

Onshore Oil&Gas Development Solution

LNG Storage Tanks and Terminal



LNG Storage Tanks and Terminal

Domestic LNG Project Performance (In Production)

COOEC has been involved in various degrees in the early-stage LNG projects such as Dapeng LNG, Fujian LNG Phase I, and Zhejiang LNG Phase I, which were initially contracted by international engineering contractors, through methods including feasibility study, preliminary design, participation in project management, construction etc.

- ✓ **Tianjin LNG Phase I Project:** $2 \times 30,000\text{M}^3$ LNG storage tanks, achieving a breakthrough from nothing to something.
- ✓ **Guangxi LNG Project:** $2 \times 30,000\text{M}^3$ LNG storage tanks, solidifying the LNG construction team of COOEC.
- ✓ **Tianjin LNG Replacement Project:** Made breakthrough from $30,000\text{ M}^3$ to $160,000\text{ M}^3$ LNG storage tanks, enhanced wholesale design capability of tanks and terminals.
- ✓ **Zhejiang LNG Phase II Project:** $3 \times 160,000\text{M}^3$ LNG storage tank sand receiving terminal, successfully won the National Quality Engineering Award
- ✓ **Tangshan LNG Phase I Project:** $4 \times 200,000\text{M}^3$ LNG storage tank sand receiving terminal, marking that the first 10 million-ton-level LNG terminal phase I project put into production in China. It completed independent unloading in 5 days, creating the shortest domestic first ship unloading period record.

Tianjin LNG Phase I



Guangxi LNG Project



Tangshan LNG Phase I Project



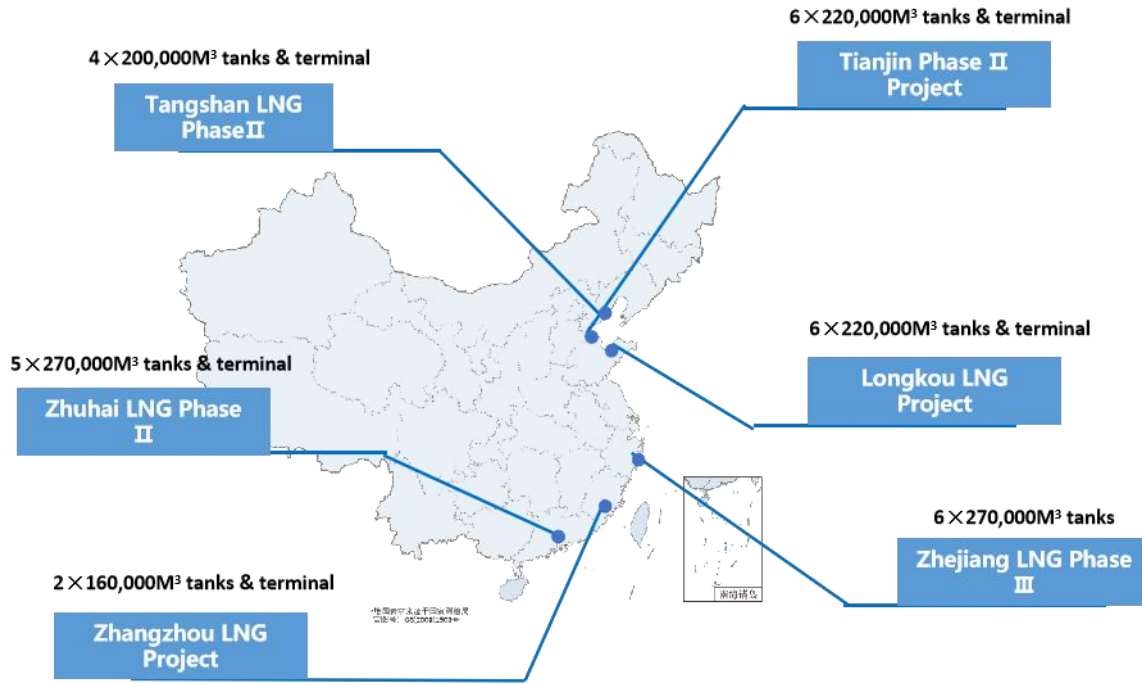
Tianjin LNG Replacement Project



Zhejiang LNG Phase II Project

LNG Storage Tanks and Terminal

Performance of Domestic LNG Project (Under Construction)



6 LNG EPC Project

- 4 Terminals, 29 full containment LNG storage tanks(here in after refers to as STs), with under construction tank capacity of 6.73 million cubic meters(here in after refers to as CM).
- 29 STs: 2*0.16mcm+4*0.2mcm+12*0.22mcm+11*0.27mcm
- In 2023, Project Participation: **≥4,200**; Cumulative Completed Man-hours: **43.57 Million**



Zhangzhou LNG Project-Terminal & Tanks



Tianjin Phase II Project-6 Tanks & Terminal Expand



Longkou LNG Project-Semi-buried & Ground-Mounted Storage Tanks(STs)



Zhuhai LNG Phase II-Domestic Largest 270,000 Cubic-Meter(CM) STs



Tangshan LNG Phase II -Four 200,000 CM STs & New Terminals



Zhejiang LNG Phase III-Six 270,000 CM STs

Design Project Performance List

Project	Scope of Work	Status
Detailed Design of Tianjin LNG Replacement Project Terminal	All equipment and facilities related to the preliminary design document for the replacement project, various systems and areas, architectures, all works that can be constructed according to the drawings to reach normal operation (including interface with the phase I project)	Completed
Lishui 36-1 Gas Field Terminal Feasibility Study Project for Adding Small-scale LNG Gasification Unit	Provided feasibility study report on terminal small LNG receiving, gasification and export facilities.	Completed
Tangshan Port Caofeidian LNG Terminal Feasible Scheme Research Project	Completed the credibility study report and project application report of Tangshan Port LNG project	Completed
Engineering Design Review Project of Wenzhou Huagang LNG Storage & Transportation Peak Shaving Center (Tank Area) Project	Preliminary design document review of Wenzhou Huagang LNG Storage and Transportation Peak Shaving Center (Tank Area) Project	Completed
Preliminary Design of LNG Refueling Station & Terminal Engineering in Gaoqiao Port Area, Zhenjiang Port	Preliminary Design, Economic Estimate, Special Article Compilation, Preliminary Design Report Compilation for the LNG Refueling Station and Terminal Engineering of the Yangtze River Mainstream Jiangsu Section Water Transport Industry LNG Application Demonstration Project at Gaoqiao Port Area of Zhenjiang Port.	Completed
Preliminary Design of The Terminal Engineering for The Wuhu Yangtze River LNG Inland River Receiving (Transfer) Station Project	Preliminary design work for land area formation, LNG Terminal, LNG Wharf, LNG Bunker Station, LNG Tank Container Yard, front area of the plant, etc.	Completed
LNG Terminal Preliminary Design Project for the Cambodia Natural Gas Group	Preliminary design, economic estimate, compilation of special articles and preliminary design reports for the terminal area and tank area of the LNG Terminal Engineering Project of the Cambodia Natural Gas Group.	Under Construction
Engineering Design Service Project for the Second Phase Expansion of Yingkou Natural Gas Processing Plant	preliminary design and construction drawing design of the natural gas processing unit, as well as the verification, renovation, and expansion design of the existing pre-separation system, the condensate treatment system currently under construction, and auxiliary supporting production facilities.	Under Construction

Provide customers with technical services such as preliminary technical solutions, feasibility studies, FEED design, project application reports, technical support, preliminary design, detailed design, etc.

LNG Storage Tanks and Terminal

Key LNG Projects

Tangshan LNG Phase II

Client : China Suntien Green Energy

ConstructionScale: 4 x 200,000 cubic meter(CM) full-containment LNG storage tanks(STs); terminal expansion

Duration: 2021.07-2024.09



LNG Storage Tanks and Terminal

Key LNG Projects

Zhangzhou LNG Project



Client : PipeChina Mintou(Fujian) Natural Gas Co., Ltd.

Construction Scale: 2 x 160,000 CM full-containment LNG STs;
a new terminal

Duration: 2018.09-2023.04

LNG Storage Tanks and Terminal

Key LNG Projects

Longkou LNG Project



Client : PipeChina Nanshan(Shandong) Natural Gas Co., Ltd.

Construction Scale: Six 220,000 CM full-containment LNG STs; a new terminal

Duration: 2020.04-2024.09

LNG Storage Tanks and Terminal

Key LNG Projects

Tianjin LNG Phase II

Client : PipeChina Tianjin LNG Co., Ltd.

Construction Scale: 6 x 220,000 CM full-containment LNG STs,
terminal expansion

Duration: 2020.04-2023.09



LNG Storage Tanks and Terminal

Key LNG Projects

Zhuhai LNG Phase II

Client : CNOOC Zhuhai Jinwan LNG Co., Ltd.

Construction Scale: 6 x 270,000 CM full-containment LNG STs,
terminal expansion

Duration: 2021.06-2024.09



LNG Storage Tanks and Terminal

Key LNG Projects

Zhejiang LNG Phase III



Client : CNOOC Gas Power Co., Ltd.

Construction Scale: 6 x 270,000 CM full-containment LNG STs

Duration: 2022.01-2025.10

Key Completed Projects

Hongkong LNG Project



- ✓ China's first and the world's largest offshore steel structure LNG terminal dock
- ✓ Hongkong's first large-scale marine engineering and key clean energy project

Client : Hong Kong LNG Terminal Limited,
Castle Peak Power Station, HK Electric

Duration : 2020.03-2023.04

Scope of Work :

- Construct a new jacket structure double-berth offshore natural gas terminal
- Construct a new natural gas terminal inside the Black Point Power Station
- Construct a new 45km 30-inch, 18km 20-inch subsea pipeline

LNG Storage Tanks and Terminal

Key Completed Projects

Zhejiang LNG Phase II Project

- ✓ Won the "Qianjiang Cup", the highest award for construction engineering quality in Zhejiang Province in 2022.
- ✓ Won the National Quality Engineering Award for 2022-2023.



Client : CNOOC Ningbo LNG Co., Ltd.

Construction Scale: 3 x 160,000 cubic meter full-containment LNG storage tanks, terminal expansion

Duration: 2018.06-2021.07

Key Completed Projects

Tangshan LNG Phase I Project

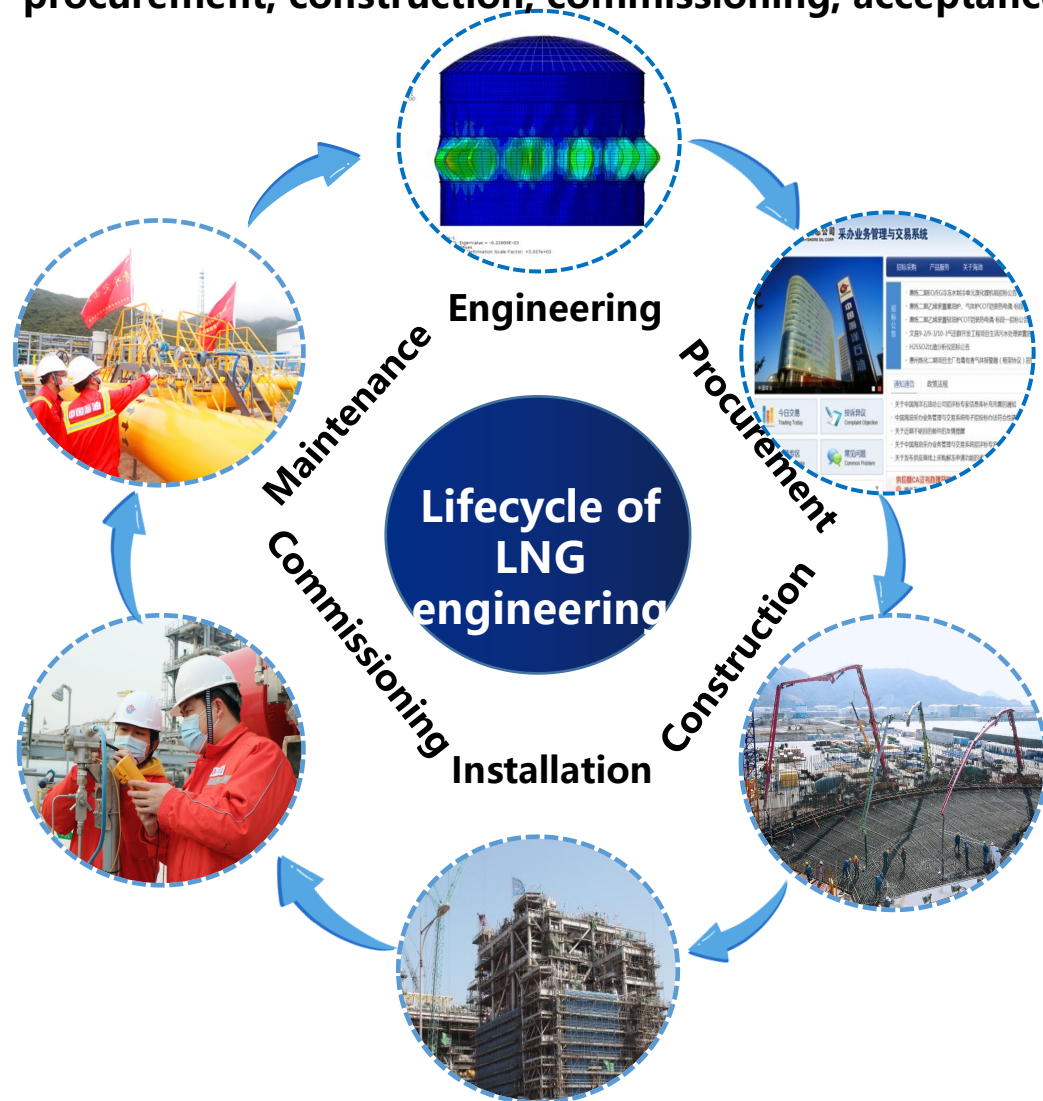
Client : China Suntien Green Energy
Construction Scale: 4 x 200,000 cubic meter full-
containment LNG storage tanks, a new terminal
Duration: 2019.07-2022.10

- ✓ China's first 10-million-ton LNG terminal project was put into operation.
- ✓ Independently completed the first shipment unloading in 5 days, setting a new record for the shortest unloading duration in China.
- ✓ The longest unloading pipeline with the largest diameter in China

LNG Storage Tanks and Terminal

Technical Advantage

In the field of onshore oil, gas, and LNG engineering, COOEC can provide owners with services including detailed design, procurement, construction, commissioning, acceptance, whole process project management etc.



1. Simulation Technology of LNG Storage Tank Precooling

Innovate simulation technology for precooling of large LNG full-containment tanks. Establish a dedicated three-dimensional simulation model for precooling of LNG STs. The precooling simulation under different working conditions for various volumes of LNG STs greatly improved the efficiency, safety and reliability of the pre-cooling process.

2. Innovative ST Precooling Temperature Control Technology

By adjusting the frequency of temperature drop monitoring and fine-tuning the ratio of the central control interface, optimizing the temperature drop calculation method, quickly track the temperature drop rate of the ST. Through various measures, precisely control the ST precooling rate, making it the leading level in China.

3. Comprehensive Terminal overall Solution

Since the first LNG terminal in China, CNOOC has accumulated more than 10 years of technical expertise and mastered the key technology for large-scale LNG terminals, achieved a leap from total rely on foreign tech to independent design and construction, established a comprehensive independent LNG terminal tech system. On the basis of practical projects, CNOOC will continue to conduct research and innovation.

4. The first LNG ST Evaporation Rate Testing System in China

CNOOC has independently developed a dedicated system for tank BOR testing using wireless communication methods, as well as the first BOR calculation software in China, with advantages in accuracy, advancement, easy operation, and efficiency. Through intelligent automatic data transmission, it has improved the efficiency of calculations and the safety of on-site testing.

LNG Storage Tanks and Terminal

Technical Advantage

We have project implementation capability of 30,000 to 270,000 cubic meter tank technology research and development, integrated design and EPC engineering.

We've established series of standardized design systems for LNG storage tanks(STs). Achieved the capability of digital collaborative design based on SPF (Smart Platform for Information Integration). With leading technological advantages in seismic isolation, ultra-low temperature cold insulation, and domestic application for ultra-large volume STs.

Guangxi LNG



Tianjin LNG



Zhejiang LNG II



Zhangzhou LNG



Tangshan LNG



Tianjin LNG II



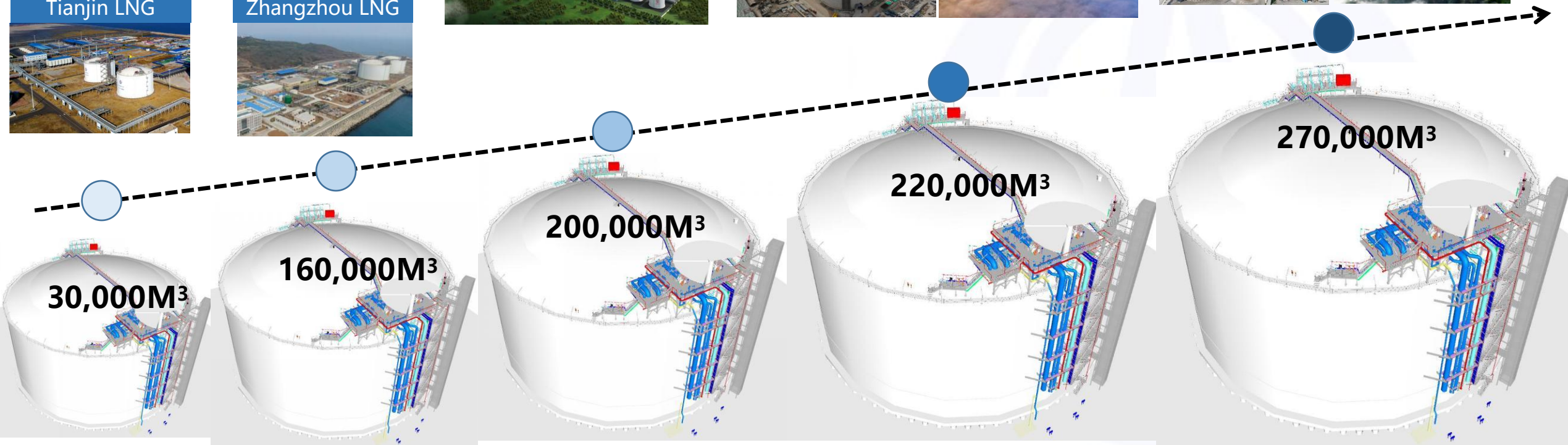
Longkou LNG



Zhuhai LNG II



Zhejiang LNG III



LNG Storage Tanks and Terminal

Technical Advantage

Automatic welding technology for vertical seam of inner tank

Engineering Application

Application results of 8 STs in 5 projects indicate that this technology has reached a mature standardized construction level and has significant advantages in terms of quality, environmental protection, and cost.

Zhuhai: Proposed to apply vertical seam welding for 2 tanks.

Zhejiang: Proposed to apply vertical seam welding for 2 tanks and circumferential seam welding for 1 tank.



Zhejiang Phase II
A 160,000 M³ ST



Zhangzhou LNG
A 160,000 M³ ST



Tangshan Phase I
Two 200,000 M³ STs completed+welding of two 200,000 M³ STs



Longkou Project
A 220,000 M³ ST



Tianjin Project
A 220,000 M³ ST

High Quality

- The weld appearance is excellent in form.
- The joints' impact toughness is outstanding (140J impact energy at -196°C, twice of the design specification).
- The welding quality process is controllable and traceable.

Environmental Protection

- Avoid back gouging, reduce noise, and lower carbon emissions.
- Virtually no need for grinding between weld layers, reducing grinding dust emissions by over 90%.
- Low welding fumes, reducing smoke emissions by 90%.
- Reduces the risk of occupational diseases.

Economic

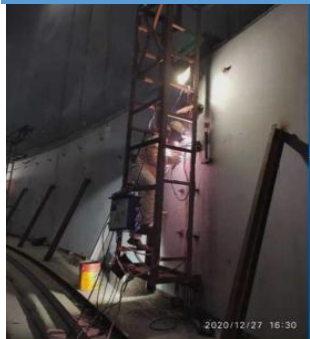
- Reduce welding material consumption of narrow groove design by 37%, reduce material loss of back gouging and grinding by 20%.
- Reduce grinding man-hour by ≥95%.
- Increase work efficiency by 130%, shorten construction period by ≥30 days(taking a 200,000 CM tank as an example).

First Pass Rate of Welding	98.6%	99.6%	99.8%	99.8%	99.8%
Overall Efficiency Improvement Rate	50%	56%	130%	110%	121%

LNG Storage Tanks and Terminal

Technical Advantage

Electrode Arc Welding



Manual operation, high dependence on welder skills

Full Automatic Welding



Mechanical automation, welding quality controllable

Electrode Arc Welding



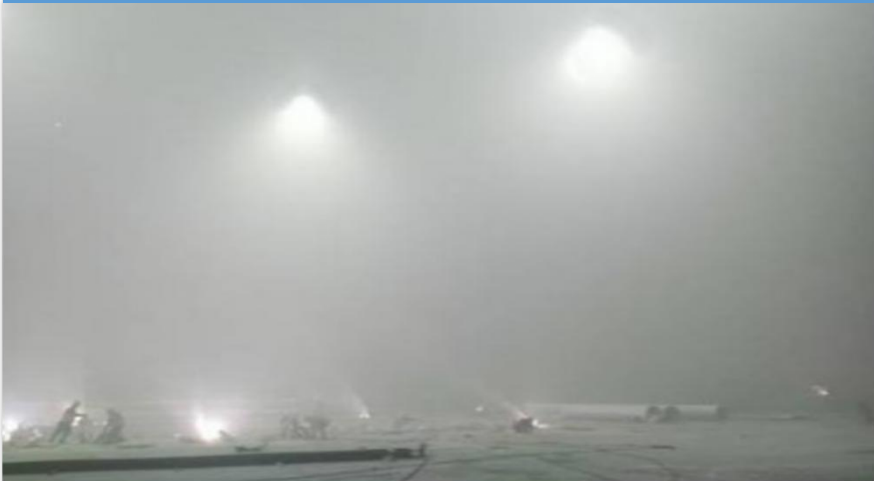
Poorly formed weld appearance, requiring back gouging.

Full Automatic Welding



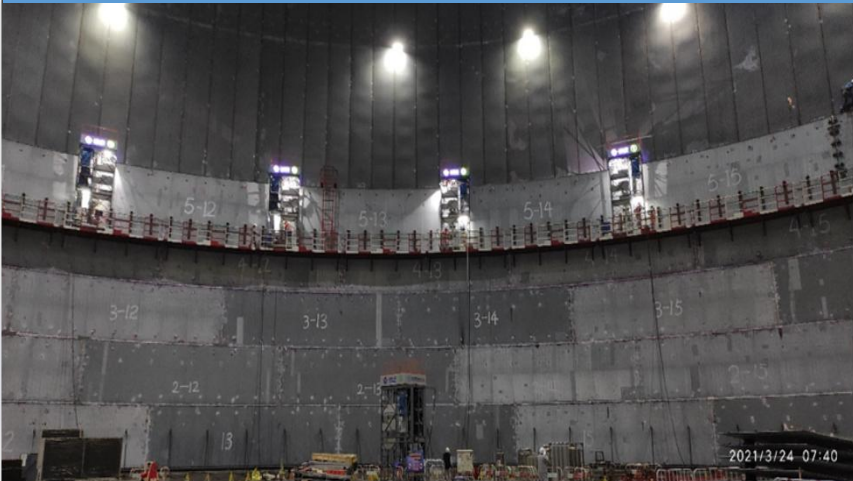
Well formed weld appearance, no need of back gouging.

Electrode Arc Welding



Large amounts of welding fumes and dust pose a high risk of pneumoconiosis

Full Automatic Welding



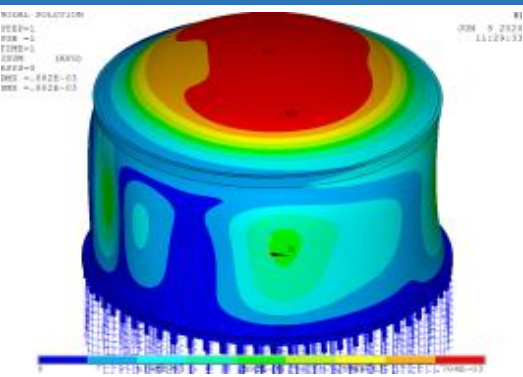
Clean, green, and low-carbon welding practices.

Items	Electrode Arc Welding Process	Automatic Welding Technology
Quality	Impact energy at -196℃: 80J (average design indicator ≥ 70J) Subject to human influence, inconsistent quality	Impact energy at -196℃: 140J Stable quality, excellent performance
Environmental	Large welding fumes, high occupational health risks	Clean and green welding, eliminating the source of pneumoconiosis
Efficiency	Maximum deposition rate of 0.7kg/h	Maximum deposition rate of 2.8kg/h
Job Intensity	High work intensity in back gouging and grinding	No need for back gouging, small amount of grinding, and low work intensity
Cost	Large amount of auxiliary work, severe welding material waste, and excessively high energy consumption	Advanced technology, shortened construction period, and remarkable economic benefits.

LNG Storage Tanks and Terminal

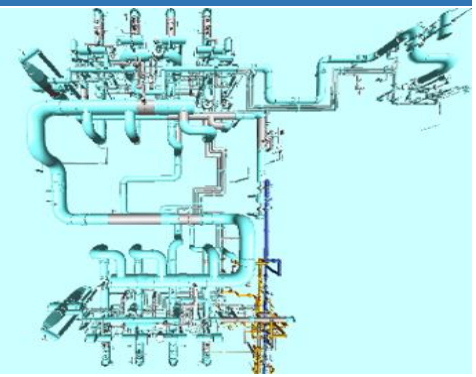
Innovative Process Application

Core Design Technology of Full Volume LNG ST



Over 10 advanced technologies, forming over 10 patent achievements

Offshore LNG Unloading & Refueling Technology



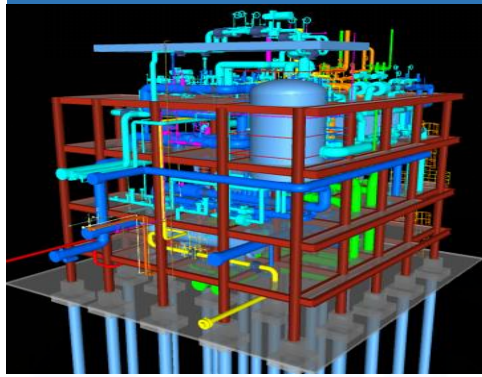
pioneering initiative domestic, providing a typical case for the development of the industry.

Winter Intergrated Pile Construction Tech



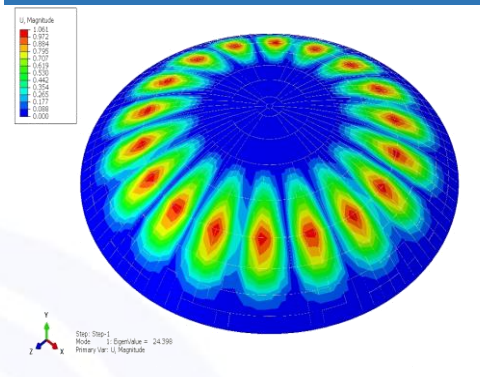
Break the technical barrier of not able to construct concrete during winter.

Intensive Regasification Module Engineering Tech



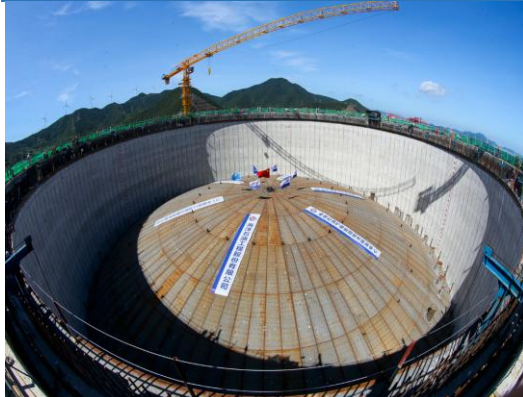
Save land and reduce equipment investment

Post-Gas Jacking Dome Optimization Design Tech



The construction period is saved by 1 month

Design Technology of LNG ST Air Lift in Winter



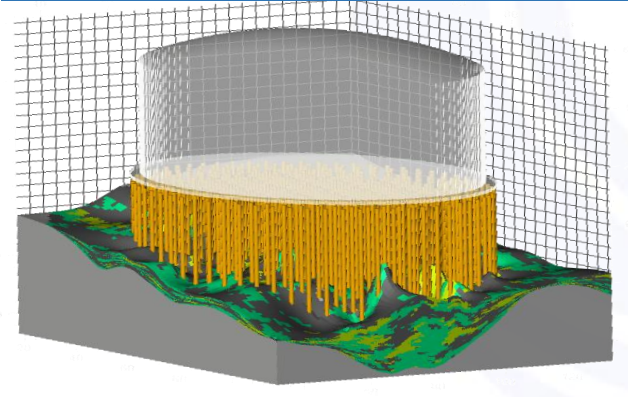
Break the traditional practice of not lifting the roof in low temperature environment in winter

Pipeline Cooling integrated prefabrication technology



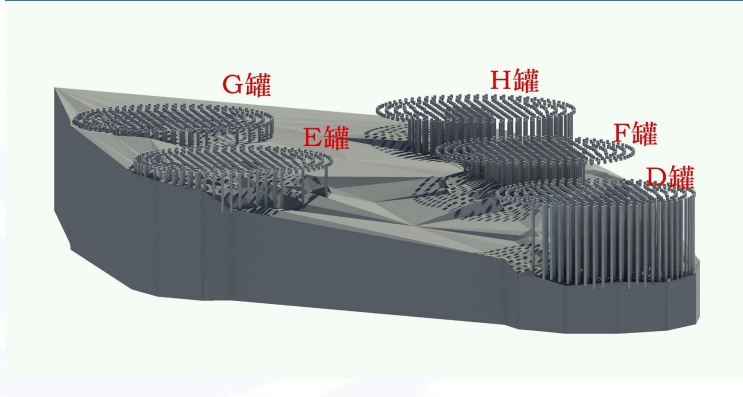
Advance the cold protection construction process, save 1 month of construction period.

LNG ST Integrated Seismic Isolation & Mitigation Technology



Save materials and costs, 3 authorized invention patents, 4 utility model patents.

3D dynamic visualization



Solving the technical difficulties of rock socketed pile construction

卓越工程 赋能未来

Empower the Future with Excellent Engineering

THANKS

谢谢