Jacket Platform Technology

Science & Technology Management Department, CNPC

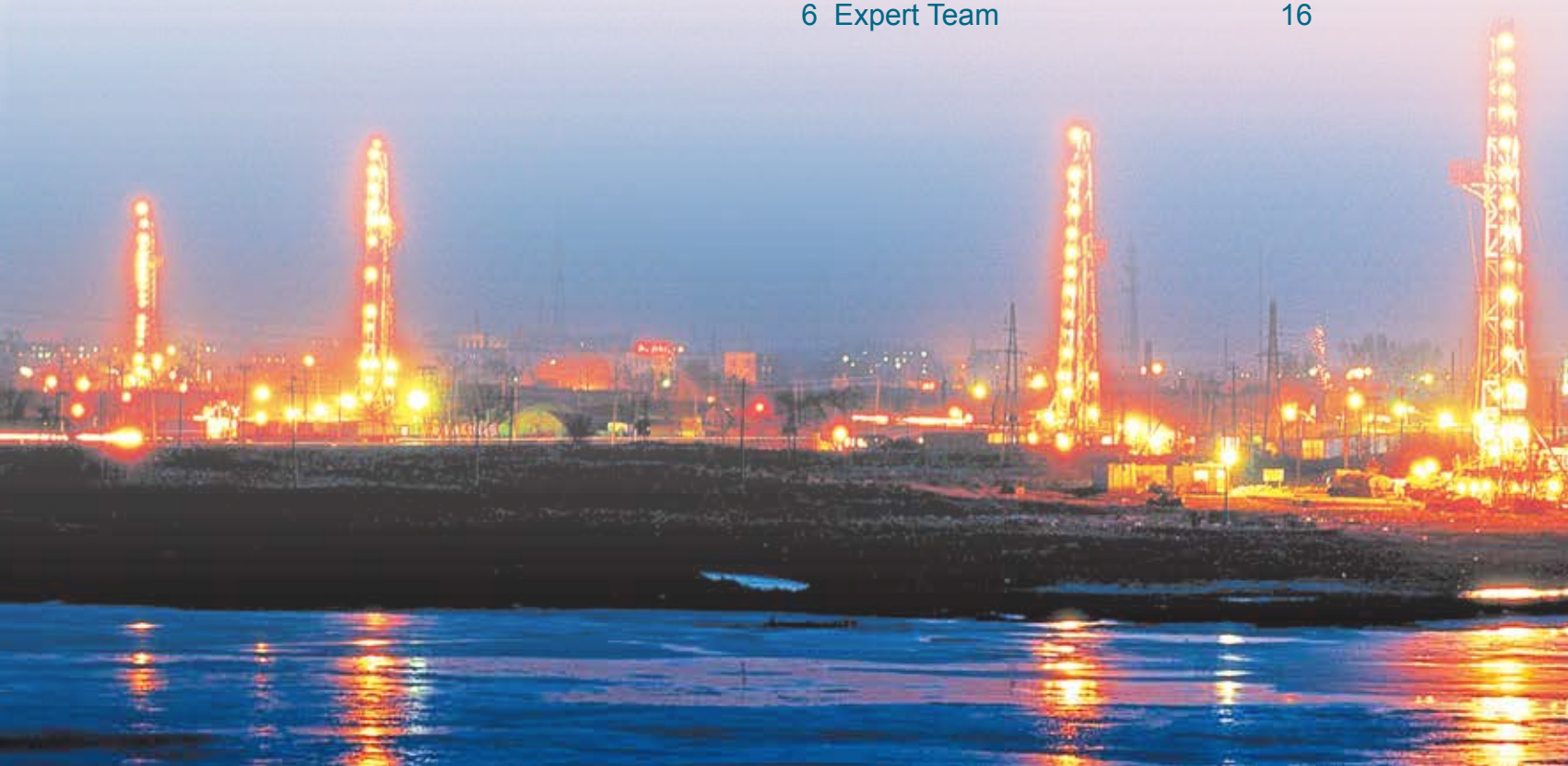
2015

CHINA NATIONAL PETROLEUM CORPORATION

Jacket Platform Technology :

A Transfer Platform for Supporting Offshore Oil and Gas Processing!

Contents



China National Petroleum Corporation (CNPC) is a state-authorized investment agency and a state holding company. On July 1998, with the implementation of the Institutional reform of the State Council, CNPC was reorgnized to become an integrated oil company of cross-regions, cross-industries and cross-countries, it adopts modern enterprise system to realize the integrations of upstream and downstream operations, internal and external trade, production and marketing. CNPC's business covers six main sectors: oil and gas operations, petroleum engineering service, petroleum engineering construction, petroleum equipment manufacturing, financial services and new energy development. In 2014 CNPC produced 113.67 million tons of crude oil and 95.46 billion cubic meters of natural gas, while crude processing volume reached 150.2 million tons. The total revenue of RMB 2,730 billion with a profit of RMB173.4 billion had been achieved the same year.

CNPC was ranked 3th among the world's largest 50 oil companies and 4th in Fortune Global 500 in 2014.

CNPC strictly follows by the combined strategies of increasing resource capacity, expanding market shares and consolidating the international role, and persists in regarding technical innovation as a key framework to advance technological progress. To develop its core businesses, focuses will be placed on the solutions of key bottleneck technologies and key proprietary technologies. Thanks to continuously improving of the technical innovation system, optimizing the configuration of technological resources and strengthening the construction of strong talent teams, CNPC's technological creativity has been considerably upgraded. Consequently, a large number of technologies have been developed independently, with its own intellectual property.

The jacket platform technology is one of representatives for major innovations of CNPC.

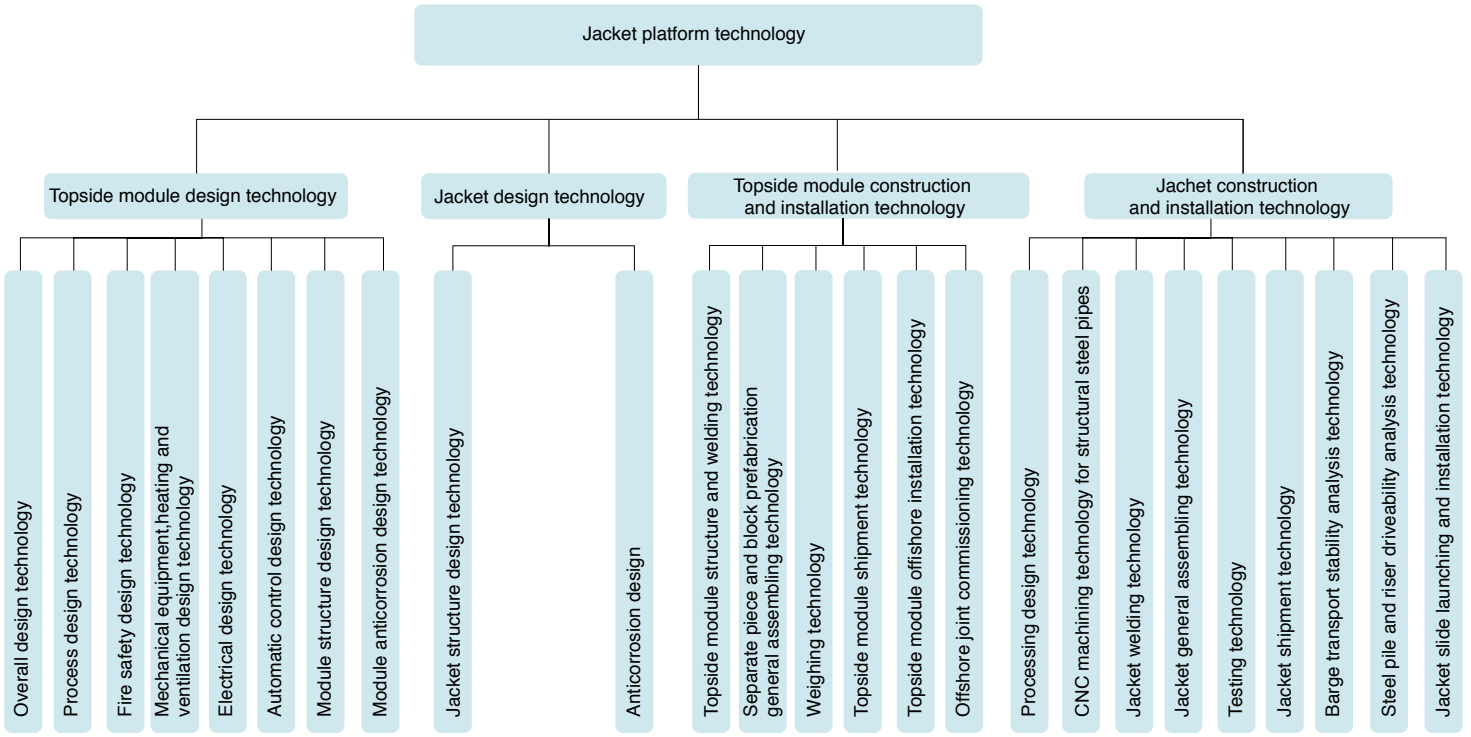
OFFERING ENERGY SOURCES, CREATING HARMONY

1 INTRODUCTION

The jacket platform fixes the structure in the seabed using piles and includes three parts such as topside module, jacket and pile foundation. The jacket platform is characterized by good adaptability, high safety and high reliability and has become the primary structure form in the development of beach and shallow sea oil and gas fields.

CNPC has greatly increased its offshore engineering service capacity based on the technical development concept “perfecting beach fields, development shallow sea fields and reserving deep sea fields”. In terms of jacket platform technology, CNPC has formed totally 4 major technology series such as topside module design technology, jacket design technology, topside module construction and installation technology and jacket construction and installation technology and 25 characteristic technologies. They have been widely applied in the development of offshore oil and gas fields in Bohai Bay area.

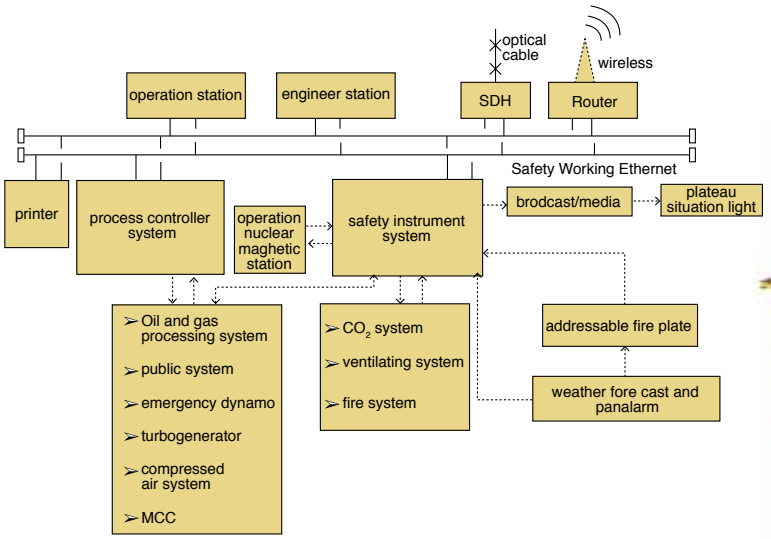
Through steady development of comprehensive offshore engineering service capacity, CNPC has achieved leapfrog development and has EPCI engineering general contracting capacity of large jacket platforms.



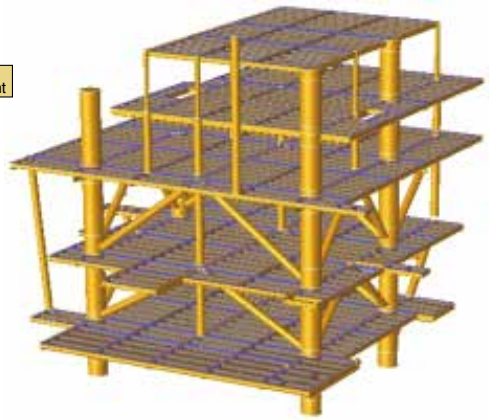
2 CHARACTERISTIC TECHNOLOGIES

2.1 Topside module design

The topside module design technology includes topside module structure design and oil and gas processing and production system design of the jacket platform, overall design, process, piping, structure, safety, fire control, machinery, heating and ventilation, electricity, automatic control, communication, drainage, anticorrosion, etc. The overall development plan for oil and gas fields, physical properties of oil and gas in reservoirs, natural conditions and other factors shall be comprehensively considered in the topside module design. In addition, the safety concept “Putting prevention first and combing prevention with control” shall be fully carried out, platform azimuth and all equipment and facilities shall be planned reasonably, the systems involving process, utility, production and living shall be optimized, and the whole topside module shall be protected against corrosion. Moreover, ensure safe use of the topside module structurally and improve the performance of the whole platform in terms of reasonableness, practicability and normalization degree.



Schematic of the central control system of the topside module



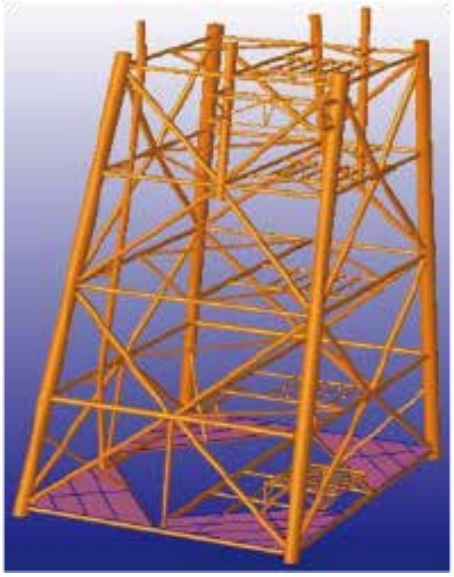
Topside module structure schematic

2.2 Jacket design

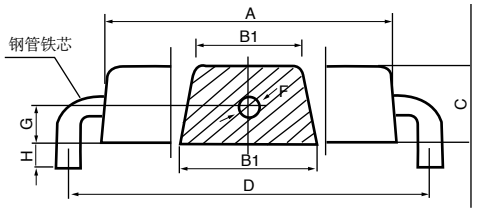
The jacket design technology is intended to determine the jacket structure form according to the general layout of oilfield blocks, technological process and natural environment conditions of the sea area, carry out calculation and analysis as required by specifications, provide advanced, reasonable, safe and economic schemes and meet the actual needs of various projects.

(1) The jacket structure design includes on-bottom analysis and installation analysis. On-bottom analysis: after platform installation and emplacement, various loads on the jacket are analyzed in the whole life cycle of the platform, including dead weight load, equipment load, operation load, wind load, wave and current load, ice load, seismic load, accidental load, etc., for the purpose of ensuring the stress on the structure meets the requirements of relevant standards and specifications. Jacket installation analysis: the process of the jacket from site building to offshore emplacement is calculated and analyzed according to the area and load bearing capacity of the site, the capacity of operation machines and tools, the weight and height of the structure and possible shipment mode.

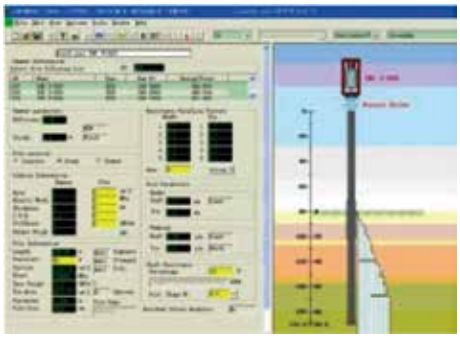
(2) Jacket anticorrosion design covers the steel structure corrosion in all areas including atmospheric area, splashing area, sea water area and sea mud area. According to international standards and actual marine environment conditions and through reasonable external anticorrosive coating design and cathode protection design, prohibit steel structure corrosion, slow down wall thickness thinning and strength reduction, and ensure long-period safety of the structure.



3D schematic of the jacket



Schematic of aluminum alloy sacrificial anode structure for jacket



Pile driving analysis schematic

2.3 Topside module construction and installation

The topside module construction and installation technology includes topside module structure and welding technology, separate piece and block prefabrication general assembling technology, weighing technology, topside module shipment technology, topside module offshore installation technology, offshore joint commissioning technology, etc. Select shipment mode and offshore installation mode according to the weight and size of the topside module as well as floating crane and barge parameters.

Separate piece prefabrication

Site general assembling of topside module

Topside module hoisting and shipment

Slide shipment of topside module

Topside module hoisting and installation

2.4 Jacket construction and installation

The jacket construction and installation technology mainly includes processing design, CNC processing of structural steel pipes, jacket welding, jacket general assembling, testing, etc. An integral space structure is built through the construction process involving design, processing, welding, prefabrication, site assembling, etc. of materials such as plates, section steel, etc., thus meeting production requirement .

The jacket installation technology mainly includes shipment technology, barge transport stability analysis technology, steel pile and riser drivability analysis technology, jacket slide launching and installation technology, etc.

Integral overturning and closure of large jacket

Jacket hoisting and shipment

Jacket slide shipment

Offshore installation of jacket

3 TYPICAL CASES

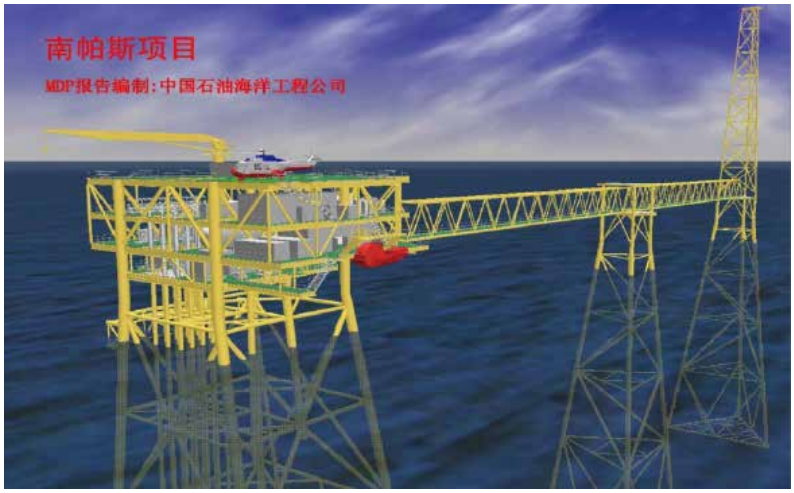
3.1 NP1-5/NP1-29 offshore gathering and transportation project

NP1-5/NP1-29, located in Nanpu sea area, Tangshan City, Hebei Province, is China's first jacket platform project studied, designed and constructed independently and was put into operation in 2009. Up to now, the platform is safe and reliable. The construction scale of NP1-5 is 9.7×10^4t/a crude oil and $1747\times10^4m^3$/a natural gas, and it is an unattended platform. It includes two built-up wellhead platforms, 3 newly built production platforms, 1 8in submarine mixed transportation pipeline and 1 submarine cable. Wellhead fluids are metered at the production platforms; after being heated, they enter the submarine pipeline and are transported to NP1-3D. The water depth of NP1-29 offshore gathering and transportation project is 5.4~7.1m and it includes 1 production platform and 3 wellhead platforms. Wellhead fluids are metered at the production platform; after being heated, they enter the submarine pipeline and are transported to NP1-2D.

3.2 Design of the jacket platform in South Pars, Iran

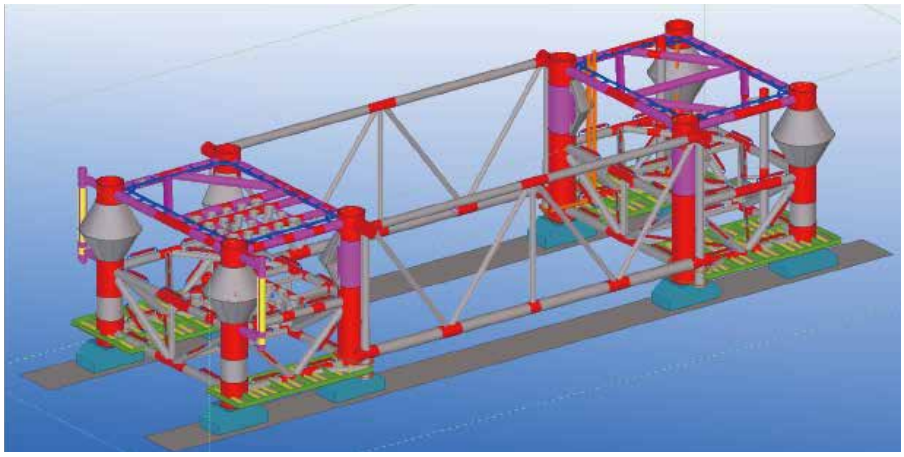
Block 11 in South Pars, Iran has totally two wellhead platforms. Each platform has 15 wellhead slots and annual production of $200\times10^8 m^3$. In addition, there are 6 submarine pipelines and optical cables and 1 set of single-point mooring transportation system.

CNPC has favorably completed the detailed design of the jacket and the basic design of topside module, submarine pipeline and single-point mooring facilities. The project has the following features: large gas quantity, unattended design, gas field's gathering and transportation flow design of offshore wet gas transportation; produced water treatment flow and control scheme selection for high pressure gas fields; special requirements of unattended gas fields for general layout; high isolation grade, compact equipment layout, high channel requirements; analysis and calculation of the platform's restricted area/fire area with software, noise analysis; design technology for platform fixing with 70m deep jacket.



3.3 JZ9-3 jacket project

JZ9-3 jacket is the project in cooperation with CNOOC and is the jacket with the largest tonnage that is being built by CPOE at present. There are two 4-leg jackets such as CEPD1-2 and CEPD3-4, and an auxiliary frame connects the two jackets in the middle of 40m. Main structure weight: 1528t; pile pipe weight: 2792t; riser weight: 578t; total weight of the steel structure: 4973t.



4 ANCILLARY EQUIPMENT

4.1 Offshore engineering construction base

The offshore engineering construction base, located in the Haixi Bay of Qingdao Economic & Technological Development Area, covers a total land area of $107\times10^4m^2$ and is fitted with a 750m terminal shoreline, a 4000t slideway, a 8000t slideway and matching production facilities such as module structure shop, painting shop, etc. The base has the annual steel product production capacity of 9.8×10^4t and is fitted with offshore construction equipment such as large hoisting and pipe laying ships and matching ships, various pile hammers, etc. The base has plentiful offshore construction experience and abundant strength and can build offshore oil and gas field production facilities such as jacket platforms, pile foundation platforms, compliant-articulated tower platforms, TLP platforms, Spar platforms, single-point mooring platforms, FPSO, etc., and provide the business involving land prefabrication and construction of offshore structures, shipment, engineering ship berthing services, etc.

The offshore engineering construction base has completed the construction of totally 10 jackets and 6 topside modules such as Yudong A1 and A2 offshore platforms, NP1-29 offshore gathering and transportation project, etc.

Terminal shoreline

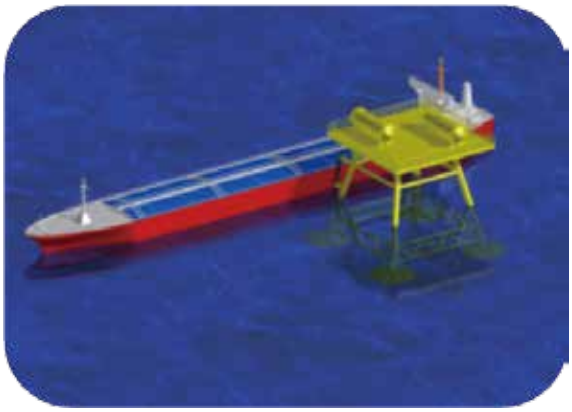
Slideway construction

Module shop

CPOE 101 400t hoisting and pipe laying ship

4.2 Key laboratory

The building area of the key offshore engineering laboratory of CNPC is 5000m^2. The laboratory has over 100 pieces (sets) of various test equipment. The laboratory has the research capacity in the fields involving underwater equipment engineering, offshore engineering structure subgrade and foundation, deepwater structure engineering, etc. and can perform wave current water trough experiment, structural mechanics experiment, special material experiment and numerical simulation analysis on offshore engineering structures.



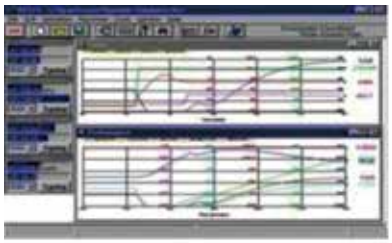
Bucket foundation model diagram

Bench diagram (mud basin)

Dynamic triaxial shear equipment for earthwork

4.3 Professional software

Over 20 sorts of internationally advanced jacket platform design software have been introduced. They can be used in offshore platform process design, pipeline design, flare and venting system design, structure design, finite element analysis, hydrodynamic performance analysis, mechanical design, electrical design, instrument design, etc.



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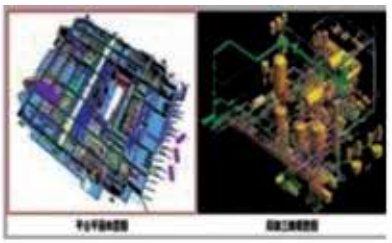
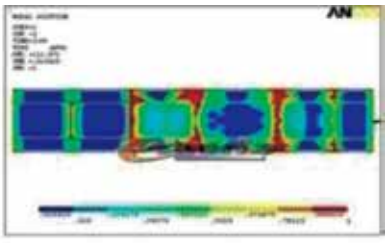
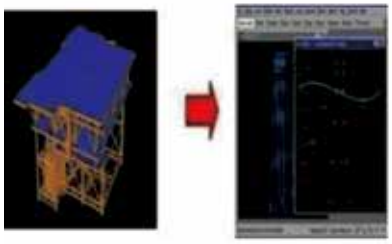


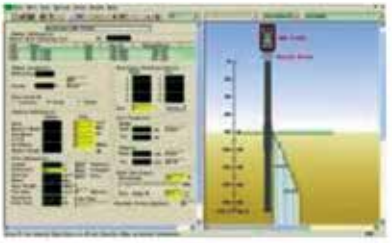
PDMS



ANSYS



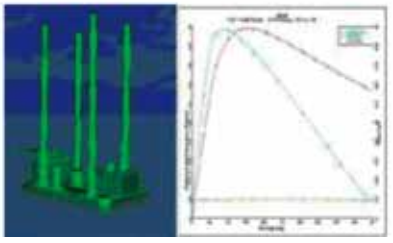
SACS



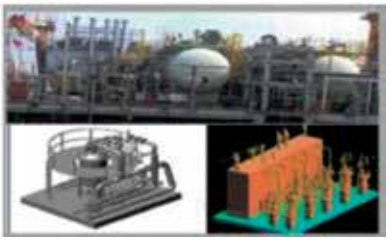
Glweap

Autopipe

Pipeflo



Moses



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5 QUALIFICATION STANDARDS

5.1 Enterprise qualification

CNPC has qualifications including grade A offshore petroleum engineering design, grade I offshore petroleum engineering contracting, grade B engineering consultancy as well as special equipment licenses including harbor operation license, pressure pipeline and pressure vessel license, etc., and is a national high-tech enterprise.

5.2 Technical standards

The Guide to Design of Offshore Oil and Gas Field Engineering has been published; multiple relevant offshore engineering standards and specifications have been quoted, including those of API, ABS, DNV, ASTM, ISO, IEC, GB, CCS, SY, etc., thus providing a powerful guarantee to design, construction and installation of offshore platforms.

Single technology name	Number of main standards and specifications	Remarks
Overall design technology	7	GB, Industrial standards etc.
Process design technology	42	ISO, API, GB, Industrial standards etc.
Fire safety design technology	32	API, ABS, NFPA, GB, Industrial standards etc.
Mechanical equipment, heating and ventilation design technology	58	API, ASME, GB, Industrial standards etc.
Electrical design technology	49	IEC, IEEE, API, GB, Industrial standards etc.
Automatic control design technology	45	API, IEC, ISA, GB, Industrial standards etc.
Module and jacket structure design technology	45	API, DNV, CCS, AISC, ASTM, Industrial standards etc.
Module and jacket anticorrosion design technology	40	CAN, ISO, NACE, GB , Industrial standards etc.
Module and jacket construction and installation technology	41	CCS, GB, API, ASTM, AWS, AISC, JS, Industrial standards etc.

6 EXPERT TEAM

Tang Rongyu

Senior engineer, member of CSNAME, Deputy Director of Shallow Sea Central Station of CPS Engineering Committee, Deputy Secretary-General of Offshore Petroleum Engineering Specialized Standardization Committee, member of CCS Offshore Engineering Committee, member of Editorial Committee of China Offshore Platform and Petroleum Engineering Construction. He is mainly engaged in design and R&D of offshore oil and gas fields as well as construction, design and management of equipment base. As project manager or principal, he has taken charge of over 30 offshore engineering projects. He has chiefly formulated and has participated in formulation of 4 industrial specifications. Over 20 papers written by him have been published.

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Liu Jieming

National grade I registered structure engineer, member of Production, Learning and Research Committee of CSTAM, member of Beijing Society of Theoretical and Applied Mechanics, member of CPS, member of Offshore Engineering Specialized Standard Group of CNPC Standardization Committee. He has taken charge of over 50 offshore engineering designs. Over 10 papers written independently by him or co-authored by him (ranking first) and other persons have been published in national journals or at international conferences. As the industrial standard invitee, he has formulated 1 industrial standard and 1 enterprise standard. As the industrial standard chief reviewer, he has chiefly reviewed 4 industrial standards or enterprise standards.

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Guo Hongshen

Senor engineer. He has occupational qualification in US PMP project manager. He is mainly engaged in the study and design of offshore petroleum engineering equipment as well as the design and management of offshore engineering structures and submarine pipelines. He has participated in and taken charge of completing R&D of multiple national and ministerial key scientific research subjects, platforms and ships.

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Zhang Fenglian

Senior engineer, national grade I registered structure engineer, national stage II registered architect. He is mainly engaged in the construction of oilfield mining areas, surface engineering and offshore engineering as well as design and management of submarine pipelines. He has taken charge of over 20 surface engineering construction and submarine pipeline projects. Over 10 papers written by him have been published.

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Qin Yanlong

Senior engineer, member of CSNAME Offshore Engineering Branch, member of Offshore Engineering Work Department of CPS Petroleum Engineering Specialized Committee, member of Offshore Engineering Equipment Overall Technology Expert Panel and Offshore Engineering Equipment Special System and Equipment Expert Panel of the Ministry of Industry and Information Technology. He is mainly engaged in the study and design of offshore petroleum engineering development technology and equipment. He has taken charge of and participated in completing over 20 national, provincial and ministerial key scientific research subjects. He has obtained 2 grade II provincial and ministerial science and technology advance prizes and 1 grade V provincial and ministerial science and technology advance prize. 53 papers written by him have been published. He has obtained 25 patents.

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Li Chunrun

Senior engineer, member of CWA, Deputy Director of Welding Professional Committee of China Petroleum Engineering Construction Association. He is mainly engaged in the study, development and management of offshore and land petroleum engineering construction and installation technology and special equipment. He has taken charge of and participated in completing over 20 ministerial key scientific research subjects and national key projects. He has obtained 2 grade II provincial and ministerial science and technology advance prizes and 3 grade IV provincial and ministerial science and technology advance prizes. Over 40 papers written by him have been published. He has obtained over 20 patents.

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Zheng Li

Senior engineer, grade I national architect. He is engaged mainly in construction and installation of offshore structures. He has organized the construction and installation of over 50 offshore structures including PY30-1 jacket, Yuedong module and jacket, etc.
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Gao Zhaoxin

Senior engineer. He has occupational qualification in US PMP project manager. He is mainly engaged in construction and installation management of offshore structures as well as laying management of submarine pipelines and submarine cables. He has participated in construction and installation of multiple topside modules and jackets of jacket platforms as well as laying of multiple submarine pipelines such as Hong Kong branch of Xier Line.
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