	0	15	14	119	0	47	0	0	171	4
Total	**482**	**1227**	**0**	**69**	**73**	**395**	**80**	**251**	**0**	**3**	**497**	**8**

[1] Estimates will be conservative due to the risk-assessment approach used

[2] Typically multiple jumpers or stingers per entry require cover-up material or insulation

[3] Triangles or similar perch guards

[4] Mission Engineering *Bird Guards* or Zena *Mini-Zena Perch Preventer*

[5] Pole-top grounds or grounded metal brackets

9.8 New Construction

As discussed in Chapter 8.0, it is recommended that new construction should include the following to minimize risks of avian electrocutions:

- All new equipment should be installed with bushing covers and covered jumpers.
- All arresters should be installed with factory ordered wildlife caps and installed with covered jumpers.
- Gapped arresters should continue to be retired.
- 60 inches of phase-to-phase and phase-to-neutral/ground separation should be provided in eagle habitat.
- 44 inches of phase-to-phase and phase-to-neutral/ground separation should be provided in habitats not typically occupied by eagles.
- Down guys should include insulating links to eliminate a potential path to earth, when needed.
- Pole-top grounds should be gapped or eliminated.
- Crossarm braces should be nonconducting wood.
- Nonconductive arrester/pothead brackets should be used instead of metal brackets, and their metal bases should not be grounded.
- Deadends should employ insulating links at the center phase.
- Primary jumpers with less than adequate separation for either eagles or hawks should be covered with a minimum of 600V-rated insulation.

When working on poles, extra materials such as wrap ties, jumpers, nuts, bolts, and broken insulators should be removed from the pole base and either disposed of or salvaged. Ravens and hawks often use shiny material (such as wire) in their nests. When these birds construct their nests on transmission or distribution poles the wires can lead to operational problems.

Installing new distribution lines underground in certain areas also can be a construction option to preventing electrocution risks to birds of prey. However, the costs to underground lines can be prohibitive and may pose maintenance issues that increase surface disturbance in the long term.

9.9 Monitoring and Reporting

A key component of any APP is treating potential electrocutions as an incident requiring prompt reporting. Despite these surveys and subsequent retrofitting, additional problems will likely arise. It is important to continue collecting detailed information on these events to direct future retrofitting efforts. It also is important to follow up on retrofitting measures to gauge their performance. When dead or injured birds are found, employees shall report them to the APP Coordinator, and an Avian Incident Report shall be completed. It is important to completely fill out the Report, because effective retrofitting requires detailed knowledge on both the devices contacted and the bird species affected. Contractors working on TID's system also should be informed of these procedures.

9.10 Conclusions

TID's system has a wide variety of structure configurations. Although the bird electrocution problem can be nearly eliminated by retrofitting every dangerous structure on a system, this is not cost effective. In addition, since most electrocutions concentrate on a small percentage of structures, a "preferred-structure" approach allows a quicker and more economical elimination of the problem. This approach targets structures with inadequate separation in habitats and terrains preferred by large birds of prey. This report takes the "preferred-structure" approach and, by accepting the report's recommendations, the number of raptor electrocutions will decrease. New construction practices also must incorporate bird-friendly standards to prevent future electrocution problems. The combination of retrofitting "hot spots" and new bird-friendly construction will greatly reduce costly outages while improving service reliability.

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11.0 - APPENDIX A

E&OA Avian Incident Procedure
E&OA Nest Management Procedure
E&OA Avian Incident Report

ENGINEERING & OPERATIONS ADMINISTRATION

AVIAN PROTECTION PLAN

AVIAN INCIDENT PROCEDURE

Purpose: The purpose of this procedure is to identify the E&OA Employee actions necessary to comply with the Avian Protection Plan (APP) when an Avian Incident has occurred and is discovered by an E&OA Employee.

Performed by:	Action:
District Employee	1) Discovers a bird injured or killed at a TID facility.
	2) Contact the APP Coordinator.
	3) If the bird is only injured, contact Stanislaus Animal Services at 209.558.7387. Declare an emergency and ask for an immediate response, if the bird is alive and in an area where it may cause injury to you or it may further its own injuries. **DO NOT TAKE POSSESSION OF OR TRANSPORT THE BIRD IN ANY DISTRICT VEHICLE OR EQUIPMENT.**
	4) When it is safe, go to Step 7.
	5) If the bird is dead, and if it is necessary to move the carcass, don appropriate personal protective equipment and move the carcass to an adjacent location that will not interfere with the work. **DO NOT TAKE POSSESSION OF OR TRANSPORT THE BIRD IN ANY DISTRICT VEHICLE OR EQUIPMENT.**
APP Coordinator	6) Investigate the incident and provide guidance as necessary.
District Employee	7) Determine if a retrofit is required.
	8) If a retrofit requires bushing covers, cut out covers, pot head cover, or bird guard, install what is required and return power to the customer.
	9) If the retrofit requires more extensive work, such as insulated jumpers, complete the work to return power to the customer.
	10) Fill out the AVIAN INCIDENT REPORT.
	11) Submit the AVIAN INCIDENT REPORT to his/her supervisor.

ENGINEERING & OPERATIONS ADMINISTRATION

AVIAN PROTECTION PLAN

AVIAN INCIDENT PROCEDURE

Performed by:	Action:
Supervisor	12) Review AVIAN INCIDENT REPORT for accuracy and completeness, and sign.
	13) Enter the AVIAN INCIDENT REPORT information into the Blue Tag System.
	14) Send the AVIAN INCIDENT REPORT via inter-office mail to the APP Coordinator.
Supervisor	15) When the retrofit is complete, update the Blue Tag System.
APP Coordinator	16) Complete the AVIAN INCIDENT REPORT.
	17) Review and analyze pertinent information
	18) If a retrofit is necessary:
	19) Develop a Job Package.
	20) Deliver it to the Crew Scheduler (Ken Olson).
	21) Follow-up on the retrofit.
	22) Update the Blue Tag System when the retrofit is complete.
	23) File and document the AVIAN INCIDENT REPORT.

ENGINEERING & OPERATIONS ADMINISTRATION

AVIAN PROTECTION PLAN

NEST MANAGEMENT PROCEDURE

Purpose: The purpose of this procedure is to identify the E&OA Employee actions necessary to comply with the Avian Protection Plan (APP) when a bird nest is involved in any E&OA Employee proposed action.

Performed by:	*Action:*
District Employee	1) Proposes any action that will involve working in the proximity, the removal, relocation, or destruction of any bird nest.
	2) Determine the species of the bird, which used or is using the nest.
	3) If the nest belongs to a Common Crow, Yellow Billed Magpie, House Sparrow, European Starling, Common Pigeon, or Monk Parakeet, proceed with the proposed action.
	4) If the nest does not belong to a Common Crow, Yellow Billed Magpie, House Sparrow, European Starling, Common Pigeon, or Monk Parakeet, stop immediately, and
	5) Contact the APP Coordinator, Les Barrigar at 883-4767 or (cell) 765-3819.
APP Coordinator	6) Review the proposed action and the site.
	7) Determine if the nest belongs to an Eagle/Listed Species.
	8) If the nest belongs to a Non-Eagle/Non-Listed Species and is **INACTIVE**, District Employee may proceed with the proposed action.
	9) If the nest belongs to a Non-Eagle/Non-Listed Species and is **ACTIVE**, request a Depredation Permit from USFWS.
	10) Receives Depredation Permit and approval to "take" the nest.
	11) Notifies the District Employee to proceed with the proposed action and sends a copy of the Permit, which must be on-site at the time of the nest removal.

ENGINEERING & OPERATIONS ADMINISTRATION

AVIAN PROTECTION PLAN

NEST MANAGEMENT PROCEDURE

Performed by:	Action:
APP Coordinator	12) Shall maintain records of all permits, amendments, and listing of all actions taken regarding affected nests.
	13) Annually submit a report to USFWS as required which contains the date and location of each nest removed, the species of bird, the name of the person who removed the nest, and the permit number under which the nest was removed.
	14) If the nest belongs to an Eagle/Listed Species and the nest is **ACTIVE** or **INACTIVE** will request a USFWS consultation.
USFWS	15) Will issue an **Incidental Take Permit**, or require that the proposed action be redesigned or apply for mitigation.
APP Coordinator	16) Inform the District Employee of the USFWS decision.
	17) If **IMMINENT DANGER** (i.e. threats to human health or safety), will attempt to obtain either USFWS or State authorization by phone and then notify District employee to Take Action.
	18) If agency contact is impossible, document all actions and contact applicable regulatory agencies as soon as practicable.

BLUE TAG NUMBER: _____

ENGINEERING & OPERATIONS ADMINISTRATION
AVIAN PROTECTION PLAN
AVIAN INCIDENT REPORT

1) Date of discovery: _____ Injured: ☐ Dead: ☐
2) Approximate date of incident: _____
3) Map Number: _____ Pole Number: _____
4) Location: _____
5) Check type of Pole;

	Transmission		Transmission w/Distribution		Distribution

6) Check location of Bird Mortality/Injury:

	At Structure		Mid Span		Substation

7) Evidence of burn marks on the bird? Yes ☐ NO ☐

If yes, please describe location of burns: _____

8) Check the probable cause of Mortality/Injury:

	Electrocution		Wire Strike		Other
	Unable to determine				

If other specify: _____

9) If Bird was injured/killed by a utility structure please check the known or likely points contacted:

	Transformer Bushing		Bare Jumper Wires		Primary Wires Phase to Phase
	Capacitor		Cutout		Lightning Arrestor
	Re-Closer		Regulator		Underground Riser at Pole
	Mid-Span Contact				

10) What is the pole configuration:

	Four Wire: Horizontal		Four Wire: Vertical		Three Wire: Horizontal		Two Wire
	Three Wire: Wide Triangular		Three Wire: Compact Triangular		Thee Wire: Vertical		
	Tangent		Dead-end		Line w/Buck		

11) Does pole employ any avian protection? Yes ☐ No ☐

If yes, please check:

	60" Spacing		48" Spacing		Capacitor Covers
	Cutout Covers		Insulated Jumpers		Transformer Bushing Covers
	Pin Covers		Dead-end Covers		Perch Guards
	Other				

If Other, please specify: _____

12) Bird Species:

	Osprey		Bald Eagle		Golden Eagle		Red-Shouldered Hawk		Swainson's Hawk
	Red-Tailed Hawk		Ferruginous Hawk		Rough-Legged Hawk		Turkey Vulture		Barn Owl
	Great Horned Owl		Great Blue Heron		Great Egret		Sandhill Crane		American Crow
	Common Raven		Yellow-Billed Magpie						

13) Recommendations to retrofit structure to mitigate future impacts to protected species:

_____

14) TID Employee: _____
Signature

15) Reviewed by: _____
Signature

BLUE TAG NUMBER: _____

ENGINEERING & OPERATIONS ADMINISTRATION
AVIAN PROTECTION PLAN
AVIAN INCIDENT REPORT

FOR AVIAN PROTECTION PLAN COORDINATOR USE ONLY

16) Does pole require retrofit for avian protection? Yes ☐ No ☐

If yes, please check:

	60" Spacing		48" Spacing		Capacitor Covers
	Cutout Covers		Insulated Jumpers		Transformer Bushing Covers
	Pin Covers		Dead-end Covers		Perch Guards
	Other				

If Other, please specify: _____

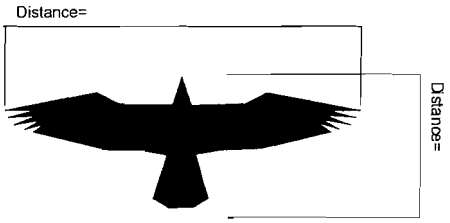
17) Does nearest pole structure employ any avian protection? Yes ☐ No ☐

If yes, please check:

	60" Spacing		48" Spacing		Capacitor Covers
	Cutout Covers		Insulated Jumpers		Transformer Bushing Covers
	Pin Covers		Dead-end Covers		Perch Guards
	Other				

If Other, please specify: _____

18) Bird measurements:



19) Habitat:

	Native Vegetation		Low Growing Field Crops		Disturbed Habitat Without Vegetation

20) Bird Use:

	High Use: Whitewash, Castings, Prey Remains		Moderate Use: Whitewash		Low Use

21) Vantage Point:

	Commanding View		Moderate View		Limited View

22) Pole Risk Classification:

	High Risk:		Medium Risk:		Low Risk:
	• Three phase transformer banks and other three phase equipment poles • Tangent structure with all primary wires supported on a crossarm • Three phase deadend and angle poles • Three phase riser poles		• Single phase transformer banks and other single phase equipment poles • Single phase riser poles		• Three phase tangent structures with the center phase on the pole top • Two phase tangent structures • Single phase structures