Marine Corps Base Camp Pendleton
Avian Power Line Protection Plan

Prepared for
Assistant Chief of Staff, Environmental Security
Marine Corps Base Camp Pendleton
Camp Pendleton, CA 92055
and
Naval Facilities Engineering Command, Southwest
1220 Pacific Highway
San Diego, CA 92132

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San Diego, CA 92123

February 2010

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EXECUTIVE SUMMARY

An Avian Protection Plan (APP) is a program developed to protect and conserve migratory birds by reducing the operational and avian risks that result from avian interactions with electric utility facilities (Avian Power Line Interaction Committee (APLIC) 2006). An APP should be specific to the utility or installation for which it is designed, targeting issues and providing solutions applicable to that particular utility or installation. In order to reduce the potential for loss of raptors, waterfowl, and other migratory birds, Marine Corps Base Camp Pendleton (Base) has voluntarily prepared this Avian Power Line Protection Plan (Plan) in compliance with federal regulations. This Plan places emphasis on preventing avian electrocution mortality through identifying areas on the Base of high raptor use and retrofitting unsafe utility structures that threaten raptors as well as other avian species. Additionally, the creation of a reporting system for documenting the locations of future avian electrocutions will provide a proactive approach to reduce the number of power outages attributed to raptors and other migratory birds throughout the Base.

The development of an avian protection program will benefit the Base in a number of ways. The overall goal of an avian protection plan is to reduce avian mortality, but the practical effect of such a plan translates to advantages for the Base power supply. Power outages are costly and threaten Base power reliability. The implementation of this Plan will first and foremost protect the Base power supply interests. The expense of retrofitting poles to raptor-safe standards is insignificant compared to the costs associated with repairing power outages, fire management, and violations of avian regulatory laws. The implementation of this voluntary Plan not only benefits avian species but provides long-term value to the Base power network, Base personnel, and the 38,000 residential customers on the Base.

Federal agencies have a responsibility to protect migratory birds under Executive Order 13186 (EO 13186). Per the EO 13186, the DoD and the United States Fish and Wildlife Service (USFWS) have entered a Memorandum of Understanding (MOU) for the conservation of birds during non-readiness military actions. Additionally, there are several federal laws that apply to the protection of avian species. A federal rule (The "Migratory Bird Rule," 50 CFR Part 21) allows authorization for take (defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect") by the Department of Defense (DoD) only during military readiness activities. Compliance with these laws is one of the goals established by the Plan.

The Plan is based on the APP Guidelines, a joint guidance document prepared by the Avian Power Line Interaction Committee (APLIC) and USFWS in 2005 and *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*, a publication created by the Edison Electric Institute, APLIC, and the California Energy Commission. This Plan supports practices of avian protection and includes raptor-safe standards for future installations.

Camp Pendleton's undeveloped land supports a variety of diverse habitats characteristic of the semiarid Mediterranean climate, topography, and soil types of southern California. Camp Pendleton's diverse habitat supports an abundant population of birds, including waterfowl, wading birds, raptors, owls and songbirds. One hundred and thirty seven species occur throughout the year on the Base, and an additional 205 species occur or have been known to occur on the Base as migrants, wintering residents, breeding residents, or vagrants (MCBCP checklist). Avian species that occur on Base use a variety of habitats including coastal sage scrub, chaparral, riparian and oak woodlands, grasslands, agricultural and urban or developed settings. Many of the 342 species of birds occurring on the Base are not at risk of electrocution or collision with power lines.

Some bird groups are more susceptible to electrocution and collision mortality, and will benefit from the implementation of an avian protection plan. Raptors are more susceptible to power line electrocution and collision mortality due to their large size and use of power poles for hunting, feeding, resting, roosting and nesting. In general, the use of utility structures by raptors is influenced by the presence and distribution of natural perches and the abundance and availability of prey. Identifying and modifying preferred structures that are utilized by raptors may reduce or minimize the electrocution risk associated with that structure.

Avian electrocutions occur in combination with biological/environmental factors and electrical design factors. Biological and environmental factors are those that influence avian use, such as habitat, prey abundance and availability, species and behavior. The most critical electrical design factor that contributes to avian electrocution is inadequate spacing between energized and/or grounded structures, conductors, hardware or equipment that can create two points of contact for a bird allowing an electrical circuit to run through the bird (APLIC 2006).

All utility structures pose some threat to birds, but certain configurations have been shown to be more dangerous than others (APLIC 2006). A non-raptor safe pole is one in which the distance between two energized parts or an energized and grounded part is less than the wrist-to-wrist distance (60 inches) or height (48 inches) of a landing or perching bird (this measurement is based on a golden eagle). Electrocution risk is also greater on poles with exposed hardware or equipment such as transformers, capacitor banks, jumper wires, cutouts or lightning arresters. These design configurations were once the common industry standard; however with the increased awareness of avian electrocution issues, many utilities are retrofitting older poles and building newer poles to avian-safe standards in their service areas.

In order to reduce the threat of mortality to raptors on the Base, utility structures that are not considered raptor-safe and occur in high-risk areas based on the Avian Electrocution Susceptibility Spatial Model (AVES), should be modified to raptor-safe standards. AVES is an HDR-developed biological model for Camp Pendleton that predicts areas of risk for raptor electrocution. Unsafe structures in high risk areas should be given top priority, although unsafe structures outside of the high risk areas should not be ignored as the potential for an avian interaction still exists. When new utility structures are proposed, the siting locations should be evaluated for avian use in the area based on preferred avian habitat types and historic nesting locations on the Base. Avian-safe structures (proper spacing between conductors, perch guards, nest platforms and line flight diverters) should be the preferred construction standard for all areas where birds are known to frequent.

Through adaptive management, the Base can continually improve the practice of avian protection by evaluating the outcome of avian-power line interactions and incidents on the Base. As incidents occur and problem utility structures become apparent, the Base should follow the procedures outlined in this Plan, which includes documentation via the Avian Reporting System and incorporation of the data into the AVES model. In the event of an avian injury or mortality, the Base should implement retrofitting techniques, as outlined in this Plan. All new utility structures should be built to avian-safe standards. Minimizing the potential for an avian-power line interaction can help prevent future incidents, reducing the need for costly utility repairs and possible violations of the various bird regulatory laws.

As part of its ongoing commitment to natural resource management and compliance with its Integrated Natural Resource Management Plan, it is recommended that the Base adopt and implement the avian protection measures as described in the Plan to reduce potential avian mortality as a result of electrocution and collision incidents with the Base utility structures. Adoption and implementation of the Plan serves to minimize avian mortality as well as comply with federal avian protection regulations and reduce power outages to the Base facilities.

In order to effectively implement this Plan, it is recommended that the Base develop a program to train all appropriate personnel (Facilities Maintenance Department and AC/S Environmental Security staff, for example) on the issues and protocols outlined in this Plan. This training will ensure that all appropriate personnel have a thorough understanding of the Plan and their responsibility to avian protection and regulatory compliance.

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1.0 INTRODUCTION

1.1 SCOPE

An Avian Protection Plan (APP) is a utility-specific program developed to protect and conserve migratory birds by reducing the operational and avian risks that result from avian interactions with electric utility facilities (APLIC 2006). In order to reduce the potential for loss of raptors, waterfowl, and other migratory birds, Marine Corps Base Camp Pendleton (Base) has voluntarily prepared this Avian Power Line Protection Plan (Plan) in compliance with federal guidelines for reducing impacts to migratory birds from utility infrastructure regulations. This Plan places emphasis on preventing avian electrocution mortality by identifying areas on the Base of high raptor use and retrofitting unsafe utility structures that threaten the raptors as well as other bird species. Additionally the implementation of a reporting system for documenting the locations of future avian electrocutions will provide a proactive approach to avian electrocution issues while reducing the number of power outages attributed to raptors and other migratory birds and contributing to species' protection throughout the Base.

Implementation of this Plan will support the Base's effort to reduce potential violations of the Migratory Bird Treaty Act (MBTA)[1], the Bald and Golden Eagle Protection Act (BGEPA)[2], and the Endangered Species Act (ESA)[3] while demonstrating a proactive management of avian resources and avoiding a source of potential violations to the MBTA, BGEPA, and ESA. Additionally, implementation of this Plan will also result in fewer power outages and reduce costs for the repair of structures involved in avian electrocutions.

1.2 PRINCIPLES OF AN AVIAN PROTECTION PLAN

This Plan was developed based on recommendations from the APP Guidelines (APLIC and USFWS 2005). Implementing the principles contained in the APP Guidelines will reduce avian electrocution risk. These principles provide a framework for the Base to systematically recognize, address, monitor and prevent avian electrocution incidents. This Plan includes sections from the following principles outlined in the APP Guidelines:

- Corporate or Base Policy (6.1)
- Training (6.4)
- Compliance (6.3)
- Construction Design Standards (5.2)
- Nest Management (7.2.5)
- Avian Reporting System (7.0)
- Risk Assessment Methodology (4.6)
- Mortality Reduction Measures (5.0)
- Avian Enhancement Options (6.5)
- Quality Control (6.6)
- Public Awareness (6.7)
- Key Resources (6.8)

[1] Migratory Bird Treaty Act of 1918 (Title 16, United States Code (USC), Parts 703 – 712).
[2] Bald and Golden Eagle Protection Act of 1940 (as amended Title 16 USC 668-668d).
[3] Endangered Species Act of 1973 (as amended, Title 16, USC 1531-1544).

1.3 BENEFITS OF AN AVIAN PROTECTION PROGRAM

The overall goal of an avian protection plan is to reduce avian mortality, but the results of such a plan also translate to practical advantages for the Base power supply. Power outages are costly and threaten Base power reliability. Costs associated with avian-related outages include 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. The implementation of this Plan will first and foremost protect the Base power supply interests.

In the state of California, wildlife interactions with power lines account for 10 to 25 percent of all power outages and the total cost of wildlife-caused power outages for California ranges from $32 million to $317 million per year (Energy and Environmental Economics, Inc. 2005). Wildlife-related reliability issues and the costs associated with them can be minimized by retrofitting avian-unsafe structures and installing avian protection devices. Simple, cost-effective retrofits, as described in this Plan, may reduce power outages on the Base and improve power reliability.

Avian electrocutions may increase risk for occurrence of wildfires on the Base. The Base frequently experiences wildfires due to a combination of dry climatic conditions and an abundance of fuel sources. It is unknown whether avian electrocutions have resulted in wildfires on the Base, but avian electrocutions have caused wildfires elsewhere in the state. In 2004, a hawk collided with a utility structure in Santa Clarita, CA which resulted in a fire that prompted the evacuation of over 1,600 homes and burned over 6000 acres (Energy and Environmental Economics, Inc. 2005). Wildfires threaten the safety and welfare of Base personnel, and containing wildfires is a costly and time-consuming process. Implementing an avian protection program which focuses on minimizing avian electrocutions likely will reduce the risk of wildfires on the Base.

The voluntary implementation of an avian protection plan will support compliance with the MBTA, BGEPA, and ESA. Noncompliance with these acts and/or failure to take reasonable measures to avoid impacting avian species may result in large fines and penalties or in extreme cases, imprisonment. The consequences of violations to the environmental regulations protecting avian species are further described below in Section 1.5.

The expense of retrofitting poles to raptor-safe standards is insignificant compared to the costs associated with repairing potential power outages, fire management, and violations of avian regulatory laws. The implementation of this voluntary Plan not only benefits avian species but provides long-term value to the Base power network, Base personnel, and the 38,000 residential customers on the Base.

1.4 FEDERAL AVIAN PROTECTION LAWS

Although the primary designated purpose of the Base is to train military personnel for battle, the Base is also responsible for managing the natural resources located within its boundaries. As defined by the Sikes Act (USFWS website), the purpose of natural resource management on military installations should be "…*CONSISTENT WITH THE USE OF MILITARY INSTALLATIONS TO ENSURE THE PREPAREDNESS OF THE ARMED FORCES***,** provide for the conservation and rehabilitation of natural resources on military installations; the sustainable multipurpose use of the resources, which shall include hunting, fishing, trapping, and non-consumptive uses; and subject to safety requirements and military security, public access to military installations to facilitate the use [of these resources].” Conservation of military lands serves to both comply with the Sikes Act as well as provide habitat for the federal listed species that occur on the Base.

In a court ruling in 2000, it was determined that federal agencies are not exempt from compliance with the MBTA and that a federal agency’s unpermitted taking of migratory birds is in violation of the MBTA. Federal agencies have a responsibility to protect migratory birds under Executive Order 13186 (EO 13186). A federal rule (The “Migratory Bird Rule,” 50 CFR Part 21) allows authorization for take by the Department of Defense (DoD) only during military readiness activities. EO 13186 defines ‘take’ as ‘a means to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect’. Per the EO 13186, the DoD and the USFWS has entered a Memorandum of Understanding (MOU) for the conservation of birds during non-readiness military actions. In addition, there are several federal laws that apply to the protection of avian species. Compliance with these laws and regulations is one of the goals established by the Plan. The following laws and regulations are applicable to the issues associated with avian mortality from electrocutions and collisions, and nest management on utility poles and towers. Violation of the laws outlined below can result in fines or imprisonment (NEPA, DoDPIF, and USFWS websites).

Executive Order 13186 (EO 13186)

EO 13186 was issued by President Clinton on January 10, 2001. EO 13186 directs federal agencies (who are) ‘taking actions with a measurable negative effect on migratory bird populations’ to develop and implement a MOU with the USFWS. The purpose of the MOU is to promote the conservation of migratory bird populations. The EO 13186 requires federal agencies to incorporate migratory bird conservation measures into their agency activities. EO 13186 applies to departments and agencies of the federal government including the Departments of Interior, Commerce, Agriculture, Transportation, Energy, Defense and the Environmental Protection Agency. Federal agencies are encouraged to incorporate the following actions into their MOU, as practicable and appropriate:

(1) Support the conservation intent of the migratory bird conventions by integrating bird conservation practices into agency activities and by avoiding or minimizing adverse impacts on migratory bird resources when conducting agency actions;

(2) Restore and enhance the habitat of migratory birds;

(3) Prevent or abate the pollution or detrimental alteration of the environment for the benefit of migratory birds;

(4) Design migratory bird habitat and population conservation practices into agency plans;

(5) Ensure that agency plans and actions promote programs and recommendations of comprehensive migratory bird planning efforts;

(6) Ensure that environmental analyses of federal actions required by the National Environmental Policy Act (NEPA) or other established environmental review processes evaluate the effects of actions and agency plans on migratory birds, with emphasis on species of concern;

(7) Provide notice to USFWS in advance of conducting an action that is intended to take migratory birds, or annually report to USFWS on the number of individuals of each species of migratory birds intentionally taken during the conduct of any agency action, including but not limited to banding or marking, scientific collecting, taxidermy, and depredation control;

(8) Minimize the intentional take of species of concern by delineating standards and procedures for such take and developing procedures for the review and evaluation of take actions;

(9) Identify where unintentional take is having, or is likely to have, a measurable negative effect on migratory bird populations (focusing first on species of concern, priority habitats, and key risk factors) and develop practices that will lessen the amount of unintentional take;

(10) Control the import, export, and establishment in the wild of live exotic animals and plants that may be harmful to migratory bird resources;

(11) Promote research and information exchange related to the conservation of migratory bird resources;

(12) Provide training and information to appropriate employees on methods and means of avoiding or minimizing the take of migratory birds and conserving and restoring migratory bird habitat;

(13) Promote migratory bird conservation in international activities and with other countries and international partners, in consultation with the Department of State;

(14) Recognize and promote economic and recreational values of birds; and

(15) Develop partnerships with non-federal entities to further bird conservation.

Federal Rule for Take Authorization for Department of Defense

In March 2002, the U.S. District Court ruled that military training exercises on DoD lands that result in the incidental take of migratory birds violate the MBTA. However, in December 2002, Congress authorized an interim period during which the prohibitions on incidental take of migratory birds would not apply to authorized military readiness activities. Readiness activities are defined as training and operations that relate to combat and adequate and realistic testing and training of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use. Readiness activities do not include routine operation of installation operating support functions.

This take authorization serves to achieve an appropriate balance between the needs of national security and those of bird conservation. On February 28, 2007, USFWS finalized a rule (The "Migratory Bird Rule," 50 CFR Part 21) allowing the Armed Forces to "take" migratory birds in the course of military readiness activities, as directed by the 2003 National Defense Authorization Act. The rule directs the Armed Forces to assess the effects of military readiness activities on migratory birds, in accordance with NEPA. The Armed Forces are also required to develop and implement appropriate conservation measures if a proposed action may have a significant adverse effect on a migratory bird population. If conservation measures require monitoring of migratory bird populations, the Armed Forces must retain the data for five years.

Memorandum of Understanding (MOU) to Promote the Conservation of Migratory Birds

On July 31, 2006, the DoD and the USFWS entered into a MOU to promote the conservation of migratory birds, in accordance with EO 13186. This MOU describes specific actions that should be taken by DoD to advance migratory bird conservation, avoid or minimize the take of migratory birds, and ensure DoD operations (with the exception of military readiness activities) are consistent with the MBTA. The MOU also describes how USFWS and DoD will work together cooperatively to achieve these ends. The MOU does not authorize the take of migratory birds. USFWS, however, may develop incidental take authorization for federal agencies that complete an Executive Order MOU. This MOU specifically pertains to the following categories of DoD activities:

(1) Natural resource management activities, including, but not limited to, habitat management, erosion control, forestry activities, agricultural outleasing, conservation law enforcement, invasive weed management, and prescribed burning;

(2) Installation support functions, including but not limited to, the maintenance, construction or operation of administrative offices, military exchanges, road construction, commissaries, water treatment facilities, storage facilities, schools, housing, motor pools, non-tactical equipment, laundries, morale, welfare, and recreation activities, shops, landscaping, and mess halls;

(3) Operation of industrial activities;

(4) Construction or demolition of facilities relating to these routine operations; and

(5) Hazardous waste cleanup.

Migratory Bird Treaty Act (MBTA)

The MBTA implements treaties from the United States, Great Britain, Mexico, Japan, and the former Soviet Union for the protection of migratory birds. The MBTA states: "…it shall be unlawful to pursue, hunt, take, capture, kill…possess, offer for sale, sell…purchase…ship, export, import…transport or cause to be transported any migratory bird, any part, nest, or eggs of any such bird, or any product…composed in whole or in part, of any such bird or any part, nest, or egg thereof…" The MBTA does not provide definitions for any of the terms listed above, but the USFWS has defined 'take' broadly for the purposes of the MBTA. USFWS states that 'take' "means to pursue, hunt, shoot, wound, kill, trap, capture or collect or to attempt the foregoing". The MBTA currently protects 836 migratory bird species, including waterfowl, shorebirds, seabirds, wading birds, raptors, and songbirds.

Endangered Species Act (ESA)

Under the provisions of the ESA, federal agencies are directed to conserve threatened and endangered species and the habitats in which these species are found. Federal agencies are required to ensure that actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of any endangered, threatened, or proposed (for listing as threatened or endangered) species or its critical habitat. An endangered species is defined as a species that is at risk of extinction throughout all or a significant portion of its range (ESA Section 3[6]). A threatened species is defined as a species that is likely to become endangered within the foreseeable future (ESA Section 3[19]). Section 9 of the ESA makes it unlawful for a person to 'take' a listed species. 'Take' under the ESA is defined as "…harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct."

Bald and Golden Eagle Protection Act (BGEPA)

Under the authority of the BGEPA, bald eagles (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) are given additional legal protection. The BGEPA makes it unlawful to import, export, take, sell, purchase, or barter any bald eagle or golden eagle, their parts, products, nests, or eggs. 'Take' includes pursuing, shooting, poisoning, wounding, killing, capturing, trapping, collecting, molesting, or disturbing the eagles. Permits may be granted for scientific or exhibition use, or for traditional and cultural use by Native Americans. However, no permits may be issued for import, export, or commercial activities involving eagles.

1.5 VIOLATIONS AND ENFORCEMENT OF THE MBTA, BGEPA, AND ESA (AVIAN POWER LINE INTERACTIONS)

The MBTA is a strict liability statute; therefore proof of intent is not required in the prosecution of a "taking" violation. An individual who violates the MBTA by taking a migratory bird may be fined up to $15,000 and/or imprisoned for up to six months for a misdemeanor. Violators of the BGEPA may be fined up to $100,000 and and/or imprisoned for up to one year. The BGEPA has additional provisions where, in the case of a second or subsequent conviction, penalties of up to $250,000 and/or two years imprisonment may be imposed (USFWS website). Felony violations of the ESA may result in fines up to $50,000 and/or one year imprisonment (for crimes involving endangered species) and $25,000 and/or six months imprisonment (for crimes involving threatened species). Misdemeanor violations of the ESA may result in fines up to $25,000 for endangered species and $12,000 for threatened species (ESA Handbook website).

In response to the continuing large number of raptors electrocuted along power lines, USFWS has become increasingly more vigilant in the prosecution of violators of federal avian protection laws in regards to avian power line interactions. In 1993, USFWS issued its first citation against Pacific Gas and Electric of California (PGE) for violating the MBTA. PGE was fined $1500 and agreed to retrofit power lines to raptor safe standards. In 1998, USFWS issued its second notification of violation to Sand Point Electric of Alaska, resulting in a fine of $500 and an agreement to retrofit dangerous structures.

In a landmark case in 1999, the Moon Lake Electric Association of Colorado (MLEA) was given three years of probation, ordered to pay $100,000 in fines and restitution, and was required to retrofit power lines with bird-safety devices after being found guilty of violating the MBTA and the BGEPA. MLEA was also required to enter into a Memorandum of Understanding (MOU) with the USFWS and to hire a qualified consultant to develop an Avian Protection Plan (Harness 2000).

MLEA was charged with killing 17 raptors and six counts of violating the MBTA and the BGEPA. However, in addition to the 17 raptor mortalities that held charges, another 21 raptors had been electrocuted and found dead under MLEA power lines over the years. The judge presiding over this case brought special attention to the fact that MLEA failed to install inexpensive retrofits on 2,450 of 3,096 poles in the area where raptor mortalities had occurred. This is the first significant case of a utility being criminally prosecuted under the MBTA and BGEPA, and raised awareness of avian electrocutions associated with utilities. This case sets the precedent that the MBTA is violated if one unintentionally harms or kills a bird under preventable circumstances (Harness 2000).

The most recent case of MBTA and BGEPA violations involving an electric utility occurred in July 2009. PacifiCorp, one of the largest electric utilities in the West, was charged with 34 counts of unlawfully taking golden eagles, hawks, and ravens in violation of the MBTA and BGEPA. PacifiCorp has received the strictest sentence to date for violations of the MBTA and BGEPA: $10.5 million and five years probation (USFWS PacifiCorp Release website).

PacifiCorp was sentenced to pay a $510,000 criminal fine and an additional $900,000 in restitution. Additionally, the company will spend the next five years on probation. During the probation period, PacifiCorp has been ordered to spend $9.1 million to repair or replace its equipment to avian safe standards (USFWS PacifiCorp Release website).

A USFWS investigation revealed that PacifiCorp had killed 232 eagles in Wyoming from January 2007 to July 2009. It was determined in the ruling that PacifiCorp had failed to address avian electrocutions in Wyoming and must now implement an Avian Protection Plan in an attempt to reduce avian electrocution mortality (USFWS PacifiCorp Release website).

The PacifiCorp case exemplifies the commitment of the USFWS to hold utilities accountable for avian electrocutions. The USFWS maintains that it will continue to seek criminal charges against companies that refuse to take a proactive approach in reducing avian electrocutions (USFWS PacifiCorp Release website).

1.6 GOALS OF THE PLAN

This Plan supports practices of avian protection and includes raptor-safe standards for future installations. The Plan is based on the APP Guidelines, a joint guidance document prepared by the Avian Power Line Interaction Committee (APLIC) and USFWS and *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*, a publication created by the Edison Electric Institute, APLIC, and the California Energy Commission. Voluntary implementation of this Plan will meet several goals with the overall purpose of reducing the potential for bird mortality associated with the Base's electrical utilities. The goals of the Plan are to:

- Assist the Base in compliance with federal laws regarding avian species to avoid the threat of penalties and fines;
- Improve Base reliability and service by reducing power outages due to avian interactions, and reduce repair costs due to electrocutions**;**
- Identify and isolate where electrocution and collision mortality has occurred or has the potential to occur to minimize future electrocutions and collisions;
- Reduce the potential for electrocution and collision impacts to raptors and other bird species present on the Base by implementing specific mortality reduction actions;
- Create an avian reporting system to document incidents of electrocution and collision mortality; and
- Ensure new transmission and distribution line construction follows raptor-safe standards.

1.7 IMPLEMENTATION

Meeting the goals of the Plan require the following actions to provide the necessary information for successful implementation.

- Verify raptor electrocution, update mapped data, and develop additional data on concentrations of raptors and other migratory birds;
- Identify the environmental and behavioral factors that lead to areas of high raptor use and potentially higher numbers of electrocutions and outages;
- Assist in refining criteria and protocols to further avian conservation;
- Increase accuracy and detail of incident reporting; and
- Assist in the continuation of the testing and evaluation of protective equipment and materials used to manufacture protective equipment.

2.0 STUDY AREA

2.1 DESCRIPTION OF MARINE CORPS BASE CAMP PENDLETON

Camp Pendleton was officially established in 1942 by President Franklin D. Roosevelt as part of an effort to bolster national security during World War II. This formalized dedication made Camp Pendleton the largest Marine Corps Base in the United States, and one of the largest military installations on the West Coast. Since then, Camp Pendleton has continued to grow to support military training for almost 60,000 active and reserve duty personnel in the Marine, Navy, Army, Air Force and National Guard units. Training exercises take place in a variety of locations on the Base, which include but are not limited to the 31 training areas, 100 live-fire facilities, seven amphibious assault landing beaches, six Combat Training Towns, 19 obstacle courses, and two heavy equipment training sites. Over 5000 buildings and structures, 500 miles of roads, and almost 335 miles of utility lines currently exist on the Base (Camp Pendleton website and J. Shields, personal communication).

Camp Pendleton encompasses more than 125,000 acres of coastal southern California (Figure 1). It is located in the northwest corner of San Diego County and is positioned between Los Angeles, 82 miles to the north, and San Diego, 38 miles to the south. Only 10,000 acres of Camp Pendleton are developed, while the rest remains undeveloped for use in training. Camp Pendleton, along with the neighboring Cleveland National Forest to its north, occupies some of the last open space and wildlife habitat in coastal areas of southern California. Urban communities surrounding Camp Pendleton include Oceanside to the south, Fallbrook to the east and San Clemente to the northwest (MCBCP 2007).

Camp Pendleton's undeveloped land supports a variety of diverse habitats, characteristic of the semi-arid Mediterranean climate, topography, and soil types of southern California. Included among the habitat types are coastal sage scrub, coastal bluff scrub, chaparral, oak woodlands, riparian, marsh, coastal dunes, and grasslands (native and non-native) (Figure 2). These habitat types support over 800 plant species, hundreds of invertebrates, 50 mammals, 35 reptiles, 12 amphibians, 342 birds and 83 fish species (MCBCP 2007).

San Diego County has more rare and federally endangered and threatened species than any other county in the nation (MCBCP 2007). Camp Pendleton provides year-round or seasonal habitat to 16 federally listed species, including: California least tern (*Sternula antillarum browni*), coastal California gnatcatcher *(Polioptila californica californica)*, least Bell's vireo *(Vireo bellii pusillus)*, light-footed clapper rail *(Rallus longirostris levipes)*, southwestern willow flycatcher *(Empidonax traillii extimus)*, western snowy plover *(Charadrius alexandrinus nivosus)*, pacific pocket mouse *(Perognathus longimembris pacificus)*, Stephens' kangaroo rat *(Dipodomys stephensi)*, southern steelhead trout *(Oncorhynchus mykiss)*, tidewater goby *(Eucyclogobius newberryi)*, arroyo toad *(Bufo californicus)*, Riverside fairy shrimp *(Streptocephalus woottoni)*, San Diego fairy shrimp *(Branchinecta sandiegonensis)*, San Diego button-celery *(Eryngium aristulatum* var. *parishii)*, spreading navarretia *(Navarretia fossalis)*, and thread-leaved brodiaea *(Brodiaea filifolia)*.

2.2 DESCRIPTION OF BASE POWER LINE NETWORK

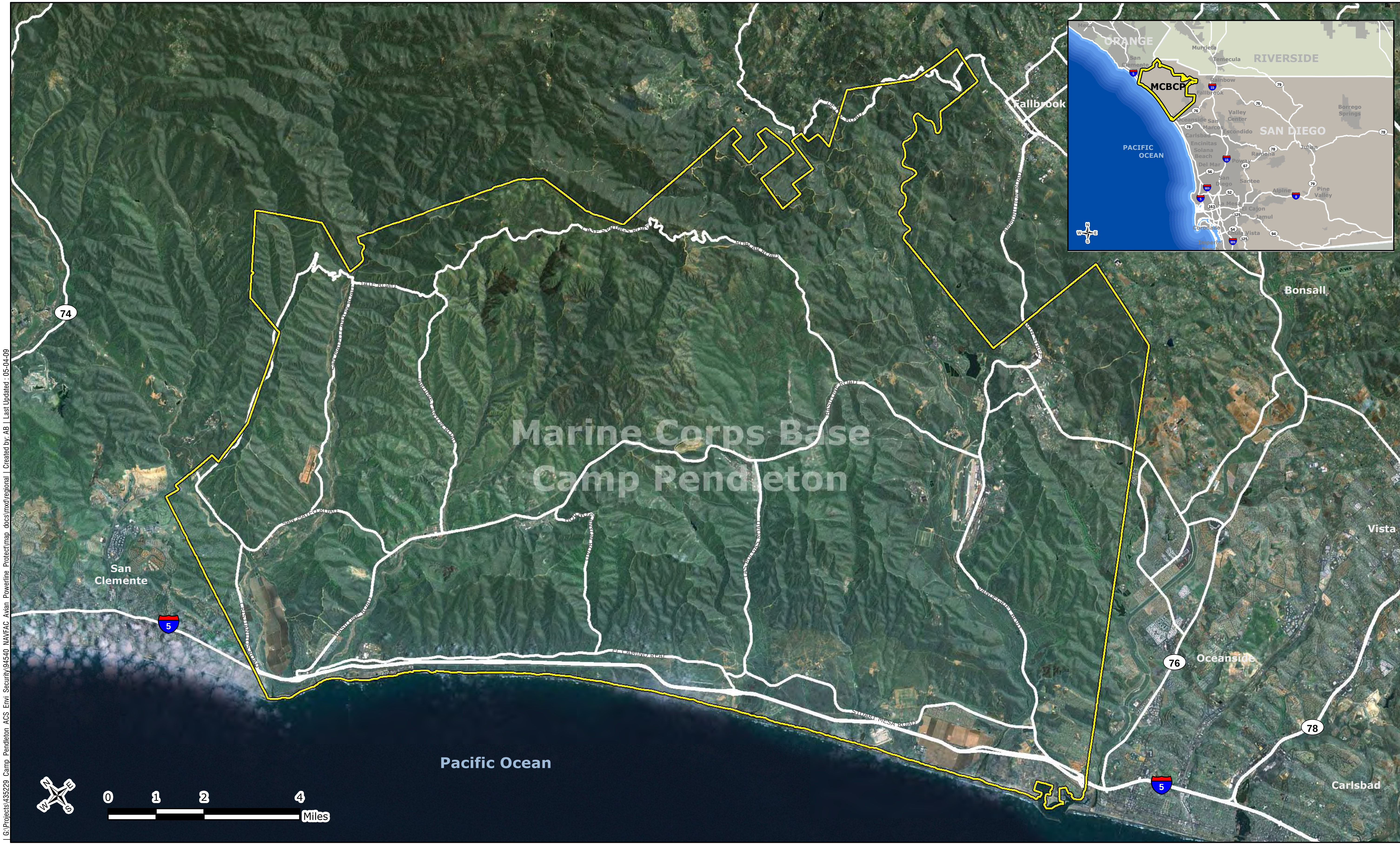
Camp Pendleton's electrical distribution system includes all facilities, equipment, lines, poles, cables, transformers and substations that distribute electric power throughout the Base. Sixty percent of the distribution system is owned and operated by the Base, while 40 percent is controlled by San Diego

Gas and Electric (SDG&E). SDG&E power lines fall under the jurisdiction of their Avian Protection Plan, therefore this Plan only applies to Base-owned equipment.

Electrical power on Base is distributed by SDG&E through nine on-base substations and three off-base substations. The on-base Haybarn substation (69kV-12kV) is the largest substation distributing power to areas that consume approximately 60 percent of the total power consumption for the Base. Other SDG&E substations providing power to the Base include Las Pulgas, Stuart, San Mateo, Oceanside, and San Luis Rey.

Camp Pendleton owns approximately 40 substations and over 175 transformers, as well as the distribution lines that distribute power from all of the substations (with the exception of the Oceanside substation whose lines are primarily owned by SDG&E). Most of the Base-owned 4kV distribution lines are overhead lines installed 40 years ago. These lines are considered to be in fair condition, while the Base-owned 12kV lines, installed 25 years ago, are considered to be in good condition (MCBCP 2003 and J Shields, pers. comm.).

Almost 335 miles of utility lines currently exist on Base (Figure 3). Over 12,000 poles and 10,000 individual line segments make up the power line network. The highest concentration of poles and lines occur in the most urbanized areas of the Base, such as the Mainside area, Del Mar Beach, and San Onofre. Many poles and lines occur along the main roads running throughout the Base as well. These roads include Interstate 5, Vandegrift Boulevard, Basilone Road, Las Pulgas Road, San Mateo Road, Christianitos Road and Case Springs Road. In addition to occurring along the main, paved roads of the Base, the utility network expands to follow dirt roads, creeks and drainages along Talega Creek to the north and the Santa Margarita River to the south. A 20-mile linear stretch of poles and lines also runs parallel to Interstate 5 on the western edge of the Base. The Base power line network is extensive, occurring in a variety of habitats including riparian, scrub, oak woodland, chaparral, and grasslands.



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Regional and Vicinity

FIGURE 1

NAVFAC | Marine Corps Base Camp Pendleton | Avian Power Line Protection Plan

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Vegetation Communities

FIGURE 2

NAVFAC | Marine Corps Base Camp Pendleton | Avian Power Line Protection Plan

Base Utility Network

FIGURE 3

NAVFAC | Marine Corps Base Camp Pendleton | Avian Power Line Protection Plan

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3.0 SPECIES OF INTEREST

3.1 PROTECTED SPECIES OCCURRING ON BASE

Most birds occurring on Camp Pendleton are protected by the MBTA, with the exception of three introduced exotic species (house sparrow, European starling, and rock pigeon), two game species (California quail and mountain quail), and one babbler (wrentit). Bald and golden eagles are further protected by the BGEPA. There are six species listed as federally endangered or threatened that receive protection on the Base. Additionally, several species occurring on the Base are afforded special status through the state of California (state endangered/threatened, California species of special concern, California fully protected, and California Department of Forestry and Fire Protection sensitive species), USFWS (USFWS 2008 Birds of Conservation Concern) and the United States Forest Service (United States Forest Service sensitive species). While these birds do not receive protection on the Base, it is important to note their occurrence in a global context. All special status birds are shown on Table 1.

3.2 BIRD POPULATION AND USE WITHIN BASE

Camp Pendleton's diverse habitat supports an abundant population of birds, including waterfowl, wading birds, raptors, owls and songbirds. One hundred and thirty seven species occur year-round on the Base, and an additional 205 species occur or have been known to occur on the Base as migrants, wintering residents, breeding residents, or vagrants (MCBCP checklist). Avian species that occur on Base use a variety of habitats including coastal sage scrub, chaparral, riparian and oak woodlands, grasslands, agricultural and urban or developed settings.

Many of the 342 species of birds occurring on the Base are not at risk of electrocution or collision with power lines. Some bird groups are more susceptible to electrocution and collision mortality, and will benefit from the implementation of an avian protection plan. On record, fifteen birds have been electrocuted on the Base since 2004. However, it is unknown how many more birds may have been killed on utility structures but were not detected or reported. Creating a system that documents avian electrocutions while identifying problem utility structures will help minimize further avian electrocution incidents.

The following avian groups are at the highest risk of a utility interaction, with special emphasis on raptors, as they are the most commonly electrocuted avian group on the Base. Therefore, raptors will be targeted and specifically addressed in regards to reducing electrocution and collision mortality and implementing protective measures.

3.2.1 Raptors

Seventeen species of raptor and seven species of owl have been recorded on Camp Pendleton. Bald eagle (*Haliaeetus leucocephalus)*, sharp-shinned hawk (*Accipiter striatus)*, Swainson's hawk (*Buteo swainsoni)*, zone-tailed hawk (*Buteo albonotatus*), ferruginous hawk (*Buteo regalis)*, merlin (*Falco columbarius)*, peregrine falcon (*Falco peregrinus)*, prairie falcon (*Falco mexicanus)*, flammulated owl (*Otus flammeolus*), and burrowing owl (*Athene cunicularia)* are present as either migrant, vagrant or wintering residents, while turkey vulture (*Cathartes aura)*, osprey (*Pandion haliaetus)*, white-tailed kite (*Elanus leucurus)*, northern harrier (*Circus cyaneus)*, Cooper's hawk (*Accipiter cooperii)*, red-shouldered hawk (*Buteo lineatus)*, red-tailed hawk (*Buteo jamaicensis)*, golden eagle

(*Aquila chrysaetos)*, American kestrel (*Falco sparverious)*, barn owl (*Tyto alba)*, great-horned owl (*Bubo virginianus)*, western screech owl (*Megascops kennicottii)*, long-eared owl (*Asio otus)*, and short-eared owl (*Asio flammeus*) are present year round as either breeding or non-breeding residents.

Turkey vulture, white-tailed kite, Cooper's hawk, red-shouldered hawk, red-tailed hawk, American kestrel, barn owl, western screech-owl and great-horned owl are the most abundant raptor species on the Base using a variety of habitat types amongst them.

Since 2004, the Base has recorded the electrocution of 12 raptors. This figure is based on incidental reports and may underestimate the true number of avian electrocutions on the Base. While these records document the existence of avian electrocutions on the Base, they may only represent a fraction of the actual number of avian-utility interactions.

Of the documented avian electrocutions on the Base, six were red-tailed hawks, two were turkey vultures, and the remaining birds were individuals of golden eagle, red-shouldered hawk, osprey and barn owl. Information regarding the electrocution incidents is limited, including the location and identification number of the structure, and it is unknown whether the structures have been retrofitted to avian- safe standards. Implementing this Plan is crucial in reducing Base-wide avian-utility interactions.

Raptor nesting data exists for white-tailed kite, northern harrier, Cooper's hawk, red-shouldered hawk, red-tailed hawk, golden eagle, barn owl, great-horned owl and long-eared owl. The nesting data is historic and is a representation of the cumulative number of nests that have occurred on the Base over an unreferenced period of time (based on MCBCP GIS data). The nesting data is the result of multiple survey efforts. It is unknown whether survey protocols were standardized amongst surveying efforts.

Of the historic number of raptor nests that have occurred on the Base, red-tailed hawk nests make up almost half of the recorded nests with the majority of their nests occurring in grassland, riparian or scrub habitat. White-tailed kite, Cooper's hawk, long-eared owl and red-shouldered hawk predominately nest in riparian habitat, while the majority of barn owl, golden eagle, great horned owl and northern harrier nests occur in scrub habitat. Table 2 compiles the nesting data of nine raptors on the Base, and Figure 4 shows the distribution of nesting raptors on the Base. Table 2 and Figure 4 only represent where the historic nests have occurred, and do not represent the number of nests in any particular year.

Raptors are more susceptible to power line electrocution and collision mortality due to their large size and use of power poles for hunting, feeding, resting, roosting and nesting. The risk factors associated with raptor electrocution are further discussed in Section 4.4.

Table 1. Special-Status Birds Occurring on Marine Base Corps Camp Pendleton and the Regularity of Occurrence

Species	Status[4]	Habitat Association	Abundance
Common Loon *Gavia immer*	CSSC	Salt water bays, harbors and tidal lagoons along coast	Uncommon migrant and winter visitor, rare in summer
Pink-footed Shearwater *Puffinus creatopus*	BCC	Open Ocean	Rare spring migrant
Black-vented Shearwater *Puffinus opisthomelas*	BCC	Open Ocean	Uncommon migrant and winter visitor
Ashy Storm-Petrel *Oceanodroma homochroa*	BCC	Open Ocean	Rare fall migrant
American White Pelican *Pelecanus erythrorhynchos*	CSSC	Lagoons, bays, estuaries and fresh water ponds along coast	Uncommon migrant and winter visitor
Brown Pelican *Pelecanus occidentalis*	CFP	Coastal salt water and open ocean	Common non-breeding resident
Double-crested Cormorant *Phalacrocorax auritus*	CSSC	Ponds, lakes, artificial impoundments, slow-moving rivers, lagoons, estuaries, and open coastlines	Common non-breeding resident
Least Bittern *Ixobrychus exilis*	CSSC	Large brackish and fresh-water marshes	Uncommon breeding resident
Great Blue Heron *Ardea herodias*	CDF	Bays, lagoons, ponds, and lakes	Common breeding resident
Great Egret *Ardea alba*	CDF	Lagoons, bays, estuaries, ponds and lakes	Common winter visitor and migrant, uncommon in summer
White Faced Ibis *Plegadis chihi*	CSSC	Fresh-water ponds, irrigated fields and brackish lagoons	Uncommon migrant and winter visitor, rare in summer
Osprey *Pandion haliaetus*	CDF, CSSC	Along the coast and lakes	Uncommon non-breeding resident
White-tailed Kite *Elanus leucurus*	CFP	Riparian woodland, live oaks, groves of sycamores that border grassland or open fields	Uncommon breeding year-round resident
Bald Eagle *Haliaeetus leucocephalus*	BCC, BGEPA, CDF, CFP, CT	Lakes, rivers, wetlands and coastal slopes	Rare winter visitor
Northern Harrier *Circus cyaneus*	CSSC	Grassland, agricultural fields, and coastal marshes	Uncommon breeding resident
Sharp-shinned Hawk *Accipiter striatus*	CSSC	Woodlands, parks and residential areas	Uncommon migrant and winter visitor
Cooper's Hawk *Accipiter cooperii*	CSSC	Riparian, Oak woodlands, parks and residential areas	Uncommon migrant and winter visitor, uncommon breeding summer resident

[4] Status Abbreviations: BCC- USFWS 2008 Birds of Conservation Concern , BGEPA- Bald and Golden Eagle Protection Act, CDF- California Department of Forestry and Fire Protection sensitive species, CE- state (California) endangered, CFP- California fully protected, CSSC- California Species of Special Concern, CT- state (California) threatened, FE- federally endangered, FT- federally threatened, and USFS- United States Forest Service sensitive species.

Species	Status[4]	Habitat Association	Abundance
Swainson's Hawk *Buteo swainsoni*	CT	Agricultural fields and coastal lowlands	Rare spring and fall migrant
Ferruginous Hawk *Buteo regalis*	CSSC	Grasslands and agricultural fields	Uncommon winter visitor
Golden Eagle *Aquila chrysaetos*	BGEPA, CDF, CFP, CSSC	Grasslands and broken chaparral or sage scrub	Uncommon breeding resident
Merlin *Falco columbarius*	CSSC	Agricultural fields and grasslands	Uncommon fall migrant and winter visitor
Peregrine Falcon *Falco peregrinus*	BCC, CDF, CE, CFP	Coastal mudflats, shores and ponds	Uncommon migrant and winter visitor, rare in summer
Prairie Falcon *Falco mexicanus*	CSSC	Open grasslands, agricultural fields and desert scrub	Uncommon fall migrant and winter visitor
Light-footed Clapper Rail *Rallus longirostris levipes*	FE	Coastal salt marshes	Uncommon breeding resident
Western Snowy Plover *Charadrius alexandrinus nivosus*	BCC, CSSC, FT	Sandy ocean beaches, lagoons and tidal mudflats	Common spring migrant and breeding summer resident, uncommon fall migrant and winter visitor
Black Oystercatcher *Haematopus bachmani*	BCC	Rocky shorelines	Rare in spring and summer
Whimbrel *Numenius phaeopus*	BCC	Tidal mudflats, salt marshes, sandy beaches, and rocky shorelines	Uncommon migrant, non-breeding summer resident, and winter visitor
Long-billed Curlew *Numenius americanus*	BCC	Tidal mudflats and open grassland	Uncommon migrant, non-breeding summer resident, and winter visitor
Marbled Godwit *Limosa fedoa*	BCC	Tidal mudflats, salt marshes, sandy beaches, brackish lagoons, and rocky ocean shores	Uncommon migrant, non-breeding summer resident, and winter visitor
Red Knot *Calidris canutus roselaari*	BCC	Tidal mudflats	Uncommon spring and fall migrant
Baird's Sandpiper *Calidris bairdii*	CSSC	Fresh-water ponds, lakeshores, brackish lagoons and occasionally agricultural fields	Rare fall migrant
Short-billed Dowitcher *Limnodromus griseus*	BCC	Freshwater ponds, lakeshores, brackish lagoons and tidal mudflats	Uncommon fall migrant
California Gull *Larus californicus*	CSSC	Open ocean, beaches, bays, estuaries, lagoons, garbage dumps, agricultural fields, freshwater ponds and lakes	Common migrant and winter visitor
Gull-billed Tern *Sterna nilotica*	BCC	Sandy beaches and tidal mudflats	Uncommon summer resident
Elegant Tern *Sterna elegans*	CSSC	Coastal lagoons, mudflats, and sand dunes	Uncommon migrant, non-breeding summer resident, and winter visitor
Least Tern *Sternula antillarum browni*	CE, CFP, FE	Coastal, barrier dunes at river mouths and lagoon entrances	Common summer breeding resident and migrant
Black Tern *Chlidonias niger*	CSSC	Brackish lagoons and estuaries, fresh water ponds near coast	Rare non-breeding summer resident and fall migrant

Species	Status[4]	Habitat Association	Abundance
Black Skimmer *Rynchops niger*	BCC, CSSC	Coastal beaches and sand or shell bars	Uncommon spring and fall migrant, common summer breeding resident, rare in winter
Xantus' Murrelet *Synthliboramphus hypoleucus*	BCC	Open ocean	Rare fall migrant
Cassin's Auklet *Ptychoramphus aleuticus*	BCC	Open ocean	Uncommon summer resident
Yellow-billed Cuckoo *Coccyzus americanus*	BCC, CT	Riparian woodlands	Rare summer resident
Flammulated Owl *Otus flammeolus*	BCC	Pine forests	Rare spring migrant
Burrowing Owl *Athene cunicularia*	BCC, CSSC	Grasslands, agricultural lands and coastal dunes	Uncommon year-round resident
Spotted Owl *Strix occidentalis*	BCC	Oak and pine woodlands	Rare year-round resident
Long-eared Owl *Asio otus*	CSSC	Riparian woodland and live oak woodlands	Rare year-round resident
Short-eared Owl *Asio flammeus*	CSSC	Salt marshes, open grassland and agricultural areas	Rare migrant and winter visitor
Vaux's Swift *Chaetura vauxi*	CSSC	Forests and open areas	Uncommon migrant
Costa's Hummingbird *Calypte costae*	BCC	Sage scrub and chaparral	Uncommon spring migrant, common summer breeding resident, common fall migrant and rare winter visitor
Allen's Hummingbird *Selasphorus sasin*	BCC	Coastal scrub, chaparral, riparian woodland, eucalyptus groves, chaparral, open coniferous forest, and mixed woodland habitats	Rare summer visitor, uncommon migrant
Lewis' Woodpecker *Melanerpes lewis*	BCC	Oak savannah and mountain meadows	Rare fall migrant and winter visitor
Nuttall's Woodpecker *Picoides nuttallii*	BCC	Riparian, oak, and coniferous woodlands	Common year-round breeding resident
Southwestern Willow Flycatcher *Empidonax traillii extimus*	CE, FE, USFS	Riparian woodlands	Uncommon migrant and breeding resident
Loggerhead Shrike *Lanius ludovicianus*	BCC	Grasslands, coastal sage scrub, and chaparral	Uncommon year-round resident
Least Bell's Vireo *Vireo bellii pusillus*	CE, FE	Riparian woodlands	Common summer breeding resident, common in spring and uncommon in fall
Horned Lark *Eremophila alpestris*	CSSC	Sandy ocean or bay shores, grasslands and agricultural land	Common year-round and breeding resident
Bank Swallow *Riparia riparia*	CT	Lowland areas along ocean coasts, rivers, streams, lakes, reservoirs, and wetlands	Rare fall migrant
Oak Titmouse *Baeolophus inornatus*	BCC	Oak woodlands	Uncommon year-round breeding resident

Species	Status[4]	Habitat Association	Abundance
Coastal Cactus Wren *Campylorhynchus brunneicapillus*	BCC, CSSC, USFS	Coastal sage scrub	Uncommon breeding resident
Coastal California Gnatcatcher *Polioptila californica californica*	CSSC, FT	Coastal sage scrub	Common breeding resident
Yellow Warbler *Dendroica petechia*	CSSC	Riparian woodlands	Common migrant and breeding resident
Rufous-crowned Sparrow *Aimophila ruficeps*	CSSC	Coastal sage scrub	Uncommon year-round breeding resident
Black-chinned Sparrow *Spizella atrogularis*	BCC	Coastal sage scrub and chaparral	Uncommon breeding summer resident
Bell's Sage Sparrow *Amphispiza belli belli*	CSSC	Chaparral	Uncommon year-round breeding resident
Belding's Savannah Sparrow *Passerculus sandwichensis beldingi*	CE, CSSC	Salt marshes and lagoons	Common year-round breeding resident
Tricolored Blackbird *Agelaius tricolor*	BCC, CSSC	Freshwater marshes, agricultural areas and lakeshores	Rare summer resident
Hooded Oriole *Icterus cucullatus*	CSSC	Residential areas, parks and orchards	Common spring migrant and summer breeding resident, uncommon fall migrant, rare winter visitor
Lawrence's Goldfinch *Carduelis lawrencei*	BCC	Montane oak woodlands	Uncommon year-round resident

Table 2. Number of Nests per Habitat Type for Nine Raptors that Occur on Marine Corps Base Camp Pendleton

Habitat	Species									Total
	White-tailed Kite	Barn Owl	Cooper's Hawk	Golden Eagle	Great Horned Owl	Long-eared Owl	Northern Harrier	Red-shouldered Hawk	Red-tailed Hawk	
Agriculture								3 (3%)	1 (<1%)	4
Chaparral	2 (3%)	2 (2%)	1 (4%)	2 (22%)	4 (9%)		1 (9%)	5 (5%)	18 (6%)	35
Disturbed/Urban Developed	4 (6%)	4 (5%)	4 (15%)		6 (13%)	1 (20%)		21 (19%)	32 (10%)	72
Grasslands	13 (20%)	17 (20%)	3 (11%)		8 (18%)		2 (18%)	13 (12%)	62 (19%)	118
Marsh	1 (2%)				1 (2%)			1 (1%)	1 (<1%)	4
Oak Woodlands	4 (6%)	5 (6%)	2 (7%)		3 (7%)			10 (9%)	32 (10%)	56
Riparian	30 (45%)	22 (27%)	14 (52%)	1 (11%)	10 (22%)	3 (60%)	3 (27%)	38 (35%)	79 (25%)	200
Scrub	10 (15%)	24 (29%)	3 (11%)	6 (67%)	12 (27%)	1 (20%)	5 (45%)	16 (15%)	85 (26%)	162
Unvegetated Habitat	2 (3%)	9 (11%)			1 (2%)			3 (3%)	12 (4%)	27
Total[5]	66	83	27	9	45	5	11	110	322	678

[5] Cumulative number of nests based on historic nesting data provided by MCBCP.

Historic Distribution of Nesting Raptors on Base

FIGURE 4

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3.2.2 Waterfowl

Camp Pendleton serves as a migration corridor and wintering residence for many ducks and geese. The most abundant waterfowl include Canada goose (*Branta canadensis*), green-winged teal (*Anas carolinensis*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), cinnamon teal (*Anas cyanoptera*), northern shoveler (*Anas clypeata*), gadwall (*Anas strepera*), American wigeon (*Anas Americana*), canvasback (*Aythya valisineria*), lesser scaup (*Aythya valisineria*), surf scoter (*Melanitta perspicillata*), red-breasted merganser (*Mergus serrator*) and ruddy duck (*Oxyura jamaicensis*). Waterfowl often overwinter in wetlands, agricultural fields, ponds, rivers and lakes. Although there is very little data on waterfowl electrocution and collision mortality, ducks and geese can be susceptible to collision mortality when flying in large flocks or during periods of low visibility, such as during seasonal marine fogs at the Base.

3.2.3 Wading Birds and Other Water Birds

Camp Pendleton's proximity to the Pacific Ocean and inclusion of rivers, creeks and lakes makes it a desirable residence for both breeding and non-breeding wading birds, pelicans, ibis, cormorants, gulls and terns. Electrocution of wading and water birds can occur in areas where birds perch on poles due to insufficient vertical separation of energized and/or grounded parts. Pelicans, cormorants and gulls often perch on power poles and lines, while large wading birds, such as great blue heron (*Ardea herodias*) and great egret (*Ardea alba*) can be at risk of collision mortality when flying during periods of low visibility. Great blue herons are at high risk of electrocution susceptibility due to their large size, abundance on Base and prevalence of known electrocution data. Documentation exists on Base for one electrocution incident and one collision incident for great blue heron. Following the mortality reduction measures provided in this document will benefit great blue herons and other wading birds as well.

3.2.4 Other Birds

Common raven (*Corvus corax*) and American crow (*Corvus brachyrhynchos*) (included in the family of corvids) are abundant on the Base and occur almost anywhere. These birds are at risk to electrocution mortality, like raptors, due to their large size and potential to use utility poles as nesting structures. There is significant off-site historical electrocution data on corvids, demonstrating considerable impacts on power reliability (APLIC 2006). Common raven and American crow are at high risk of electrocution susceptibility due to their large size, abundance on Base, perching and nesting preferences and prevalence of known electrocution data. One common raven has been documented as being electrocuted on the Base, therefore these corvids would also benefit from the implementation of this plan.

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4.0 THREAT ASSESSMENT

4.1 AVIAN USE OF UTILITY STRUCTURES

Utility structures are often used by birds for a variety of reasons. These structures provide perching, roosting and nesting substrates for many birds, especially raptors. Most raptors prefer a high perch in order to ‘still hunt’ or ‘perch hunt’, an energy efficient hunting strategy which allows a raptor to view a large area of prey habitat from one location. Power line structures offer raptors elevation above terrain, offering a wide field of view for hunting and territory defense. In areas where there are few trees, power line structures essentially provide habitat where there are no natural perches. Raptors may also choose utility structures over trees (in areas where the poles are taller than the trees) for greater field of view and more effective still hunting. The tops of power line structures provide feeding platforms for birds after they have captured prey, protection from predators and inclement weather, and nocturnal roost sites. Raptors frequently use utility structures as nesting platforms, especially in open areas where there are few trees. In general, the use of utility structures by raptors is influenced by the presence and distribution of natural perches and the abundance and availability of prey. Identifying and modifying preferred structures that are utilized by raptors may reduce or minimize the electrocution risk of that structure.

4.2 CAUSES OF AVIAN MORTALITY

4.2.1 Electrocution

Avian electrocutions occur due to a combination of biological/environmental factors and electrical design factors. Biological and environmental factors are those that influence avian use, such as habitat, prey abundance and availability, species and behavior. The most critical electrical design factor that contributes to avian electrocution is inadequate spacing between energized and/or grounded structures, conductors, hardware or equipment that can create two points of contact for a bird allowing an electrical circuit to run through the bird (APLIC 2006).

Electrocutions can occur when phase conductors are separated by less than the wrist-to-wrist or head-to-foot distance of a bird (as shown in Figure 5), or when the distance between grounded hardware and an energized phase conductor is less than the wrist-to-wrist or head-to-foot distance of a bird. The wrist-to-wrist distance only considers the fleshy parts of the bird, not the feathered wing tips, as dry feathers act as insulation (APLIC 2006).

Larger birds of prey, such as eagles, are clearly at higher risk of electrocution as electrical design standards may not provide adequate spacing for them to land and perch on utility structures (Figure 6). A raptor-safe structure provides proper clearance between energized and/or grounded parts. The standard for raptor protection, according to *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*, allows for 60 inches (150 cm) of horizontal separation between energized and/or grounded parts, and 48 inches (120 cm) of vertical spacing between energized and/or grounded parts. These separation standards accommodate for the wrist-to-wrist distance (31-42 inches) and head-to-foot distance (18-26”) of an adult golden eagle (APLIC 2006). The 48-inch vertical separation will also accommodate for the height of a great blue heron.

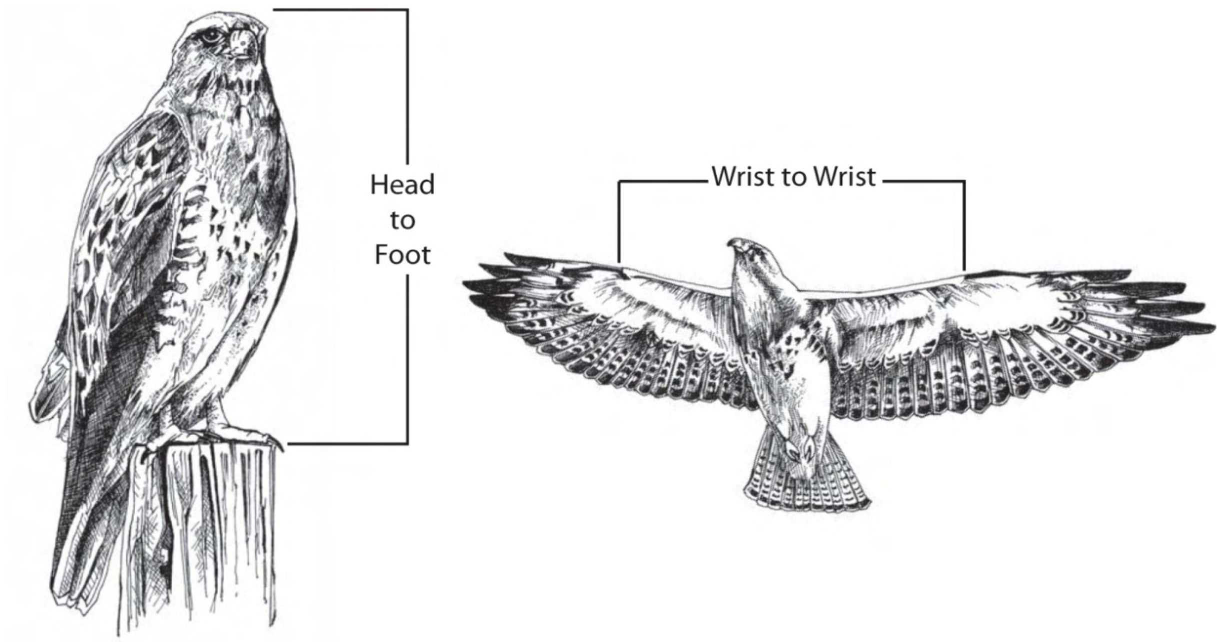


Figure 5. Measured Distances of a Raptor

Figure 6. Electrocuted Golden Eagle (Source: USFWS)

Although these raptor-safe pole design standards will greatly reduce the potential of avian electrocution and mortality, some risk of electrocution still exists. Wet feathers and wet wood are conductive, and birds can be electrocuted on poles that would normally be considered raptor-safe (APLIC 2006). Adequate spacing between energized and/or grounded parts, in conjunction with insulator and phase conductor covers, may provide the greatest protection against avian electrocution in situations where birds may have wet feathers.

4.2.2 Collision

Risk of collision is highest during circumstances when power lines are not detected by flying birds. Factors that influence collision risk can be divided into three categories: avian, environmental and power line configuration (APLIC 2006).

A bird's size, flight behavior, age and flocking behavior may contribute to its electrocution risk. Larger, slower moving, less agile birds may collide more frequently with power lines, as well as birds that fly in large flocks or fly at night. Juvenile birds, and raptors distracted by hunting or territorial activities, may also be at a higher risk of line collision. All of these species-related scenarios can affect a bird's ability to quickly negotiate obstacles, such as power lines (APLIC 2006).

Environmental factors that influence the risk of collision include reduced visibility due to inclement weather or time of day, or vegetation that may obscure the line. Surrounding land use practices may also attract birds to an area with power lines, therefore increasing the chance of collision mortality (APLIC 2006). The Base experiences seasonal marine fog which may also reduce visibility leading to an increased chance of collision mortality.

Utility structures with small conductors, which are less visible to flying birds, also increase the risk of collision mortality. Collisions are more likely to occur with the overhead static wire, whose small size makes it less visible (APLIC 2006).

4.2.3 Bird Nesting

As previously mentioned, utility structures provide nesting opportunities for many raptors, especially in areas where other nesting habitat is limited. Red-tailed hawks and golden eagles breed on the Base and are known to use transmission towers for nesting sites. Nests that pose the greatest risk to birds are those that are built in close proximity to energized conductors and hardware. While a nest that is not in close proximity to energized parts may not be a risk in and of itself, it will draw its occupants to the area where they may land on an unsafe structure or collide with power lines (APLIC 2006).

4.3 BIOLOGICAL AND ENVIRONMENTAL FACTORS INFLUENCING RISK

4.3.1 Size

Birds with large wingspans, or very tall birds, are at most risk to electrocution mortality. These birds have a greater probability of touching two energized parts or an energized and grounded part when they land to perch on a power pole, or stretch their wings when perched. Tall birds, such as herons, may simultaneously contact different conductors on poles with vertical construction. The 60-inch (150 cm) standard of separation between energized or grounded parts is intended to allow sufficient clearance for an eagle's wrist-to-wrist span, while the vertical separation of 48 inches (120 cm) allows for clearance of a wading bird's head-to-foot distance. These separation standards will also afford protection to smaller species (APLIC 2006).

4.3.2 Age

The age of a bird can play a role in its risk of electrocution. Research on golden eagles suggests that young birds are more susceptible to electrocution than adults (APLIC 2006). Young birds are generally less experienced at landing on, taking off from, and hunting from perches. They are less adept at maneuvering than adults, and often land with much wing flapping, increasing the chance of being electrocuted. Young birds may also hunt from poles more than adults, as they have more success hunting from a stationary perch. This increased exposure to poles increases their risk of electrocution (APLIC 2006).

4.3.3 Seasonal Patterns

Bird electrocutions may occur more during certain times of the year, depending on the species. Electrocution data on golden eagle suggests that most mortalities occur during the winter when birds occur in larger concentrations in open areas with power lines. Southern California also experiences seasonal marine fog (May through October) which may reduce visibility and contribute to bird collisions with power lines. Other birds experience greater electrocution rates during the breeding season due to an increase in population (APLIC 2006).

4.3.4 Behavior

Avian electrocutions may increase based on a bird's behavior. Nesting, courtship and territorial behavior can make birds more susceptible to electrocution. During courtship and territorial displays, raptors often lock talons effectively doubling their size which allows them to bridge the gap between energized parts. Birds that nest on poles may have an increased chance of electrocution while carrying prey items or nesting material to the nest. Anything that dangles from a raptor's talons can also bridge the gap between energized parts (APLIC 2006).

4.3.5 Weather and Wet Feathers

Weather may factor into a bird's increased chance of electrocution. Rain and snow can wet the feathers, which increases their conductivity. Dry feathers provide almost as much insulation as air, and can safely insulate a bird that would be in contact with an electrical current of up to 70,000 volts, whereas wet feathers conduct current more rapidly and become dangerous at conducting electricity at 5,000 volts (APLIC 2006).

4.4 RISK FACTORS AND ELECTROCUTION SUSCEPTIBILITY OF RAPTORS THAT OCCUR ON BASE

Raptors are more susceptible to power line electrocution and collision mortality due to their large size and use of power poles for hunting, feeding, resting, roosting and nesting. Each raptor that occurs on the Base was evaluated for its risk to electrocution mortality based on four factors:

- Size (small, medium, large and very large),
- Preference of power pole or power line use (very rarely, rarely, occasionally and regularly),
- Status on the Base (rare, uncommon, common and abundant), and
- National historical electrocution data (commonly electrocuted vs. uncommonly electrocuted).

An arbitrary value was assigned to each risk factor in order to determine an overall susceptibility rating for each bird. Birds were categorized as either having a low, moderate, or high susceptibility rating depending on the combination of values assigned to each risk factor. For example, large birds that regularly use power poles to hunt, perch or nest and commonly occur on the Base would be at higher risk than a small bird that rarely uses power poles and rarely occurs on the Base. However, large raptors always assume some risk because of their sheer size, regardless of the frequency of occurrence on the Base, and should be taken into consideration when attempting to reduce avian electrocution mortality. Birds that are known to have been electrocuted on the Base are automatically categorized as having the greatest susceptibility to electrocution. Table 3 outlines the risk factors that determine a raptor's susceptibility to electrocution mortality specific to the Base. Table 4 summarizes the status, perching preference, habitat use, susceptibility to electrocution mortality and the factors that influence electrocution susceptibility of the raptors and owls that occur on the Base. Raptors with the highest electrocution or collision susceptibility will benefit most from this Plan.

Table 3. Risk Factors with their Assigned Values that Determine Raptor Electrocution Susceptibility

Risk Factor	Score				
Size[6]	Small (0)	Medium (2)	Large (4)	Very Large (6)	
Perching Preferences[7]	Very Rarely (0)	Rarely (1)	Occasionally (2)	Regularly (4)	
Status on Base[8]	Rare (0)	Uncommon (1)	Common (2)	Abundant (3)	
Historic Electrocution Data[9]	Uncommon (0)	Common (5)			
Susceptibility Rating	Low (0-5)		Moderate (6-11)		High (12 and higher)

[6] Size based on a combination of wingspan, wrist-to-wrist distance and height (when available). Complete morphological data does not exist for all species presented, but for the purposes of this table, small= less than or equal to 30"wingspan, medium= less than or equal to 40" wingspan, large= less than or equal to 50" wingspan, and very large= 70" wingspan or greater.

[7] Perching preferences were determined through behavioral descriptions found in The Birds of North America Online, *San Diego County Bird Atlas,* and *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006.*

[8] Status on Base taken from the Checklist to the Birds of Marine Corps Base Camp Pendleton. Status Definitions: Abundant—Always Encountered; Common—Easily found in appropriate habitat; Uncommon—Present but not always detected in appropriate habitat; Rare—Not detected annually.

[9] Historic electrocution data was based on data presented in *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006*. Determination of electrocution commonality was based on literature reviews of raptor electrocution issues (i.e., many studies have shown that golden eagles are commonly electrocuted, whereas few or no studies have been conducted documenting electrocution frequency for prairie falcon). Existing raptor electrocution data may underestimate the commonality of electrocution for some species due to lack of research and unpublished data. A comprehensive study revealing electrocution rates for all raptor species has not been published. Electrocution data has been obtained from regional and/or species specific research, which may bias the prevalence of historic electrocution data.

Table 4. Raptors on Marine Corps Base Camp Pendleton and Their Susceptibility to Electrocution Mortality

Species	Status	Perching Preference	Habitat Use (Home Range)[10]	Factors Influencing Susceptibility (score)	Susceptibility (rating)
Red-tailed Hawk *Buteo jamaicensis*	Abundant year-round breeding resident	Regularly hunts from, perches on and nests on utility poles, transformers and towers	Agricultural fields, grasslands, and woodlands; require elevated perches (3.9 km^2)	-Large size (4) -status on Base (3) -perching preferences (4) -prevalence of historic electrocution data (including six electrocution records on Base) (5)	High (16)
Ferruginous Hawk *Buteo regalis*	Uncommon winter visitor	Regularly perches and hunts from utility poles	Grasslands and agricultural fields	-Large size (4) -status on Base (1) -perching preferences (4) -prevalence of historic electrocution data (5)	High (14)
Great Horned Owl *Bubo virginianus*	Uncommon year-round breeding resident	Regularly perches on and hunts from poles	Agricultural fields, riparian, oak woodlands, residential areas and parks (8 km^2)	-Large size (4) -status on Base (1) -perching preferences (4) -prevalence of historic electrocution data (5)	High (14)
Golden Eagle *Aquila chrysaetos*	Uncommon year-round breeding resident	Occasionally perches on utility poles	Grasslands and broken chaparral or sage scrub (33 km^2)	-Very large size (6) -status on Base (1) -perching preferences (2) -prevalence of historic electrocution data (most commonly electrocuted raptor, including one electrocution record on Base) (5)	High (14)
Osprey *Pandion haliaetus*	Common year-round non-breeding residents	Occasionally perch on and hunt from poles (ospreys commonly nest on poles but do not nest on Base)	Along the coast and lakes	-Large size (4) -status on Base (2) -perching preferences (2) -documentation of electrocution on Base (5)	High (13)
Bald eagle *Haliaeetus leucocephalus*	Rare winter visitor	Occasionally perches on utility poles	Lakes, rivers, wetlands and coastal slopes	-Very large size (6) -status on Base (0) -perching preferences (2) -prevalence of historic electrocution data (5)	High (13)
Turkey Vulture *Cathartes aura*	Common year-round	Rarely perches on utility poles	Grasslands, agricultural fields, forested areas	-Large size (4) -status on Base (2) -perching preferences (1) -documentation of electrocution on Base (5)	High (12)

[10] Home Range given only for raptors for which Base nesting data exists

Species	Status	Perching Preference	Habitat Use (Home Range)[10]	Factors Influencing Susceptibility (score)	Susceptibility (rating)
Barn Owl *Tyto alba*	Uncommon year-round breeding resident	Occasionally perches on poles and power lines	Agricultural fields, residential areas, grassland, riparian and oak woodland ($7 km^2$)	-Large size (4) -status on Base (1) -perching preferences (2) -prevalence of historic electrocution data (including one electrocution record on Base) (5)	High (12)
Red-shouldered Hawk *Buteo lineatus*	Common year-round breeding resident	Occasionally hunts from wires and perches on utility poles	Riparian, Oak woodlands, residential areas ($1.1 km^2$)	-Medium size (2) -status on Base (2) -perching preferences (2) -documentation of electrocution on Base (5)	High (11)[11]
Swainson's Hawk *Buteo swainsoni*	Rare spring and fall migrant	Occasionally perches on utility poles	Agricultural fields and coastal lowlands	-Large size (4) -status on Base (0) -perching preferences (2) -prevalence of historic electrocution data (5)	Moderate (11)
Prairie Falcon *Falco mexicanus*	Uncommon fall migrant and winter visitor	Regularly perches and hunts from power lines and utility poles	Open grasslands, agricultural fields and desert scrub	-Large size (4) -status on Base (1) -perching preferences (4) -lack of electrocution data (0)	Moderate (9)
Peregrine Falcon *Falco peregrinus*	Uncommon migrant and winter visitor, rare in summer	Occasionally observed perching on utility poles	Coastal mudflats, shores and ponds	-Large size (4) -status on Base (1) -perching preferences (2) -lack of electrocution data (0)	Moderate (7)
American Kestrel *Falco sparverious*	Common year-round breeding resident	Regularly perches and hunts from power lines and utility poles	Grasslands, agricultural fields, oak woodlands, residential areas, parks and chaparral	-Small size (0) - status on Base (2) -perching preferences (4) -lack of electrocution data (0)	Moderate (6)
Northern harrier *Circus cyaneus*	Uncommon year-round breeding resident	Rarely perch and hunt from poles	Grassland, agricultural fields, and coastal marshes ($8 km^2$)	-Large size (4) -status on Base (1) -perching preferences (1) -lack of electrocution data (0)	Moderate (6)
Long-eared Owl *Asio otus*	Rare year-round resident	Occasionally perches on and hunts from poles	Riparian woodland and live oak woodland ($3 km^2$)	-Large size (4) -status on Base (0) -perching preferences (2) -lack of electrocution data (0)	Moderate (6)
Merlin *Falco columbarius*	Uncommon fall migrant and winter visitor	Regularly perches and hunts from power lines and utility poles	Agricultural fields and grasslands	-Small size (0) -status on Base (1) -perching preferences (4) -lack of electrocution data (0)	Low (5)

[11] Although the red-shouldered hawk has number rating of 11 (which would categorize it as 'moderate'), an electrocution record exists for the Base, therefore the red-shouldered hawk must be considered at high risk for electrocution susceptibility on the Base.

Species	Status	Perching Preference	Habitat Use (Home Range)[10]	Factors Influencing Susceptibility (score)	Susceptibility (rating)
Cooper's Hawk *Accipiter cooperii*	Uncommon migrant and winter visitor, uncommon breeding summer resident	Occasionally perches and hunts from poles and power lines	Riparian, Oak woodlands, parks and residential areas (1.3 km^2)	-Medium size (2) -status on Base (1) -perching preferences (2) -lack of electrocution data (0)	Low (5)
White-tailed kite *Elanus leucurus*	Uncommon breeding year-round resident	Occasionally hunts from wires and occasionally perches on utility poles	Riparian woodland, live oaks, groves of sycamores that border grassland or open fields (0.57km^2)	-Medium size (2) -status on Base (1) -perching preferences (2) -lack of electrocution data (0)	Low (5)
Short-eared Owl *Asio flammeus*	Rare migrant and winter visitor	Very rarely, if ever, perches on or hunts from poles	Salt marshes, open grassland and agricultural areas	-Large size (4) -status on Base (0) -perching preferences (0) -lack of electrocution data (0)	Low (4)
Sharp-shinned hawk *Accipiter striatus*	Uncommon migrant and winter visitor	Occasionally perches and hunts from poles and power lines	Woodlands, parks and residential areas	-Small size (0) -status on Base (1) -perching preferences (2) -lack of electrocution data (0)	Low (3)
Western-screech Owl *Megascops kennicottii*	Uncommon year-round breeding resident	Occasionally perches on poles and power lines	Riparian and oak woodlands	-Small size (0) -status on Base (1) -perching preferences (2) -lack of electrocution data (0)	Low (3)
Burrowing Owl *Athene cunicularia*	Uncommon breeding year-round resident	Very rarely, if ever, perches on or hunts from poles	Grasslands, agricultural lands and coastal dunes	-Small size (0) -status on Base (1) -perching preferences (0) -lack of electrocution data (0)	Low (1)

4.5 NON-RAPTOR SAFE DESIGNS

All utility structures pose some threat to birds, but certain configurations have been shown to be more dangerous than others (APLIC 2006). Medium-voltage distribution lines (4 to 34.5 kV) cause more electrocutions than high-voltage lines as the spacing between conductors on these lines are usually closer together. A non-raptor safe pole is one in which the distance between two energized parts or an energized and grounded part is less than the wrist-to-wrist distance (60 inches) or height (48 inches) of a landing or perching bird (Figure 7). Electrocution risk is also greater on poles with exposed hardware or equipment such as transformers, capacitor banks, jumper wires, cutouts or lightening arresters (Figure 8). These design configurations were once the common industry standard, but due to the increased awareness of avian electrocution issues, older poles are being retrofitted and newer poles are being built to avian-safe standards. Appendix A details specific design problems (non-raptor safe) and modifications that will help guide Base utility personnel when locating non-raptor safe poles for retrofitting, and when designing and installing new raptor safe poles. The raptor safe designs in Appendix A are recommended from *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* and are proven-effective and accepted methods for reducing avian electrocution mortalities.

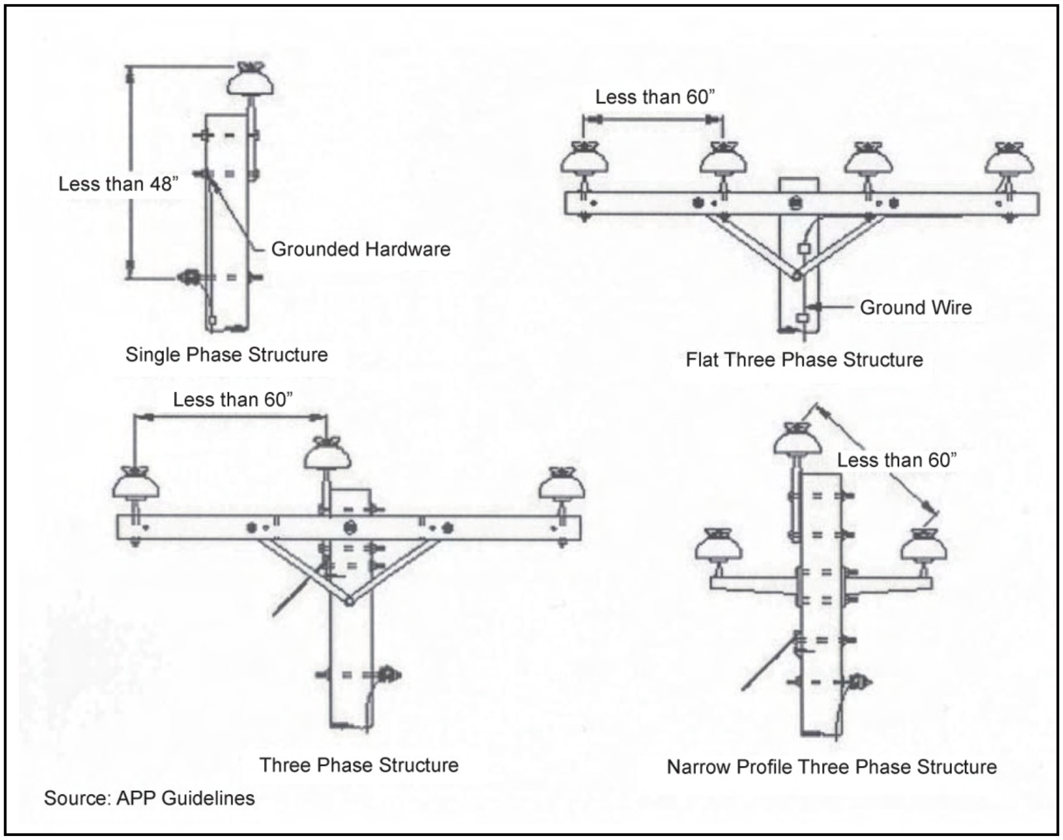


Figure 7. Typical Avian Risk Structures

4.5.1 Single-Phase Designs

Single-Phase designs (APLIC 2006, Appendix A, Figures A1-A5, A21-A23, A40 and A42), used for distribution lines, are typically designed with an energized phase mounted on the top of the pole and a neutral (grounded) conductor mounted on the side of the pole. Avian electrocution occurs when a bird perches on the grounding conductor while contacting the phase conductor simultaneously. A single-phase pole may also be designed with a crossarm, where a phase conductor is supported on one of the crossarms. In this scenario, avian electrocution occurs when a raptor perches on the crossarm and simultaneously contacts the phase and grounded conductors.

4.5.2 Three-Phase Designs

Three-Phase designs (APLIC 2006, Appendix A, Figures A6-A20, A24- A36, A38, A39, A41), used for distribution and transmission lines, are designed with three or four energized conductors. Raptors may be electrocuted while attempting to perch on a structure when the separation between the phases and grounded hardware is less than 60 inches. Exposed jumper wires on these designs may also increase the risk of avian electrocution.

In an armless configuration, phase conductors are mounted on horizontal posts. When an overhead conductor is grounded, a bird may be electrocuted if it comes in contact with the grounded hardware while perching on the horizontal post.

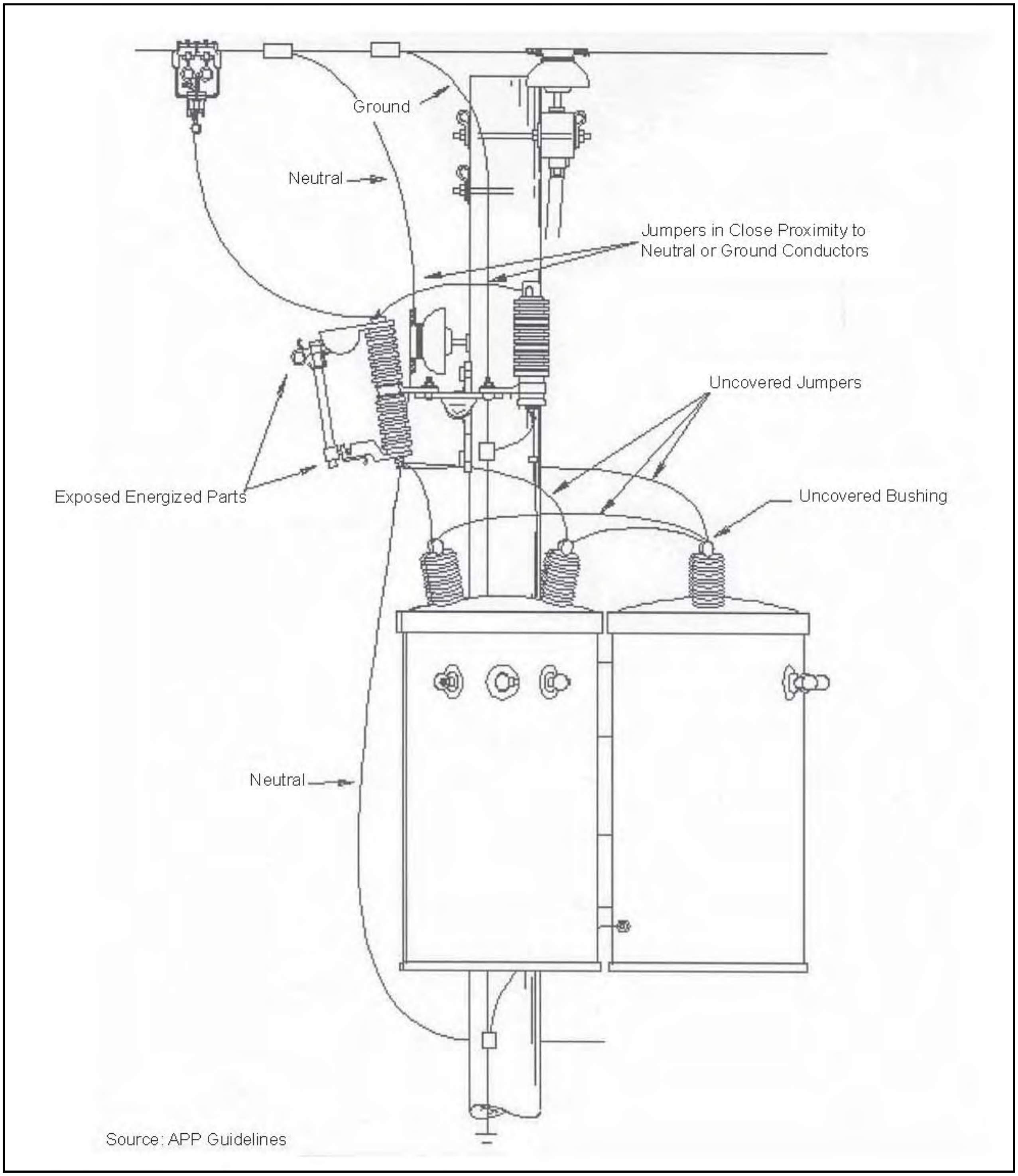


Figure 8. Typical Avian Risk Equipment

Three-phase designs constructed in a corner-pole configuration are designed to provide directional changes in power lines. Jumper wires are normally required to complete electrical connections. Raptors are at risk of electrocution if they simultaneously contact uncovered phase jumpers and the grounded structure.

Poles designed in a wishbone configuration are commonly used for distribution lines. When the distance from the top of the phase to the lower arm is less than 36 inches, raptors perched on the lower crossarm are at risk of electrocution. While perched on the lower arm, a raptor may simultaneously contact the energized conductor above their head and the grounding conductor at their feet, resulting in electrocution.

4.5.3 Switches

Switches (APLIC 2006, Appendix A, Figures A43-A45) are used to isolate circuits or redirect current for the operation and maintenance of a distribution system. Switches are closely separated and therefore pose a risk of electrocution to raptors.

4.6 THREATS OF AVIAN ELECTROCUTION MORTALITY ON BASE: THE AVIAN ELECTROCUTION SUSCEPTIBILITY SPATIAL MODEL

The Avian Electrocution Susceptibility Spatial Model (AVES) is an HDR developed Geographic Information System (GIS) based model for Camp Pendleton that predicts areas of risk for raptor electrocution. It is an additive model based on four inputs (raptor nesting data, vegetative habitat data, utility structure data and raptor incident data). While the model is designed to incorporate raptor incident data, such data is yet to be used in this model because of its geographic uncertainty. Thus, the current model output is based entirely on raptor nesting, vegetation and utility structure data. Furthermore, the current utility structure data lacks detailed information regarding each utility structures retrofitting status (i.e., raptor safe or raptor unsafe). Therefore, the model assumes that every utility structure on Camp Pendleton is unsafe at the beginning of the modeling process. Based on the current available data used in this model, the results should only be used as a preliminary assessment of electrocution susceptibility.

Raptor nesting, vegetation and utility structure GIS data were obtained from Camp Pendleton. Each file was imported to a geodatabase for processing organization. Additional blank data fields were added to the nesting data for modeling purposes but no geographic edits were made to the data. The vegetation data was reclassified into 12 classes according to Holland (1986). This classification was chosen in order to streamline the 41 existing vegetation communities and reduce redundancy amongst the data. Additionally, blank data fields were added to the reclassified vegetation data layer for modeling purposes. The nesting data is primarily historic with specific survey data from 2003 and 2004 for two raptor species (red-tailed hawk and red-shouldered hawk). While the use of this nesting data does not allow for any estimates of the annual population of raptors on Camp Pendleton, it provides a good cumulative measure of the probable spatial distribution of raptor nests on the Base. Furthermore, while the model is temporally insensitive and unable to predict raptor electrocution risk at any specific point in time, it can calculate electrocution risk based on regions which are historically frequented by raptors

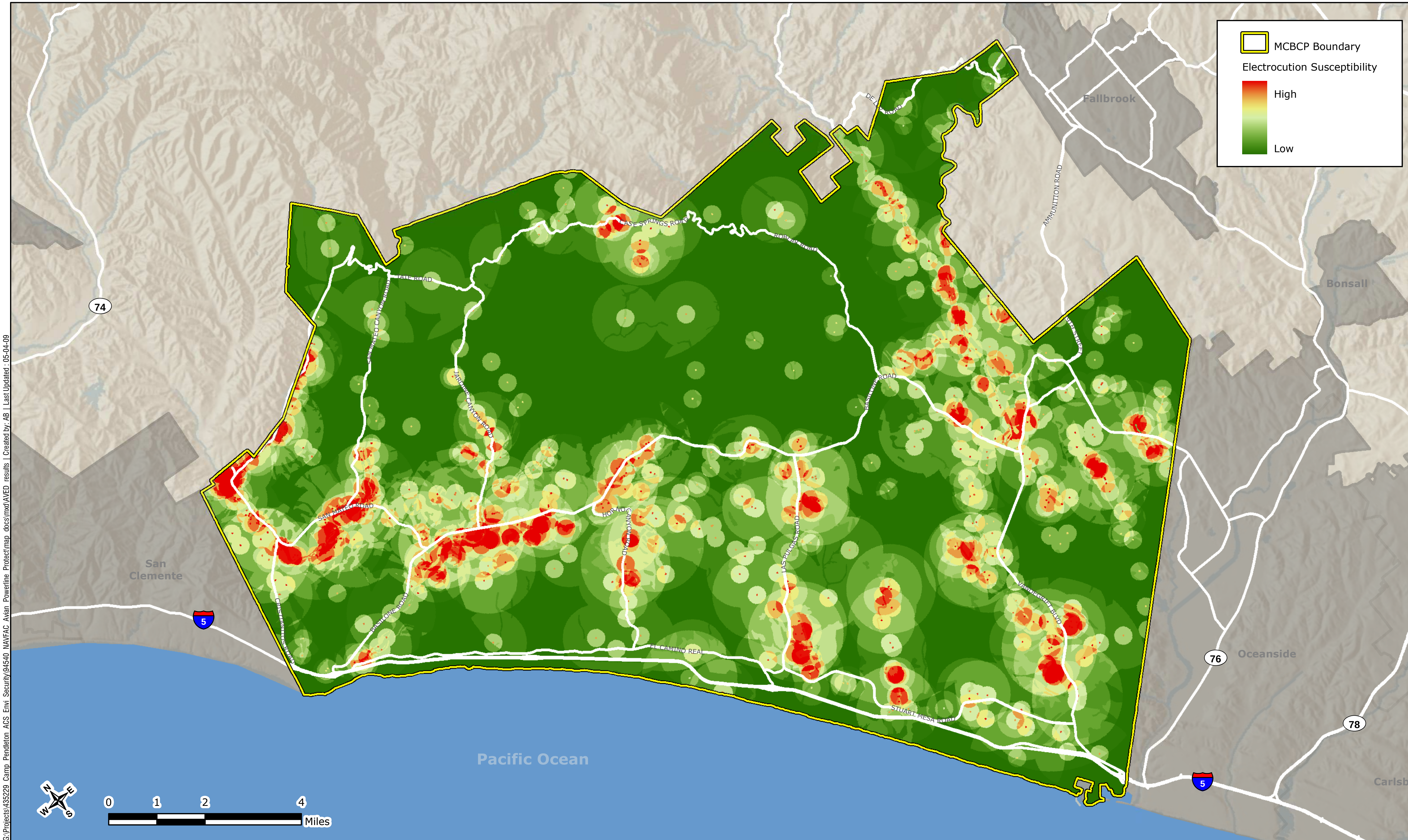
To assess the risk of avian electrocution and collision, historic locations of raptor nesting data were used to determine where raptors are most likely to occur. While the nesting areas may not be suitable to describe raptor home ranges beyond the breeding season, they do represent areas of significant susceptibility due to repeated flight to a central location (nest). Because of this, all area within the home range surrounding each nest was considered at risk (home ranges have species specific radii). Areas within 1,000 ft of the nests were considered at even greater risk because it was assumed that raptors spend a significant portion of time in the immediate vicinity of an active nest (perching and foraging). Additionally, those areas within 100 ft of nest locations were considered the greatest risk areas because it is expected that raptors spend the majority of their time protecting and feeding their young. This area was also considered most at risk because there is potential for raptors to nest directly on utility structures. In addition to nesting data, vegetation data was used to add additional risk to areas where raptors are likely to forage. Like the home range areas, these foraging areas are species specific. This information is summed to describe the overall risk for raptors on Camp Pendleton in the form of a color-ramped susceptibility map (Figure 9). The map is classified into risk categories (low to high) allowing utility structures to be ranked for their likelihood of causing an avian electrocution incident.

The use of raptor incident data to help predict incident risk is not included in this methodology due to the lack of information (location, date, etc.) for the thirteen documented incidents on the Base. However, avian electrocution data collected via the Avian Reporting System (Section 7.0) can be utilized in the AVES model for future analysis. The use of raptor incident data and other specifics of the model are explained in more depth in Appendix F.

4.6.1 Results of the AVES Model

There are two outputs from the model: (1) an ESRI raster GRID covering Camp Pendleton, and (2) the utility structures point data classified by risk. It is recommended that this raster GRID be classified or symbolized with color to visualize areas of high susceptibility, as shown in Figure 9. The utility structure data was assigned the scores from this raster GRID base on which cell of the grid each structure overlapped. The scores were classified into four risk rankings (High, Medium, Low, and Very Low) as shown in Figure 10. The table associated with this structure data should help determine which structures have priority to be retrofitted.

The current output GRID and classified utility structures demonstrate that hot spots of raptor susceptibility are spread throughout the Base and can generally be found along roads and riparian corridors. The prevalence of hot spots near roads (such as Basilone, San Mateo, and Horno Canyon Roads) may simply be a function of the location of the majority of structures falling along roads as well as the nesting data collection bias toward accessible areas. The hot spots in the riparian corridors are to be expected because the tall vegetation present in riparian areas is ideal for nesting and perching.



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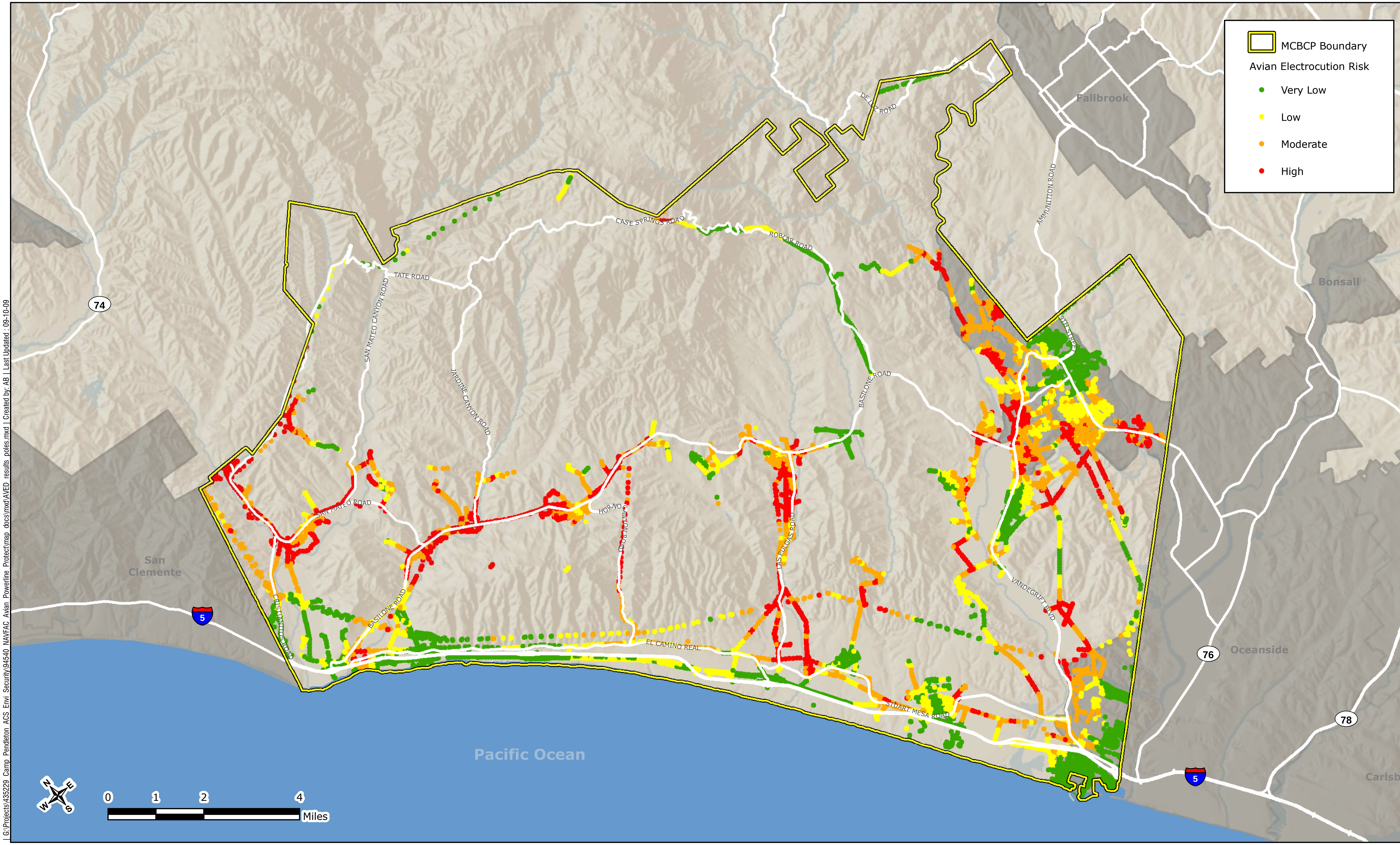
Areas of Avian Electrocution Susceptibility

FIGURE 9

NAVFAC | Marine Corps Base Camp Pendleton | Avian Power Line Protection Plan



Avian Electrocution Risk of Utility Structures

FIGURE 10

NAVFAC | Marine Corps Base Camp Pendleton | Avian Power Line Protection Plan

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5.0 AVIAN PROTECTION MEASURES AND RAPTOR-SAFE MODIFICATIONS

5.1 MORTALITY REDUCTION ACTIONS

Avian interactions with utility structures that result in mortality occur when birds perch on structures and come in contact with energized hardware, or when birds collide with power lines. In order to reduce the threat of mortality to raptors on the Base, it is recommended that utility structures that are not considered raptor-safe and occur in high-risk areas based on the AVES model be modified to raptor-safe standards. Unsafe structures in high risk areas should be given top priority, although unsafe structures outside of the high risk areas should eventually be retrofitted as well since the potential for an avian interaction still exists. Appendix A details solutions to non-raptor safe poles and should act as a guide for Base utility personnel when retrofitting and installing new poles. The raptor safe designs in Appendix A are recommended from *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* and are proven-effective and accepted methods for reducing avian electrocution mortalities. Base utility personnel may refer to the list of vendors who supply avian protections devices, located in Section 6.11, for more information on retrofitting structures. The following sub-section outlines general modifications required to retrofit an unsafe pole to raptor-safe standards.

5.2 RAPTOR-SAFE DESIGNS AND MODIFICATIONS

5.2.1 Underground Facility Installation

The only way to completely prevent avian electrocution mortality is to install utility facilities underground. In order to install lines underground, the Base must consider the needs of their customers, terrain, environment restrictions, costs, and code requirements. Where technically and financially feasible, the Base should consider burying existing facilities and installing all new facilities underground.

5.2.2 Conductor Separation

A horizontal clearance of at least 60 inches between uninsulated conductors, ground wires and grounded hardware is the standard recommended spacing that can accommodate an eagle (Figures 11-15). A minimum vertical clearance of 48 inches is required on utility structures to safely accommodate eagles and great blue herons. An 8-foot crossarm with center phase conductor should provide the 60-inch clearance. These standards should be applied to all raptor-unsafe poles on the Base as golden eagles occur through out the Base and one electrocution record exists for the Base.

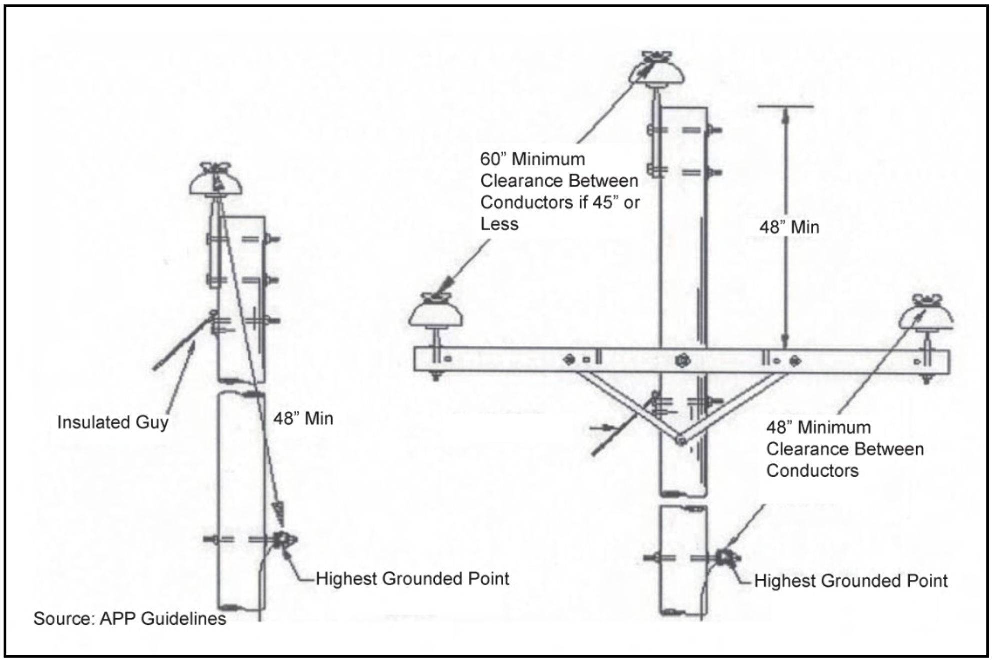

Figure 11. Avian-safe Structure with Proper Conductor Separation

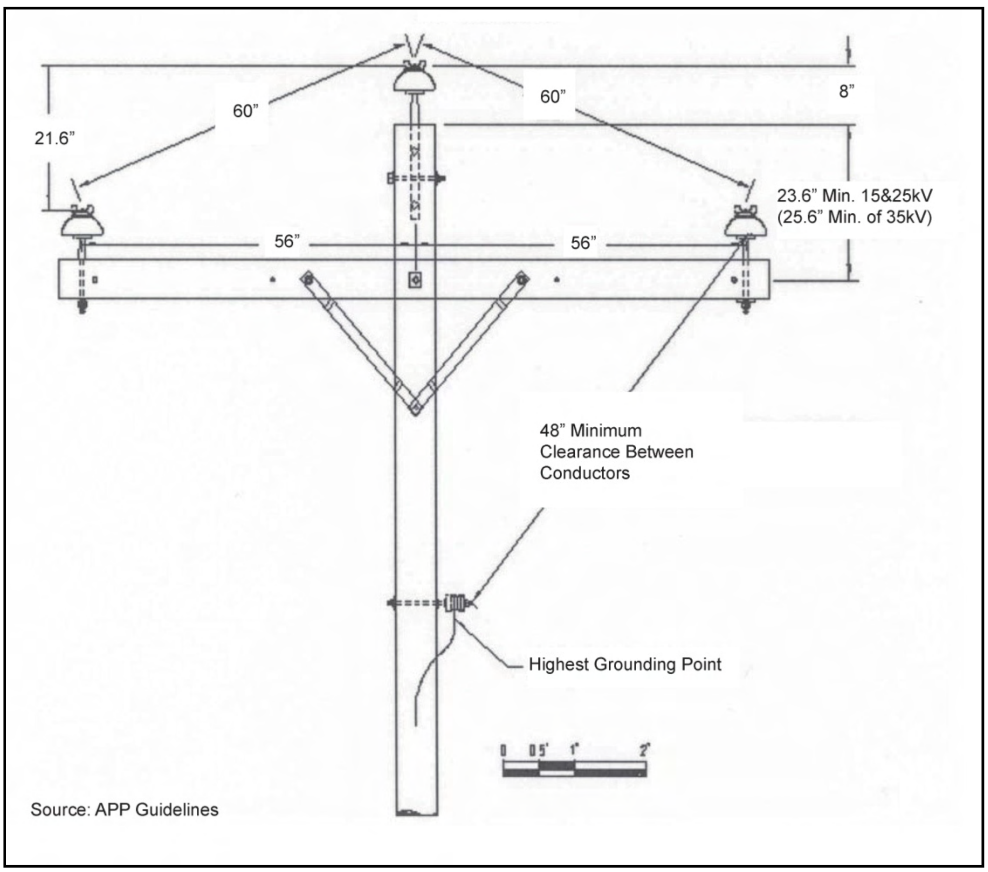

Figure 12. Avian-safe Structure with Proper Conductor Separation

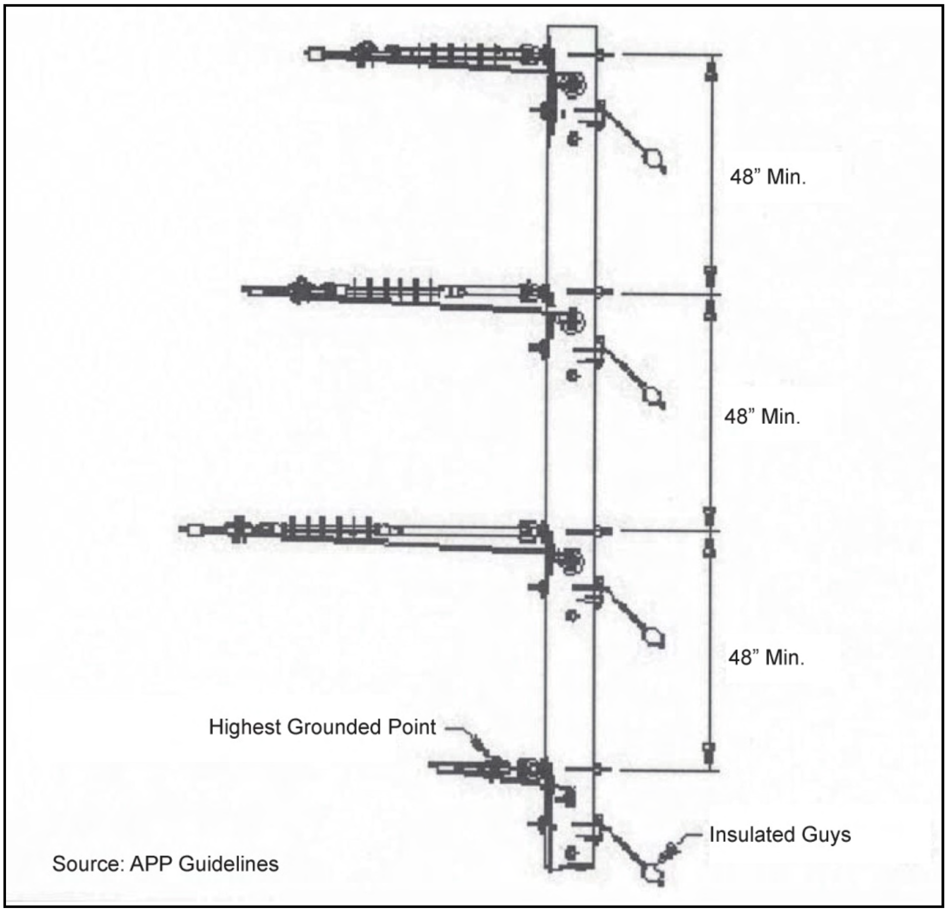

Figure 13. Avian-safe Structure with Proper Conductor Separation

Figure 14. Avian-safe Structure with 60-inch Conductor Separation

Figure 15. Avian-safe Structure with 60-inch Conductor Separation

5.2.3 Modification of Existing Structures

When adequate separation of conductors, or conductors and grounded parts cannot be achieved, insulating the hardware is the best solution (Figures 16-19). Insulated covers over transformers, capacitor banks, jumper wires, cutouts or lightening arresters can significantly reduce the risk of electrocution to raptors. Retrofitting currently unsafe poles with insulated covers is an inexpensive and easy solution to minimize avian electrocution.

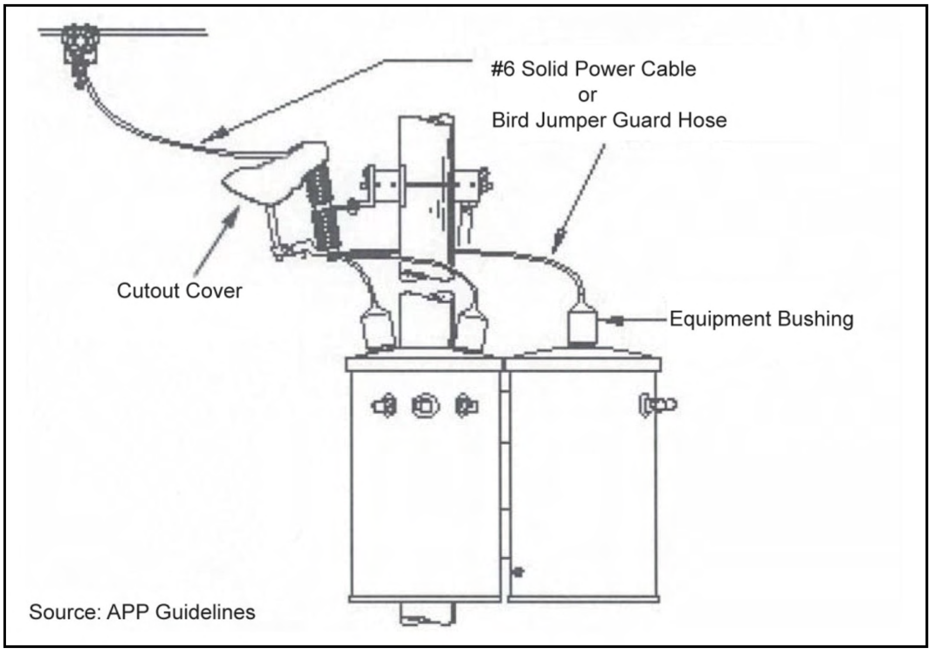

Figure 16. Avian-safe Structure with Insulated Covers

Figure 17. Bushing Covers, Lightning Arrester Covers and Jumper Coverups

Figure 18. Pin and Insulator Covers, Transformer Bushing Covers and Jumper Coverups

Figure 19. Transformer Bushing Covers and Jumper Coverups

5.2.4 Pole Mounted Bird Perch and Guard

Perch guards (triangles) with optional perches can be used to minimize avian electrocution when conductor separation or retrofitting is not possible (Figures 20-22). The installation of perch guards between closely-spaced conductors will reduce the chances of a bird landing in an area where the risk of electrocution is high. An alternate perch should be provided in conjunction with perch guards to provide a safe perch for birds and reduce the risk of electrocution. An installed perch above the perch guard, or the open part of the crossarm next to the perch guard (as long as spacing is adequate) would suffice.

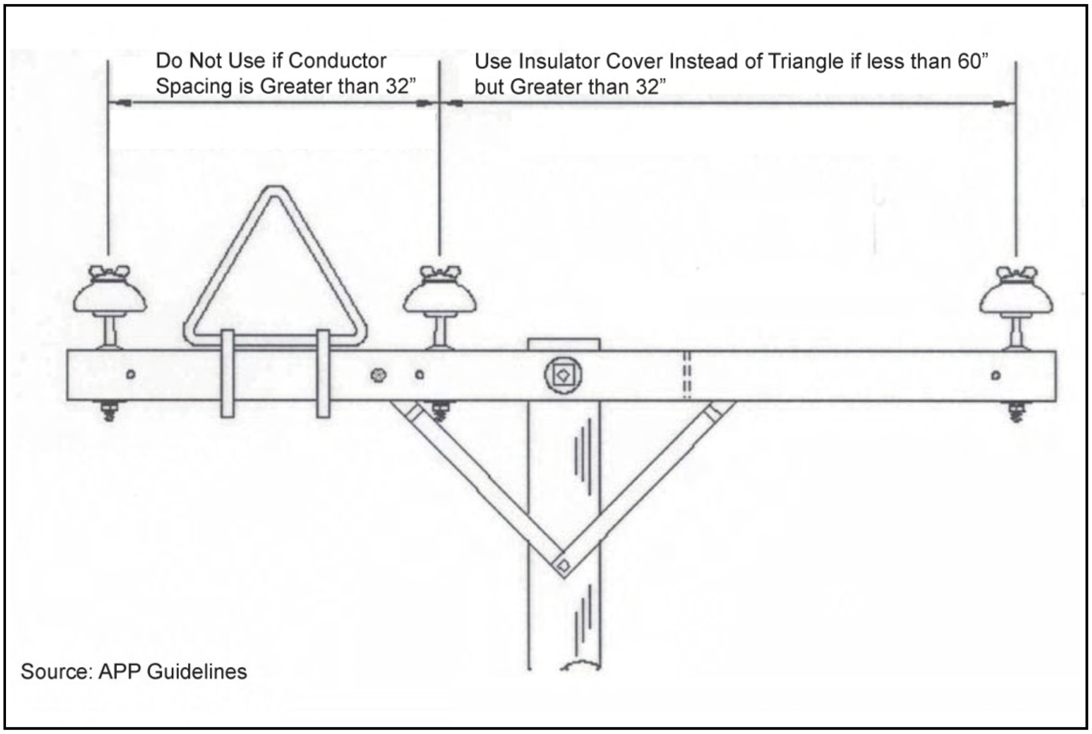

Figure 20. Avian-safe Structure with Perch Guard

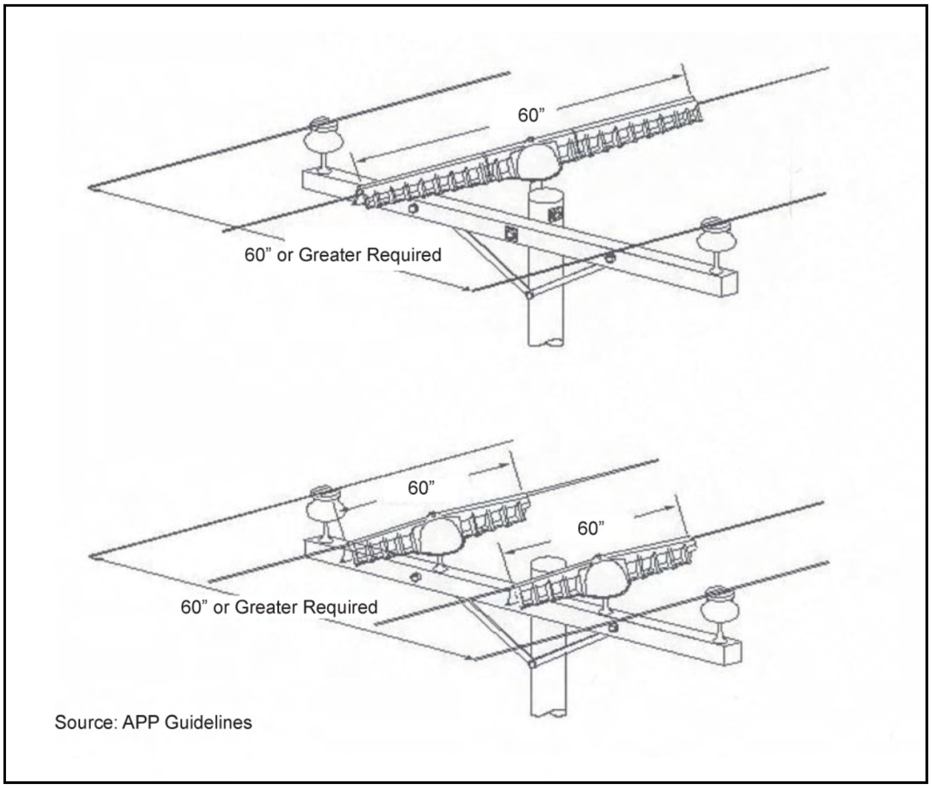

Figure 21. Avian-safe Structure with Perch Covers

Figure 22. Pin and Insulator Cover

5.2.5 Collisions

Marker balls, swinging markers, spiral vibration dampers or other types of avian flight diverters can be installed on overhead lines to increase their visibility in high avian-use areas (Figure 23). These devices are installed directly on the line and make the line more visible to birds as they fly through the area thus minimizing collisions.

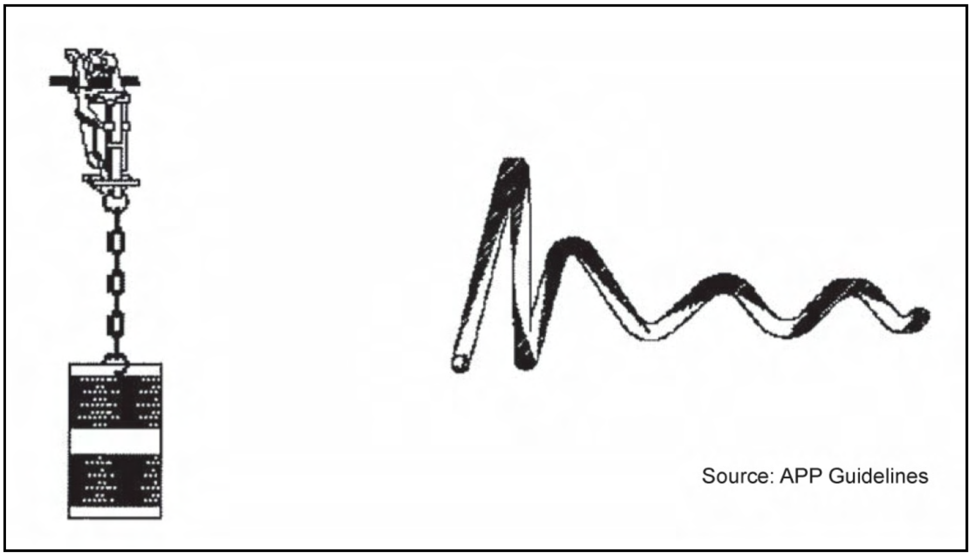

Figure 23. Swinging Marker Device (Left) and Bird Flight Diverter (Right)

5.2.6 Nest Protection

Utility structures are commonly used by raptors as nest sites. While many nests are placed on top of transmission lines and transformers and never cause power outages, presenting an alternative nest site on the utility structure greatly reduces the potential for electrocution. Nest platforms installed above distribution lines, transformers and crossarms provide a safer location for birds to nest thus minimizing electrocution risk (Figure 24). Nest management of existing nests on utility structures will be discussed in Section 7.2.5.

5.3 NEW UTILITY STRUCTURE RECOMMENDATIONS

When new utility structures are proposed, it is recommended during the NEPA process that the siting locations be evaluated for avian use in the area based on preferred avian habitat types and historic nesting locations on the Base. All utility work (new construction or retrofitting/repairs) should submit a Preliminary Environmental Datasheet to the ES-NEPA Branch for review. During this review, the following criteria should be included in the planning process:

- Review the most current map of raptor concentration areas
- Examine local habitat conditions and topography
- Conduct raptor, and other bird, surveys of the proposed corridor area
- Review and identify suggested structure designs and preferred pole types

Figure 24. Nest Platform and Crossarm Covers

Avian-safe structures (proper spacing between conductors, perch guards, nest platforms and line flight diverters) should be the preferred construction standard for all areas where birds are known to frequent (Figures 11-24 and Appendix A).

Avian interactions with electrical facilities can create operational risks, health and safety concerns, and avian injuries or mortalities. The use of avian-safe designs and construction may significantly reduce future electrocution problems and power reliability issues. While it is not mandatory to design and construct utility structures to avian safe standards, it is highly recommended that the Base build new structures with adequate conductor separation to accommodate the occurrence of golden eagles on the Base. Utility structures built to past construction standards present threats to avian populations. If conductor separation is not feasible, perch guards, discouragers and insulator covers should be employed.

It is in the best interest of the Base to ensure that new structures are raptor safe. Not only will avian-safe structures reduce the risk for electrocution mortality, they may potentially save the Base thousands of dollars due to lost revenue and equipment repair. Avian-safe structures may reduce electrical system unreliability and customer dissatisfaction as well. Additionally, the Base could be at risk of strict fines and penalties for non-compliance with the MBTA, BGEPA, and/or ESA if avian electrocutions occur on Base. Preventing avian electrocutions is beneficial to the Base and should be a priority when new utility structures are proposed.

5.4 EXISTING UTILITY STRUCTURE RETROFITTING RECOMMENDATIONS

Areas of high avian mortality risk on the Base, as identified by the AVES Model, should be physically evaluated to determine which method of retrofitting is most appropriate for the structures in those areas. It is recommended that any non avian-safe structure in the areas with the highest mortality risk be modified to reduce potential mortalities and meet the current protections from regulatory drivers such as the MBTA, ESA, and/or BGEPA.

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6.0 IMPLEMENTATION AND ADAPTIVE MANAGEMENT ACTIONS

6.1 BASE POLICY

As part of its ongoing commitment to natural resource management and compliance with its INRMP, the Base will voluntarily adopt and implement the avian protection measures as described in the Plan to reduce potential avian mortality as a result of electrocution and collision incidents with the Base utility structures. The Base has a responsibility to protect migratory birds under EO 13186 and the MOU (between the DoD and the USFWS) for the conservation of birds during non-readiness military activities. Adoption and implementation of the Plan serves to minimize avian mortality as well as comply with federal and state avian protection regulations and reduce power outages to the Base facilities.

6.2 ASSESSMENT AND IMPLEMENTATION APPROACHES

6.2.1 Reactive Approach

Through adaptive management, the Base can continually improve the practice of avian protection by evaluating the outcome of avian-power line interactions and incidents on the Base. As incidents occur and problem utility structures become apparent, the Base will respond appropriately through documentation via the Avian Reporting System (Section 7.0). The Base will evaluate the circumstances leading to the incident and begin taking proper action to prevent similar incidents in the future. In the event of an avian injury or mortality, the Base should implement retrofitting techniques, as explained in Section 5.0 and Appendix A, which will provide adequate avian protection and reduce the potential for future incidents. An examination of surrounding structures with similar construction should take place as well, with a plan to retrofit any unsafe structures, so that avian mortality may be prevented in areas of known avian use in the future.

6.2.2 Proactive Approach

New and replacement structures should be built to avian-safe standards. Minimizing the potential for an avian-power line interaction can help prevent future incidents and possible violations of the MBTA, ESA and BGEPA. Utility structures that are built to avian-safe standards will reduce the potential for future replacements and retrofits. Proper installation of avian-safe structures is the most cost-effective approach in reducing avian electrocution mortalities. While insulator covers may reduce avian electrocutions on utility structures, these devices may wear down over time, compromising their effectiveness. Conductor separation is the most economical and preferred construction standard.

6.3 PERMIT COMPLIANCE

There may be situations where the Base finds it necessary to obtain additional federal permits regarding avian species as it relates to electrocution and collision mortality, and nest removal and relocation. The Base currently possesses collection and salvage permits as it relates to migratory birds and eagles.

The Base may seek out a Section 7 consultation with USFWS if they are unable to completely prevent the mortality of a federally listed bird and the take is not covered by the Base's existing programmatic biological opinions. USFWS has issued an Environmental Assessment (EA) for issuance of bald and golden eagle take permits, which when applied for, would allow the Base to take, possess or transport bald and golden eagles. This permit is also pursuant to the approval of a habitat conservation plan that minimizes and mitigates the impact of the take.

Under the circumstances that the Base may wish to collect bird carcasses for necropsy to determine the cause of death, the Base will need to coordinate with USFWS to obtain a Federal Migratory Bird Permit and a State Scientific Collecting Permit (if the carcass leaves the Federal Reservation). These permits allow the Base to collect, salvage, and transport injured birds to rehabilitation facilities and otherwise handle any bird or bird body part including feathers. If the bird is a protected species, the Base will need to coordinate with USFWS to make sure all applicable permits have been issued.

The active nests of all birds are protected under the MBTA. In order to remove and/or relocate nests that pose an electrical risk to the birds or a power outage, the Base must coordinate with USFWS to obtain the proper permits for such an action. Inactive nests of all birds, except eagles or threatened or endangered species, can be removed without federal permits.

If the Base elects not to obtain a nest relocation permit, they must comply with federal regulations and contact USFWS to handle any active nest (or inactive nest of eagles and threatened and endangered species) that have been impacted by a utility structure.

6.4 PERSONNEL TRAINING

In order to effectively implement this Plan, ES-Wildlife will develop a program to train all appropriate personnel (Facilities Maintenance Department, Base Game Wardens, Resident Officer in Charge of Construction and AC/S Environmental Security staff, for example) on the issues and protocols outlined in this Plan. This training will ensure that all appropriate personnel have a thorough understanding of the Plan and their responsibility to avian protection and regulatory compliance.

ES-Wildlife will create a Plan PowerPoint presentation for use in the training of all appropriate Base personnel. The presentation should include a thorough description of avian electrocution issues as well as a review of all of the information presented in this Plan such as: applicable federal regulatory laws, federal listed species that occur on the Base, raptor use and distribution on the Base, the AVES Model, identification of susceptible raptors using the avian identification guide (Appendix D) or a published field guide, avian-safe construction standards, the Power Outage Detection Card (PODC) and Avian Incident/Nest Form (AINF), and management of the avian mortality database. It is also recommended that the Base incorporates the DVD, ‘Raptors at Risk’, created by the Raptor Protection Video Group, into its training program. This DVD is an excellent visual aid that explains the issue of avian electrocution, the federal laws that protect birds, and the avian-safe construction standards that will reduce avian mortality.

Base personnel should also refer to the APLIC workshop schedule, available at www.aplic.org, for further information regarding avian electrocution issues. APLIC holds annual workshops with the intention of educating utilities, resources agencies and the public on avian interaction utility issues. These annual workshops update participants on the newest techniques and equipment for reducing avian electrocution mortality.

6.5 AVIAN ENHANCEMENT OPTIONS

The Base's commitment to natural resource management through implementation of its INRMP will continue to promote habitat protection and conservation of avian species. Maintaining and restoring habitats such as scrub, chaparral, oak woodland and riparian will enhance habitat for avian species. In addition to habitat protection, the Base may also implement one of the avian-safe utility standards of installing perch guards and nest platforms to utility poles. These actions safely enhance habitat for avian use.

6.6 QUALITY CONTROL

In order to successfully achieve the primary goal of this Plan (reduction of utility-induced avian mortality), the Base should implement periodic reviews of the Plan and evaluate quality control measures to monitor the effectiveness of this Plan. Such quality control measures include annual reviews of the mortality database and AVES model, AINF, and recommended mortality reduction actions. The Base should also regularly monitor retrofitted and avian-safe structures to assess their effectiveness and need for maintenance, and update avian high risk area maps annually with the addition of new data.

6.7 PUBLIC AWARENESS

This component of an APP does not apply in the traditional sense of public outreach as the Base is not regularly accessible to the general public. However, with over 60,000 active military personnel training on the Base, their families, and the myriad civilian contractors and employees on the Base, it is important to highlight the issues of avian protection and avian electrocution issues in a public forum. The Base Wildlife Management Branch Head (WMBH) may publicly distribute information on avian protection and electrocution issues via the Environmental Information webpage on the Base website, brochures created by AC/S Environmental Security and Facilities Maintenance Department, or educational presentations. Increasing awareness of avian electrocution through public awareness campaigns may increase detection or reporting of utility-induced avian mortality.

6.8 KEY RESOURCES

The following resources are available to the Base to assist in providing expertise in permitting, bird populations and behavior and avian-safe utility design. Calling upon these resources can further ensure that the Base successfully implements this Plan.

Base Contacts

Resource Enforcement and Compliance Branch (Base Game Wardens)
Jim Asmus, Assistant Chief Game Warden
AC/S Environmental Security
MCB Camp Pendleton
Box 555008, Bldg 2648
Camp Pendleton, CA 92055-5008
760-725-3360

Environmental Security-Wildlife Management Branch
Beth Forbus
Wildlife Biologist
AC/S Environmental Security
MCB Camp Pendleton
Box 555008, Bldg 22165
Camp Pendleton, CA 92055-5008
elizabeth.forbus@usmc.mil
760-725-9739

Environmental Security-NEPA
John Burke
NEPA Planner
AC/S Environmental Security
MCB Camp Pendleton
Box 555008, Bldg 22165
Camp Pendleton, CA 92055-5008
760-725-9759

Federal Agencies

U.S. Fish and Wildlife Service Migratory Bird Permit Office-Region 8
2800 Cottage Way
Sacramento, CA 95825
Tel: (916) 978-6183
Email: jennifer_c_brown@fws.gov

U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office
6010 Hidden Valley Road, Suite 101
Carlsbad, CA 92011
Tel: (760) 431-9440

Utilities

San Diego Gas and Electric
101 Ash Street
San Diego, CA 92101
Tel: (619) 696-2034

Organizations

San Diego Audubon Society
4891 Pacific Highway, Suite 112
San Diego, CA 92110
Tel: (619)682-7200

The Nature Conservancy
3033 5th Avenue, Suite 105
San Diego, CA 92103
Tel: (619) 209-5830

Manufacturer of Avian Protection Utility Devices

Eco Electrical Systems, Inc.
7758 Pickering Circle
Reno, NV 89511
Tel: (775) 853-8623
Fax: (775) 853-8615
http://www.ecoelectrical.com/index.html

Wildlife Outage Protectors
37 Appletree Lane
P.O. Box 450
Plumsteadville, PA 18949
Tel: (888) 414-2398
http://www.nikg.com/pdm/pages/page.asp

Kaddas Enterprises, Inc.
3588 West Directors Row
Salt Lake City, UT 84104
Tel: (888) 658-5003
Fax: (801) 972-3200
http://www.kaddas.com/products-and-solutions/success-stories/9-outage-protection

PDT, L.L.C
P.O. Box 802
Springhouse, PA 19477
Tel: (215) 643-2028
Fax: (215) 540-9759
http://www.pdtllc.us/pages/wopp.htm

Phoenix Manufacturing, Ltd.
141 Fulton Street South Milton
Ontario, Canada, L9T 2J8
Tel: (905) 878-2818
Fax: (905) 878-0051
http://www.phnxmfg.com/outdoor.html

Wildlife Rehabilitation Centers

Project Wildlife
887-1/2 Sherman Street
San Diego, CA 92110
Tel: (619) 225-9453

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7.0 AVIAN REPORTING SYSTEM

The Avian Reporting System (ARS) is a methodology that will allow the Base to record, monitor, and manage all avian-utility structure interactions. The four components of the ARS will be considered standard protocol and will be implemented in the event of an avian-power line incident.

7.1 DETECTION

Avian mortalities will be detected through the investigation of avian-caused power outages and casual observations. Nest sites will be detected through general observations and monitoring of known nest sites.

In the event of a power outage, Base utility personnel will determine whether the outage is the result of an avian electrocution incident. If an avian electrocution has occurred or if a nest is discovered at the location of the power outage, Base personnel will fill out a Power Outage Detection Card (PODC) (Appendix B) and call AC/S Environmental Security-Wildlife (ES-Wildlife) for further consultation. While it may be impossible to interface with all Base personnel regarding incidental detection of avian mortality, it is encouraged that the Base Wildlife Management Branch Head (WMBH) direct personnel who will be in most contact with utility structures to be on alert for utility-induced avian mortalities. Base personnel responsible for conducting routine maintenance on utility structures should report all avian-electrocution incidents to ES-Wildlife.

7.2 INVESTIGATION AND RESPONSE PROCEDURES

Once a dead or injured bird is detected below a utility structure, an ES-Wildlife representative will record data concerning the incident on the standardized Avian Incident and Nest Form (AINF) (Appendix C). When a bird-caused power outage results in avian mortality, identification of the bird species (using the guide provided by this Plan (Appendix D) along with verification of identification of the species) should occur. In addition to recording bird species, the type of injury, the pole type and configuration, and any other relevant data should be recorded. Only ES-Wildlife personnel possessing salvage permits or Base Game Wardens may handle and dispose of deceased birds.

7.2.1 Response Procedures for Injured Birds

Personnel discovering an injured bird within or around Base facilities or right-of-ways (ROWs) should contact ES-Wildlife or the Base Game Warden's office immediately. Base utility personnel should not attempt to capture or restrain the injured bird. The ES-Wildlife representative will complete the AINF and make arrangements with an identified animal care facility or authorized rehabilitator in the area for retrieval of the injured bird. If arrangements for retrieval cannot be made, the appropriate resource agency should be contacted for further guidelines and recommendations.

7.2.2 Response Procedures for Deceased Birds

Personnel discovering a deceased bird within or around Base facilities or ROWs should contact ES-Wildlife immediately. Base utility personnel should not attempt to handle the deceased bird. The ES-Wildlife representative will complete the AINF and properly dispose of the deceased bird. The ES-Wildlife representative will notify USFWS in the event of a mortality of a protected species or an eagle for proper documentation. Deceased birds with special leg bands, markers, or neck collars shall also be reported to USFWS.

7.2.3 Documentation of Deceased or Injured Birds

Proper documentation of all injured and deceased birds found within or around Base facilities and ROWs should be completed by an ES-Wildlife representative. The AINF will be used to document the data for injured or deceased birds. The data from the AINF should be entered into a database and the AVES model for avian protection evaluation purposes. The following steps will assist ES-Wildlife personnel in completing the AINF.

- **Identify the Species of Bird (Raptor or Non-Raptor)**

  Identify the species if possible, especially to determine whether the bird is an eagle or another raptor (see representative photos in Appendix D and/or a published field guide). Adult golden eagles range anywhere from 30-40 inches in length and have a 78-84 inch wingspan, other raptors have smaller but still large wingspans (Appendix D). Note any visible leg bands or wing markers. Take photos of the dead or injured bird. If a bird carcass is damaged beyond recognition, take a close-up photo of both the talons and the beak. Always include a photo of the pole number and the top of the pole or structure where the bird may have made contact. If the electrocuted bird is an eagle, or other protected species, notify USFWS for proper documentation.

  Only personnel possessing proper take permits may transport a dead or injured eagle—it is illegal to transport eagles in the United States without a permit (BGEPA).

- **Fill out an Avian Incident and Nest Form**

  The AINF should be on file at AC/S Environmental Security. Fill out the report as completely as possible. Include photos of both the injured or dead bird, and the pole or structure number involved. This information is critical to determining further steps to prevent another contact on the pole at issue. Submit the AINF, with the photos, to the WMBH within 24 hours after the contact is discovered and recorded.

7.2.4 Disposal of Deceased Birds

Only Base personnel possessing proper handling and salvage permits may remove or have in possession the carcass of a deceased bird. It is a violation of federal law to take (kill, transport, sell, or possess) a protected species without proper permits or authorization.

If an eagle is electrocuted, the ES-Wildlife representative should contact the USFWS. The USFWS may investigate an eagle mortality, which frequently requires an autopsy of the carcass to determine the cause of death.

Base personnel discovering mortalities of unlisted birds or non-eagle species should contact ES-Wildlife for documentation of the findings and possible cause of death. These birds should be buried on-site without transporting. The ES-Wildlife representative should contact USFWS if the carcass is marked (special leg bands, markers, or neck collars).

Species other than federal threatened or endangered species and eagles can be buried at a site-approved location, away from Base facilities without a permit. Protected species lists and procedures should be reviewed annually or after regulatory changes have occurred to keep the management plan accurate to the current regulatory environment.

7.2.5 Response Procedures for Nesting Birds

Raptors and occasionally other species benefit from the presence of power lines because they utilize poles and transmission structures for nesting. Bird nests can cause problems to an electric system, such as an outage, when the nest materials span the distance between the conductors/phases. Removal of nests generally does not solve the problem because most bird species are site-tenacious and rebuild shortly after the nest material has been removed or damaged. Active nests that do not interfere with power operations should be left in place. If a specific nest may be a problem in the future, Base personnel may wish to take certain actions during the non-breeding season before the nest is occupied for an unprotected species. Base personnel can perform appropriate activities without the need for a permit or permits if the nest is not occupied. The breeding season for most birds is between February 1 and August 31.

Prior to taking any action associated with a nest, Base personnel need to determine:

- Is the nest occupied? If yes, does the nest contain an incubating adult, eggs, or young?
- What is the species of bird using the nest? Is the species federally threatened/endangered or an eagle?

After answering the above questions, Base personnel should follow the procedures below based on the status of the nest and the species of bird.

7.2.5.1 Occupied/Unoccupied Nest of Federal Listed or Eagle Species

All nests of federally or state threatened or endangered or eagle species are protected by federal laws regardless of whether the nest is occupied or unoccupied (Please refer to Table 1 for a list of special-status species that occur on Base). For each violation of Sections 11(a)(1) and 11(b)(1) of the ESA, the Base and responsible Base personnel may be fined between $500 and $50,000. Base personnel could face imprisonment for up to one year. Base utility personnel should contact ES-Wildlife for confirmation if a nest is suspected to be that of a federal or state threatened or endangered or eagle species. Prior to any management action, ES-Wildlife will obtain appropriate permits and requirements from the USFWS.

In case of an emergency, Base utility personnel should contact ES-Wildlife immediately. For purposes of this Plan, an emergency means “the immediate potential for fire or other safety hazards to the Base’s facilities, employees and/or the public.” Do not take any action such as trimming nest material, moving conductors, or other actions prior to contacting ES-Wildlife. Base utility personnel should not take any action that may affect the adult birds, eggs, chicks or the occupied nests of threatened or endangered species. USFWS could consider any unauthorized action as a “take” under the ESA. In an emergency situation and an adult or young bird has already made contact with equipment and is deceased, it may be removed from the equipment and placed on the ground in order to prevent further damage. Before moving the bird to the ground, take several photographs of the position of the bird on the equipment. The ES-Wildlife representative will notify USFWS in the event of an eagle mortality. In cases where an injured bird is involved or removal of the nest, eggs and/or chicks is required, the ES-Wildlife representative will contact USFWS. The ES-Wildlife representative must be present during the removal process.

7.2.5.2 Occupied Nest of Non-listed or Non-Eagle Species

All occupied nests are protected by the MBTA. Permits issued by the USFWS are required before taking action on, or managing, an occupied nest. When managing an occupied nest, Base utility personnel should immediately contact ES-Wildlife before taking any actions.

In an emergency (as described above), some limited activities may be performed such as trimming nest material prior to the Base obtaining authorization. Removal of occupied nests requires authorization from USFWS. Base personnel should not take any action that may affect an occupied nest prior to contacting ES-Wildlife. An ES-Wildlife representative should be on site to determine if removal is the only option available to Base utility personnel. ES-Wildlife should appropriately document any action taken on an occupied nest. If action is taken because of an emergency, the welfare and protection of adult birds, eggs and young must still be taken into serious consideration and caution must be used to avoid any potential 'take' or injury to the birds or eggs. When necessary, the ES-Wildlife representative will make arrangements for the transport and care of injured birds, eggs and chicks.

7.2.5.3 Unoccupied Nest

A federal permit is not required to remove or manipulate an unoccupied nest for a non-threatened/ endangered or non-eagle species during the non-breeding season (Sept 1 – Feb 14). However, Base utility personnel must notify ES-Wildlife of the action and location[12]. Reoccupation and rebuilding of nests during subsequent breeding seasons is common. Therefore, simply removing an unoccupied nest may not be a long-term solution. To prevent these future complications and costs, several management options will be considered to address the particular situation. For example, constructing a nest platform or modifying the pole to accommodate both the nest and power operations are management options that benefit both the Base and the birds (see Section 5.0).

7.3 REMEDIAL ACTION

When an avian electrocution or collision incident occurs on a Base utility structure, ES-Wildlife and Base Utility Point of Command (BUPC) will discuss the proper and immediate actions required to prevent further incidents on this structure. BUPC will be responsible for performing the required remedial action. Until the structure has been modified to avian safe standards, power should not be restored to the structure. ES-Wildlife should be notified once the structure has been modified to avian-safe standards.

[12] While a permit is not required to remove or relocate an inactive nest, personal possession of an inactive nest is illegal and prohibited.

7.4 REPORTING

When an avian fatality or injury has occurred, ES-Wildlife will compile all the documentation pertaining to the incident, including the PODC, AINF, photos of the utility structure and the dead or injured bird, the preferred method of retrofitting or modification to the structure, and the final outcome of the remedial actions. This documentation will be scanned and saved electronically as well as filed as a hard copy. The compiled avian electrocution incident data can then be submitted with annual permit reports. Additionally, the information recorded on the AINF should be entered into a Microsoft Access or Excel database. This database should be set up so that the data may be imported into the AVES model.

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8.0 LITERATURE CITED

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_____. 2009. PacificCorps Release. http://www.fws.gov/home/feature/2009/pdf/0947PacificCorppressrelease.pdf

8.1 PHOTO CREDITS

Front Cover: Golden eagle and red-tailed hawk in hexagons. Source: USFWS

Appendices: Source: Peter Bloom, USFWS, USDA Forest Service, and National Park Service (NPS), as noted.

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APPENDIX A

Non-Raptor Safe Design Problems and Recommended Modifications

APPENDIX A

Non-Raptor Safe Design Problems and Recommended Modifications

The following figures are from *Suggested Practices for Avian Protections on Power Lines: The State of the Art in 2006.* A variety of non-raptor safe designs are presented along with recommendations for modifying the problem configurations. Base utility personnel should reference this guide when determining whether poles are not raptor-safe and in need of retrofitting, as well as when new utility structures are proposed.

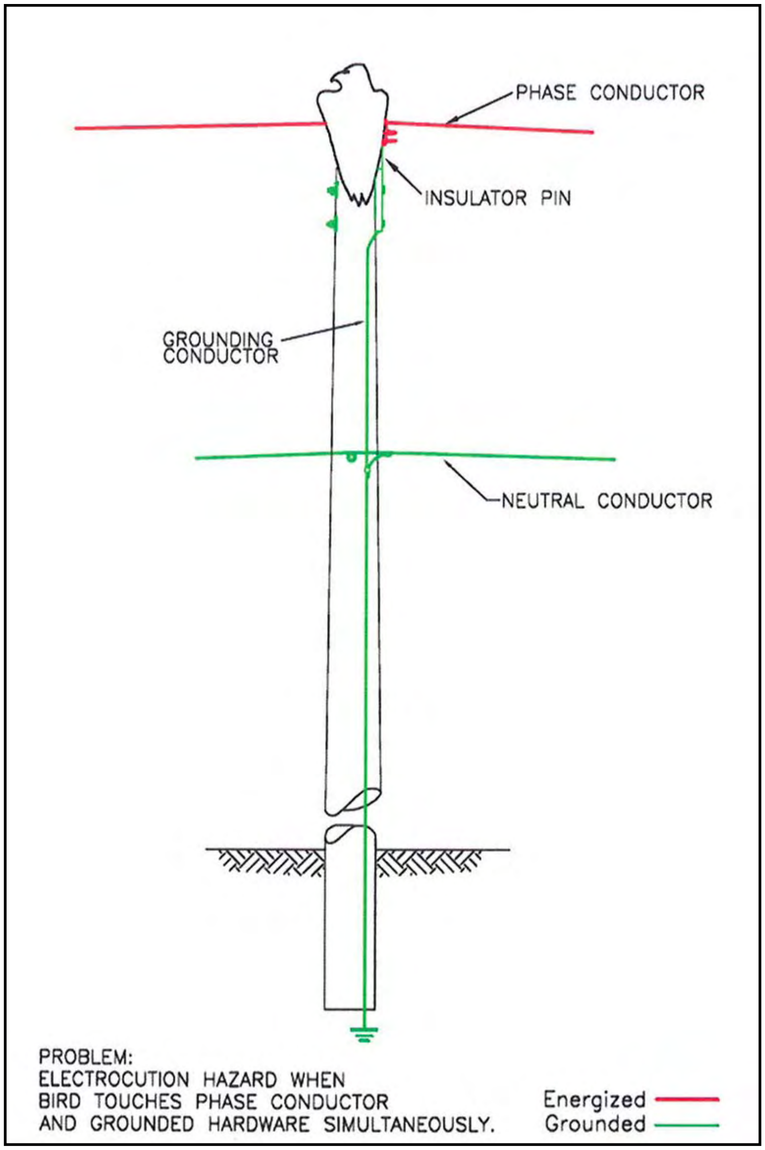

Figure A-1. Problem single-phase with ground pole-top pin.

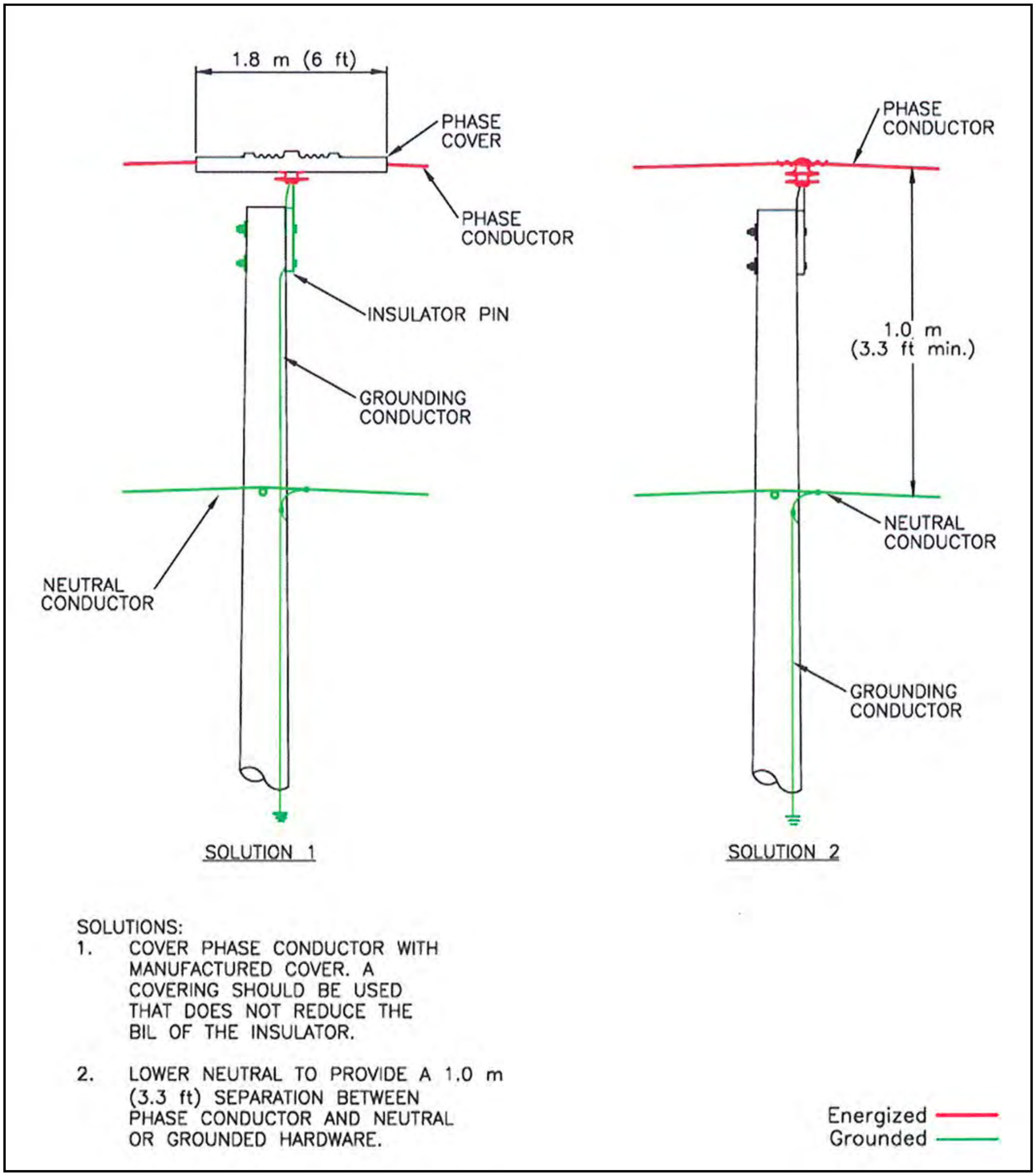

Figure A-2. Solutions for single-phase with ground pole-top pin.

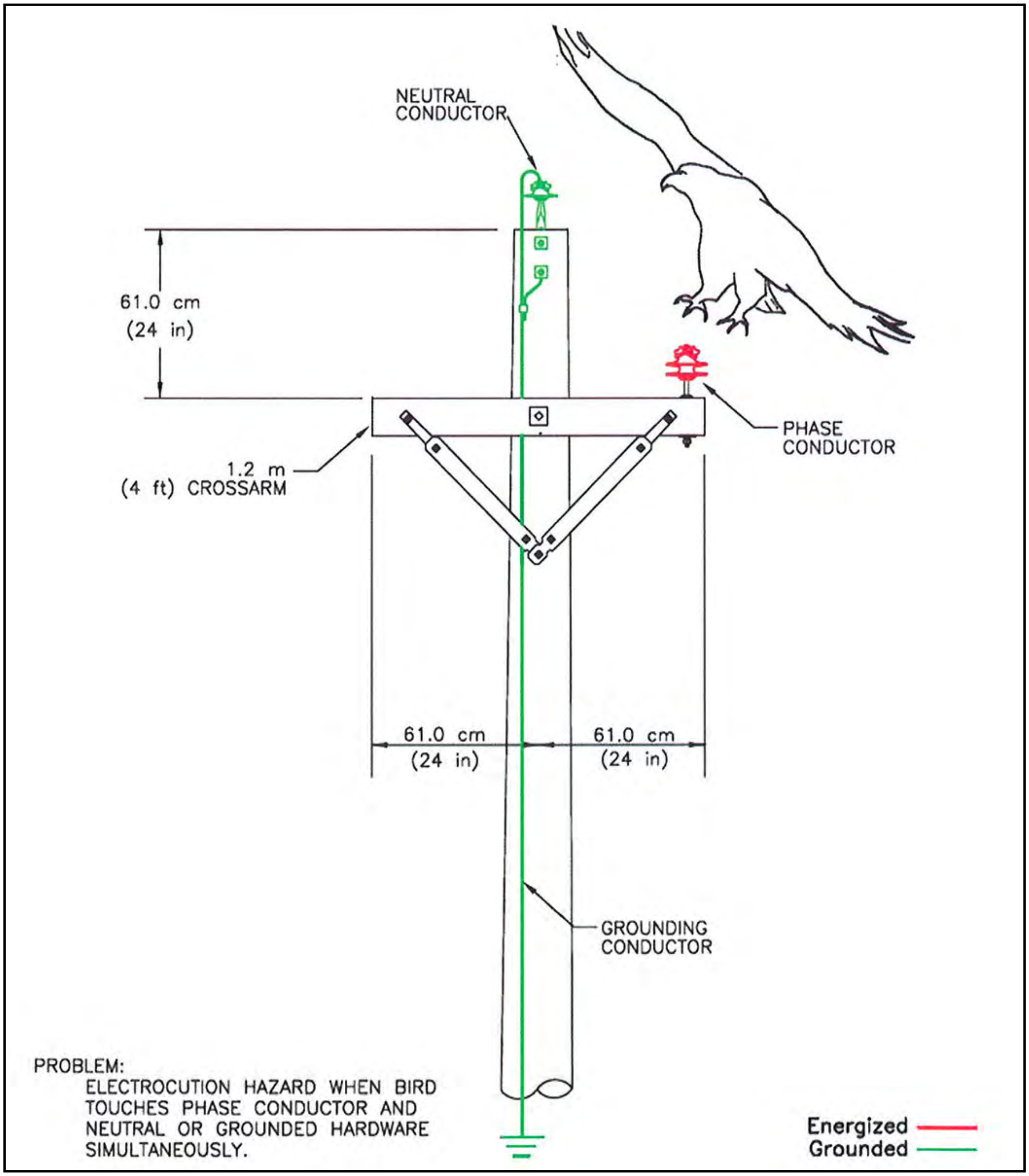

Figure A-3. Problem single-phase configuration with crossarm and overhead neutral.

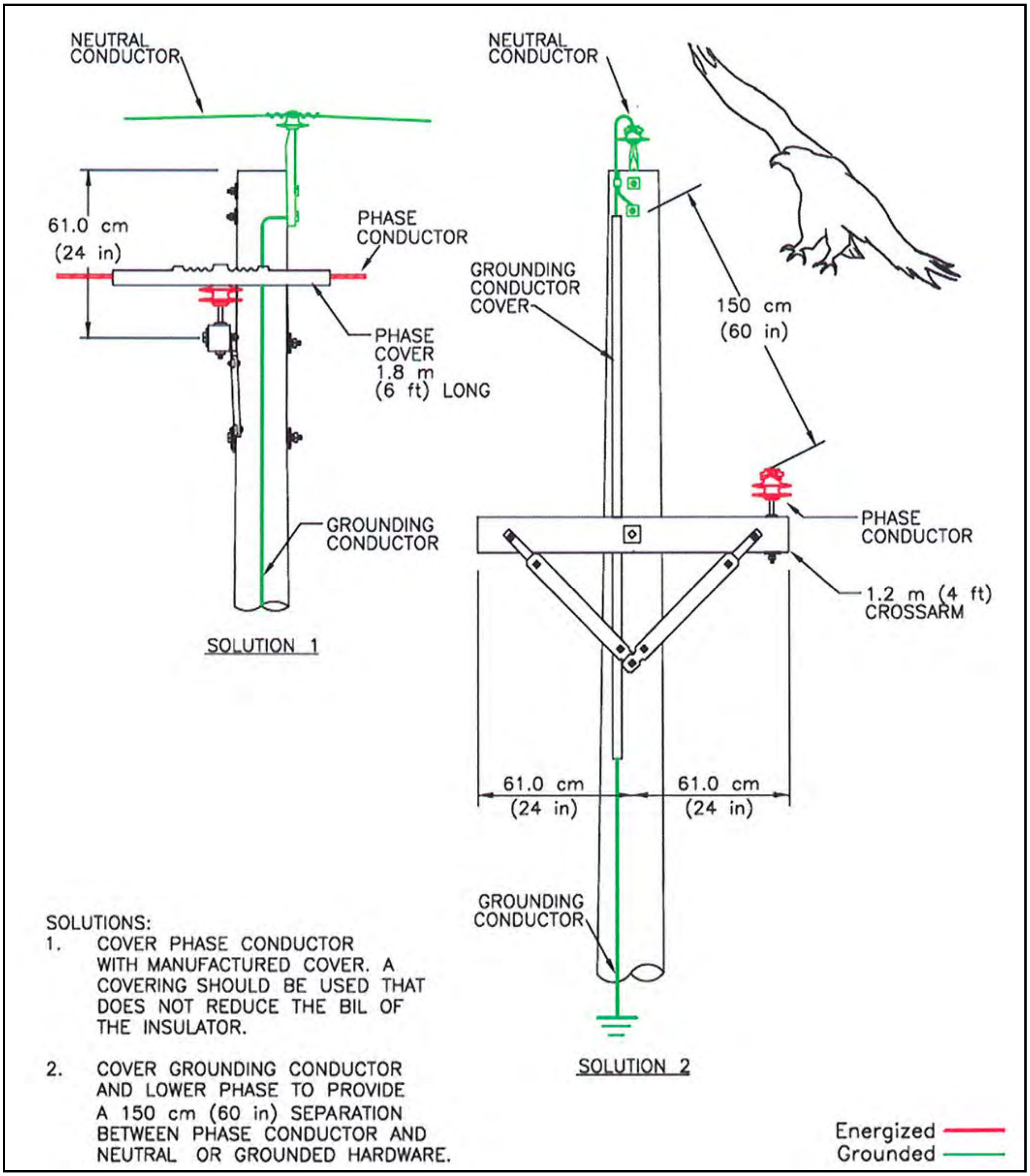

Figure A-4. Solutions for single-phase configuration with crossarm and overhead neutral.

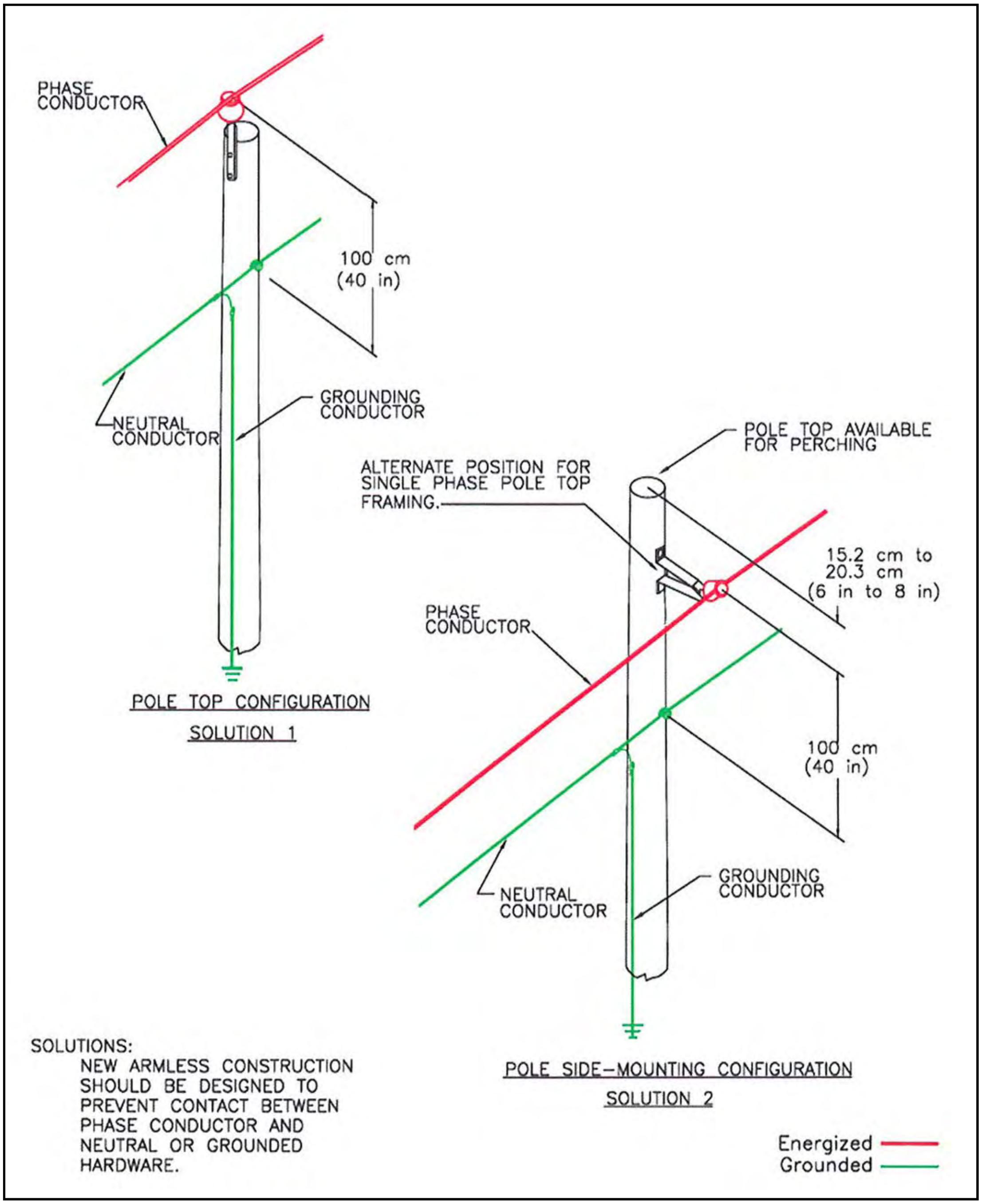

Figure A-5. Single-phase avian-safe new construction.

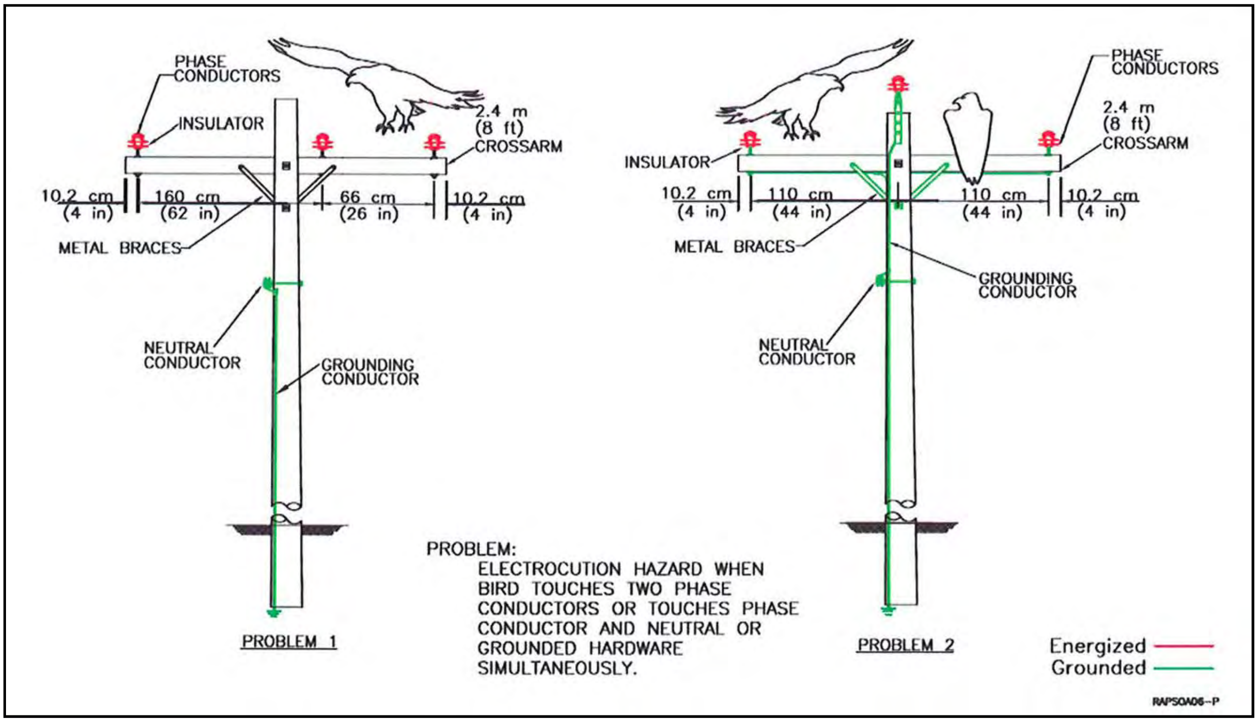

Figure A-6. Problem three-phase crossarm designs with and without grounded hardware.

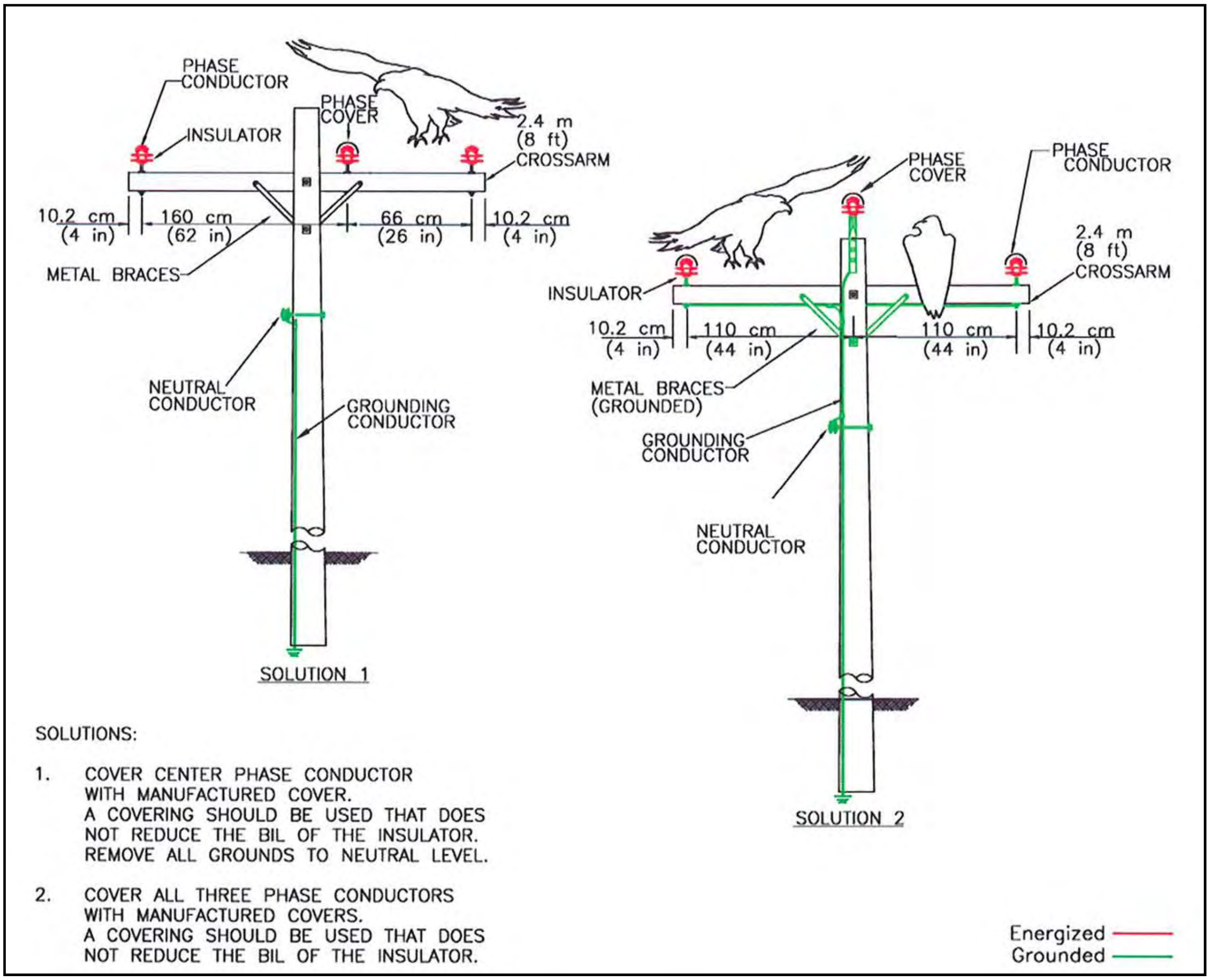

Figure A-7. Solutions for three-phase crossarm designs with and without grounded hardware.

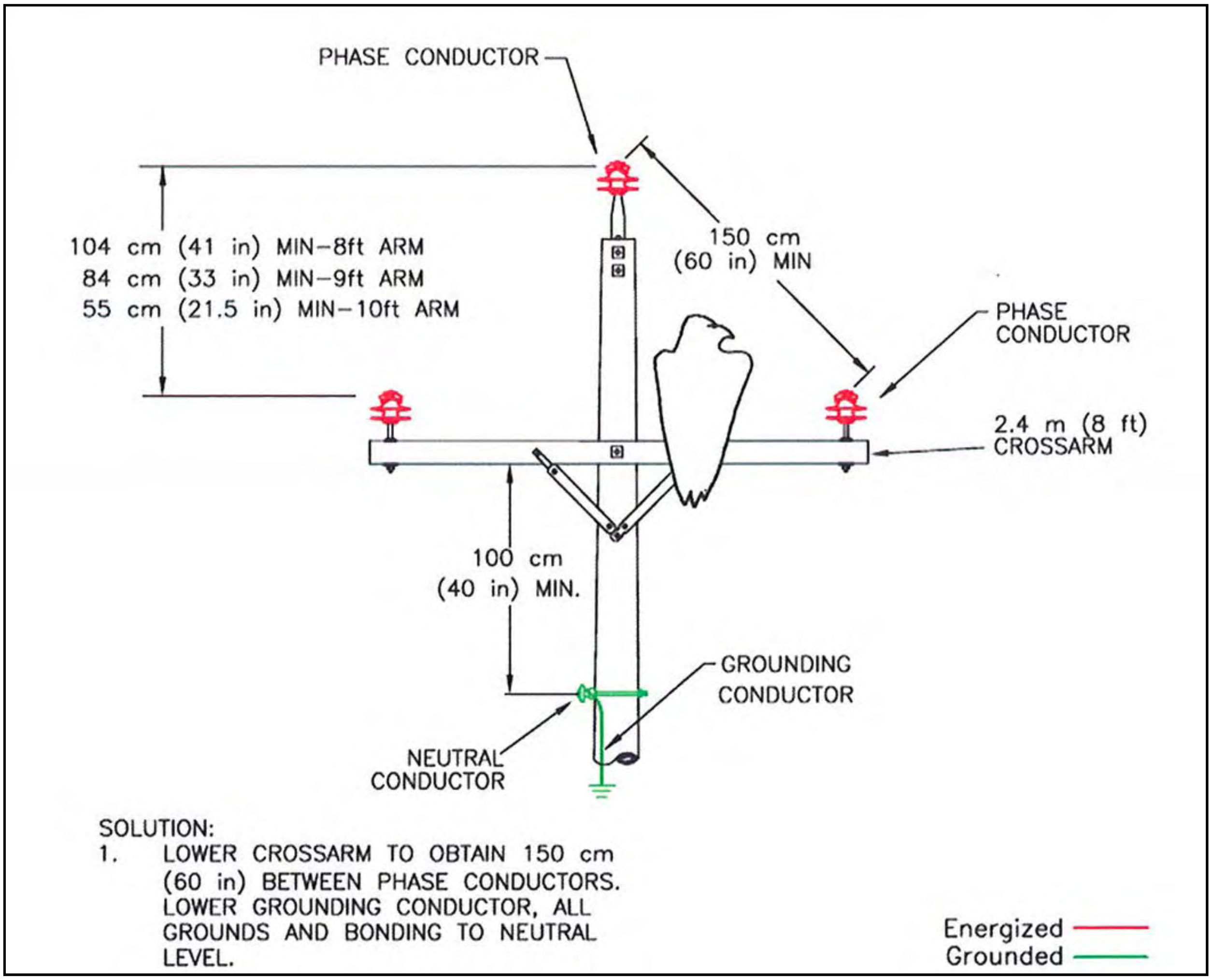

Figure A-8. Avian-safe three-phase construction for different length crossarms.

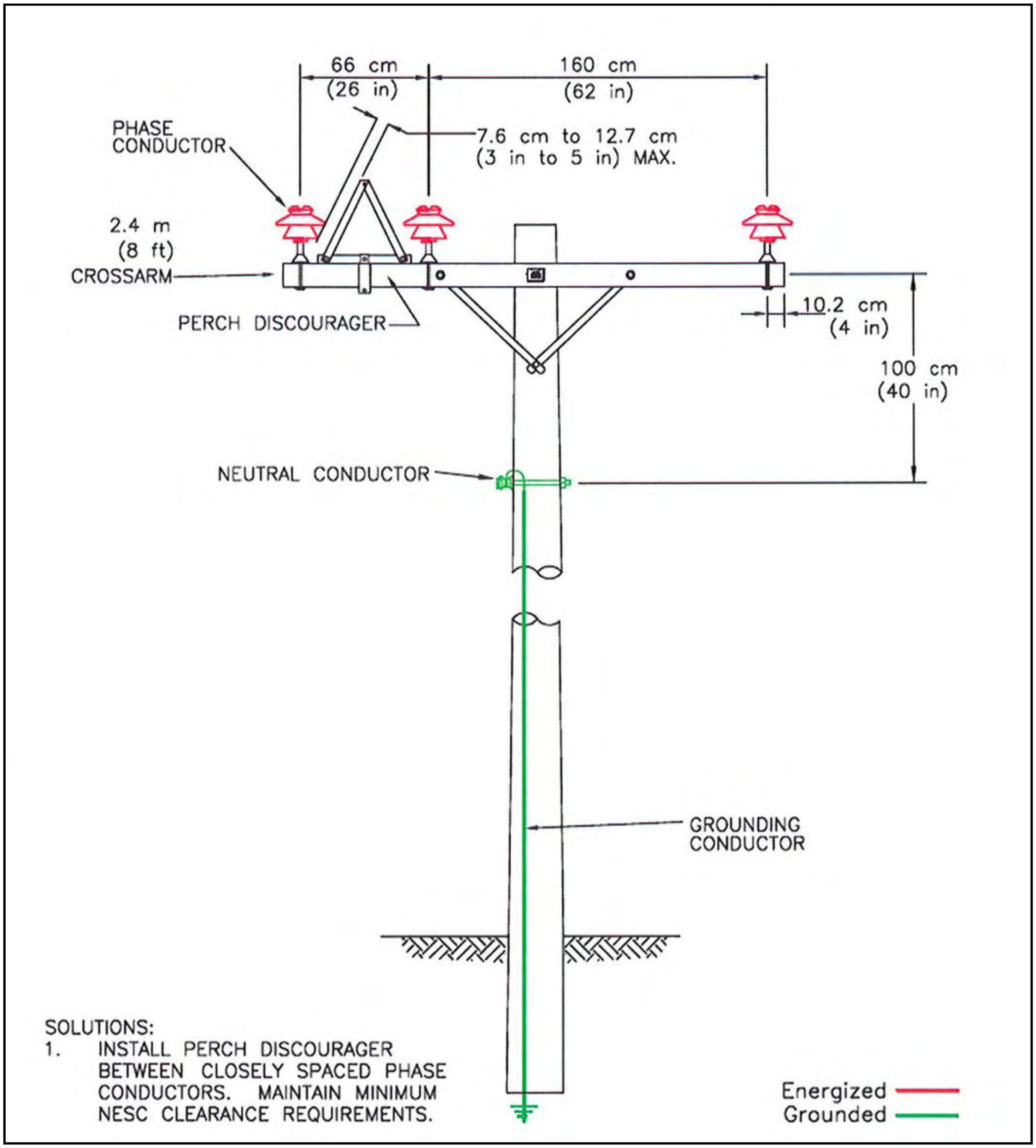

Figure A-9. Solution for three-phase crossarm using perch discourager.

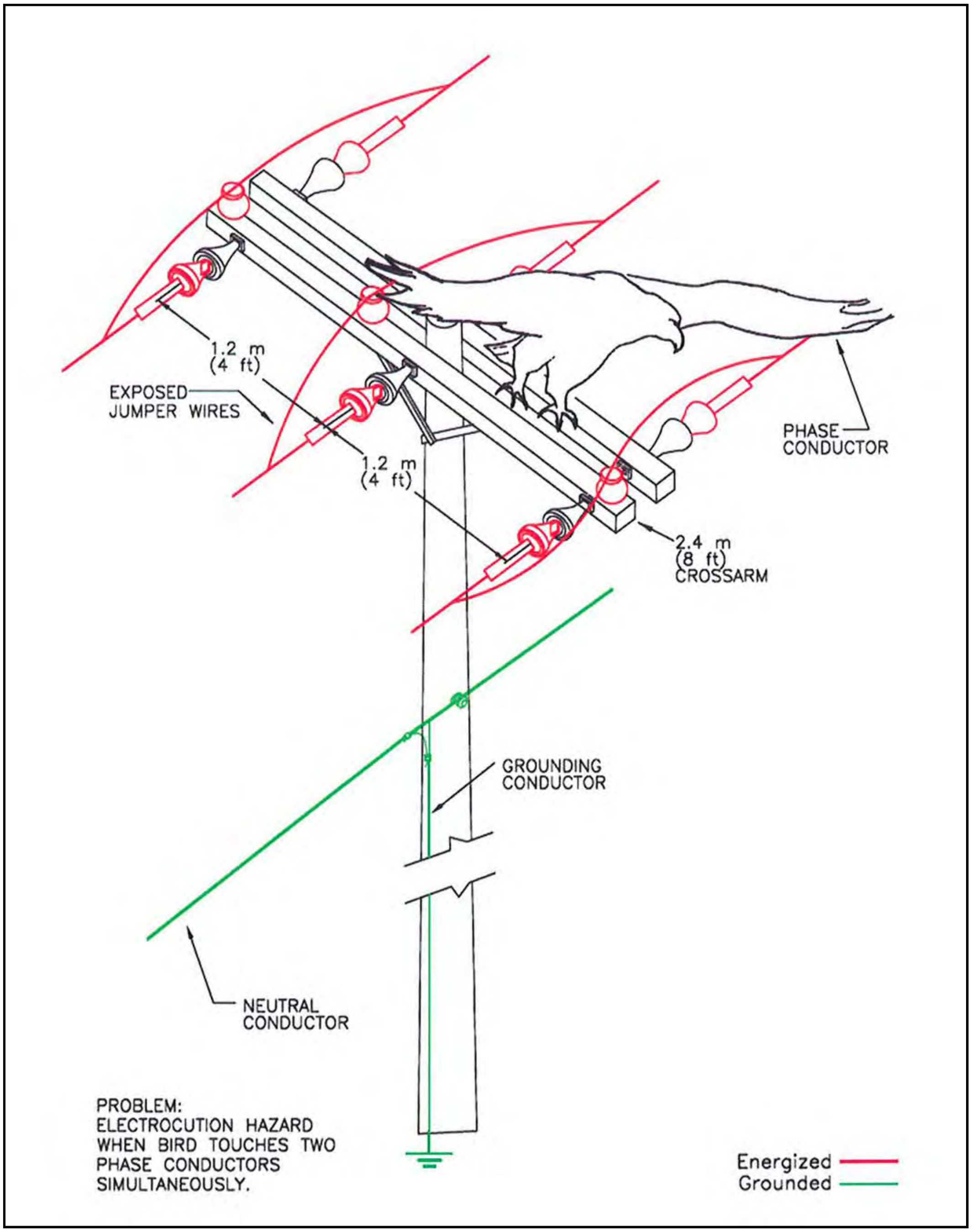

Figure A-10. Problem three-phase double dead-end with exposed jumper wires.

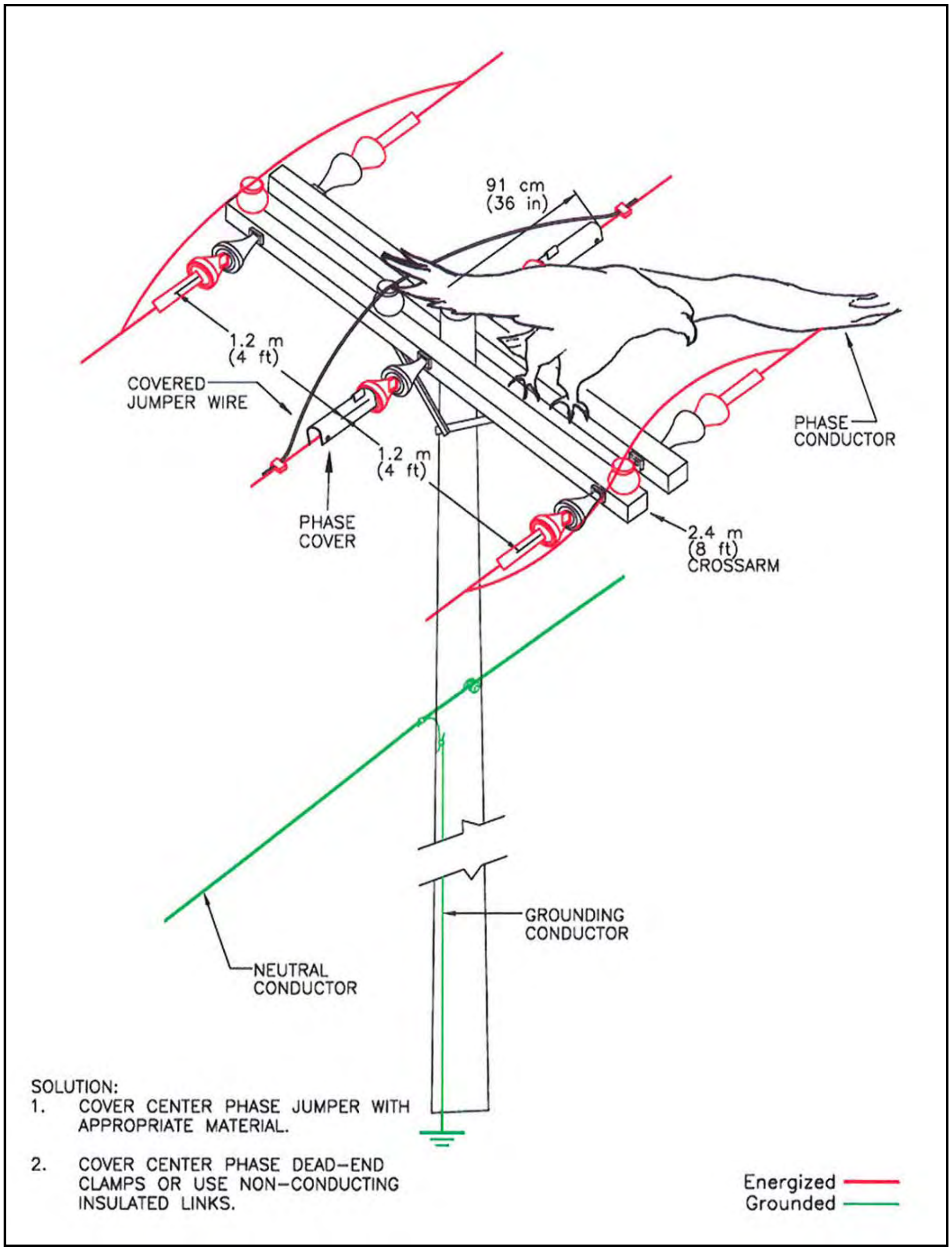

Figure A-11. Solution for three-phase double dead-end with exposed jumper wires.

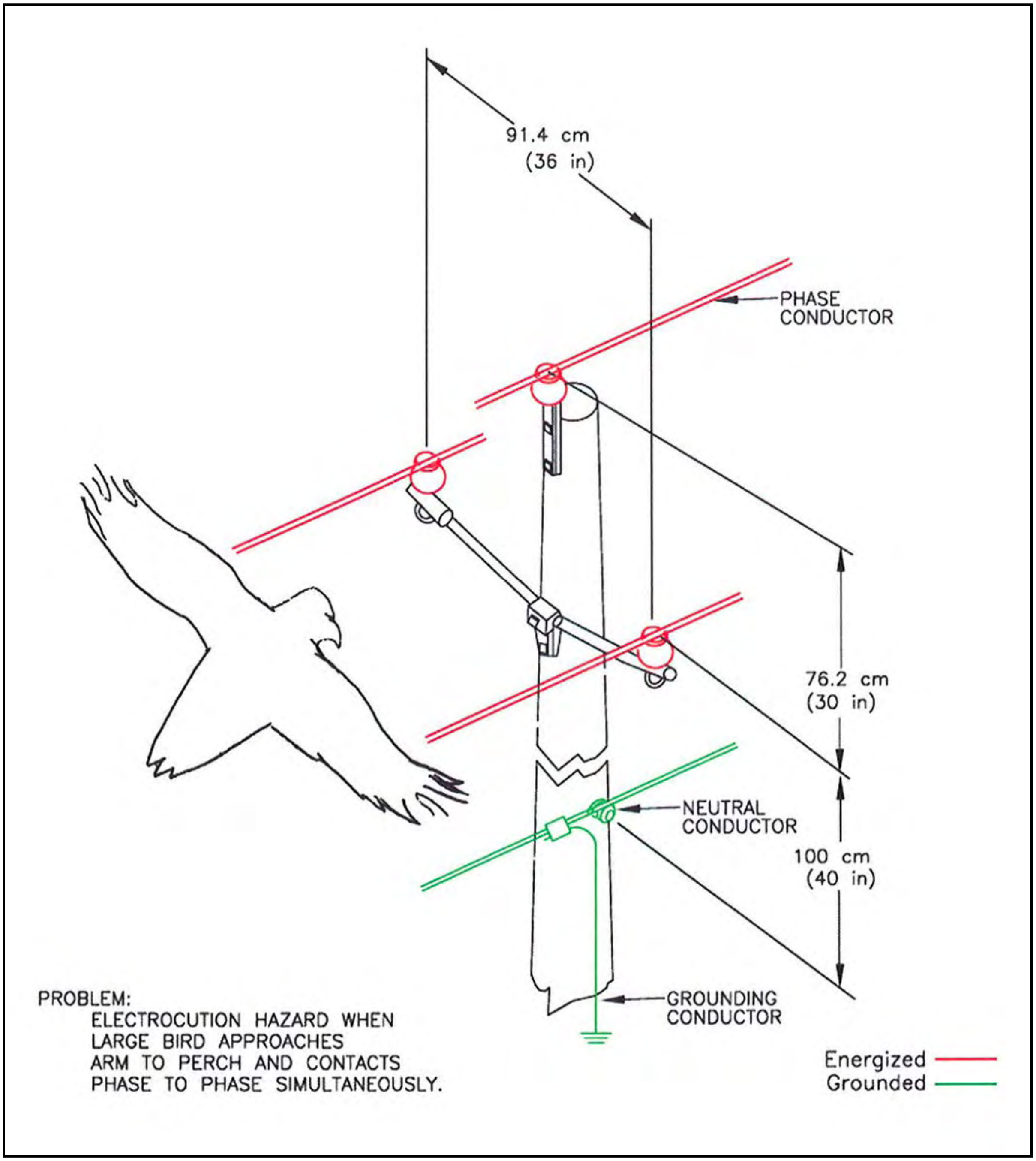

Figure A-12. Problem compact three-phase design.

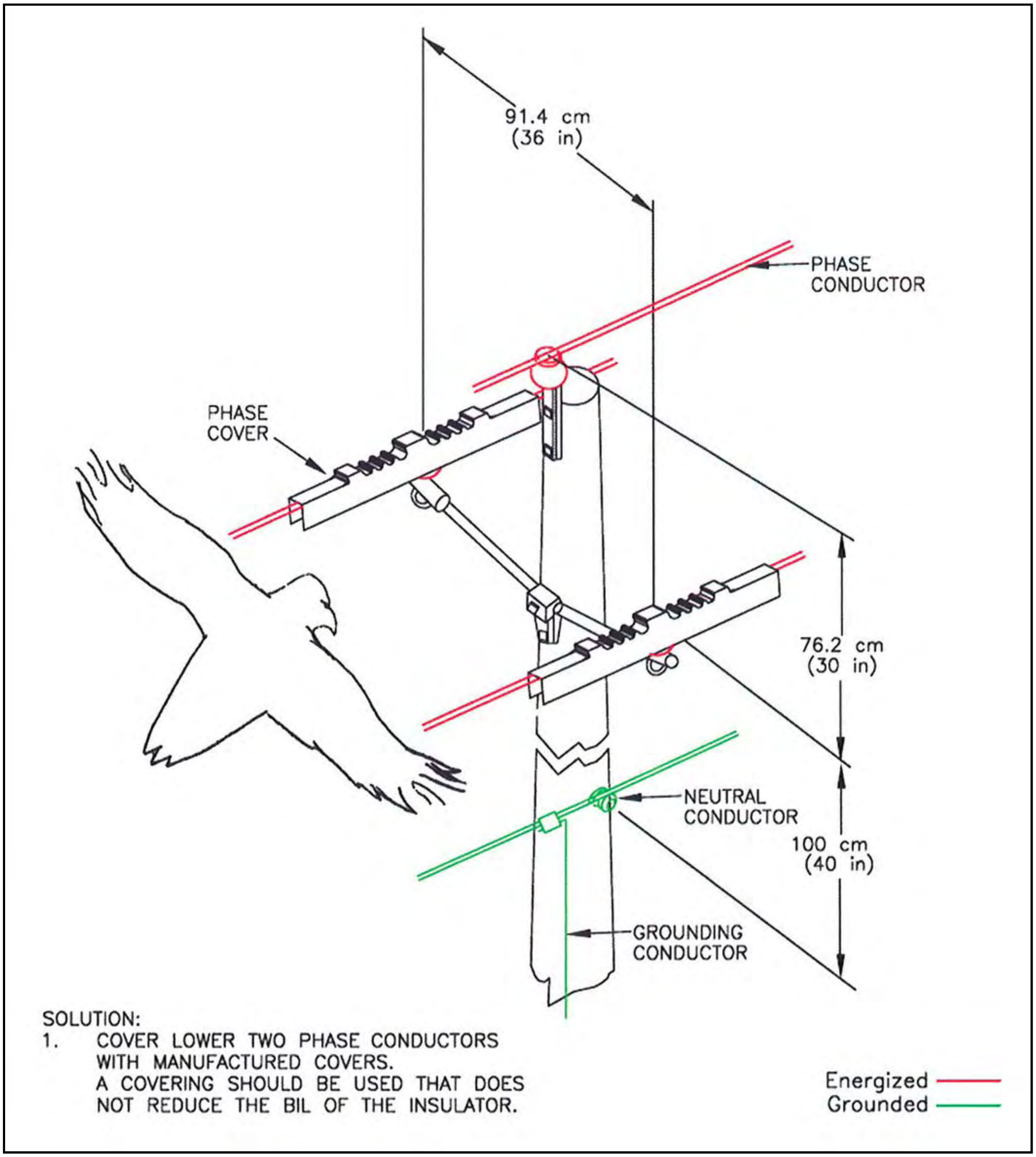

Figure A-13. Solution for compact three-phase design.

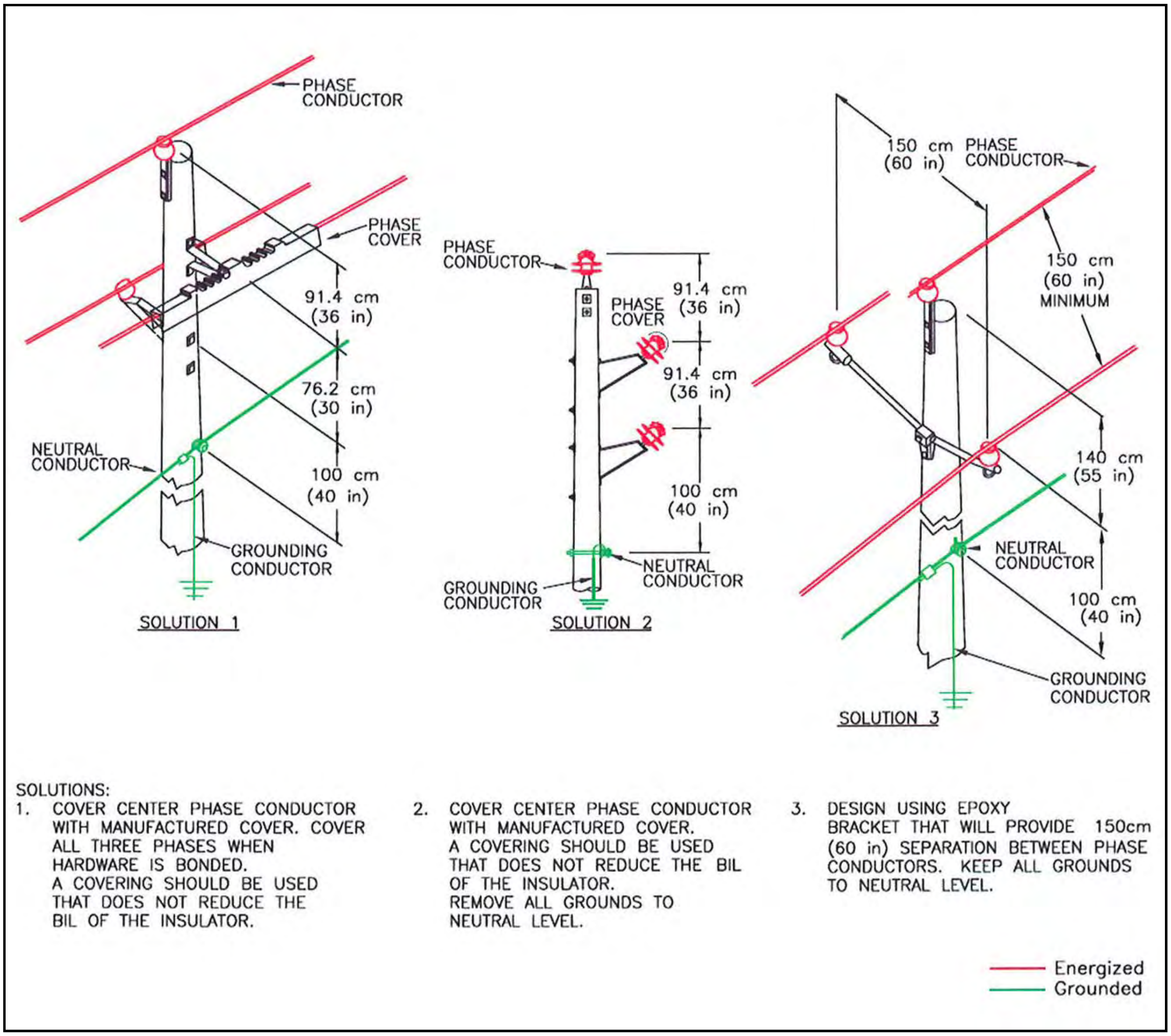

Figure A-14. Avian-safe compact three-phase designs for new construction.

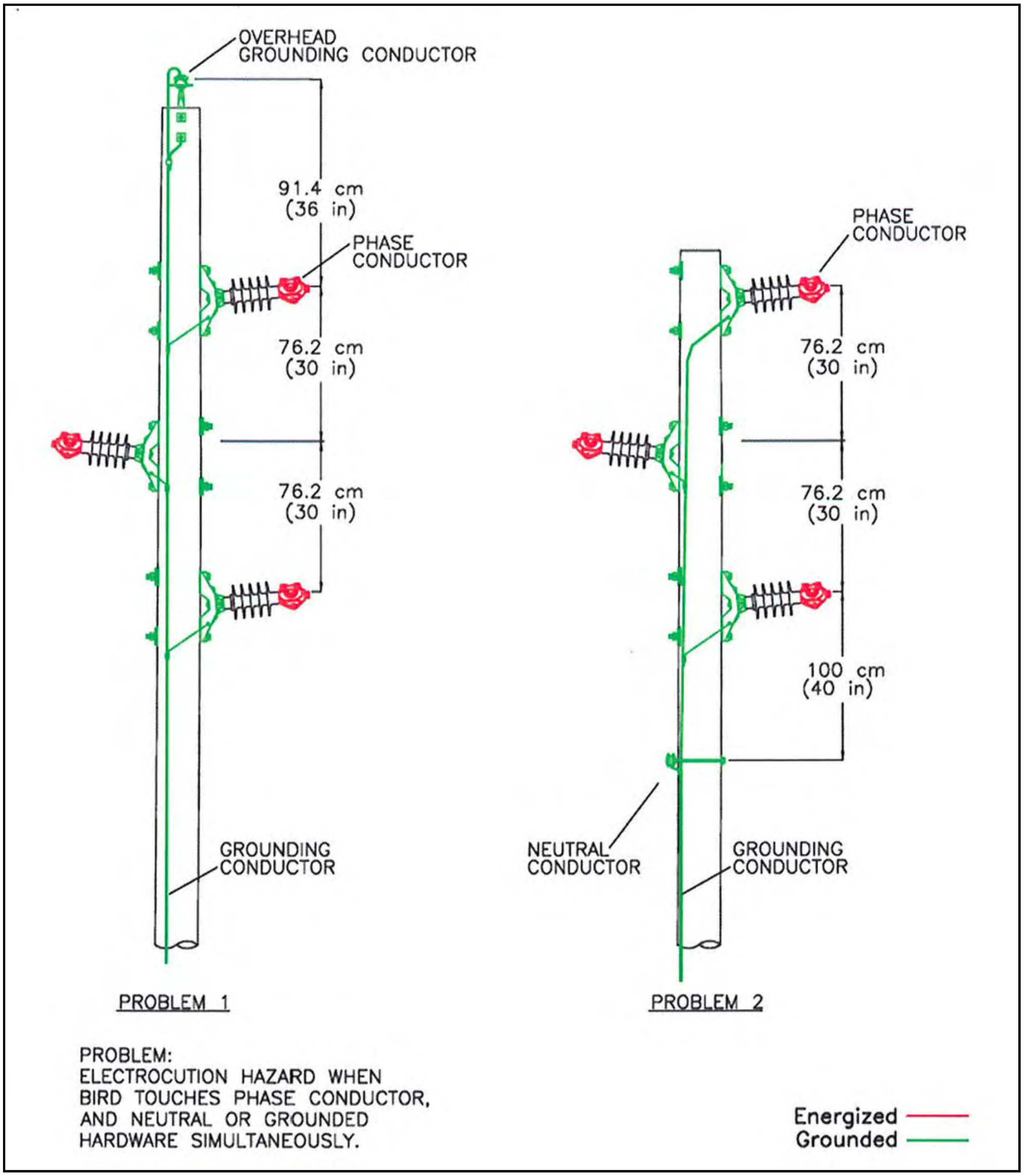

Figure A-15. Problem distribution horizontal post insulator designs.

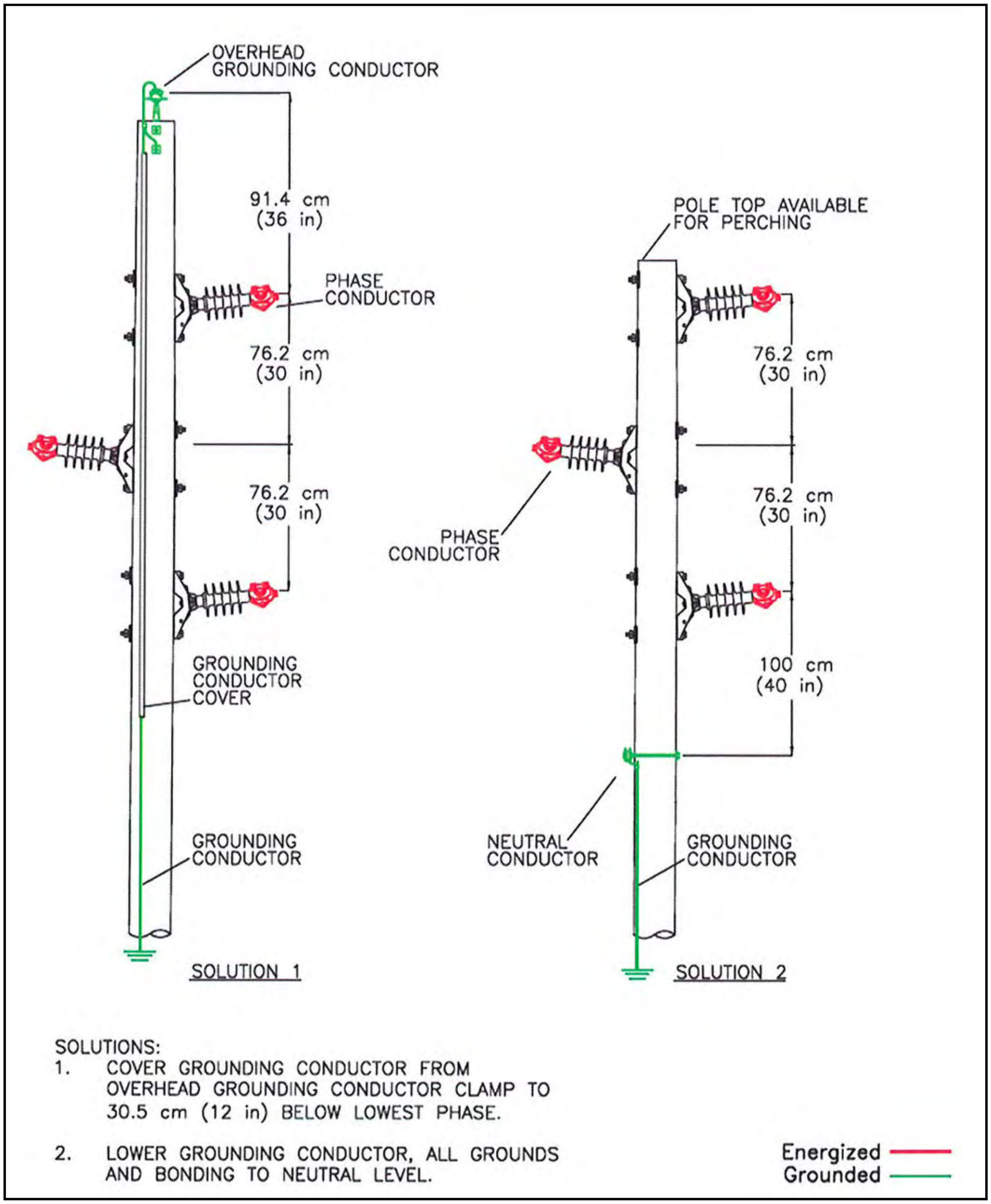

Figure A-16. Solutions for distribution horizontal post insulator designs.

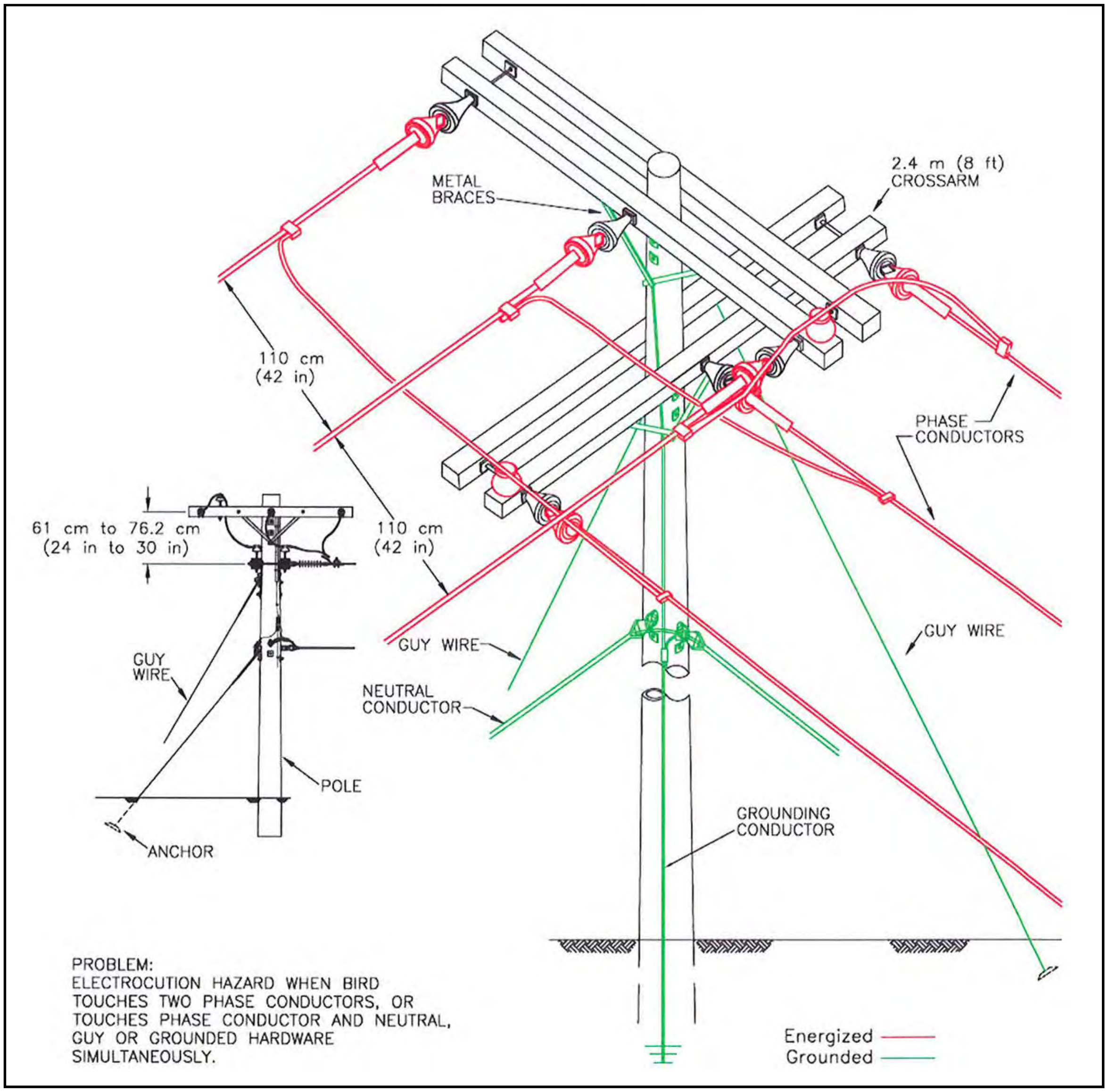

Figure A-17. Problem three-phase distribution corner configuration.

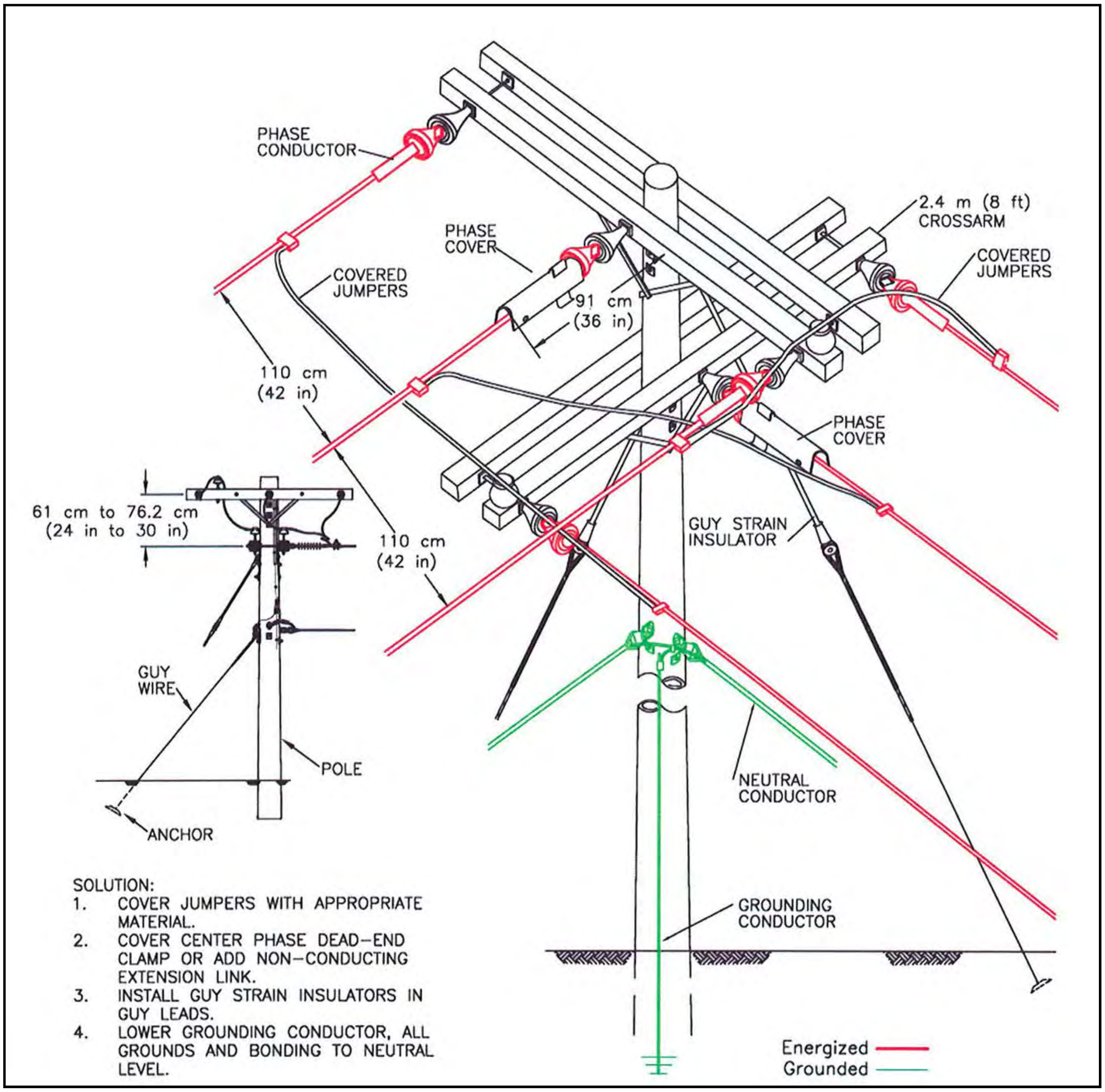

Figure A-18. Solution for three-phase distribution corner configuration.

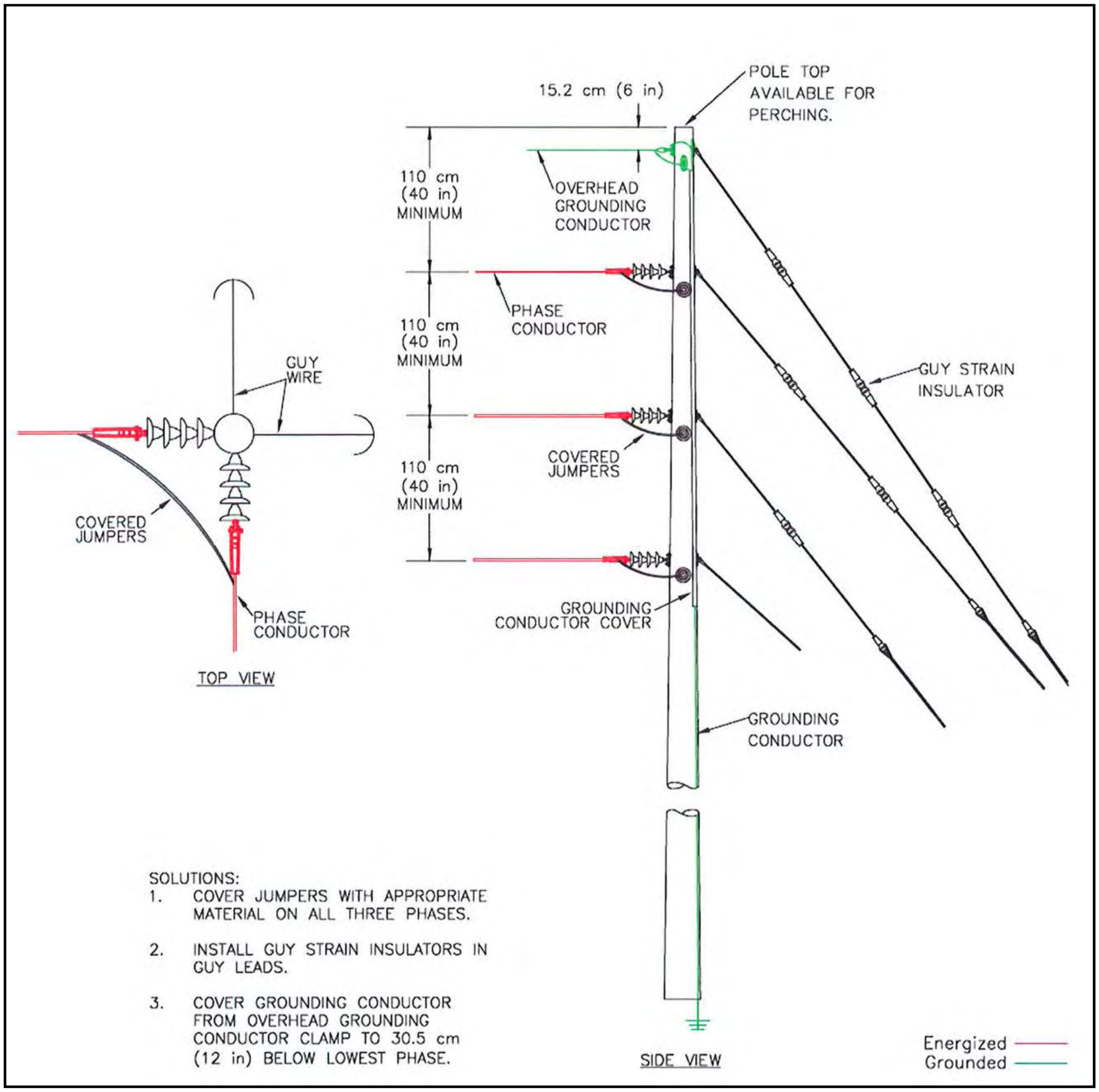

Figure A-19. Three-phase vertical corner configuration—overhead grounding conductor on pole top.

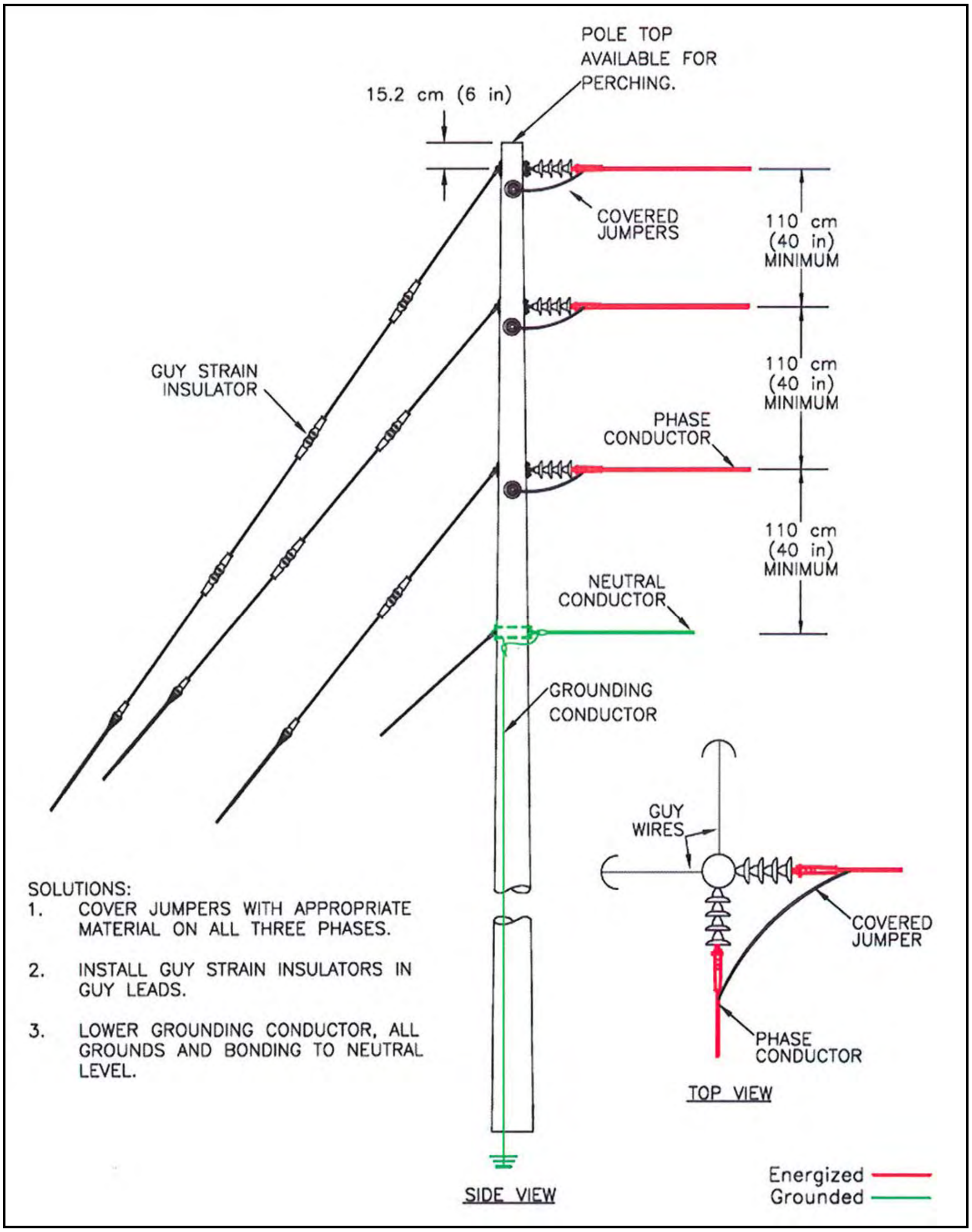

Figure A-20. Three-phase vertical corner configuration—neutral below phases.

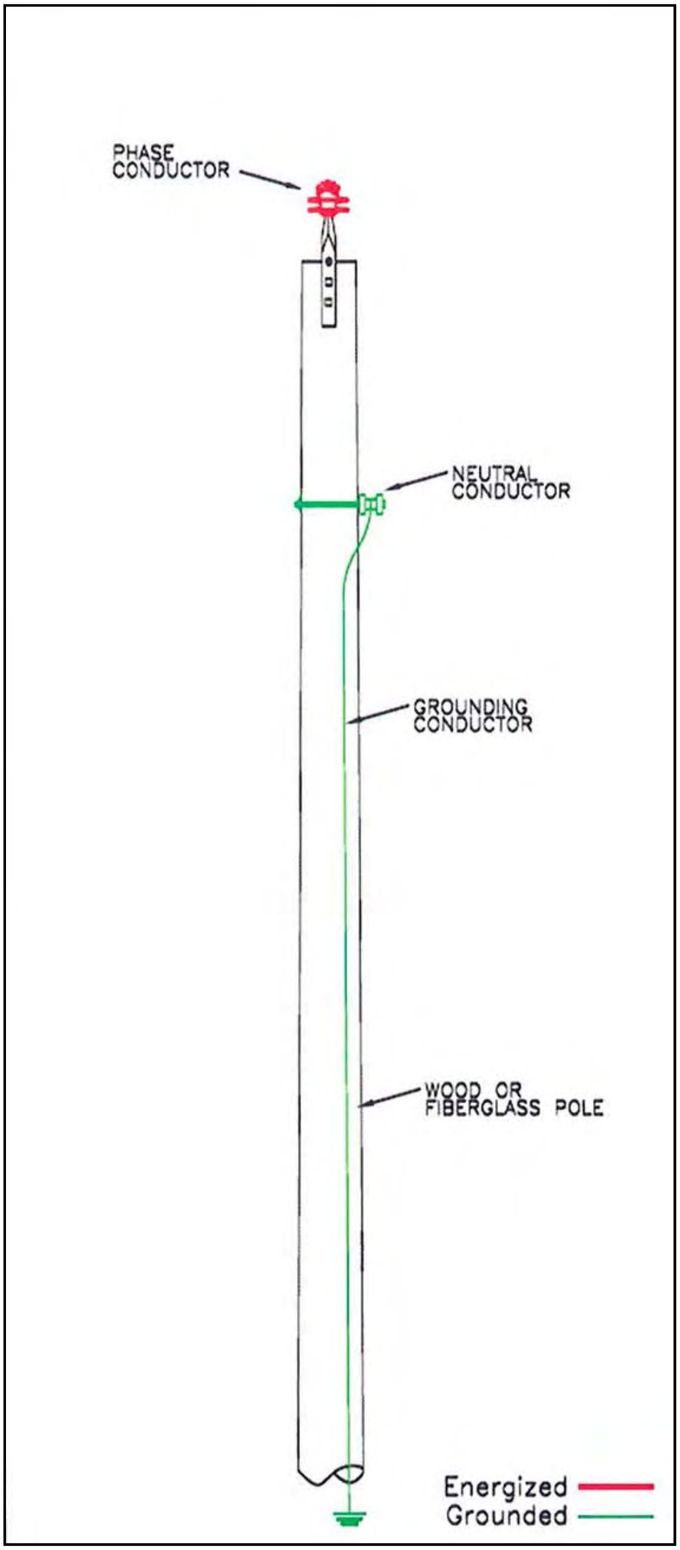

Figure A-21. Typical single-phase distribution configuration on a wood or fiberglass pole.

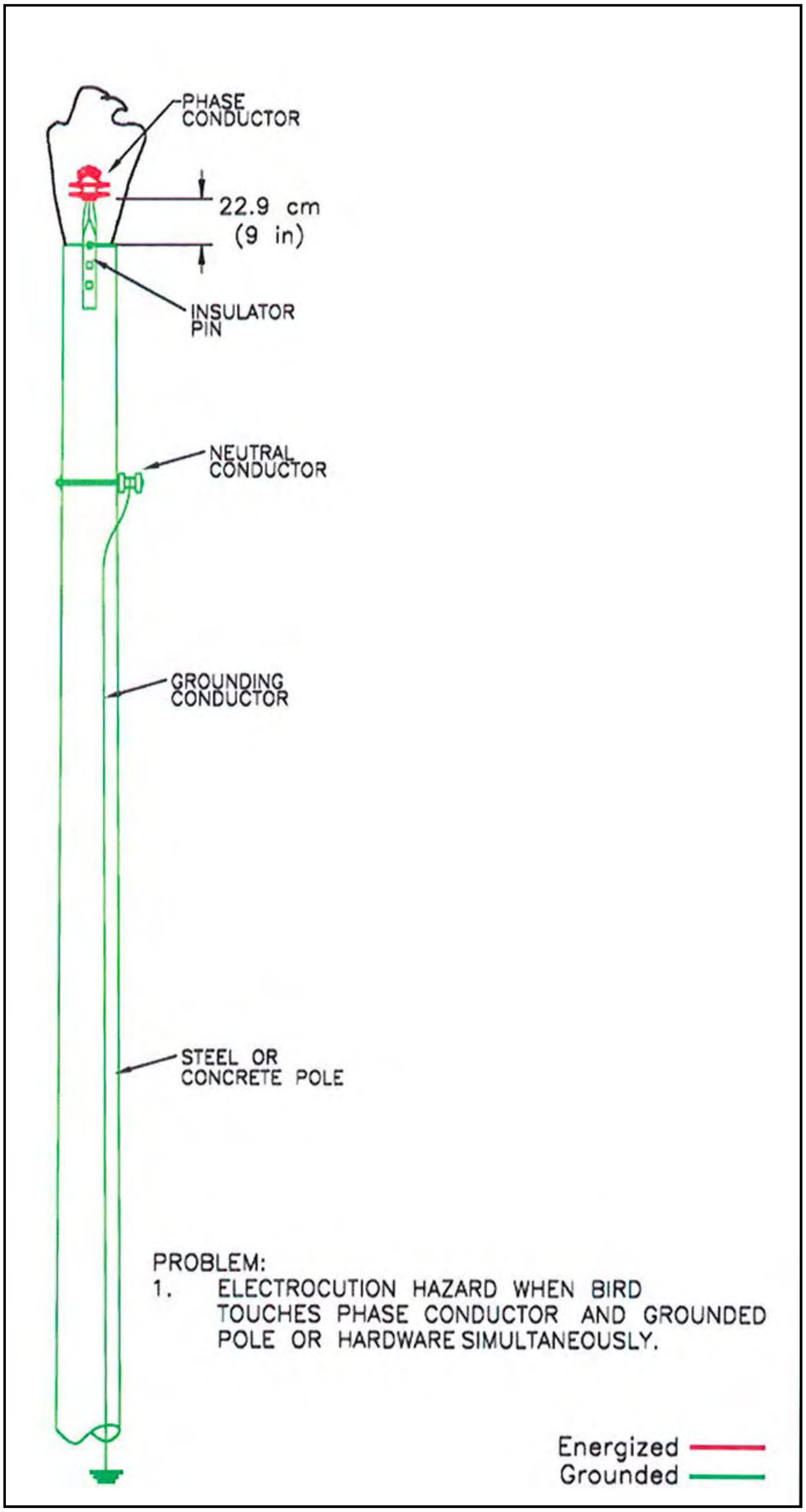

Figure A-22. Problem single-phase configuration on a steel or reinforced concrete pole.

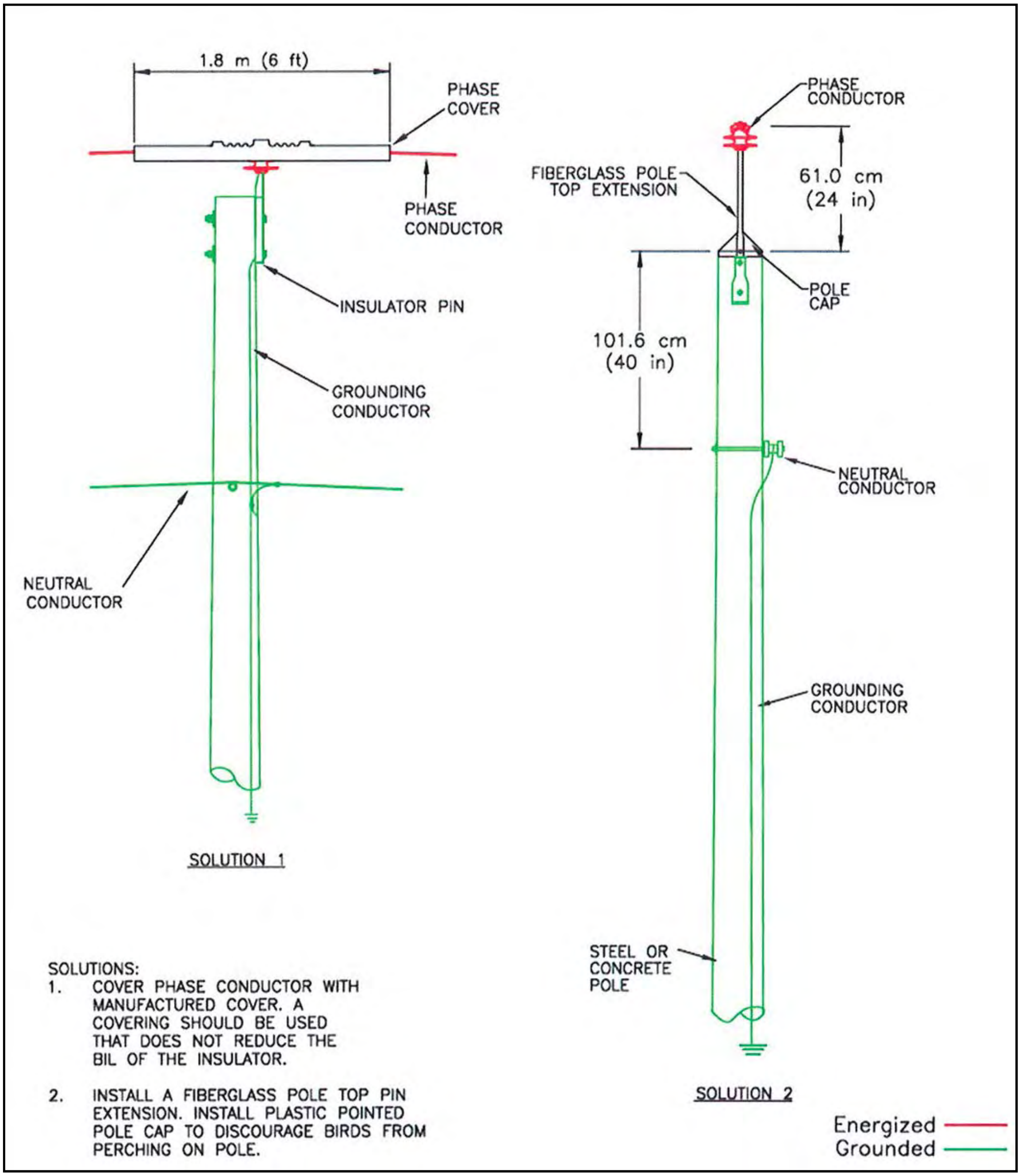

Figure A-23. Solutions for single-phase configuration on a steel or reinforced concrete pole.

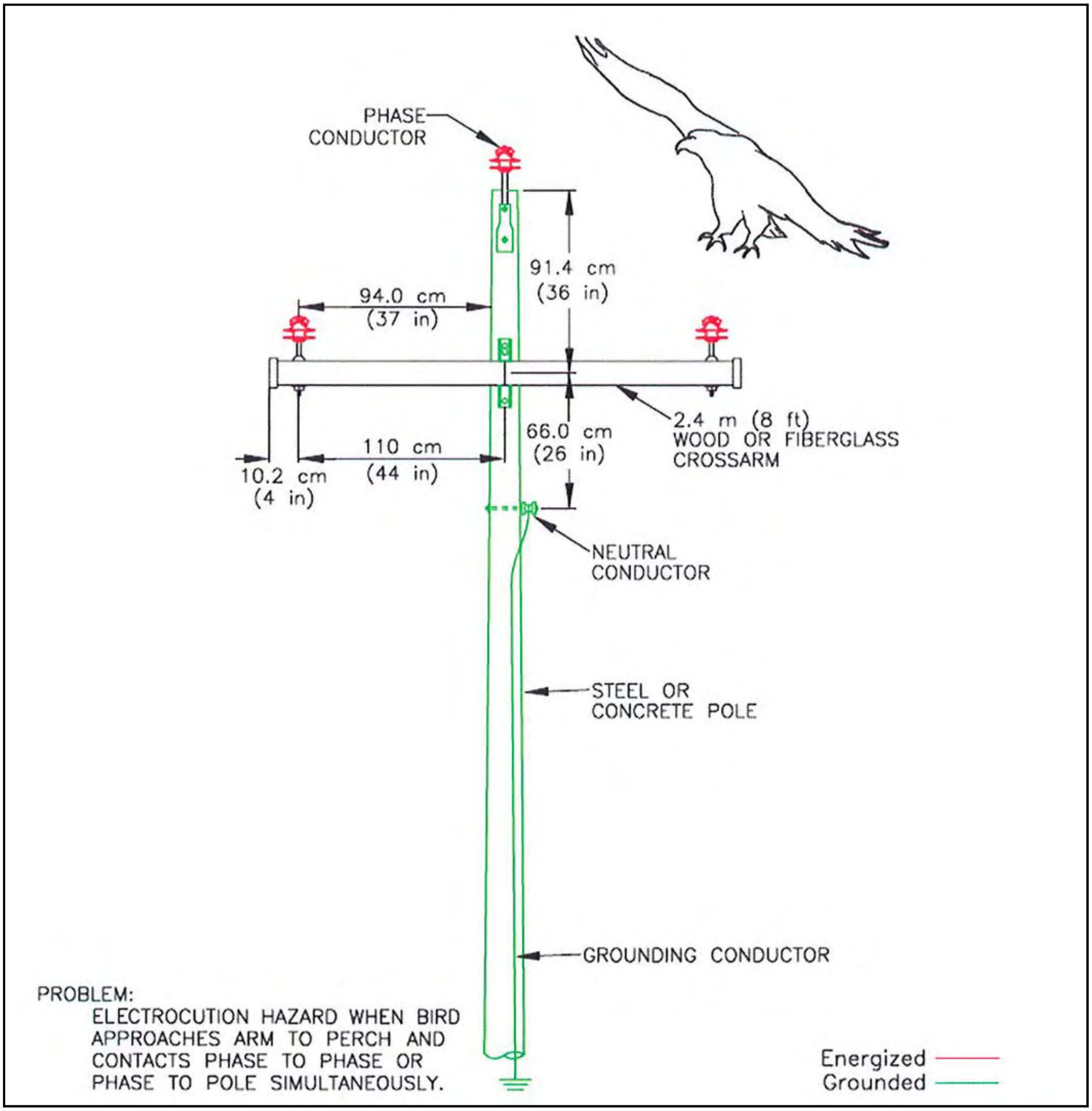

Figure A-24. Problem three-phase configuration on a steel or reinforced concrete pole.

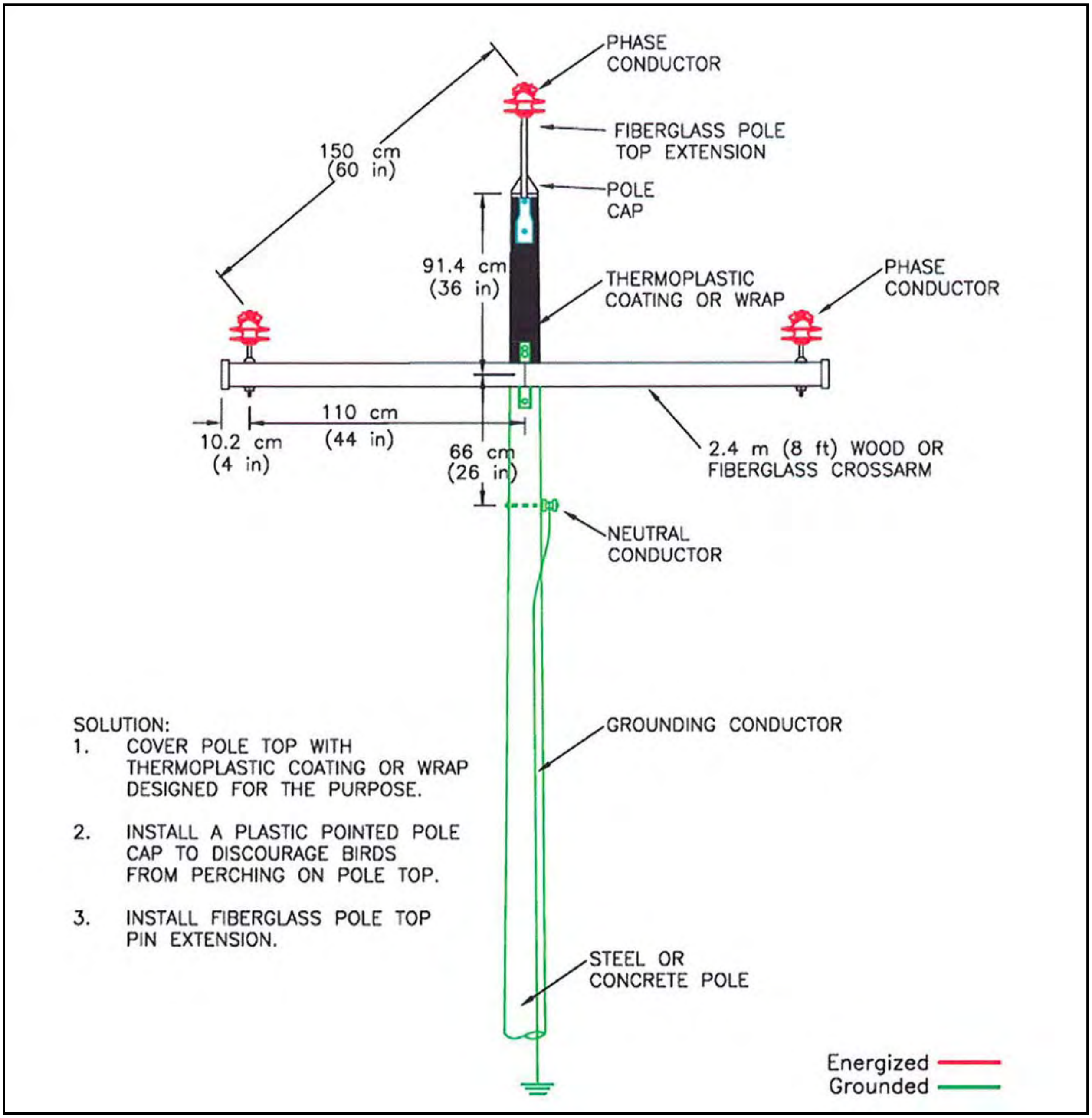

Figure A-25. Solution for three-phase configuration on a steel or reinforced concrete pole using thermoplastic wrap.

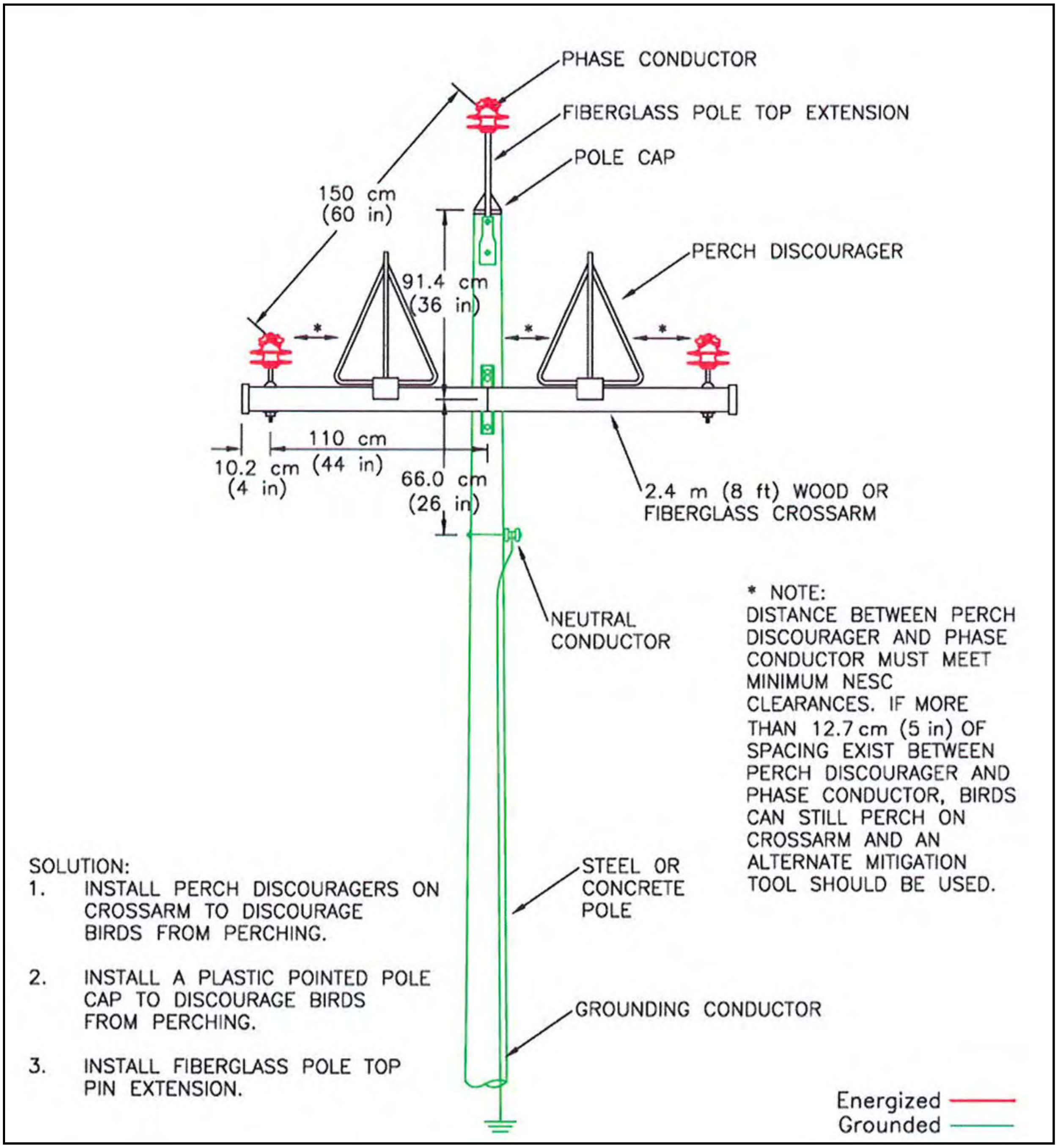

Figure A-26. Solution for three-phase configuration on a steel or reinforced concrete pole using perch discouragers.

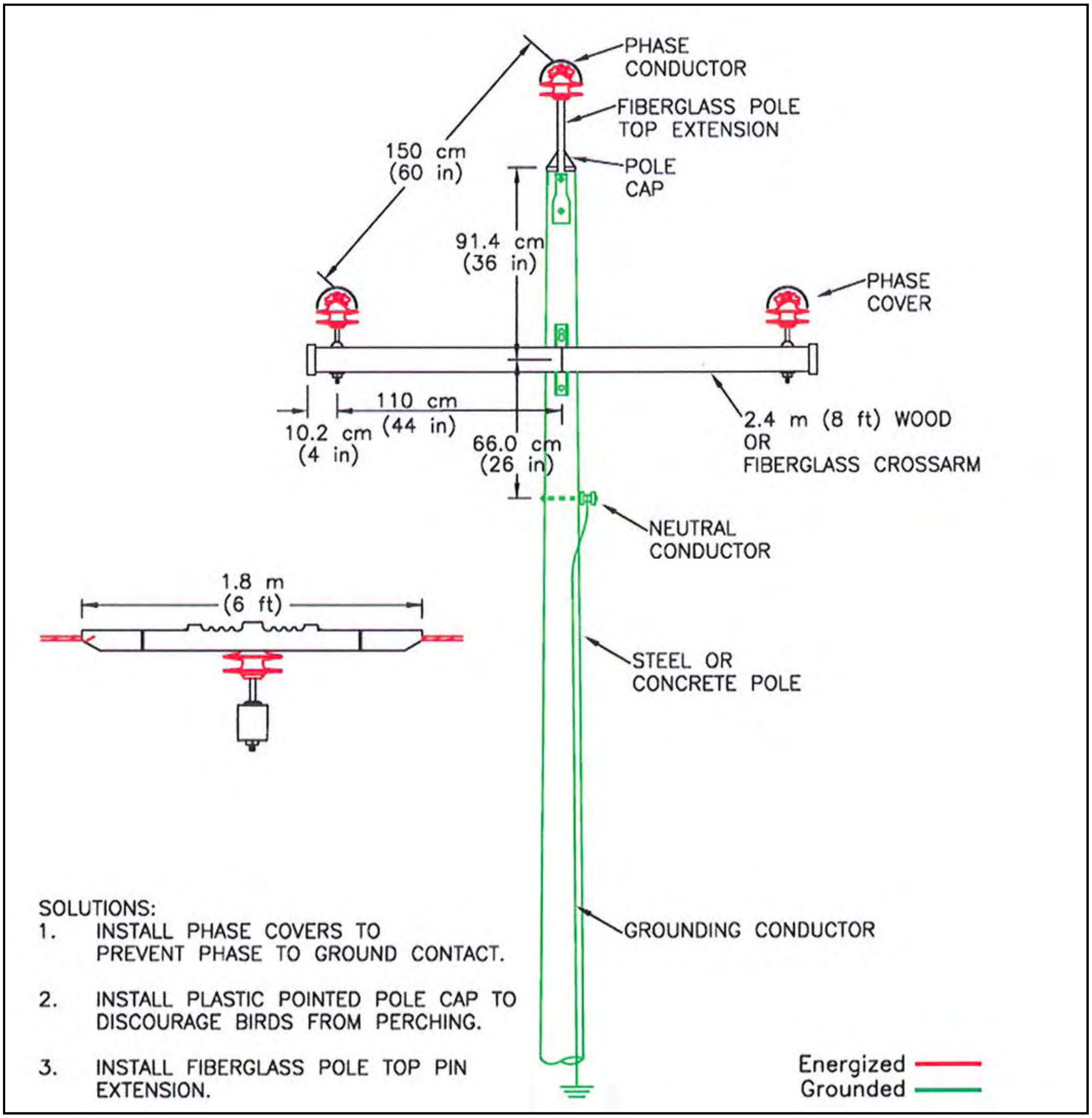

Figure A-27. Solution for three-phase configuration on a steel or reinforced concrete pole using phase covers.

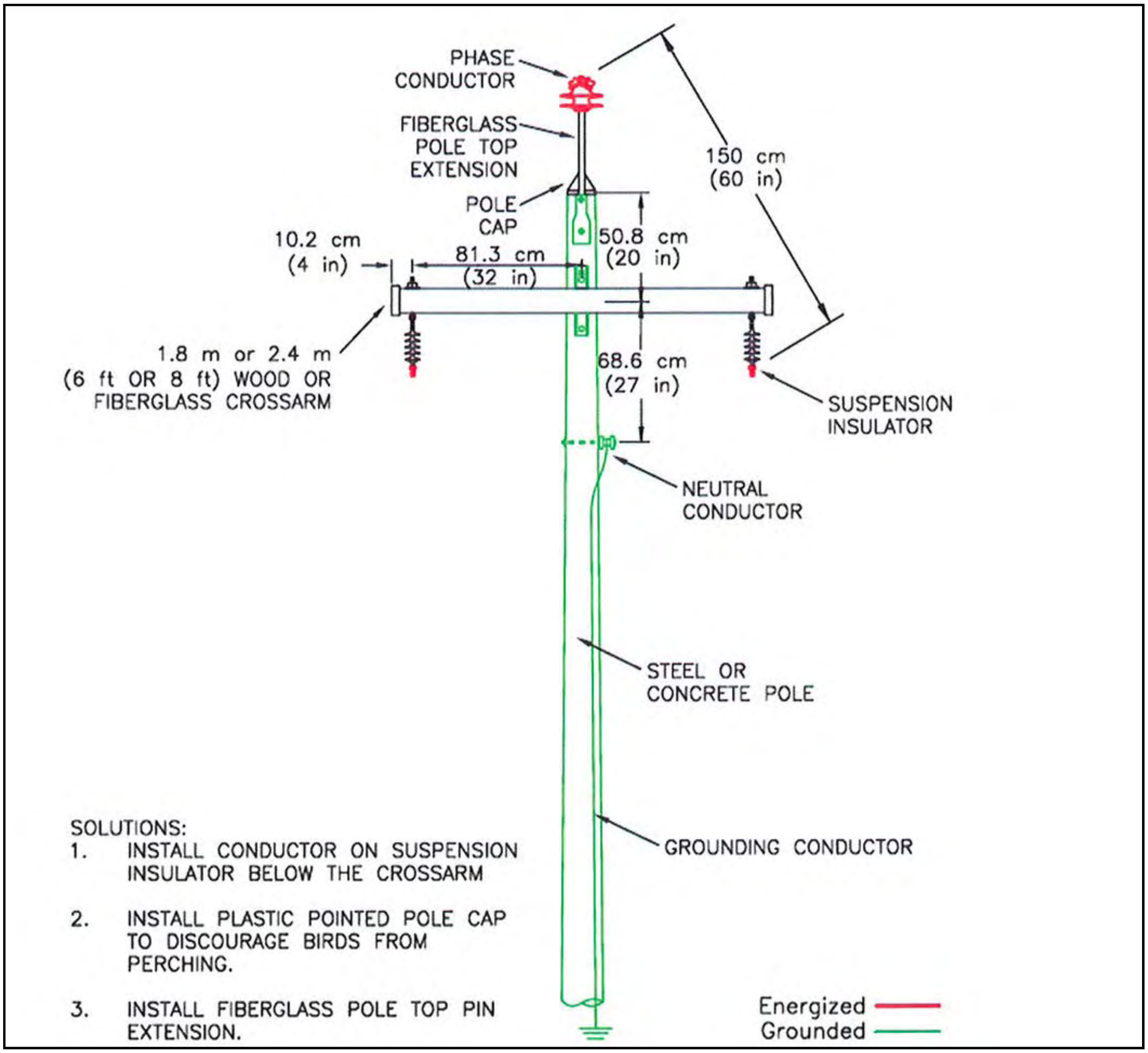

Figure A-28. Three-phase configuration on a steel or reinforced concrete pole with suspended insulators.

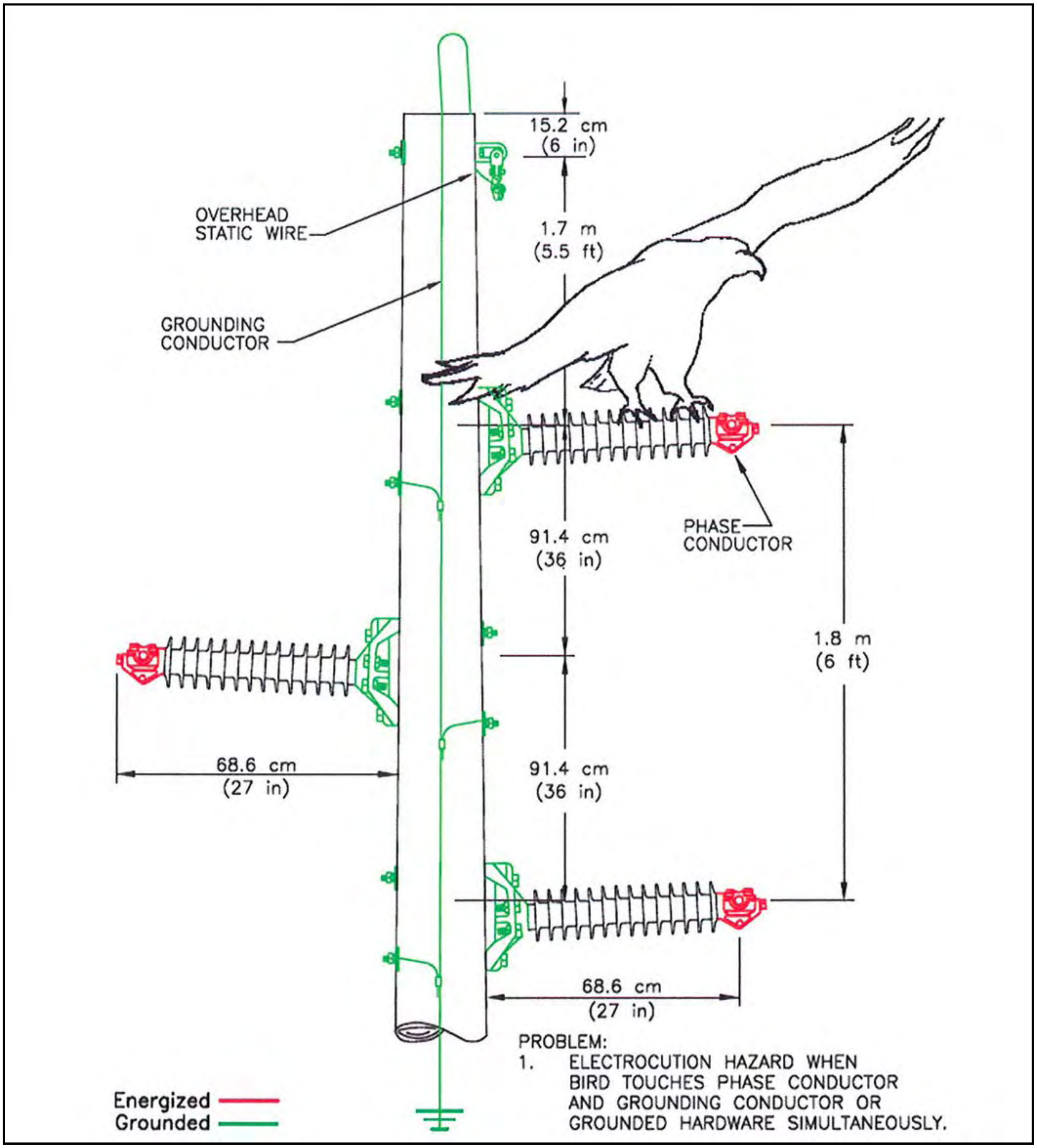

Figure A-29. Problem 69-kV post insulator design.

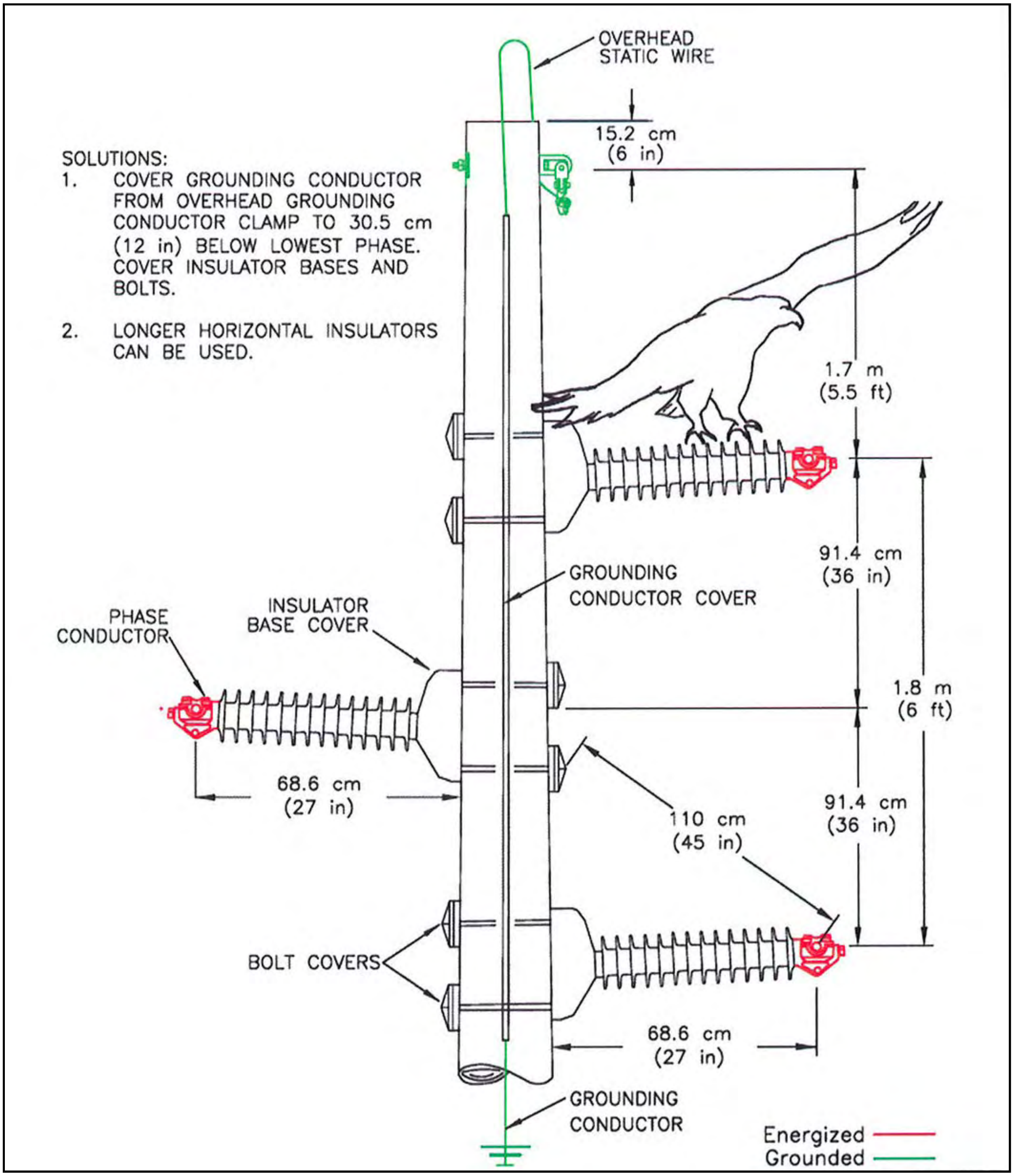

Figure A-30. Solutions for 69-kV horizontal post insulator design.

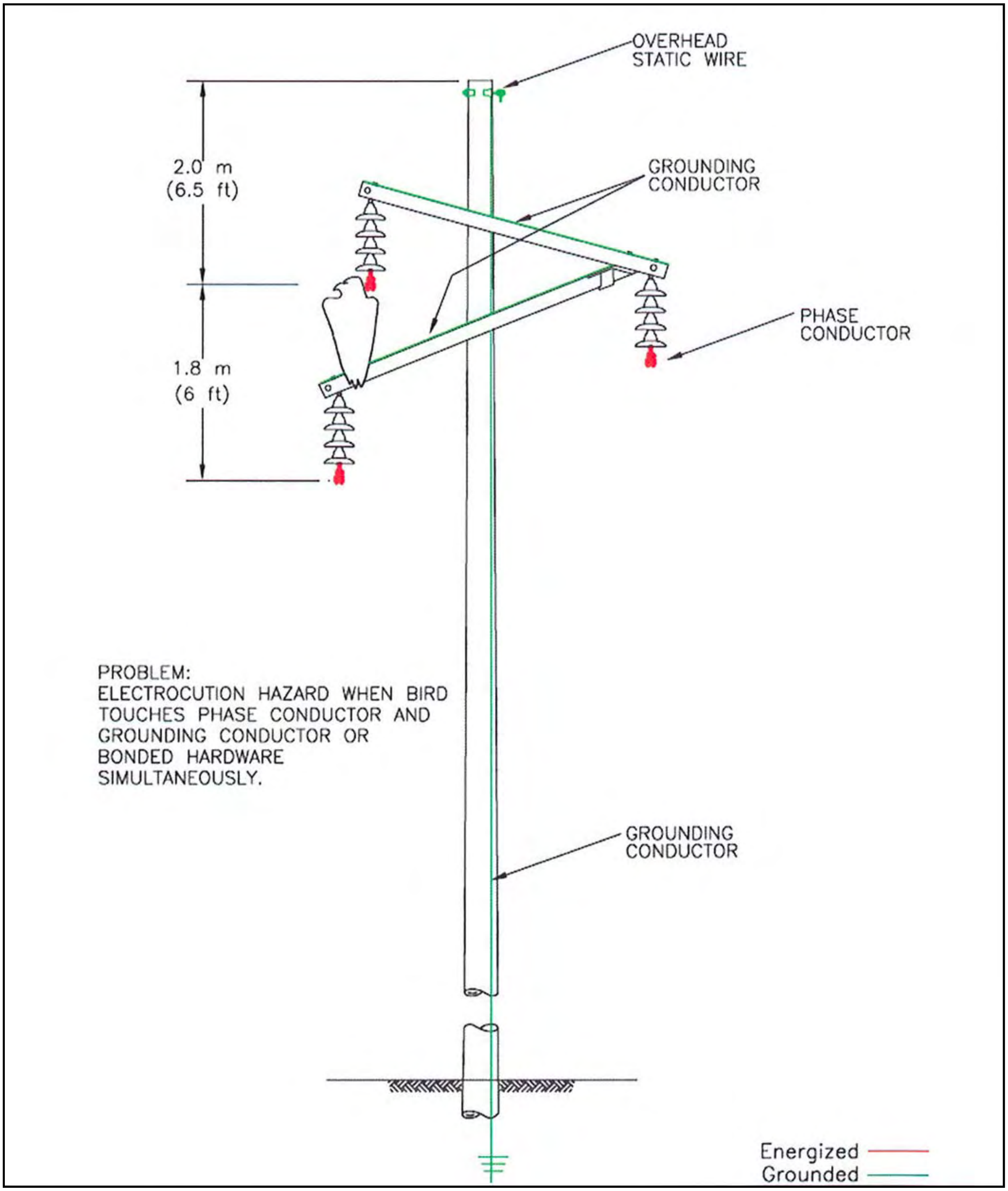

Figure A-31. Problem wishbone design.

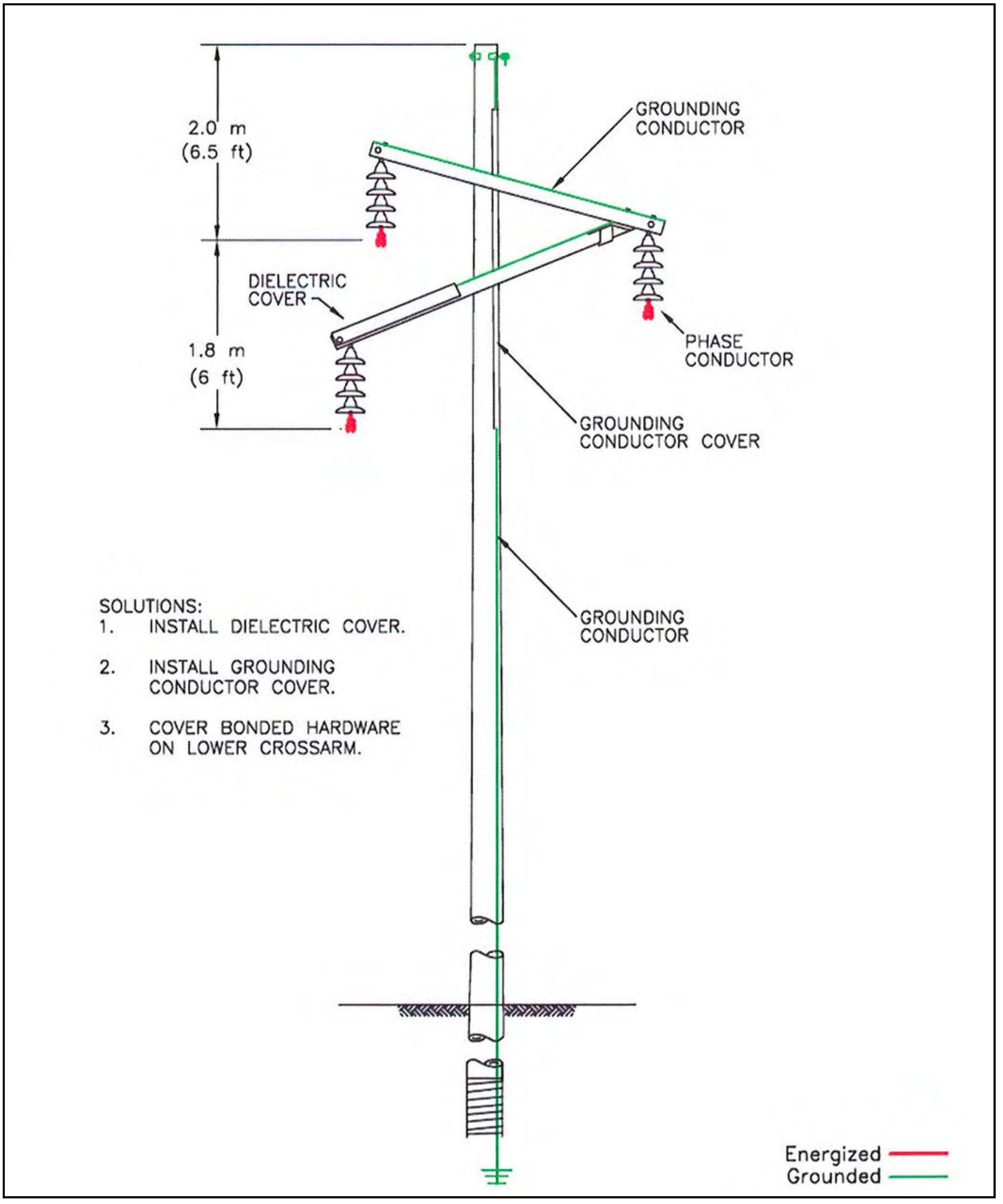

Figure A-32. Solution for the wishbone design.

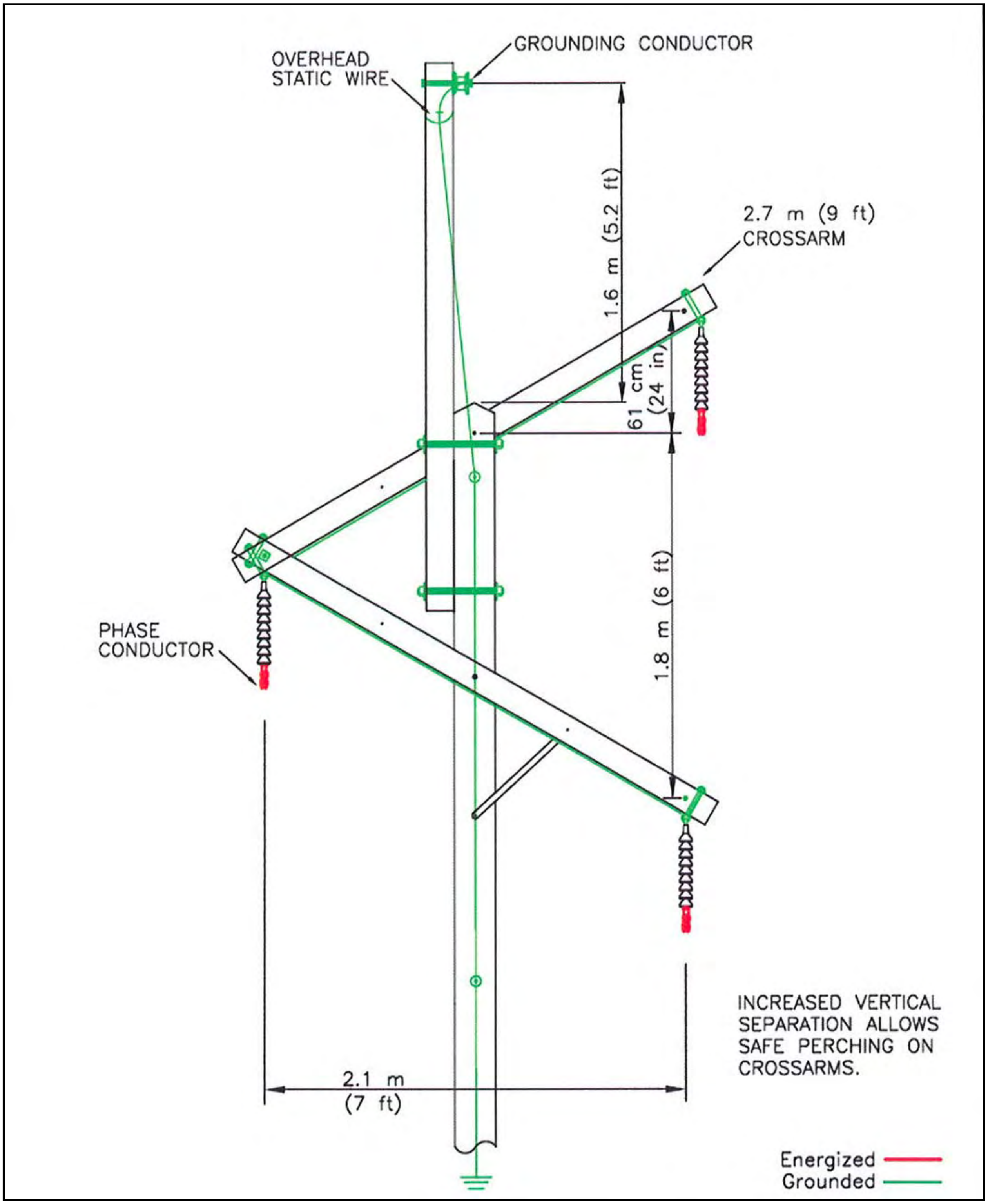

Figure A-33. Avian-safe wishbone construction.

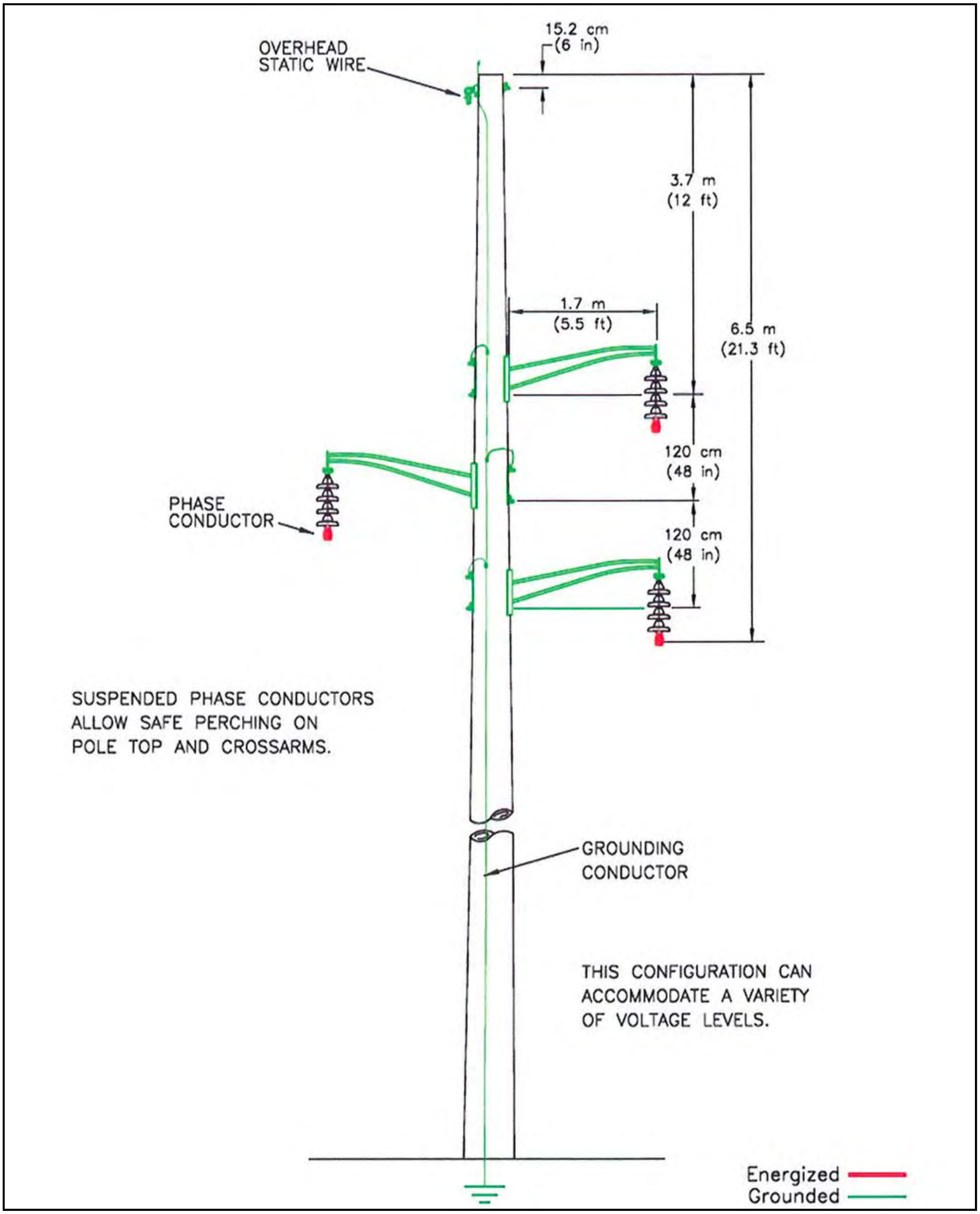

Figure A-34. Avian-safe suspension configuration.

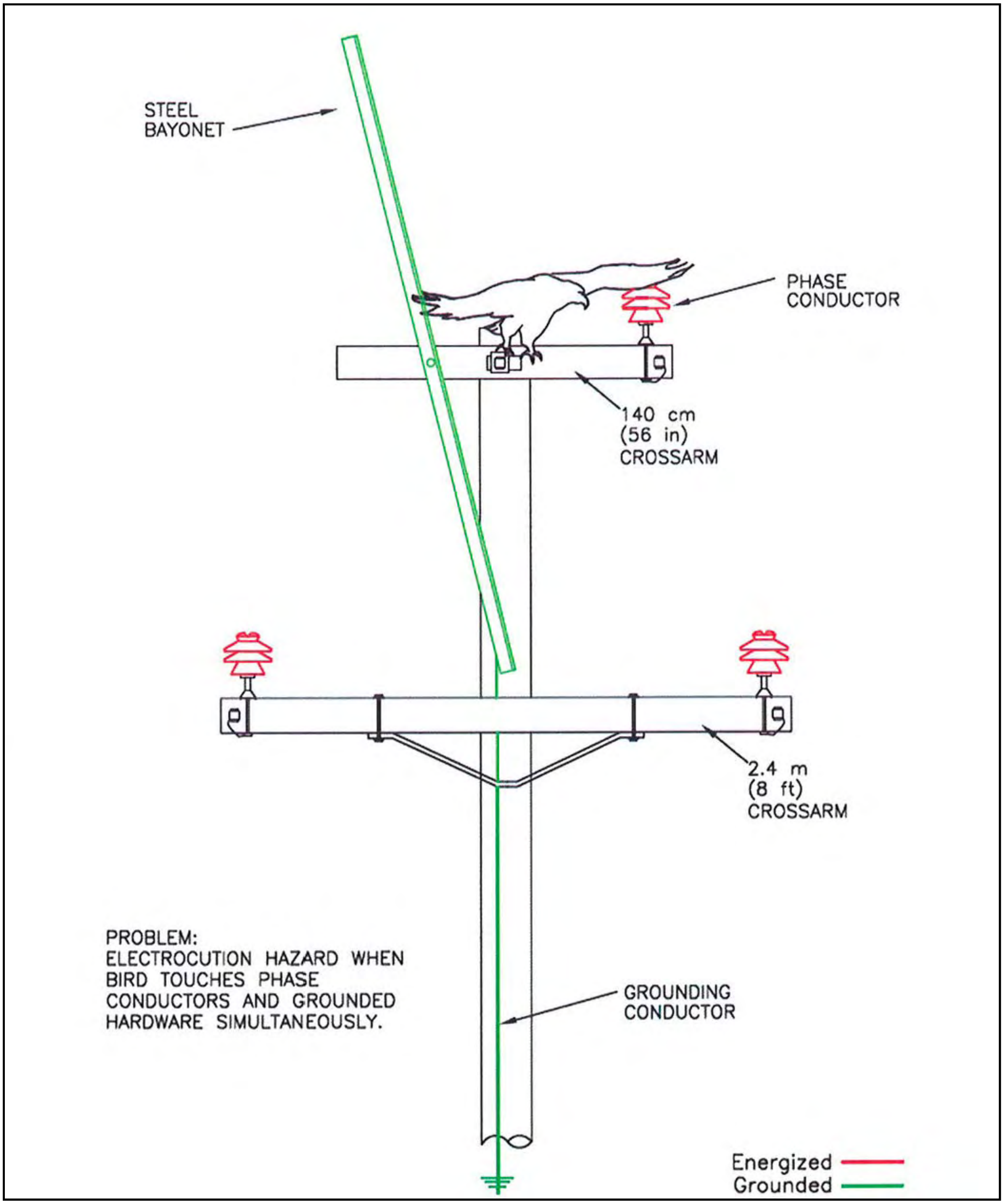

Figure A-35. Problem design with grounded steel bayonet.

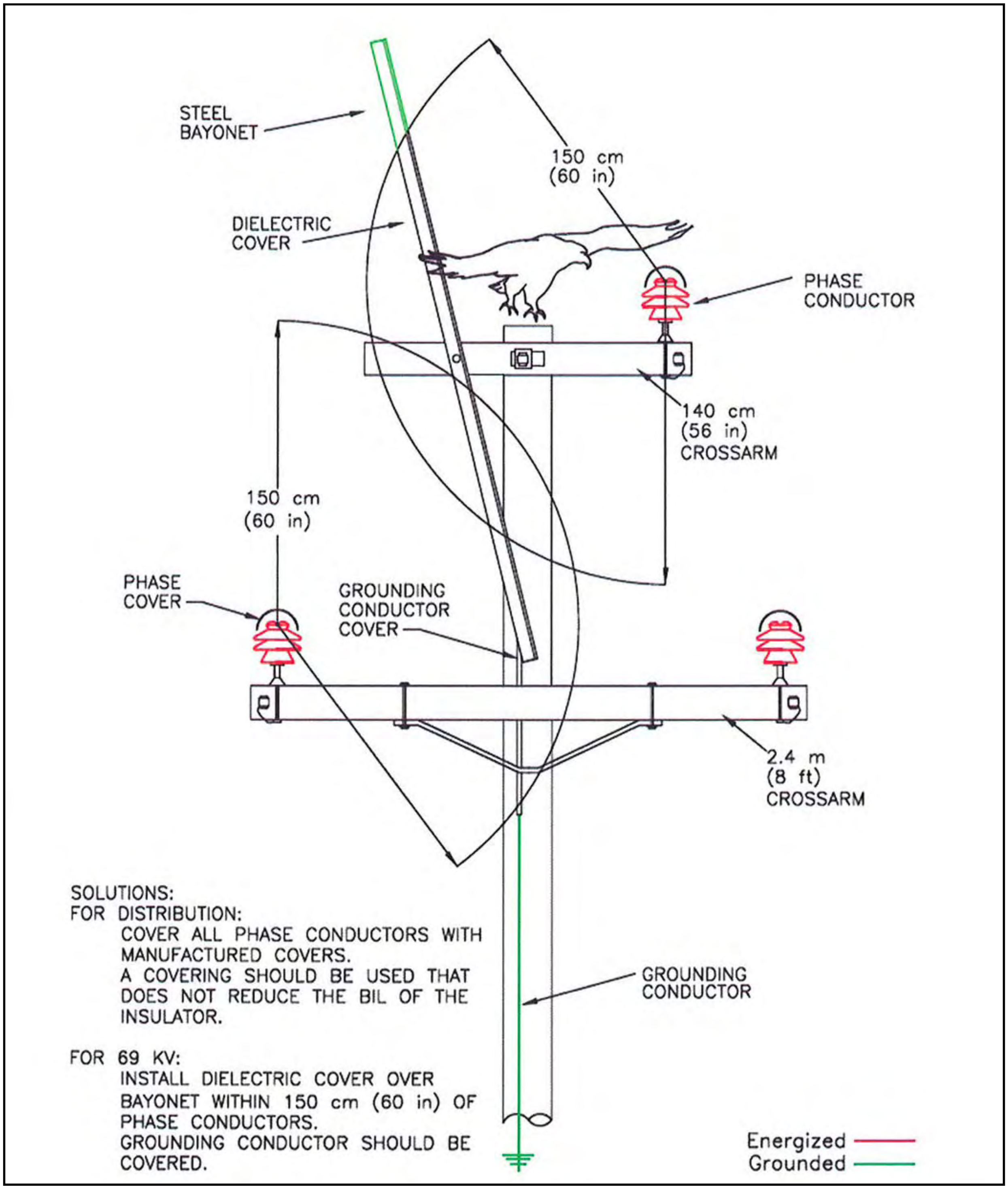

Figure A-36. Solution for design with grounded steel bayonet.

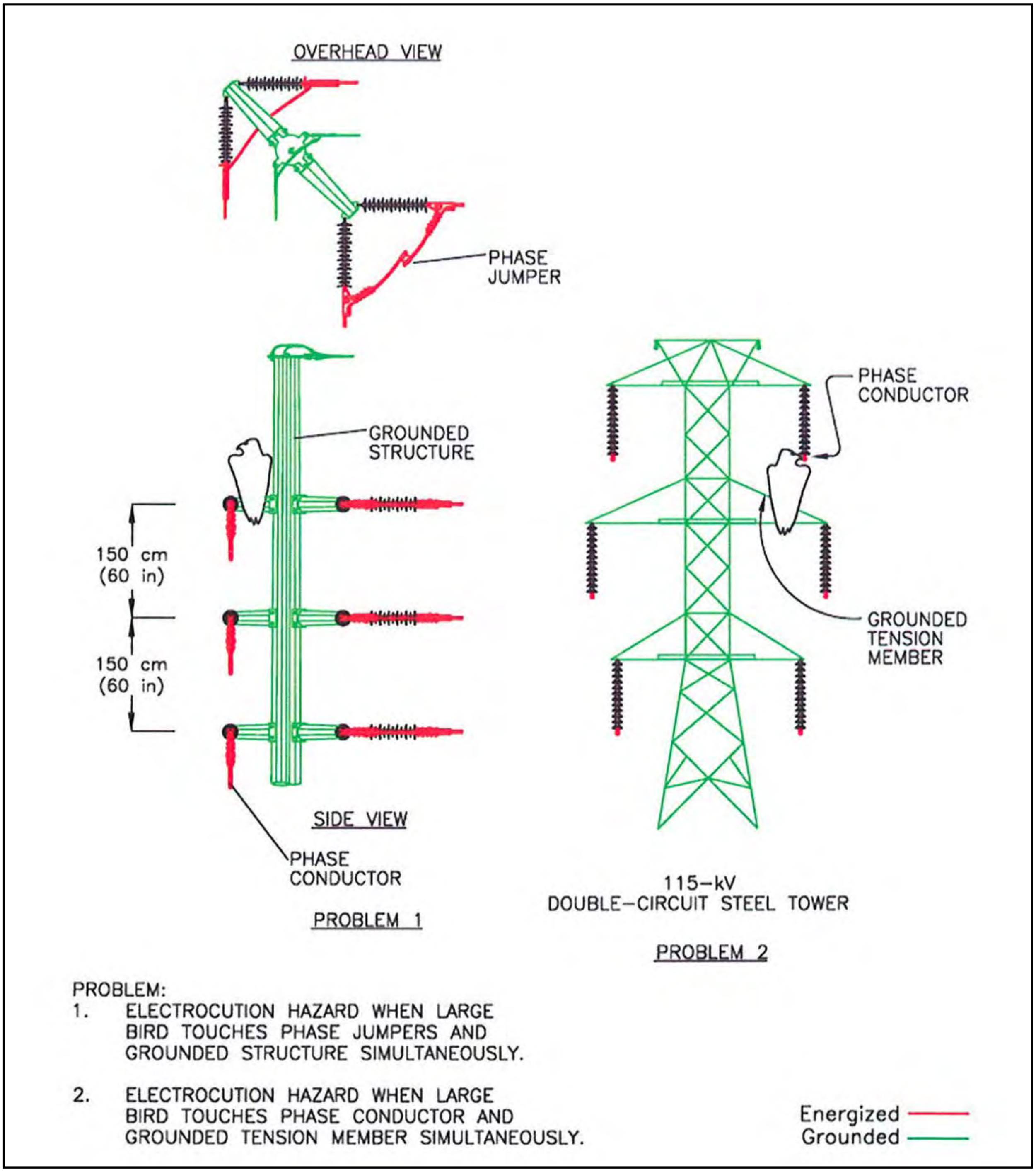

Figure A-37. Problem transmission designs.

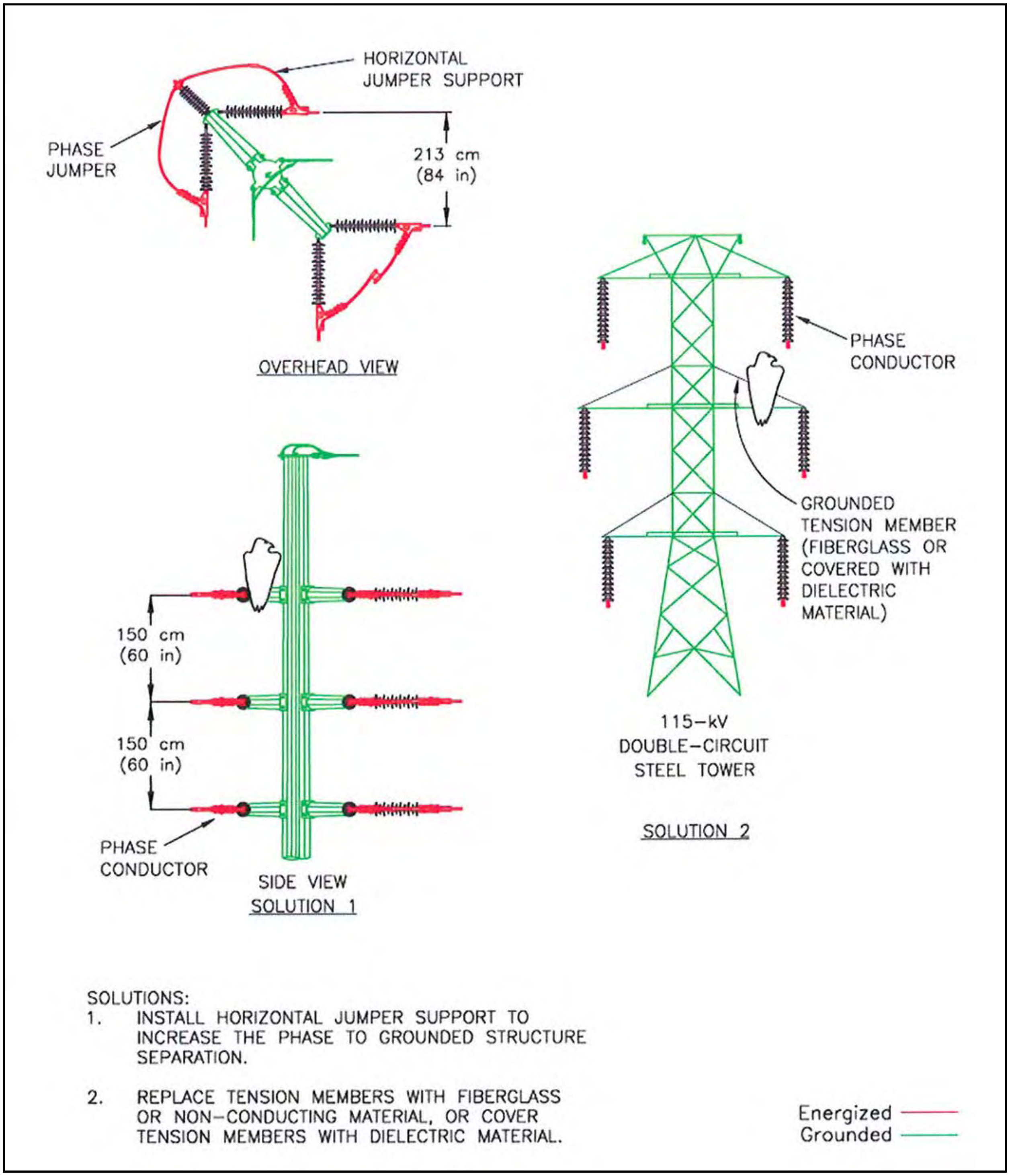

Figure A-38. Solutions for transmission design.

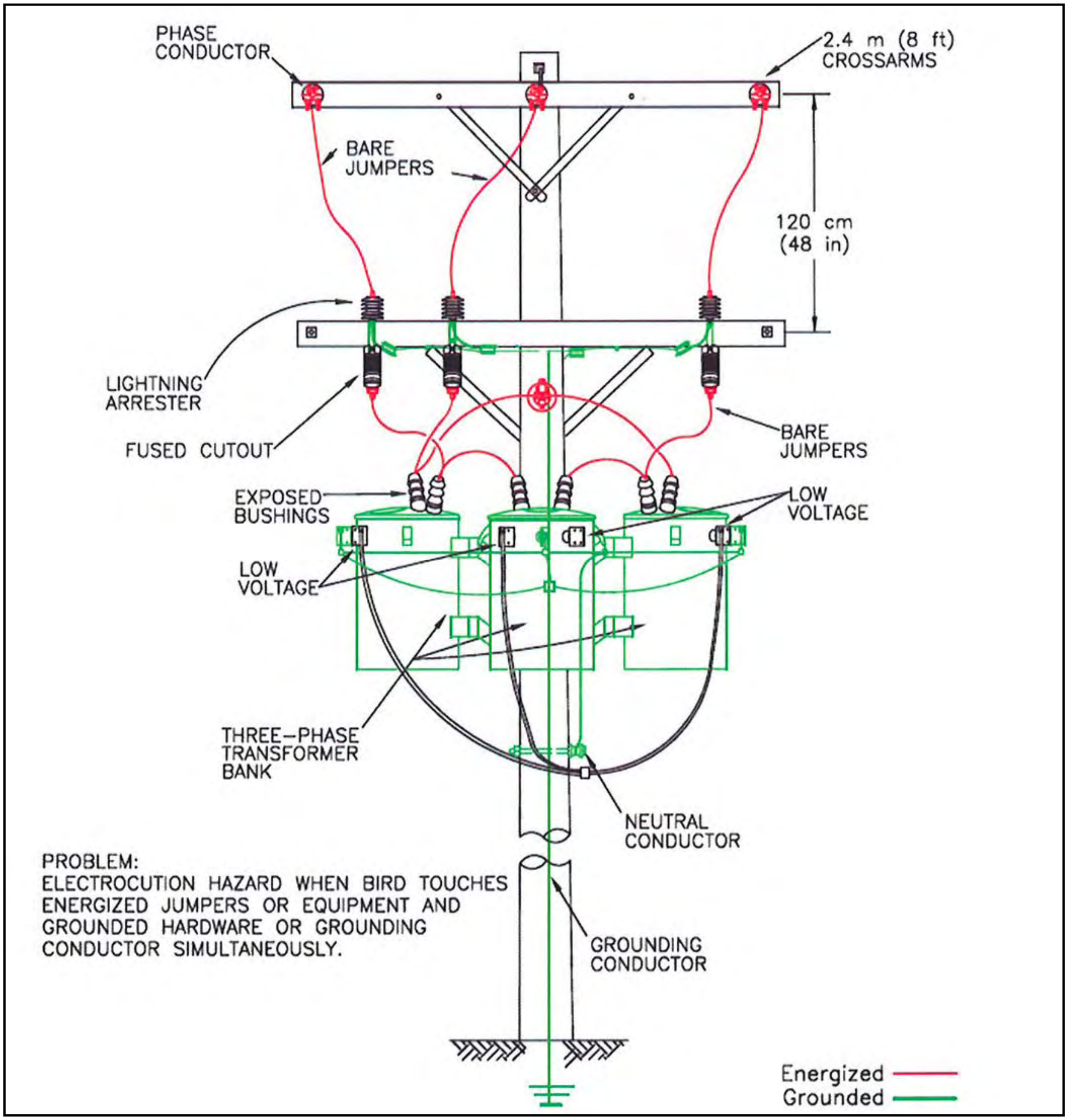

Figure A-39. Problem three-phase transformer bank.

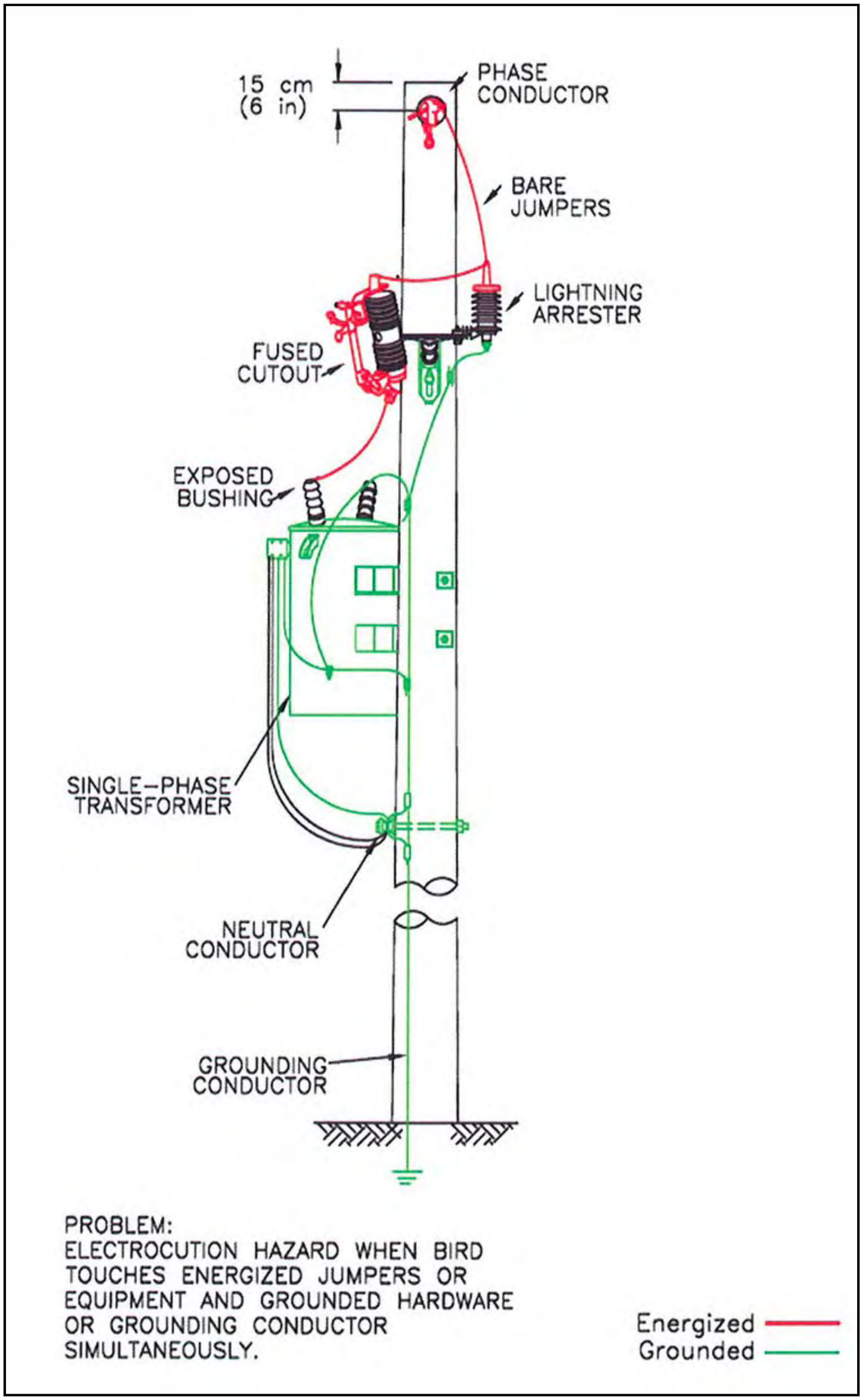

Figure A-40. Problem single-phase transformer bank.

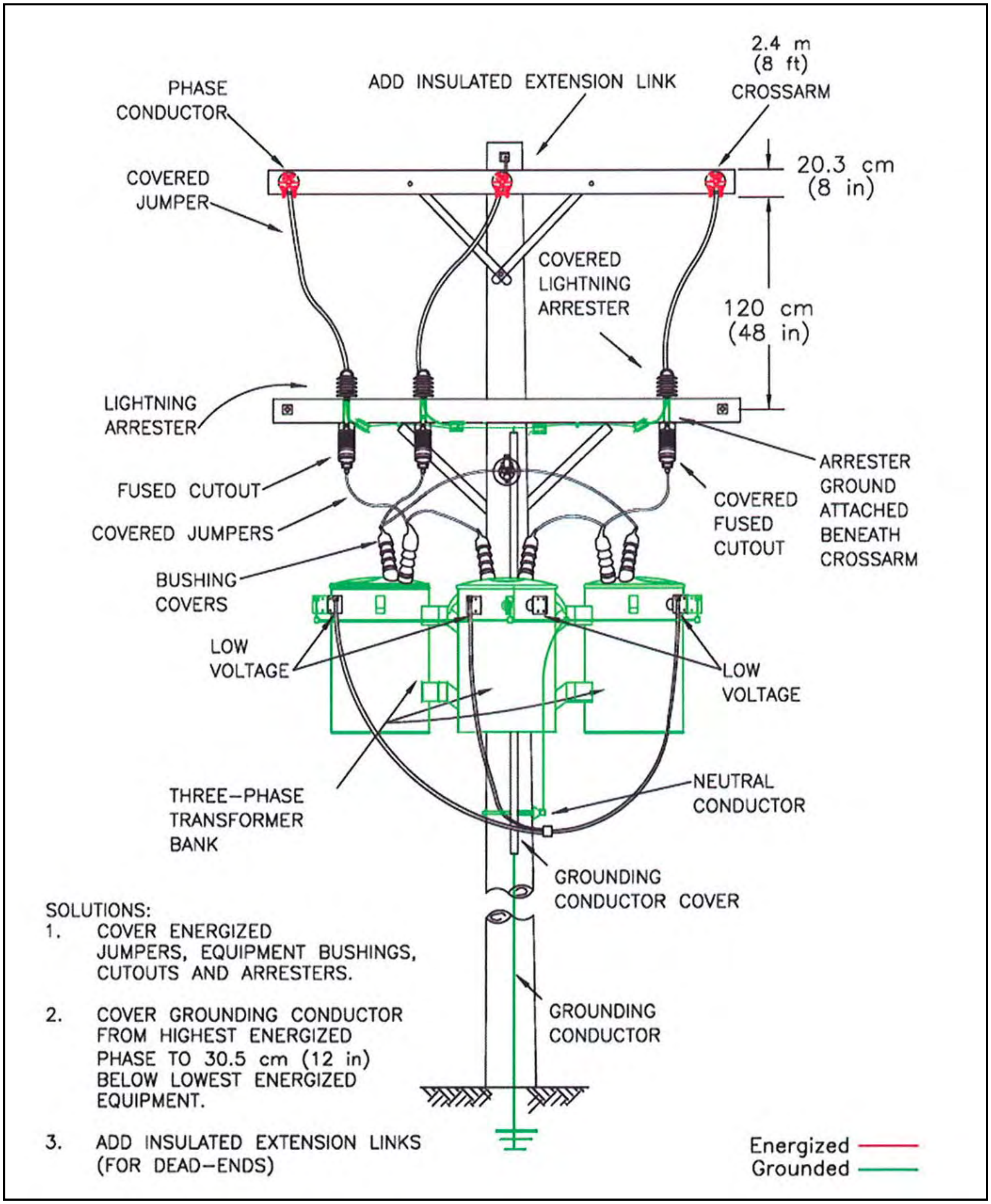

Figure A-41. Solution for three-phase transformer bank.

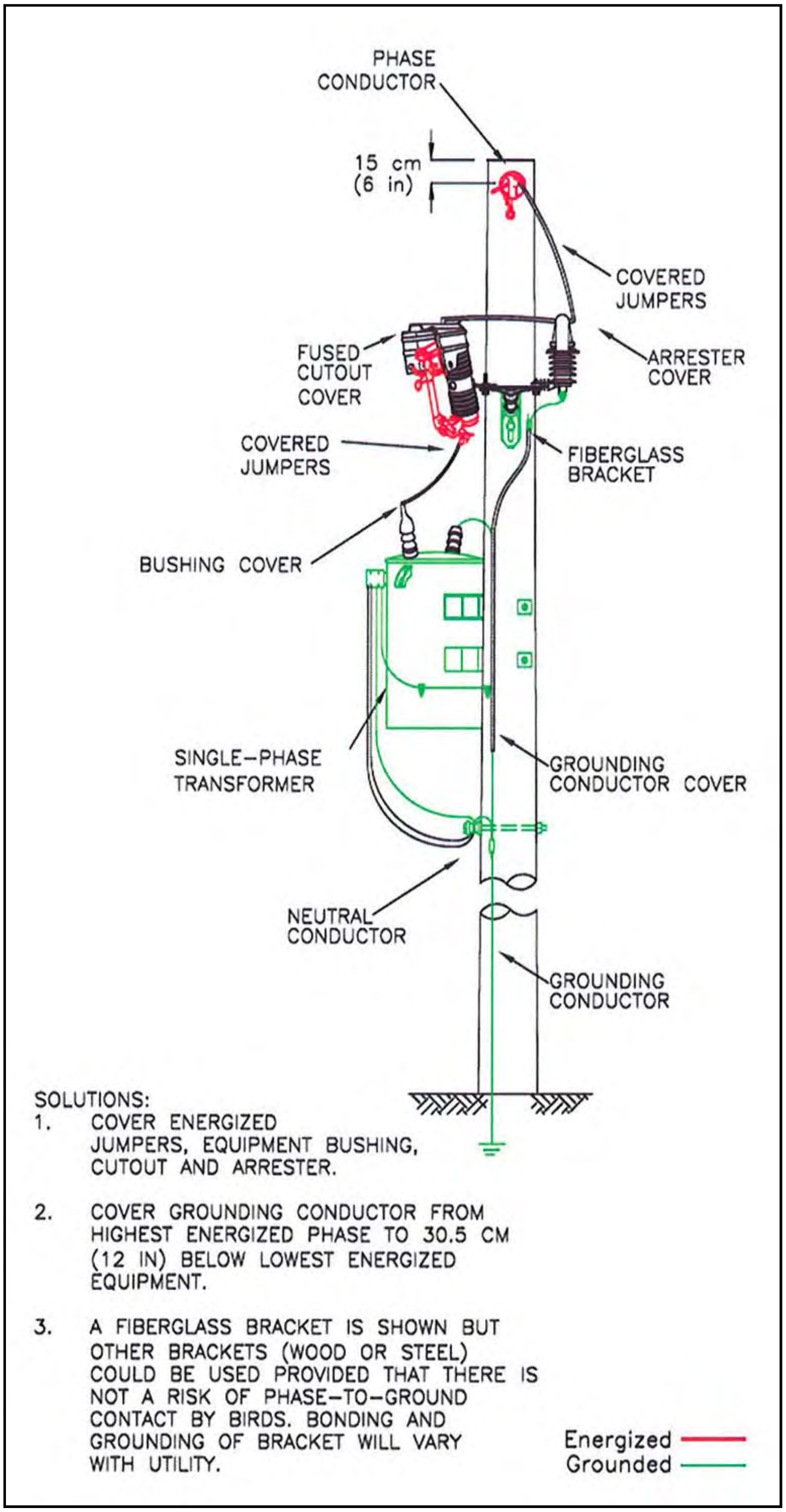

Figure A-42. Solution for single-phase transformer bank.

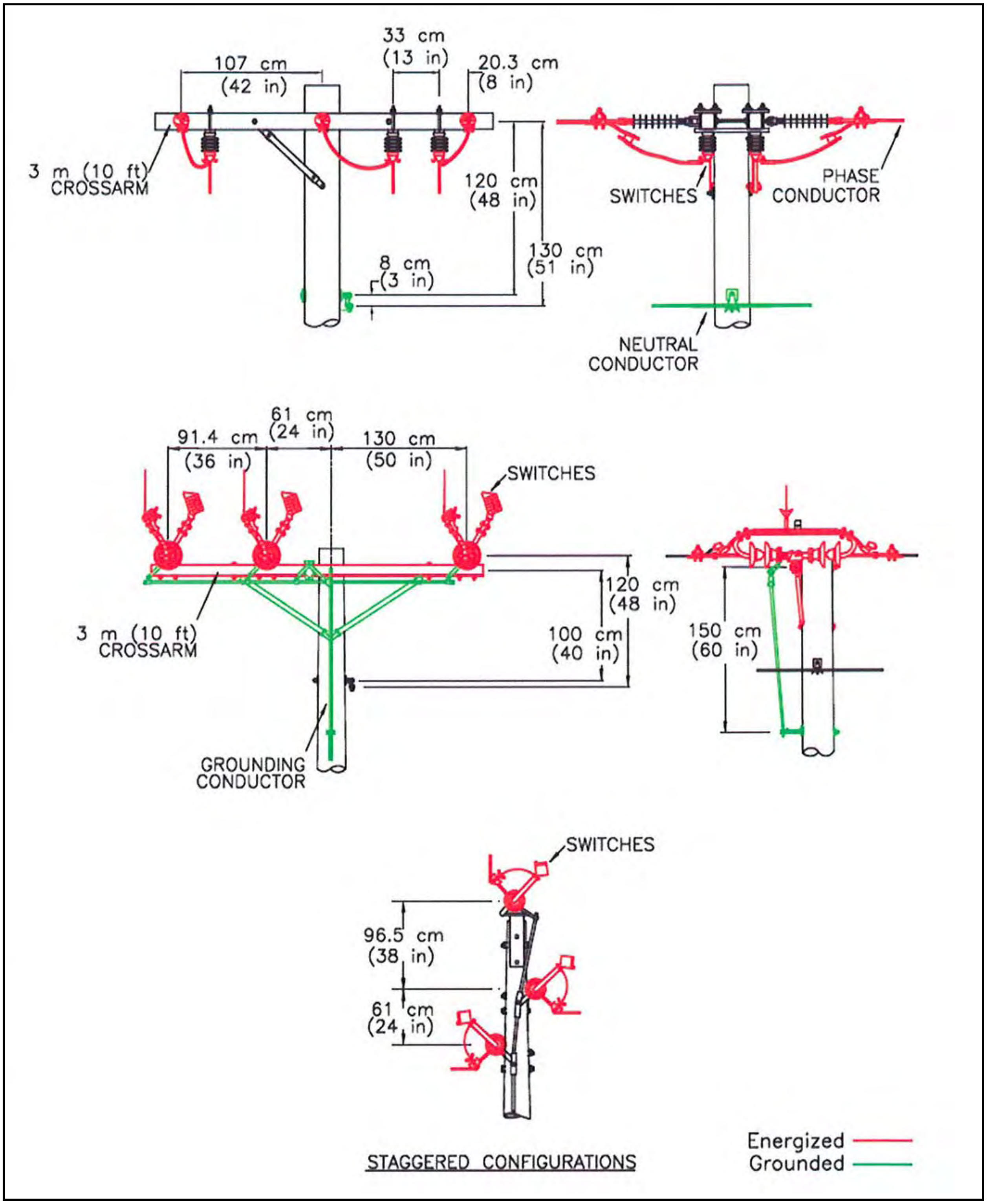

Figure A-43. Pole-mounted switches.

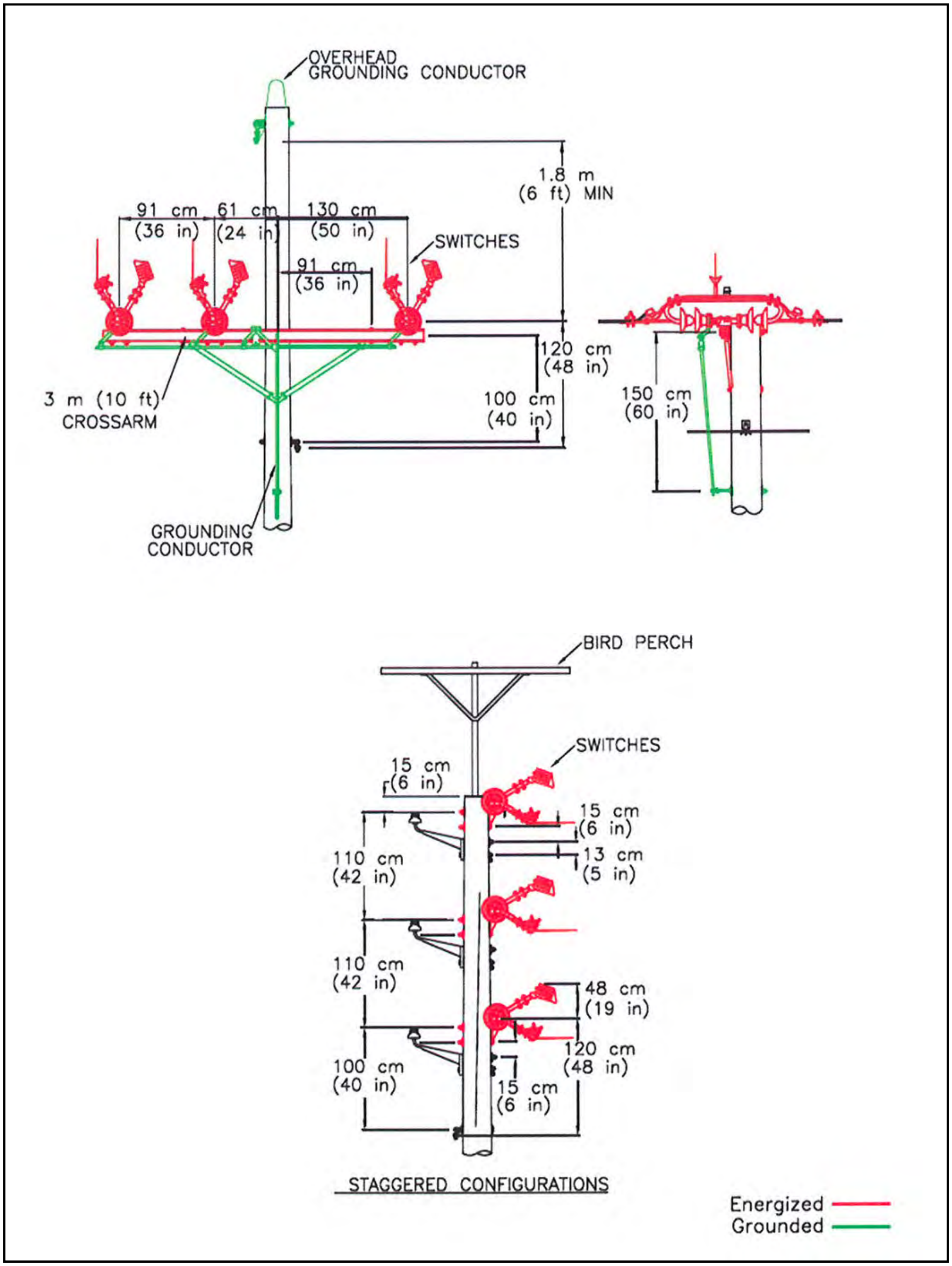

Figure A-44. Pole-mounted switches

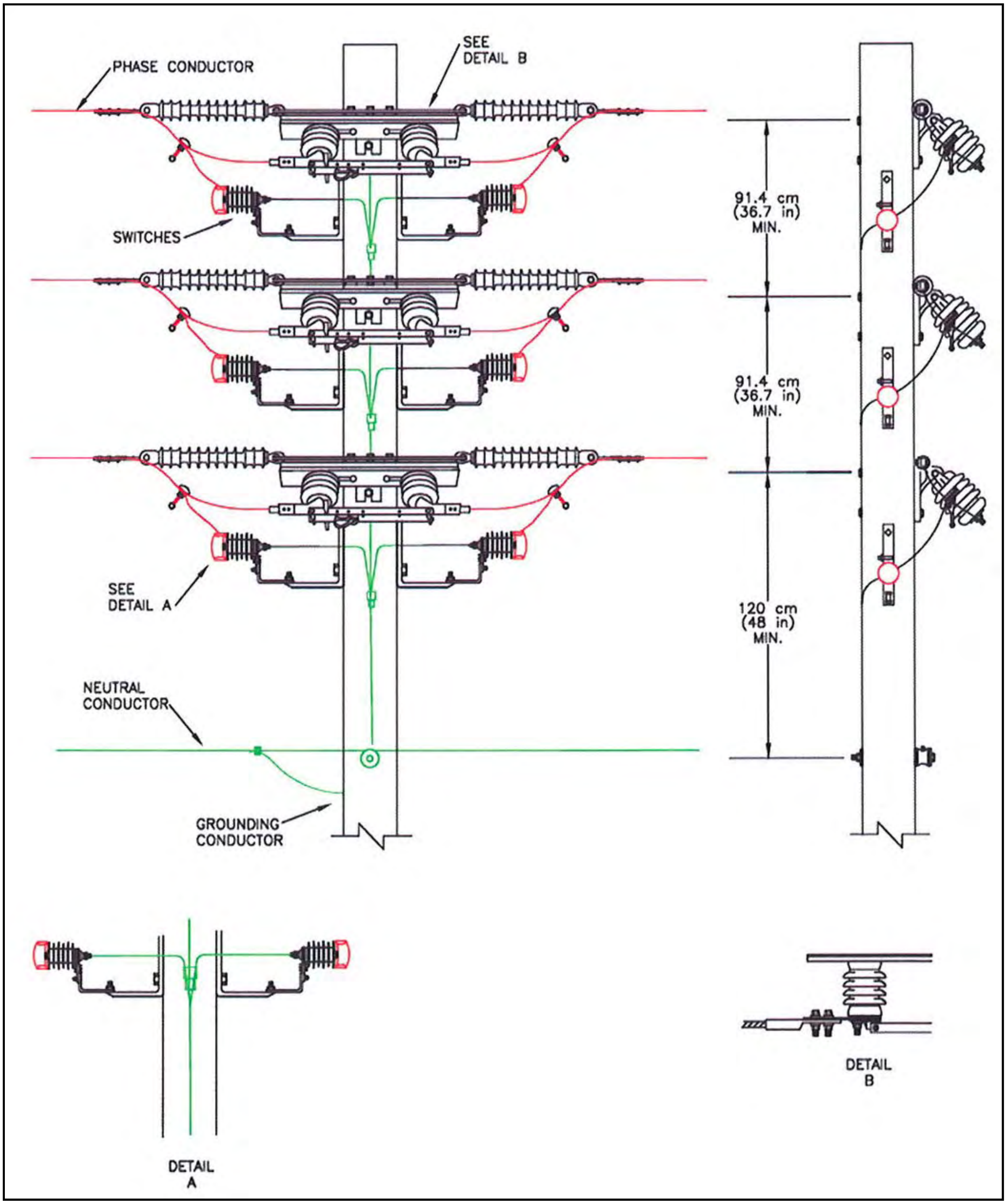

Figure A-45. Pole-mounted switches.

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APPENDIX B

Power Outage Detection Card

Power Outage Detection Card

To: Wildlife Management Branch Head
AC/S Environmental Security
Building 22165
760-725-9729

Date Found:___________________
Name of Observer:__________________
Contact Information:_________________

Notify Wildlife Management Branch Head IMMEDIATELY if bird is injured, threatened/endangered, an eagle, or a band or wing marker is present.
DO NOT TRANSPORT THESE ANIMALS WITHOUT AUTHORIZATION.

Location:
Line (Circuit) Name:_____________ **Segment:**________ **Voltage:**__________ **Pole/Tower ID:**___________
GPS coordinates (if available):___________ _____________
Pole type and configuration:____
Retrofitted Pole? Yes No
Did electrocution cause power outage? Yes No
Type of Contact (circle): Bird Nest
Bird (circle): Dead Injured
Location of Bird Relative to Pole or Line (circle): underneath pole underneath line
Distance in feet from pole/line:___________
Work Order Number: _________________

Risk to Birds/System (circle): No Risk Imminent Risk Non-imminent Risk

Please attach photos of bird and structure (if available) and submit form to ES-Wildlife.
Please use back of form to capture any additional details.

APPENDIX C
Avian Incident and Nest Form

Avian Incident and Nest Form

To: Wildlife Management Branch Head
AC/S Environmental Security
Building 22165
760-725-9729

Date Found:____________________
Name of Observer:______________________
Contact Information:_____________________
Form Completed by:_____________________

Location:
Line (Circuit) Name:_____________ **Segment:**________ **Voltage:**__________ **Pole/Tower ID:**___________
GPS coordinates (if available):___________ _____________
Pole type and configuration:____
(this information may be copied from Power Outage Detection Card)

Type of Contact (circle): Bird Nest
Bird (circle): Dead Injured
Suspected Cause of Injury or Mortality (circle): Electrocution Collision Unknown
Other____
Condition of bird (circle): fresh partially decomposed mostly decomposed bones and feathers
Injuries (circle): burn marks dismembered holes trauma none visible
Describe:____
Location of Bird Relative to Pole or Line (circle): underneath pole underneath line
Distance in feet from pole/line:___________

Species (if known) or Bird Group (circle bird group or write in species):_____________________
Hawk Eagle Falcon Owl Waterfowl Heron/Egret
Crow/Raven Large Unidentified Bird Small Unidentified Bird

Age of bird (if known): adult juvenile

Condition of Nest (circle): Active Inactive Deteriorating
Eggs or Nestlings Observed:____
Risk to Birds/System (circle): No Risk Imminent Risk Non-imminent Risk

Recommended Actions (circle all that apply):

Dead Bird Actions
Install insulator covers/ Cover transformer equipment
Install perch guards
Reframe structure
Replace structure
Remove Pole
De-energize
No action (justification required)
Other:___________________________

Nest Actions
Install nest platform
Relocate Nest
Trim Nest
Install nest guards
Remove nest
No action

Please attach photos of bird and structure (if available) and submit form to ES-Wildlife.
Please use back of form to capture any additional details.

APPENDIX D

Identification Guide to Raptors of High Electrocution Susceptibility on Marine Corps Base Camp Pendleton

APPENDIX D

Identification Guide to Raptors of High Electrocution Susceptibility on Marine Corps Base Camp Pendleton

This guide is meant to provide basic identifying characteristics of raptors that are most susceptible to electrocution on MCBCP. It is not comprehensive, and it is recommended that additional sources be referenced in the event of an avian electrocution incident so that the bird is accurately identified. Recommended resources include, but are not limited to, *The Sibley Guide to Birds* and *National Geographic Society's Field Guide to the Birds of North America*.

Please note that severely injured or dead birds may not resemble their pictures in this or any field guide.

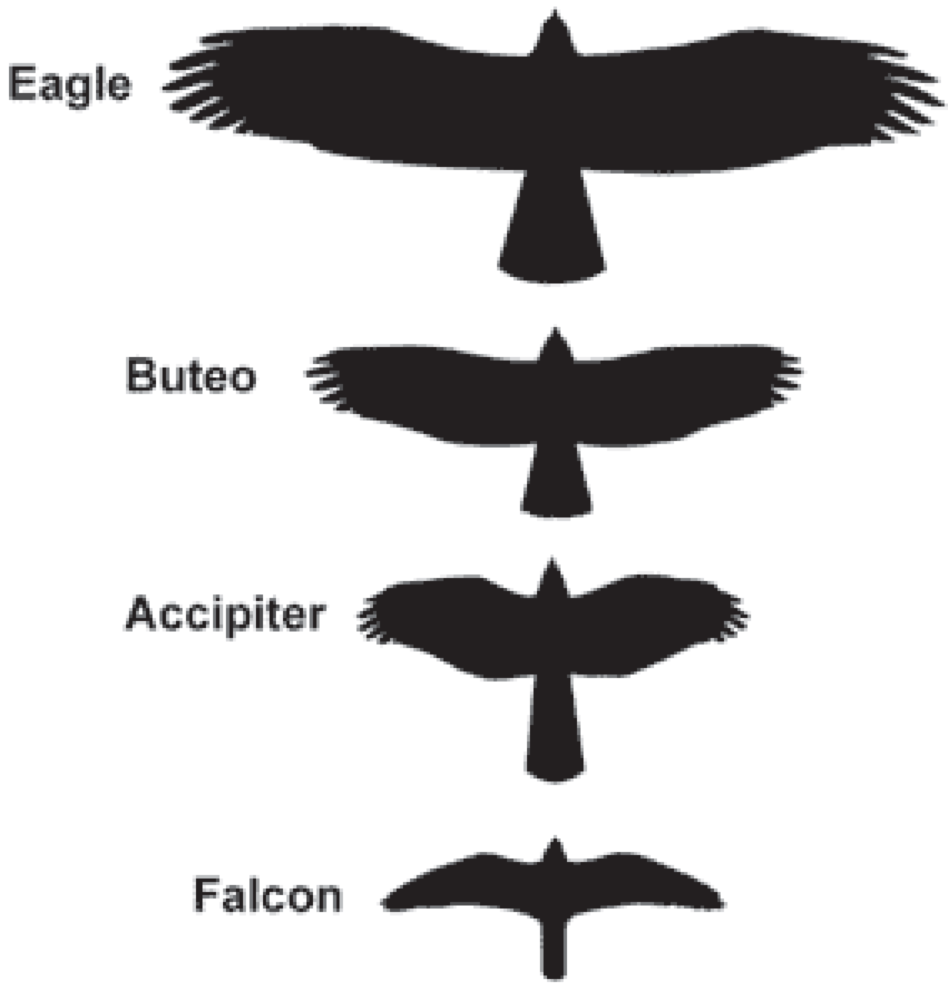


Diagram source: BLM

Bald Eagle

Photo source: USFWS

Length: 31-37”
Wingspan: 70-90”
Adult: White head and tail; dark brown body.
Juvenile: Dark head and very black beak; dark brown body.

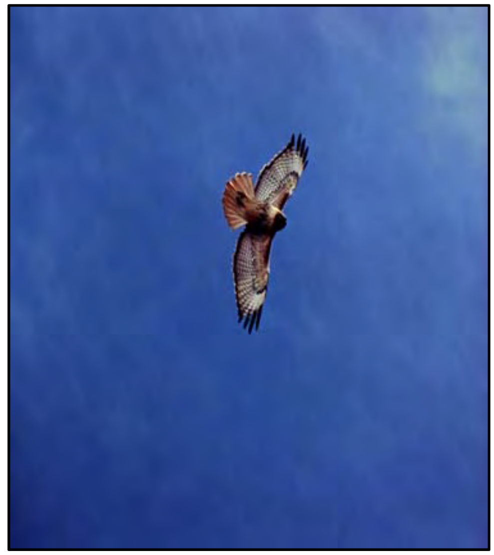
Golden Eagle

Photo source: USFWS

Length: 30-40”
Wingspan: 80-88”
Adult: Dark brown with golden nape and crown; legs are feathered to the toes.
Juvenile: Head and body are uniformly dark brown with white crescents in the wings and white at the base of the tail feathers.

Red-tailed Hawk





Photos source: USFWS and NPS

Length: 22"
Wingspan: 50"
Adult: Dark head and dark belly band; red tail and generally reddish colored breast.
Juvenile: Brownish tail with dark barring; white breast.

Ferruginous Hawk


Photos source: USDA Forest Service, Dave Herr

Length: 23"
Wingspan: 53"
Adult: Underside of wings and tail are primarily white; the top of tail is white at the base, then reddish to the tip. Shoulders and back are tinged red. Red legs.
Juvenile: White legs.

Osprey

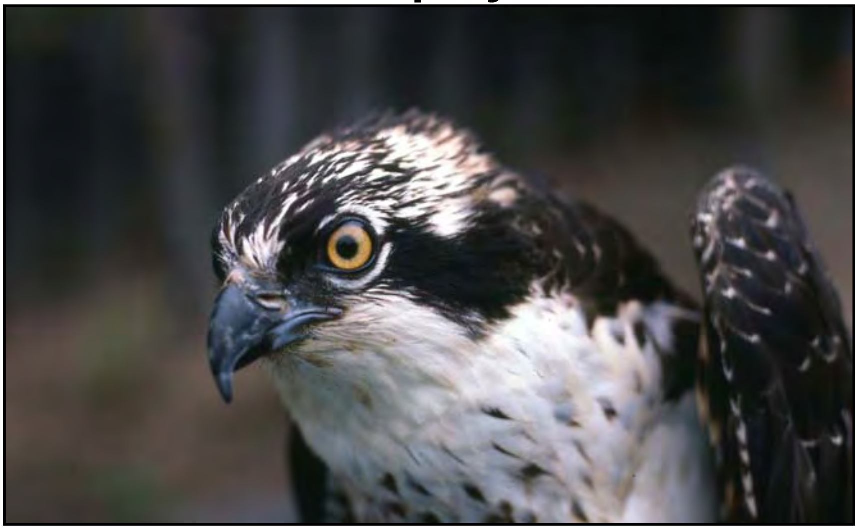


Photo source: Peter Bloom

Length: 23”
Wingspan: 63”
Adult: Dark brown above, white below; white head, and dark eye stripe; females have darker streaking on neck.
Juvenile: Plumage is fringed with pale buff above.

Turkey Vulture

Photo source: Peter Bloom

Length: 26”
Wingspan: 67”
Adult: Two-toned wings, black lining with silver-gray flight feathers. Red head, white bill, and brown legs.
Juvenile: Dark head and bill.

Barn Owl

Photo source: USFWS

Length: 16"
Wingspan: 42"
Dark eyes surrounded by a heart shaped face. Back of body is cinnamon brown with gray and black mottling.
Female: White chest with brown and black mottling.
Male: Nearly pure white chest.

Great Horned Owl

Photo source: USFWS

Length: 22"
Wingspan: 44"
Prominent ear tufts. Mottled above with chestnut, black and grayish white.
Buff below with heavy dark brown horizontal barring. Large yellow eyes with black irises.

Red-shouldered Hawk

Photo source: Peter Bloom

Length: 17”
Wingspan: 40”
Adult: Reddish shoulders and wing linings, and spotting on back; relatively long-tailed and long-legged.
Juvenile: Variable, but generally less red than adults.

Swainson’s Hawk

Photo source: Peter Bloom

Length: 19”
Wingspan: 51”
Adult: Long, narrow, pointed wings. Plumage is variable with light and dark morphs. Light morphs have a dark ‘bib’ and wings, and are pale below. Dark morphs are dark below.

Juvenile: Light morph birds have dark moustachial stripe and white eyebrows.

Prairie Falcon

Photo source: Peter Bloom, DeeDee Gollwitzer

Length: 16"
Wingspan: 40"
Adult: Pale brown above, creamy white and heavily spotted below. Dark moustachial stripe and ear coverts.
Juvenile: Streaked below instead of spotted, and generally darker overall.

Peregrine Falcon

Photo source: Peter Bloom

Length: 16"
Wingspan: 41"
Adult: Dark nape and crown forming 'helmet' look. Dark above with rufous wash on breast. Long, pointed wings.
Juvenile: Heavily streaked breast.

American Kestrel

Photo source: Peter Bloom

Length: 9”
Wingspan: 22”
Adult: Russet back and tail; two black stripes on white face; pale underwings. Males have blue-gray wings; females have have russet wings.

Juvenile: Breast is heavily streaked.

Merlin

Photo source: Peter Bloom

Length: 12”
Wingspan: 25”
Adult: Male is gray-blue above; females dark brown above. Strongly barred tail and streaked breast. Lacks prominent facial marking of other falcons.

Juvenile: Dark brown above.

Northern Harrier

Photo source: Peter Bloom, DeeDee Golwitnzer

Length: 18"
Wingspan: 43"
Adult: Owl-like face; male is grayish above, white below with some chestnut spotting; female is brown above, white below with heavy streaking on breast and flanks; both sexes have black wing tips.

Juvenile: Resemble adult females but are cinnamon below.

White-tailed Kite

Photo source: Peter Bloom

Length: 15"
Wingspan: 39"
Adult: Overall white with with conspicuous white tail and black shoulders; grayish wings; long pointed wings; long tail.

Juvenile: Underparts and head lightly tinged with rufous.

Cooper's Hawk

Photo source: Peter Bloom

Length: 16.5"
Wingspan: 31"
Adult: Reddish breast; grayish head and back; long rounded tail. Barred tail with broad white tip at the base.
Juvenile: Finely streaked, dark brown above.

Sharp-shinned Hawk

Photo source: Peter Bloom

Length: 11"
Wingspan: 23"
Adult: Very similar to Cooper's Hawk, with shorter, more squared tail. Barred tail with narrow white tip.
Juvenile: Course streaking on breast.

Long-eared Owl

Photo source: Peter Bloom

Length: 15”
Wingspan: 36”
Adult: long, close-set ear tufts; boldly streaked and barred on belly; rusty facial disk; dark vertical stripe through eye
Juvenile: Resemble adults.

Short-eared Owl

Photo source: Peter Bloom

Length: 15”
Wingspan: 38”
Adult: Tawny, boldly streaked on breast; pale belly; ear tufts are barely visible; female has reddish belly.
Juvenile: Resemble adults.

Western Screech-Owl

Photo source: Peter Bloom

Length: 8.5”
Wingspan: 20”
Adult: Generally gray overall; ear tufts; breast and belly are intricately patterend with dark streaks and fine barring.
Juvenile: Resemble adults.

APPENDIX E

Avian Electrocution Susceptibility (AVES) Spatial Model Parameter Values

APPENDIX E

Avian Electrocution Susceptibility (AVES) Spatial Model Details

AVES Design and Parameter Details

The model can be separated into four general modules: (1) nest module, (2) site module, (3) home range module, and (4) incident module.

(1) The nest module is used to weigh the risk of electrocution of raptors within 100 ft of the nests. This weight is controlled by the nest module's one parameter, the Nest Buffer Weight.

(2) The site module is used to weigh the risk of electrocution of raptors perching as they approach the nest (within 1,000 ft), a common practice among all raptors. This weight is controlled by the site module's one parameter, the Site Buffer Weight

(3) The home range module is intended to capture the relevant risk for raptors when they are away from their nest. These distances vary by species and can be found in Table 4. This weight is controlled by the home range module parameter Home Range Weight. In addition to the general home range of each species, vegetation information is used to indicate the likelihood of raptor perching as they forage. Like the home range, each species has different foraging habitats that add greater risk in the home range module. This weight is controlled by the home range module parameter Foraging Habitat Weight.

(4) The incident module is used to weigh the actual raptor electrocutions and collisions. Although no incident data is currently used in the model, if it was to be included the model will add weight to the area where the incident occurred and spread weight over the entire map using an exponential distance decay function. The exponential distance decay was used due to its rapid decrease at large distances where it is suspected the incident will have little empirical power in predicting other incidents. The incident module contains two parameters: (1) the weight at the actual incident location (alpha) and (2) the multiplier for the exponential decay function (beta). Alpha is comparable with the weights for the other three modules as it is additive, however, beta is considered independent because it simply sets the function by which to dissipate the weight assignment from the incident location outward.

In addition, there are two final parameters that affect all modules equally; they are the High and Medium Susceptibility Weights. These weights are species specific based on Table 4. Because there is no nesting data for the two low susceptibility species (sharp-shinned hawk and burrowing owl) there is currently no parameter for low susceptibility in this model. The difference between these two weights indicates the importance of protecting the high versus the moderately susceptible species.

Default Parameter Values

All parameters are defaulted to 1 or 0, excluding the parameters for the incident module. Figure F1 displays the design and default parameter values graphically. These default parameters are used because there is currently no knowledge pertaining to bird prevalence as a function of distance from nest, or as a function of activity such as foraging, nest watching, feeding, etc. It is recommended that these parameters are not changed unless specific information is gathered about bird prevalence.

These parameter values are not exposed to the ArcToolbox because it is recommended that they are not changed; however, they can easily be exposed from inside Model Builder, if necessary.

Parameters for the incident module are exposed to ArcToolbox users because these two parameters are based on user preference. The alpha parameter should be set so that it is comparable to the overlapping weights of the nest, site, and home range weights. Without including the incident module, we found a maximum overall weight of 19 for the model output, thus we set the default alpha parameter to a value greater than 19 such that any area where an incident occurred will be weighed substantially greater than all other areas. This is because the primary goal of the model is to predict areas of future incidents. The beta parameter must be negative because it specifies the exponential rate of change away from the incident. We found that -0.5 fit the current model through visual inspection; however, if the user is interested in spreading the impact of the incident to greater areas, this parameter must be increased (i.e. -0.2). Conversely, if the beta parameter is decreased to -1 or -2 the effect of the incident will be much more local in the model output.

Updating Raptor_Incident Feature Class

The Avian Incident and Nest Form (Appendix A) needs to be entered into the Raptor_Incident Feature Class if any incident data is to be used in the AVES model. While Editing, create a new point feature in the correct X Y (or lat long) location and fill out the table with all relevant information. This will keep a geographic record of all raptor incidents, and it will enable the use of the positions in the AVES model.

Executing AVES

The spatial model was constructed using the ESRI Model Builder application and can be executed from either the ArcToolbox or the Model Builder environment. Below is a tutorial to execute the model and display the result in ArcMap.

(1) Place the APP_Model directory that holds the APP_data.gdb in an appropriate place on your local server or drive. (WARNING: if you only copy the GDB and not the directory folder the model will not run properly. The GDB can sit anywhere on the drive but it must sit within a directory named APP_Model)

(2) Within the ArcToolbox panel in either ArcMap or ArcCatalog right click on the ArcToolbox header and click Add toolbox. Then navigate to the appropriate directory where the toolbox sits and add the Pendleton_APP toolbox.

(3) Expanding the toolbox should reveal five models (AVES model, Home Range, Incident, Nest, and Site) and one python script (PoleClass). The AVES model is the model that will be executed, as each of these other models/scripts in called by AVES model as sub-models. Double click (or right click run) on the AVES model icon.

(4) In the tool parameters window set the appropriate data paths and parameter values (defaults should already exist). The location of the data files should already be set in the correct location if the GDB sits in the correct directory. Once you have set all the parameter values or accepted the defaults click OK. Note: because the model has four sub-models, the response of the computer when entering parameter values and data paths may be slow, please be patient.

(5) The model will take anywhere from 5 to 10 minuets to execute, please be patient. When the model execution is complete, close the dialog and add either the aves_output GRID or classified utility structures to ArcMap depending on your visualization needs. The GRID should be sitting in the APP_Model directory outside of the GDB. The utility structures will reside within the feature dataset Output called Utility_Pole_Aves_Output. You may see additional file names both in the APP_Model directory and within the GDB feature dataset Working. While executing the model from the toolbox, as explained in this tutorial, all intermediate data should be deleted. However, depending on local Arc environment settings this may not always happen. Feel free to delete intermediate data that was created. (WARNING: make sure not to delete the five original feature classes in the GDB (Base_Polygon, Nests, Raptor_Incident, Veg_HDR, utility_pole_tower_point) and the two GRIDs outside the GDB (decay, app_output).

Note: If you want to re-run the model, you may need to delete the app_output GRID and the Utility_Pole_Aves_Output feature class depending on your environment settings. If you allow overwriting by the geoprocessor, you can run the model over and over without deleting these files.

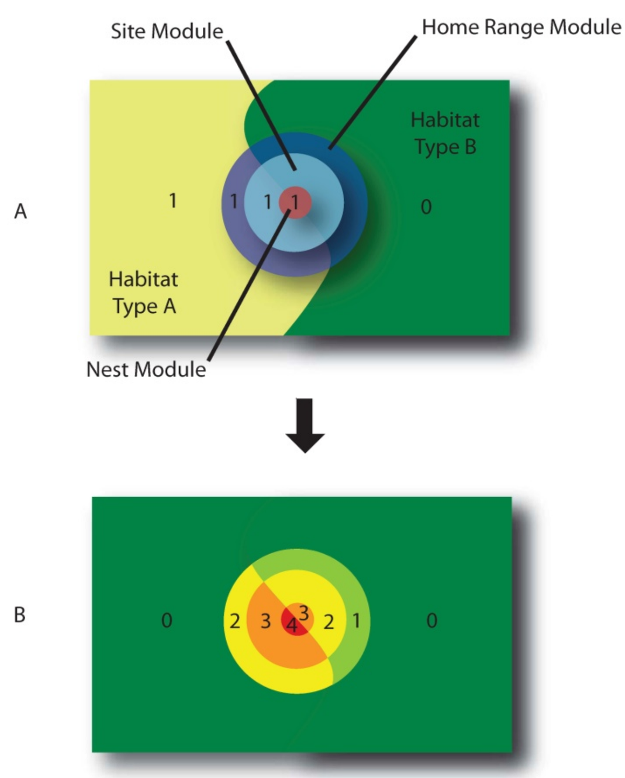


Figure E-1. A: The overlapping scores for the three modules at a theoretical nest location including the underlying habitat which is added to the score of the Home Range Module.

B: The spatial addition of the three modules generating a theoretical model output.

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