STATE GRID

PINGGAO GROUP CO.,LTD.

Gas Insulated Metal ClosedTransmission Line (GIL)

Corridor Engineering Company ofPinggao Group
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PINGGAO GROUP CO.,LTD.

CONTENTS

The figure is the internal space of group

GROUP OVERVIEW

China's biggest R&D and production base of high-tension switch and whole set equipment

Technical leader of China's high-tension switch equipment, with world-leading technology level

Equipment integrator of surveying, design, production and construction.

Own advanced international industrial park and world cutting-edge modern production line

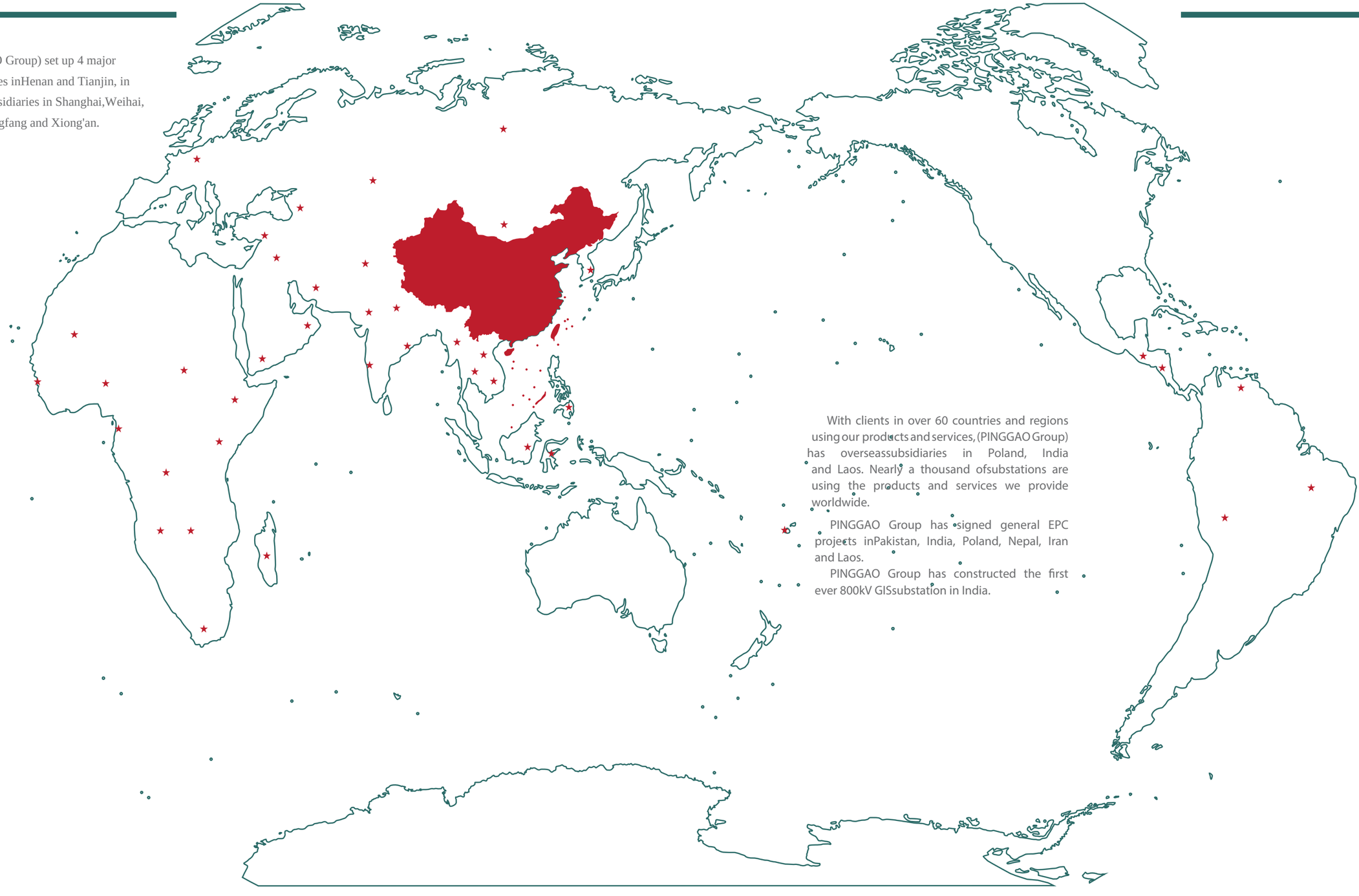
Strive to provide integral solution for power, railway, coal, petroleum, new energy and city rail transport and other industries.

Innovate commercial mode of rental, and develop from manufacturing to operation

DOMESTIC INDUSTRIAL LAYOUT

(PINGGAO Group) set up 4 major productionbases inHenan and Tianjin, in addition tosubsidiaries in Shanghai,Weihai, Changsha,Langfang and Xiong'an.

OVERSEAS INDUSTRIAL LAYOUT



With clients in over 60 countries and regions using our products and services, (PINGGAO Group) has overseassubsidiaries in Poland, India and Laos. Nearly a thousand ofsubstations are using the products and services we provide worldwide.

PINGGAO Group has signed general EPC projects inPakistan, India, Poland, Nepal, Iran and Laos.

PINGGAO Group has constructed the first ever 800kV GISsubstation in India.

GIL application and promotion

PRODUCT OVERVIEW

Gas insulatedmetal-enclosed transmission line (GIL)

Big transmission capacityand low electricity loss

Environmental friendly,without electromagneticinterference

Full life cycle, and lowcost

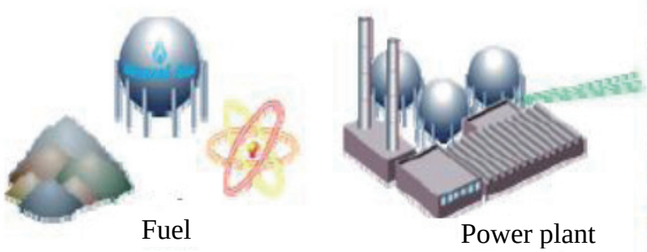
Full life cycle, and lowcost

High security andreliability, low fault rate,and long service life

Free from influence of laying height difference and bending radius

Free from influence of air pollution, altitude, and other environmental factors

GIL is the best solution to substitute overhead transmission line and high voltage cable to solve electricity transmission corridor restrictions, such as residential areas, airports, hydropower station, and other special environment, as well as the first option for large capacity transmission in city center.



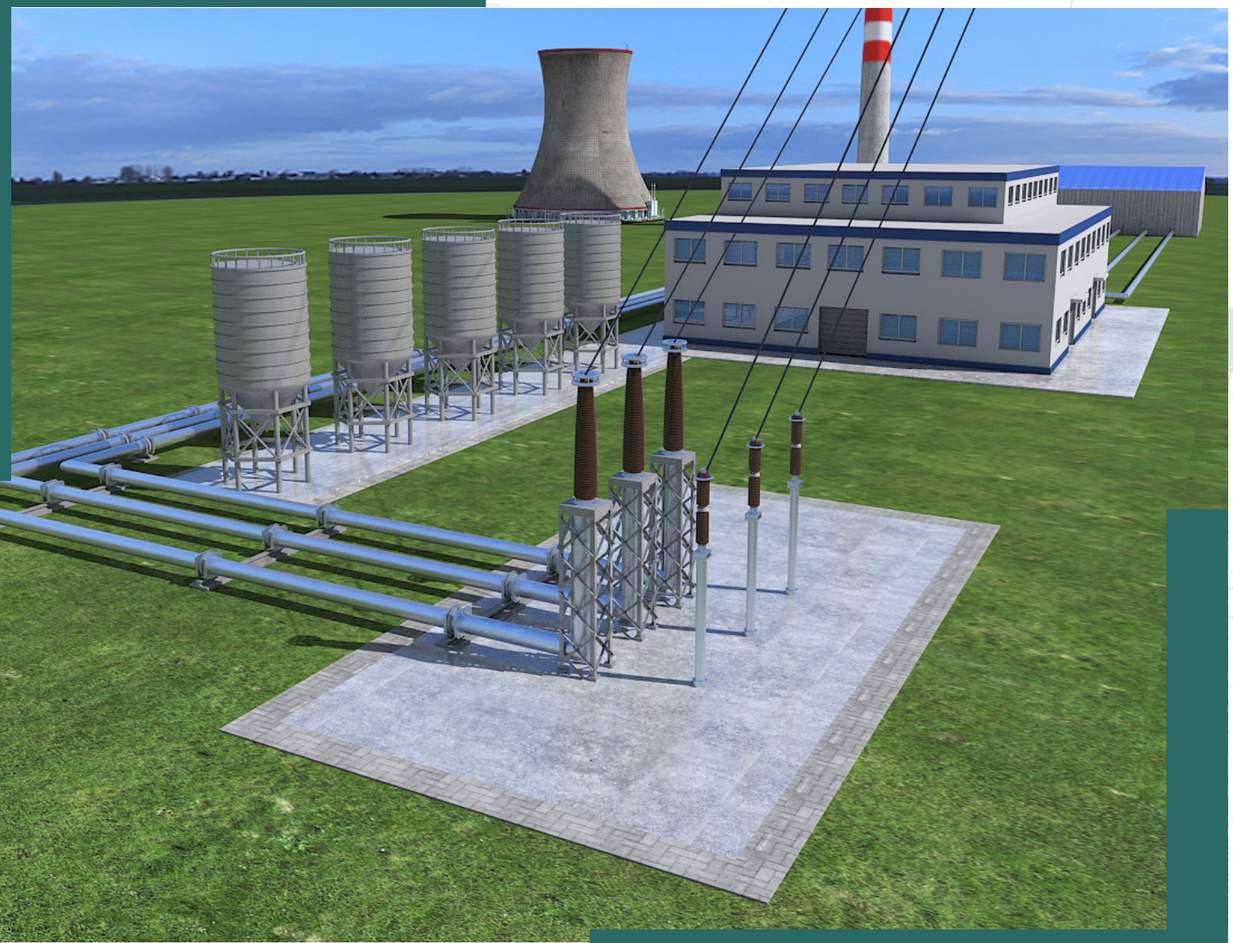
APPLICATION ADVANTAGE

Property comparison of GIL with cable

GIL equipment VS cable		Reason analysis
Electricity transmission loss	Compared with cable, GIL equipment reduces by 30% to 50%	GIL equipment conductor and shell has large cross section, with low resistive loss.
Transmission capacity	Maximal rated current of GIL equipment can reach 8000A, and maximal transmission power exceeds 10GW.	GIL equipment conductor has big cross section.
High security	GIL equipment has strong seismic capability, without the hidden danger of aging and fire.	GIL equipment is metal enclosed steel structure, with insulation gas filled inside.
State testing	GIL equipment can have state testing (such as gas density, fault current, partial discharging, shell temperature, etc.), while cable can't.	Product structure is different
Environmental friendly	Peripheral external space electromagnetic field of GIL equipment is nearly 0.	Circulating current generated by electromagnetic induction of three-phase shell return circuit of GIL equipment is about the current of the bus, and their directions are opposite, which makes the electromagnetic field of the shell nearly disappears.
Operation maintenance	Low operation maintenance cost	GIL equipment is free from maintenance within 30 years, with 50 years operation service life, while cable just has 25 years operation service life.

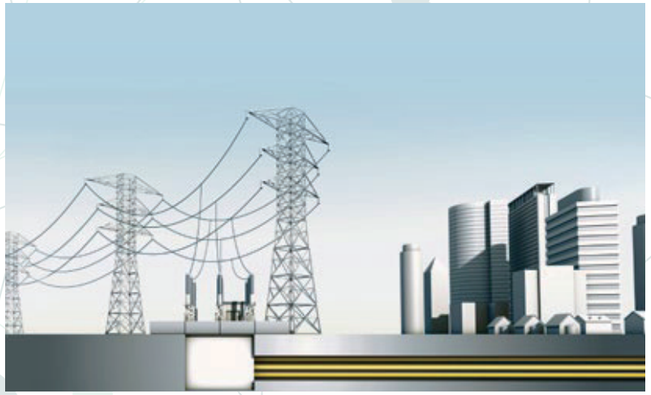
GIL solves the problems of cable, such as weak circulation ability, high loss, high heating, high overhaul cost, etc., and realizes fire prevention, fast fault positioning and recovery, full life cycle and large capacity transmission.

APPLICATION



Pumped storage power station, hydropower station, thermal power station, and nuclear station.

Import and export line of transformer substation



Substitute overhead line or powercable in power transmission engineering

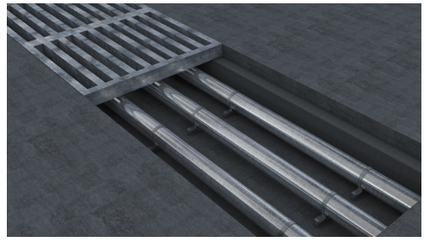
Municipal comprehensive corridor

LAYING METHOD

In-duct laying is not convenient to use in ground or overhead laying for power transmission engineering.

In-duct laying needs to do the drainage of groove and protection of cover plate.

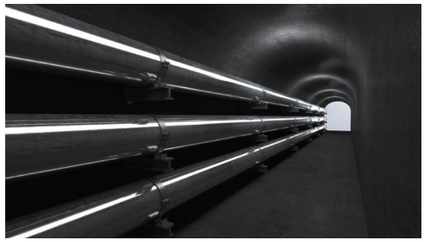
In-duct laying method



Groove laying mode

Tunnel laying is usually determined by geographic and line planning. While Other laying methods are restricted in city, island, river, mountain, etc, the adoption of tunnel laying can shorten line laying distance and reduce cost of transmission line.

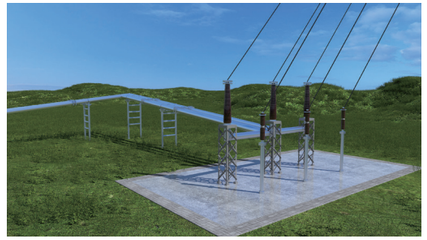
Tunnel laying method



Mode of tunnel laying

Ground and overhead laying method is usually used for electricity corridor tension, power plant or transformer substation, river crossing, and other areas. Ground and overhead laying height is usually confirmed according road requirements and protection needs to be done well. It is a wide deployment form.

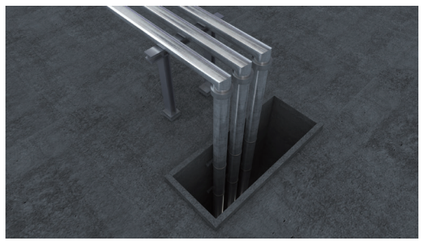
Ground and overhead laying method



Ground overhead laying mode

Because of its special structure, hydropower station usually adopts shaft laying method; in city power grid, because of special underground corridor, tunnel needs to be constructed in relatively deep stratum, and also usually adopts shaft laying method.

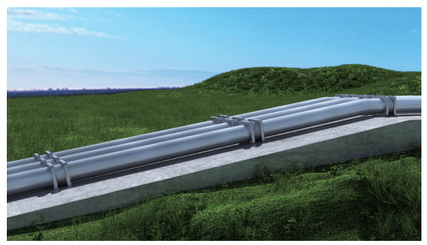
Shaft laying method



Shaft laying mode

Slope laying is usually used in hydropower station. Because of its peculiarity, hydropower plant is usually built in mountain areas in the form of underground workshop, therefore, it can only use slope laying, with the slope between 5°-35°.

Slope laying method



Slope laying mode

Introduction of GIL product

Using environment

SN	Name		Unit	Parameter value
1	Peripheral air temperature	Highest temperature	℃	+40
		Lowest temperature		-40
		Maximal daily temperature difference	K	25
2	Sunlight radiation intensity		w/m^2	1000
3	Wind speed		m/s	34
4	Humidity	Average value of relative daily humidity	%	≤95
		Average value of relative monthly humidity		≤90
5	Earthquake intensity (Horizontal accelerated velocity)		---	AG5
6	The installation place should be free from frequent severe vibration and influence of combustible, inflammable, and chemical erosion.			

Main technical parameters

SN	Project name	Unit	Parameter value						
1	Rated voltage	kV	1100	550	420	363	252	126	40. 5
2	Rated current	A	6300	5000	4000	4000	3150	2500	3150
3	Rated power frequency withstand voltage (1 min relative effective value)	kV	1150	740	650	510	460	230	95
4	Peak value of withstand voltage of rated lightning impulse (1.2/50μs) (relative peak value)	kV	2640	1675	1425	1175	1050	550	185
5	Rated short term withstand current	kA	63	63	63	63	50	40	40
6	Rate peak withstand current	kA	170	160	160	160	125	100	100
7	SF6 gas pressure	MPa	0. 45	0. 45	0. 45	0. 4	0. 4	0. 4	0. 1
8	Shell diameter	mm	900	1522	448	448	332	452	250
9	Deployment form		Sub-phase	Sub-phase	Sub-phase	Sub-phase	Sub-phase	Shared enclosure of three phase	Sub-phase

PRODUCT SERIATION

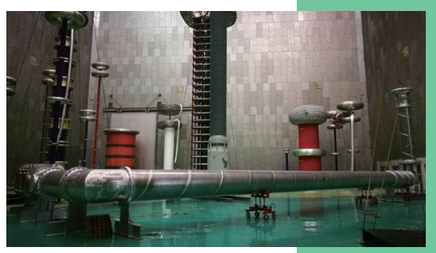
40.5kV GIL

126kV GIL

252kV GIL

363/420kV GIL

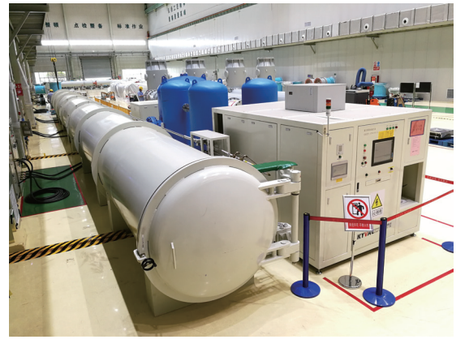
550kV GIL



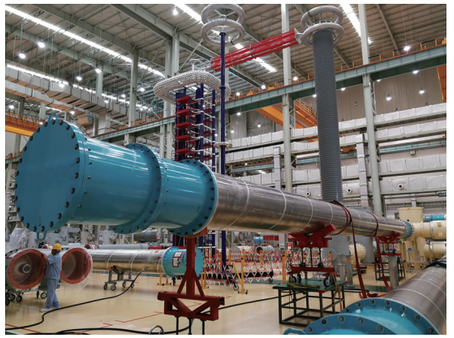
1100kV GIL

OQCexperiment

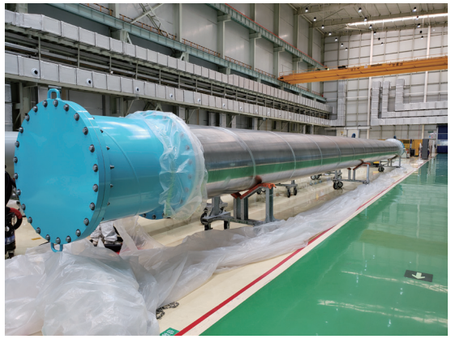
The company owns series and professional parts testing instruments, able to realize the tests and experiments of parts in the whole process of production and manufacturing and ensures quality of products delivered.



Helium leak test



Insulation test



气密试验

GIL Type test report of 40.5kV/252kV/550kV/1100kV

40.5kV GIL（Single phase）

252kV GIL（Single phase）

550kV GIL（Single phase）

1100kV GIL（Single phase）

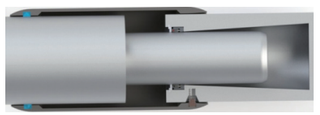
KEY EQUIPMENT

I. Shell and conductor

- Shell: Adopts high intensity aluminum, with stable and reliable quality, with manufacturing length reaching 18m, able to reduce product sealing surfaces effectively and reduce gas leak rate and insulator load requirements.
- Conductor: Adopt high intensity rods and bars of aluminum alloy, with big circulation cross section and strong circulation ability.

II. Electrical connection

- Adopt socket structure, able to regulate according heat expansion and cold shrinkage; with shielding cover set outside, able to make the electric field uniform and collect particles
- Adopt HM contact, having high circulating ability than traditional contact, able to meet the needs of long term large current circulation.
- Able to realize compensation of ± 2.5°, and axial compensation of ±40mm

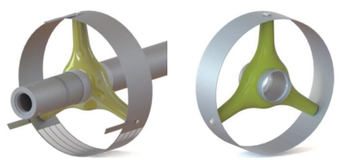


Electrical connector

HM contact

III. Insulators

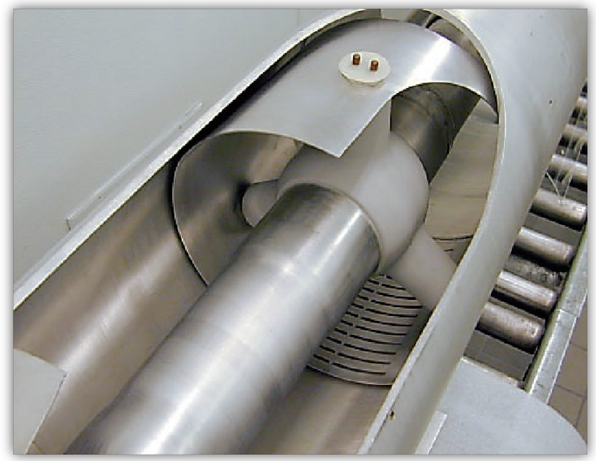
- Utilizes triple strut insulator and embedded bowl insulator.



Three-post insulator (fix, slide)

Basin-type insulator

IV. Particulate filter

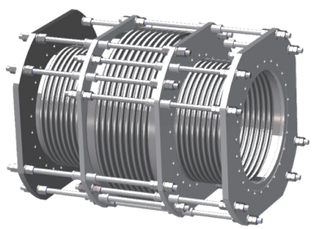


Particulate filter

- Adopt partial grid opening cylindrical particle filter structure
- Used together with insulators, in product operation, absorb charged particle to particulate filter, reduce the discharging rate of surface of insulators caused by charged particles, and improve insulation reliability of GIL

V. Compensation parts

Compound pull rod telescopic section



Force balance telescopic section

Hinge telescopic section

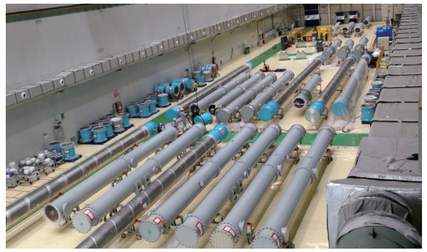
- Able to absorb basic error, installation error, axial andradical deformation,heatexpansion and cold shrinkage,and uneven sediment of foundation
- Effectively improve the flexibility of pipes, reduce pipes' requirement on installation environment (uneven sediment, foundation error).

GIL production and installation

PRODUCTION CAPACITY

Workshop grade and production capability

Our 5000m2 GIL production and assembly workshop is fitted with central air conditioning andcentral air processing systems, which boosts air rating to level 8 for internal assembly areas and level9 for external assembly areas. The state-of-the-art production facility provides the entire componentproduction process with washing, drying, assembly, experimentation and storage. The annualproduction power is 80km of 252kV GIL products, 55km of 550kV GIL, and 45km of 1100kV GIL.



GIL assembly workshop

Production capability of surface processing and insulators.

Digital processing and production line

Shell factory production line of Pinggao Group

Mechanical processing capability

Own the processing and manufacturing capability for supporting key and core parts of various switches of 1100KV and below, with comprehensive ability of mechanical manufacturing rank top in the industry. Own more than 5000 sets of main processing equipment, including more than 200 sets of CNC processing equipment. Own the most advanced CNC machine group and shell coating production line, including Hardinge, Toshiba Machine, MAZAK, Taichung Seiki and other CNC equipment.

Surface processing

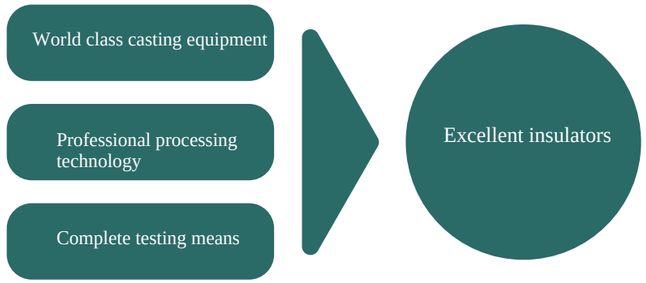
Operation area of workshop for parts surface processing reaches 17,000 square meters, with 18 production lines of silver plating on aluminum, silver plating on copper, chromium plating, etc. Automatic procedure control system, professional surface processing lab and professional testing equipment ensure safe and reliable quality for the product.

Production capability of insulators

Own modern workshop of 17000 square meters and relatively strong R&D capability of insulators, master insulator manufacturing technology of HV, EHV, UHV and other grades.

Main production equipment is world advanced vacuum casting system of epoxy resin from Germany, with technological equipment leading in domestic, powerful gluing, manufacturing and production ability of insulator casting, arc extinction nozzle and insulation pull rod, with insulation product processing and manufacturing ability of 100km of 42.5～550kV GIL per year, 70km of 1100kV GIL per year.

Guaranteed by strict technological process control system and large amount of technological innovation achievements, reliability of insulation products have always been in the leading level in the industry.

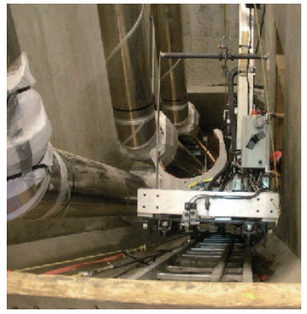


Installation & Operation

According to different tunnel types and GIL equipment of different voltage grade, and different engineering, research and develop rail or rail-less transport vehicles with different load or make GIL equipment in position in advance correctly through driving on top of the tunnel, provide regulation for GIL accessing. Hook can be set on the top of the tunnel to assist GIL accessing through hand chain hoist.

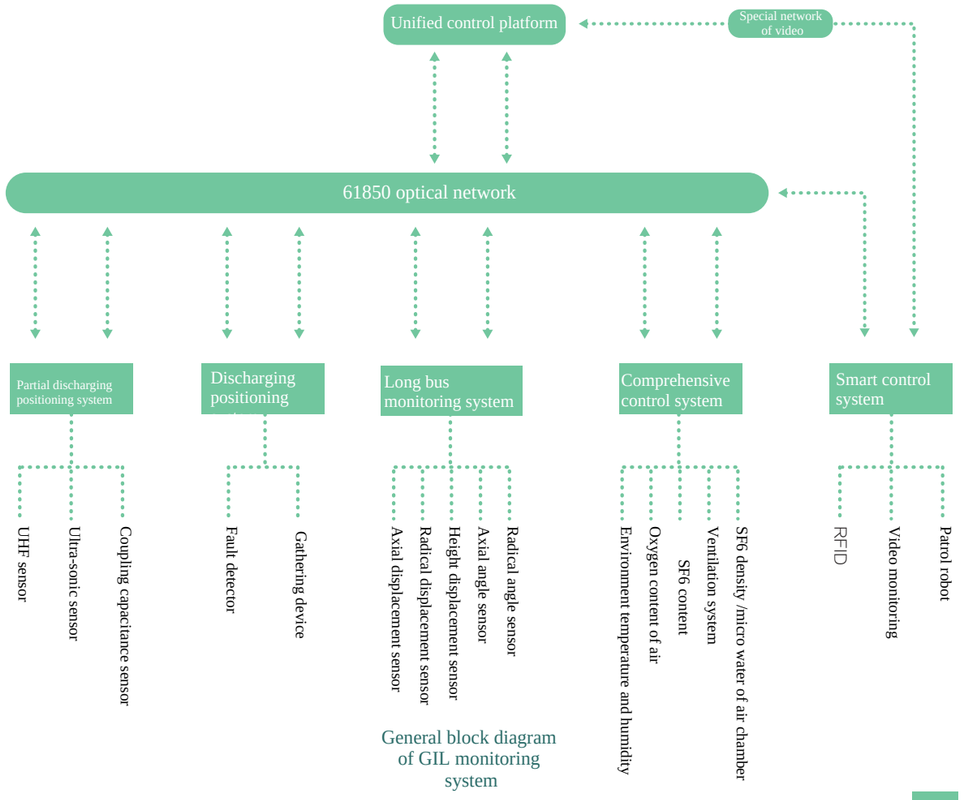
GIL tunnel transport vehicle

GIL tunnel installation vehicle



GIL slant shaft installation vehicle

GIL operation route can realize state test of SF6 density, fault current, partial discharge and shell temperature, discover problems in advance and have overhaul, avoid major security accident, and solve the world difficulty of being unable to test insulation state of cable operation route.



General block diagram of GIL monitoring system

Serve for SUTONG corridor engineering

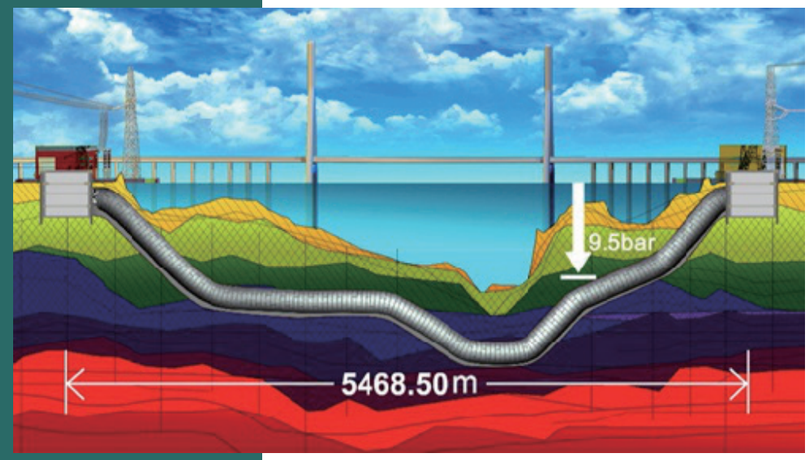
Construction background of SUTONG Engineering

ENGINEERING APPLICATION

SUTONG GIL corridor engineering of Huainan-Nanjing-Shanghai UHV AC is the first UHV GIL corridor engineering in the world. Single phase GIL pipeline length reaches 5.8 km, 6 phase of 2 return circuits are 35km in total. Currently, it is a super long distance UHV GIL innovation engineering in the world, with the highest grade of voltage, the largest transmission capacity, the longest single GIL, and the highest technology level.

PINGGAO Group provided 50% of the GIL equipment for the engineering and realized self production

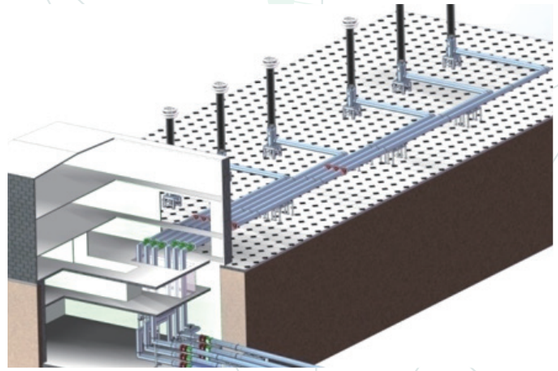
Huainan-Nanjing-Shanghai UHV engineering



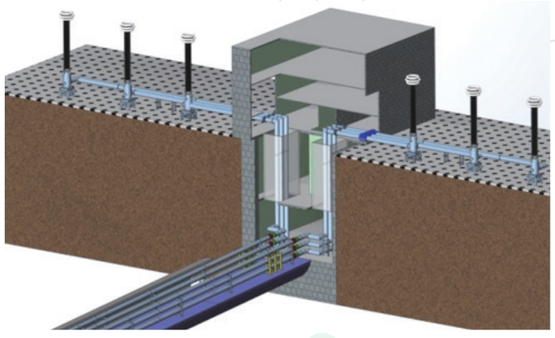
Rendering of cross section of cross river GIL corridor

Engineering application

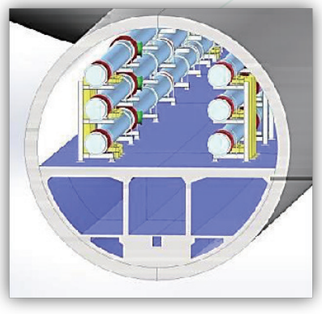
According to the actual work condition of large arc curve direction of the tunnel in SUTONG engineering, it adopts the engineering innovation design method of multi broken line fitting and 3D whole parameter model construction, which not only improves design accuracy and efficiency, but also realizes visualization of product design.



South bank connection station and shaft of SUTONG engineering



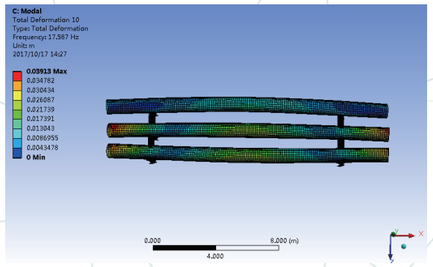
North bank connection station and shaft of SUTONG engineering



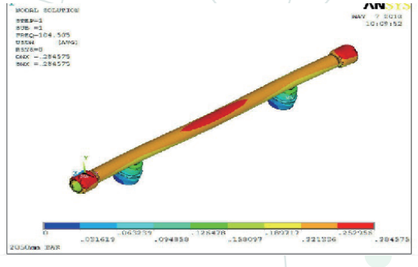
Cross river corridor of SUTONG engineering

According to peculiarity of SUTONG GIL equipment (long distance, special deployment form), on the basis of adopting traditional CAD design, carry out 3D design , flexibility compensation design of whole engineering, big air chamber design, particulate governance and study and management of full life cycle, to ensure the quality and efficiency of SUTONG engineering design.

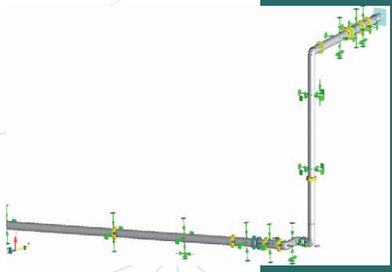
3D data analysis



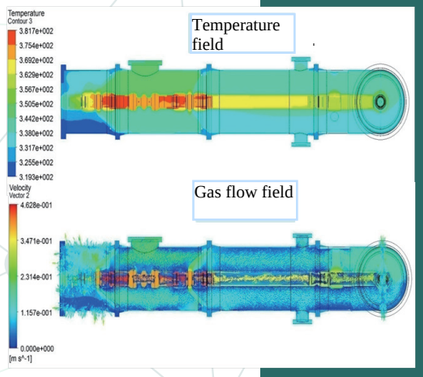
Analysis of anti-seismic design



Resonance frequency analysis under electro-dynamic force



Analysis of flexibility compensation design



Temperature field and gas flow field analysis

Particulate governance and study

Experiment base of Wuhan UHV AC

SN	Project name	Product name
1	New construction engineering of 220kv power transmission and transformation of Changchun, Tiebei	220kV GIL
2	Guanyingyan hydropower station engineering at middle reaches of Jinsha River	550kV GIL
3	Houziyan 500kV hydropower station engineering of Dadu River of China Guodian Corporation	550kV GIL
4	Mouping 500kV Power transmission and transformation project	550kV GIL
5	Bus project of 550kVclosed pipe bus engineering of Nanqiao, Shanghai	550kV GIL
6	500kV convertor station engineering of Jinhua, Zhejiang	550kV GIL
7	Zhengzhou convertor station engineering	550kV GIL
8	Luxi convertor station engineering of asynchronous grid connection engineering	550kV GIL
9	Convertor station engineering of Shaoxing, Zhejiang	550kV GIL
10	Grade I hydropower station engineering of Jinping, Ertang, Sichuan.	550kV GIL
11	SUTONG UHV 1100kV GIL corridor engineering	1100kV GIL
12	Nanjing station engineering of UHV 1100kV	1100kV GIL

Test run

● Branch bus of Nanjing Station GIS engineering of UHV adopts 1100kV GIL

● Stage I and Stage II equipment of 1100kV GIL line of Wuhan UHV AC experiment base both adopt 1100kV GIL, with the insulation medium of Stage I as mixed gas（N2/SF6）and of Stage II as SF6.

UHV Nanjing Station

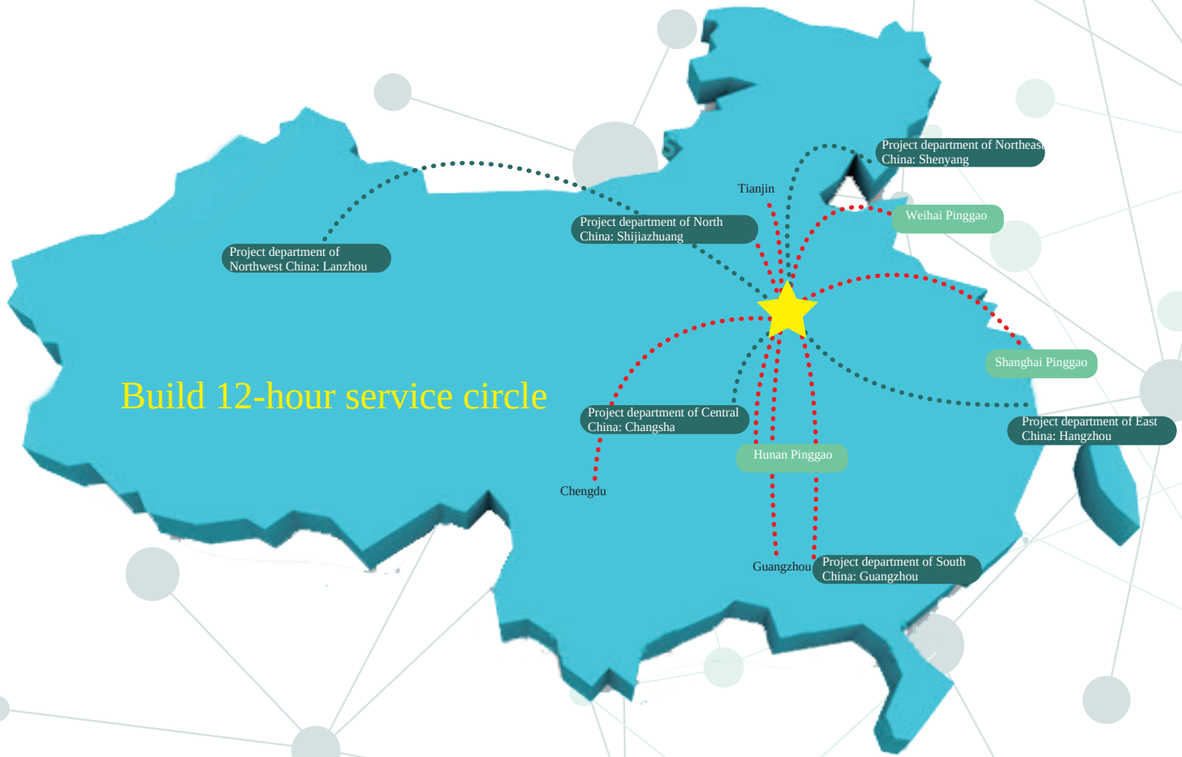
Experience accumulation

In recent years, Pinggao Group takes serving SUTONG GIL comprehensive corridor engineering as an opportunity, completes UHV GIL product R%D by establishing cooperation with American AZZ in depth, masters key technologies of GIL, establishes complete technological process system, forms series GIL product and industry chain of 40.5kV, 220kV, 550kV, 1100kV, and accumulates rich and mature experience in design R&D, production assembly, site installation and operation and maintenance service .

SERVICE NETWORK

Our mission:

Strive to provide complete system solution and establish fast response mechanism of after-sales service



PINGGAO GROUP CO.,LTD.

Serve for you sincerely