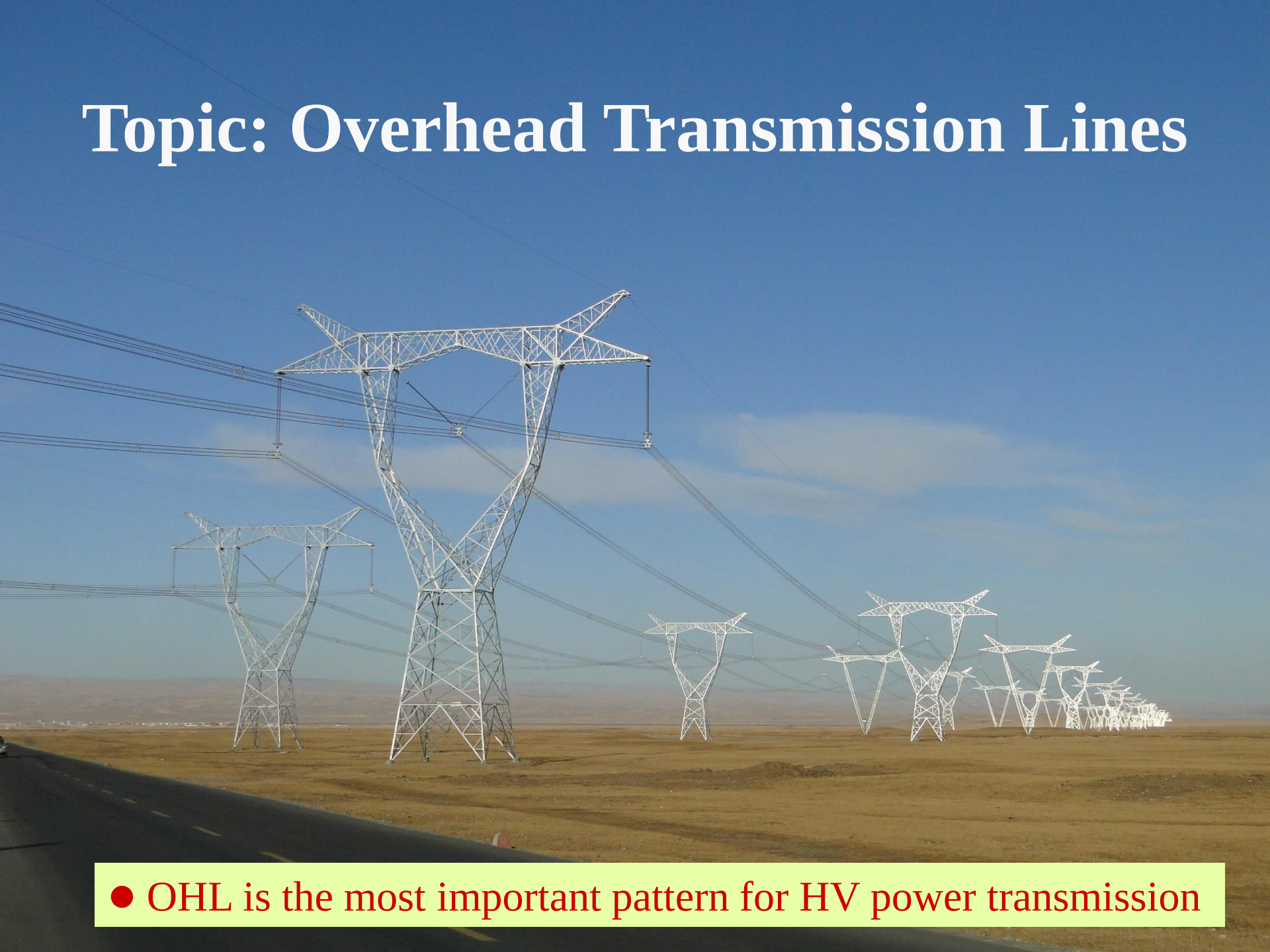
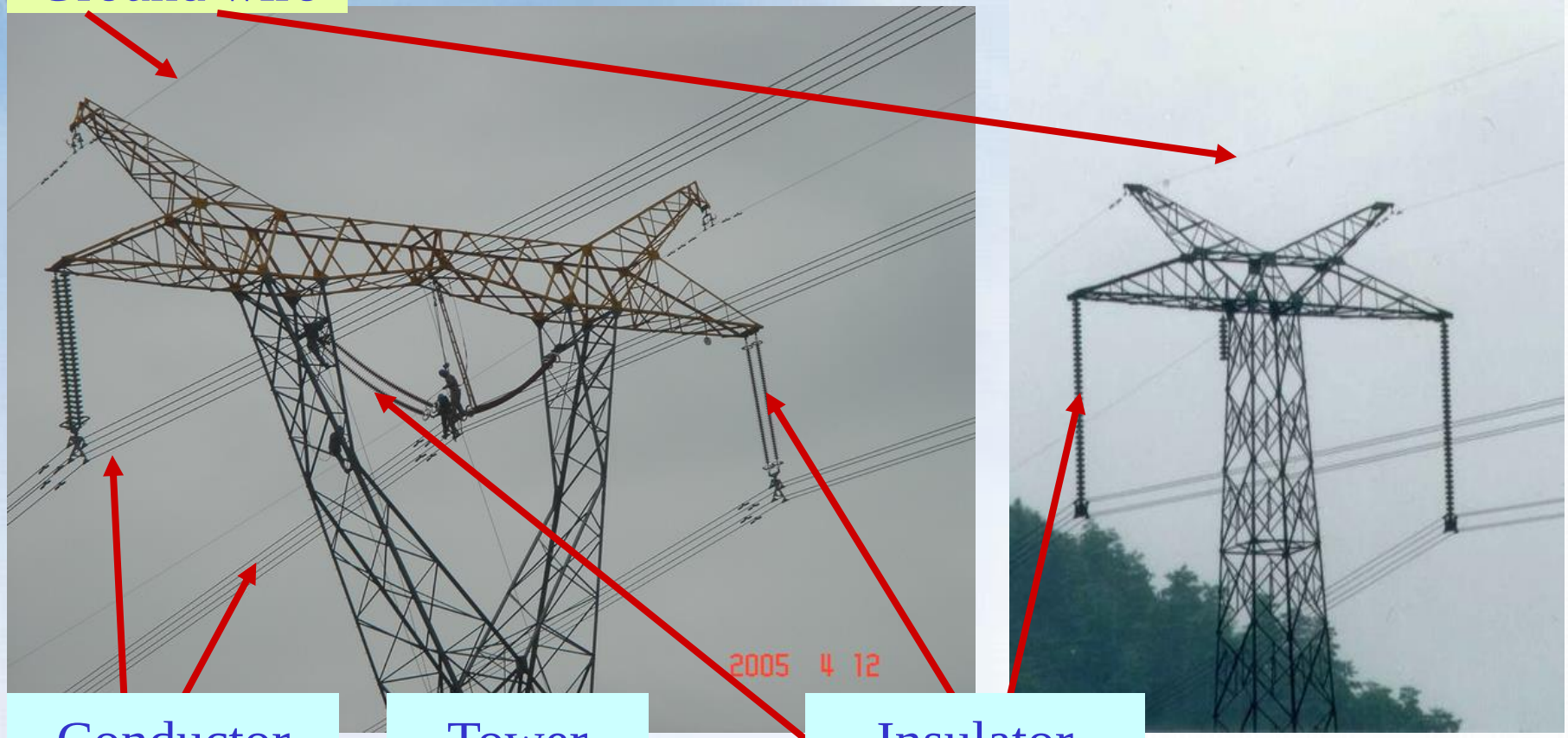
Topic: Overhead Transmission Lines



- OHL is the most important pattern for HV power transmission

1. Basic component of OHL
2. Tower
3. Conductor
4. Insulator
5. Problems and future directions

1. Basic component of OHL



Insulation of OHL: Air gap insulation between conductor and tower.

Internal and surface insulation of insulator,

Most of the faults of overhead lines are related to insulators.

The component of OHL and basic functions of each part

Conductor: carry current; Tower: support conductor

Insulator: ***mechanically connect*** (fix) conductor and tower, ***electrically isolate*** conductor and tower (bare conductor). Thus, a certain insulation distance is maintained between tower and conductor, as well as between the conductors of different phases or different circuits.

Different arrangements of towers and insulators provide a variety of conductor configurations

Insulation of OHL: Air gap insulation between conductor and tower.

Internal and surface insulation of insulator,

Most of the faults of overhead lines are related to insulators.

2. Towers

Self-supporting tower, tension tower, Guyed tower

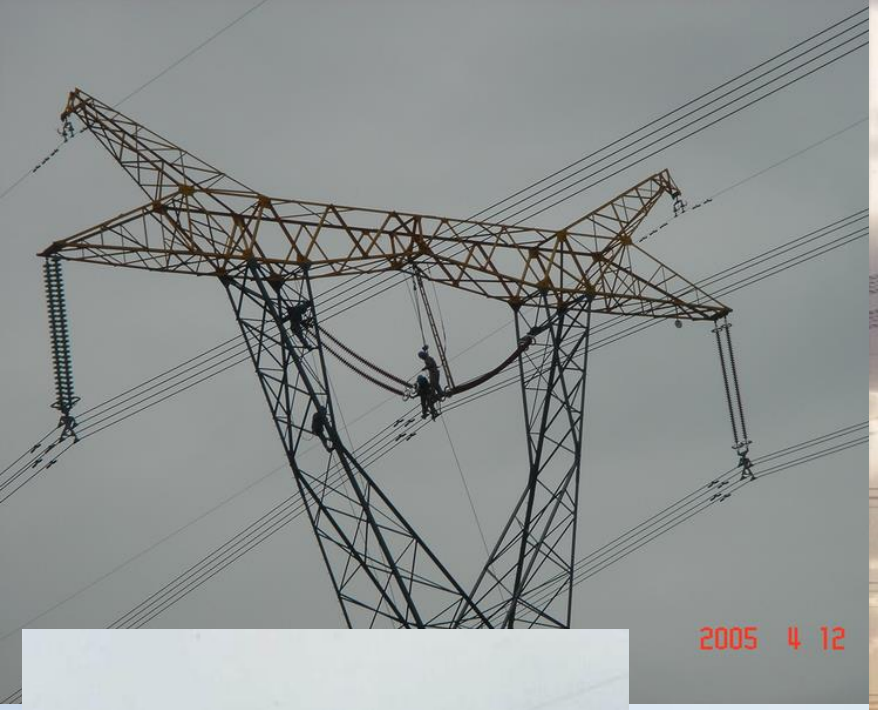
Angle tower, transposition tower

Single circuit tower, multi-circuit tower

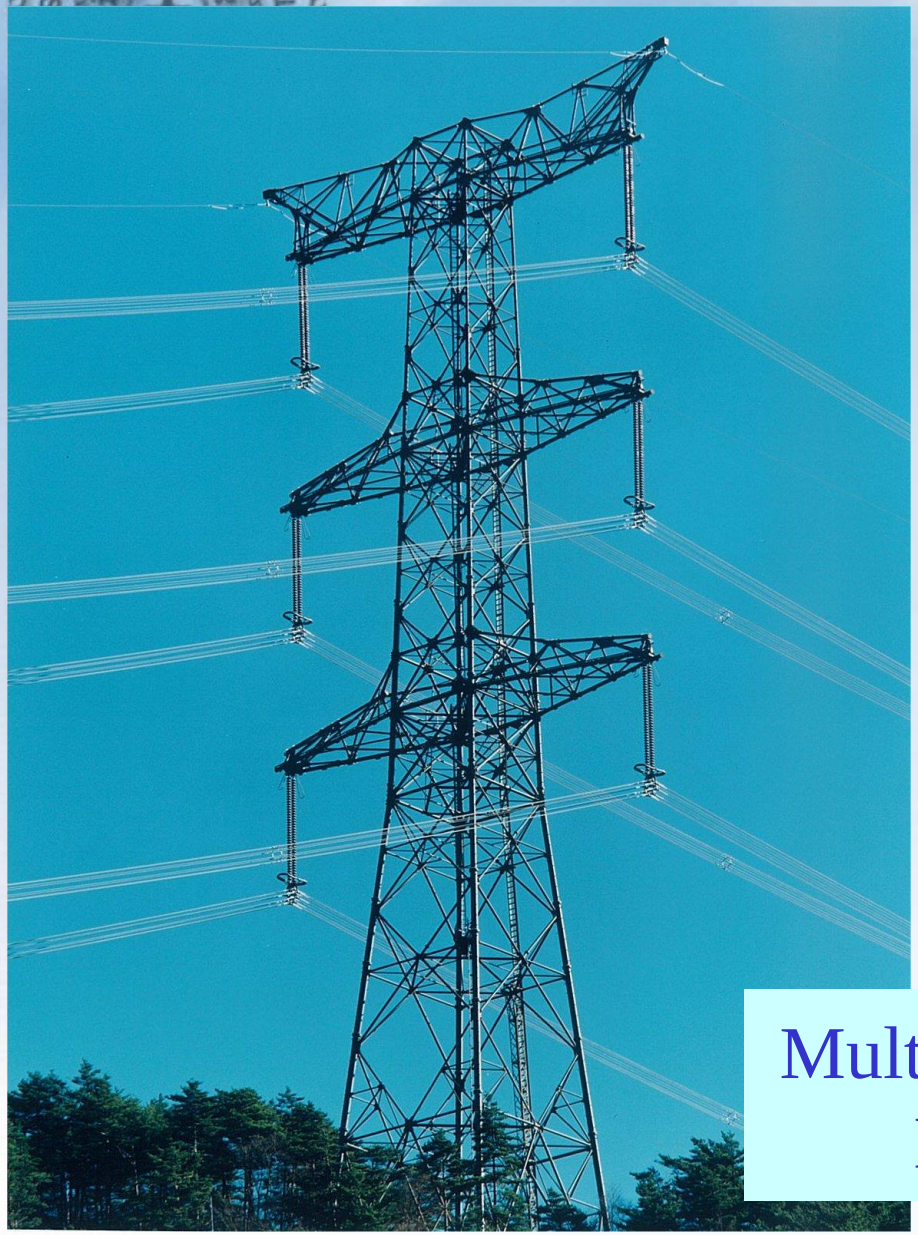
Lattice tower, steel pipe tower, concrete tower, wooden tower

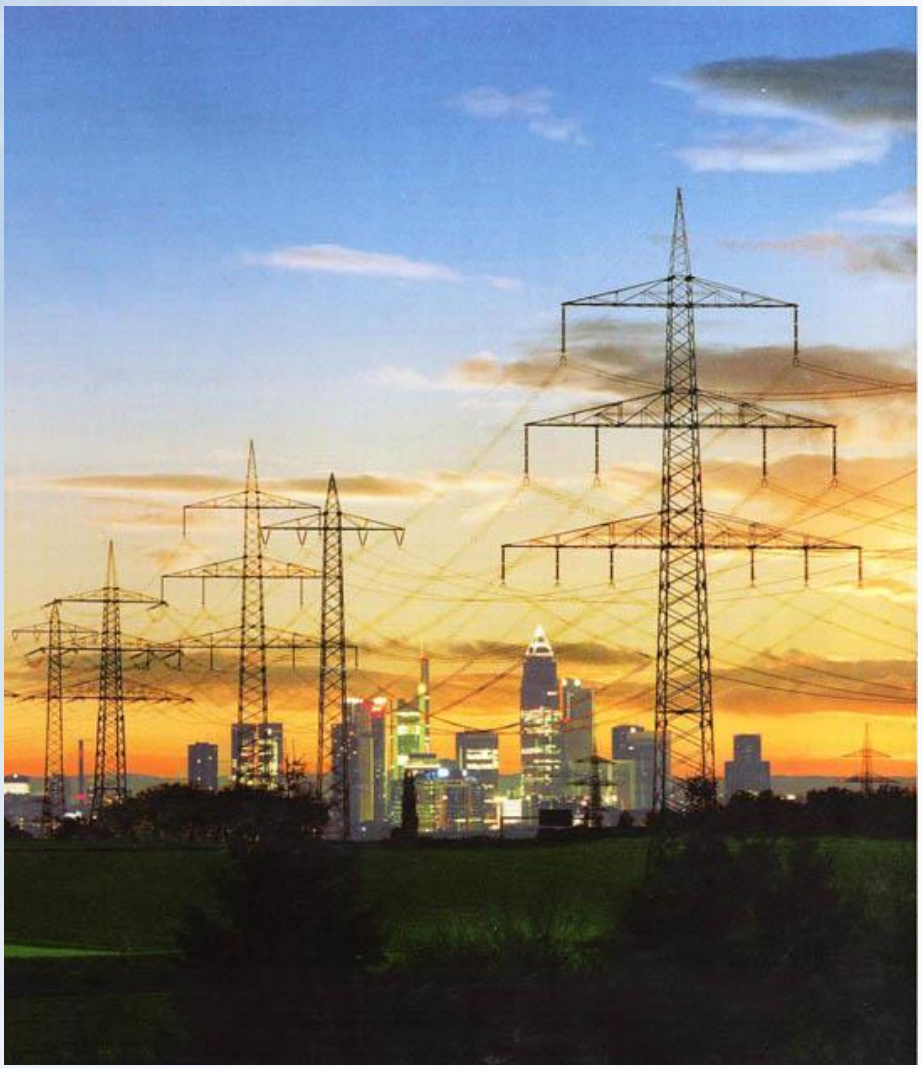
cup type tower, cat head tower...

There are different voltages, different insulator strings...



AC/DC
Single circuit
Self-supporting tower
Insulator I string, V string

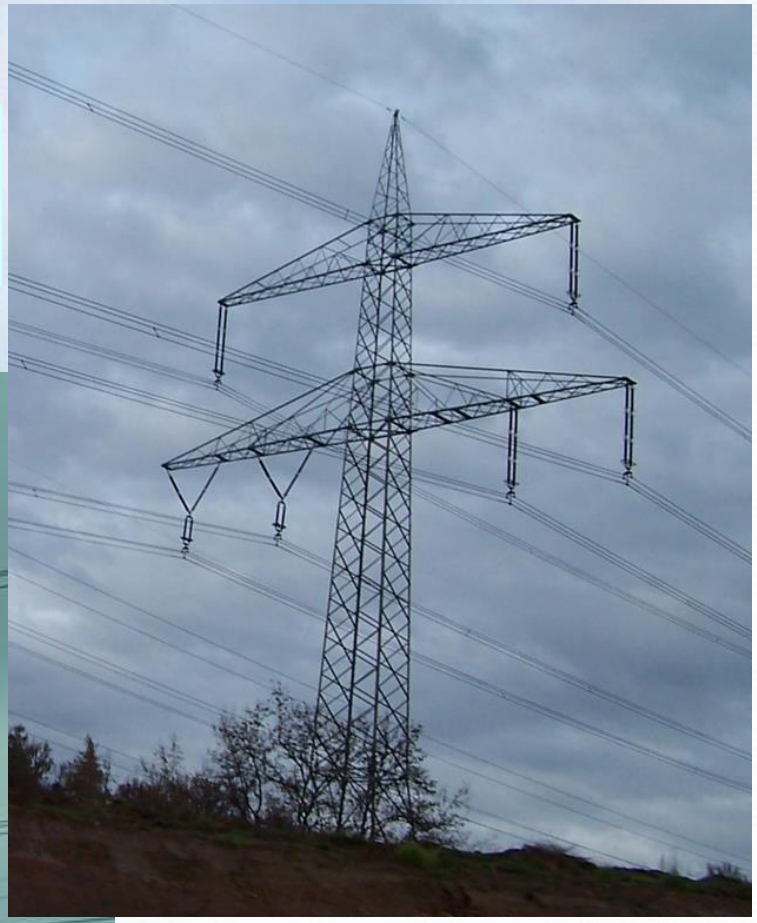




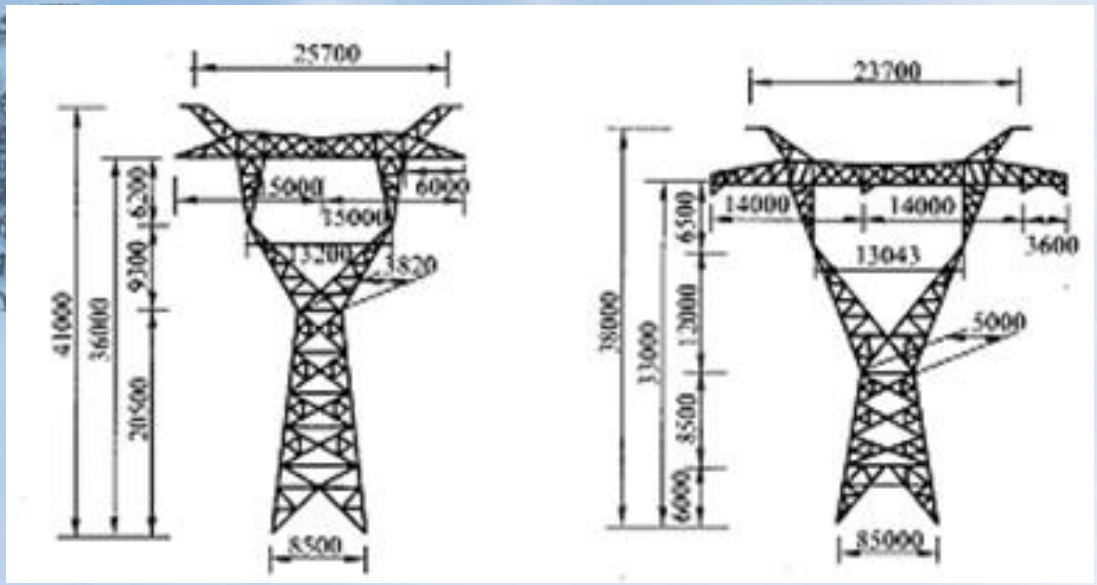
Multi-circuit self-supporting tower

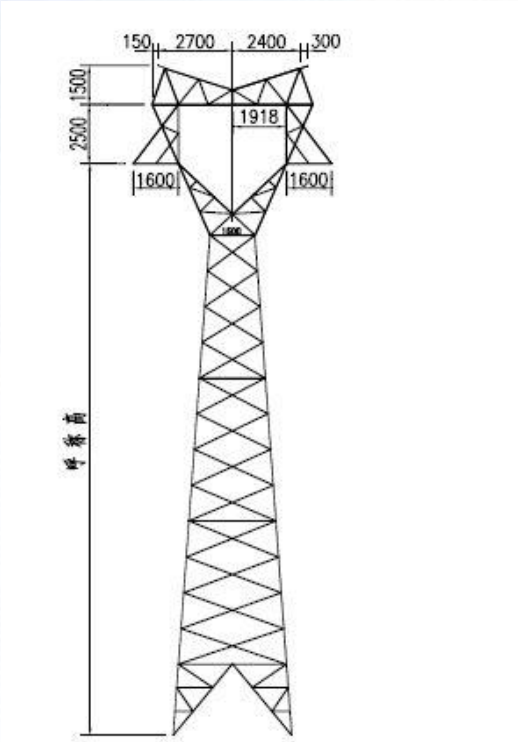
Insulator I string, II string

Multi-circuit self-supporting tower



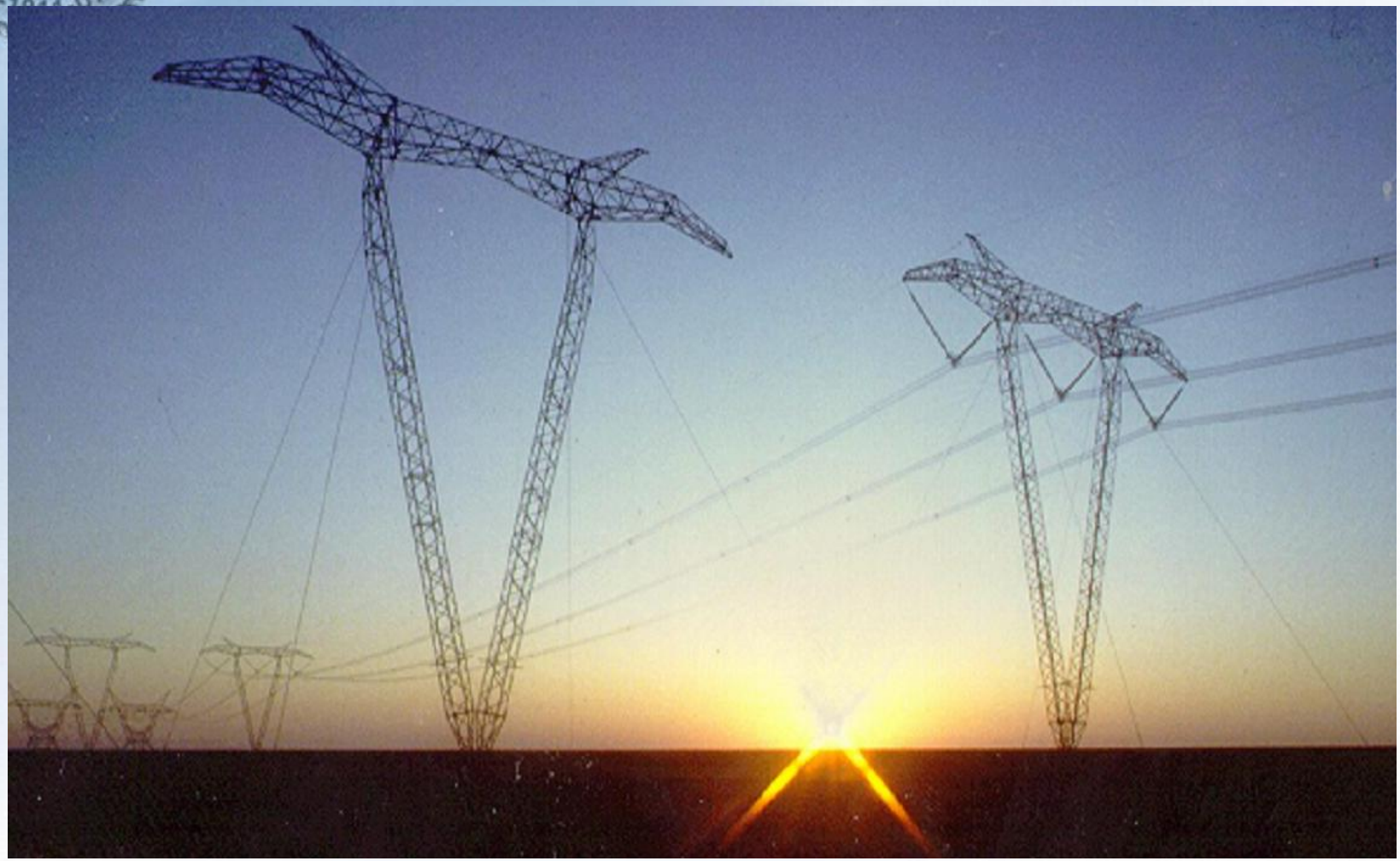
Insulator
V string,
II string,
Y string





110kV 典型猫头杆塔图(塔型 ZM1)

Guyed tower (Guyed V tower), insulator V string



AC, DC guyed tower
Insulator I string

guyed tower, Insulator I string

Guyed tower
Insulator T string

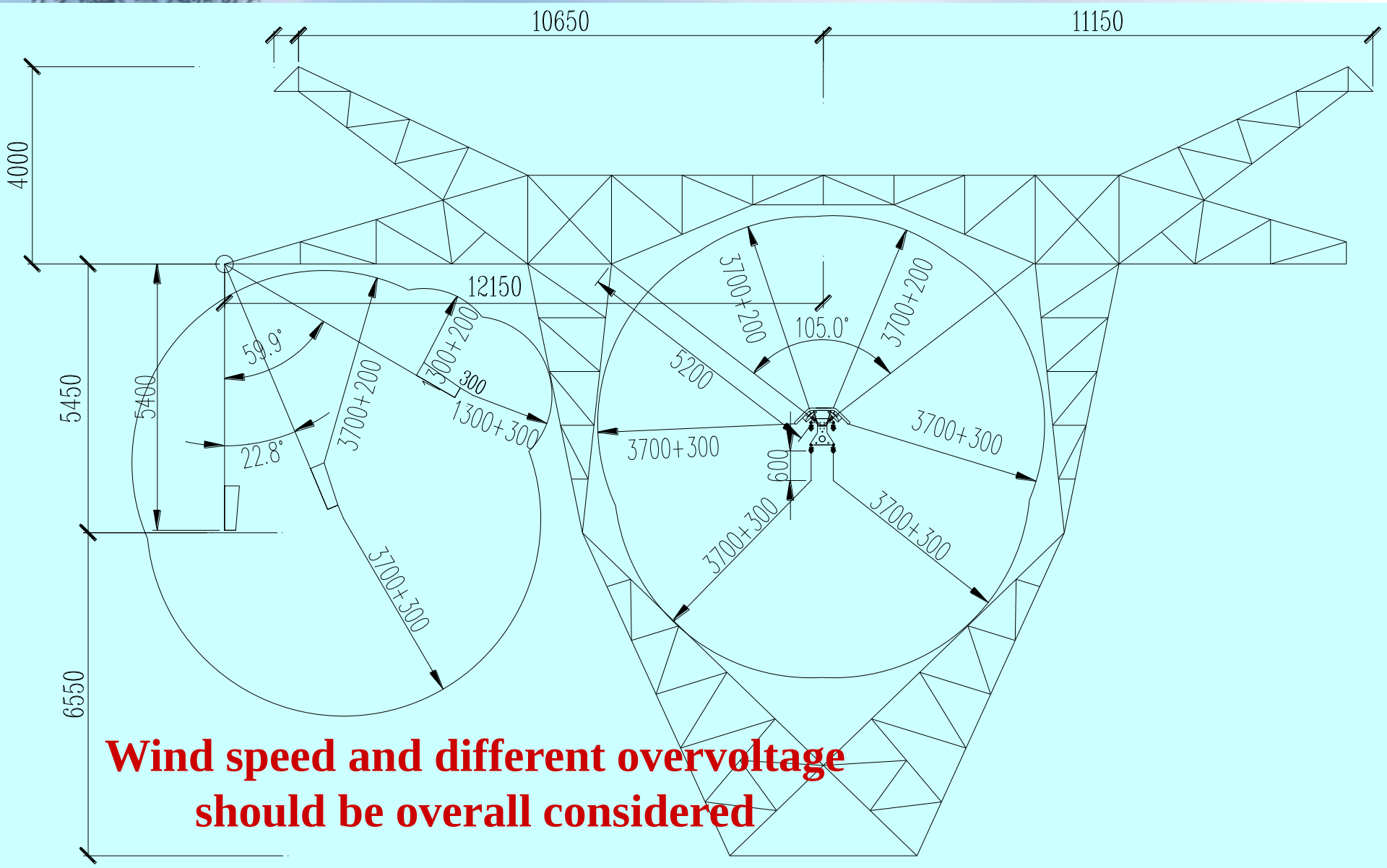
Tension tower

Tension insulator string

Tension tower
Insulator tension string

China's first double-circuit UHV AC OHL completed the first operation of defect elimination when stop power transmission

clearance circle of tower window



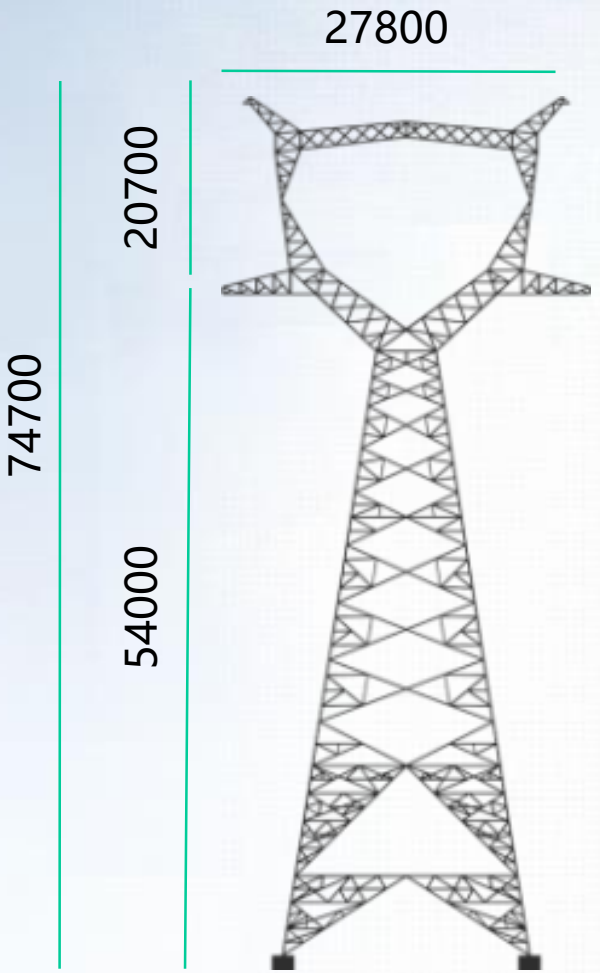
Wind speed and different overvoltage should be overall considered

UHV cat head tower

The optimized tower:

64% weight reduction

60% cost reduction



Tower span and conductor sag

Tower span and conductor sag

Changji-Guquan ±1100 kV UHV DC transmission line

Tower span and conductor sag

1000kV Suzhou-Nantong Yangtze river crossing initial OHL design

(finally changed to GIL)

5057m distance between two main tension towers

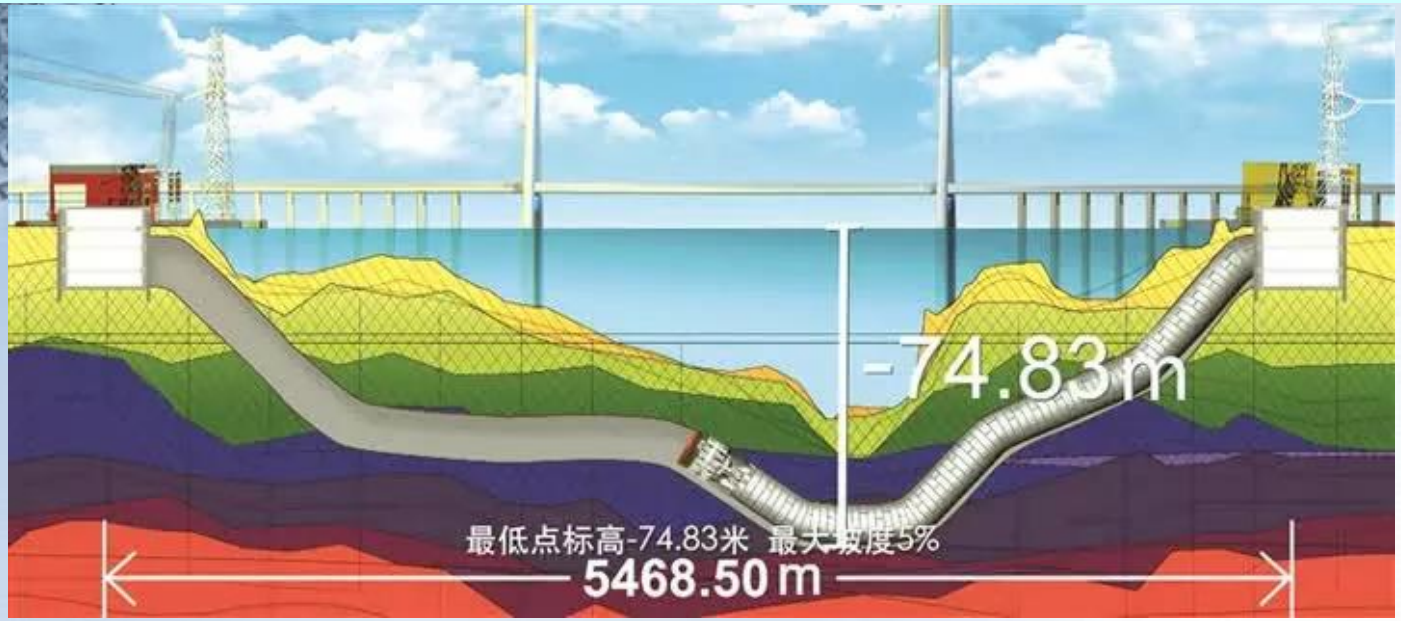
“Tension - straight line - straight line – tension” with span of “1187-2600-1270m” respectively

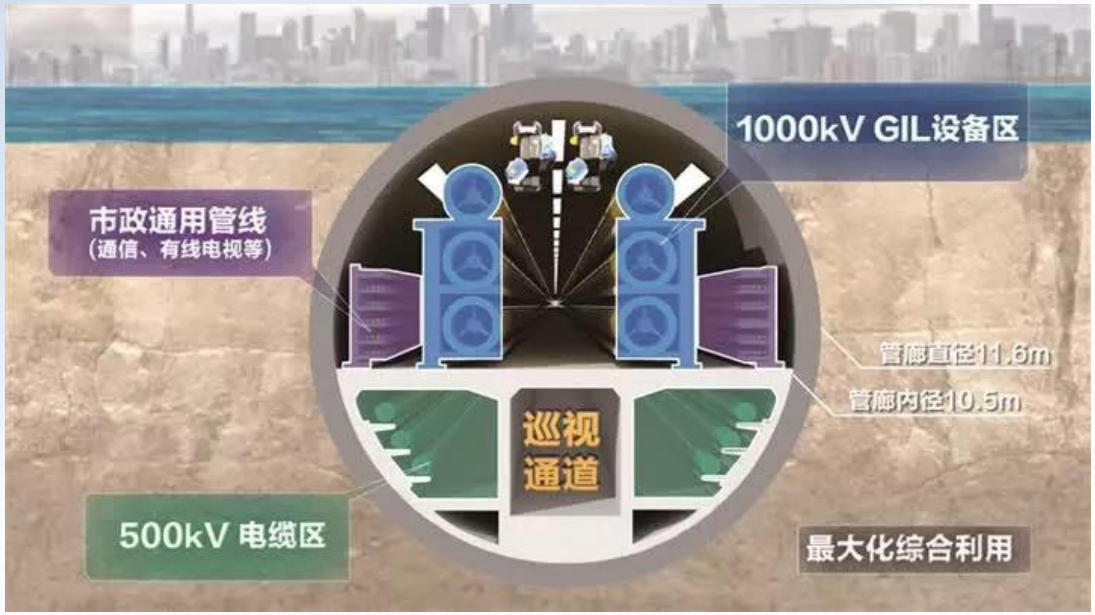
The river crossing tower is 455m high

The amount of steel for single tower is 12200 tons

The tallest tower and the largest construction scale in the world

Suzhou-Nantong 1000kV UHV GIL: 2019.9.26 Put into operation





3. Conductors

Aluminum Conductor Steel Reinforced (ACSR),

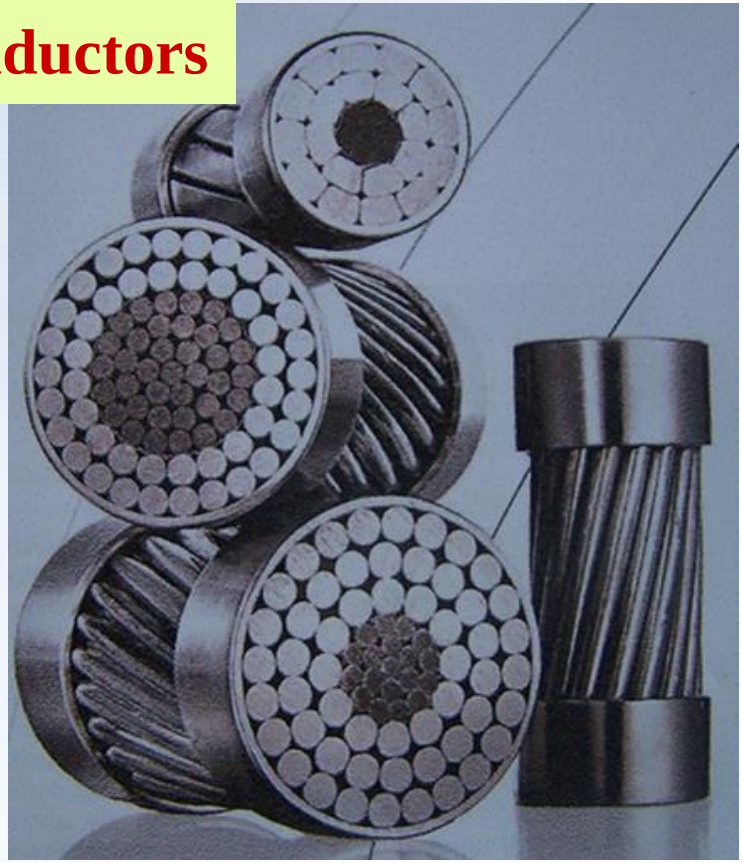
large cross-section conductor, heat resistant conductor,

TW conductor, composite reinforced core conductor (low sag),

low noise conductor...

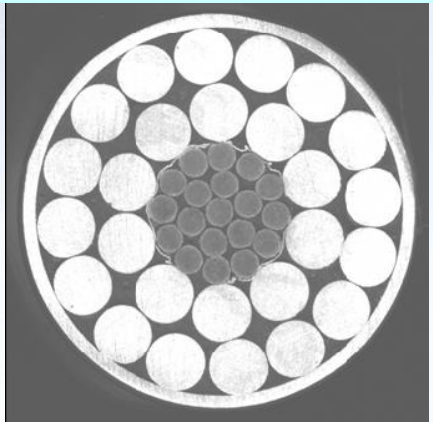
ground wire, OPGW

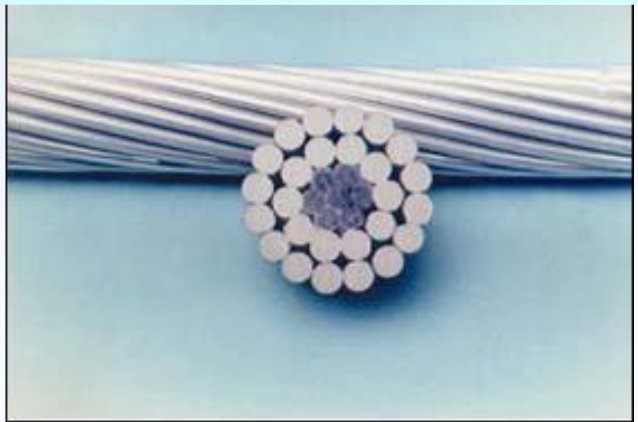
Different conductors



Aluminum Conductor Steel Reinforced (ACSR)

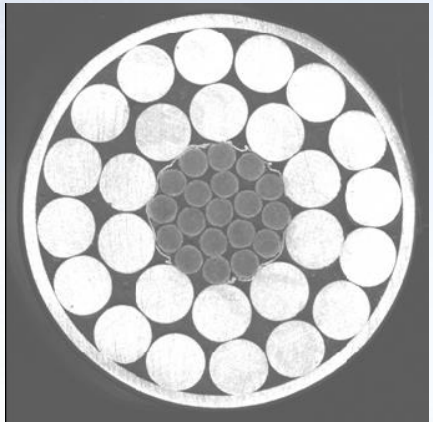
Diameter mm								
indiv Core	2.2	2.4	2.7	2.9	2.1	2.2	2.4	2.6
indiv Al	2.9	3.1	3.4	3.7	4.4	3.6	4.0	4.4
Core	6.7	7.3	8.0	8.7	10.4	10.9	12.1	13.1
Total D	18.3	19.9	21.8	23.5	28.1	32.8	36.2	39.2
Area mm^2								
Al	170	201	241	282	403	564	685	806
Total A	198	234	281	328	467	635	771	908
Weight kg/m								
	0.566	0.669	0.802	0.937	1.333	1.812	2.200	2.589

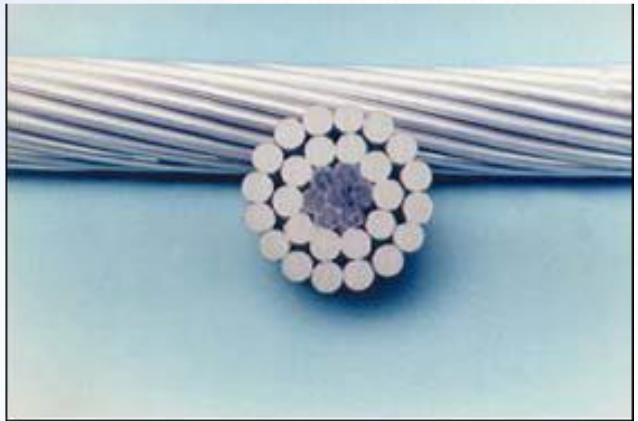




Area mm^2							
Al 170	241	322	403	523	645	685	806
Total Area							
198	281	374	467	590	726	771	908

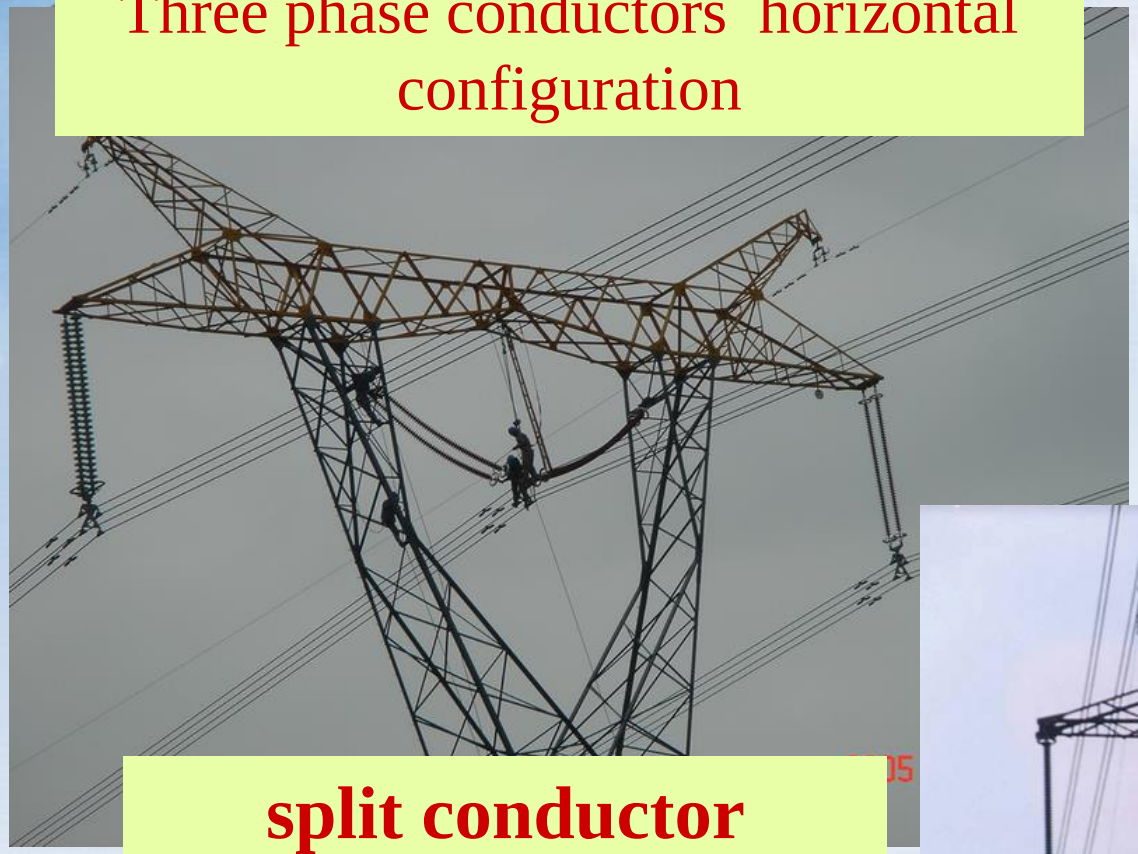
Resistance ohms/km							
DC @ 20C							
0.1614	0.1138	0.0854	0.0683	0.0535	0.0435	0.0409	0.0348
AC @ 25C							
0.1652	0.1165	0.0875	0.0700	0.0548	0.0445	0.0419	0.0356
AC @ 75C							
0.1979	0.1396	0.1048	0.0838	0.0657	0.0533	0.0502	0.0427





Conductor configuration

Three phase conductors horizontal configuration

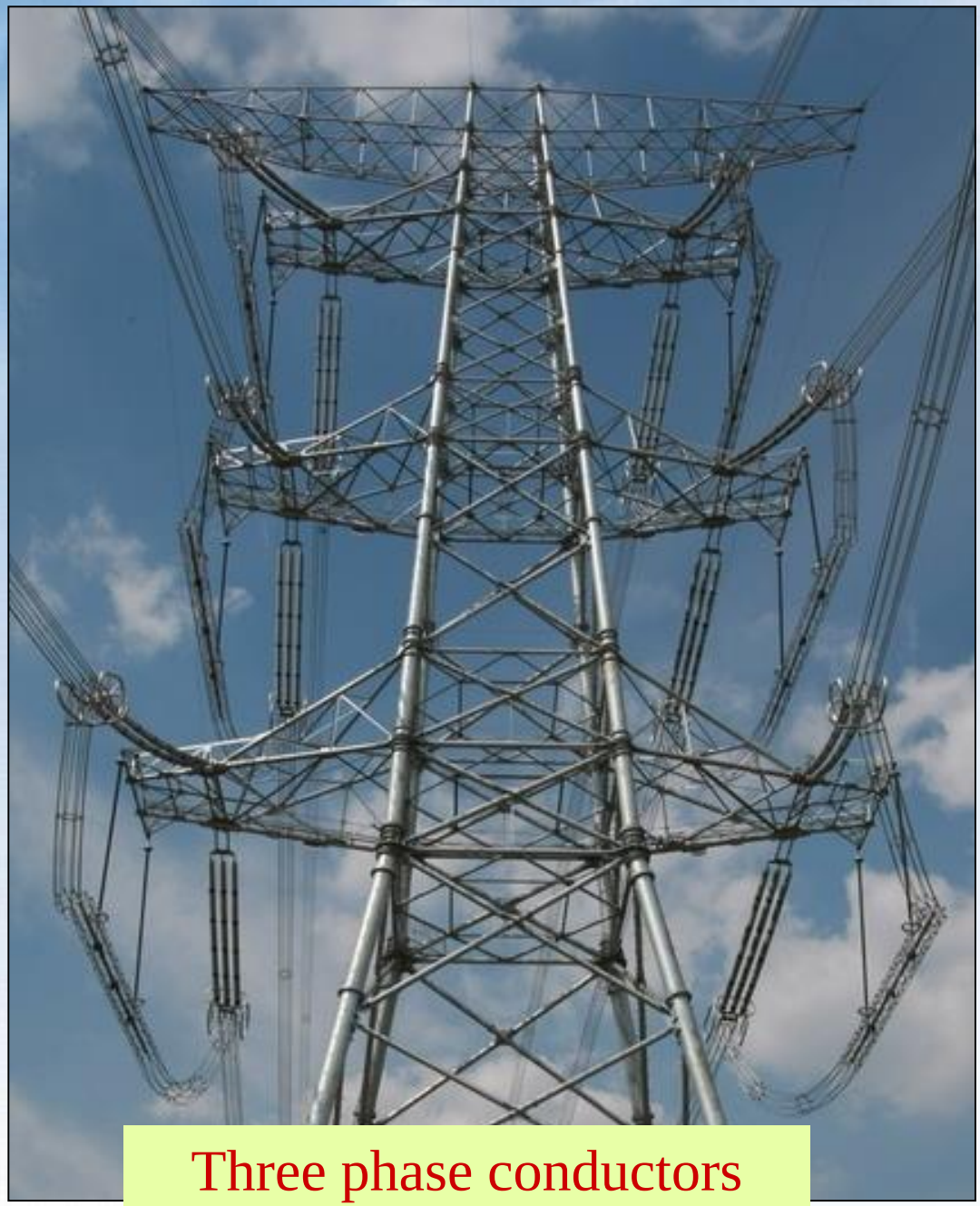


split conductor

Reduce conductor surface electric stress

500kV AC and DC OHL, usually 4-split conductor in China

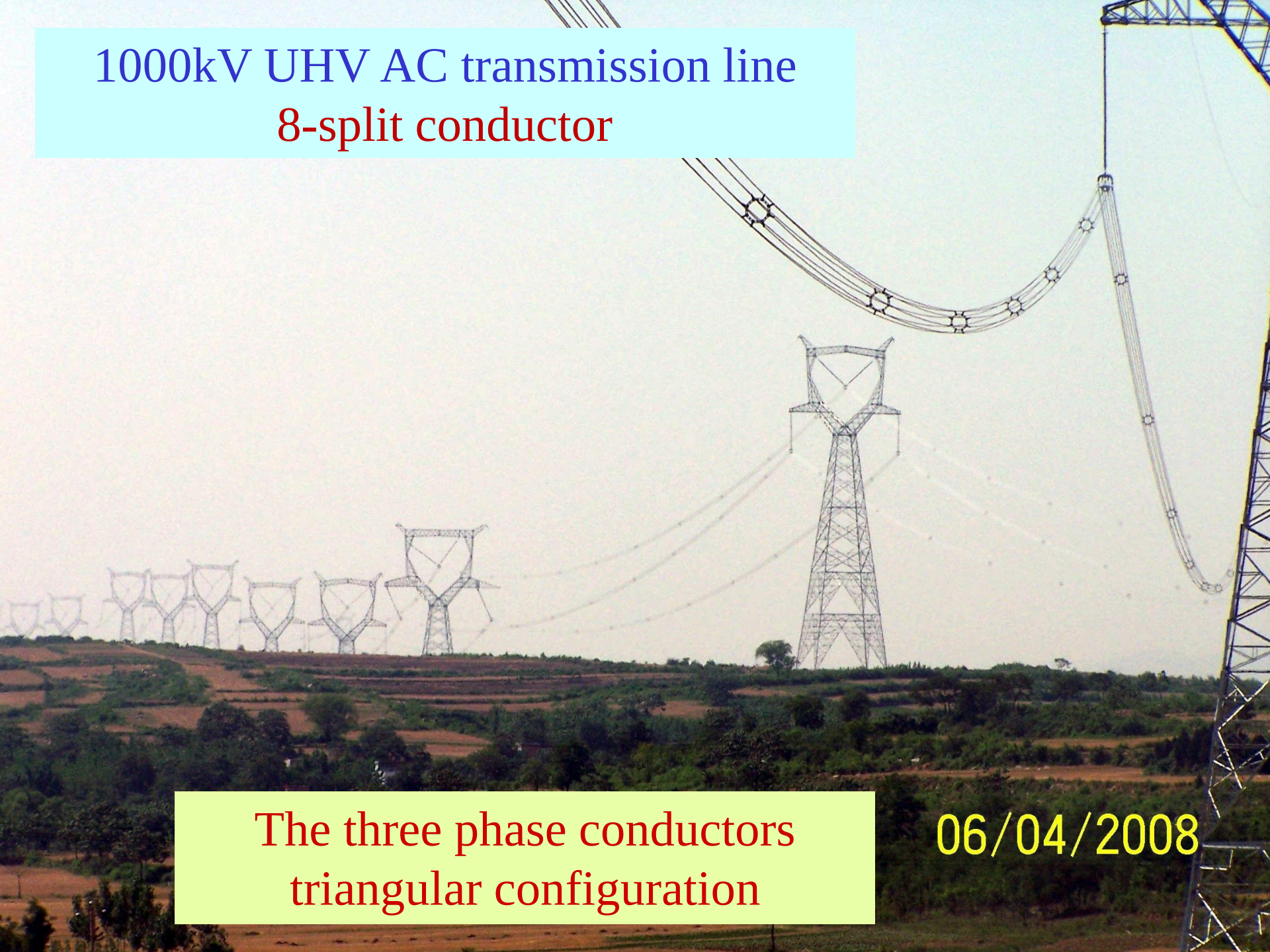
750kV AC OHLs usually 6-split conductor in China



Three phase conductors
vertical configuration

Fig. 9• Installation of low-noise conductors in an actual 1,000-kV

1000kV OHLs usually
8-split conductor in China


1000kV UHV AC transmission line
8-split conductor
The three phase conductors
triangular configuration
06/04/2008

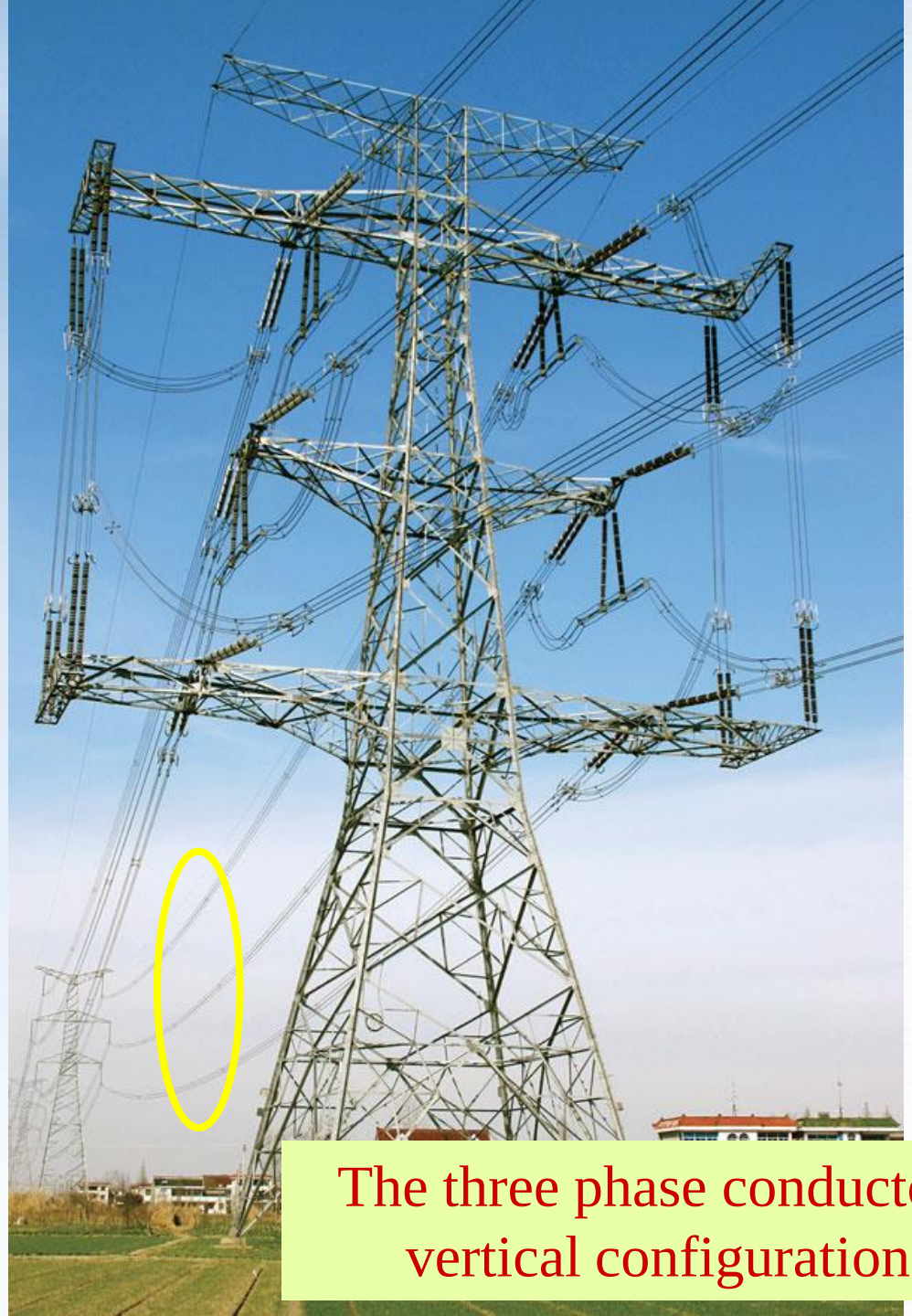
500kV tower

double circuit tower

small angle tower

tension tower

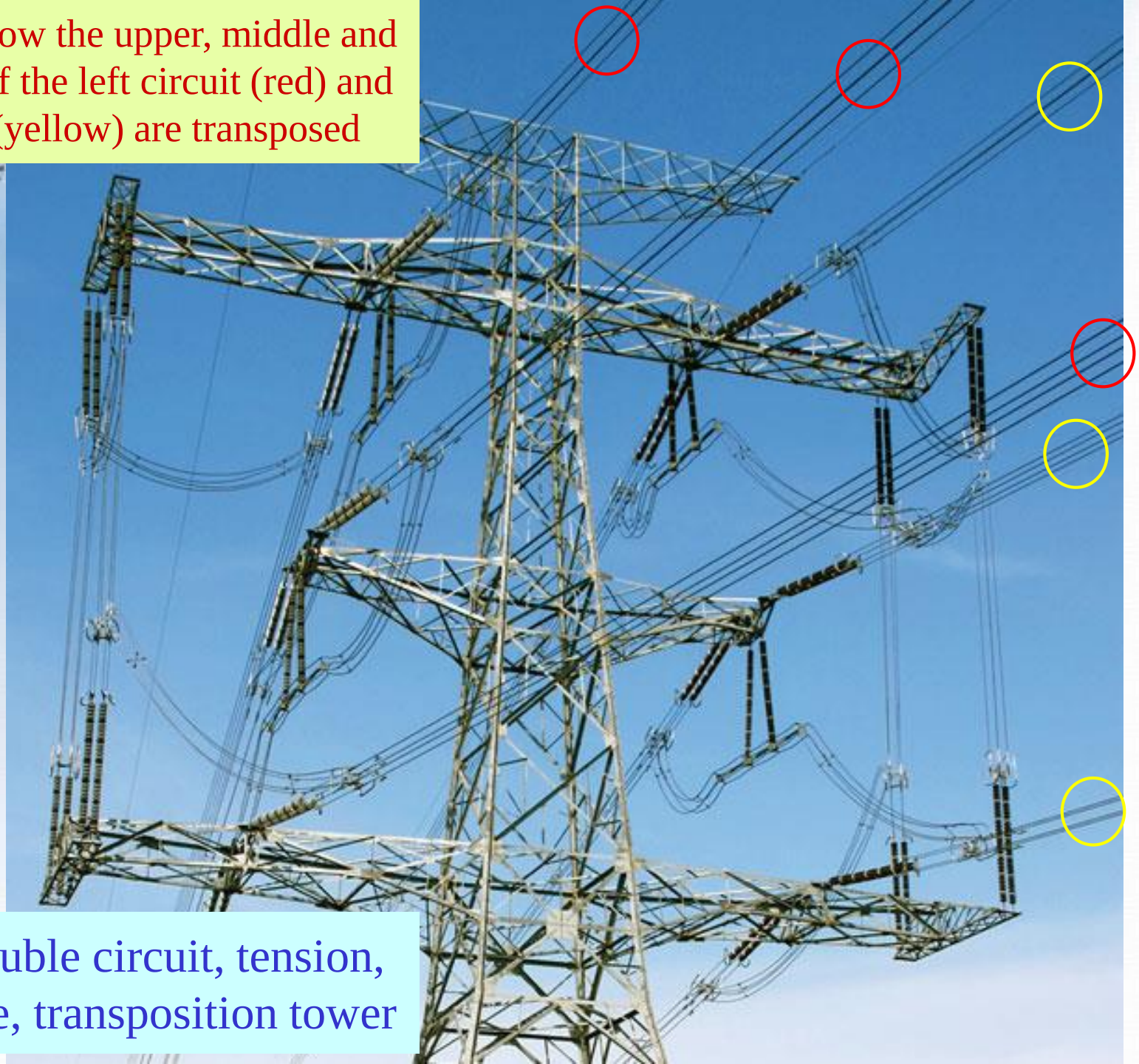
transposition tower



Please note: How the upper, middle and lower phases of the right circuit (yellow) are transposed?

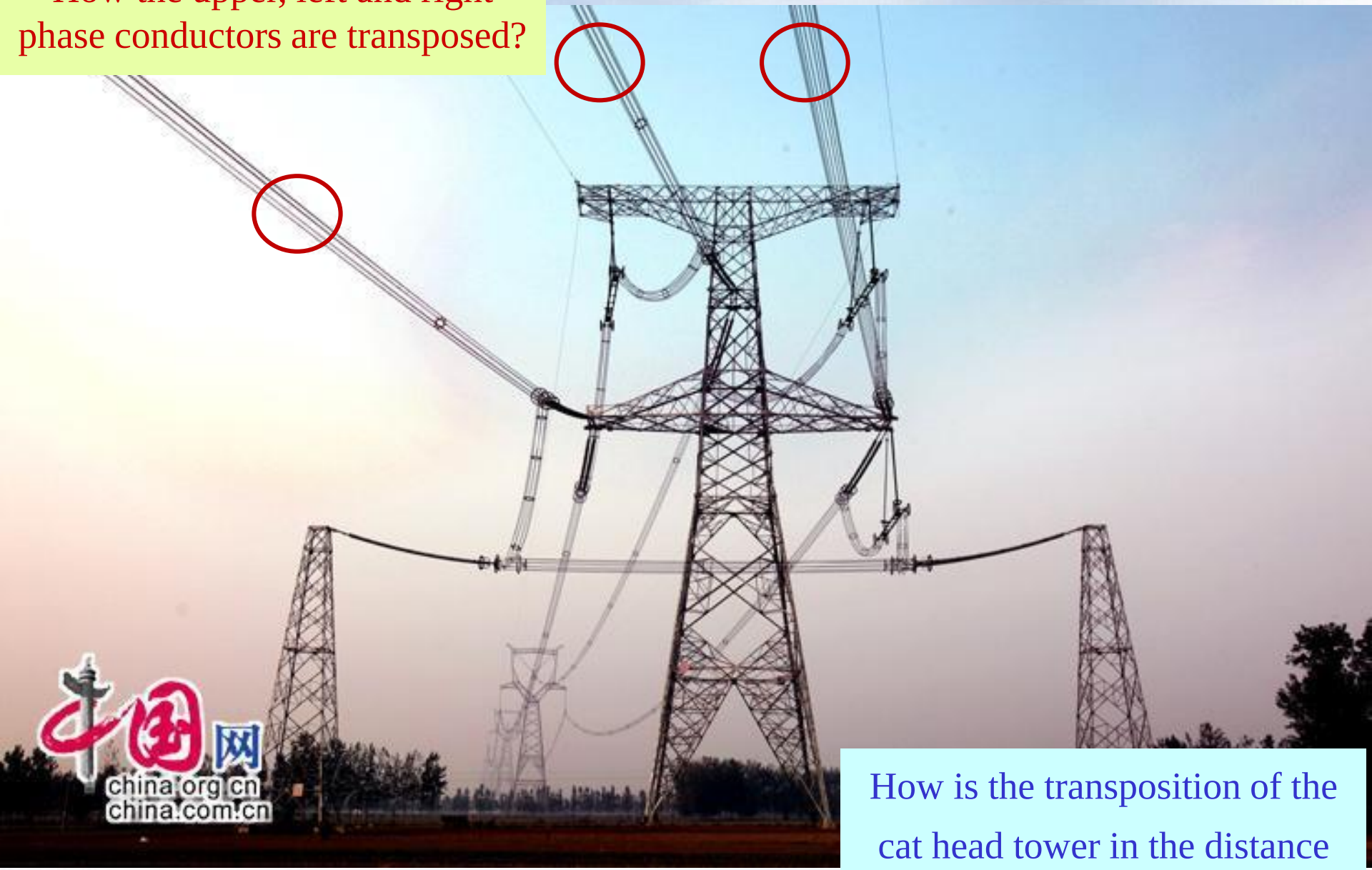
The three phase conductors vertical configuration

Please note: How the upper, middle and lower phases of the left circuit (red) and right circuit (yellow) are transposed



500kV, double circuit, tension, small angle, transposition tower

How the upper, left and right phase conductors are transposed?



How is the transposition of the cat head tower in the distance achieved by this tension tower?

Multi-circuit tower

tension tower

angle tower

transposition tower