Present Situation and Development Trend of Power Transmission Equipment in China

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1. Foreword

- Energy Distribution (China)
- UHV Equipment
- Smart Grid
1. Foreword

Energy Distribution (China)

- Coal resource
- Oil/gas resource
- Water resource
- Load center
1. Foreword

UHV Equipment

UHV AC  1100kV

UHV DC  ±1100kV/ ±800kV

Insulation test on 1100kV GIS  Project site of ±800kV UHV thyristor valves
1. Foreword

Smart Grid

UHV

Main Grid

Strong
High voltage AC power transmission equipment manufacturing
Provide complete sets of domestic equipment for the first 330kV AC transmission project in 1972.

Provide complete sets of domestic equipment for the first 500kV EHV AC transmission project in 1981.

Provide complete sets of domestic equipment with world advanced level for the 750kV AC transmission project in 2005.

Provide complete sets of domestic equipment with world advanced level for the first 1000kV UHV AC transmission project in 2008.
2. AC Power Transmission

2.1 Present Situation

- Can’t develop well without the development and the progress of any related parameters.

- Significant increase
  - standard system construction
  - product design capability
  - manufacturing capability
  - test verification capability

- The achievement is the cornerstone of the rapid growth of Transmission Equipment Manufacturing.
2. AC Power Transmission

2.1 Present Situation

2.1.1 Standard System Construction

- Completed standard system
- Equivalent to international standard
- Covered all aspects of product
- Guaranteeing performance and quality of the product
2. AC Power Transmission

2.1 Present Situation

2.1.2 Product Design Capability

3D assembly modal and cross section electric field of high-voltage switchgear

Temperature field of high-voltage switchgear during breaking the short-circuit current
2. AC Power Transmission

2.1 Present Situation

2.1.2 Product Design Capability

Assembly site of 1100kV HGIS

1000kV 1000MVA Autotransformer on test

1000kV capacitor voltage transformer

1100kV arrester
2. AC Power Transmission

2.1 Present Situation

2.1.3 Manufacturing Capability

- Manipulator complex processing center
- Complex processing center
- Horizontal processing flexible production line
- Cross cut transformer core production line
2. AC Power Transmission

2.1 Present Situation

2.1.3 Manufacturing Capability

Digital Manufacturing

DNC/MDC system

CAM system
2. AC Power Transmission

2.1 Present Situation

2.1.3 Manufacturing Capability

- Insulating factory building with high cleanliness, constant temperature and constant humidity
- Production line for dry-type bushing
- Assembled 1100kV UHV bushing of transformer
- Pouring production line
- Insulation Process Equipment
- Workshop of arrester valves
2. AC Power Transmission

2.1 Present Situation

2.1.3 Manufacturing Capability

- Stacked assembled table for 250 tons transformer
- Workshop of transformer coil
- Assembly visualization technology
- Digitized installation guide
2. AC Power Transmission

2.1 Present Situation

2.1.4 Test Verification Capability

- Significant Indicator
- First One
- Rated Voltage 1000kV
- 1100kV GIS
2. AC Power Transmission

2.1 Present Situation

2.1.4 Test Verification Capability

- 6500MVA Short-circuit generator
- Dielectric test on 1100kV GIS
- Artificial climate lab
- 4800kV Impulse generator
2. AC Power Transmission

2.2 Development Trend

2.2.1 Intelligent

Condition monitoring (sensor and monitoring curve)

Intelligent system
2. AC Power Transmission

2.2 Development Trend

2.2.1 Intelligent

Electronic transformer and its merging unit

UHF partial discharge sensor and partial discharge monitoring
2. AC Power Transmission

2.2 Development Trend

2.2.2 More environmentally friendly

The main study is finding the alternatives for greenhouse gas SF6, including:

- Using the medium voltage vacuum technology in high voltage equipment.
- Study on mixed gas.
- Develop the medium voltage solid insulation products.
2. AC Power Transmission

2.2 Development Trend

2.2.3 Save energy

- Reduce
  - weight
  - size
  - consumption
  - number
  - material

- Improve
  - reliability
2. AC Power Transmission

2.2 Development Trend

2.2.4 Efficient

- New materials of insulation and arc-extinguishing medium
- High-temperature superconducting materials
- Semiconductor (mixed) equipment

2020 - 2030
2. AC Power Transmission

2.2 Development Trend

2.2.5 High Reliability

- Develop on-line monitoring technology
- Develop failure diagnosis technology

- Reduce cost of equipment operation
- Improve life of the equipment
- Produce products do not need maintenance
3. DC Power Transmission

High voltage DC power transmission equipment manufacturing
3. DC Power Transmission

**Milestones**

- Provide complete sets of domestic equipment for the first ±31kV DC transmission line in 1977.
- Provide complete sets of domestic equipment for the first ±50kV DC transmission line in 2003.
- Provide complete sets of domestic equipment for the first ±500kV DC transmission line which is complete built domestically in 2009.
- Provide complete sets of domestic equipment for the first commercial operation DC transmission line with rated voltage ±800kV in 2010.
3. DC Power Transmission

3.1 Present Situation

➢ To the end of 2012, 23 DC transmission projects

➢ Ability

  ✓ system research
  ✓ packaged design
  ✓ equipment manufacture
  ✓ test verification
  ✓ field installation

➢ Highest voltage level and biggest transmission capacity
3. DC Power Transmission

3.1.1 Standard System Construction

- Develop the national standards
- Guarantee the quality of the project
- Guarantee operating reliably of equipment
- TC115 August 15, 2008
3. DC Power Transmission

3.1 Present Situation

3.1.2 System study and Product Design Capability

- RTDS real-time digital simulation system
- security and stability control
- over-voltage insulation coordination
- electromagnetic environmental
- external insulation
- ±800kV UHV DC

Establish

- technical standard system
- technical specifications
3. DC Power Transmission

3.1 Present Situation

3.1.3 Manufacture of superpower thyristor cell

5000A 8500V large power electronically controlled thyristor cell

3400A/8000V large power light controlled thyristor cell

Chip technology workshop
3.1 Present Situation

3.1.4 Thyristor Valves Manufacturing

Project site of ±800kV UHV thyristor valves

Project site of ±500kV EHV thyristor valves
3. DC Power Transmission

3.1 Present Situation

3.1.5 Control Protection system

The world’s first ±800kV DC control protection prototype on test
3. DC Power Transmission

3. 1 Present Situation

3. 1. 6 Test Verification Capability

Thyristor valves test

- ±800kV UHV Thyristor valves on test

- ±1100kV Thyristor valves on insulation test

Insulation test

operation test
3. DC Power Transmission

3.1 Present Situation

3.1.6 Test Verification Capability

Thyristor valves test

Insulation test

√ operation test

±1100kV thyristor valves components on synthetic circuit test
3. DC Power Transmission

3.1 Present Situation

3.1.6 Test Verification Capability

- Converter transformer and smoothing reactor test

±800kV converter transformer on test

±800kV dry-type smoothing reactor on test

±1100kV
3. DC Power Transmission

3.2 Development Trend

3.2.1 Technology of ±1100kV UHV DC project

- Possible and inevitable
  - overvoltage suppression
  - insulation coordination
- Research
  - air gap
  - electromagnetic environment
- ready for engineering practice conditions
- 2015, ± 1100 kV
3. DC Power Transmission

3.2 Development Trend

3.2.2 Technology of flexible DC transmission

**History**

1990s, based on HVDC

**Key technology**

- high-voltage, high-power voltage source converter
- turn-off device
- multi-terminal flexible DC transmission
- intelligent flexible DC power distribution network
3. DC Power Transmission

3.2 Development Trend

3.2.2 Technology of flexible DC transmission

Flexible HVDC thyristor valves

Multi-level dynamic simulation experiment platform of 49 level modular
3. DC Power Transmission

3.2 Development Trend

3.2.2 Technology of flexible DC transmission

- Design of ± 300 kV valve hall
- Layout of ± 300 kV converter station
Summary

1100kV

Intelligent

High Reliability

Environmentally friendly

Efficient

Save energy

± 1100kV

Technology of ±1100kV UHV DC project

Flexible DC transmission
Thank you!