

CAUTION: ELECTROCUTION!



Suggested Practices for Bird Protection on Power Lines



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- Production/Paper:** agence GmbH, Cologne/Printend on Lenza Top Recycling Paper
- Photos:** H. Löffler (Cover), M. Gloger (p. 1), D. Lange (p. 2), S. Lemmes (p. 3 left), H. May (p. 3 right), K. F. Gaugel (p. 4 top), W. Feld (p. 4 bottom; p. 7), D. Haas (p. 5 top + bottom; p. 6 top + bottom; p. 9; S. 10 bottom; p. 11 top; p. 12, p. 20), G. Fiedler (p. 8 top + bottom; p. 10 top; p. 11 bottom)
- Cover:** Electrocutation on a power pole in the medium voltage range – White Stork (*Ciconia ciconia*) about to land and about to die

This brochure has been published within the project “Studies on issues related to large birds and electrocution in Central and Eastern Europe with suggested practices for effective solutions”, funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

■ In many countries around the world the widespread availability of electricity has become common and is now considered essential to our standard of living. In particular, above-ground power lines have continued to increase in number and area covered. What has at first sight proved to be a benefit to mankind, is turning out to be a threat to wild animals, an issue that has received too little attention in the past. Depending on the type of construction used power poles and power lines may cause fatal injuries to birds. This is particularly true for large birds such as storks and raptors.

The routes of Eurasian migratory birds specifically are concentrated in those regions around the world which at the same time have erected the most elaborate grid of electric power lines. We therefore are called upon to acknowledge the responsibility of the States located in Central, Western and Eastern Europe to minimize the potential risks for many critically endangered bird species.

The number of States that have already passed legislation on the protection of birds from risks associated with utility structures and power lines is still small. One positive example is the Federal Nature Conservation Act in Germany which was recently amended and became valid in April 2002. It provides for the protection of bird species in that “all newly erected powerpoles and technical structures in the medium voltage range have to be designed to protect birds. Power poles and technical hardware in the medium voltage range that are already in use and pose a high risk to birds are to be retrofitted to exclude electrocu-

tion as a threat within the next ten years”. If we do not succeed in reaching cross-border agreements and do not succeed in taking appropriate action, our efforts to provide effective protection for migratory species will remain fragmentary.

Together with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety NABU has drawn up a resolution on bird electrocution for the 7th Conference of parties of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). It was adopted by delegates from more than 80 Parties. It calls for and suggests practices based on research and practical application as described in this brochure. It contains the technical standards necessary for construction as well as mitigation within the medium voltage range. NABU and its BirdLife partners all hope that these efforts will be supported widely and strongly in the years to come – all over the world. The solutions towards bird protection as presented here demonstrate a clear-cut path which can lead to an effective reduction in the number of bird fatalities caused by electrocution provided our governments, our electric utility companies and we as nature conservationists cooperate.



A handwritten signature in blue ink, appearing to read 'Olaf Tschimpke'.

Olaf Tschimpke • President, NABU



With its extremely long wings this Griffon Vulture (*Gyps fulvus*) has touched at least one of the energized power lines and caused a short-circuit.

Mainly large birds such as storks and raptors are effected but depending on the type of construction smaller species are as well, even those as small as the House Sparrow (*Passer domesticus*). Numerous studies have already documented electrocution as one of the most frequent causes

■ All over the world utility companies provide electricity to their customers by means of a network of overhead power lines. In many regions such as Central and Eastern Europe this network has become even more dense in the past decades. These power lines – and even more so poorly designed and thus dangerous power poles – pose a high risk to birds, especially migratory birds. Many birds prefer power poles as a perch or roost site. Whether or not the power pole is safe depends on the way it is constructed. A number of power poles within the medium voltage range (1 kV to 60 kV) are constructed with close spacing between the pole resp. its crossarm and its wires or other energized parts. In such instances birds when landing or taking off can complete an electric circuit between live and ground wire which literally executes them. But even perching birds can be killed as soon as their wings touch energized parts.

Death by short-circuit: If a bird's wings bridge the gap between energized wires with different voltages, electricity flows through its body – severe burns and paralysis can be fatal.

Death by ground-fault: Ground-faults are more frequent than short-circuits and occur when spanning the gap between a wire and a grounded power pole. This happens when the body itself or nesting material contact the parts. Close spacing and high humidity can even increase the risk of electric sparks (“electric arc”). But even when a bird urinates the contact can be fatal.

of death among large endangered bird species worldwide. So-called “flagship-species” in ecosystems such as White Stork and Black Stork (*Ciconia ciconia*, *Ciconia nigra*), Spanish Imperial Eagle (*Aquila adalberti*), Lesser Spotted Eagle (*Aquila pomarina*), Greater Spotted Eagle (*Aquila clanga*), and Steppe Eagle (*Aquila nipalensis*) are at great risk. Most species fall within the highest conservation status as listed in the Appendices to the “Convention on the Conservation of Migratory Species of Wild Animals”, also known as the “Bonn Convention”.

Bird species endangered

Recent figures, compiled by NABU experts in Central and Eastern European countries, show how great the risk of bird electrocution is. Looking at Estonia, Poland, Czech Republic, Hungary, Slovenia and Croatia we find as many as 42 bird species as listed in the Appendices I and II of the Bonn Convention that are threatened due

to power poles that have yet to be retrofitted. 22 species are already classified as critically endangered (see table p.18-19).

Kazakhstan gives a good example of the horrendous effects poorly designed power poles have. In a nature reserve on Lake Tengiz numerous birds, including 200 Kestrels, 48 Steppe Eagles, two Spanish Imperial Eagles, one White-tailed Eagle and one Black Vulture were recorded killed by electrocution along an eleven kilometer medium voltage overhead power line for the month of October 2000 only.

Studies on population and biology in which telemetry was used have traced losses among large birds to electrocution, e.g. on the Eagle Owl (*Bubo bubo*) in Norway and the Bonelli's Eagle (*Hieraaetus fasciatus*) in Spain. These studies verify that in many regions electrocution poses one of the greatest risks to large birds and their populations.

Bird strikes with medium voltage overhead power lines are the main cause of death for White Storks (Ciconia ciconia). Landing accounts for 16 per cent, electrocution for 84 per cent.

Not only do power poles pose a lethal threat to birds. Birds are killed by colliding with power lines or injured severely and thus die from their injuries. Birds that migrate at night are especially threatened.



Is this a new issue on today's agenda?

IS THIS A NEW ISSUE ON TODAY'S AGENDA?

■ Awareness is low of the high mortalities associated with electrocution that growth in the electricity industry has brought with it. Only a small number of electric utility companies has reacted to the problem, although bird-induced electrical outages cause substantial costs. Information on electrocution of birds and the problems it causes – for the utility companies as well – is not new but dates back to the beginning of the 20th century – when the topic was put on the agenda. At the “III. Deutscher Vogelschutztag” in 1913 in Hamburg Hermann Hähnle, an engineer, gave a talk titled “Electricity and Bird Protection” in which he described the disastrous impact of electrocution. The conclusion he reached back then is still valid today: “It is fair enough to maintain that electricity companies are in a position to reduce bird deaths to isolated cases without jeopardizing their financial interests in any manner whatsoever.” Hähnle recommended that “electric utility companies be required to provide comprehensive protection for wild birds so that, if accidents occur mitigation measures can be put to work at once.”

Even back then he emphasized that solutions based on cooperation would be in the interest of the industry to avoid elec-



Wood poles can become a hazard in wet weather as they lose their insulating capacity.

trical outages and damage to their utilities. The very first regulation on the “Prevention of Risks to Wild Birds” was passed. It listed the minimum standards for erecting power lines. Given the good personal contacts between the bird protection community and electric utility companies, the risk of electrocution of wild birds decreased as the suggestions on the construction of power poles and power lines were put into practice. Poles made of wood were used in the medium voltage range because – unlike steel and metal – they are, at least in dry weather, not grounded.



With its extremely long wings the White Stork has bridged the insulators and was killed by the electric flow through its body.



■ In the past few decades power poles in the medium voltage range have undergone drastic changes in their construction. Poles were designed with materials that conduct well (steel and metal) and the three power lines were secured at the same height (on the same plane). Some of the power lines were attached to large suspended insulators below the crossarm as is the custom for high voltage transmission lines. This type of construction is relatively bird-friendly. However, a large number of newly installed power lines were attached to upright insulators mounted on top of the crossarm. Large birds perching on this type of pole – often called “killer poles” – can easily contact energized wires. These poles are responsible for the drastic losses in numerous bird species and, especially in Eastern Europe, are one of the greatest risks for large endangered bird species.

*Even birds smaller than this Buzzard (*Buteo buteo*) are threatened. Although only 25 cm in height the upright insulators make this power pole a dangerous landing site.*



*This Red-footed Falcon (*Falco vespertinus*) lost its claws and right wing after contacting an exposed structure.*

A fatal development

Most electrocuted birds drop from the poles and if the electric shock has not killed them at once, they suffer serious or fatal injuries from the fall. The entry marks are hardly noticeable and without professional help difficult to detect. The bird seems to have suffered no outward harm.

Invisible victims

Many of the carcasses are quickly taken by predators such as foxes and marders. Only a small number of carcasses can be found hanging from the pole or on the ground where they have fallen. Therefore, estimations of the number of birds killed by electrocution are difficult to make.



The scorched feathers of a Kestrel clearly mark the entry of the electricity. In most cases it is very difficult to detect such entry marks.

*The feathers of this Kestrel (*Falco tinnunculus*) caught fire in an electric arc. Birds frequently catch fire and burn like torches. When they drop to the ground they are likely to set off ravaging wildfires. Electric utility companies may face charges for damages caused by wildfires with claims for high compensation.*



■ There is no justifiable reason nowadays why a single bird should be killed due to an interaction of any sort with electrical structures. Indeed, there is no lack in the assortment of technical solutions available. One of the safest methods to avoid bird losses is for example to lay medium voltage power lines under the ground. Several companies in Germany decided a number of years ago that new power lines would no longer be erected above ground but be laid under the surface (e.g. Schleswig AG in the State of Schleswig-Holstein and the Energieversorgung Weser-Ems in northern part of the State of Lower Saxony).

Given that insulated hanging cables are already in use in low voltage power lines, this practice could also easily be applied to the medium voltage range. Insulators would then no longer be required as the cables can, for example, be attached directly to the poles. Thus birds no longer risk electrocution.

A new bird protection paragraph

The most important technical requirement with respect to bird-safe medium voltage power lines calls for, “crossarms, insulators and other parts of high voltage power lines to be constructed so that birds find no opportunity to perch near energized power lines that might be hazardous”. NABU has consistently called for this requirement and in 1985 it was included as a new paragraph on bird protection with respect to the regulations on the construction of power lines (VDE 0210, 1985, Section 8.10 Bird Protection) in Germany. Once the bird protection paragraph was accepted the electric utility companies

became interested in the technical regulations regarding the installation of cables. Mitigation guidelines for power poles posing a risk to birds (VDEW 1991) were written up in collaboration with electric utility companies.



White Stork on a safe roosting site. The insulated cable is attached directly to the pole.



In the past reflecting glass balls were used first on this pole and were later replaced by bird diverters. It was not until in a third attempt that the insulators were effectively covered with molded plastic hoods.

These guidelines are still valid and have even been adopted by several other European countries, e.g. Switzerland. The objective of the guidelines is to help companies avoid otherwise costly investments in the development of technical hardware that has already been tested and is on the market.

Power poles and power lines that are fairly bird-safe:

- voltage is greater than 60 kV (high voltage power lines)
- voltage is lower than 1 kV (low voltage power lines)

Migrating storks like to roost on power poles. The four young storks shown here have found a bird-friendly power pole with suspended insulators.



Various types of bird diverters have been developed, certain types, however, frequently fail to fulfill their purpose.

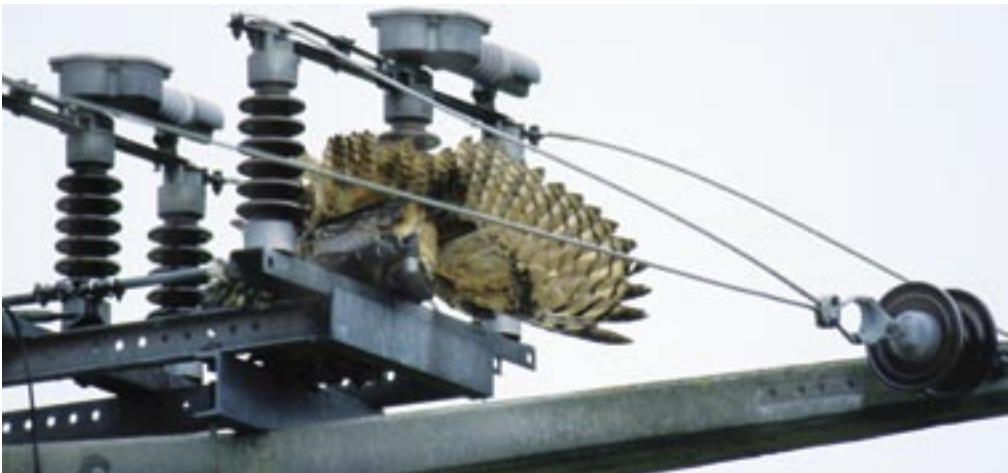
Provided the space is greater than 60 cm between a likely perch site and energized parts, power poles in the medium voltage range can be considered relatively bird-safe. An optimal solution would be to attach power lines to long suspended insulators. Both types of construction have been available for the past 20 to 30 years.

In many countries electric companies, though, are still constructing and installing power poles in the medium voltage range that are hazardous for birds. Upright insulators can be deadly if the gap between the power lines and the crossarm is narrow. Large birds will seek out poles with crossarms and upright insulators to perch on and risk contacting closely spaced energized wires – a deathtrap which can cause a ground fault when body parts touch a grounded wire.

Hazardous power poles are those:

- with upright insulators
- with power lines spaced less than 140 cm
- with power lines mounted on the crossarm resp. the pole top with distribution insulators or suspended insulators (with gaps less than 60 cm). This applies to all other energized parts.
- with switch towers if when open the bird can bridge the gap.

*Switch towers with upright structures are extremely dangerous for birds. Contact with the energized wires on this power pole was unavoidable and led this Eagle Owl (*Bubo bubo*) into a deadly trap.*



Bird safety lies in the hands of the engineer

Transmission lines along railway tracks can also pose a threat to birds. In Germany guidelines are now being prepared for bird-safe construction and mitigation of overhead transmission lines.



A favorite perch site but dangerous as well: the pole top of transmission lines of the German Railway Company. The energized power line is attached to the pole top. To reduce the shock hazard the power line was covered with insulator hoods 130 cm in length later on.

Still widely used in Eastern Europe: The top of the power pole of the railway transmission line is separated from the energized parts only by a very short insulator.



■ Migratory birds do not stop at national boundaries. The routes of Eurasian migratory birds are concentrated in those very regions of the earth where the demand for electricity has produced the most finely meshed transmission grid. It goes with saying that the States in Central, Western and Eastern Europe are called on to fulfill their responsibility with regard to global efforts to protect species.

All efforts we undertake in this particular region of the world to protect migratory species effectively will be in vain, if

Only the power pole with suspended insulators is safe. Mitigation measures to protect birds from electrocution will pay off only if carried out consistently and on a large scale.

we fail to reach agreements transgressing national boundaries. The number of States that have passed legislation on the protection of birds on power lines is, however, still small. At regional levels advances have been made thanks to joint efforts of conservationists, governmental agencies, electric utility companies and manufacturers. Given the sustained demand around the world for electricity, bird deaths by electrocution are all the more imminent. Even greater efforts on our part are necessary if we wish to minimize this threat.

A step in the right direction: The Federal Nature Conservation Act for the Republic of Germany, valid as of April 2002. New is Paragraph 53 “Bird Protection on power lines” which dictates: “Newly erected power poles and technical hardware have to be constructed to exclude the possibility of bird electrocution. Mitigating measures are to be undertaken on existing power poles and technical hardware in the medium voltage range within the next ten years. (...)”

These two young storks have landed safely. This dangerous insulator has been retrofitted with a plastic molded cap. Bird electrocutions have declined sharply in those areas where mitigation measures have been accepted.





■ To protect birds from the risk of electrocution in the future NABU is pressing politicians and energy companies to follow its lead and address the guideposts listed below:

1. It is of utmost urgency to withstand and on the long-term to minimize the on-going worldwide threat to birds by electrocution.
2. We therefore strongly recommend that all States introduce agreed technical standards for the construction of new medium voltage power poles, furthermore to retrofit existing killer power poles and, moreover, to pass legislation covering bird protection on power lines.
3. To protect migrating birds in particular, newly erected power poles and technical structures on medium voltage power poles are to be constructed to protect birds from electrocution.
4. Existing power poles and technical structures are to be retrofitted to the extent that the protection of birds from electrocution is guaranteed.
5. Where possible medium voltage transmission cables are to be laid underground as they are the safest precaution in bird protection and subsequently avoid losses.
6. Power lines should be diverted from areas where large numbers of birds regularly fly through at a low altitude (coastal lines, topographical bottlenecks, breeding colonies).
7. Conservationists, ornithologists, energy companies and politicians should cooperate to effectively reduce the threat of bird electrocution.
8. We recommend that the guidelines compiled by NABU (BirdLife partner in Germany) and its partner organizations with the support of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety as presented in this brochure be negotiated to the extent that in future birds will no longer be able to land on perch sites spaced close to energized power lines.

■ The construction of certain pole types and the spacing of power lines used in the medium voltage range can pose a risk to large birds in particular.

The following describes the most widely used types of power poles worldwide, their potential risk and steps towards miti-

gation. Recommendations are made for power poles made of concrete, steel, composite steel and wood. This brochure is based on standards set up by the Vereinigung Deutscher Elektrizitätswerke (1991) as well as studies carried out by the NABU National Working Group on Electrocutation (2002).

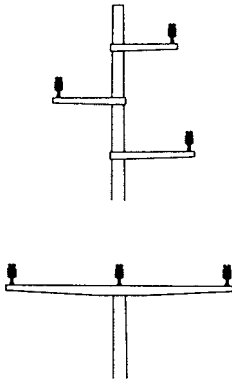
The safety of the installations depends primarily on

- how insulators are attached to the poles and

- the actual space between the power lines and other energized and grounded parts.

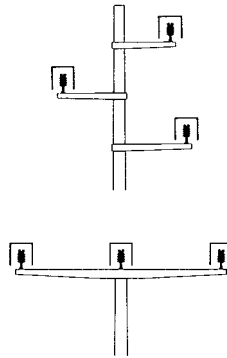
POWER POLES WITH UPRIGHT INSULATORS

Risk: high



Power poles with upright insulators are widely used and rank as the most dangerous of all types. The gap between the power lines and the crossarm is small, in older structures the lines run along the side of the top of the power pole.

Suggested practices

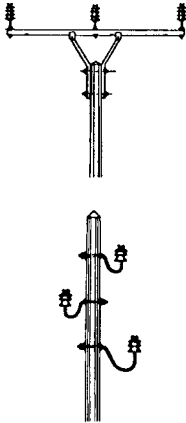


Insulated caps

Mitigating electrocutation effectively is possible either by treating poles (a) with insulating caps made of plastic for outdoor use 130 cm in length or (b) insulating power lines with tubing 130 cm in length. Power lines have to be spaced at a distance of at least 140 cm. If this is not possible, they should be insulated with tubing.

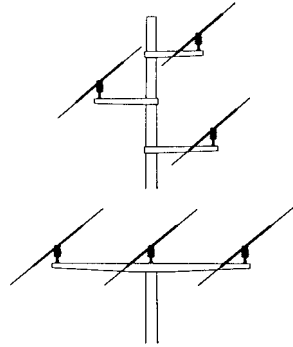
POWER POLES WITH UPRIGHT INSULATORS

Risk: high



In wet weather wooden poles with upright insulators can be a hazard as well as poles that are grounded. The top of armless poles has to be well above the uppermost wire.

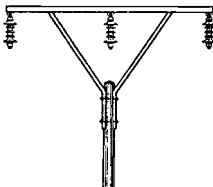
Suggested practices



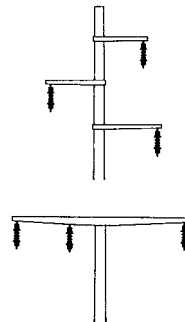
Insulated tubing on power lines

Alternatively, upright insulators on power poles can be retrofitted to suspend.

POWER POLES WITH SUSPENDED INSULATORS



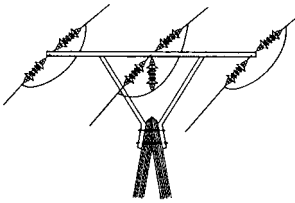
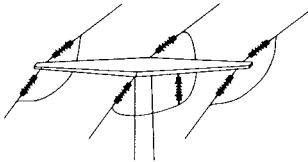
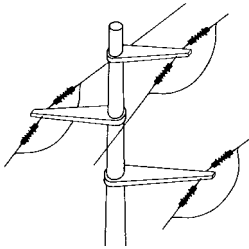
Poles with suspended insulators are fairly safe provided the distance between a likely perch (crossarm) to the energized parts (power lines/wires) is 60 cm. Power



lines/wires should be spaced at least 140 cm apart. Hardware that is used to prevent arcing (“St. Elmo’s fire” on both sides of the insulators) should not be used.

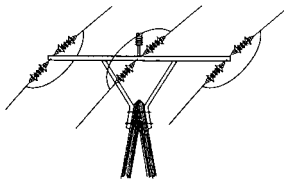
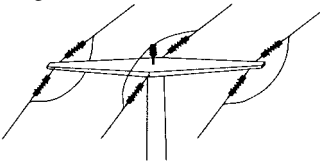
STRAIN POLES

Risk: low



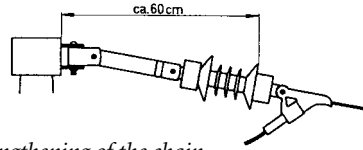
Strain poles with power lines below the cross-arm

Risk: high



Strain poles with power lines above the cross-arm

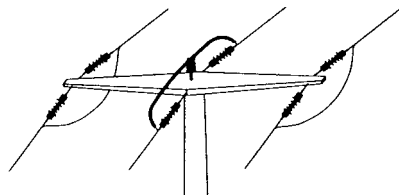
Suggested practices



Lengthening of the chain

Bird-safe strain poles require insulating metal chains at least 60 cm in length. Hazardous constructions can be mitigated by lengthening the chains. In instances where the power lines/wires run above or too close to the crossarm, tubing should be used. Junction power poles should be treated in the same way.

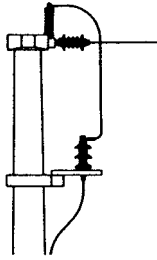
Suggested practices



Insulated hood or insulated tubing

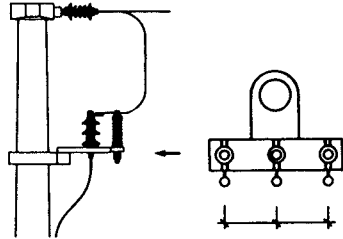
TERMINAL POLES AND TOWER STATIONS

Risk: high



Terminal poles

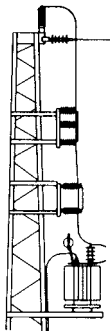
Suggested practices



Terminal poles

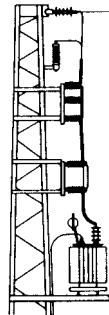
Frequently over voltage reactors extend above the tops of terminal poles and tower stations. This hazard for birds can be avoided if the over voltage reactor is attached below the crossarm and all exposed wire contacts are insulated with tubing. On tower stations all contacts directly above the switch as well as between the switch and transformer should be treated likely. Hardware used to prevent electrical arcs should not be used (mitigation measure: dismantle).

Risk: high



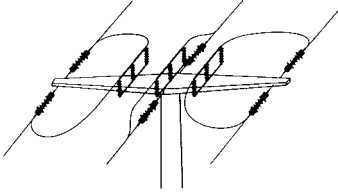
Tower station

Suggested practices



SWITCH TOWERS

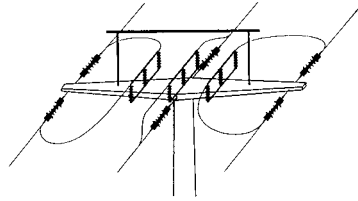
Risk: high



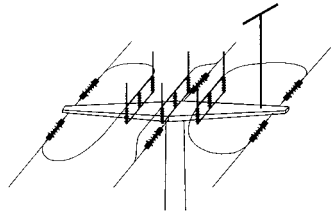
Switch tower

The safest switch towers have their switches attached below the crossarm. Otherwise, mitigation measures are more complicated and do not provide the same high degree of safety for birds. As hooding is usually not possible, various techniques have been tested.

Suggested practices



a) Insulated perch sites



b) Insulated perch sites lengthwise to the crossarm and acrylic glass rods

Insulated perch sites can be installed (a) lengthwise to the crossarm or (b) at its edge. They should be as long as possible and have a rough texture. Installation of acrylic glass rods above the switches (b) will prevent birds from perching on the poles. Additional safety is reached by increased distances between the phases and by insulation with tubing.

Bird Species threatened by electrocution

BIRD SPECIES THREATENED BY ELECTROCUTION

■ The following table includes bird species threatened by electrocution and is based on a study carried out by NABU (2002) in countries in Central and Eastern Europe. Bold print: critically endangered species.

Species	Latin name	Size (cm)	Wing length (cm)	Status
				BeC BoC
Night Heron	<i>Nycticorax nycticorax</i>	58-65	105-112	II
Great White Egret	<i>Egretta alba</i>	85-102	140-170	
Grey Heron	<i>Ardea cinerea</i>	90-98	160-175	
Purple Heron	<i>Ardea purpurea</i>	78-90	120-150	II II
Black Stork	<i>Ciconia nigra</i>	95-100	165-180	II II
White Stork	<i>Ciconia ciconia</i>	100-115	175-195	II II
Honey Buzzard	<i>Pernis apivorus</i>	52-60	125-145	II II
Black Kite	<i>Milvus migrans</i>	55-60	135-170	II II
Red Kite	<i>Milvus milvus</i>	60-66	155-180	II II
White-tailed Eagle	<i>Haliaeetus albicilla</i>	70-90	190-250	II I
Lammergeier	<i>Gypaetus barbatus</i>	100-115	240-300	II II
Egyptian Vulture	<i>Neophron percnopterus</i>	60-70	155-170	II II
Griffon Vulture	<i>Gyps fulvus</i>	95-105	230-270	II II
Black Vulture	<i>Aegyptus monachus</i>	100-110	250-295	II II
Short-toed Eagle	<i>Circus gallicus</i>	62-67	170-190	II II
Marsh Harrier	<i>Circus aeruginosus</i>	48-56	120-135	
Hen Harrier	<i>Circus cyaneus</i>	44-52	105-125	II II
Pallid Harrier	<i>Circus macrourus</i>	40-48	100-125	II II
Montagu's Harrier	<i>Circus pygargus</i>	43-47	105-125	II II
Goshawk	<i>Accipiter gentilis</i>	48-62	95-125	
Sparrowhawk	<i>Accipiter nisus</i>	28-38	60-80	
Levat Sparrowhawk	<i>Accipiter brevipes</i>	32-38	65-75	II II
Buzzard	<i>Buteo buteo</i>	51-57	115-137	
Long-legged Buzzard	<i>Buteo rufinus</i>	57-65	135-160	II II
Rough-legged Buzzard	<i>Buteo lagopus</i>	55-61	130-150	
Lesser Spotted Eagle	<i>Aquila pomarina</i>	62-68	145-165	II II
Spotted Eagle	<i>Aquila clanga</i>	65-72	155-180	II II
Steppe Eagle	<i>Aquila nipalensis</i>	67-87	170-220	II II
Imperial Eagle	<i>Aquila heliaca</i>	72-83	180-215	II II
Golden Eagle	<i>Aquila chrysaetos</i>	76-93	190-240	II II
Booted Eagle	<i>Hieraetus pennatus</i>	50-57	115-135	II II
Bonelli's Eagle	<i>Hieraetus fasciatus</i>	65-72	145-175	II II
Osprey	<i>Pandion haliaetus</i>	55-63	145-170	II II
Lesser Kestrel	<i>Falco naumanni</i>	29-32	60-70	II II
Kestrel	<i>Falco tinnunculus</i>	30-34	60-75	II II
Red-Footed Falcon	<i>Falco vespertinus</i>	29-31	60-75	II II
Merlin	<i>Falco columbarius</i>	25-30	55-65	
Hobby	<i>Falco subbuteo</i>	30-36	65-85	
Lanner	<i>Falco biarmicus</i>	40-50	90-115	II II
Saker	<i>Falco cherrug</i>	47-57	105-135	II II
Gyr Falcon	<i>Falco rusticolus</i>	50-60	110-140	II II
Peregrine	<i>Falco peregrinus</i>	36-48	85-120	II II
Mediterranean Gull	<i>Larus melanocephalus</i>	36-38	100-110	II II
Common Gull	<i>Larus canus</i>	40-42	110-120	III

Bird Species threatened by electrocution

Species	Latin name	Size (cm)	Wing length (cm)	Status	
				BeC	BoC
Lesser Black-backed Gull	<i>Larus fuscus</i>	52-60	135-150		
Herring Gull	<i>Larus argentatus</i>	56-64	138-150		
Yellow-legged Gull	<i>Larus cachinnans</i>	55-67	138-155		
Rock Dove	<i>Columba livia</i>	31-34	63-70		
Stock Dove	<i>Columba oenas</i>	32-34	63-69		
Wood Pigeon	<i>Columba palumbus</i>	40-42	75-80		
Collared Dove	<i>Streptopelia decaocto</i>	31-33	47-55		
Turtle Dove	<i>Streptopelia turtur</i>	26-28	47-53		
Barn Owl	<i>Tyto alba</i>	33-35	85-93	II	
Eagle Owl	<i>Bubo bubo</i>	60-75	160-188	II	
Snowy Owl	<i>Nyctea scandiaca</i>	53-66	142-166	II	
Little Owl	<i>Athene noctua</i>	21-23	54-58	II	
Twany Owl	<i>Strix aluco</i>	37-39	94-104		
Ural Owl	<i>Strix uralensis</i>	60-62	124-134		
Long-eared Owl	<i>Asio otus</i>	35-37	90-100		
Short-eared Owl	<i>Asio flammeus</i>	37-39	95-110	II	
Tengmalm's Owl	<i>Aegolius funereus</i>	24-26	54-62	II	
Bee-Eater	<i>Merops apiaster</i>	27-29	44-49	II	II
Roller	<i>Coracias garrulus</i>	30-32	66-73	II	II
Hoopoe	<i>Upupa epops</i>	26-28	42-46		
Northern Wheatear	<i>Oenanthe oenanthe</i>	14,5-15,5			
Black-eared Wheatear	<i>Oenanthe hispanica</i>	14,5		II	II
Ring Ouzel	<i>Turdus torquatus</i>	23-24		II	II
Blackbird	<i>Turdus merula</i>	24-25		III	II
Fieldfare	<i>Turdus pilaris</i>	25,5		III	II
Song Thrush	<i>Turdus philomelos</i>	22		III	II
Redwing	<i>Turdus iliacus</i>	21		III	II
Mistle Thrush	<i>Turdus viscivorus</i>	27		III	II
Red-backed Shrike	<i>Lanius collurio</i>	17		II	
Lesser Grey Shrike	<i>Lanius minor</i>	20		II	
Great Grey Shrike	<i>Lanius excubitor</i>	24		II	
Woodchat Shrike	<i>Lanius senator</i>	17		II	
Jay	<i>Garrulus glandarius</i>	33-34			
Maggpie	<i>Pica pica</i>	44-48			
Nutcracker	<i>Nucifraga caryocatactes</i>	32			
Jackdaw	<i>Corvus monedula</i>	33			
Rook	<i>Corvus frugilegus</i>	46-47			
Carrion Crow	<i>Corvus corone</i>	47			
Raven	<i>Corvus corax</i>	55-65			
Starling	<i>Sturnus vulgaris</i>	21			
Rose-coloured Starling	<i>Sturnus roseus</i>	21			
Yellowhammer	<i>Emberiza citrinella</i>	16,5		II	
Corn Bunting	<i>Miliaria calandra</i>	18		III	

Sources

Size and wing length: Beaman, M. & S. Madge (Hrsg. der dt. Ausg.: J. Nicolai, 1998): "Handbuch der Vogelbestimmung: Europa und Westpaläarktis", Ulmer, Stuttgart.
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www.nabu.de/vogelschutz/

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