ASIA CLEAN ENERGY FORUM 2025

Empowering the Future: Clean Energy Innovations,
Regional Cooperation and Integration, and Financing Solutions

2–6 June | ADB Headquarters, Manila

ADB

Spotlight Session on

Interregional Connectivity
State-of-the-Art Subsea Power Cables:
Unlocking the Future of Global Energy Trade

4 June 2025 | 2–5:30 p.m. (GMT+8)

In cooperation with

Global Energy Interconnection
Development and Cooperation Organization
全球能源互联网发展合作组织

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Muhammad, Awais

Chief Engineer (Electrical R&D)
Ningbo Orient Wires & Cables Co., Ltd,
China

ORIENT 东方电缆 ORIENT CABLE | Linking the Land and the Sea

Featured Speaker

Agenda

- Background & Significance
- Brief Overview of Cable System
- HVDC Cable Technology
- Design and Development of HVDC Cable System
- Discussion and Conclusion

Background & Significance

Surplus Energy Demand

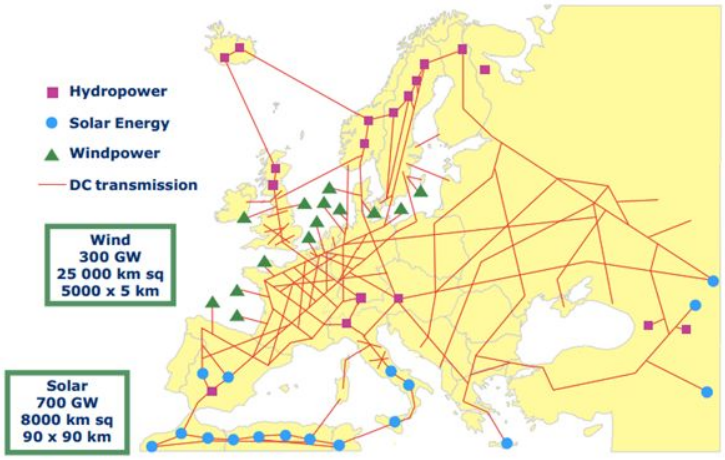
Rapid Industrialization

Greener Environment

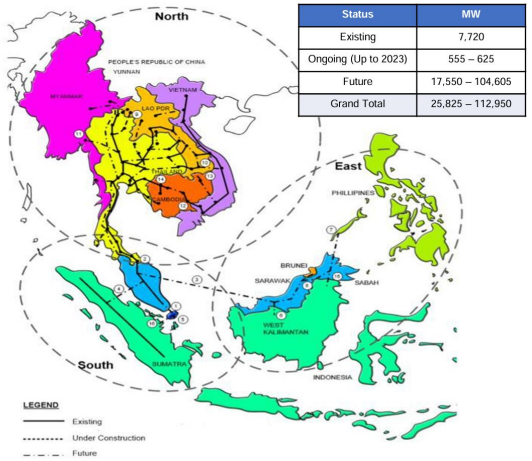
Rise in Renewable Energy Resources

Stringent Demand for Cables for Power Transmission

Global energy interconnection

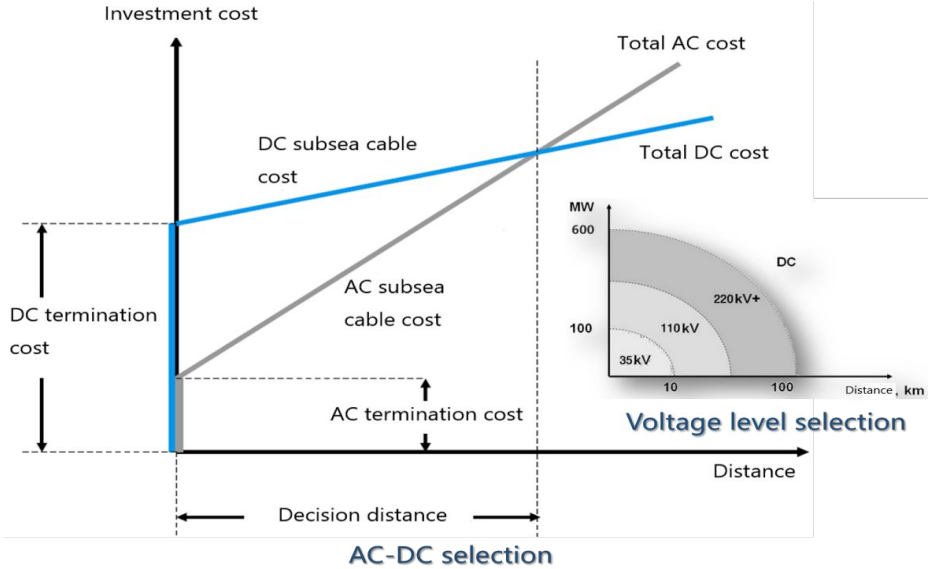


European super grid



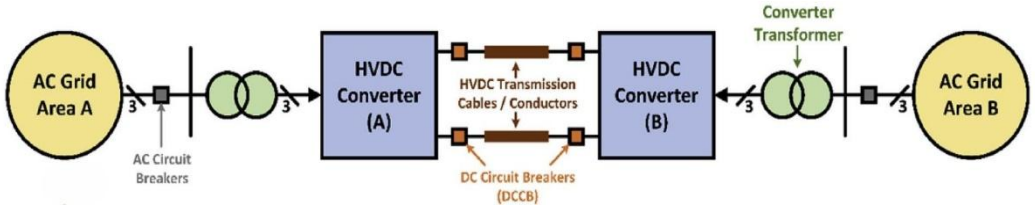
Status	MW
Existing	7,720
Ongoing (Up to 2023)	555 – 625
Future	17,550 – 104,605
Grand Total	25,825 – 112,950

ASEAN super grid



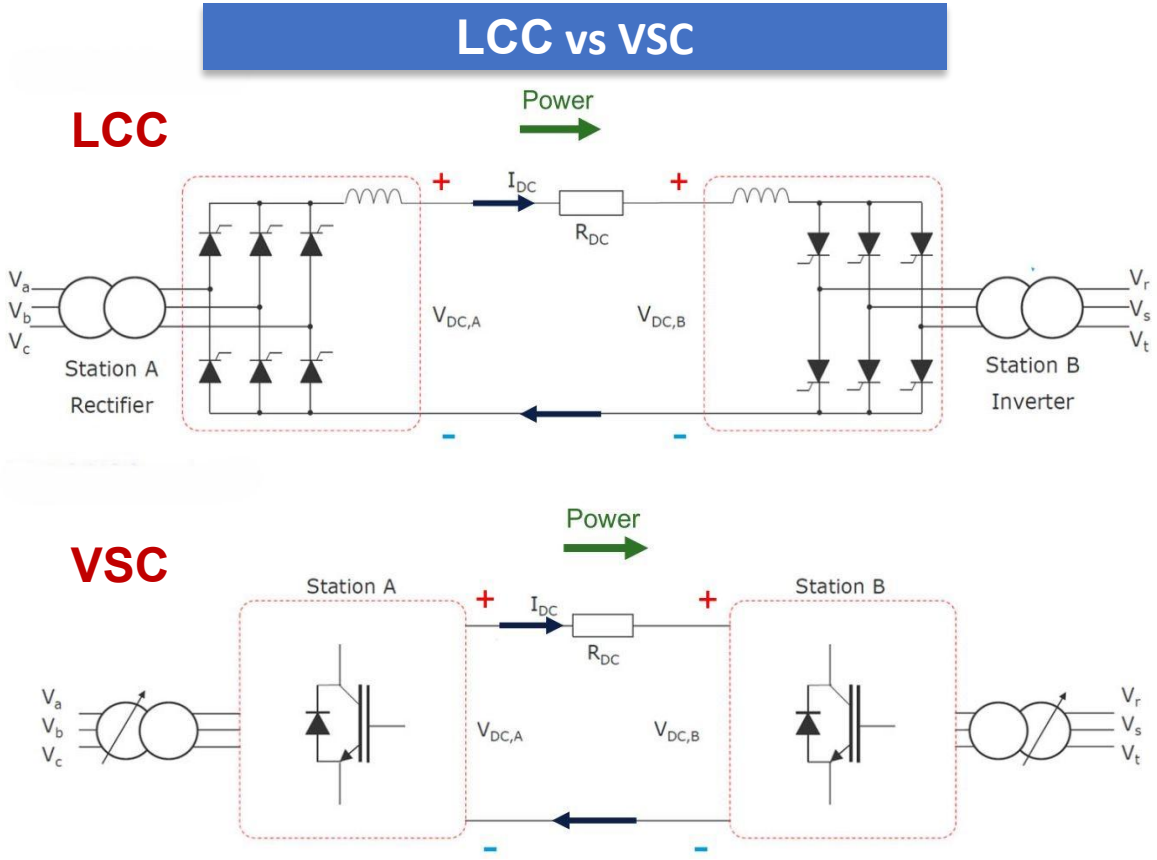
Brief Overview of HVDC System

Components & Technologies



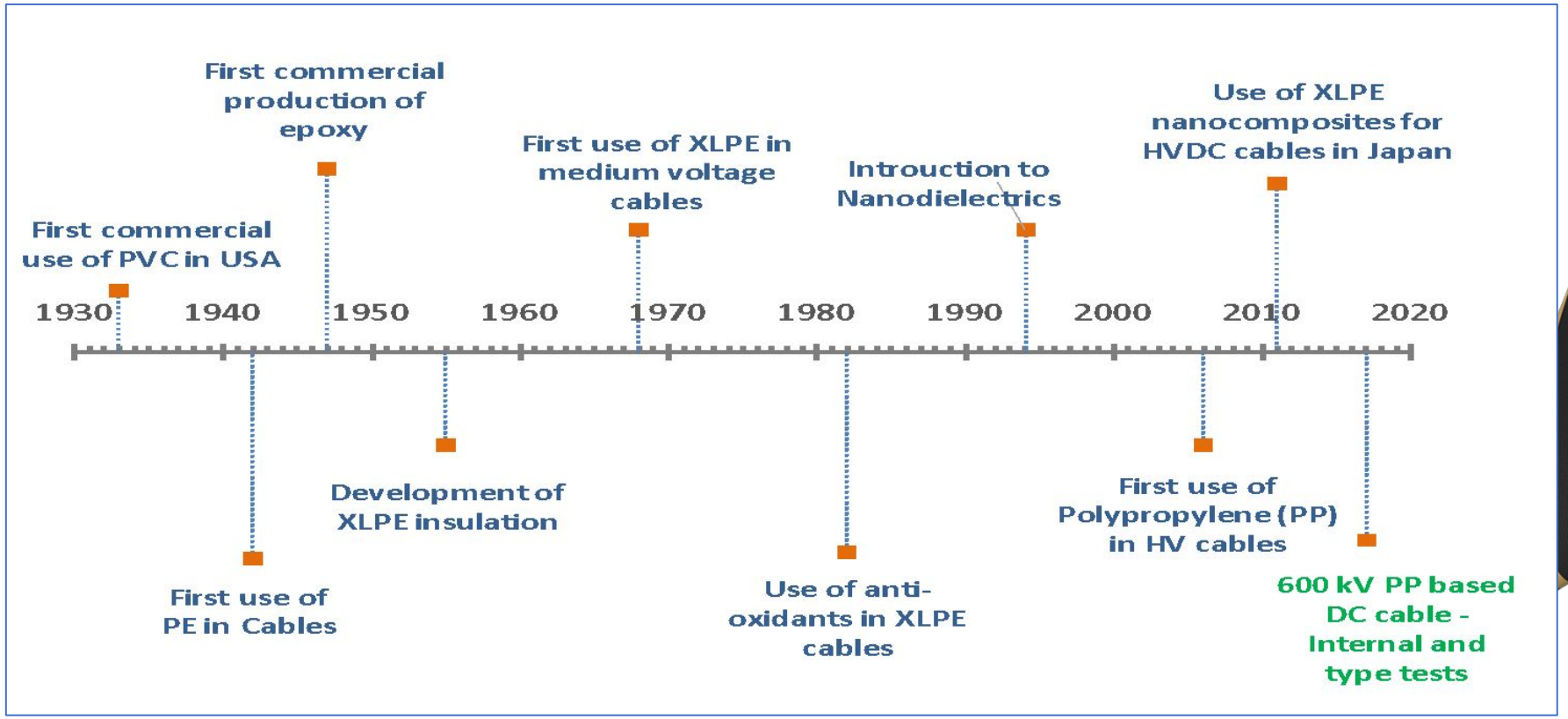
A HVDC system mainly consists of:

- AC side
  - Grid, generation side
  - Converter station
- Converter station
  - AC switchyard
  - Converters
  - DC switchyard
- HVDC OHTL/Cables

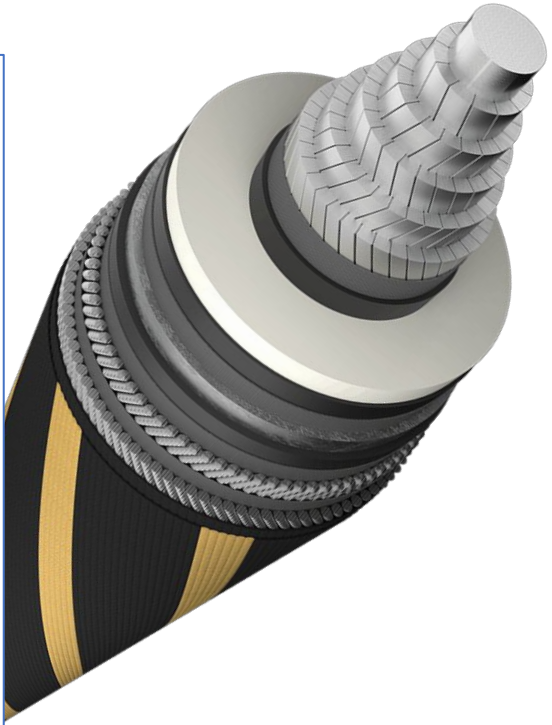


HVDC Cable Technology

Evolution of XLPE Cables

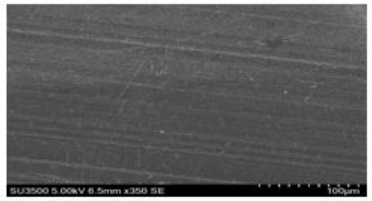


Development Timeline of Electrical Insulations

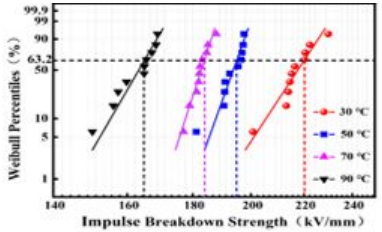


± 525 kV XLPE HVDC cable

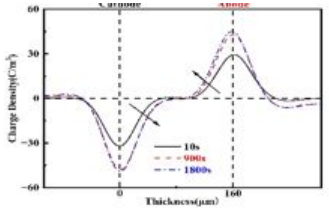
Design and Development of HVDC Cable System



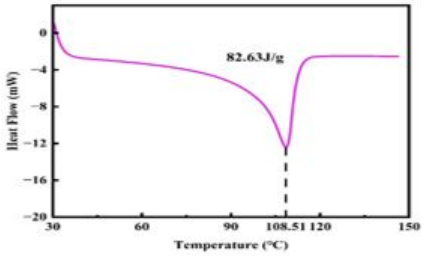
FESEM image of interface between conductor screen and insulation layer



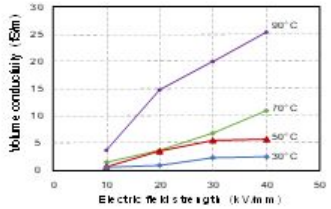
Lightning impulse strength of XLPE insultation



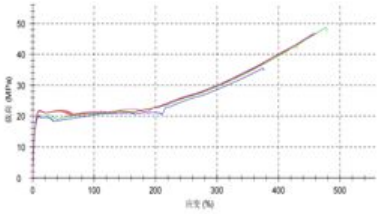
Space Charge Distribution of XLPE insulation at 90°C



DSC curves of XLPE insulation

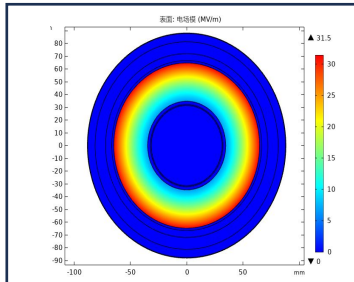


Volume conductivity of XLPE insulation material at different temperatures and electric fields

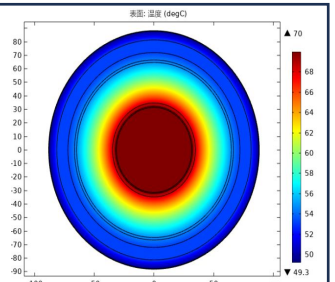


Stress-strain curve of XLPE insulation

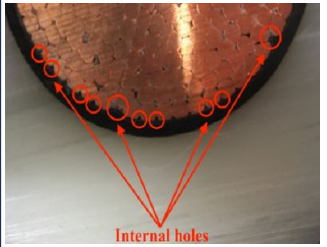
Research on XLPE Electromechanical and Physicochemical



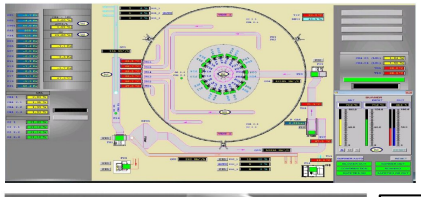
Temp Distribution

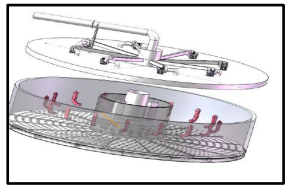


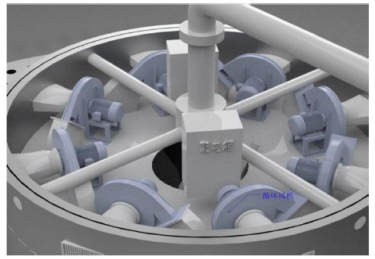
EF Distribution

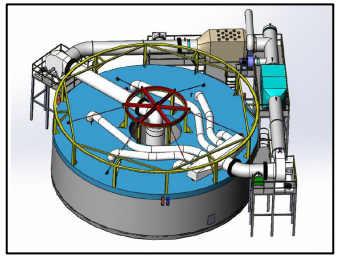


Design and Optimization of Conductor Structure

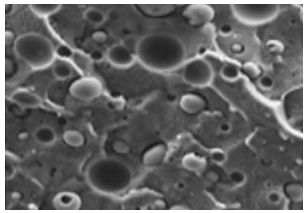


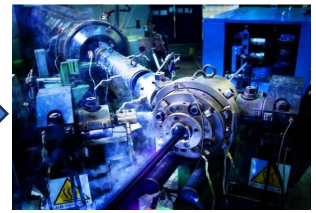


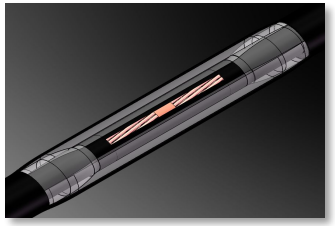


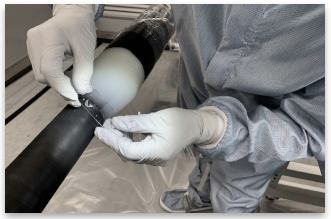


Advanced Degassing Design





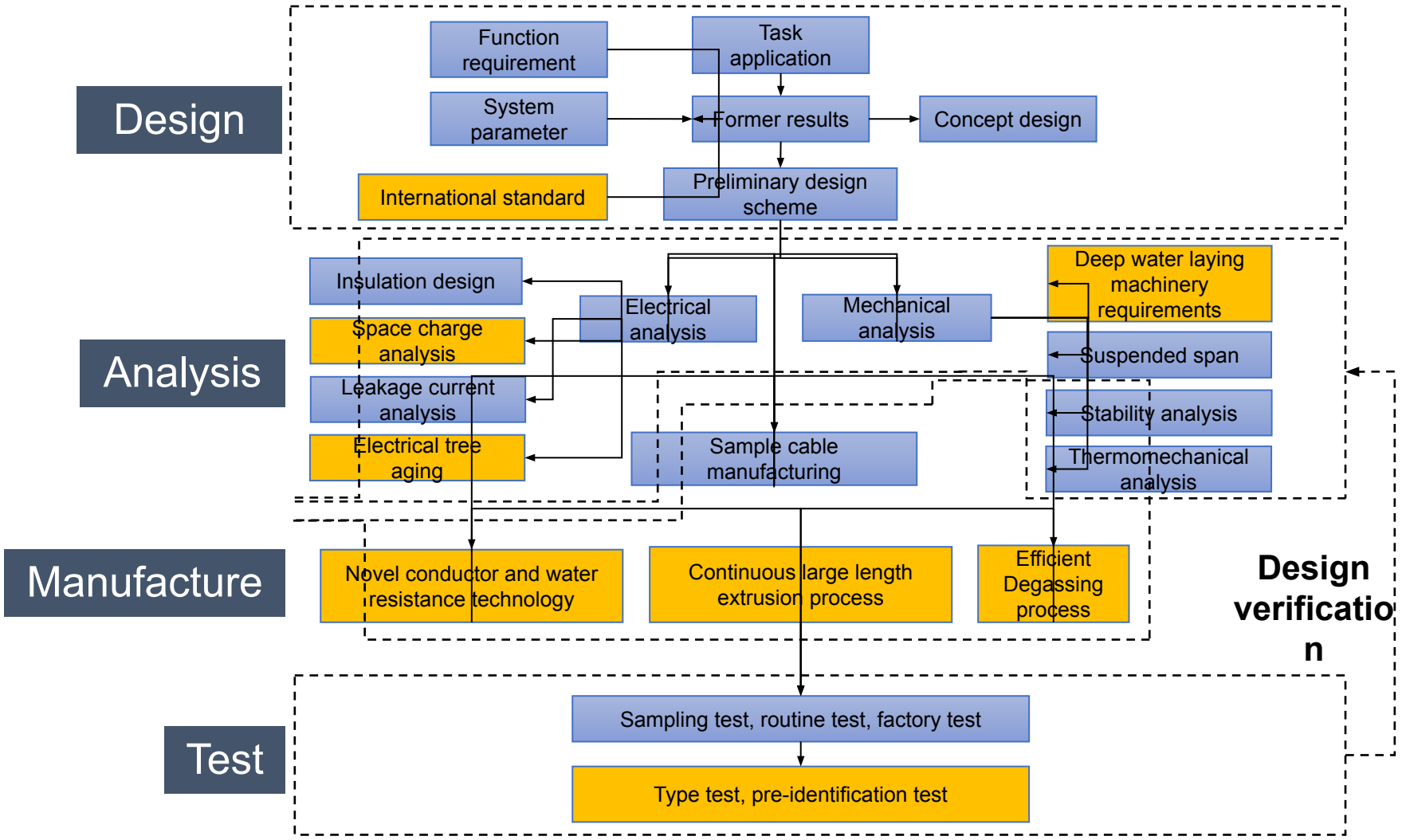


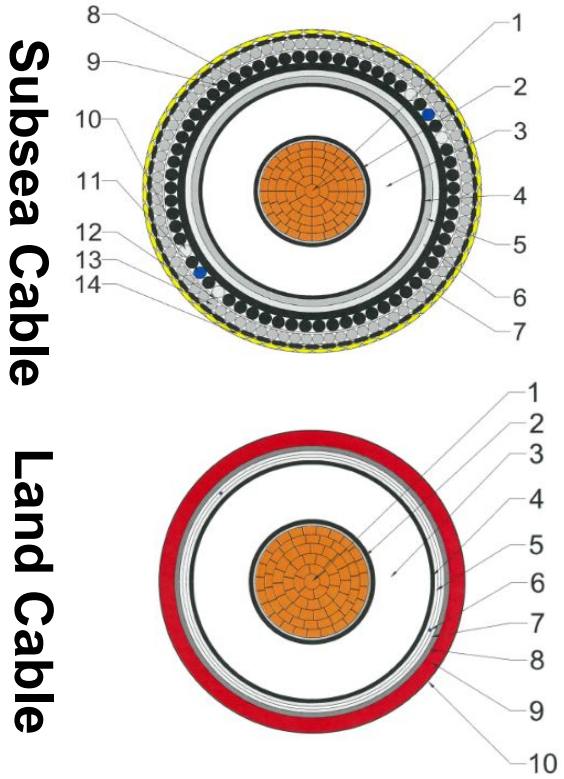


Factory Joint Design & Development

Design and Development of HVDC Cable System

Design Optimization & Development





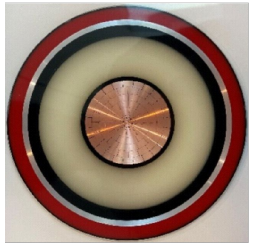
Copper Conductor: 2500mm^2

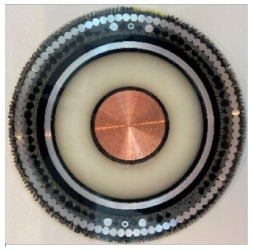
Design and Development of HVDC Cable System

Cable Manufacturing Overview

Conductor Stranding Al/Cu → Tape Wrapping → VCV

Vertical Production Line (169 m)





Cable Manufacturing Flow Chart

Semi-PE ← Lead Extrusion ← Armouring ← PP yarn

Design and Development of HVDC Cable System

Qualification of HVDC Cable System

■ **Main Standards for DC cable**

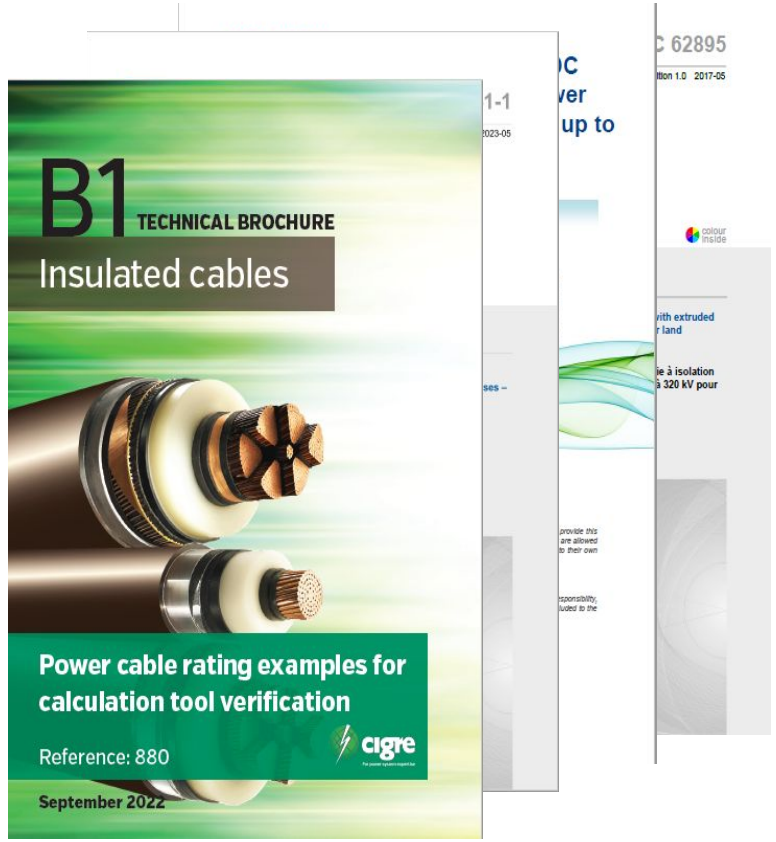
- IEC 62895

- IEC 60949
- IEC 62067
- IEC 60502
- IEC 63026
- IEC 60840
- IEC 60287
- etc.

■ **Main Specifications for DC cable**

- CIGRE TB 852

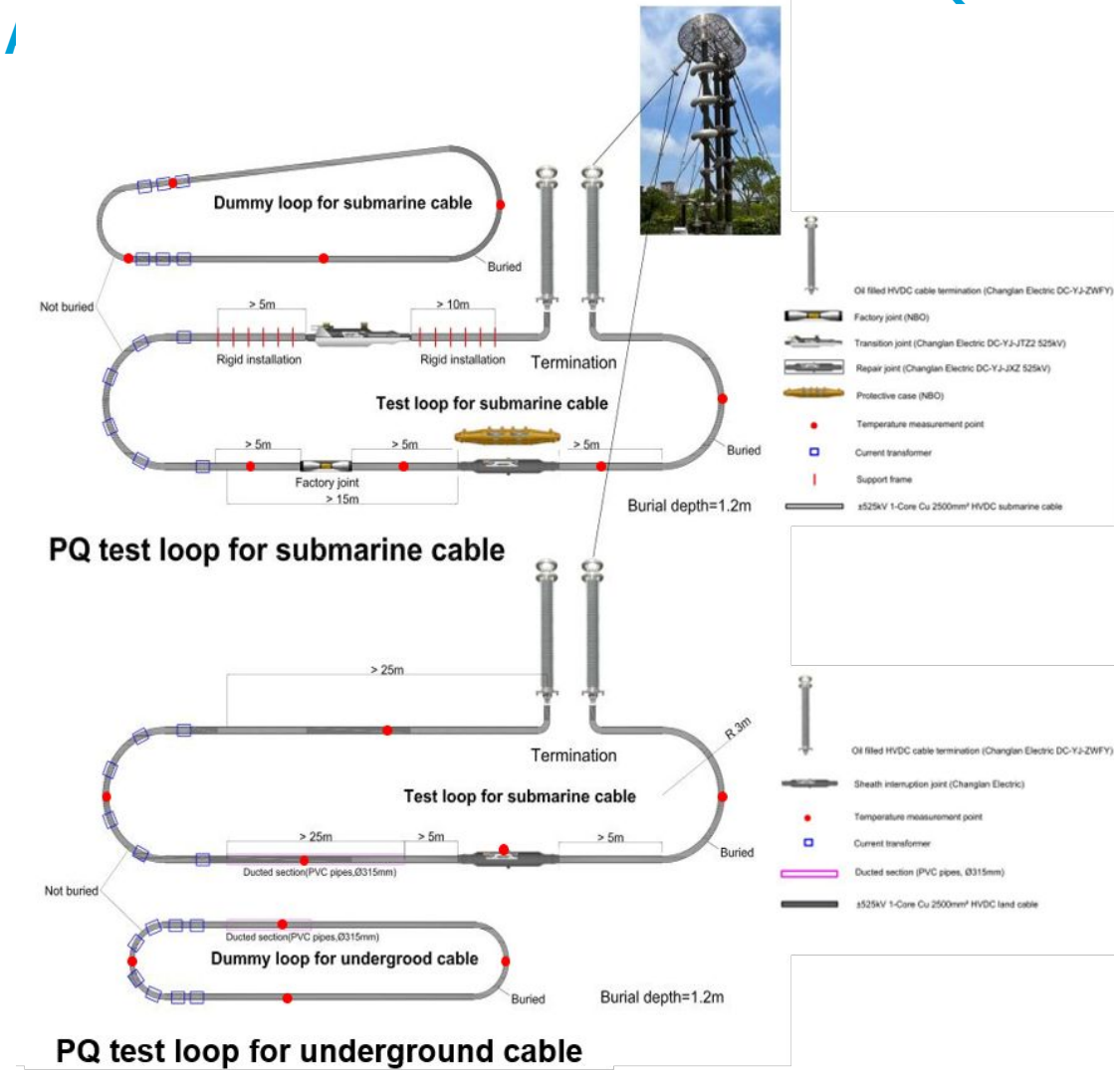
- CIGRE TB 490
- CIGRE TB 722
- CIGRE TB 446
- CIGRE TB 880
- CIGRE TB 303

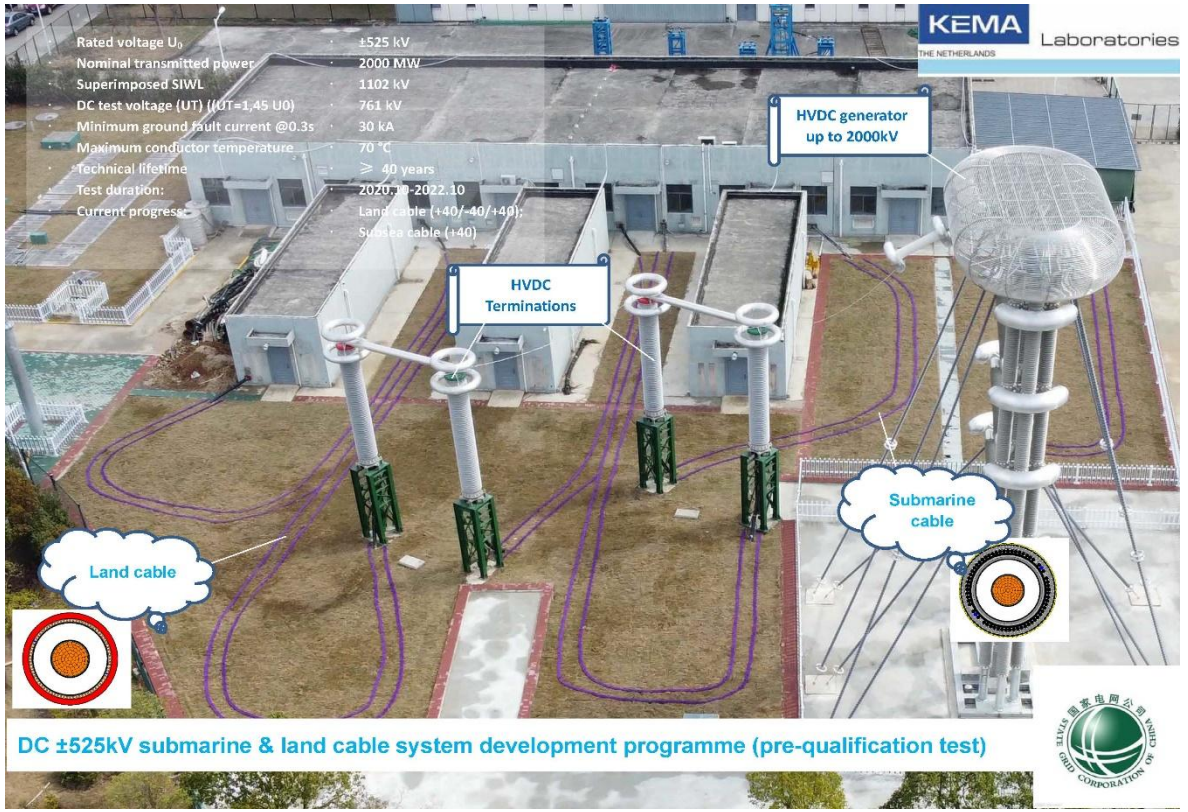


 All the above standards refer to the latest version

Design and Development of HVDC Cable System

Qualification of HVDC Cable System – PQ Test Loop



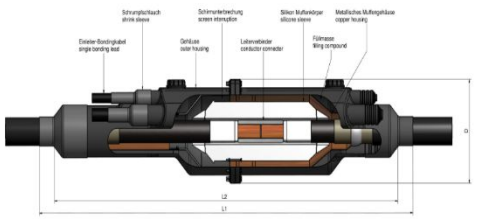


Design and Development of HVDC Cable System

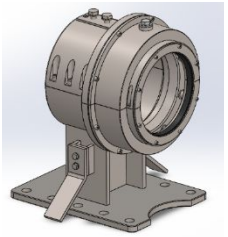
Accessories & Layout

GIS termination

AIS termination

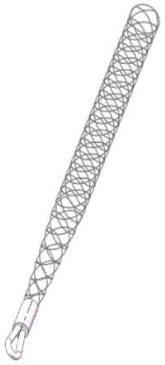


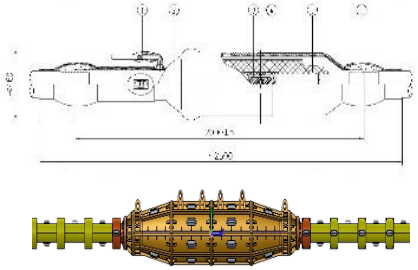
Transition Joint



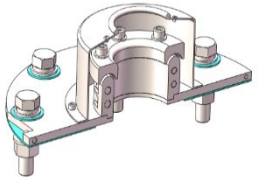
Anchor Clamp

Pulling Head



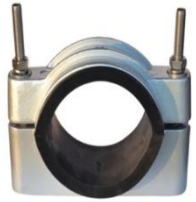


Repair joint and Protection case

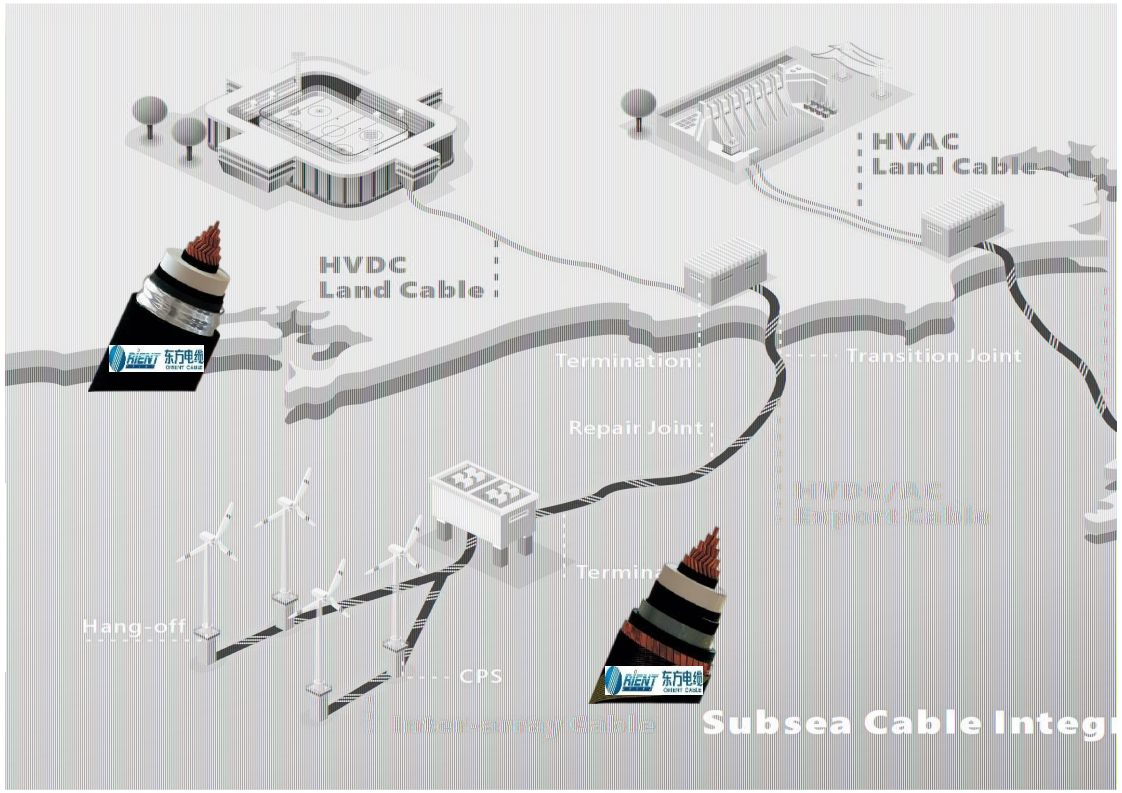


Hang-off

Factory joint



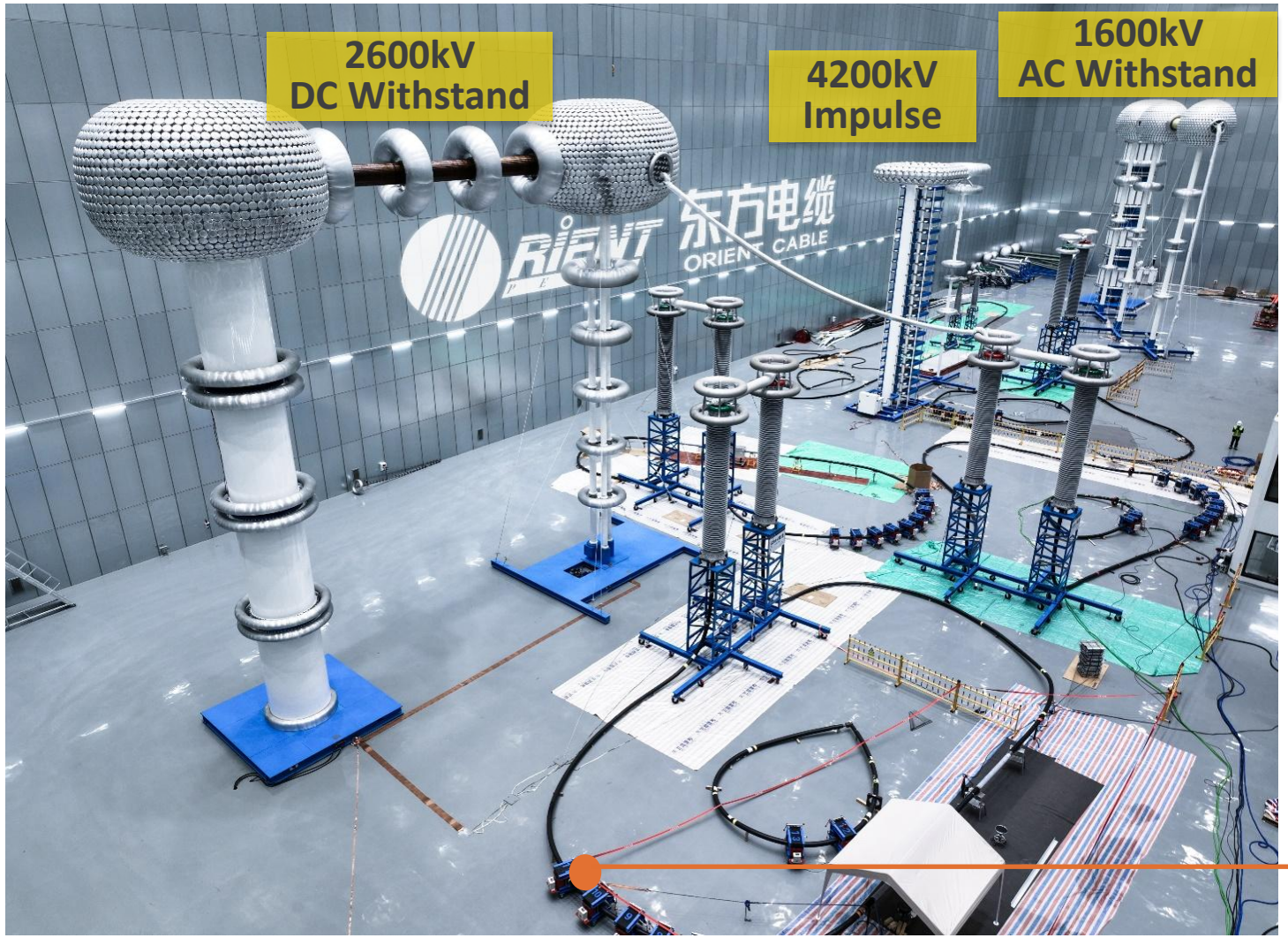
Cable cleats



General Layout of OWF Power Transmission

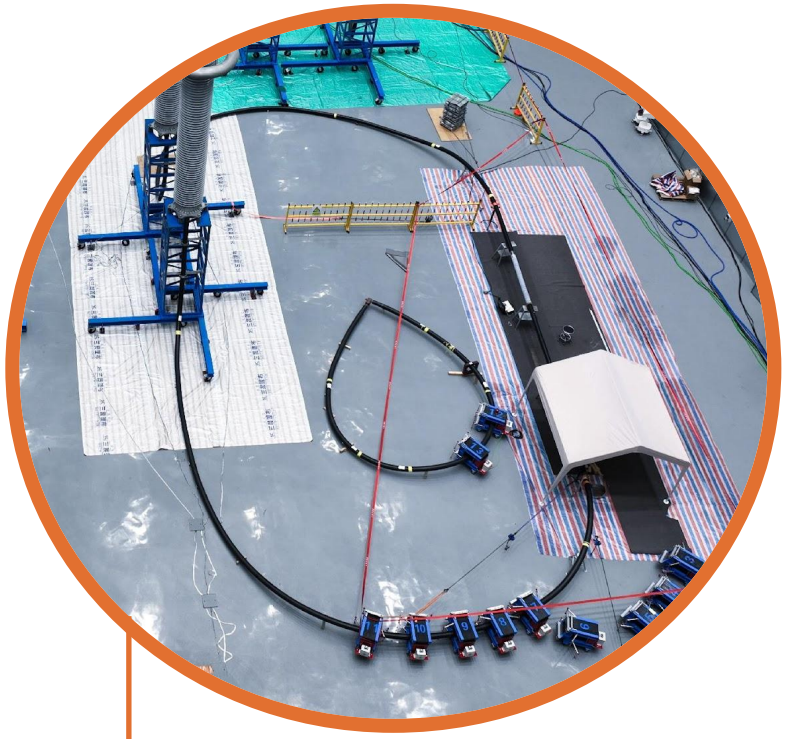
Design and Development of HVDC Cable System

Qualification of HVDC Cable System – Quality Control



Lab Size:

120L x 42W x 35H



DC 525KV Testing Loop

Design and Development of HVDC Cable System

Qualification of HVDC Cable System – Quality Control

Partial Discharge Test

Heating Cycle Voltage Test

TOV Test

Factory Acceptance Test

PD test equipment for Factory Joint

Produced a local PD test equipment prototype

Performing local PD test

Tuning to get test results

Passed

Failed

Increase voltage level and test again

Design improvement

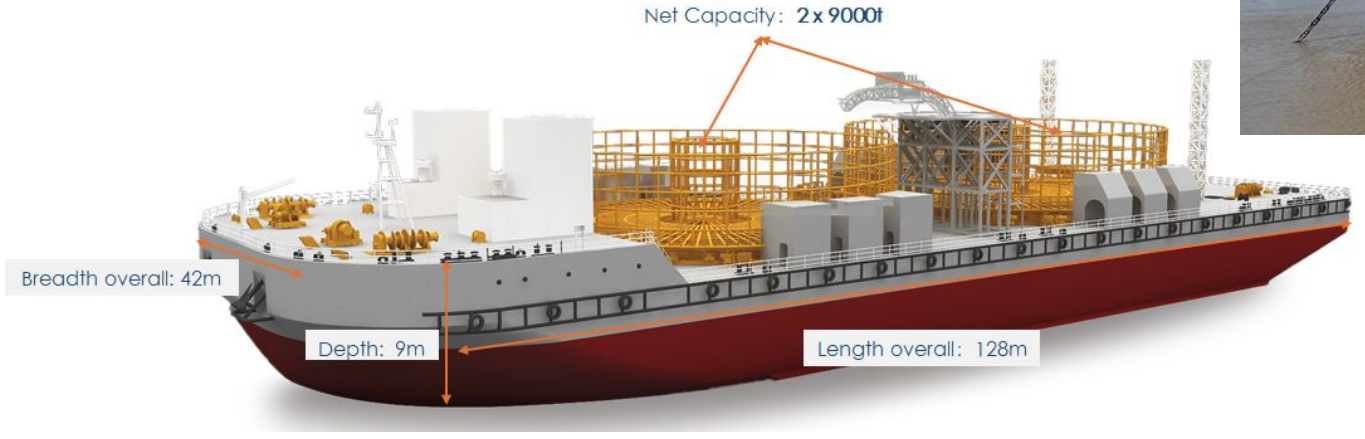
Design and Development of HVDC Cable System

Qualification of HVDC Cable System – Logistics and Installation - Subsea Cable

Haigong07 Barge

Transportation example for HKWB project:

1. Cable length ≈ 140km
2. Total weight ≈ 15000ton
3. From Ningbo to Netherland
4. Duration ≈ 50days

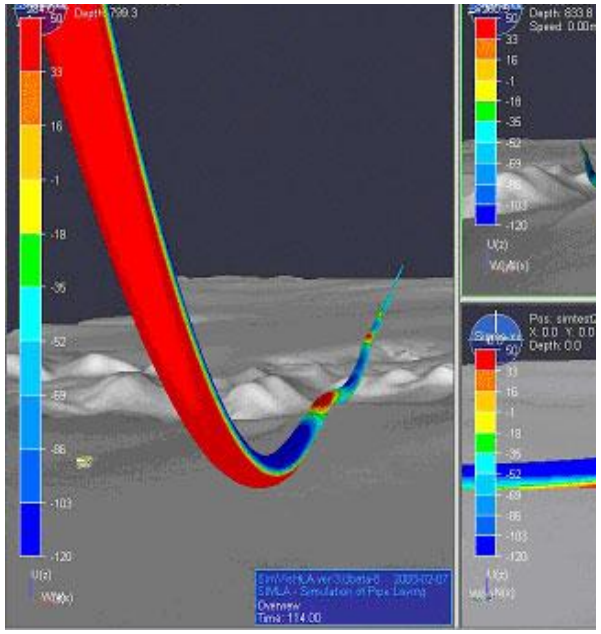


Design and Development of HVDC Cable System

Qualification of HVDC Cable System – Logistics and Installation

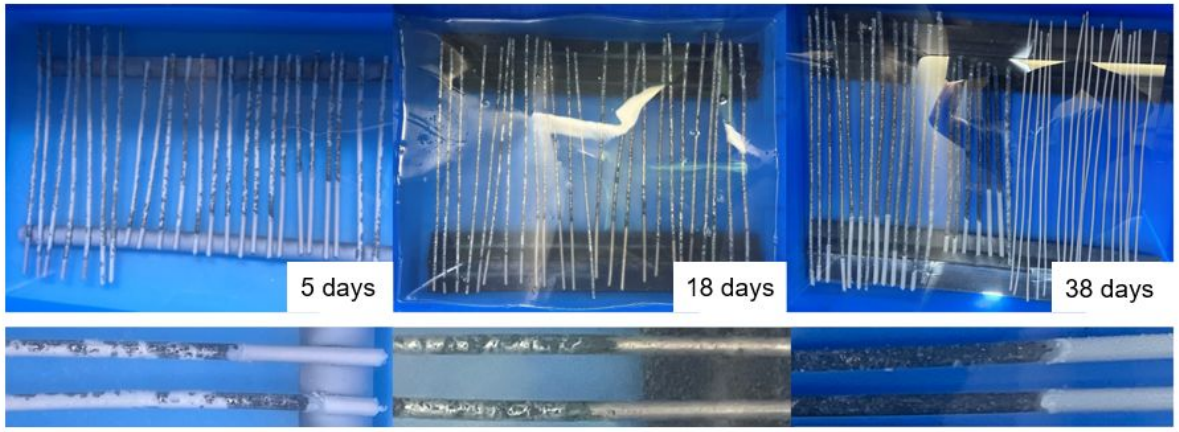
Hydro-dynamic analysis, structural analysis, thermal-magnetic analysis and **electrical analysis**.

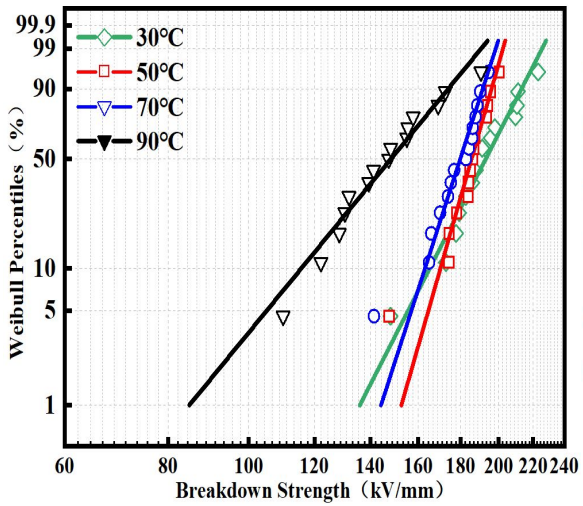
Features	Software
Structural analysis	Abaqus / UFLEX
Electric field analysis	CYMCAP / Multi-physics
Magnetic field analysis	CYMCAP / COMSOL / Workbench
Temperature analysis	Ansys / COMSOL
Stability analysis	Stableline
Accessory design	Work Bench / Soild work / AutoCAD
Cable monitoring	DTS / DAS
Fluid mechanics analysis	Orcaflex
Fatigue analysis	Orcaflex / UFLEX Abaqus

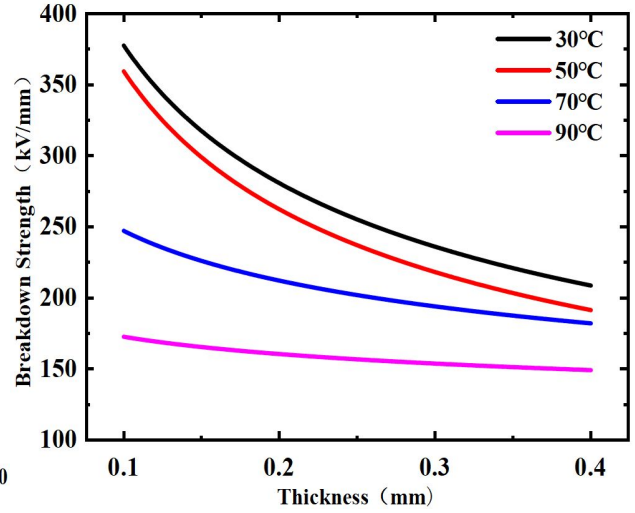


Design and Development of HVDC Cable System

Cable Design Life







Lifetime of Zinc layer:
A: 13.04 years
B: 12.89 years
C: 12.86 years

Armour protection:
Inner bedding: PP yarn;
Bitumen;
Outer sheath: PP yarn

In the marine environment
Stainless steel corrosion rate: 0.04mm/a
Carbon steel corrosion rate: 0.09mm/a

Armor comprehensive corrosion life > 40 years

Breakdown strength at different temperatures

Power function fitting of breakdown strength and thickness of insulation material at different temperatures

Conclusion

Insulation aging life > 40 years

Conclusion & Discussion

- Efficient Long-Distance Power Transmission.
- Better Grid Stability and Integration.
- Compact and Environmentally Friendly.
- Technology Limitation and Advancements
- De-commissioning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ORIENT PEARL
东方电缆
ORIENT CABLE
Linking the Land and the Sea