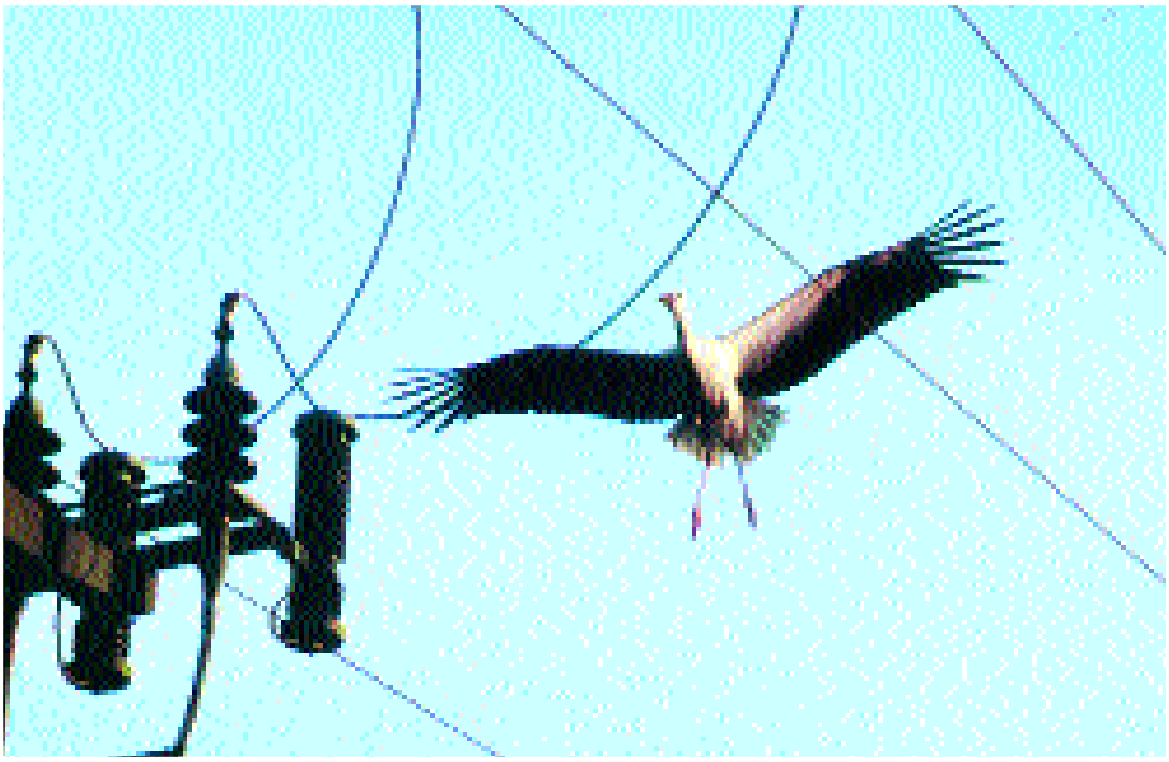
CAUTION: ELECTROCUTION!



Suggested Practices for Bird Protection on Power Lines

NABU

Bundesministerium
für Umwelt, Naturschutz
und Reaktorsicherheit

EDITORIAL

NABU-German Society for Nature Conservation, Registered Charity
Herbert-Rabius-Straße 26 • 53225 Bonn • Germany
Postal adress: NABU, 53223 Bonn
Phone: (0)228.40 36-0 • Telefax: (0)228.40 36-200
E-Mail: NABU@NABU.de • Internet: www.NABU.de

Text: Dr. Dieter Haas, Dr. Markus Nipkow
in collaboraton with Georg Fiedler, Markus Handschuh,
Dr. Martin Schneider-Jacoby and Richard Schneider

Editors: Britta Demmer, Nadja Nohlen, Jochen Heimberg

Layout: A. Eichen, Konzeption & Grafik, Köln

Translation: Ann Grösch

Production/Paper: agence GmbH, Cologne/Printend on Lenza Top Recycling Paper

Subscription information and orders: NABU, Lieferservice, 53223 Bonn

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), U. Mades (p. 21)

Cover: Electrocution 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.

FOREWORD

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 electrocution 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.

Standards in construction and design have to be agreed which will largely exclude the risk of bird deaths caused by electrocution.

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 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.

Jochen Flasbarth • President, NABU

ELECTROCUTION – A WORLDWIDE THREAT FOR BIRDS

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.

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 (10 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.

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

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?

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 jeoparizing their financial interests in any manner whatsoever." Hähnle recommended that "electric ultility 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 electrical 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.

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

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.

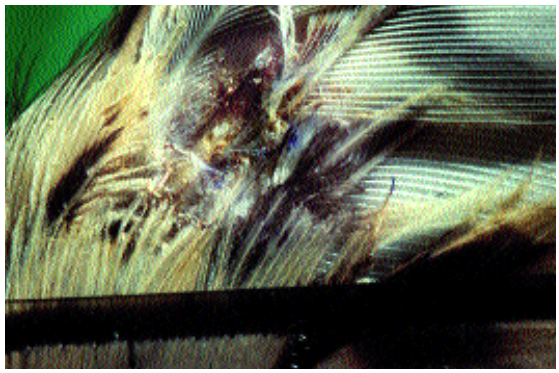
Even birds smaller than this Buzzard (Buteo buteo) are threatened. Although only 25 cm in height the upright insulators make this power pole a dangerous landing site.

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

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 numer 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.

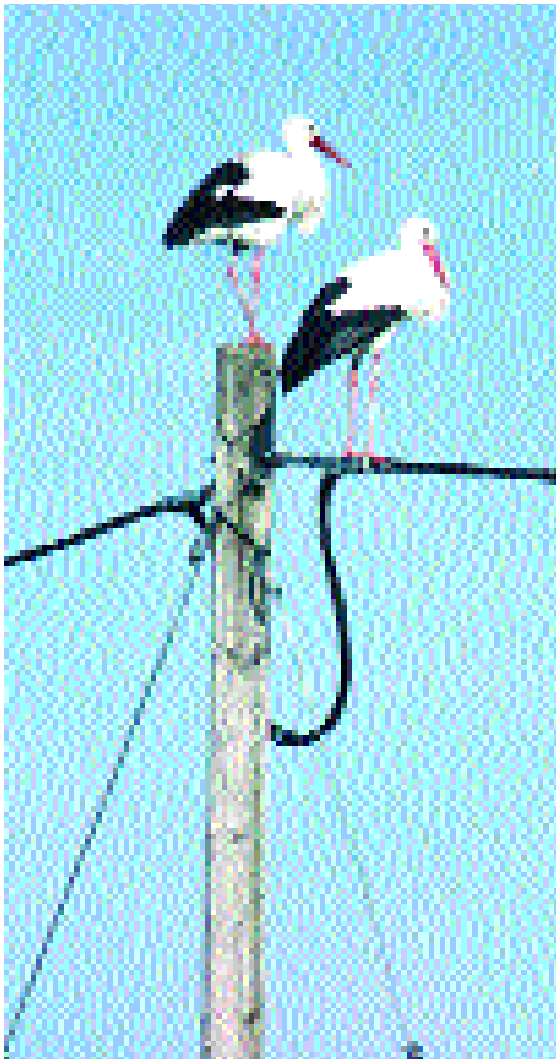
The feathers of this Kestrel (Falco tinnunculus) caught fire in an electric arc. Birds frequently catch fire and burn like torches. When they drop to the ground they are likely to start ravaging wildfires. Electric utility companies may face charges for damages caused by wildfires with claims for high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

There is no justifiable reason nowadays why a single bird should be killed due to an interaction of any sort with electricial 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).

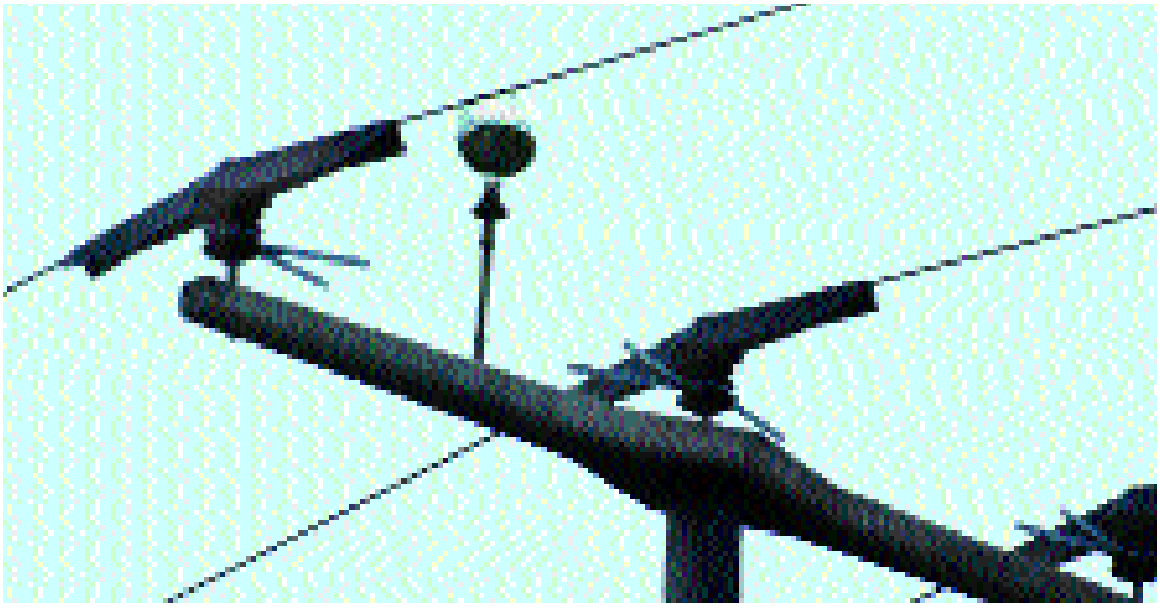
A further possibility would be to install insulated hanging cables as is the practice for low voltage power lines. The cable can then be attached directly to the poles for example and insulators would not be required.

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 consistantly 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.

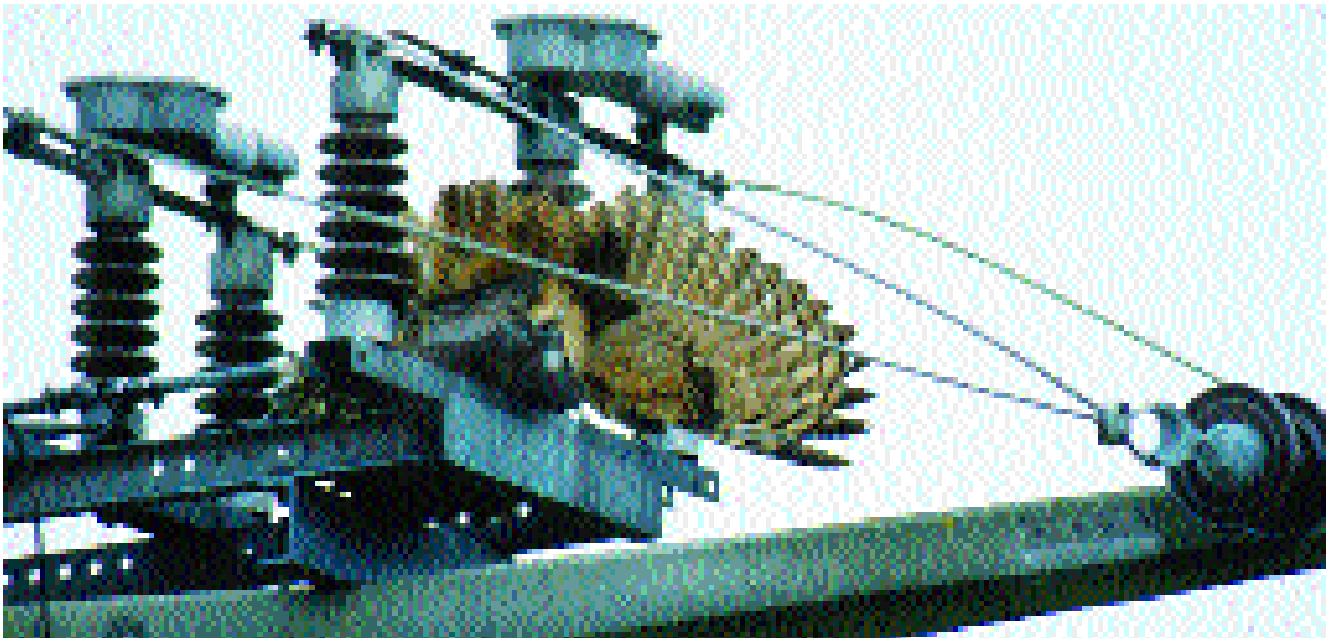
Provided the space is greater than 60 cm between a likely perch site and energized parts, power poles in the medium voltage range (1 kV and 60 kV) can be considered relatively bird-safe. An optimal solution would be to attach power lines to long suspended insulators.Both types of construction have been 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.

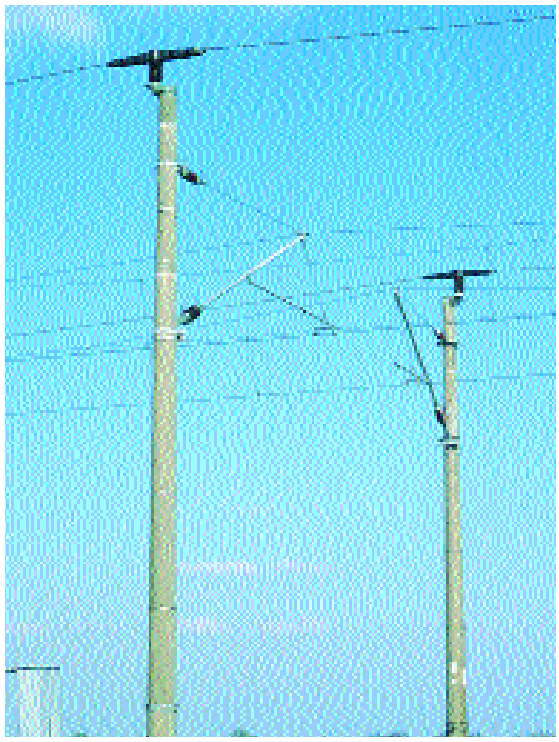
Hazardous power poles are those:

- 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. This Eagle Owl (Bubo bubo) was killed when it bridged the ends of the open switch.



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.

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

Migratory birds do not stop at national boundaries. The routes of Eurasion 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 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. Dangerous upright insulators have been mitigated using plastic molded caps. 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 posssible 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.

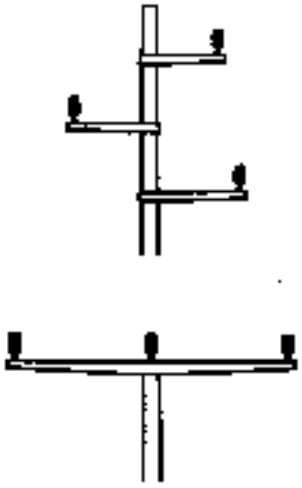
The following describes the most widely used types of power poles worldwide, their potential risk and steps towards mitigation. Recommendations are made for power poles made of concrete, steel, composite steel and wood. This brochure is based on standards set up by the Vereinigung Deutscher Elektrizitätswerke (1991) as well as studies carried out by the NABU National Working Group on Electrocution (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.

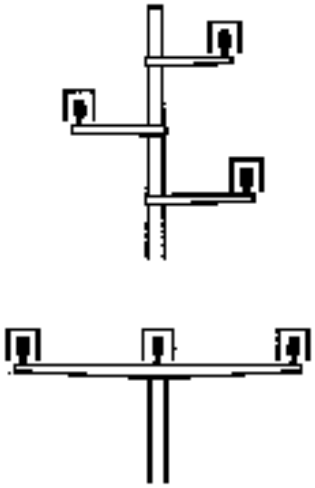
POWER POLES WITH UPRIGHT INSULATORS

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

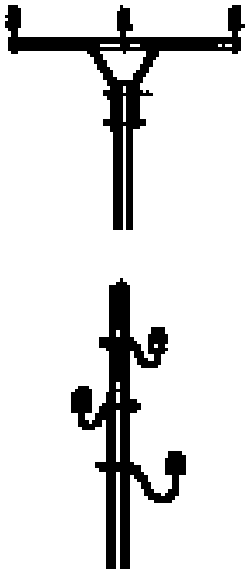


Insulated caps

Mitigating electrocution effectively is possible either by treating poles (a) with insulating caps made of plastic for outdoor use 130 cm in length or (b) insulating powers 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.

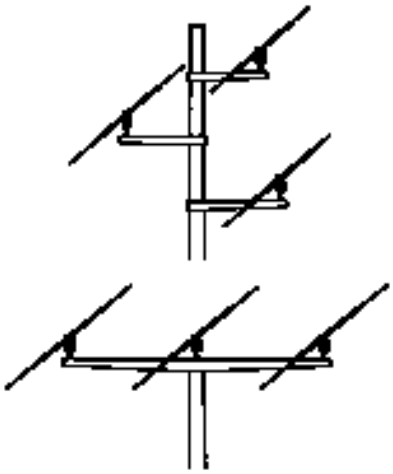
POWER POLES WITH UPRIGHT INSULATORS

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.

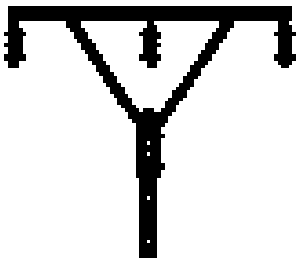
Suggested practices

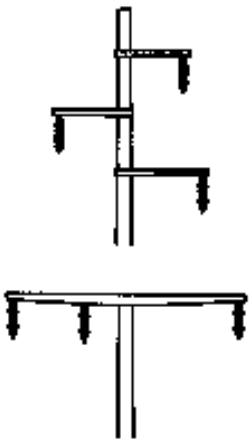


Insulated tubing on power lines

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

POWER POLES WITH SUSPENDED INSULATORS

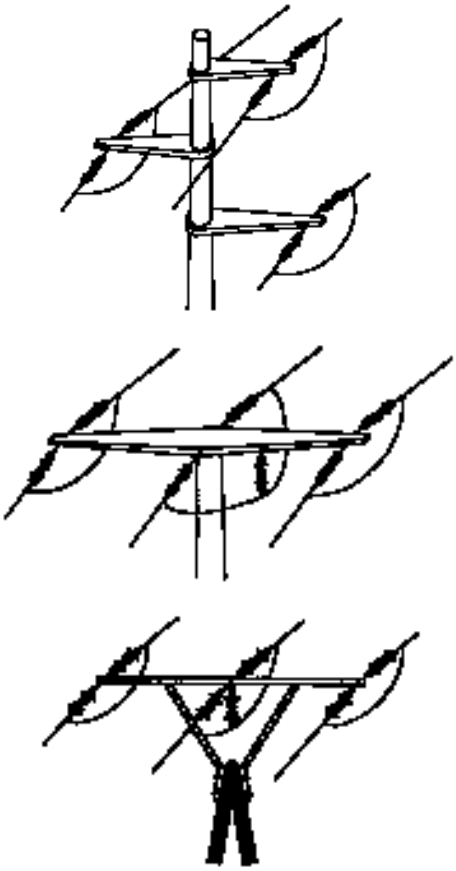




Poles with suspended insulators are fairly safe provided the distance between a likely perch (crossarm) to the energized parts (power lines/wires) is 60 cm. Power lines/wires should be spaced at least 140 cm apart. Hardware that is used to prevent arcing ("St. Elmo's fire" on both sides of the insulators) should not be used.

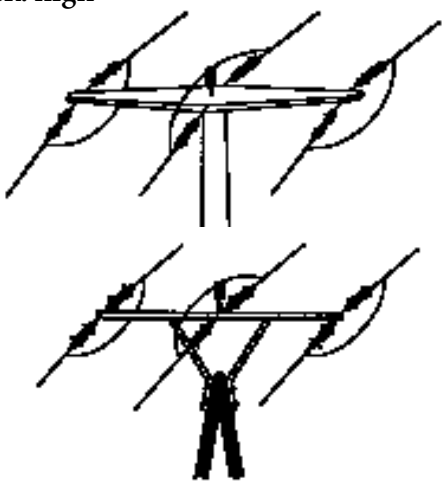
STRAIN POLES

Risk: low



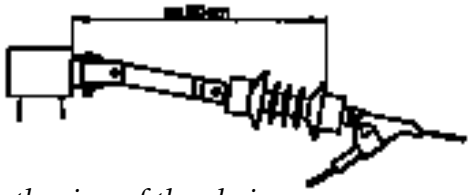
Strain poles with power lines below the crossarm

Risk: high

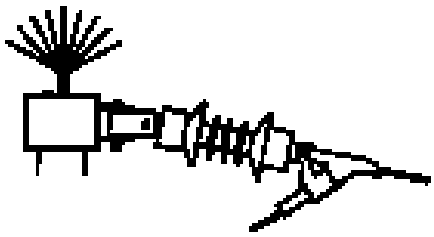


Strain poles with power lines above the crossarm

Suggested practices



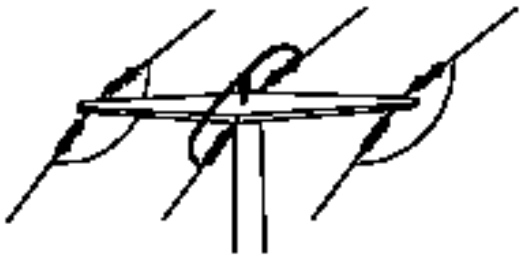
Lengthening of the chain



Perch detectors

Bird-safe strain poles require insulating metal chains at least 60 cm in length. Hazardous constructions can be mitigated by (a) lengthening the chains or (b) installing perch detectors (upright "whisk brooms") on the crossarms. In instances where the power lines/wires run above or too close to the crossarm, (c) tubing should be used. Junction power poles should be treated in the same way.

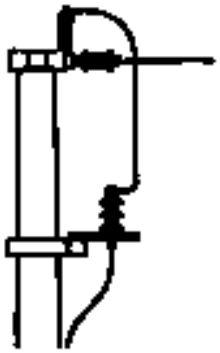
Suggested practices



Insulated hood or insulated tubing

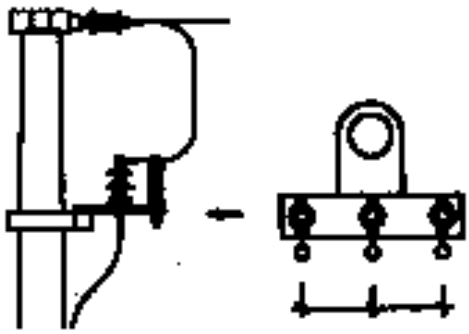
TERMINAL POLES AND TOWER STATIONS

Risk: high



Terminal poles

Suggested practices



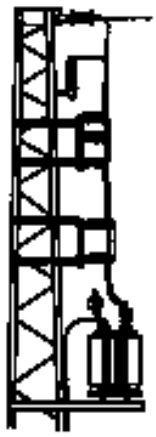
Terminal poles

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

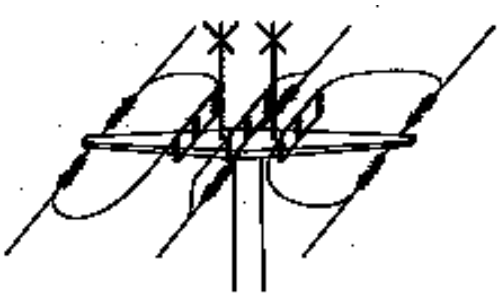
Risk: high

Switch tower

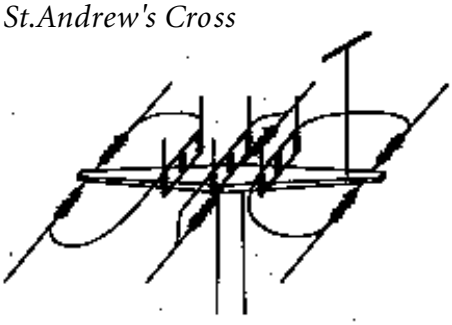
The safest switch towers have their switches attached below the crossarm. Otherwise, mitigation measures are more complicated and do not provide the same high degree of safety for birds. As hooding is usually not possible, various techniques have been tested.

Suggested practices

a) Insulated perch sites



b) St.Andrew's Cross



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

Insulated perch sites can be installed (a) lengthwise to the crossarm or (c) at its edge. They should be as long as possible and have a rough texture. Perching deterrents ("St. Andrew's Cross") (b) installed above the switch keep birds from perching on the poles, as does the installation of acrylic glass rods (c).

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

Species	Latin name	Size	Wing length	Status	
	Links Links	(cm)	(cm)	BeC	BoC
Lesser Black-backed Gull	Larus fuscus	52-60	135-150		
Herring Gull	Larus argentatus	56-64	138-150		
Yellow-legged Gull	Larus cachinans	55-67	138-155		
Rock Dove	Columba livia	31-34	63-70		
Stock Dove	Columba oenas	32-34	63-69		
Wood Pigeon	Columba palumbus	40-42	75-80		
Collared Dove	Streptopelia decaocto	31-33	47-55		
Turtle Dove	Streptopelia turtur	26-28	47-53		
Barn Owl	**Tyto alba**	33-35	85-93	II	
Eagle Owl	**Bubo bubo**	60-75	160-188	II	
Snowy Owl	Nyctea scandiaca	53-66	142-166	II	
Little Owl	Athene noctua	21-23	54-58	II	
Twany Owl	Strix aluco	37-39	94-104		
Ural Owl	**Strix uralensis**	60-62	124-134		
Long-eared Owl	Asio otus	35-37	90-100		
Short-eared Owl	Asio flammeus	37-39	95-110	II	
Tengmalm's Owl	Aegolius funereus	24-26	54-62	II	
Bee-Eater	Merops apiaster	27-29	44-49	II	II
Roller	Coracias garrulus	30-32	66-73	II	II
Hoopoe	Upupa epops	26-28	42-46		
Northern Wheatear	Oenanthe oenanthe	14,5-15,5			
Black-eared Wheatear	Oenanthe hispanica	14,5		II	II
Ring Ouzel	Turdus torquatus	23-24		II	II
Blackbird	Turdus merula	24-25		III	II
Fieldfare	Turdus pilaris	25,5		III	II
Song Thrush	Turdus philomelos	22		III	II
Redwing	Turdus iliacus	21		III	II
Mistle Thrush	Turdus viscivorus	27		III	II
Red-backed Shrike	Lanius collurio	17		II	
Lesser Grey Shrike	Lanius minor	20		II	
Great Grey Shrike	Lanius excubitor	24		II	
Woodchat Shrike	Lanius senator	17		II	
Jay	Garrulus glandarius	33-34			
Magpie	Pica pica	44-48			
Nutcracker	Nucifraga caryocatactes	32			
Jackdow	Corvus monedula	33			
Rook	**Corvus frugilegus**	46-47			
Carrion Crow	Corvus corone	47			
Raven	**Corvus corax**	55-65			
Starling	Sturnus vulgaris	21			
Rose-coloured Starling	Sturnus roseus	21			
Yellowhammer	Enberiza citrinella	16,5		II	
Corn Bunting	Miliaria calandra	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. – Status: BeC (Bern Convention 1987), BoC (Bonn Convention 1994).

REFERENCES

- **Fiedler, G. (1999):** Zur Gefährdung des Weißstorchs (Ciconia ciconia) durch Freileitungen in europäischen Staaten. In: Schulz, H. (Hrsg.): Weißstorch im Aufwind? – White Storks on the up? – Proc. Int. Symp. White Stork, Hamburg 1996 : 505-511.

- **Fiedler, G., & A. Wissner (1989):** Weißstorch-Unfälle an Freileitungen und Abhilfemaßnahmen. – In: Rheinwald, G., J. Ogden & H. Schulz (Hrsg.): Weißstorch – White Stork. Proc., Int. Stork Conserv. Symp. Schriftenreihe DDA 10 : 423-424.

- **Haas, D. (1980):** Gefährdung unserer Großvögel durch Stromschlag – eine Dokumentation. – Ökol.Vögel 2, Sonderheft : 7-57.

- **Naturschutzbund Deutschland NABU, BAG Stromtod (2002):** Untersuchung von Stromschlagproblemen bei Großvögeln in Mittel- und Osteuropa sowie Erarbeitung von Lösungsvorschlägen. (unpublished project report)

- **Olendorff, R. R., Miller, A. & R. Lehman (Hrsg.) (1996):** Suggested Practices for Raptor Protection on Power Lines. – The State of the Art in 1996. A report prepared in the public interest, published and distributed for the Edison Electric Institute by Raptor Research Foundation, c/o Department of Veterinary Biology, University of Minnesota, St. Paul, Minnesota.

- **VDEW, Vereinigung Deutscher Elektrizitätswerke e. V. (Hrsg.) (1991):** Vogelschutz an Starkstrom-Freileitungen mit Nennspannungen über 1 kV. Erläuterungen zu Abschnitt 8.10 "Vogelschutz" der Bestimmung DIN VDE 0210/12.85. 2. Auflage, Verlags- und Wirtschaftsgesellschaft der Elektrizitätswerke mbH (VWEW), Frankfurt a. M., 16 p.

LINKS

www.wcmc.org.uk/cms/
Convention on the Conservation of Migratory Species of Wild Animals (Bonner Convention)

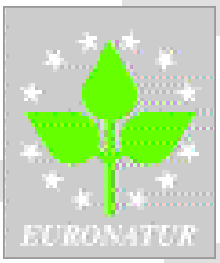
www.nabu.de/vogelschutz/
Vogelschutz im NABU - Naturschutzbund Deutschland e.V., BirdLife Partner in Germany

www.euronatur.de
European Natural Heritage Fund (Euronatur)

This paper is recommended by:

BirdLife International

Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS)



European Natural Heritage Fund (EURONATUR)