

VNT

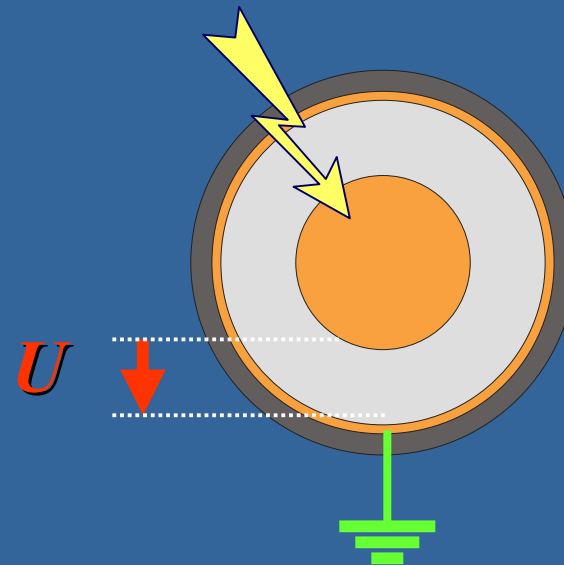
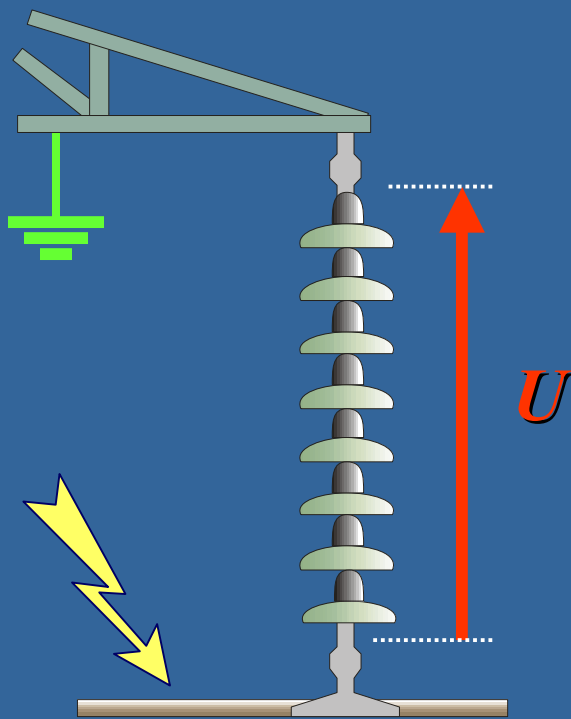
Visokonapetostna tehnika

*Izolatorska veriga pri
nadzemnih vodih*



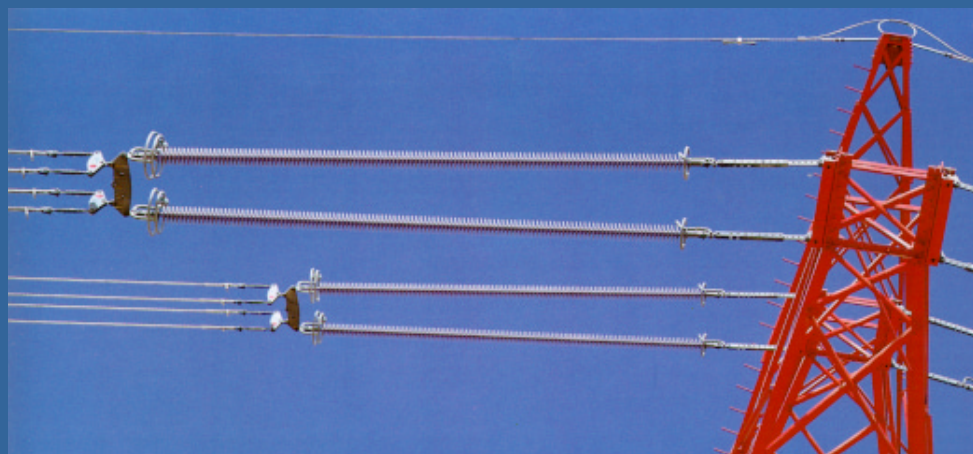
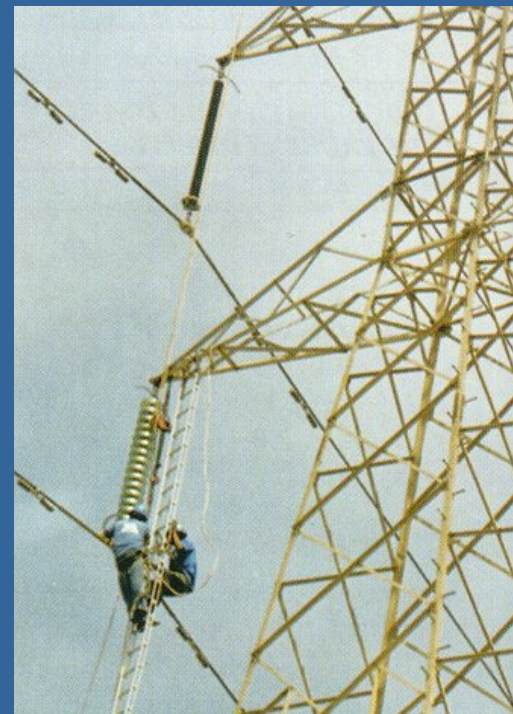
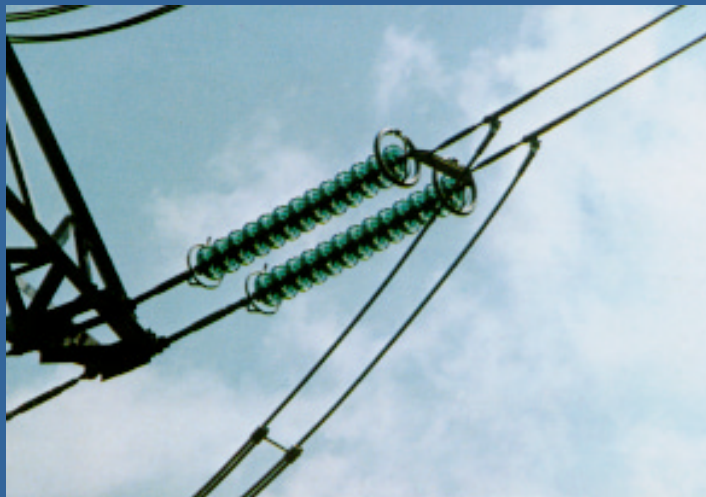
Električna energija od proizvajalcev (elektrarne) do porabnikov (mesta, industrija)

- Nadzemni vodi
- Kabli
- GIL ("gas insulated line")



Prenos velikih moči \Rightarrow

VISOKA NAPETOST



VNT



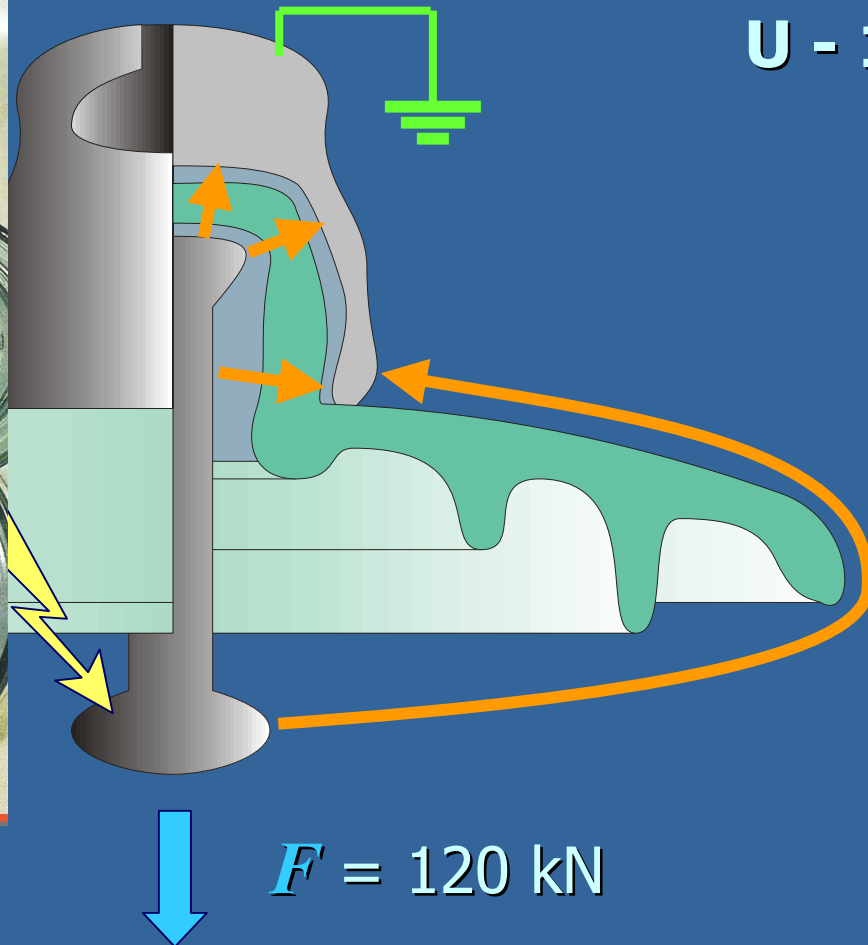
Kabli



Kapasti izolator (porcelan ali steklo)
je element izolatorske verige



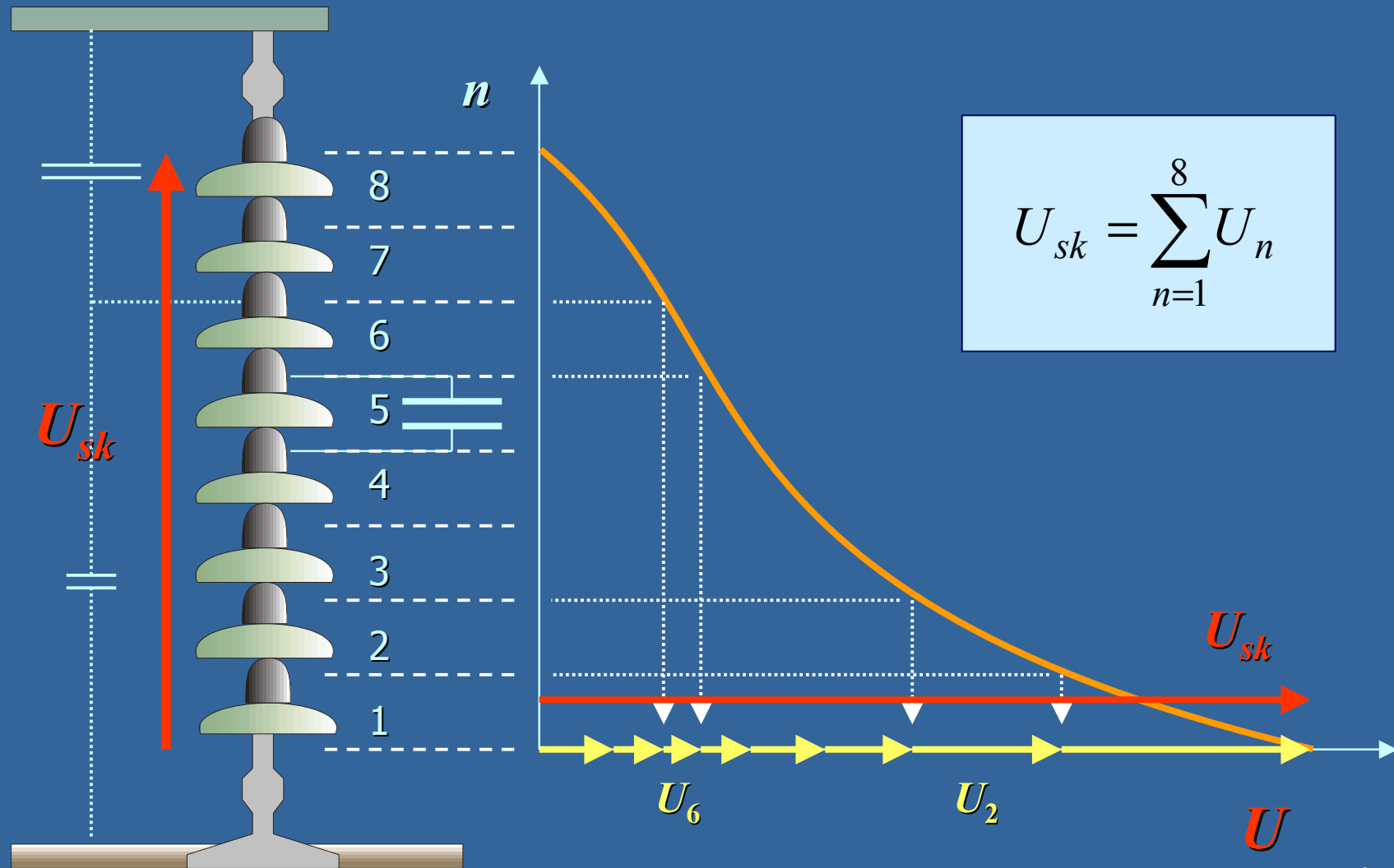
Standard IEC 60305



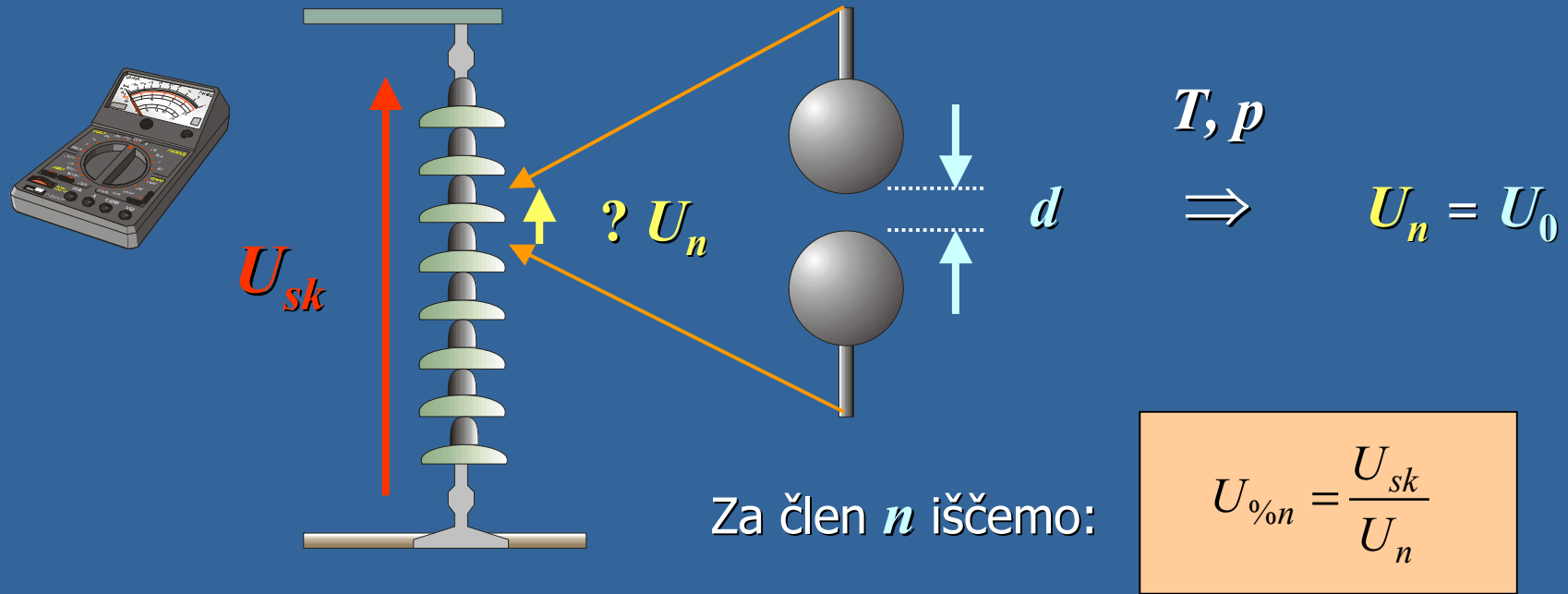
U - 120

$F = 120 \text{ kN}$

Napetost se neenakomerno porazdeli vzdolž izolatorske verige

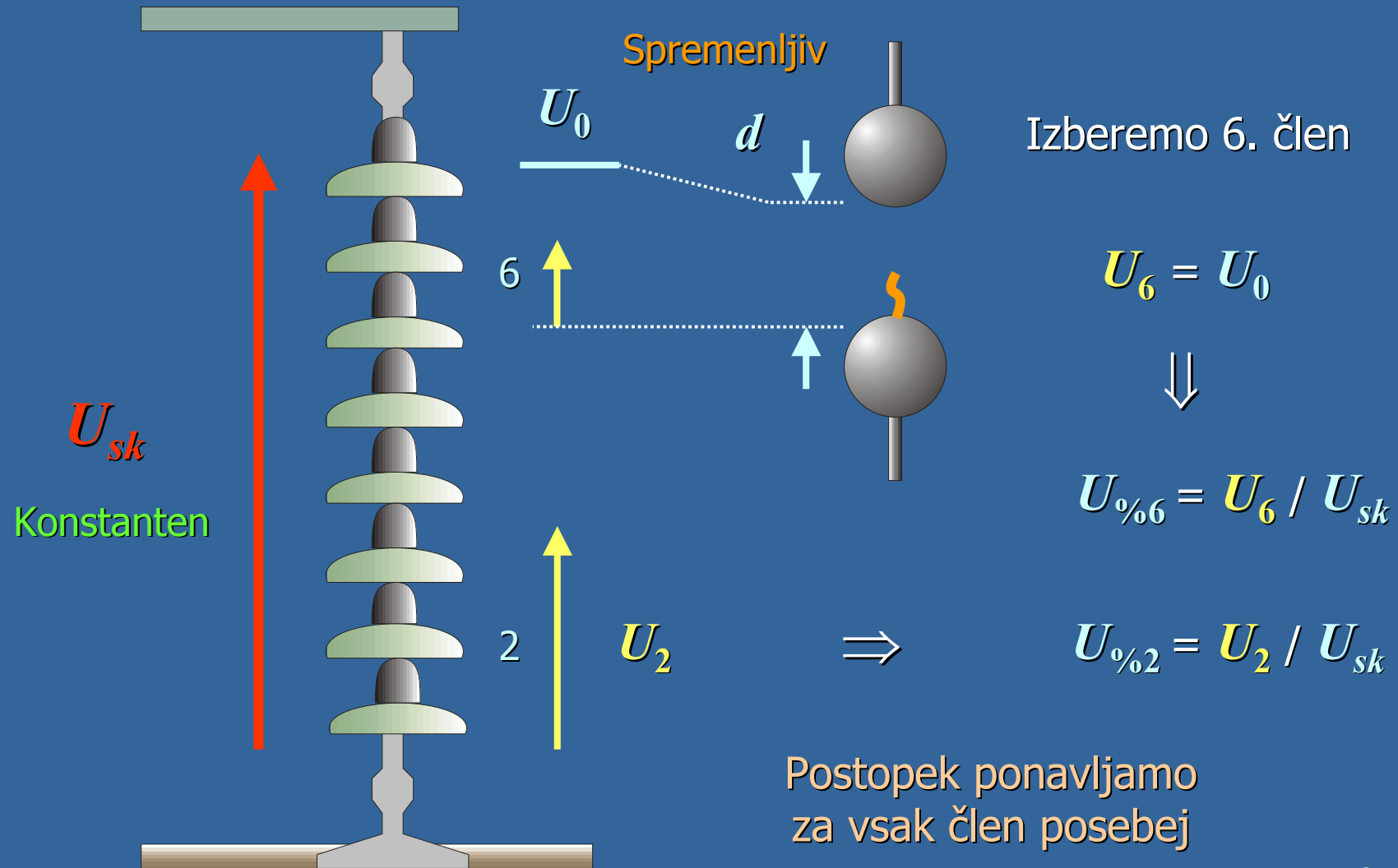


Postopek ugotavljanja porazdelitve napetosti vzdolž izolatorske verige

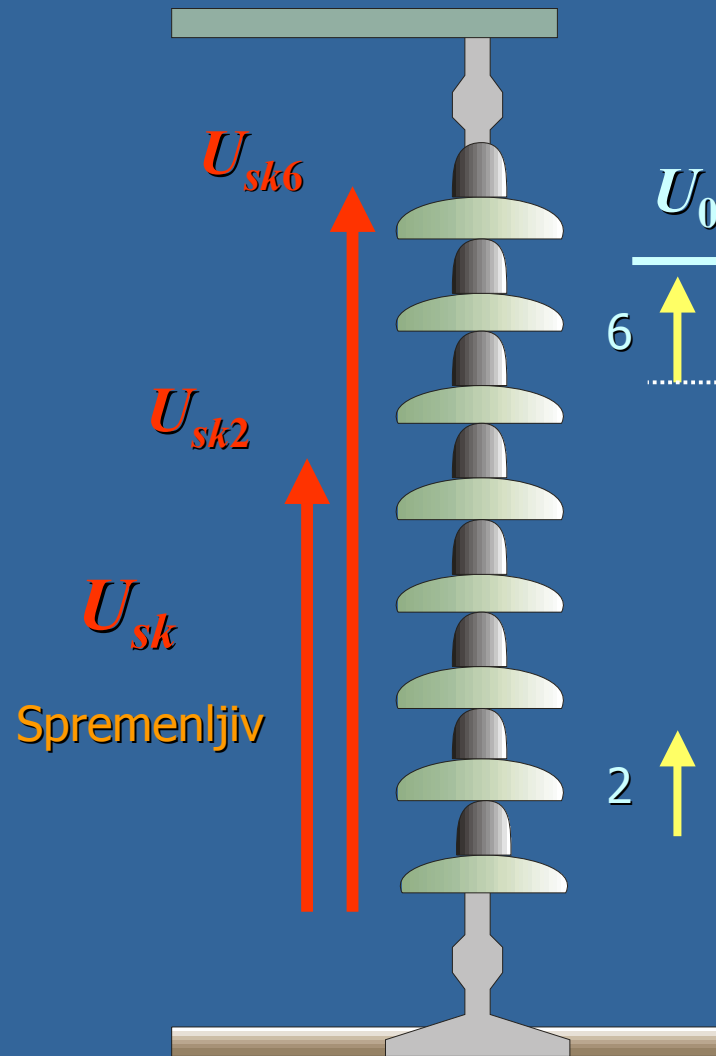


Postopek	U_{sk}	$d (U_0)$	Lastnosti
1	Konstanten	Spremenljiv	Zamuden, lahko razumljiv
2	Spremenljiv	Konstanten	Hiter, manj razumljiv

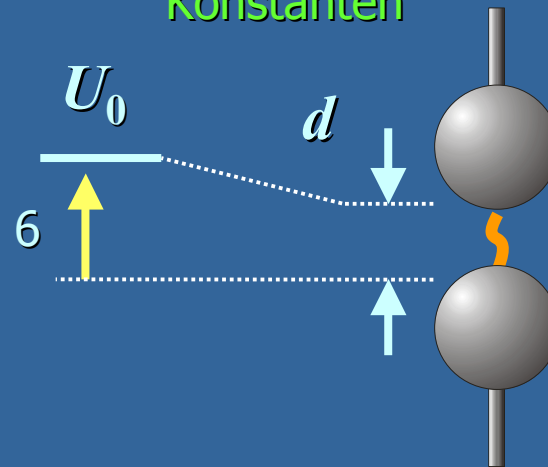
1. Postopek: dokaj zamuden, vendar nekoliko lažje razumljiv



2. Postopek: manj zamuden, vendar nekoliko težje razumljiv



Konstanten



Izberemo 6. člen

$$\Rightarrow U_{\%6} = U_0 / U_{sk6}$$

Postopek ponavljamo za vsak člen posebej

$$\S \Rightarrow U_{\%2} = U_0 / U_{sk2}$$

$$U_{sk} = \sum_{n=1}^8 U_n = U_1 + U_2 + \dots + U_8$$

 \Rightarrow

$$1 = \frac{U_1 + U_2 + \dots + U_8}{U_{sk}} =$$

$$= \frac{U_1}{U_{sk}} + \frac{U_2}{U_{sk}} + \dots + \frac{U_8}{U_{sk}} =$$

$$\cdot \frac{U_0}{U_0}$$

1. metoda

$U_{sk} = \text{konst.}$

$$= \frac{U_1}{U_{sk} U_0} \cdot U_0 + \frac{U_2}{U_{sk} U_0} \cdot U_0 + \dots + \frac{U_8}{U_{sk} U_0} \cdot U_0 =$$

$$U_{skn} = \frac{U_{sk} U_0}{U_n}$$

$$= \frac{U_0}{U_{sk1}} + \frac{U_0}{U_{sk2}} + \dots + \frac{U_0}{U_{sk8}} =$$

2. metoda

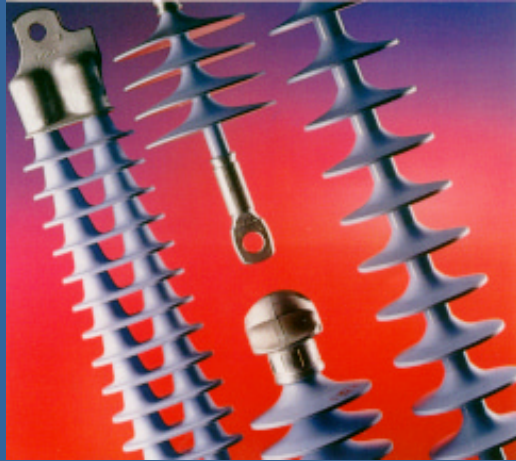
$U_0 = \text{konst.}$

$$= U_0 \left(\frac{1}{U_{sk1}} + \frac{1}{U_{sk2}} + \dots + \frac{1}{U_{sk8}} \right) = 1$$

 \Rightarrow

$$U_0 = \frac{1}{\sum_{n=1}^8 \frac{1}{U_{skn}}}$$

Kompozitni izolatorji - naslednja stopnja v tehnologiji izolatorjev



V uporabi približno 30 let

Prednosti:

- Majhna teža
- Enostavno prevažanje, nameščanje, rokovanje z njimi
- Večja dielektrična zadržnost (vodoodbojnost)
- Večja mehanska zadržnost (oblok, vandalizem)
- Zanesljivost obratovanja
- Nizki stroški vzdrževanja



Zgradba kompozitnega izolatorja

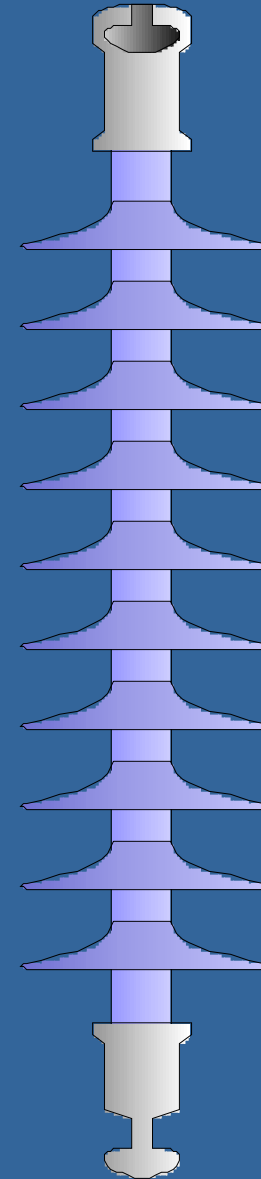


- Jedro
(steklena vlakna v polnilu)

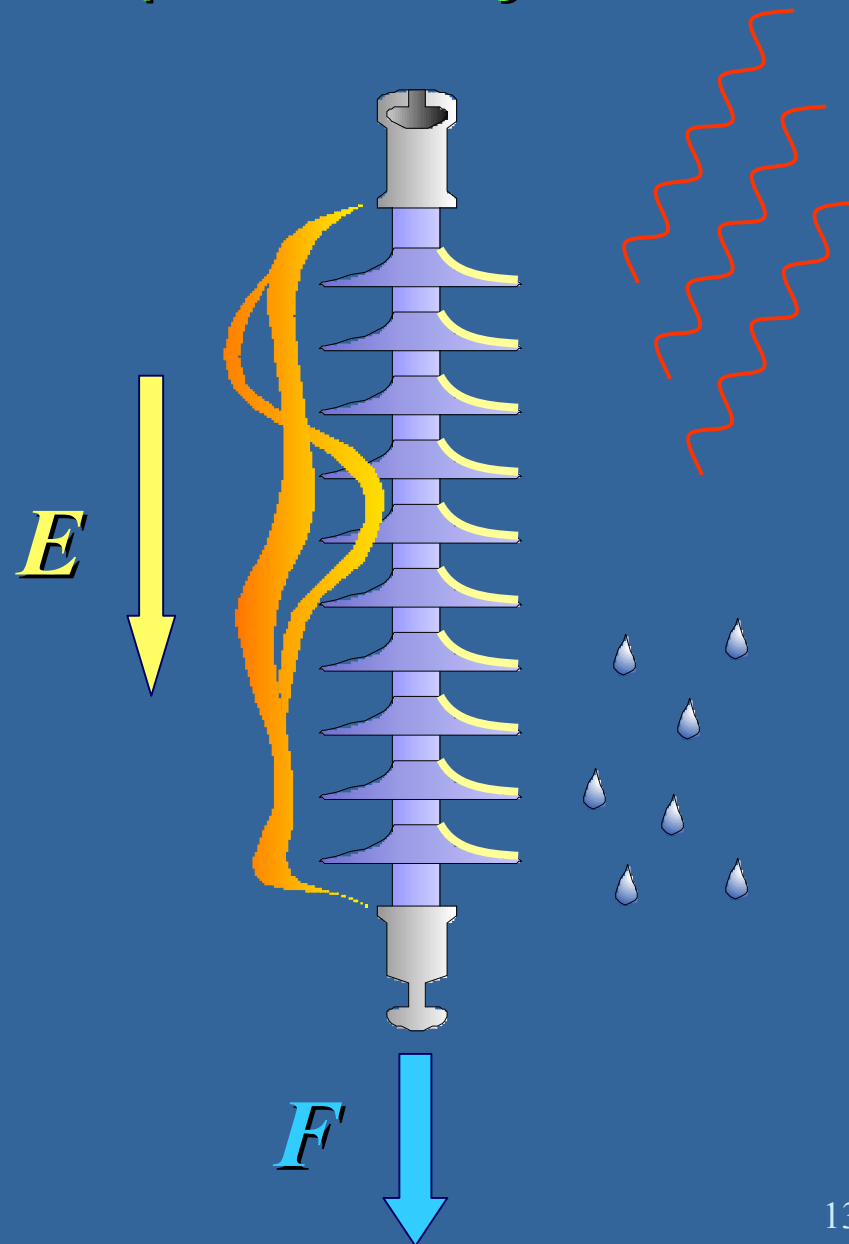


- Zaščitna obloga z obroči
(polimerni material)

- Končniki za pritrditev
(kovinski material)

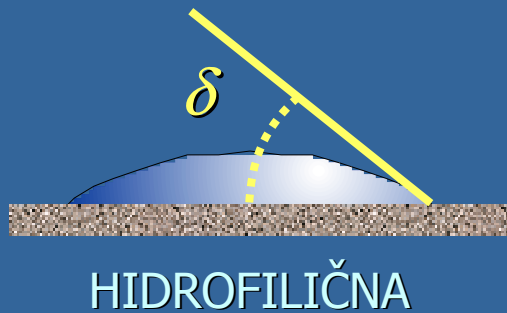
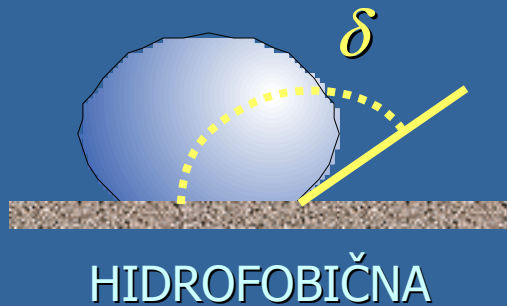


- Električno polje
- Mehanske sile
- Onesnaženje
- Vlaga
- UV žarki
- Oblak



Dobra lastnost polimerne obloge je vodoodbojnost (hidrofobičnost)

Površina izolatorja



Materiala za oblogo:

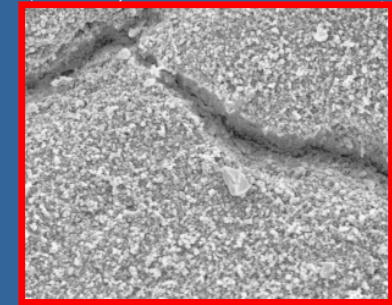
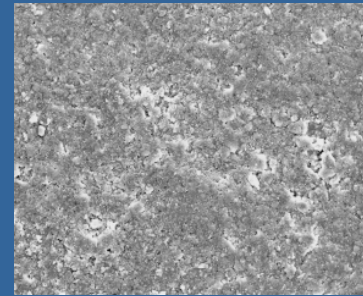
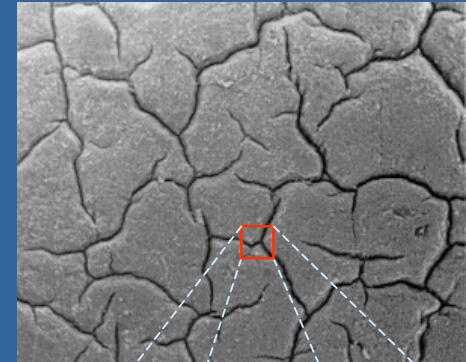
EPDM

Silikonska guma

Staranje polimerne obloge (organski materiali)

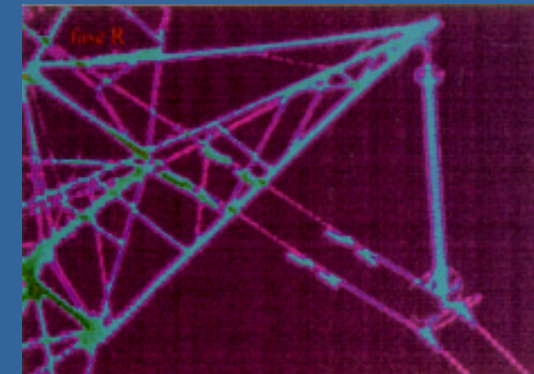
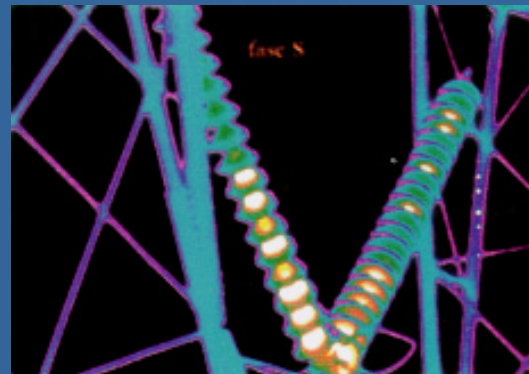


10 μm



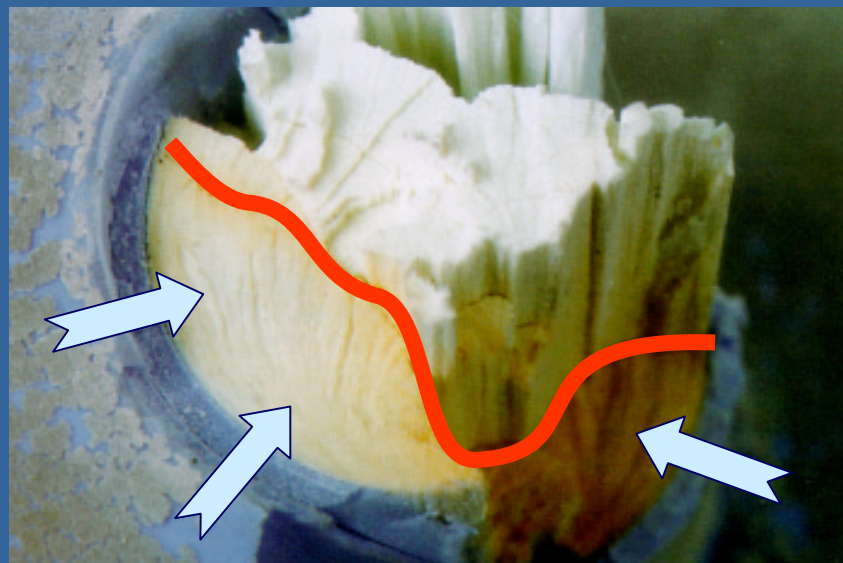
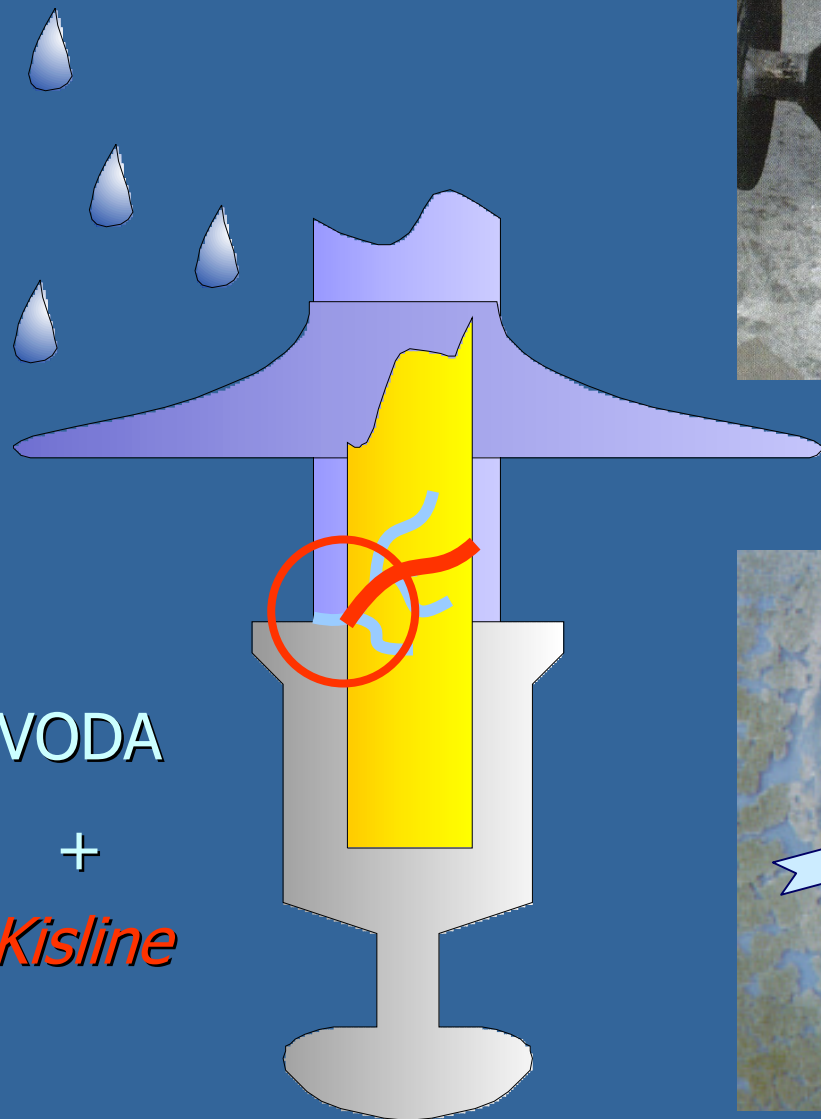
Silikonska guma

EPDM



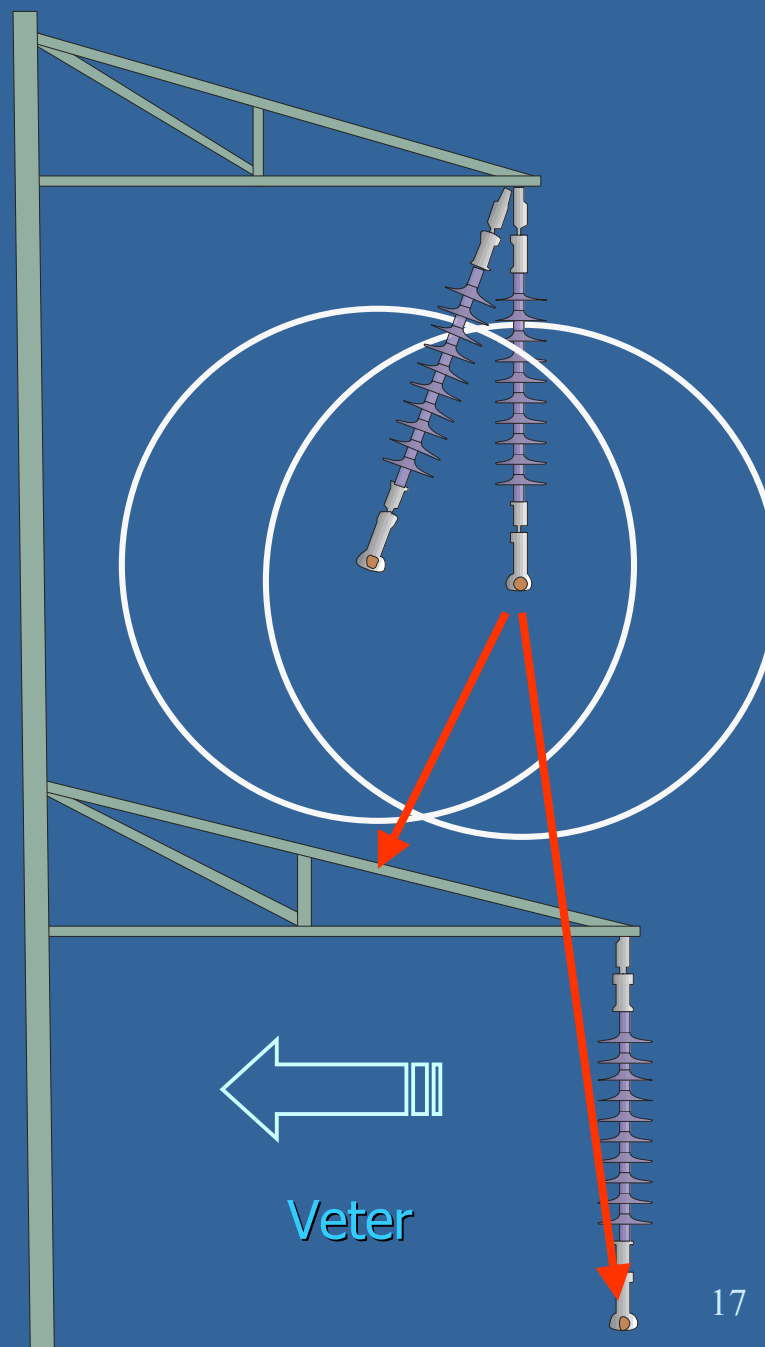
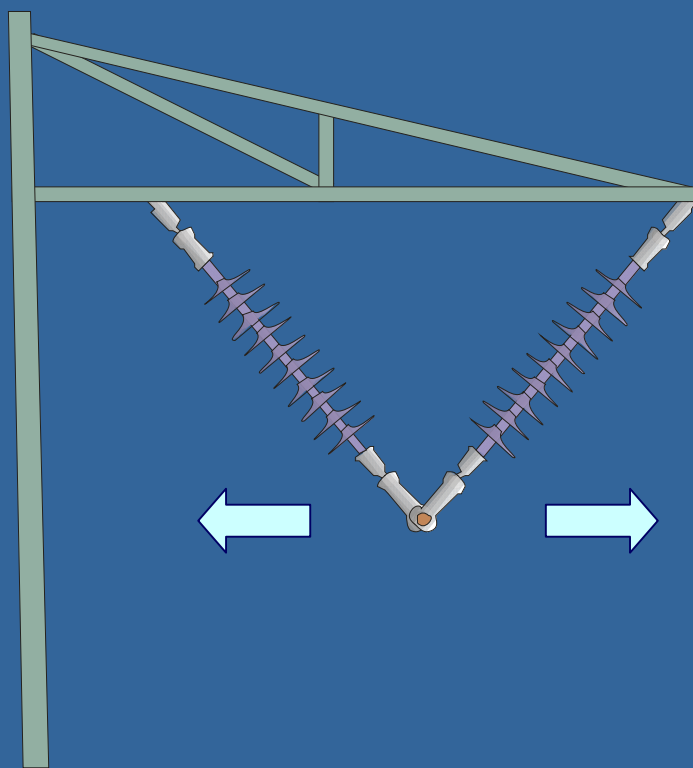
VNT

Nevarnost - krhi lom



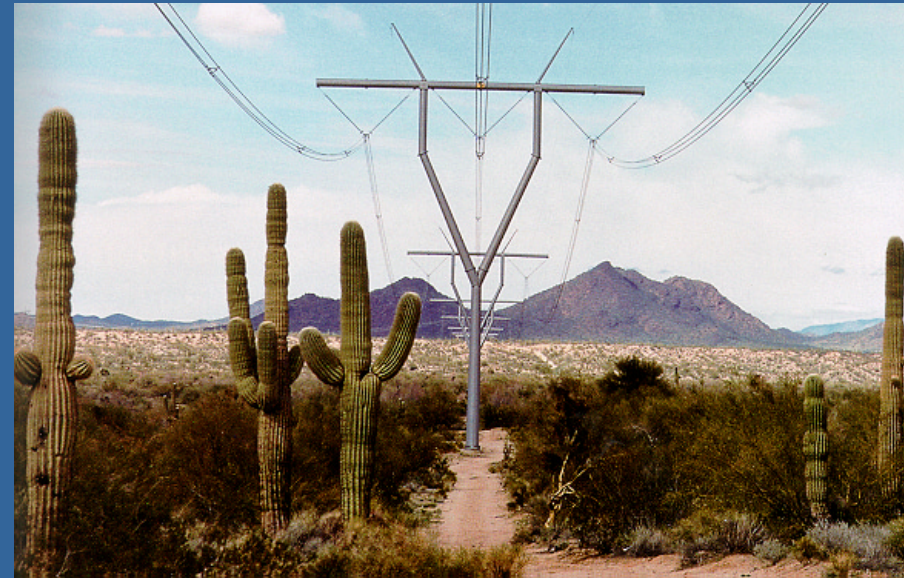
Viseče obešanje

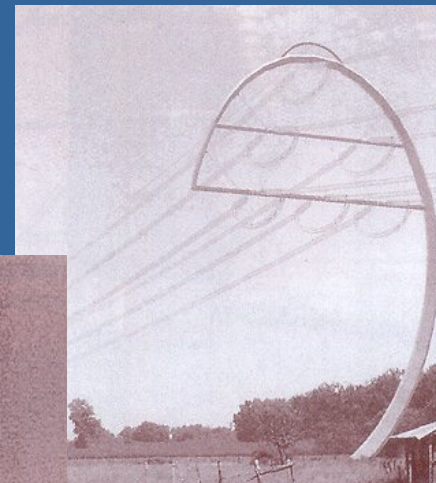
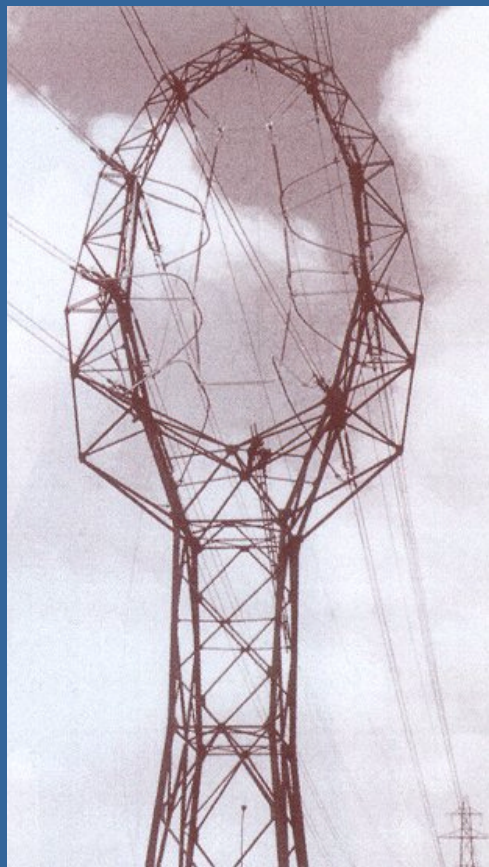
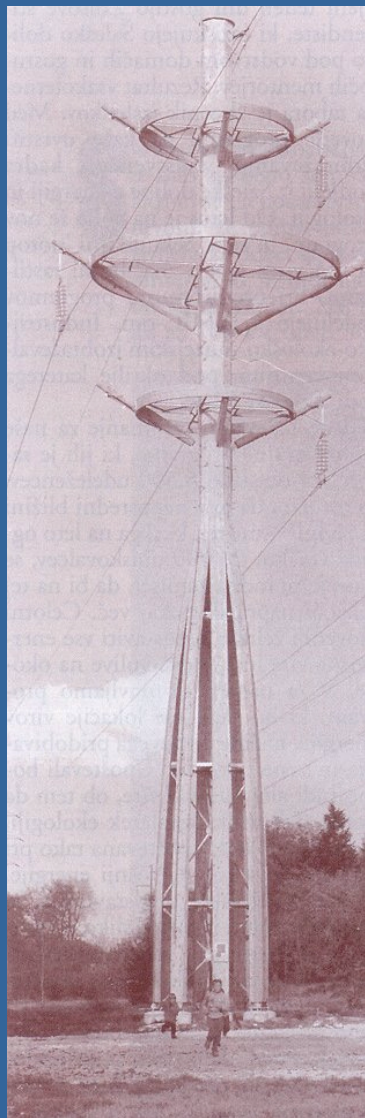
V obliki črke "V"
(dva izolatorja)



VNT

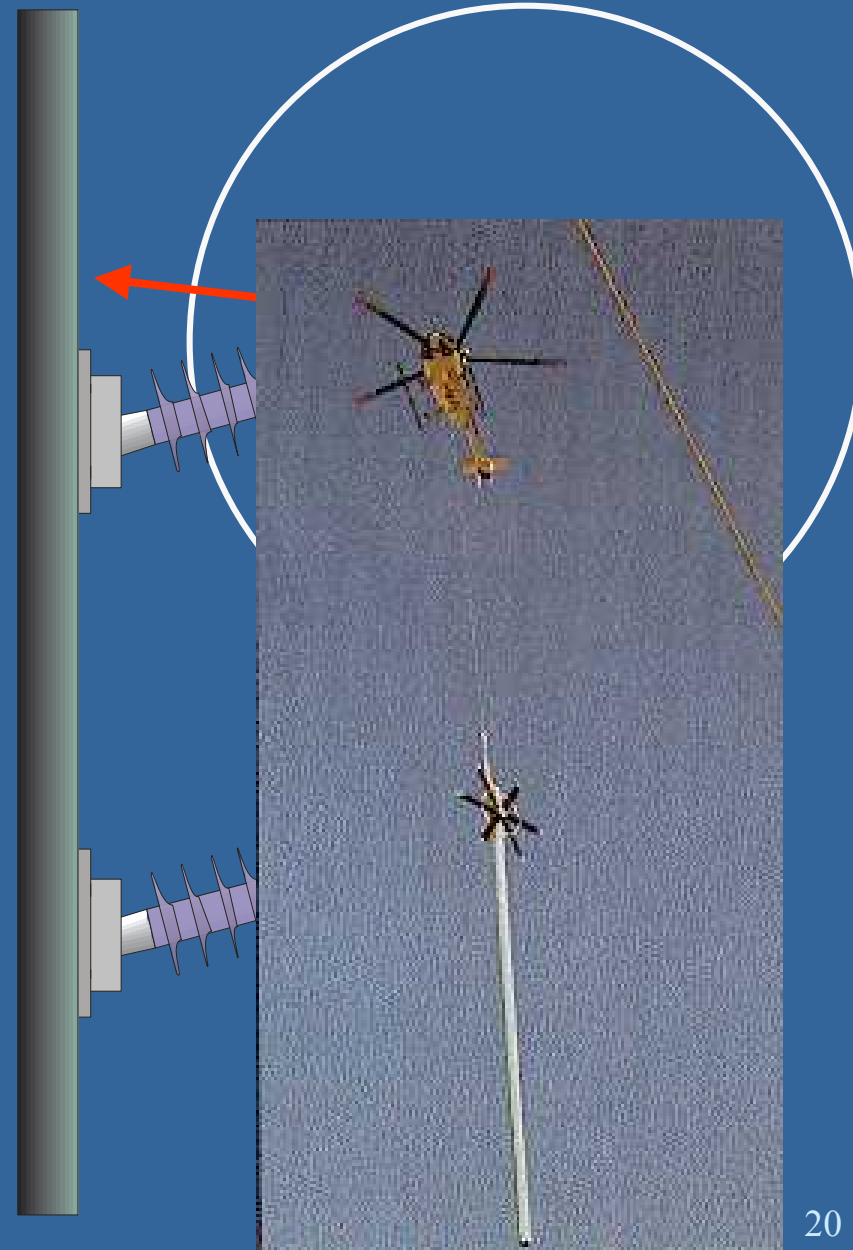
Nadzemni vodi z visečimi izolatorji





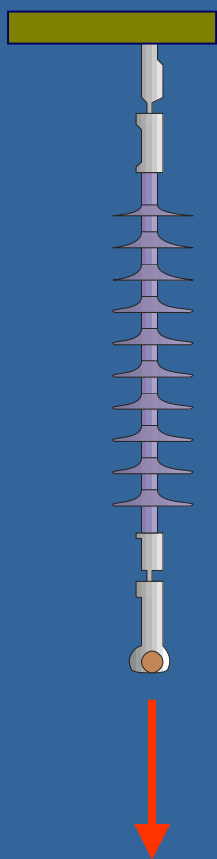
Prednosti:

- Estetski vpliv na okolje
- Zmanjšanje razdalj med vodniki
 - Možnost nadgraditve na višji napetostni nivo (obstoječe trase)
 - Zmanjšan vpliv na okolje (elektromagnetna polja)
 - Večja odpornost proti atmosferskim prenapetostim
 - Poenostavljena izgradnja daljnovodov (že sestavljeni stebri)

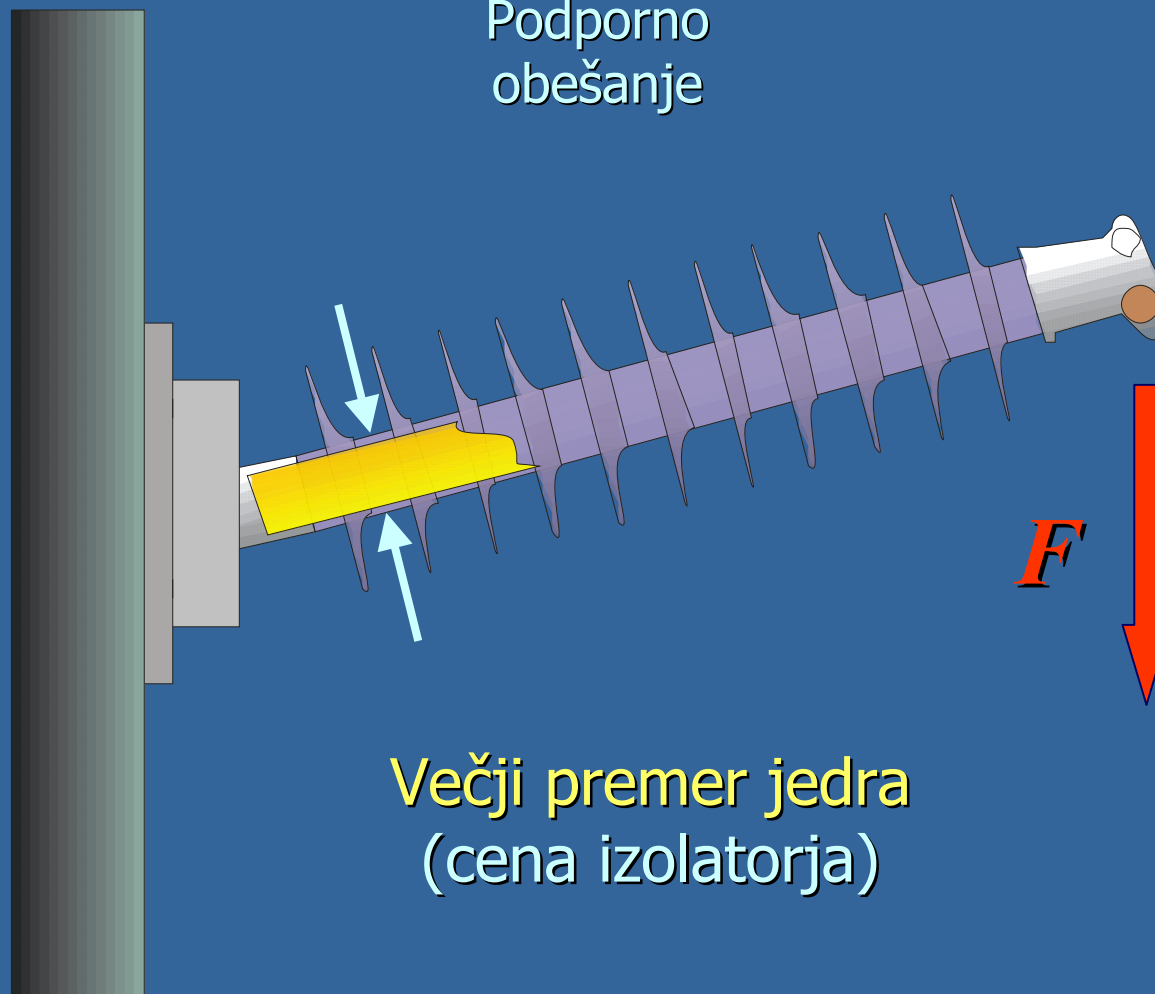


Delovanje sil na podpornih izolatorjih (konzolne obremenitve)

Viseče
obešanje



Podporno
obešanje



Večji premer jedra
(cena izolatorja)

Podporno obešanje z dvema izolatorjema za največje obremenitve

Zateva za izolator

Viseče obešanje

$$F = 120 \text{ kN}$$

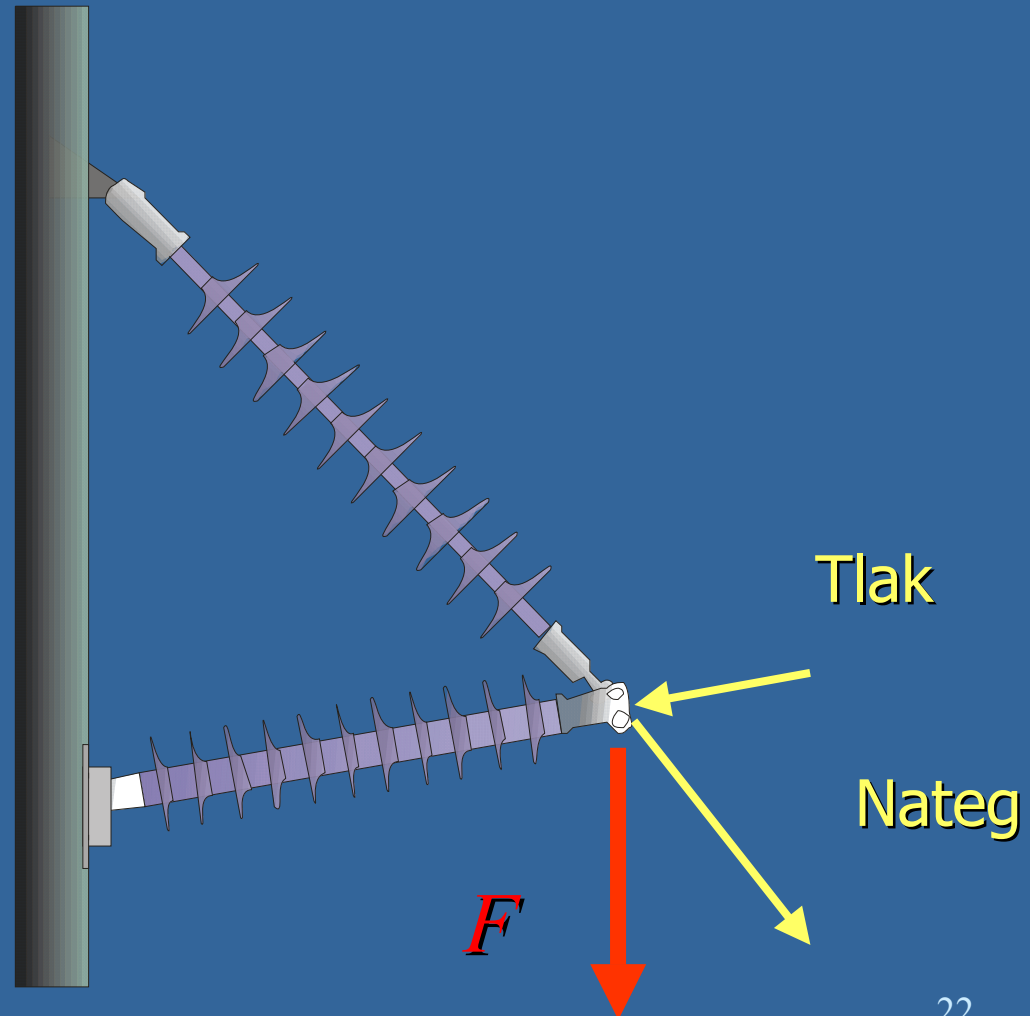
Podporno obešanje

1 izolator: $< 20 \% F$

110 kV

2 izolatorja: $< 80 \% F$

400 kV

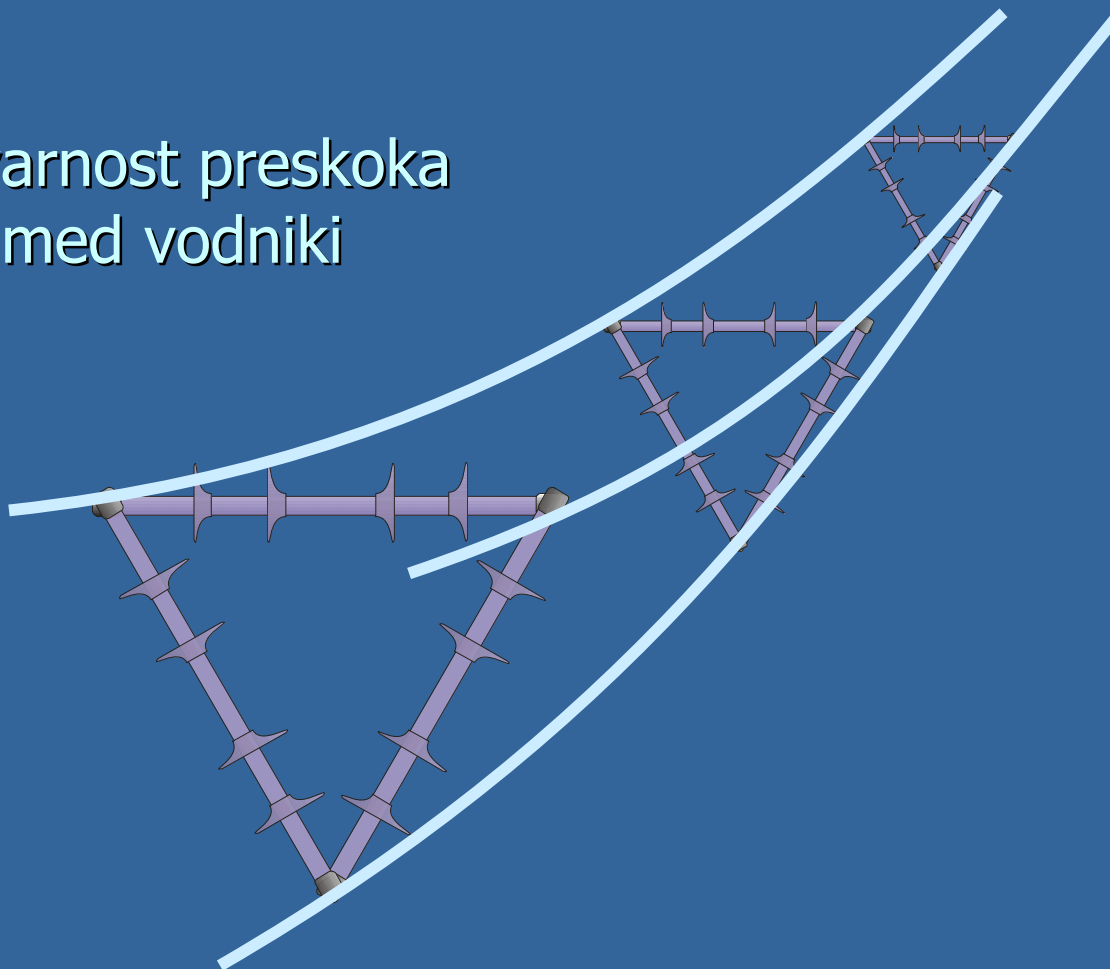
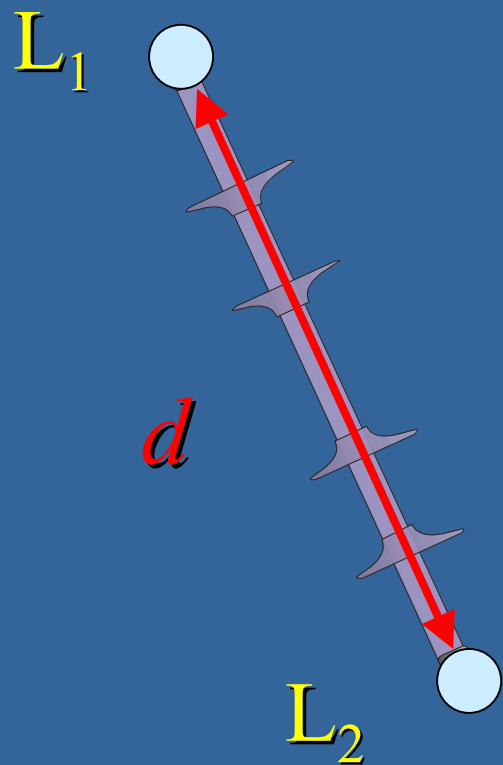


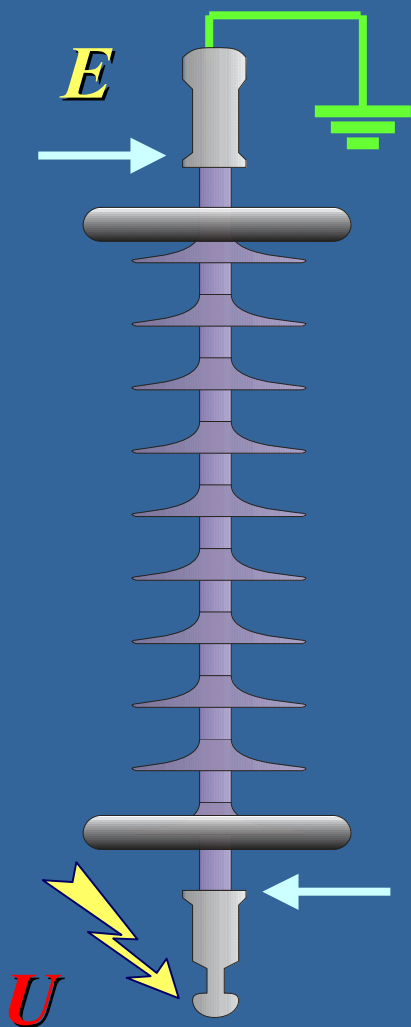
Nadzemni vodi s podpornim obežanjem vodnikov



Z zmanjšanjem razdalj med vodniki izvedemo kompaktiranje vodov

Nevarnost preskoka med vodniki





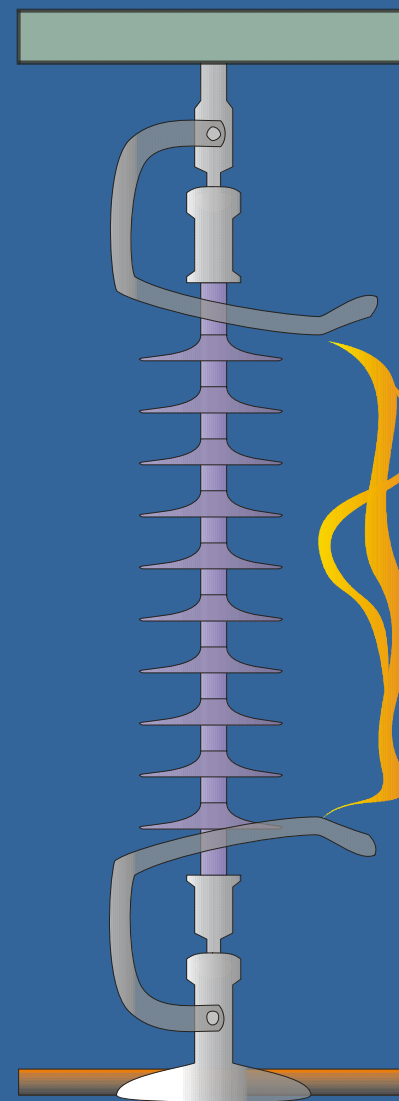
Obroči z
potencia

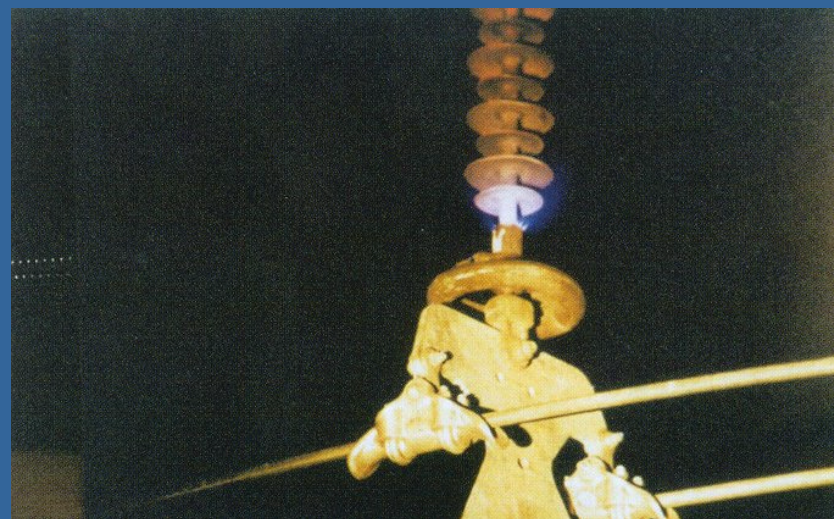
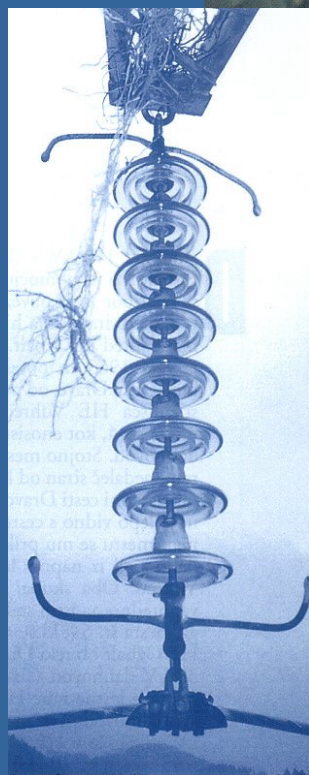
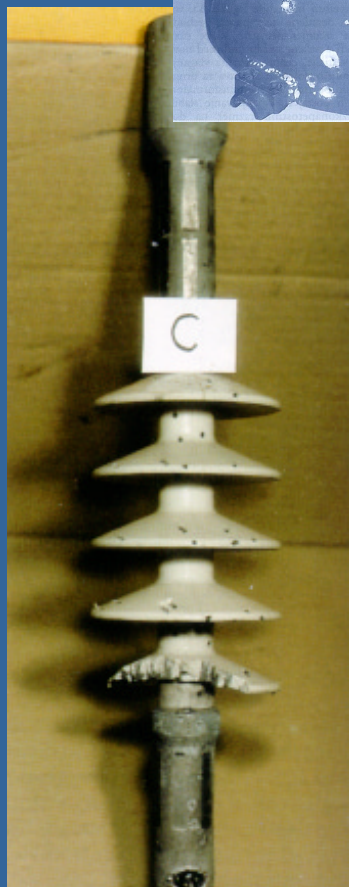
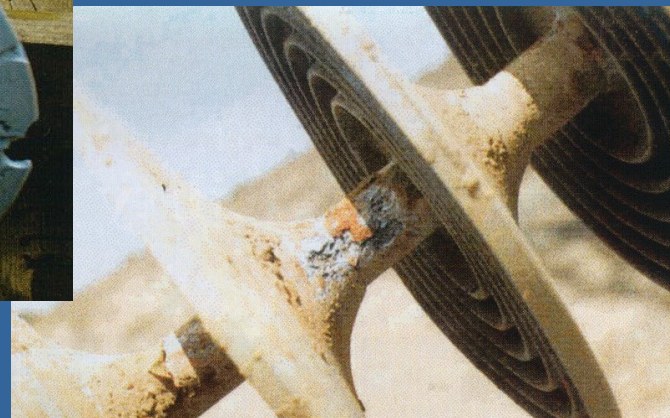
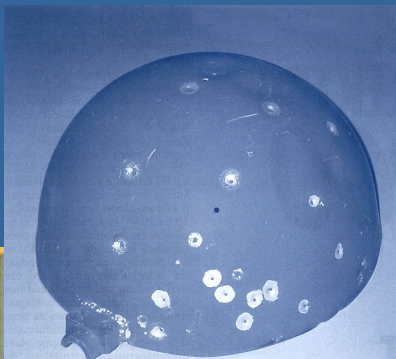
- 110 kV
(brez obroč p
- 220 kV
(obroč p
- 400 kV
(obroč n



Zaščitni rogljiči

- Odmik oblaka
- Omejevanje prenapetosti







Niskonapetostno
omrežje

