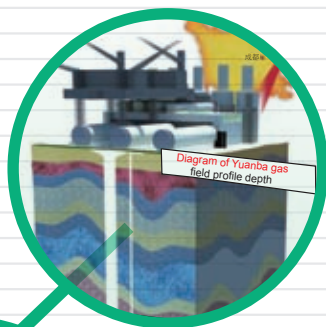


# 12000m Extra-deep Well Drilling Rig

Science & Technology Management Department

2013

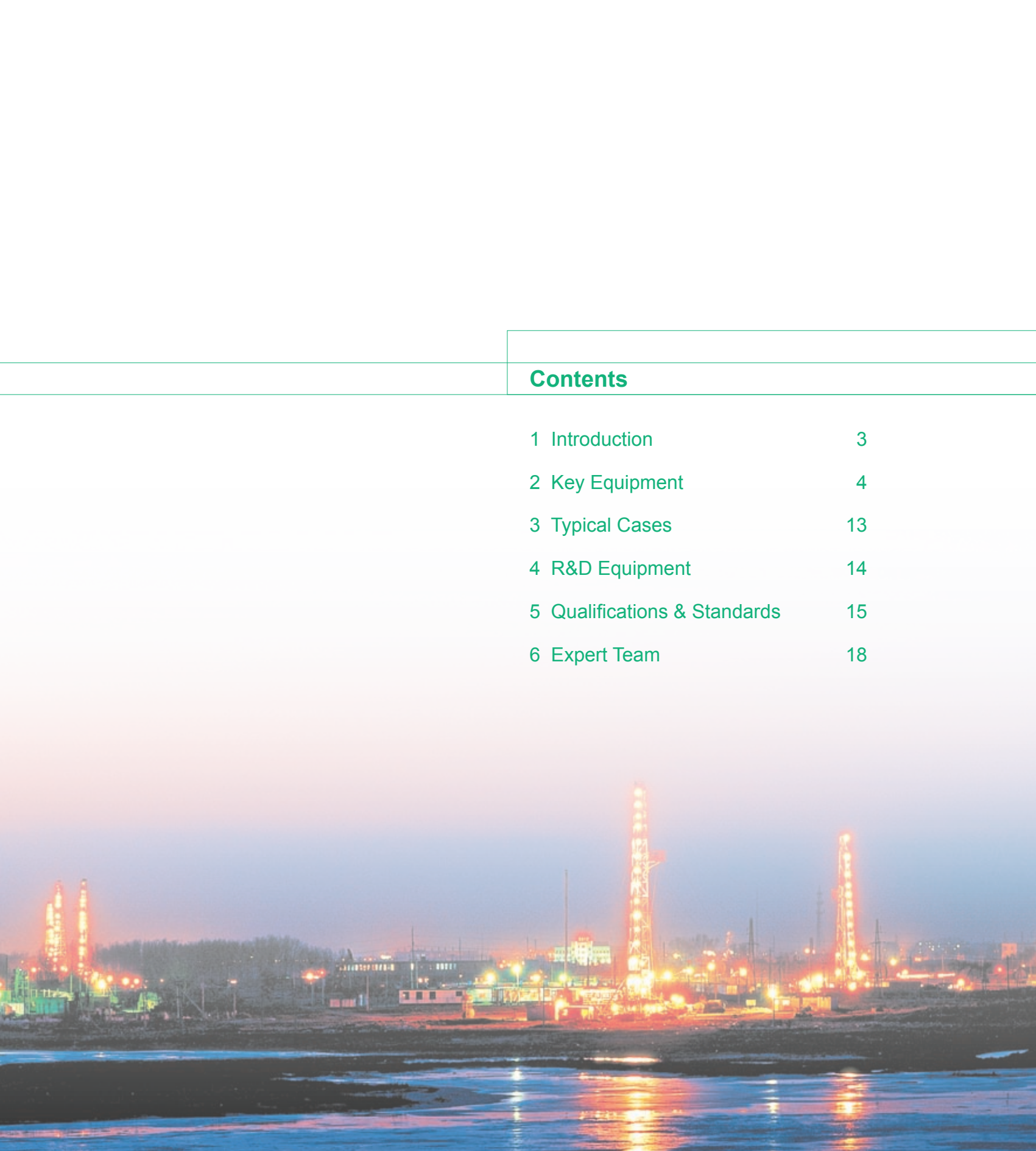


CHINA NATIONAL PETROLEUM CORPORATION

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*12000m Drilling Rig of CNPC, “Miraculous  
Earth Exploration Needle!”*





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**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 reorganized 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 2012 CNPC produced 110 million tons of crude oil and 79.82 billion cubic meters of natural gas, while crude processing volume reached 191 million tons. The total revenue of RMB 2,690 billion with a profit of RMB139.1 billion had been achieved the same year.

CNPC was ranked 4th among the world's largest 50 oil companies and 6th in Fortune Global 500 in 2012.

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.

**12000m Extra-deep Well Drilling Rig** is one of representatives for major innovations of CNPC.

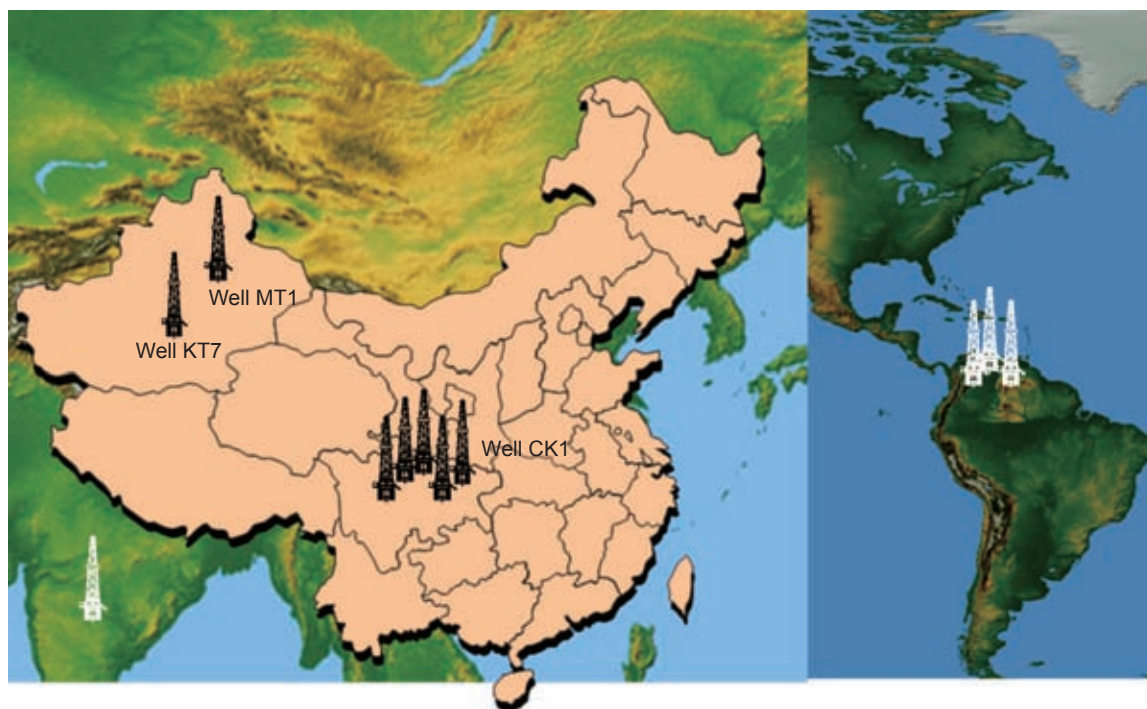
## CLEAN ENERGY SUPPLY FOR BETTER ENVIRONMENT



# 1

## INTRODUCTION

The 12000m drilling rig is the world's first land extra-deep well AC VFD drilling rig developed by CNPC with independent intellectual property rights. The overall performance of the drilling rig reaches the advanced level of international land drilling rigs. The successful development of the 12000m drilling rig has changed the situation of China's dependence on import for super-deep well drilling rigs and is of much significance to the exploration and development of China's deep oil and gas resources.



Application and popularization of key technologies of the 12000m drilling rig

# 2

## KEY EQUIPMENT

### 2.1 Overall Technical Parameters

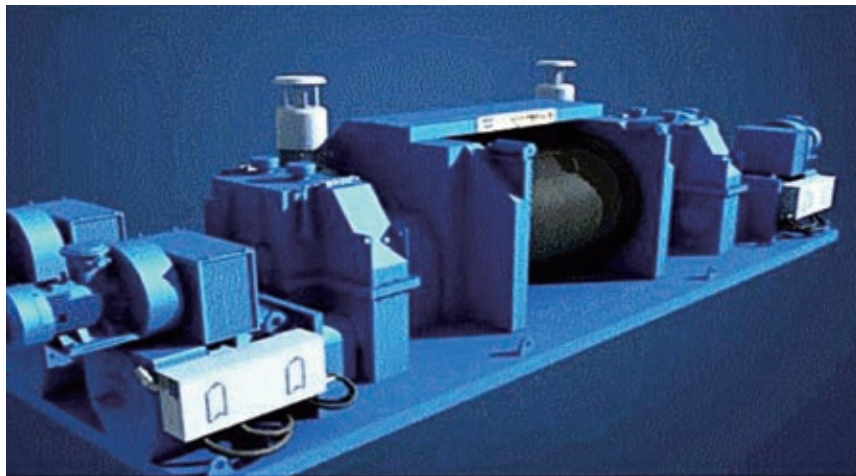
Overall technical parameters of 12000m extra-deep well drilling equipment			
Nominal drilling depth	12000m	Maximum hook load	9000kN
Rated power of the drawworks	4400kW (6000hp)	Drawworks gears	Gear I, AC frequency-variable motor driven, stepless speed regulation
Rope system of lifting system	7×8	Diameter of drilling line	φ48mm
Pulley OD of the lifting system	φ1829mm	Drift diameter of the swivel center tube	φ102mm
Model and number of drilling pumps	F-2200HL 3 units	Nominal diameter of rotary table opening	φ1257.3mm (49 1/2in)
Rotary table gears	II+IIR, AC frequency-variable motor driven separately, stepless speed regulation	Derrick type and effective height	"K" type 52m
Substructure type and floor surface height	Rotary lifting type 12m	Power transmission mode	AC-DC-AC AC variable frequency vector control
Diesel generating unit model	CAT 3512B/SR4 B	Unit number × output power	5×1900kVA
Number of AC frequency-variable motor(s)	4×1100kW (drawworks)	AC variable frequency control unit (VFD) input voltage, output voltage, frequency	Common DC bus control
	6×900kW (drilling pump)		600VAC
	1×800kW (rotary table)		0~600V 0~150Hz (adjustable)
MCC system	600V/400V (3-phase)/230V (single-phase) 50Hz	High pressure manifolds	φ102mm×70MPa Interfaces reserved between kill manifolds and cementing manifolds

## 2.2 Key Components of Subsystems

### 2.2.1 6000hp Large Power Drawworks

The drawworks is the core component of the drilling rig. The drawworks functions in various operations such as tripping of drilling tools, casing running, WOB control, accident treatment, core barrel lifting, production test, etc. and also is used to lift and lower the derrick substructure during petroleum drilling.

CNPC has originally invented the quick clutch mechanism for the drilling drawworks drum and innovatively developed the 6000hp modular drilling drawworks with neutral position that has the largest power in the world on lands. The developed JC-120DB drawworks is a sort of new AC VFC single-shaft gear drawworks and consists of mainly units and components such as AC variable-frequency motor, reduction gear, hydraulic disc brake, drum shaft, drawworks support, automatic drilling device, air system, lubricating system, etc.



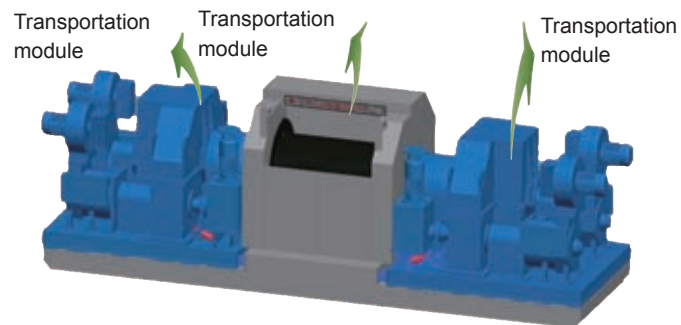
Large power modular drilling drawworks

(1) Technical parameters of the large power modular drawworks.

Rated input power	4×1100kW
Maximum tensile force of fast line	850kN
Wire line diameter	φ48mm
Drum speed	0~328r/min
Grooved drum dimension	(diameter × length) φ1320mm×2305mm
Brake disc diameter	φ2400mm
Outside dimension of the drawworks	12000mm×3375mm×3260mm

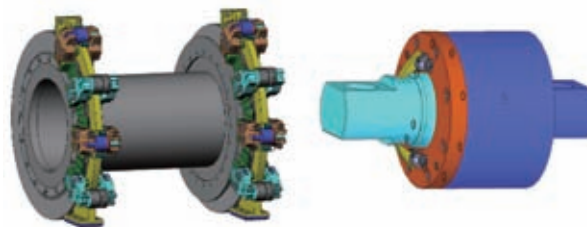
(2) Synchronous drive by four 1100kW large power AC variable-frequency special motors, balanced load distribution and stable switching in/out of multiple motors in drilling drawworks for the first time.

(3) Due to the modular design of the large power drawworks, it can be transported both integrally and on a block basis, thus effectively solving the technical problem about road transportation of ultra-large power land drawworks, high efficiency installation and hoisting at field drilling sites, etc.



Modular decomposition of the drawworks

(4) The hydraulic disc brake has functions such as automatic brake clearance adjustment, remote control of hydraulic station, lower pressure alarming, low liquid level alarming and temperature alarming, and all shaft sleeves are free of lubrication. With the automatic clearance compensation technology for disc brake, the precision of lowering and lifting drill strings is improved from  $\pm 15\text{mm}$  to  $\pm 8\text{mm}$ , thereby improving the safety of drilling operations.



Hydraulic disc brake structure



2.2.2 9000kN Derrick and Substructure

The single-rotary integral self-lifting technology and cylinder lifting A-bracket technology for the drilling rig substructure that were invented by CNPC have replaced the existing slingshot dual-rotary split structure, thus realizing low position installation of all equipment running on the 12m ultra-high drill floor and then integral lifting of the equipment together with the substructure to the working position and solving the difficult problems of safe and quick installation at drilling sites.

Main parameters of the derrick	
Maximum hook load	9000kN
Effective height	52m
Bottom front opening	10m
Stand capacity $\phi$ 127(5in) drill pipe	12000m
Anti-wind capability:	
Wait on weather	36 m/s
Security equipment	47.8 m/s
Derrick lifting and lowering	$\leq$ 8.3 m/s
Main parameters of the substructure	
Drill floor height	12m
Effective height	10m
Drill floor area	13m $\times$ 13.8m
Stand capacity $\phi$ 127(5in) drill pipe	430 stands
Maximum load of the rotary table	9000kN
Rated stand load	4320kN



### 2.2.3 Traveling and Hoisting Equipment with Large Load Bearing Capacity

The heavy-duty crown block, traveling block, hook and elevator link with the load bearing capacity of 6750kN and 9000kN and the rotary swivel of 6750kN load bearing capacity and 52MPa pressure resistance all are manufactured by low temperature resistant materials and can meet the requirements of -40°C working environments.

Crown block——max load bearing capacity: 9000kN, number of sheaves: 8, sheave diameter:  $\phi 1829\text{mm}$ ;

Traveling block——max load bearing capacity: 9000kN, number of sheaves: 7, sheave diameter:  $\phi 1829\text{mm}$ ;

Hook——max load bearing capacity: 9000kN;

Elevator link——max load bearing capacity: 9000kN, length: 4.88m;

Rotary swivel——max load bearing capacity: 6,750kN, center pipe diameter:  $\phi 102\text{mm}$ , working pressure: 52MPa, max speed: 300r/min.



9000kN Traveling block



9000kN Hook



SL675 Rotary swivel



DG900 Hook

2.2.4 F-2200HL High Pressure Drilling Pump

The F-2200HL high pressure drilling pump can meet the requirements of ultra-deep well drilling and high pressure jet drilling technology and is obviously better than foreign plunger drilling pumps of the same grade in the convenience of assembling, disassembling and maintenance. In addition, the drilling pump uses the technology for cooling of inner and outer surfaces of cylinder liners, thus obviously increasing the service life of cylinder liners and pistons.

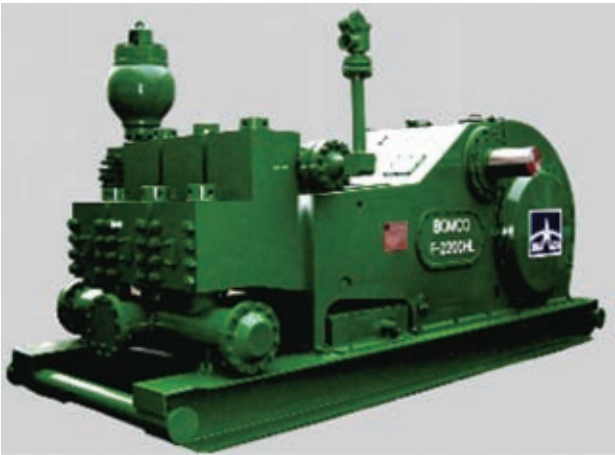
The F-2200HL high pressure drilling pump uses the technologies such as new “L-shaped” hydraulic end, vertical suction air bag, etc., thereby improving the pressure bearing capacity and suction performance of the drilling pump;

The cylinder liners and pistons used in the F-2200HL high pressure drilling pump are better than plunger packing;

The new valve assembly used in the F-2200HL high pressure drilling pump has reliable performance and long service life at high pressures;

The air bag used in the F-2200HL high pressure drilling pump has long service life.

Main technical parameters of the F-2200HL high pressure drilling pump	
Rated input power	2200hp
Maximum pressure	52MPa
Rated strokes	105r/min
Maximum displacement	77.65L/s



F-2200HL Drilling pump

2.2.5 ZP495 Rotary Table and Rotary Table Drive Unit

Main technical parameters of ZP495 rotary table and its drive unit	
Maximum static load	9000 kN
Through-hole diameter	1257.3 mm
Maximum speed	300 r/min
Maximum working torque	66000 N·m
Motor power	800kW

Large load bearing capacity, strong torque transmission capacity;  
The rotary table driving box is designed with two gears, which can meet the drilling needs in different operating modes;  
The inertia brake of the rotary table uses the pneumatic disk hydrostatic braking mode, which has quick response speed.



ZP495 Rotary table

### 2.2.6 AC Frequency-variable Electric Control System

Comprehensive application of synchronous control of running of multiple motors and braking control of large power energy consumption;

Reasonable matching of the control system with the motor's output characteristics ensures the comprehensive performance of the drilling rig;

Various logic, interlocking and safety protection functions;

Adoption of the intelligent integrated instrument control technology;

Automatic drilling function combining the main motor with a small motor.



AC Frequency-variable electric control system





9000kN TDS

### 2.2.7 9000kN TDS

The test of DQ120BSC TDS was completed in well LG36 in Yilong Region of Sichuan from Apr. 26, 2008 to May 28, 2009, with the TVD of 6956m, and the TDS was used reliably and completely met field demands.

#### Main Technical Parameters of 9000kN TDS

Maximum load	9000kN (1000t)
Speed range	0~180 r/min
Working torque (continuous)	85kN·m (62000lbf·ft)
Maximum break-out torque	135kN·m (99000lbf·ft)
Backup clamp clamping range	87~216mm ( $2\frac{7}{8}$ ~ $6\frac{5}{8}$ in)
Through-hole diameter of the center pipe	102mm (4in)
Effective height of the body	6.5m (21.3ft)

# 3

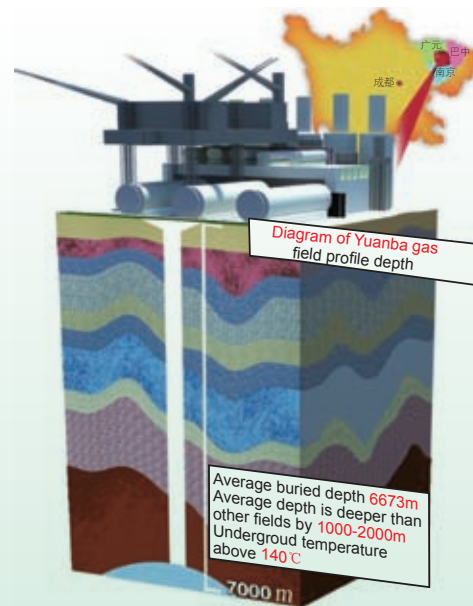
## TYPICAL CASES

Since 2007, three sets of 12000m drilling rigs of CNPC have been applied in Yuanba gas field. The first 12000m drilling rig was used to drill China's first marine ultra-deep scientific exploration well in Xiaoquan structure of Western Sichuan depression in Sichuan basin, with the TVD of 7560m. After undergoing complex natural environment conditions, complex geologic conditions and "5.12" Wenchuan earthquake, all the equipment of the drilling rig still runs normally. The drilling rig was used to drill through continental strata and into marine strata. A series of high and new indexes were created in Western Sichuan Region; in the under-balanced operation interval (4671~5431.7m), the pure drilling time was 837.75h and the average ROP reached 1.02m, which is 30% higher than that with a conventional drilling rig.

With the drilling rig, the large marine gas field—Yuanba gas field with the largest buried depth in China was discovered in Sichuan Basin in Sept. 2011. Phase I proven OGIP of Yuanba gas field is

$1592.53 \times 10^8 \text{m}^3$ . Yuanba gas field is the large marine gas field with the largest buried depth in China at present and its depth exceeds 7000m.

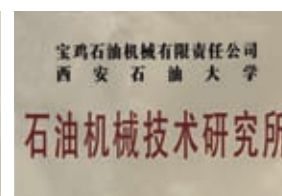
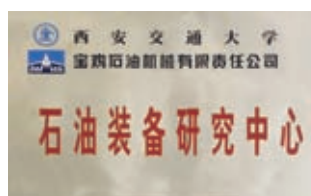
The successful development of the 12000m extra-deep well drilling equipment has greatly increased the competitiveness of China's petroleum drilling equipment in the international market. Part matching equipment has been applied in the drilling rig modules of offshore deepwater drilling platforms.



# 4

## R&D EQUIPMENT

The R&D and manufacturing environment of the 12000m extra-deep well drilling equipment is excellent and the test equipment is advanced. The “National Oil and Gas Drilling Equipment Engineering Technology Research Center” has been established based on CNPC Baoji Petroleum Machinery Co., Ltd.



Supporting qualification



# 5 QUALIFICATIONS AND STANDARDS

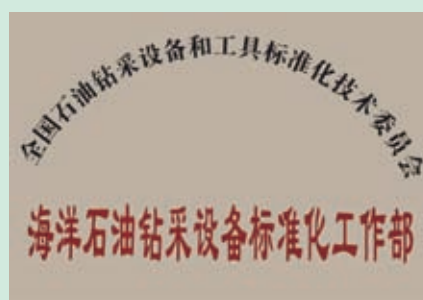
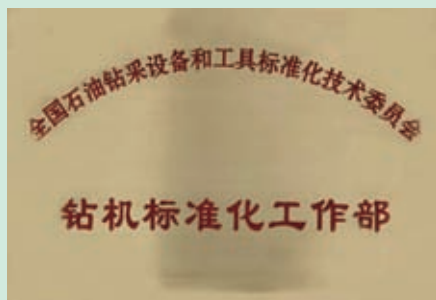
## 5.1 Qualifications

CNPC has obtained the right to use API monogram for 15 major types and 67 products and is the enterprise that has the most products with the API monogram use right owned internationally.



## 5.2 Standards

CNPC has two national standardization working departments (National Drilling Rig Standardization Working Department and National Offshore Drilling and Production Equipment Standardization Working Department), which are responsible for drawing up and revising the national and industrial standards for drilling rigs and offshore drilling and production equipment.





Formation and revision of 5 national and industrial standards

No.	Standard No.	Standard name
1	GB/T23505-2009	Petroleum Drilling Rig and Workover Rig
2	SY/T6724-2008	Basic Configuration of Petroleum Drilling Rig and Workover Rig
3	SY/T6726-2008	Top Drive System for Petroleum Drilling Rig
4	SY/6727-2008	Hydraulic Disc Brakes for Petroleum Drilling Rig
5	SY/T5532-2009	Drawworks of Petroleum Drilling Rig

5.3 Patents

The 12000m extra-deep drilling rig of CNPC was granted with 1 USA authorized patent of invention, 3 China authorized patents of invention and 20 China authorized utility model patents.





### Patent list

Patent	Type	Country (Region)	Patent No.
Cooling Device for Interior and Exterior Surfaces of a Mud Pump Liner	invention	USA	11/966,277
Cast Steel and Manufacturing Method for Traveling and Hoisting Systems of Petroleum Drilling Rig	invention	China	ZL 200710018444.8
Cooling Device for Interior and Exterior Surfaces of Drilling Pump Liner	invention	China	ZL 200710018524.3
Brake Calipers for Automatic Compensation Clearance of Disc Brakes	invention	China	ZL 200710178675.5

## 5.4 Honors & Awards

The 12000m extra-deep drilling rig of CNPC was awarded with grade II national science and technology advance prize, national self-innovation product certificate, grade I science and technology advance prize of CNPC, etc.



Grade II national science and technology advance prize



Grade I science and technology advance prize of CNPC



National self-innovation product certificate

# 6

EXPERT TEAM



**Su yinao** Academician of the Chinese Academy of Engineering, Ph. D. candidate supervisor, He is of great attainments in the study and application of drilling technologies involving directional wells, cluster wells, horizontal wells, etc. His multiple innovative achievements in the study of drilling mechanics, trajectory control and downhole tools reach the international advanced level, and the formed systems have obtained remarkable benefits from their production applications.  
Tel.: 010-52781869



**Wang Jinquan** Doctor, professor level senior engineer, expert enjoying the “government special allowance of the State Council”, senior technical expert. He is the leader of the 12000m drilling rig subject and one of main personnel who completed the study of the overall drilling rig scheme and integrated innovative technologies. He worked out the overall technical scheme for the project and the research approach and examined and approved the technical scheme for the whole drilling rig and key components. He completed 2 papers related to the subject and obtained 2 patents.  
Tel.: 0917-3462007  
Email: wjq@bomco.cn



**Huang Yuehua** Senior engineer, senior technical expert. He is one of the personnel who completed the study of the overall drilling rig scheme and integrated innovative technologies. He was fully responsible for the routine implementation of technologies for the project and technical control of structure members and innovatively studied the overall scheme for the drilling rig’s structure members, derrick and sub-structure and structure form. He completed 5 papers related to the subject and obtained 2 patents.  
Tel.: 0917-3462166  
Email: jszxhyh@bomco.cn



**Jia Bingyan** Senior engineer, technical expert. He is the main designer of the 12000m drilling rig and took charge of the overall design of the overall technical interface of the drilling rig and 6000hp drawworks. He completed 4 papers related to the subject and obtained 4 patents.  
Tel.: 0917-3462205  
Email: jszxjby@bomco.cn



**Pu Rongchun** Senior engineer, technical expert. He is the main person who worked out the overall scheme for the traveling and hoisting equipment of the 12000m drilling rig and was fully responsible for technical research on the high pressure large power drilling pump. He completed 5 papers related to the subject and obtained 1 U.S. patent, 1 Chinese patent of invention and 1 utility model patent.  
Tel.: 0917-3462168  
Email: jszxprc@bomco.cn



**Wu Zhanxue** Senior engineer, technical expert. He completed the design of the technical scheme for factory assembling and testing of the 12000m drilling rig project and its research task and obtained 1 Chinese patent of invention.  
Tel.: 0917-3462850  
Email: wuzhx@bomco.cn



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