Transmission towers may afford nesting raptors some protection from the elements. Beams and cross-braces provide shade and windbreaks for nesting birds (Anderson 1975). Compared to cliffs, towers allow more air circulation and lower heat absorption. Raptors nesting on transmission towers are also more protected from range fires (Steenhof et al. 1993).

Some studies have documented greater nest productivity on artificial nesting substrates than on natural substrates (van Daele et al. 1980; Gaines 1985; Olendorff 1993a). Martial eagles *(Polemaetus bellicosus)* in southern Africa had higher breeding success on electrical transmission towers than elsewhere (Boshoff 1993). Ospreys using artificial sites in Germany produced more young than those nesting in trees (Meyburg et al. 1996). Similar rates of raptor nest success have been found between natural and man-made substrates in the Canadian Great Basin and in southern Wisconsin (Ewins 1996; Stout et al. 1996). Improved productivity on poles, towers and other artificial structures can usually be attributed to nest stability and protection from mammalian predators.

DISADVANTAGES TO RAPTORS NESTING ON UTILITY STRUCTURES

Raptors that nest on power poles face disadvantages that include: increased risk of electrocution and collision, susceptibility to nest damage from wind and weather, disturbance from line maintenance or construction, and vulnerability to shooting. Raptors nesting on power line structures may also impact some prey species and can reduce power reliability by contaminating equipment with excrement or nesting material (see Reliability Concerns). Another possible disadvantage is that raptors, specifically ospreys, reared from power pole nests may only select power poles as nest substrates when they nest as adults (Henny and Kaiser 1996).

Raptors nesting on utility structures have an increased electrocution risk if nearby poles are not avian-safe (see Chapter 5). Entanglement in wires and other utility hardware can also occur (Olendorff et al. 1981). In the United States, raptor collisions with power lines do occur, but not as frequently as electrocutions (Oldendorff and Lehman 1986; Kochert and Olendorff 1999). Although raptors may become familiar with power lines in their breeding territory, repeated flights across power lines increases the risk of collision, especially in bad weather or in the pursuit of prey (Manosa and Real 2001). In Europe, transmission lines near nests were associated with high turnover rates of breeding Bonelli's eagles *(Hieraaetus fasciatus)*. Collisions with power lines were the suspected cause (Manosa and Real 2001).

The dense latticework of transmission towers offer some protection from the elements, but relatively open distribution poles do not. Consequently, nests on distribution poles are more often damaged or destroyed by strong winds (Gilmer and Wiehe 1977; Postovit and Postovit 1987). Raised edges on nesting platforms can help stabilize and protect nests during high winds. Destruction of nests by wind was a common cause of nest failures (14%) on transmission towers in Idaho. Poles with artificial platforms afforded more protection from wind than poles without platforms (Steenhof et al. 1993). A bald eagle nest on an H-frame structure in Florida repeatedly fell during windstorms until an artificial platform was erected to support it (Marion et al. 1992).

Although short-lived, the activity and alteration of surrounding habitat that occurs during power-line construction can disturb raptors. Maintenance operations may also temporarily disrupt normal bird nesting, hunting and roosting behavior (Williams and Colson 1989).

Indiscriminate shooting of raptors may

be higher along power lines than at natural nest sites because poles are often highly visible and close to access roads (Williams and Colson 1989).

The addition of artificial raptor nests can have negative impacts on others animals (Fitzner 1980a). For example, burrowing owls *(Athene cunicularia)*, which are preyed upon by larger raptors, can be more susceptible to predation if nest platforms are erected in their territories. The introduction of great horned owls into an area via nest platforms can threaten nestlings of diurnal raptors.

OTHER BIRDS

Perching

Many other bird species use distribution poles, transmission towers, and conductors for perching, particularly where suitable foraging or nesting habitat is nearby (e.g., Yahner et al. 2002). As they do for raptors, power line structures provide a view of the surroundings, and facilitate hunting. From these perches, kingfishers pursue fish in lakes or streams and shrikes seek their prey along power line corridors (Figure 6.5). Utility structures, especially conductors, are commonly used as perches by flocking birds, such as blackbirds, swallows, and European starlings *(Sturnus vulgaris)*.

Roosting

Species such as cormorants, vultures, ravens, and crows use power line structures for roosting. Poorly adapted to cold environments, vultures often seek roosts that are protected from harsh weather. Cape Griffons, or Cape vultures *(Gyps coprotheres)* and, to a lesser extent, white-backed vultures *(Gyps africanus)*, roost in large numbers on transmission towers in southern Africa (Ledger and Hobbs 1999). Likewise, turkey vultures *(Cathartes aura)* and black vultures *(Coragyps atratus)* use transmission towers for roosting in North America.

FIGURE 6.5: Loggerhead shrike *(Lanius ludovicianus)* perched on conductor.

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Some corvid species roost communally or congregate on power line structures. Engel et al. (1992b) documented the largest known communal roost of common ravens in the world. There were as many as 2,103 ravens on adjoining 500-kV transmission towers in southwestern Idaho. The towers appeared to present an attractive alternative to natural roost sites by offering increased safety from predators and close proximity to food sources.

Nesting

A number of non-raptor species also nest on utility structures. Transmission tower latticework can provide suitable nesting substrate for ravens, herons, cormorants and other large birds. Distribution poles are used by smaller birds that build their nests on support brackets, transformers, or capacitors. Table 6.2 presents a list of non-raptor species that have nested on power line structures. This list is not comprehensive, but it illustrates the variety of species attracted to utility structures.

Birds that build stick nests may find areas on transmission and distribution structures suitable for nesting sites. In Europe, the white stork *(Ciconia ciconia)* commonly nests on distribution and transmission towers (Janss 1998). Double-crested cormorants *(Phalacrocorax auritus)* and great blue herons *(Ardea herodias)* nest on steel-lattice transmission towers along the Great Salt Lake in Utah (PacifiCorp,

TABLE 6.2: Examples of non-raptor species nesting on power line structures.*

Species	Source
Double-crested cormorant *(Phalacrocorax auritus)*	PacifiCorp (unpubl. data)
Great blue heron *(Ardea herodias)*	PacifiCorp (unpubl. data)
Hadeda ibis *(Bostrychia hagedash)*	C.S. van Rooyen (pers. comm.)
White stork *(Ciconia ciconia)*	Janss 1998
Egyptian goose *(Alopochen aegyptiaca)*	C.S. van Rooyen (pers. comm.)
Canada goose *(Branta canadensis)*	J. Burruss (pers. comm.)
Monk parakeet *(Myiopsitta monachus)*	J. Lindsay (pers. comm.)
Eastern kingbird *(Tyrannus tyrannus)*	The Maryland Ornithological Society (http://www.mdbirds.org/atlas/spnotes.html)
Western kingbird *(T. verticalis)*	M. Fiedler (pers. comm.); PacifiCorp (unpubl. data)
Scissor-tailed flycatcher *(T. forficatus)*	Georgia Ornithological Society (http://www.gos.org/rbas/ga2000/2000-05.html)
Pied crow *(Corvus albus)*	C.S. van Rooyen (pers. comm.)
Cape crow *(C. capensis)*	C.S. van Rooyen (pers. comm.)
Common raven *(C. corax)*	Knight and Kawashima 1993; Steenhof et al. 1993
Chihuahuan raven *(C. cryptoleucus)*	Bednarz and Raitt 2002; Brubaker et al. 2003
Sociable weaver *(Philetairus socius)*	C.S. van Rooyen (pers. comm.)

* *This table includes species that have constructed nests or used existing nests on poles, not those which may nest in cavities within poles, i.e. woodpeckers, chickadees, etc.*

FIGURE 6.6: Common raven nest on distribution underbuild of transmission structure.

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FIGURE 6.7: Western kingbird nest (see highlighted area) on transformer.

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unpubl. data). In the western United States, Canada geese *(Branta canadensis)* have nested on platforms erected for raptors (J. Burruss, pers. comm.).

Common ravens often nest on utility structures (Figure 6.6). Within ten years of the construction of a 500-kV transmission line across Oregon and Idaho, 81 pairs of common ravens nested on the transmission structures (Steenhof et al. 1993). Their success was similar to or greater than nest success in natural substrates. In New Mexico, ravens preferred to nest on the configuration with two poles supporting four paired sets of crossarms (Brubaker et al. 2003).

Throughout a 45,000-km^2 (17,375-mi^2) area of the Mojave Desert in southern California, 26 pairs of common ravens used power line structures for nesting. There were more nests than expected based on the availability of natural nest substrates

(Knight and Kawashima 1993).

Some species exhibit preferences for nest location on a structure. For example, 98% of raven nests (n=408) were found on the uppermost portion of towers (Steenhof et al. 1993). Western kingbirds often nest on transformer brackets, riser poles, switches, and transmission structures (Figure 6.7) (M. Fiedler, pers. comm.; PacifiCorp, unpubl. data).

The use of non-raptor nests by raptors on power line structures has been reported. For example, prairie falcons have been documented using common raven nests (DeLong and Steenhof 2004), and a pair of peregrine falcons *(Falco peregrinus)* occupied a common raven nest on a transmission tower along the Great Salt Lake, Utah (J. Burruss, pers. comm.). In south Texas, a pair of aplomado falcons *(Falco femoralis)* used a common raven nest on an H-frame, 138-kV tower (D. Bouchard, pers. obs.). Although the nest was destroyed by wind, a platform was installed in the same place and was also successful.

MONK PARAKEETS

Though native to South America, monk parakeets were brought to the United States in the late 1960s as pets. Escaped birds have adapted well and established populations from Florida to New York, Texas to Oregon, and in parts of southern Canada. Populations in some states have grown exponentially in the last 10 to 15 years (Pruett-Jones et al. 2005). Monk parakeets build bulky stick nests on trees, power poles, and substations (Spreyer and Bucher 1998; Newman et al. 2004). The number of nests can range from several on distribution or transmission poles to more than 50 in a single substation (Figures 6.8, 6.9). Since monk parakeets are colonial breeders, the size

FIGURE 6.8: Monk parakeet nests on transmission tower.

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FIGURE 6.9: Monk parakeet nest on distribution pole.

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of their nests can increase each year and may reach several meters in diameter. Examination of the monk parakeet's annual nesting patterns in south Florida suggests an increasing preference for both power line structures and substations (Newman et al., in press).

Monk parakeet nest site selection on power line structures in Florida is quite predictable, and they show similar behavior in other states as well (Newman et al. 2004). In south Florida, 82% of nests occurred on distribution poles with transformers and capacitor banks. Most of these nests were built on the brackets that attach the equipment to poles. On the transmission towers surveyed, most nests were located on the secondary arms, followed by the primary arms (Newman et al., in press). A commonality between nests on substations and transmission lines is the parakeets' apparent preference for nesting on 45°-angled braces. On transmission towers, 93% of nests occurred on 45°-angle braces. In substations 44% of nesting occurred on 45°-angle crossbeams, followed by switches (18%) and vertical supports (18%) (Newman et al., in press). The remaining 20% were on 90° primary supports, insulator/switches, and substation support structures.

Monk parakeet nests have caused power reliability, fire, and safety problems, especially when they contact energized portions of a utility structure. This problem is compounded when one structure supports multiple nests. Safety concerns related to monk parakeet nests include loss of power to critical care facilities, risk of injury to maintenance crews, and risk of electrocution to trespassers attempting to capture wild birds. In service areas such as New York City, some distribution poles have signs indicating that continuous power is necessary for a resident on life-support. Nests on these poles or nearby distribution feeders pose a serious risk to these residents.

Psitticosis is a rare disease that can be transmitted from psitticine birds (parrots) to humans. Thus, nest removal activities associated with colonial psitticines can present a risk to utility workers. Utility crews should also protect themselves from nest materials that may contain mites and insects that can cause discomfort.

MONK PARAKEET NEST MANAGEMENT

The significant increase in monk parakeet population and associated power reliability problems, management costs, and safety concerns warrant short- and long-term nest management strategies. Short-term objectives include removing high-risk nests from utility structures and preventing birds from re-nesting on them. Long-term objectives include reducing population size and growth, and enacting legislation to aid in the control of this species. Because of structural and operational differences between transmission lines, distribution lines, and substations, specific nest management and control strategies need to be developed for each (Newman et al. 2004). Much of what is known about monk parakeet management has been developed through field-testing in Florida where the species has been a challenge for utilities for over a decade (J. Lindsay, pers. comm.; Newman et al. 2004). Monk parakeets are not protected by the Migratory Bird Treaty Act, however removal of nests and birds can be received negatively by the public.

Short-term control of monk parakeets by nest removal alone is ineffective and can actually increase the number of new nests. Often, multiple pairs of monk parakeets occupy a single nest. When a nest is destroyed, the pair that started the nest will not rejoin its neighbors. Instead, it will build a separate nest on the same or nearby structure. Simultaneously removing the parakeets **and** the nest has proven successful in reducing the number of high-risk nests and in preventing re-nesting in the short-term. Birds are removed from the nests at night and the nests are removed later.

Nets have been designed for trapping monk parakeets on distribution poles, but because monk parakeets are vigilant and astute, the trapping efficiency per nest is approximately 50% (Tillman et al. 2004). Trapping and nest removal are labor intensive and also have public acceptance issues. Trapping may be effective as a long-term strategy for reducing populations if these efforts are continued until all nesting ceases at a particular location (Newman et al. 2004). Passive trapping with a cage is somewhat effective for substations. Trapping techniques for transmission towers have not been developed.

Florida Power & Light has investigated a wide range of other strategies including physical, behavioral, chemical and biological controls. Presently, only one potential long-term control has been identified. In the laboratory, Diazacon, a chemical sterilant, has been effective in reducing the number of eggs laid. However, additional research is needed to determine if its use is practical and effective in the field.

NEST MANAGEMENT

ENCOURAGING BIRDS TO NEST IN DESIRED AREAS

Distribution Poles

Installing nest platforms in safe areas on or near utility structures is effective for both nest management and line maintenance. Of 88 utilities that responded to a survey regarding raptors nesting on their utility structures, 66% had raptor nest enhancement projects (Blue 1996). Artificial nest platforms were most commonly used (*n*=40) and 95% of these companies erected platforms for ospreys. Generally, there is a greater need for nest platforms on distribution poles than on transmission structures because the closer separation between distribution conductors increases the risk of electrocutions and outages.

An osprey nest structure erected above a power pole should have a well-supported platform with some nest material added to entice the birds to the new site (Figure 6.10). A perch, situated above the nest (Figure 6.11) or extending from the platform (Figures 6.12

FIGURE 6.10: Osprey nest platform design developed by Portland General Electric. The platform is constructed from the end of a 1.5-meter (m) (5-foot [ft]) diameter wooden cable spool with coated cable along the edge to contain nest material. Utilities should ensure energized parts and equipment below the nest are covered to prevent electrocution of birds or outages from nest material. Consumer's Power, Inc. retrofitted this pole to their avian-safe standards.

FIGURE 6.11: A nest platform built atop a pole using crossarms to extend the platform above the conductors. This design also includes an optional elevated perch to attract ospreys. The perch should be perpendicular to the prevailing wind.

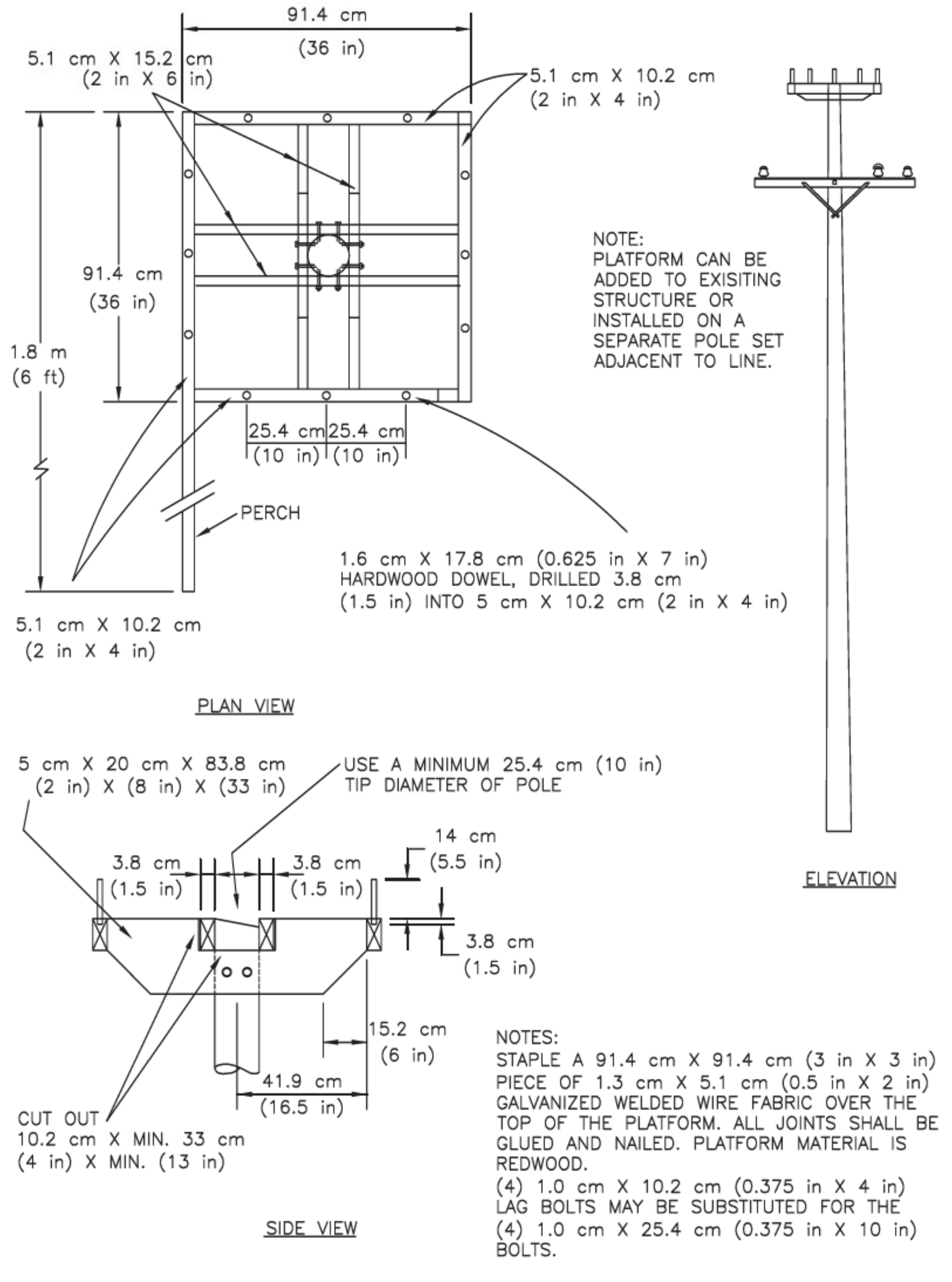

Figure 6.12: Osprey nest platform details (Idaho Power Company, PacifiCorp).

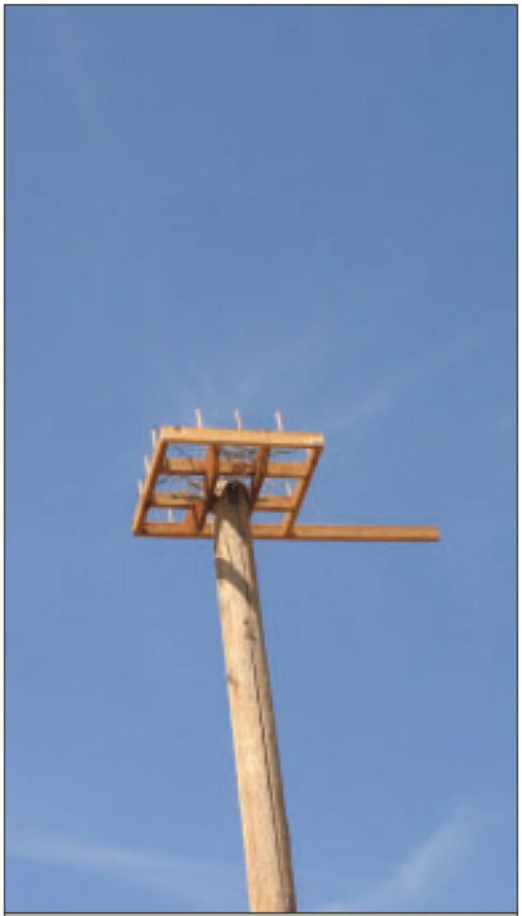

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FIGURE 6.13: Photo of nest platform depicted in Figure 6.12.

FIGURE 6.14: A simple and cost-effective offset nesting platform built for ospreys in Washington. Pallets can be used as platforms, providing ospreys with a flat nesting area.

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and 6.13) may increase its desirability. Perches should be perpendicular to the prevailing wind. Care should be taken to arrange sticks and other nest materials so they mimic the size and form of a natural nest. Various nest platform designs are used by utility companies throughout the United States, Canada, and Europe (van Daele et al. 1980; Ewins 1994).

Platforms made from discarded wooden cable spools have been used by nesting ospreys (Austin-Smith and Rhodenizer 1983) (see Figure 6.10). The offset-pallet-platform design developed in Ontario (Ewins 1994:13) is simple and cost-effective (Figure 6.14). Figure 6.15 depicts another nest platform design that may be used for some buteos and ospreys. Grubb (1995) provides a guide for eagle nest designs.

Osprey nest management may include building alternate nest platforms above power lines, installing a nearby taller non-energized pole with a nest platform, or leaving the nest intact but retrofitting the pole (Henny et al. 2003).[32] However, utilities should be aware that installing a nest platform above lines or leaving a nest on a crossarm may result in outages from nesting material, excrement, or

[32] See Chapter 5 for retrofitting recommendations.

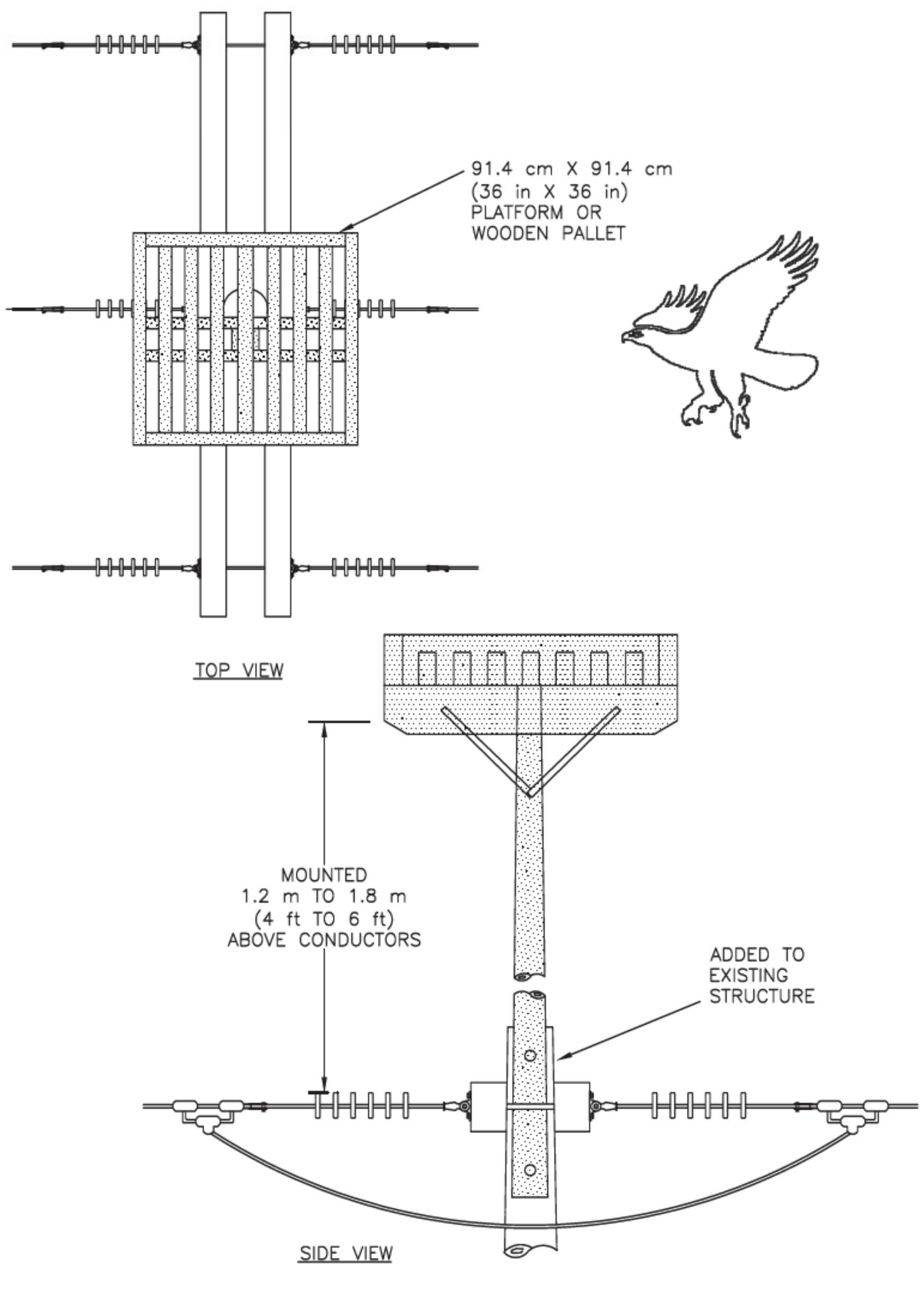

FIGURE 6.15: Raptor nest platform used by ospreys and some buteos (PacifiCorp). This design is recommended when a new nest pole cannot be erected.

prey remains dropping onto conductors or energized equipment (Figure 6.16). Installing a platform on a nearby non-energized pole reduces these risks.

Transmission Structures

The greater separation between conductors on transmission towers generally allows raptors and other birds room to nest without causing problems for electric operations (e.g., Hobbs and Ledger 1986). The latticework of some steel transmission towers provides adequate support for nests without the aid of platforms (Figure 6.17). However, a nest situated above insulator strings may cause equipment failures due to contamination with excrement, prey remains, or nest materials.

In Spain, 12 nesting platforms were placed on transmission towers, where they would not interfere with electrical operations, to draw white storks away from sites elsewhere on the towers (Janss 1998). The storks accepted the platforms, but the original nests remained in use as well.

The location of a nest platform can also influence roosting behavior, and either increase or decrease the risk of streamer-caused faults (C.S. van Rooyen, pers. comm.). In South Africa, outages caused by streamers from roosting martial eagles *(Polemaetus bellicosus)*, tawny eagles *(Aquila rapax)*, and Verreaux's eagles *(A. verreauxii)* were concentrated within a ten-transmission tower radius of active nests. These outages occurred on configurations that were both preferred for nesting and susceptible to streamer contamination (Jenkins et al. 2005). Conversely, eagles with nests located below phase conductors also roosted below conductors, reducing the outage incidence and risk.

Progress Energy reduced its osprey nest problem on double-crossarm structures by installing fiberglass nest platforms above the conductors (D. Voights, pers. comm.) (Figure 6.18).

FIGURE 6.16: Osprey nest in Wyoming atop double dead-end pole. Nesting material that may drop onto the conductors or equipment poses fire, outage, and equipment damage risks.

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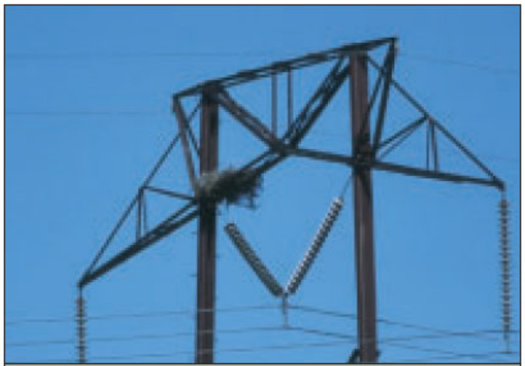

FIGURE 6.17: Golden eagle nest on transmission tower.

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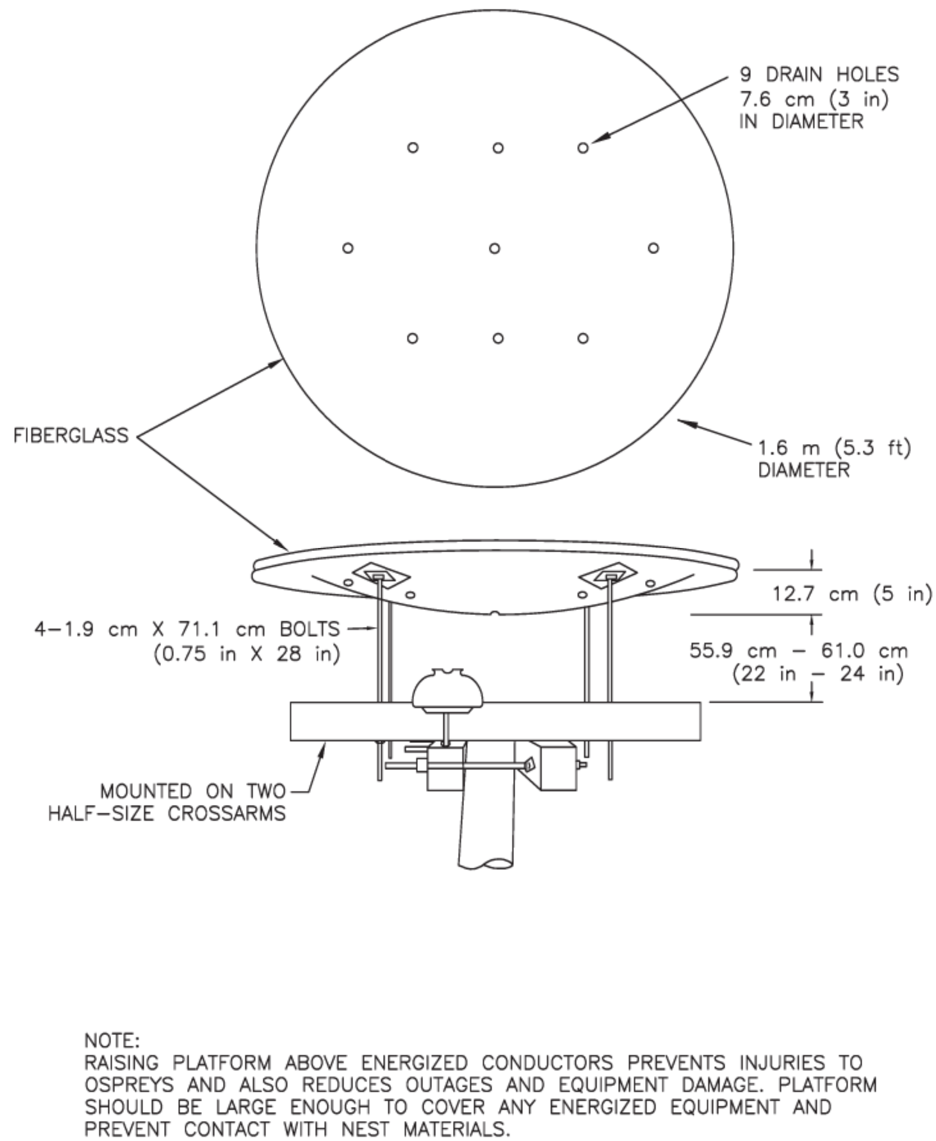

FIGURE 6.18: Osprey nest platform (Progress Energy).

Georgia Southern University and Georgia Power Company have erected nest boxes and tubes on transmission structures in Georgia for American kestrels (J. Parrish, pers. comm.). The nesting tubes were constructed of 30.5-cm (12-in) diameter, UV-resistant PVC pipe cut at lengths of either 46 or 91 cm (18 or 36 in). All tubes were drilled with drain holes in the bottom and vents on the sides, and lined with several inches of pine straw. The entrance of each nest tube was positioned to face east or south. The 91-cm (36-in) long tube included 30.5-cm (12-in) end caps with a 7.6-cm (3-in) hole cut in the middle of one of them (Figure 6.19). In 2003 and 2004, two of these tubes were mounted horizontally on transmission towers at a height of 30.5 m (100 ft). The tube mounted in 2003 was used in 2004, and both were used by nesting kestrels in 2005. The 46-cm (18-in) tube, which can be mounted either horizontally or vertically, includes a 7.6-cm (3-in) hole in either the end or the top of the tube (Figure 6.20). These tubes were installed both vertically and horizontally at a height of 4.5 m (15 ft). Kestrels used one of the four vertically mounted tubes in 2005, but did not use either of the horizontally mounted tubes that year.

FIGURE 6.19: Kestrel nesting tube (91-cm [36-in] length) installed on transmission tower in Georgia.

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FIGURE 6.20 Kestrel nesting tube (46-cm [18-in] length) installed on transmission tower in Georgia.

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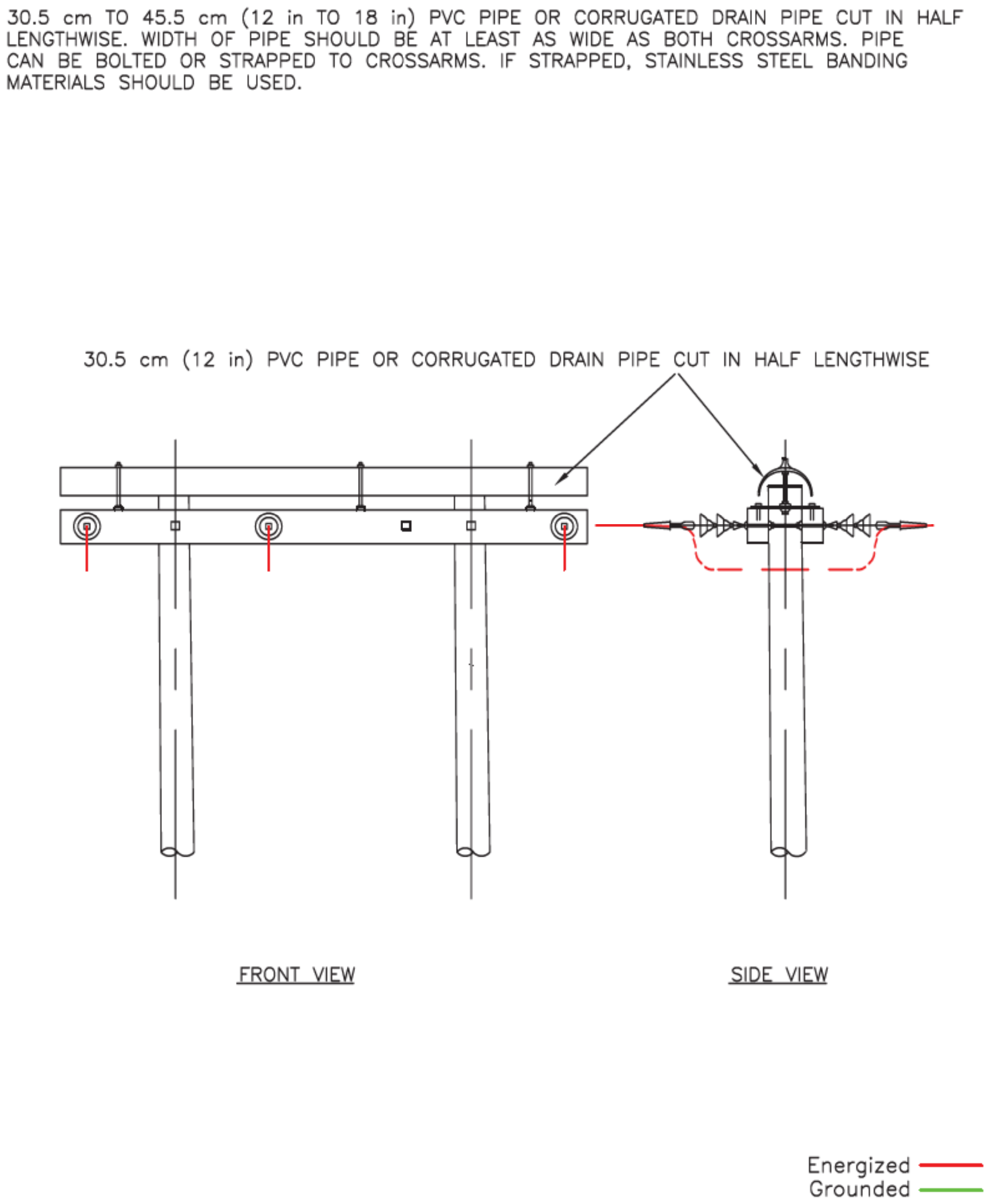

FIGURE 6.21: Nesting discourager (PacifiCorp).

FIGURE 6.22: This osprey nest was originally located on the crossarms above the center conductor where contamination from fallen nest material and excrement accumulated. It was relocated to the platform shown. A halved, corrugated pipe was installed to prevent re-nesting on the crossarms. Relocating a problem nest to a nest platform on an adjacent non-energized pole is preferred. However, if pole cost, rights-of-way restrictions, or limited access prevent installation of a new structure, it is best to install a safe nest platform on the existing structure.

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FIGURE 6.23: A segment of plastic pipe was installed on a dead-end pole in Oregon to discourage osprey nesting. However, the osprey pair continued nest construction after the pipe was installed.

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DISCOURAGING NEST CONSTRUCTION

Nesting should sometimes be discouraged due to the risks to people, nesting birds, or the power system. PVC pipe or corrugated drain pipe banded to the crossarms can prevent birds from nesting on "H" frame transmission structures (Figure 6.21). A nest platform can then be placed above the arm and away from the insulators (Figure 6.22) or on a nearby non-energized pole. To discourage nest rebuilding on distribution poles where nests have been removed, a large plastic pipe can be installed above the crossarm (van Daele et al. 1980). In Montana, this has been effective in deterring nesting ospreys (S. Milodragovich, pers. comm.). However, in other areas, this nest discourager has been ineffective (Figure 6.23). Poles with conductors and insulators above the crossarms require a more complicated design. A PVC tube positioned above and extending the length of the crossarm with diagonal tubes extending toward the crossarms can deter nesting (Figure 6.24) (Henny et al. 2003). Such nest

FIGURE 6.24: A pipe mounted above the conductors can be used as a nest discourager on distribution poles with insulators mounted on the crossarm. The use of triangles is cautioned against, as they may aid in the accumulation of nesting material. This design may pose an electrocution risk if exposed equipment and conductors are not covered or adequately spaced.

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discouragers should be installed close enough to the crossarm to prevent birds from nesting under them. They should be mounted securely on the arm, and should be installed so they do not reduce the BIL of the design.

Triangles, plastic owls, and small spikes have also been used to discourage nesting on power poles. However, these devices are often unsuccessful. For example, birds may nest in open spaces adjacent to triangles (Figure 6.25), birds may initially react to plastic owls, but over time they can become habituated to them (Figure 6.26), and plastic spikes may aid in the accumulation of nest material (Figure 6.27). As discussed in Chapter 5, materials placed on poles to discourage birds from perching or nesting degrade over time, particularly in areas with extreme weather conditions. Utilities should consult with their standards and engineering personnel to identify company-approved devices prior to installation.

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FIGURE 6.25: Red-tailed hawk nest on pole with triangle perch discouragers.

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FIGURE 6.26: Osprey nest constructed on pole with plastic owl intended to haze birds.

RECOMMENDATIONS FOR DESIGNING AND INSTALLING NEST PLATFORMS

When designing and installing nest platforms, biologists, engineers, and line workers should consider the following:

- Platforms should be placed where conductors and energized equipment will not be fouled by dropped nest material, prey remains, or excrement.
- To prevent electrocutions, avian-safe designs and retrofitting materials and methods (see Chapter 5) should be applied to poles with or near nest platforms. However, the use of perch discouragers should be avoided near nests. If a nest fails, the pair may attempt to nest on a nearby

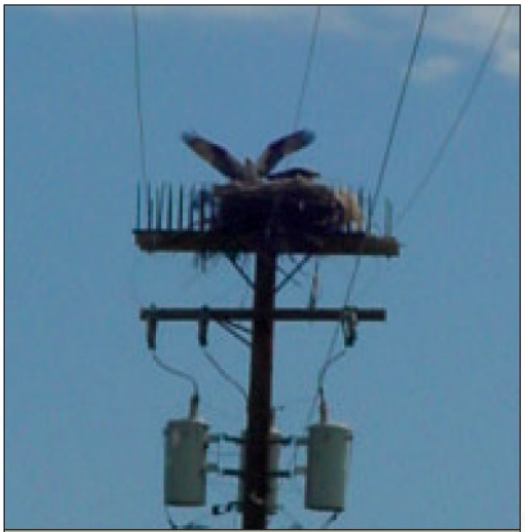

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FIGURE 6.27: Osprey nest on pole with plastic spikes.

pole, possibly selecting a pole with perch discouragers because it more easily accumulates sticks (S. Milodragovich, pers. comm.).

- Platforms should be located in areas with adequate habitat and prey for the target species.
- Discretion should be used when placing nest platforms near sites with sensitive wildlife such as sage grouse, prairie chickens, or prairie dogs that may fall prey to nesting raptors.
- Nest platforms may not be needed on all types of transmission towers. For example, the metal latticework of certain steel towers and the double crossarms of H-frame construction typically provide adequate nest substrates (Lee 1980; Steenhof et al. 1993).
- If possible and appropriate, nesting platforms can be installed on decommissioned poles to draw nesting activity away from energized structures.
- For ospreys, a 1.2-m (4-ft) square or 1.5-m (5-ft) diameter platform (see Figure 6.18) can be more effective than a 0.9-m (3-ft) square platform (see Figures 6.12 and 6.15) in preventing nest material from sloughing off (J. Kaiser, pers. comm.). A lip or pegs along the edge several inches high also helps prevent nest sticks from falling off the platform. Carriage bolts, which may already be carried on line-trucks, can be used as alternative to a lip or pegs. The addition of sticks to a newly-constructed platform may help entice nesting birds. Birds may also be more likely to use a new nest platform if it is higher than adjacent substrates or a reasonable distance away from other alternative(s).
- The weight of a nest platform under wet or snowy conditions should be considered. If it is too heavy for an existing pole, the platform should be installed on a nearby, suitable pole.
- Federal and/or state permits are required for managing active nests of protected species (see Chapter 3). No active nests (nests with eggs or young) may be altered, moved, or destroyed without proper authorization from appropriate agencies. Nests of eagles and endangered species cannot be altered, moved, or destroyed at any time without proper authorization from appropriate agencies. Because of the biological/behavioral characteristics of some birds (e.g., colonial- and ground-nesting birds), destruction of an inactive nest could also result in a take (USFWS 2003).
- If platforms are used to relocate problem nests, relocation distances should not be excessive; success is directly related to proximity. Distances between 20 and 100 m (66 and 328 ft) are most common for ospreys (J. Kaiser, pers. comm.). Golden eagle nests have been successfully moved as far as 2.6 km (1.6 mi), but in incremental steps (Phillips and Beske 1982). The new location should be in line-of-sight to the old location. A biologist should be consulted to provide guidance, and appropriate permits must be obtained.
- On poles with platform nests, predator guards can be used to prevent raccoons and other predators from climbing to the nests. A commonly used device is a 1.5-m (5-ft) length of sheet metal wrapped completely and tightly around the pole at about 1 to 1.5 m (3 to 5 ft) above the ground. However, predator guards should not be used on poles that utility personnel are required to climb.
- Maintenance of platforms and platform supports will extend the life of the structures and will minimize future conflicts with utility operations. Maintenance activities should take place before the breeding season to avoid disturbing nest building efforts, eggs, or nestlings.

RELIABILITY CONCERNS

Unfortunately, despite the benefits utility structures provide nesting birds, there are some negative effects as well. For example, nesting material, electrocuted birds, streamers, or prey debris can cause interruptions and outages. During the nest building process, birds may drop sticks onto conductors causing flashovers (Ledger and Hobbs 1999). Likewise, nests located over exposed, energized equipment can cause flashovers or nest fires during wet conditions. Osprey nests in agricultural areas may contain bailing wire or twine that could cause power outages or entangle nestlings (Blem et al. 2002; PacifiCorp, unpubl. data). Dangling or falling prey can also contact energized wires (EDM International 2004).

Utility companies have dealt with bird-caused power reliability problems in a number of ways. One management concept is to maintain nests when they are in desirable locations (Henny et al. 2003; J. Kaiser, pers. comm.). Nest material can be trimmed away from conductors (Hobbs and Ledger 1986; Toner and Bancroft 1986). Occupied nests are well maintained by raptors, but abandoned nests may partially or completely collapse, thereby threatening electrical equipment (Ledger and Hobbs 1999). The use of perch or nest discouragers alone may not be effective in preventing nesting. In Florida, monk parakeets began using raptor perch discouragers as nest substrates in areas where they had not previously nested (J. Lindsay, pers. comm.). In the western United States, red-tailed hawks, ospreys, and common ravens have built nests around perch discouragers that were installed to discourage nesting on equipment or double dead-end poles (J. Burruss, pers. comm.) (see Figures 6.23, and 6.25 through 6.27).

Suspending a vulture carcass or decoy by its feet in a tower was an effective means of ridding the structure of communally roosting black and turkey vultures for many months (Avery et al. 2002). However, before using a carcass for this, a utility must consult with federal and state wildlife resource agencies regarding permits, and should closely evaluate the public response. Shields attached below the latticework on transmission towers with roosting ravens have been used to prevent the accumulation of excrement on insulators (Engel et al. 1992a). In South Africa, high-density polyethylene (HDPE) welded rod bird guards have been effective in reducing line faults (Vosloo and van Rooyen 2001; van Rooyen et al. 2003).

BIRD-RELATED OUTAGES

Bird-related outages are a concern for many utilities. Although outages may occur as the result of an electrocution or collision, there are several other causes that do not result in avian mortality, for example:

- Nest material contact,
- Conductor-to-conductor contact caused by the line gallop started by a large flock of birds flushing,
- Prey falling on energized conductors or equipment,
- Bird streamers or contamination of equipment from accumulated bird feces, and
- Bird collisions with conductors that cause outages but do not kill the birds.

Bird electrocutions do not necessarily result in outages. Of eagle electrocutions in the western United States with known mortality dates (n=612), only 16% were associated with an outage (Harness and Wilson 2001). Likewise, only 16% of known bald eagle mortalities in western Washington from 2000 to 2005 (n=62) caused outages (M. Walters, pers. comm.). Less than 10% of raptor electrocutions documented in Arizona were associated with outages (Dwyer 2004). However, higher proportions of mortalities have been associated with outages in other areas of the western United States. For example, 55% of bird electrocutions (*n*=327) resulted in outages in Utah, Wyoming, Idaho, California, Oregon, and Washington (PacifiCorp, unpubl. data).

Momentary short circuits, which do not cause outages, can cause disruptions for customers with high power quality requirements, and can also result in electrocutions. During these disturbances, the cause of the fault is cleared from the circuit before circuit protection devices trip the line, making it difficult to identify the cause. Some utilities have begun tracking this class of disruption, which might yield important bird mortality information.

Collection of Outage Data

Two key aspects of quantifying bird-caused outages are tracking and verification. Utilities should collect data to quantify outage numbers and causes. These data may include outage location, duration, cause, associated equipment, and pole type. Outage data can help identify outage locations, quantify the impact of birds on system reliability, identify the species associated with outages, and guide retrofitting and new construction efforts for preventing outages.

To accurately address an outage, its cause(s) must be verified. Local regulations require some utilities to list the causes of all outages. In some cases, birds are just speculatively recorded as the cause. In others, their carcasses are not discovered for various reasons: scavengers or people removed them, the victim fell into dense vegetation, or a systematic search was not conducted. Identifying the causes of outages is critical to developing corrective plans. Utilities should recognize that the number of bird-caused outages reported may increase after a tracking or verification program is implemented simply because the causes of more outages are properly identified. On the other hand, the total number of bird-related outages on record may decrease when erroneous reports are corrected.

Although the causes of bird-related outages are well documented, few studies quantify bird-related outage rates. The National Rural Electric Cooperative Association (NRECA) listed animals as the third leading cause of power outages nationwide (Southern Engineering Company 1996). Of Avian Power Line Interaction Committee (APLIC) utility members surveyed in 2005 (*n*=12), 58% tracked bird-caused outages (APLIC 2005). Of utilities that provided data, bird-caused outages ranged from <1 to <10% of their total outages. Half of these utility respondents reported major outages due to birds. In California, wildlife-related incidents accounted for 10 to 25% of all outages (Energy and Environmental Economics, Inc. 2005). Wildlife was considered a contributing cause in up to 20% of outages in Wisconsin during 2003 (Kysely 2004). Birds accounted for 23.5% of substation outages for a Canadian utility in 2002–2003 (BC Hydro 2004). In an assessment of 2,174 bird-related outages documented in the western United States, 60% were caused by federally unprotected species (i.e. starlings or pigeons), 21% were associated with protected bird deaths, 12% were suspected as bird-caused although no carcasses were found (e.g., flocks flushing from lines), and 7% were due to bird nests not associated with a mortality (PacifiCorp, unpubl. data). Within this study, seasonal outage trends were also documented, and revealed that outages peaked during summer and fall (likely due to nesting activity and fall migration).

Costs of Outages

Costs associated with bird-related outages include those related to:

- Lost revenue,
- Power restoration,

- Equipment repair,
- Nest removal and other animal damage-control measures,
- Administrative and managerial time,
- Lost service to customers and negative public perception, and
- Reduced electrical system reliability.

Stocek (1981) estimated that the annual cost of bird-related damage to Canadian utilities was $374,600. Recent data from a Canadian utility estimated that wildlife outages (*n*=2,500 to 3,500) cost $2 million annually (BC Hydro 1999). Wildlife-related outages are estimated to cost up to $3 billion each year in California (Hunting 2002; Singer 2002; Energy and Environmental Economics, Inc. 2005). One utility documented that bird-related outages cost them $2 million annually (APLIC 2005). During a five-month period in 2001 in south Florida, 198 outages affecting over 10,000 customers were related to monk parakeets. Lost revenue from electric power sales due to these outages was $24,000 (Florida Power & Light, unpubl. data). Outage repair was a much more significant cost, estimated at $221,000 annually. The total estimated cost associated with the 198 outages in this small part of the service area was $245,000.

FIGURE 6.28: Red-tailed hawk expelling streamer.

BIRD STREAMERS

Large raptors, vultures, and herons can expel long streams of excrement (Figure 6.28). These "streamers" can cause flashovers and short-outs when they span energized conductors and other line structures. Flashovers are faults that originate on live hardware and travel through the streamer to the structure. Although bird streamers were first thought to be a cause of unexplained transmission line faults in the 1920s (Michener 1924), this hypothesis has been difficult to verify because flashovers are rarely witnessed, and the resulting evidence is difficult to find. Yet, Burnham (1995) estimated that bird streamers might cause as many transmission outages in Florida as lightning, dust, fecal, or industrial contamination. Recent studies in South Africa have emphasized the role of bird streamers as a cause of line faults (van Rooyen et al. 2003).

Evaluating streamer-related faults has often relied upon indirect evidence. Studies conducted by Burnham (1994), van Rooyen and Taylor (2001), Vosloo and van Rooyen (2001), Vosloo et al. (2002), and Acklen et al. (2003) documented patterns that are indicative of streamer-related transmission faults and described methods for preventing outages of this kind. There are several indicators of streamer-caused faults; e.g., the presence of large birds along transmission lines that are subject to faulting (Burnham 1995; van Rooyen et al. 2003; van Rooyen and Smallie 2004). Streamer-related faults are not normally lethal to birds, as streamers are often released as a bird departs from a structure. However, in some cases flashover mortalities do occur. Streamer-related faults occur most frequently

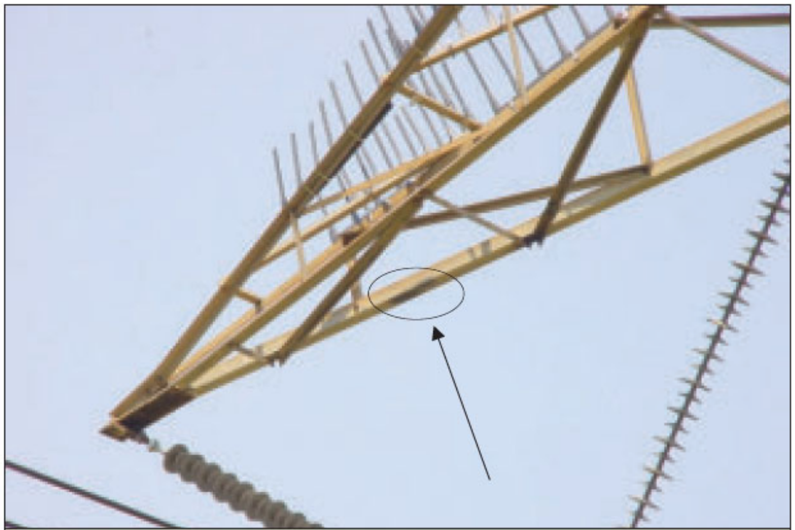
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FIGURE 6.29: Burn marks on transmission structure associated with streamer-caused flashover.

on horizontally configured, steel transmission structures that provide perching space above the conductors. Structures with small windows and shorter air-gaps are especially fault-prone (van Rooyen et al. 2003), although faults can also occur on wooden or concrete structures (Burnham 1995). Faults are most prevalent on the highest phase of the tower, or the phase closest to a preferred perching space on a tower. Such faults are less frequent on vertically configured structures that generally provide little perching space above the conductors. Streamer-related flashovers have been simulated in the laboratory and flash marks on structures and insulators were recognizable (West et al. 1971; Burger and Sardurksi 1995).

Flashovers are generally indicated by burn marks on the insulator string, or the corona ring and tower top. Burn marks may occur as pitting. They are shiny on aluminum structures and black on steel structures (Figure 6.29). Streamer-caused faults typically occur during the late evening and early morning. A late night peak, usually around 11 p.m., occurs as birds finish digesting their last meal. Likewise, an early morning peak occurs when birds leave their roosts (Burnham 1995; van Rooyen et al. 2003). Faults often occur in clusters, indicating that concentrations of large birds have been attracted by a favorable prey base or suitable habitat, or that there is a seasonal population increase.

Devices designed to prevent excrement build-up on insulator strings have had limited success because they fail to prevent the air-gap breakdown caused by streamers. The most successful devices create a barrier that keeps birds from roosting over the conductors. Examples of such devices include welded-rod bird guards and cones. The most comprehensive application of bird-guarding devices for preventing streamer-related faults is practiced in South Africa by Eskom Transmission Group through its National Bird Guard Project. Eskom has installed thousands of HDPE welded-rod bird guards, which have dramatically reduced faults (Vosloo and van Rooyen 2001; van Rooyen et al. 2003). In addition, perch discouragers installed over insulators on lines in Florida have been effective in reducing streamer-related faults (Burnham 1995).

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CHAPTER 7

Developing an Avian Protection Plan

IN THIS CHAPTER

- Choosing the Right Tool—MOUs and APPs
- Components of an APP
- Implementing an Avian Protection Plan

In 2005, the Avian Power Line Interaction Committee (APLIC) and the U.S. Fish and Wildlife Service (USFWS) announced their jointly developed Avian Protection Plan Guidelines (Guidelines) that are intended to help utilities manage their avian/power line issues. The Guidelines offer resources for developing avian protection plans (APPs). An APP should provide the framework necessary for implementing a program to reduce bird mortalities, document utility actions, and improve service reliability. The components that a utility may wish to include in its APP are summarized in this chapter.

The 1996 edition of *Suggested Practices* included a final chapter, "Cooperative Management of the Electrocution Issue," that focused on relationships among utilities and agencies and offered recommendations for mortality reporting, training, and prioritizing remedial actions. Since 1996, utilities and agencies have continued to advance the understanding of avian electrocutions. Efforts between the Avian Power Line Interaction Committee (APLIC) and the U.S. Fish and Wildlife Service (USFWS) have culminated in the Avian Protection Plan Guidelines (Guidelines) (see Appendix C). The Guidelines are a "toolbox" from which utilities may select and tailor components to fit their needs. In this chapter, an overview of the Guidelines is presented, along with recommendations for developing and implementing an Avian Protection Plan (APP). There is an abbreviated version of the Guidelines in Appendix C. The complete version can be obtained from either the APLIC (www.aplic.org) or USFWS (www.fws.gov) website.

CHOOSING THE RIGHT TOOL—MOUs AND APPs

When developing a bird protection program, two tools, the Memorandum of Understanding (MOU) and the APP, have been used effectively. Historically, MOUs have been initiated by the USFWS when it finds a utility has violated bird protection laws and has not implemented or abided by the law or an APP. MOUs are signed by both the utility and the USFWS and establish the program's requirements. They generally include a statement of purpose, the contract's duration, definitions, a requirement to develop an APP, and requirements for permitting, possessing, retrieving, salvaging, reporting, and record keeping.

Although APPs are typically a component of MOUs, they may be initiated voluntarily and signed only by the utility. This can allow for greater flexibility in developing timetables and enables a utility to tailor components to match its specific needs.

Because an APP represents a utility's commitment to reducing its avian impacts and is shared with the USFWS, it is understood to be binding. Since they emanate from the utility, APPs are more easily modified for addressing newly developing problems and unforeseen needs. Despite the fact that APPs are generally initiated by utilities, a cooperative dialog between the utility and the USFWS during development is strongly encouraged. This sets the tenor for those conversations that will inevitably follow, as the APP is implemented and refined over time.

A utility that implements the principles contained in the Guidelines will greatly reduce avian electrocution risk. Developing and implementing an APP makes good business sense because animal- and bird-caused outages can be costly. A utility that creates an APP to address its specific avian issues can benefit through reduced regulatory risk, reliability improvements, cost savings, and positive recognition from regulators, employees, and customers.

COMPONENTS OF AN APP

An APP is a utility-specific program to reduce the operational and avian risks that result from avian interactions with electric utility facilities. Although each utility's APP will be different, the overall goal of reducing avian mortality is the same. The Guidelines provide a framework along with principles and examples to help a utility craft is own APP to best fit its needs while furthering avian conservation and improving reliability and customer service. Because of utility-specific circumstances, some of the elements of the Guidelines may not be applicable. The Guidelines present a comprehensive overview of the elements that should be considered when a utility develops its own APP. An APP should also be a "living document" that is modified over time to improve its effectiveness. The following are the principles of an APP:

- Corporate policy
- Training
- Permit compliance
- Construction design standards
- Nest management
- Avian reporting system
- Risk assessment methodology
- Mortality reduction measures
- Avian enhancement options
- Quality control
- Public awareness
- Key resources

CORPORATE POLICY

An APP typically includes a statement that balances the company's commitment to minimizing its impact on migratory birds and complying with bird-protection regulations with its goal of providing reliable, cost-effective electrical service. To do this, it will comply with all necessary permits, monitor avian mortality incidents, and make reasonable efforts to construct and alter infrastructure to reduce the incidence of avian mortality.

TRAINING

Training is an important element of an APP. All appropriate utility personnel, including managers, supervisors, line crews, engineering, dispatch, and design personnel, should be