Pertemuan - 2

Transmisi dan Distribusi

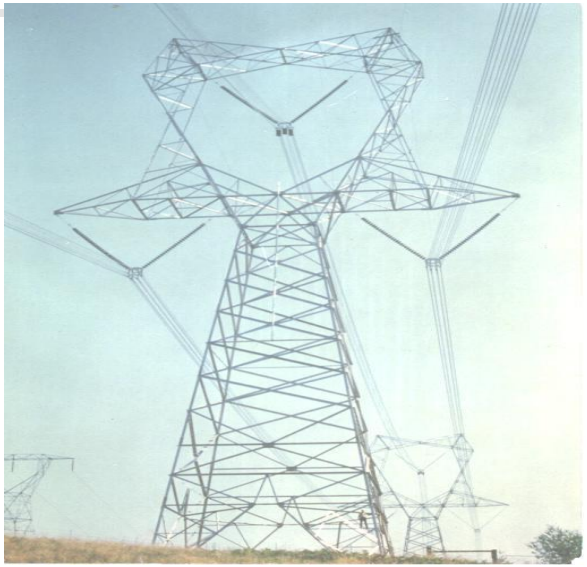
- Cek Tugas?
- Responsi

Sistem Tegangan

- Tegangan Phasa – Netral
- Tegangan Phasa – Phasa

Umum :

- Tegangan rendah ≤ 1 kV
- Tegangan tinggi > 1 kV



	Tegangan Rendah	Tegangan Menengah	Tegangan Tinggi
Phasa- netral	≤ 600 V	≤ 12 kV	> 12 kV
Phasa-phasa	≤ 1000 V	≤ 20 kV	> 20 kV

Sistem Tegangan

Tegangan tinggi

Tegangan tinggi : Kurang dari 220 kV/230 kV
Tegangan ekstra tinggi : 220(230)– 765 kV
Tegangan ultra tinggi : lebih besar 765 kV

Transmisi untuk setiap negara berbeda.
Hal ini tergantung dari :

1. Kemajuan teknologi/teknik
2. Tegangan Transmisi
3. Daya yang disalurkan
4. Jarak penyaluran

SISTEM TEGANGAN ULTRA TINGGI

Dipakai di :

- U S A
- U S S R
- ITALIA
- JEPANG
- dll

Tegangan tinggi di Indonesia

Teg. Sistem	30 kV	66 kV	110 kV	150 kV	220 kV	380 kV	500 kV
Kelengkapan	36 kV	72.5 kV	123 kV	170 kV	245 kV	420 kV	525 kV

Rekomendasi IEC (International Elektrotechnical Comitee),

Penerapan tegangan ultra tinggi (UHV)

1. BPA (Bonnielle Power Administration) 1100 kV, 4 x 400 km, 40 GWH
2. AEP (American Electric Power) 1500 kV
3. USSR 1100 kV, 1200 – 1600 km
4. Italia 1050 kV
5. Jepang (CPC/ Central Power Councill) 1000 kV

LEVEL TEGANGAN DI PLN

No	Tegangan (KV)	Kelompok tegangan
1.	500	Tegangan Ekstra Tinggi
2.	150	Tegangan Tinggi
3.	70	Tegangan Tinggi
4.	30	Tegangan Tinggi
5.	20	Tegangan Menengah
6.	12	Tegangan Menengah
7.	6	Tegangan Menengah
8.	0,22/0,38	Tegangan Rendah

Pemilihan Tegangan Transmisi

Seiring meningkatnya daya penyaluran dan jarak, maka tegangan penyaluran transmisi :

High Voltage $\Rightarrow$ Ekstra High Voltage $\Rightarrow$ Ultra High Voltage

Hal ini disebabkan karena semakin panjang saluran berarti :

1. Impedansi makin besar
2. pengaturan tegangan makin besar
3. Rugi-rugi makin besar
4. Sudut pergeseran antara sisi terima dan sisi kirim makin besar
5. Derajat kestabilan makin besar

Solusi :

Dengan mempertinggi tegangan, didapatkan :

1. Drop tegangan makin kecil
2. penghematan pemakaian konduktor
3. Effisiensi $\Rightarrow$ Kerapatan arus konstant sehingga effisiensi makin tinggi.

Jika dianalisa dari sistem kestabilan :

1. Stabilitas sistem lebih baik
2. Fleksibilitas operasi semakin baik
3. Untuk mengakomodasi perkembanan beban

Pemilihan tegangan transmisi yang ekonomis, menurut "Niesthammer" adalah :

$$V = 0.3\sqrt{Pb \; + \; 0.5l}$$

V , Tegangan dlm KV

Pb, Daya yang disalurkan dlm KW

l , Panjang saluran dlm km

Daya yang disalurkan

$$Pb = k \frac{V^2}{1000\,L}$$

Pb, daya dlm MW

V, tegangan transmissi dlm KV

L, panjang saluran dlm km

k, konstanta , 600 untuk 70 KV

800 untuk ~~150~~ KV

Kapasitas Penyaluran Sebagai Fungsi Tegangan

No	Tegangan Transmisi (kV)	Kapasitas Penyaluran Rangkaian Tunggal (MW)
1	765	2500 - 3000
2	1100	4000 - 6500
3	1300	7000 - 10000

Saluran Transmissi

Saluran Transmisi

- **Saluran Udara (Overhead Line)**
- **Saluran Bawah Tanah (Under ground)**

Saluran Udara :

- **Sistem lebih murah**
- **Cara penyambungan mudah**
- **Mudah untuk mencari gangguan**
- **Memerlukan tempat yang luas**
- **Faktor keamanan lebih tinggi**
- **Lebih mudah terkena ganguan**

Saluran Bawah tanah / Kabel

- Investasi lebih mahal
- Penyambungan lebih sulit
- Sulit mencari lokasi ganggguan
- Tidak terpengaruh cuaca
- Estetika / keindahan
- Kapasitas elektro statis lebih besar

Parameter – parameter Saluran

- Tahanan (R)
- Induktansi (L)
- Capasitansi (C)
- Konduktansi bocor (G)

→ persatuan panjang → salurannya panjang dan tak uniform

Komponen – Komponen Utama saluran Transmisi

- Menara / Tiang Transmisi
- Isolator
- Kawat penghantar
- Kawat tanah (Ground Wire

JENIS-JENIS TOWER

Menurut Bahannya

- **Tiang baja:**
  1. **Latice**
  2. **Pole**
- **Tiang Beton**
- **Tiang Kayu**

JENIS-JENIS TOWER

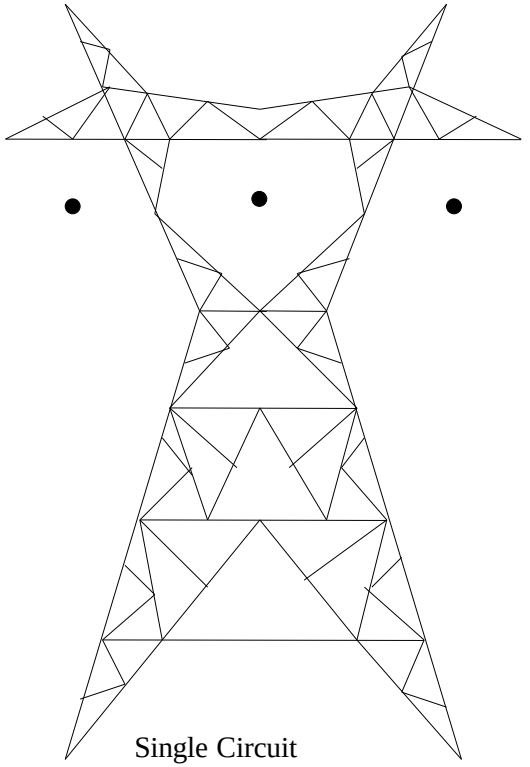
Menurut Penempatannya

- **Tension Tower :**
  1. **Angle**
  2. **Section**
- **SuspensionTower**
- **Terminal Tower**

JENIS-JENIS TOWER

Tinggi Tower

- **500 kV : 70 M**
- **150 kV : 48 M**
- **70 kV : 35 M**
- **30 kV : 28 M**

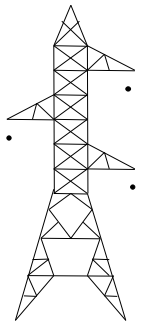


Single Circuit
Double Earth Wire

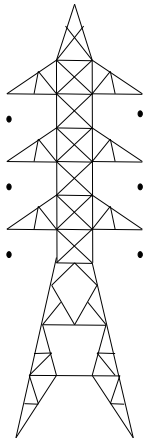
JENIS-JENIS TOWER

1. **Triangle Arrangement (Single Circuit 3 phasa 1 earth wire)**
2. **Delta (Horisontal Arrangement) Single circuit 3 phasa 2 earth wire.**
3. **Piramide (Vertical Arrangement) Double circuit (2 X 3 phasa) 1 earth wire.**
4. **Piramide (Vertical Arrangement) Double circuit (2 X 3 phasa) 2 earth wire.**

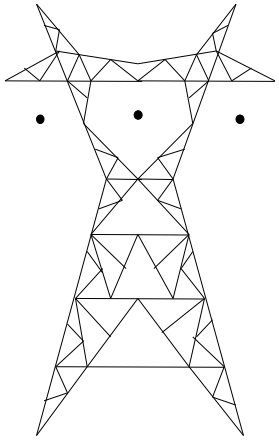
1.



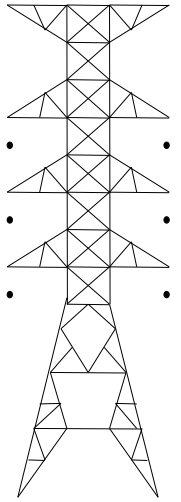
3.



2.



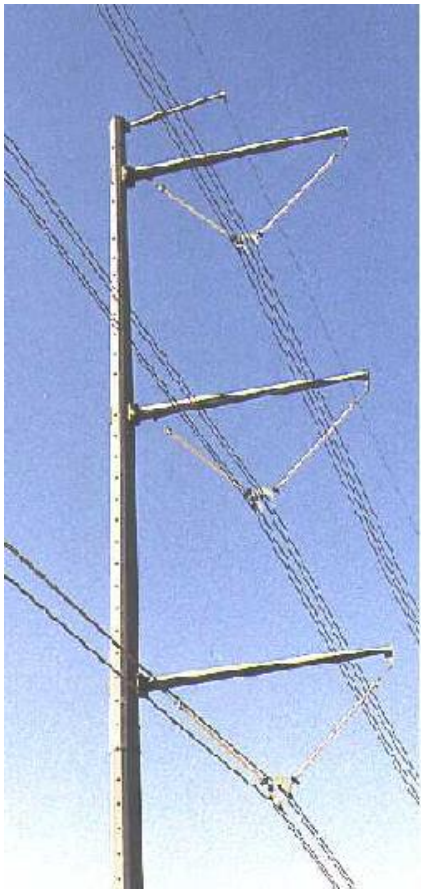
4.

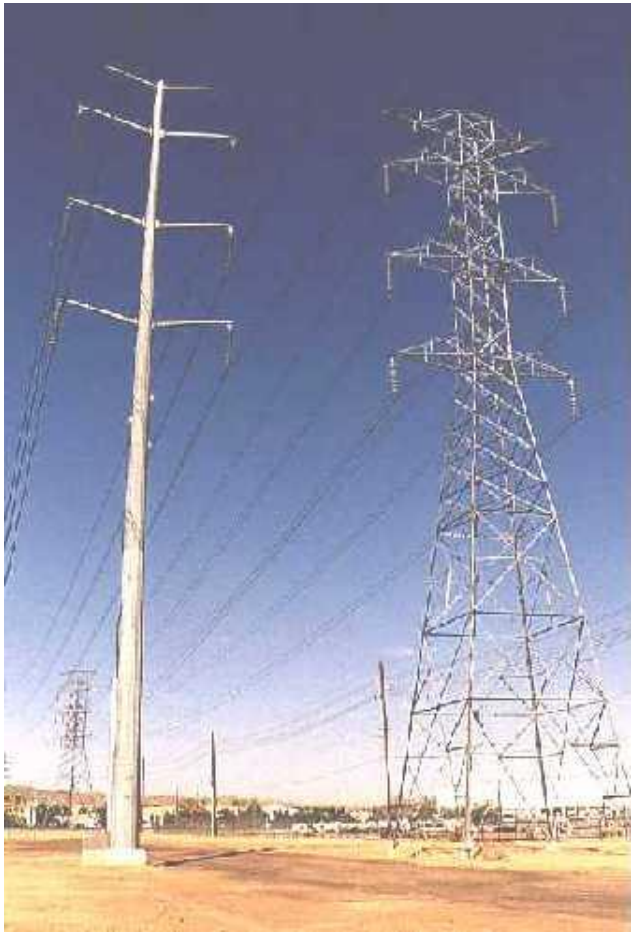


1 Million Volt Transmission Line (Courtesy:BPA /Jeff Mechenbier)

TRANSMISSION LINE

220kV





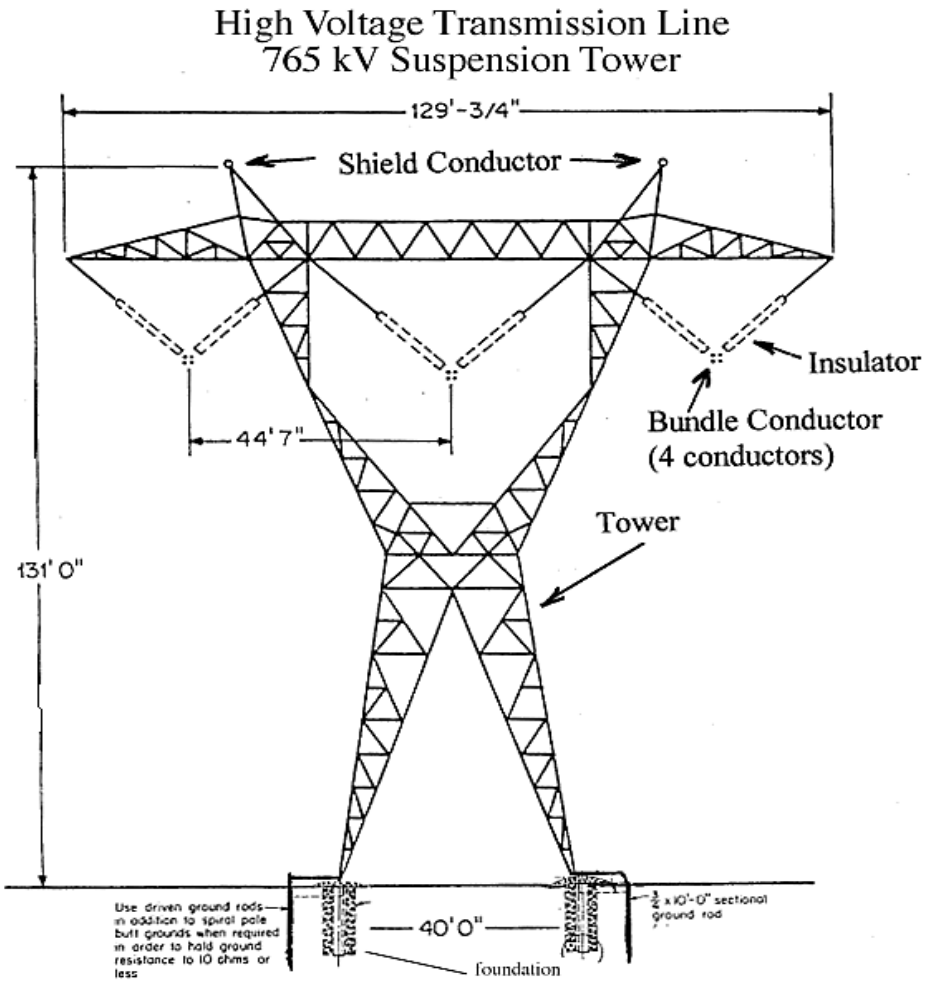
TRANSMISSION LINE

Construction

The major components are:

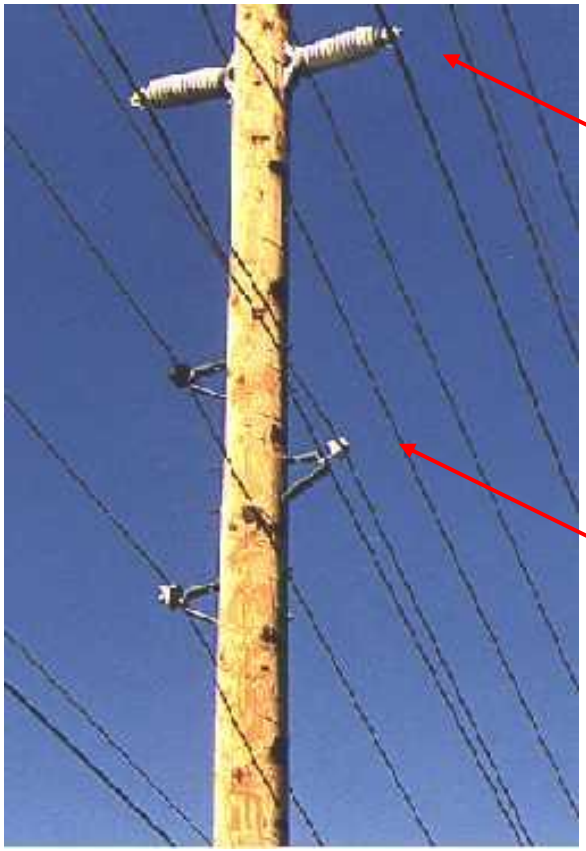
- **Shield conductors for lightning**
- **protection. (When necessary)**
- **Tower (lattice or tubular)**
- **Phase conductors**
- **Insulators (V string shown)**
- **Foundation and grounding**

Typical Extra High Voltage Line



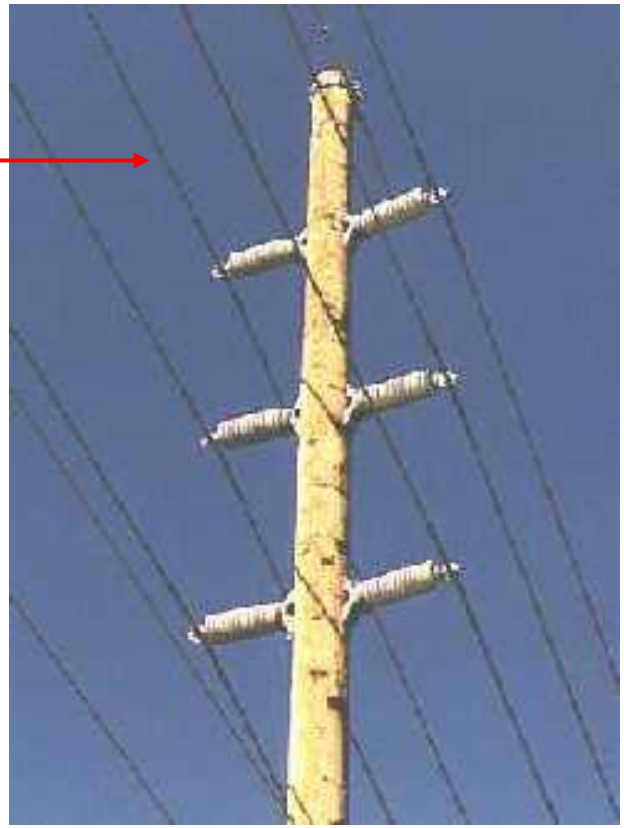
TRANSMISSION LINE

69 and 13.8kV

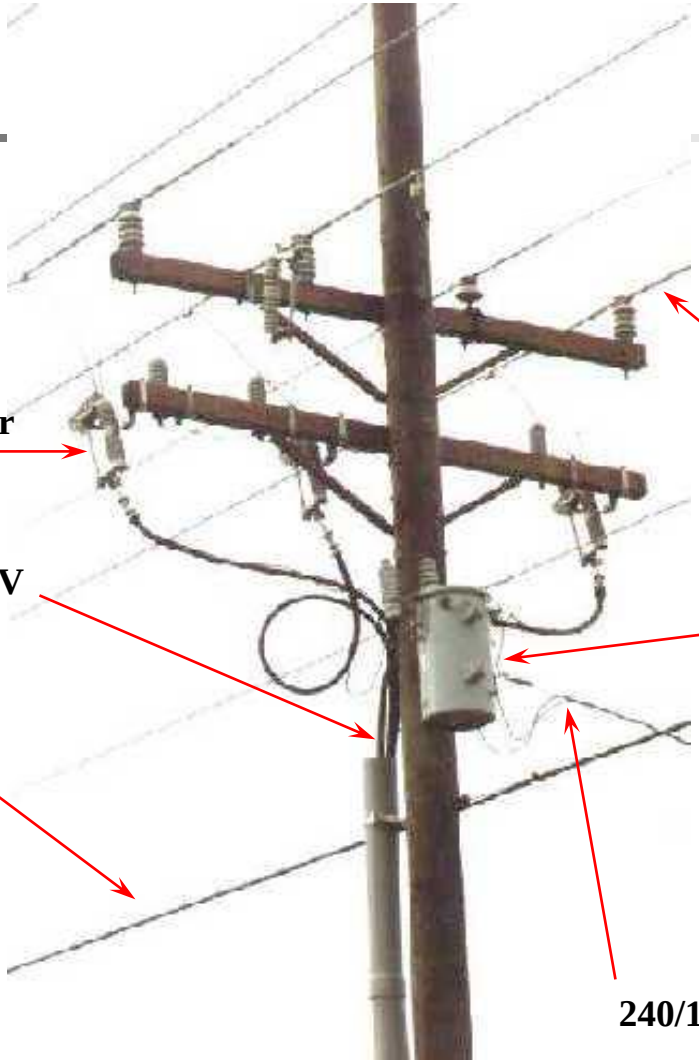


69kV

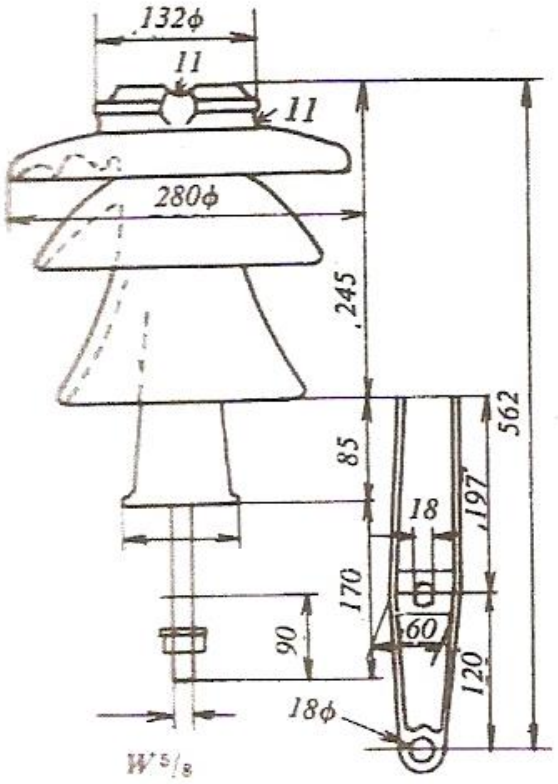
13.8kVkV

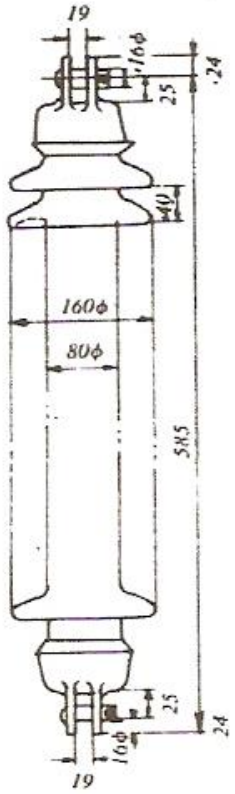


Distribution line and Transformer

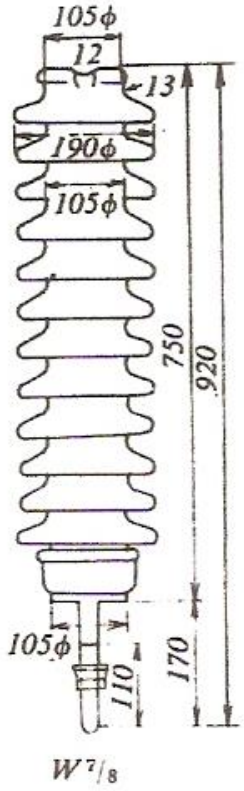


Isolator





(LC-8010)



(LP-60)

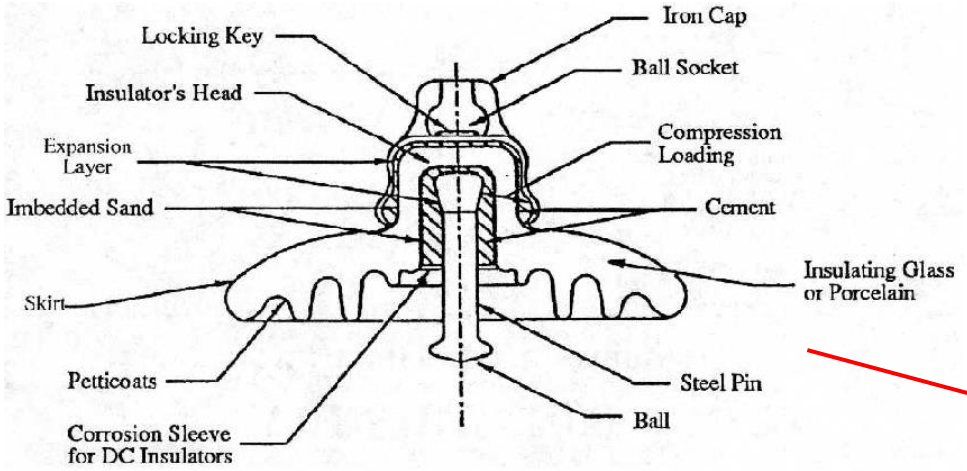
isolator pin

long rod

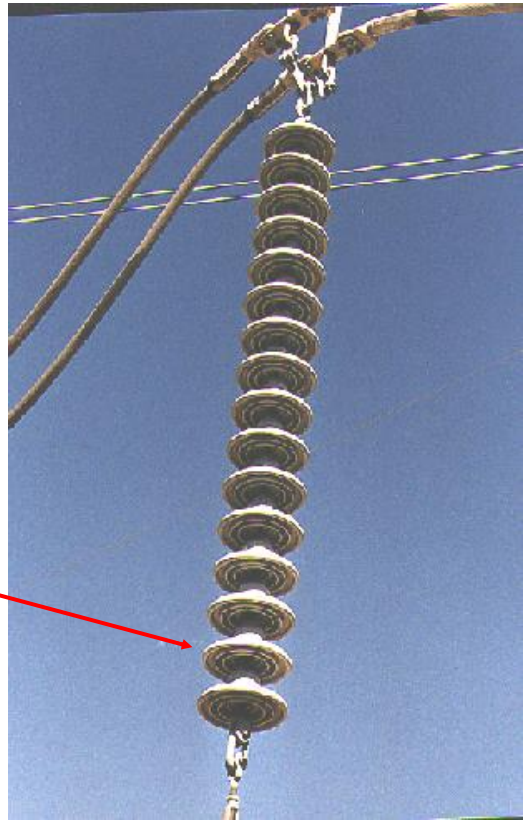
line post

Isolator

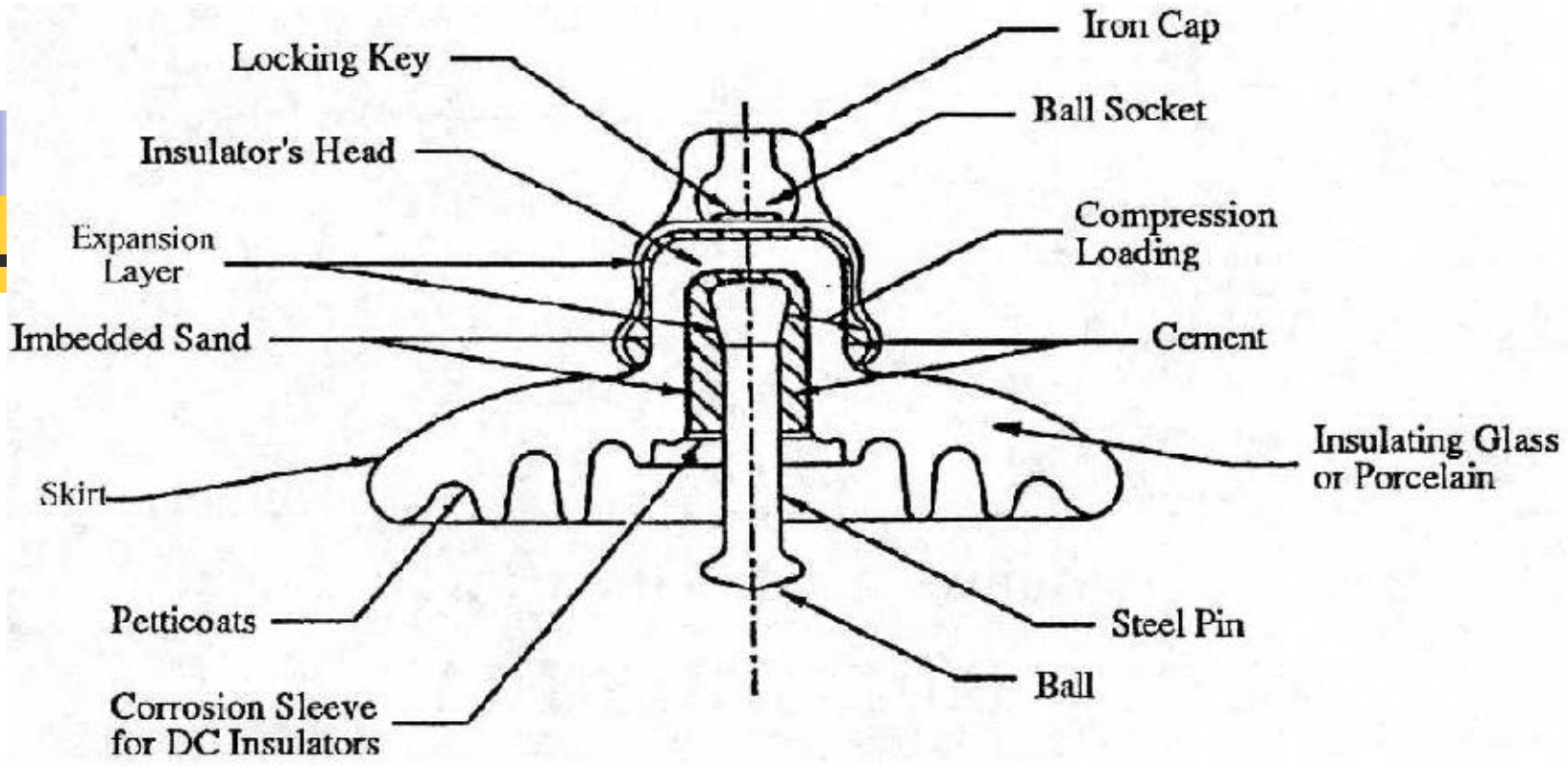
Cup and pin Insulator



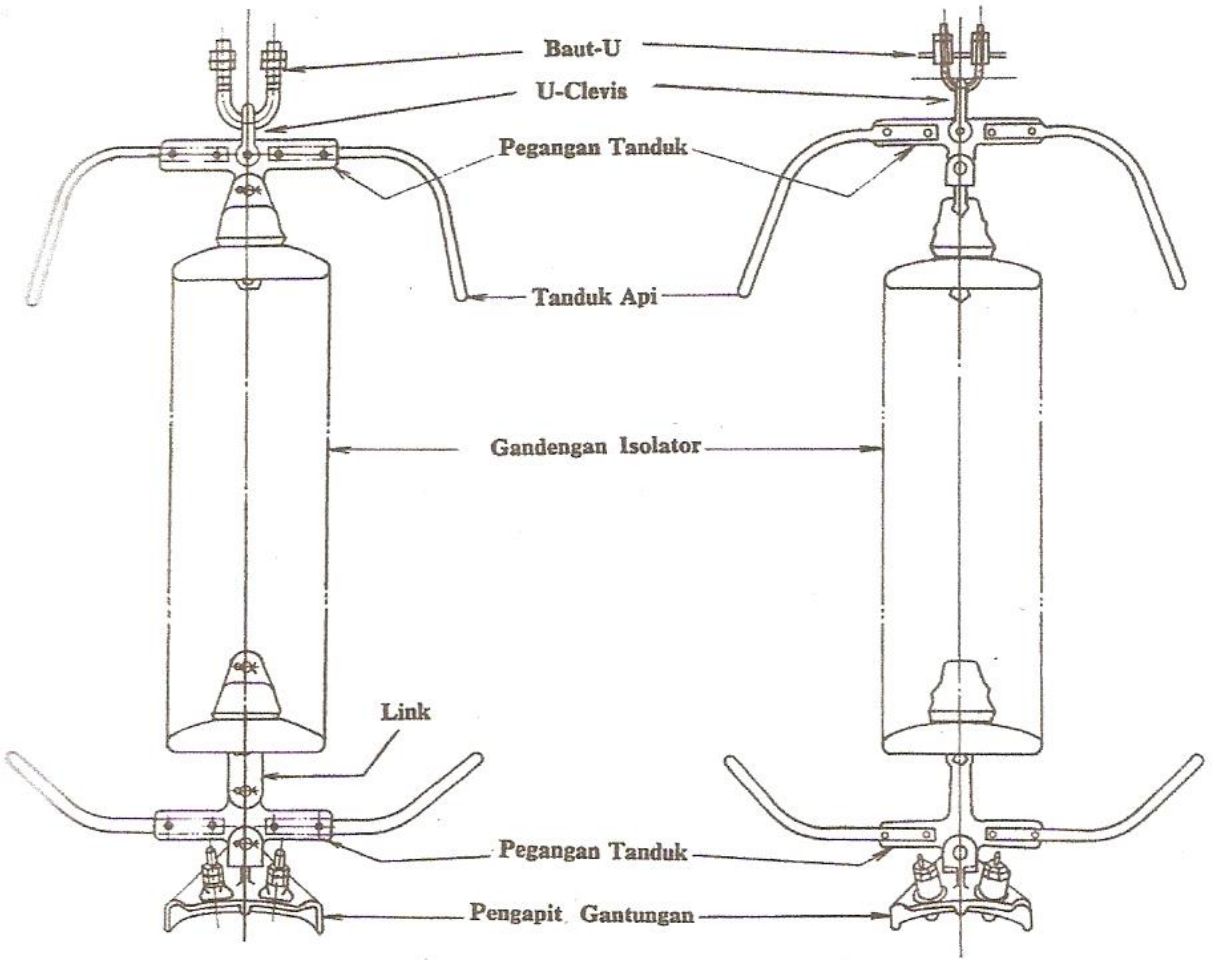
Insulator chain



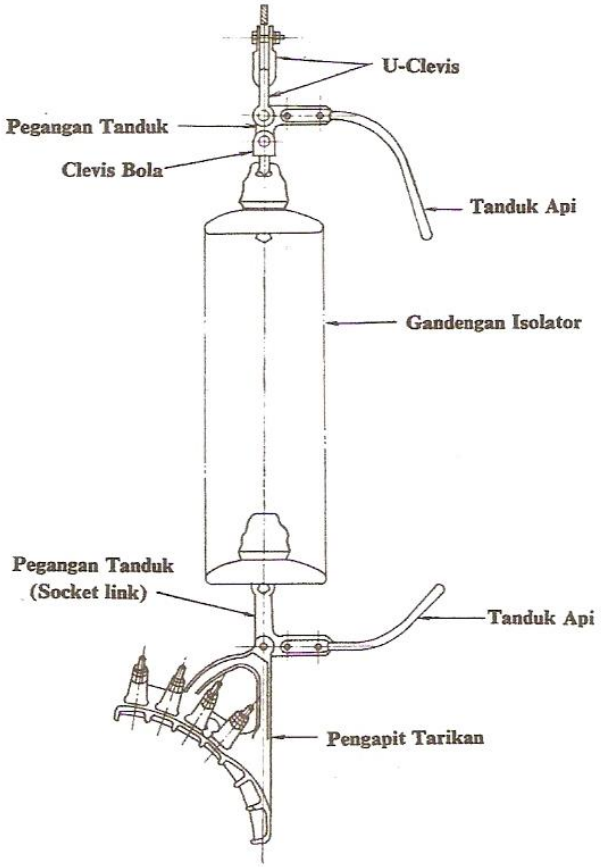
Cup and pin Insulator



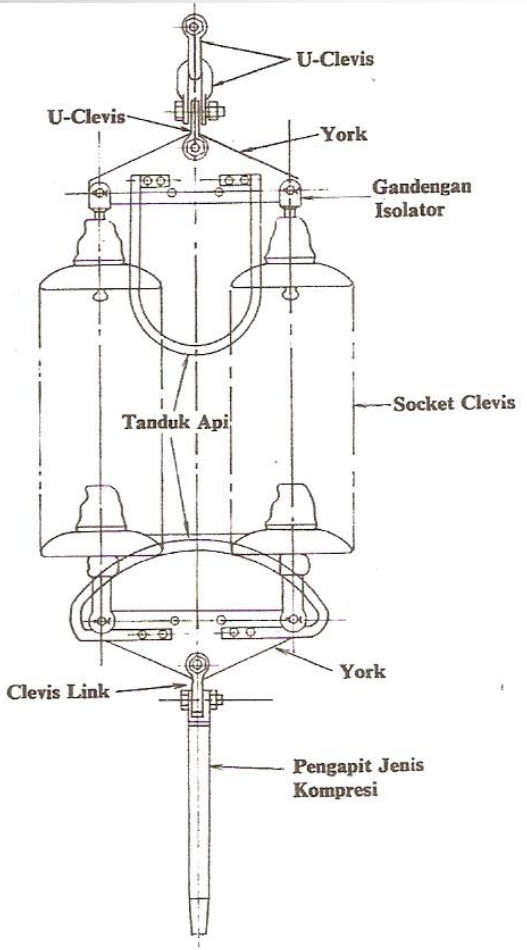
Isolator Gantung Tunggal



Isolator tarik



tunggal



ganda

Penghantar

Saluran udara → tanpa isolasi (bare/telanjang):

- padat (solid)
- berlilit (stranded)
- berongga (hollow)

Terbuat dari :
- logam biasa
- logam campuran (alloy)
- logam paduan (composite)

Tiap phasa bisa :
- tunggal
- berkas (bundle) → EHV , UHV

Jenis Penghantar

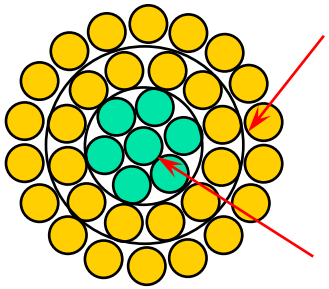
- AAAC : All Aluminium Alloy Conductor
- AAC : All Aluminium Conductor
- ACSR : Aluminium conductor (cable) Steel Reinforced
- ACAR : Aluminium conductor (cable) Alloy Reinforced
- BC : Bare Copper

Phase Conductors

- Transmission lines use stranded aluminum conductors.
- Typical type of conductors are:
  - Aluminum-Conductor-steel - Reinforced (ACSR)
  - All-Aluminum (AAC)
  - All-Aluminum Alloy (AAAC)
- Shield Conductors
  - Aluminum-clad-steel (Alumoweld)
  - Extra-High-Strength-Steel

ACSR Conductors

Most frequently used is the ACSR conductor. The steel provides mechanical strength, and the aluminum conducts the current.



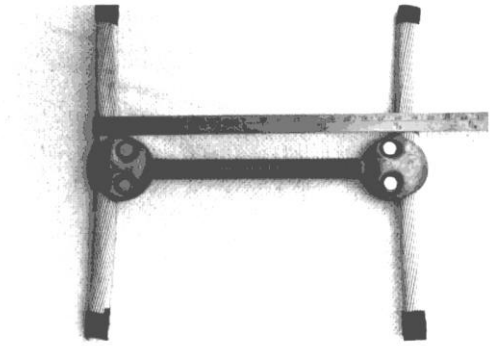
Aluminum strands
2 layers,
24 conductors

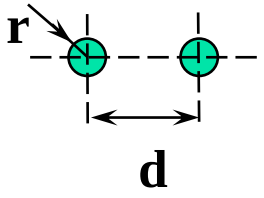
Steel strands
7 conductors

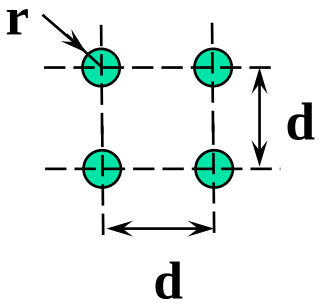
Conductors

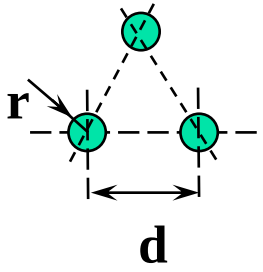
Bundle conductors

- Untuk EHV sering dipakai Bundle Conductors
  - Untuk mngurangi korona
  - Untuk meningkatkan daya hantar arus (current carrying capacity).
- Digunakan bundle dengan 2, 3, atau empat konduktor
- Pemisah konduktor yang dipakai adalah batang aluminium atau baja



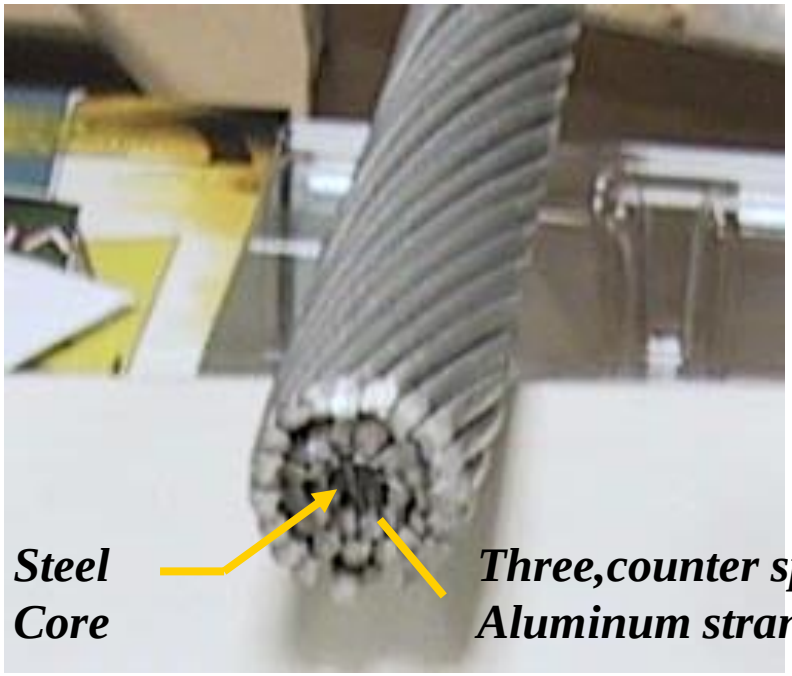




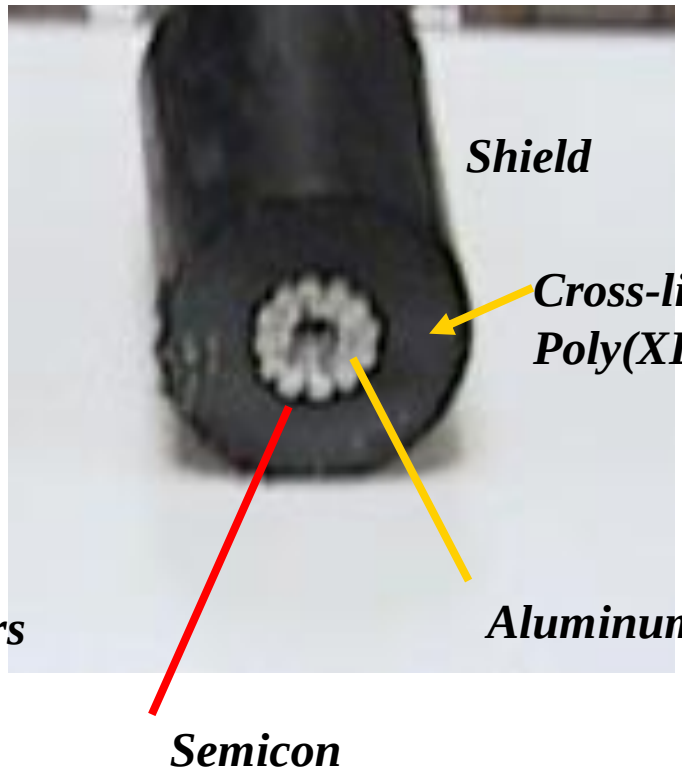


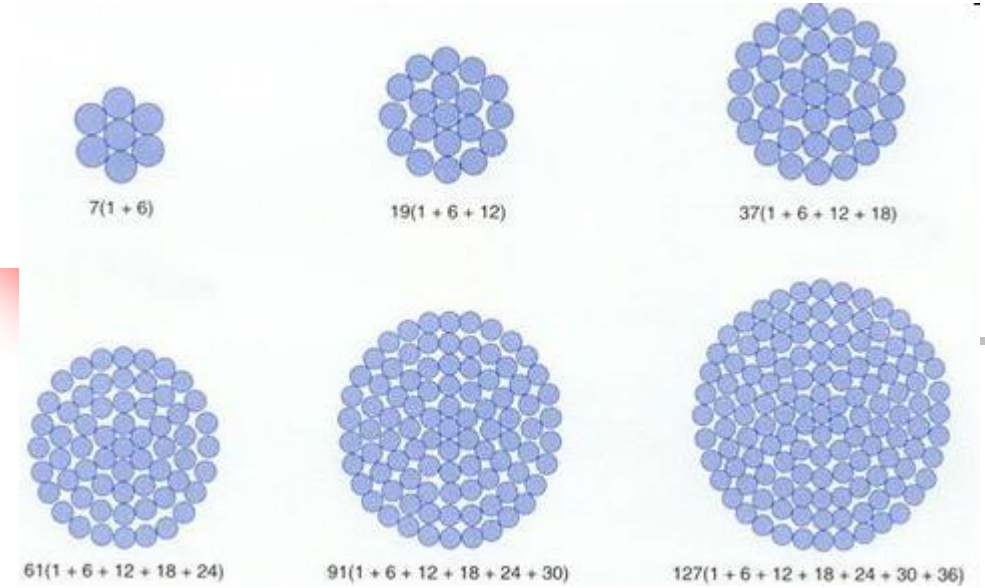
Transmission Lines-Conductors

- ACSR

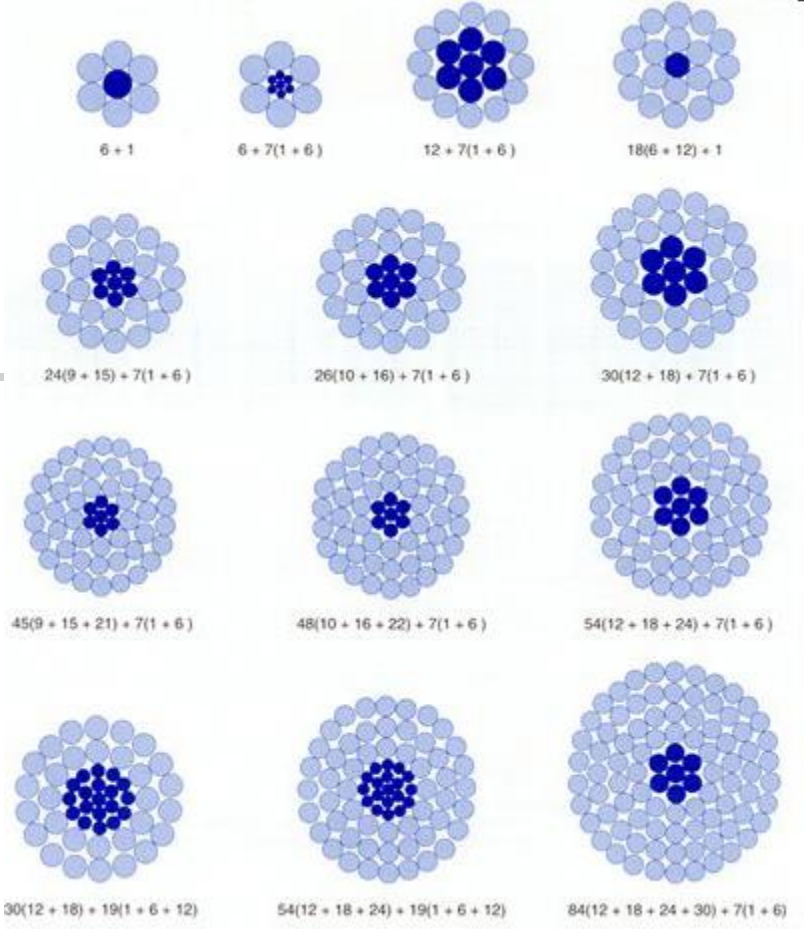


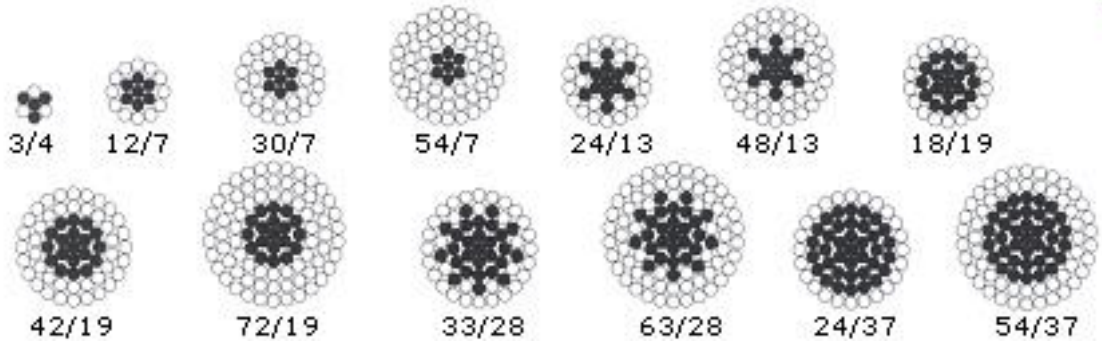
- XLPE



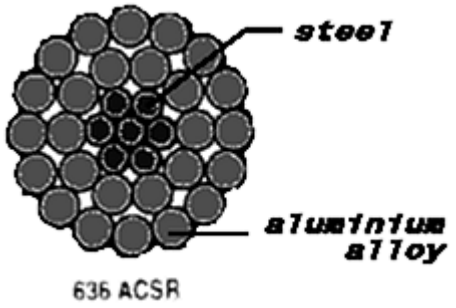


AAAC



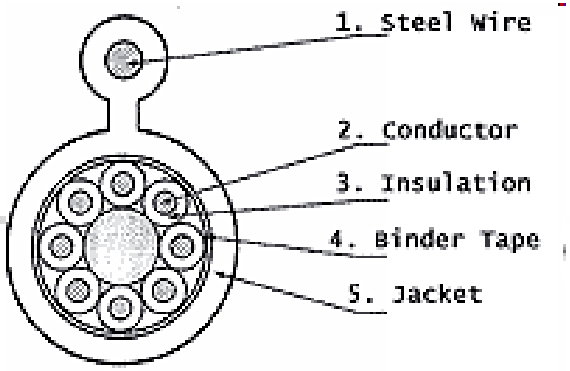


ACAR

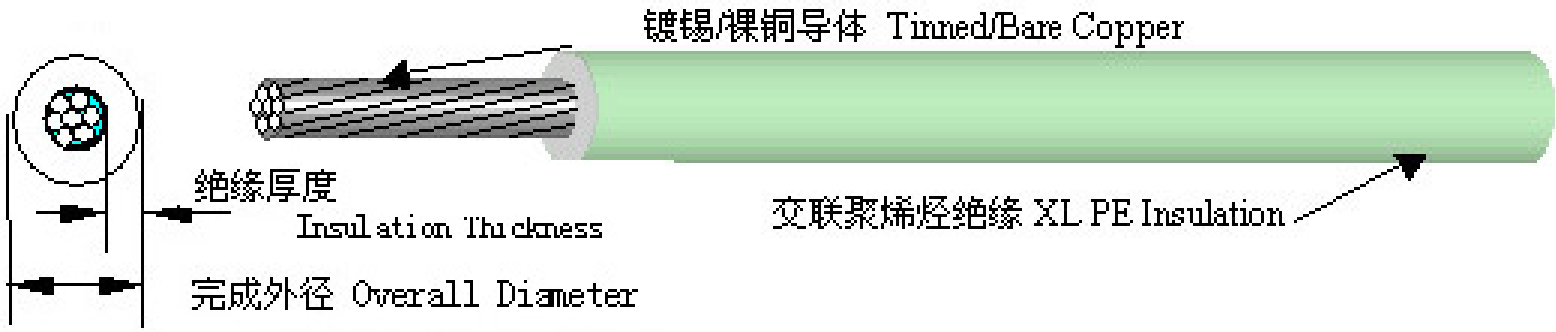


ACSR

Bare Copper


1. Steel Wire
2. Conductor
3. Insulation
4. Binder Tape
5. Jacket


Bare Copper Conductor
·CTG·Cables
Foamed PE Insulation
Braid Shield
PVC Jacket


镀锡/裸铜导体 Tinned/Bare Copper
绝缘厚度
Insulation Thickness
完成外径 Overall Diameter
交联聚烯烃绝缘 XL PE Insulation

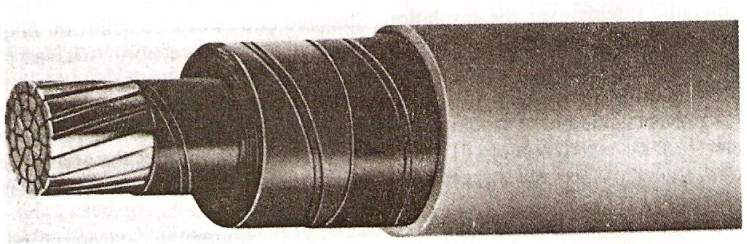
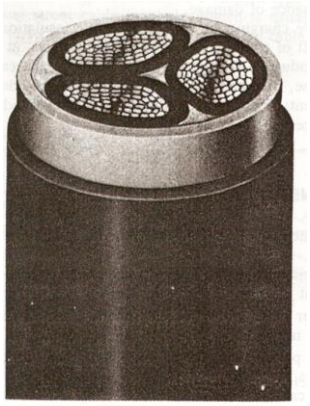
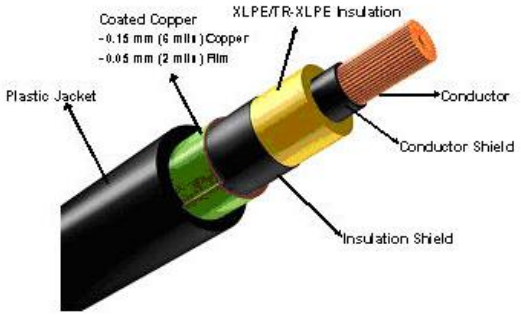
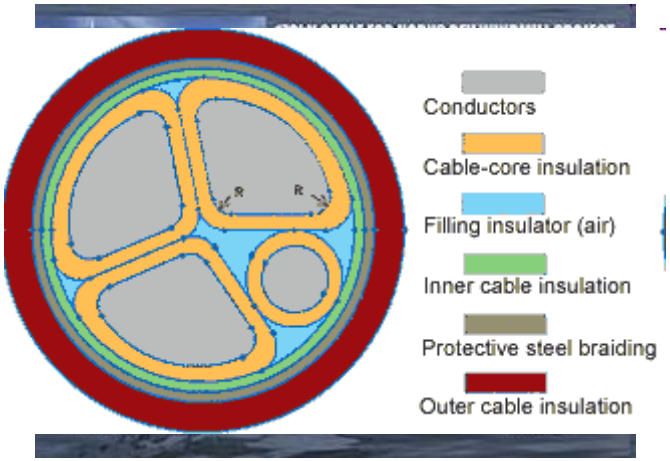


Figure 4.1. Single-conductor, paper-insulated power cable. (Courtesy of Okonite Company.)



Coated Copper Tape for Power Cable





Instalasi underground Cable

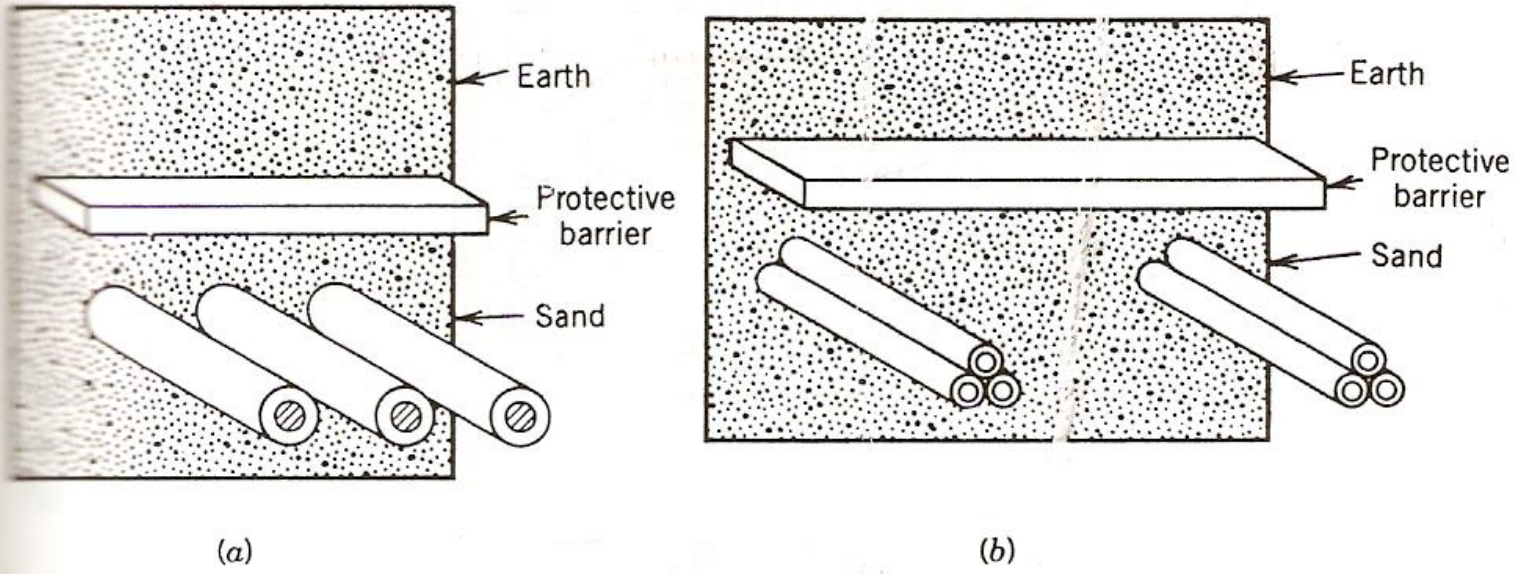


Figure 4.6. Direct burial: (*a*) for single-conductor cables; (*b*) for triplexed cables.

Instalasi underground Cable

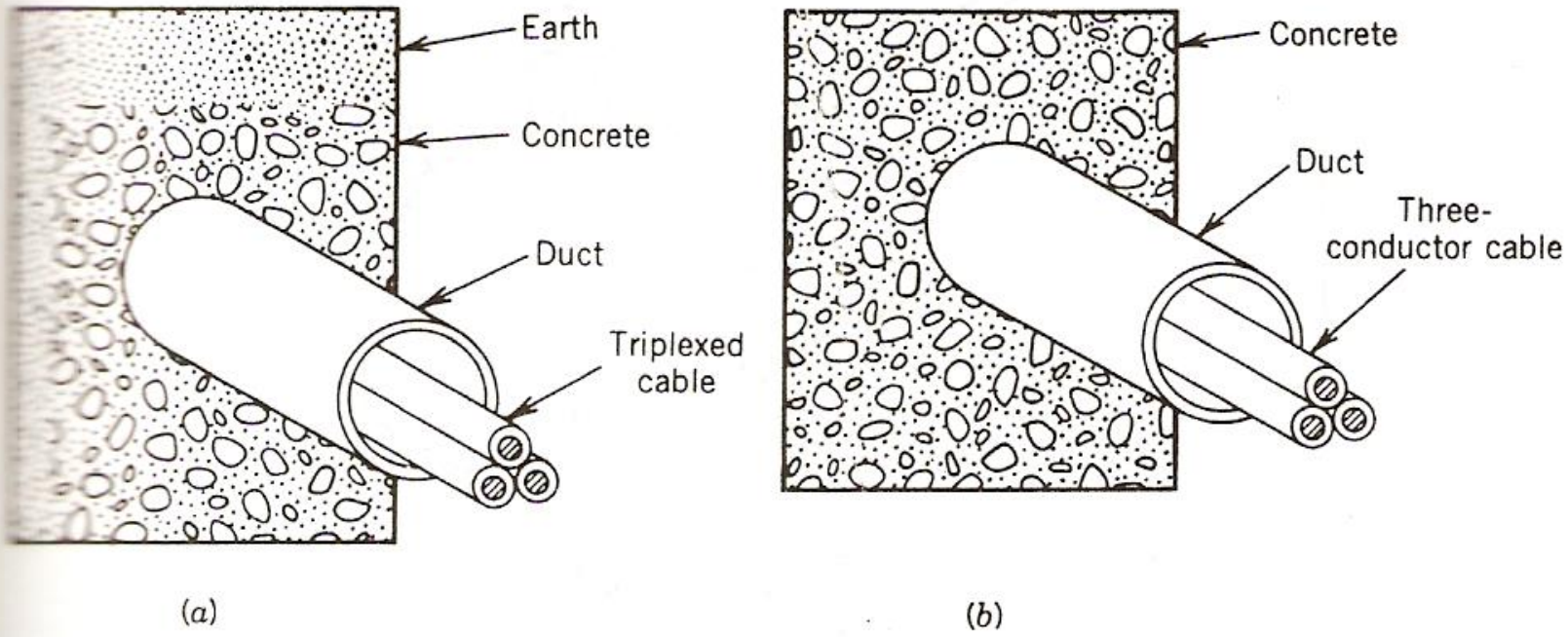


Figure 4.7. Burial in underground cuts (or duct bank): (*a*) for three single-conductor or triplexed, cables, (*b*) for three-conductor cable.

Man hole

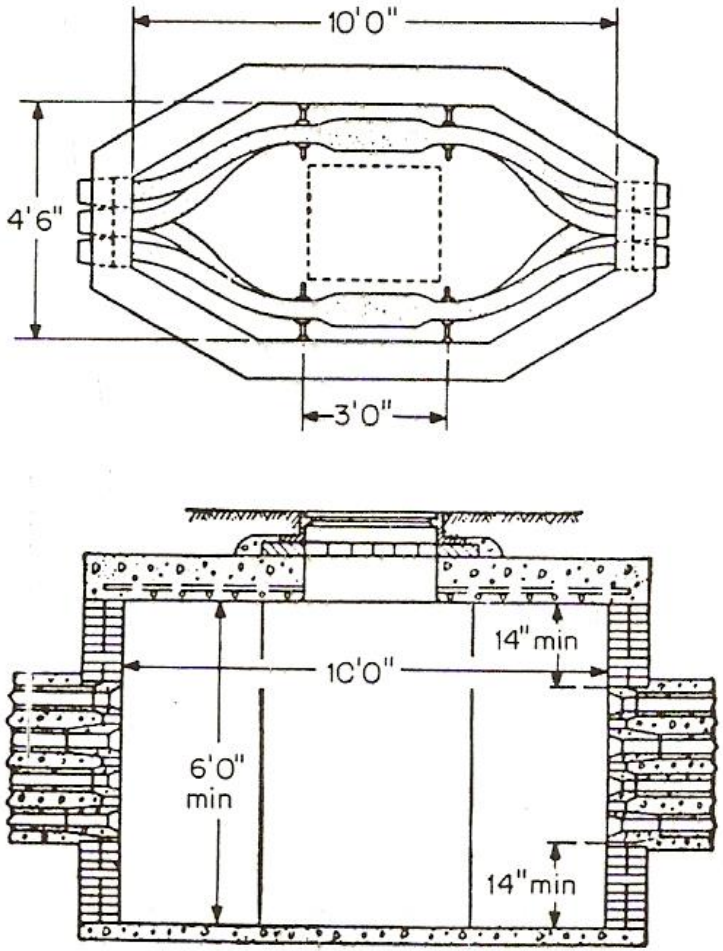


Figure 4.8. Straight-type manhole [4].

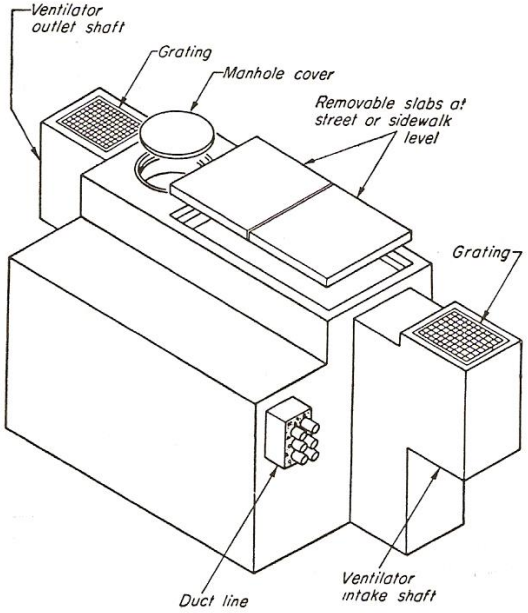


Figure 4.9. Street cable manhole [8].

Tugas Pengayaan

- Buatlah studi literatur perbedaan sistem transmisi beberapa negara, ambil perwakilannya dari 5 Benua. Bandingkan dengan di Indonesia/PLN.

- Lakukan observasi sebuah Jalur Transmisi, Kemudian Foto dan jelaskan masing-masing bagian nya.