Oilfield Services, Engineering & Construction, and Equipment Manufacturing

In 2015, we continued to speed up the transformation and upgrading of oilfield services, engineering & construction and equipment manufacturing sectors, enhance innovation of technologies and management, optimize business structure, expand high-end market, and intensify R&D as well as industrial application of advanced products. These efforts made us more competitive and competent in supporting our oil and gas businesses. Globally, we provide technical services in geophysical prospecting, well drilling, well logging and mud logging, downhole operations, as well as construction and engineering services for oil/gas field surface works, large refining and chemical facilities, pipelines and storage tanks. Our petroleum equipment and materials were exported to 81 countries and regions around the world.

Oilfield Services

2015 saw increased operational efficiency in our oilfield services, thanks to improved operating speed and profitability from innovative management and technologies, new modes of production organization such as EPC and factory drilling, and the application of new technologies.

Geophysical Prospecting

In 2015, CNPC deployed 163 seismic crew-times (84 2D and 79 3D) in 206 projects, acquiring data of 132,714 kilometers of 2D lines and 47,219 square kilometers of 3D profiles. With data acquisition registering 100% acceptance of on-site profiles and final processed profiles, the 2D and 3D surveys recorded shots per average day increase by 5.6% and 6.8%, respectively.

We consolidated our position in the domestic geophysical prospecting market by promoting economic and technical integration, optimally allocating resources and organizing production, and improving the operation and profitability of projects. In the 2D seismic project of Nyima Basin & Long'eni-Esima in northern Tibet, BGP acquired satisfactory seismic data and recorded good results in shot density and folds in the Qiangtang Basin, by selecting a landform-based optimal plan comprising high-density wide-line observation, low frequency vibroseis, and strictly controlled operating steps.

In 2015, our innovative mode of development achieved good results in the depressed international geophysical prospecting market. In the Middle East, we maintained steady growth and increased our share in the high-end market with contracts awarded on data acquisition of the Saudi Arabian S78 transition zone in the Red Sea and on a PDO project in Oman.

With enhanced market development, our deep-sea exploration saw steady growth in multi-user business. We completed offshore towing acquisition in the Australian blocks of Numbat & Quoll and Bilby, as well as Block Yucatan in the Gulf of Mexico. Processing and interpretation delivered higher profitability through proactive services and integration. The building of three major processing centers in the Middle East, South America and Southeast Asia has been improving. Information, reservoir geophysics, borehole seismic exploration, unconventional geophysics, and integrated geophysical & chemical prospecting services achieved synergy and steady development.

We intensified R&D in core software and equipment for geophysical prospecting and obtained considerable results in the application of matching technologies. The GeoEast software family gained new members and kept improving its functionality and performance. Important progress was made in velocity modeling, anisotropic migration, Q-migration, and full waveform inversion. KLSeis II software was upgraded with enhanced functionality in efficient data acquisition, complex-zone design, and static correction. G3iHD wired seismograph was launched and the performance of the Hawk wireless-node seismograph kept improving. LFV3 low frequency vibroseis was put into widespread application; and production tests were conducted on EV56 precise vibroseis. Our proprietary "wide azimuth, broadband and high density" exploration technology + efficient acquisition technology with low frequency vibroseis saw extensive application in nine Chinese 3D seismic projects covering 1,840 square kilometers, and in six overseas projects covering 10,396 square kilometers.

Geophysical prospecting operations

	2013	2014	2015
Seismic crews in operation	165	166	**166**
Domestic	95	96	**96**
Overseas	70	70	**70**
2D seismic data acquired (kilometers)	114,364	103,645	**132,714**
Domestic	40,274	42,798	**22,521**
Overseas	74,090	60,847	**110,193**
3D seismic data acquired (square kilometers)	64,491	63,990	**47,219**
Domestic	17,542	14,485	**10,722**
Overseas	46,949	49,505	**36,497**

Well Drilling

In 2015, our 1,230 drilling rigs spudded 9,390 wells and completed 9,387 wells, with a total footage of 20.89 million meters.

We promoted the EPC mode of drilling operation and kept improving the drilling speed and efficiency. Deep wells were drilled much faster, with the penetration rate increasing by 4.9% year-on-year and the average drilling cycle of wells deeper than 4,000 meters reducing by 8.5%. Our Xibu Drilling Engineering Company, as the EPC drilling contractor in Block Zhahaquan of Qinghai Oilfield, recorded several highs, with the monthly drilling rate and penetration rate increasing by 24.8% and 14.6% and the well construction cycle decreasing by 31% over 2014. These achievements were made by assigning a dedicated management team for the block and applying premium and fast drilling technology. In Chuanqing Drilling's Tazhong EPC project, 24 wells were completed with an average depth of 5,377 meters, and the average monthly drilling rate and penetration rate increased by 37% and 16.6% and the drilling cycle decreased by 16 days year-on-year. The project saw the completion of our deepest well, Keshen-902, at a depth of 8,038 meters. Our Great Wall Drilling Company finished the drilling of well Ga-E31P 16 days ahead of schedule in its EPC-contracted Block Garraf in Iraq. The company recorded the quickest drilling and completion of highly-deviated directional wells with an inclination of over 40° in the block.

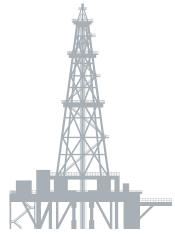
Drilling operations

	2013	2014	2015
Drilling rigs in operation	1,018	1,018	**1,230**
Domestic	823	824	**979**
Overseas	195	194	**251**
Wells drilled	13,378	12,286	**9,387**
Domestic	12,035	10,970	**8,289**
Overseas	1,343	1,316	**998**
Footage drilled (million meters)	27.50	24.92	**20.89**
Domestic	24.32	21.98	**18.38**
Overseas	3.18	2.94	**2.51**

Factory operations were deployed extensively in the development of tight oil and shale gas. Applied in more than 50 platforms and over 300 wells, the operation increased efficiency by 40% and decreased costs by more than 30%. In factory tight oil operations, our Daqing Drilling Engineering Company greatly increased its drilling efficiency by furnishing key equipment such as rig-walkers, top-drive drilling equipment, and crawlers, formulating six sets of code of practices on drilling and completion, and improving the technical templates for increasing speed in seven blocks. In a joint development project in Sulige Gas Field, Great Wall Drilling Company maintained high standard in single well controllable reserves, stage-specific recovery rate, as well as drilling, completion, and reservoir stimulation, by taking the lead in using an overall development mode of "horizontal wells + multi-stage fracturing" as well as a large-platform "well factory" operating mode. In the Weiyuan shale gas project, the operation efficiency was greatly enhanced by combining engineering with geology to predict and encounter sweet points and by using a mode comprising "dual-rig factory operation" and "zipper factory fracturing".

The spread of new technologies achieved remarkable results. The vertical drilling system, precise PCD system, and drilling acceleration tools were extensively used. Further breakthroughs were made in new technologies such as coiled-tubing sidetracking. Our Bohai Drilling Engineering Company kept researching and upgrading domestic manufacturing of vertical drilling tools, with stability and reliability further improved. In Tarim Oilfield, the BH-VDT vertical drilling tool registered the longest single well footage of 3,959 meters and greatest drilling depth of 4,303 meters. The precise PCD system was deployed in Sichuan and Xinjiang in China and in the Indonesian Block Jabung. Our drilling acceleration tools such as hydraulic rotary impact tools and hydro-oscillators were extensively used, greatly increasing the percentage of net drilling time and reducing the drilling cycle.

In 2015, we extended our reach in the international drilling market and won new contracts in Kazakhstan, Uzbekistan, Venezuela, Indonesia, the United Arab Emirates, Iraq, Iran and Kenya. We were also awarded the EPC contracts for the Maysan project and an integrated project of LUKOIL's Block 10 in Iraq.



Well logging operations

	2013	2014	2015
Logging crews	725	760	**803**
Domestic	587	623	**662**
Overseas	138	137	**141**
Well logging operations (well-time)	106,092	93,533	**88,926**
Domestic	100,129	88,000	**85,953**
Overseas	5,963	5,533	**4,993**

Well Logging and Mud Logging

In 2015, CNPC deployed 803 well logging crews and completed 88,926 well times of logging in 18 countries; and 1,252 mud logging crews and completed mud logging on 9,718 wells.

We actively changed our mode of well logging service based on the present service and production needs at oilfields. To reveal hydrocarbon content, we used imaging logging to tackle reservoir complexity and maximize output of single well. Moreover, new technologies and techniques were extensively employed to help reduce costs and enhance the profitability.

ElLog, our independently developed imaging logging outfit, was widely deployed. It greatly reduced the average time taken for operation in single uncased hole compared with conventional methods. The 15-meter "One-String" fast logging tools reduced the logging duration per well by four hours, increasing the efficiency by more than 30%. Hard-cable well logging technology was applied on a large scale, reducing the logging duration per well by 22.96 hours. The pup joint for logging cables in horizontal wells resulted in cable protection, lower costs, a higher success rate and lower operating risks since its first application at Block Longdong in 2012. We developed digital core imaging techniques, which reduced the time taken to fully describe cores from one or two months in the past down to three or four days. We also rolled out a synergistic work platform for well logging and independently developed a synchronized remote control system for mud logging, to establish highway to transmit digital information. To perform well logging under complex conditions in horizontal or highly-deviated wells, we improved and furnished techniques such as through-drill-pipe logging, crawler, coiled tubing, memory logging, and logging while drilling. These operations improved the operation capacity of each crew, reduced well-occupying time for logging, and increased the efficiency and success rate of well logging under complex conditions.

In 2015, our well logging and mud logging services proceeded smoothly in Iraq, Iran, Uzbekistan, Bangladesh, Russia and Canada. To promote the global application of our new technologies, we set up an overseas technical support center for R&D and services, as well as interpretation and evaluation of well logging data.

Downhole Operations

In 2015, our 2,153 downhole crews completed 128,879 downhole operations and 7,782 layers of formation testing.

We rolled out new technologies and techniques to improve the quality of downhole operations. High-efficiency hydraulic jet SRV fracturing delivered much greater efficiency when it was extensively used in horizontal wells for tight oil development. Sand fracturing performed at well Qing-2-40 in Yumen Oilfield at an altitude of 2,600m registered the highest pressure of 177.6MPa and the highest displacement with 960 cubic meters of fluid being pumped. This also proved our capacity for reservoir stimulation in high altitude regions. In PDM Block in Venezuela, we completed chemical plug removal with coiled tubing and gas lift by liquid nitrogen.

Factory fracturing was widely used in shale gas development, with efficiency much improved by specialized, modular, and streamlined operation under procedural control. Good results were shown with technologies of staged fracturing with drilling-free large-bore bridge plugs and fast bridge plugs, multi-cluster perforation with pump-down bridge plugs, fracture monitoring and continuous on-site blending. In Sichuan Province, well Wei-202H1-4 registered CNPC's highest amount of fluid, up to 51,600 cubic meters, pumped

Downhole operations

	2013	2014	2015
Downhole operation crews	2,052	2,090	**2,153**
Domestic	1,831	1,849	**1,929**
Overseas	221	241	**224**
Downhole operations (well-time)	143,100	143,405	**128,879**
Domestic	141,019	140,713	**126,062**
Overseas	2,081	2,692	**2,817**
Formation test (layers)	7,558	6,965	**7,782**
Domestic	6,251	5,099	**5,051**
Overseas	1,307	1,866	**2,731**

into a single well; and platform Wei-204H3 for shale gas development recorded CNPC's highest efficiency, up to six stages in a single day, of factory fracturing. After the fracturing, the highest single well output of shale gas was up to 328,600 cubic meters.

New breakthroughs were made in downhole operation technologies. Dry sand fracturing with CO_2 saw success in six wells at Changqing and Jilin oilfields, pioneering a new approach for waterless fracturing. Our independently developed drilling-free large-bore bridge plugs were successfully sent downhole and provided excellent packing and fracturing in Sulige. BH-SFP, a technology and a tool for selective multi-stage fracturing and extraction control, performed well in separate layer stimulation, testing, result evaluation, and extraction control for each layer and interval. Formation testing techniques for ultra-deep wells were improved. We designed an innovative "5-valve + 1-packer" string technique for formation testing, which addressed the challenges of mud displacement, well killing, and unpacking in its successful application in ultra-deep well Keshen-902 in Tarim Oilfield.

Engineering and Construction

In 2015, we steadily proceeded with our major engineering and construction projects by intensifying prior coordination and risk prevention, improving contractor management, enhancing project control, and perfecting our plans throughout the production management process. We implemented 21 major engineering and construction projects throughout the year.

We strengthened top-level design of market development, and explored the commercial modes of BOT, BOOT, financing + EPC, and equity investment and vigorously developed the markets along the Belt and Road, especially the high-end external market and emerging strategic markets. By doing so, we set up a market network of Central Asia, the Middle East, Africa, Asia-Pacific, the Americas, and key countries.

We kept adjusting and optimizing our business structure, in which the contribution by EPC, design, consulting, and other high-end business in our revenue increased from 47% to more than 60% in 2015. Our influential brands included CPP, CPECC, CPE, China Huanqiu and Daqing Oilfield Engineering, which had been listed as ENR Top 250 International Contractors for consecutive years. And Kunlun Engineering Corporation has become a renowned supplier of techniques and outfits for polyester and PTA production.

Gas processing plant in Tanzania

Oil and Gas Field Surface Engineering

We maintained leading position in China in production capacity building in onshore oil and gas fields. We have surface engineering technology packages for conventional fields, for high water cut, low permeability, ultra-heavy oil and high condensate content oil fields, as well as high pressure, high yield, and high sulfur content gas fields. In addition, we are capable of building 20Mt/a oil production capacity and 10bcm/a gas production capacity.

In 2015, our major capacity building projects proceeded smoothly. The surface engineering work for 6bcm/a development of Longwangmiao gas reservoir of Anyue Gas Field in Sichuan Province and the project for coal-fired boiler at Fengcheng Oilfield in the Xinjiang Uygur Autonomous Region were completed and put into operation. Construction of the 4Mt/a indirect liquefaction unit at Ningxia Coal of China Shenhua Corporation was pushed ahead as planned.

Overseas, we completed and put several major projects into operation, including the surface engineering work at North Azadegan Oilfield in Iran, Phase-II of the Halfaya project in Iraq, and the 8bcm/a renovation and upgrading project in Block A of Amu-Darya in Turkmenistan. Construction of a natural gas processing plant in Tanzania was generally completed. Smooth progress was made in gathering and transportation works at Girsan, Bota, Tangiguyi, Uzyngyi, and Odjarly-Sandykly gas fields in Block B of Amu-Darya in Turkmenistan and in the expansion of AktobeMunaiGas' No. 45 captive power station. Moreover, we were awarded many engineering and construction contracts, including an EPC contract for a clean energy project in Texas, USA.

Construction of Refining and Chemicals Facilities

In 2015, we proceeded with major domestic projects as planned and completed a number of gasoline and diesel upgrading projects. A diesel hydrogenation unit was completed and became operational at Urumqi Petrochemical. The 10Mt/a refinery is expected to be completed at Yunnan Petrochemical in 2016.

2015 also saw new progress in our overseas projects. Construction of the modern renovation project (Phase I) at Shymkent Refinery in Kazakhstan proceeded smoothly. We further extended our overseas reach by signing EPC contracts, with Petronas for a RAPID PP project in Malaysia and with Uzbekistan for a PVC project.

Pipeline and Storage Tank Construction

Regarding construction capacity and engineering technology for long-distance pipelines, we can build 6,700-9,700 kilometers of pipeline with a diameter larger than 711mm every year. In addition, we have the technologies to design and build 150kcm crude tanks and 10kcm spherical tanks. We are capable of building 26 million cubic meters of crude tanks and 16 million cubic meters of refined product tanks annually.

In 2015, the construction of a number of oil and gas pipeline made new progress. The Fangchenggang Branch of the Myanmar-China Gas Pipeline (Chinese Section) was completed and became operational. The Myanmar-China Oil Pipeline (Chinese section) was welded, pressure-tested, and ready for operation. The main part of the Yunnan Products Pipeline was completed. Construction of the eastern section of the Third West-East Gas Pipeline, Jinzhou-Zhengzhou Refined Products Pipeline, Tianjin Port-Huabei Petrochemical Crude Pipeline and Dayawan Offshore Pipeline in Huizhou City was pushed forward in an orderly manner. Construction of the Chinese section of the eastern route of the Russia-China Gas Pipeline commenced.

Our overseas pipeline construction projects proceeded smoothly. We completed and put into operation the Myanmar-China Oil Pipeline (Myanmar Section), Tanzania natural gas pipeline and Halfaya export pipeline in Iraq; finished the pilot operation of the Nakhon Sawan Gas Pipeline Project in Thailand; and steadily pushed forward Badra Crude Gathering and Transportation Pipeline and Majinoon FCP Gas Pipeline in Iraq, the Shahdol-Phulpur project in India, and the GULF project in Thailand. In addition, we also signed several pipeline construction contracts, including those for the Limbe-Yaounde Products Pipeline in Cameroon and the MEPE Gas Pipeline in Myanmar.

New progress was made in storage projects. The main part of the State Petroleum Storage Base in Jinzhou was completed. Expansion of the State Petroleum Storage Base in Zhoushan and Phase-II of the Jiangsu LNG Terminal proceeded smoothly. Internationally, we completed and put into operation the Angola Product Deport Expansion Project, completed the main part of a tank yard for asphalt and refined products in Myanmar, and proceeded with the Nassiriya oil depot project and Rumaila crude storage tanks in Iraq and petroleum storage tank project for a refinery in Papua New Guinea. We were also awarded an EPC contract for the LAUGFS LPG tank yard in Sri Lanka and the TEMA storage yard project in Ghana.

Offshore Engineering

We have the capability to provide integrated and comprehensive services for offshore production, well drilling, well completion, well cementing, production test, downhole operation, design and construction of marine engineering, and vessel services. By the end of 2015, we had 16 offshore drilling and operating platforms and 25 vessels. In 2015, we recorded 56.4% utilization with drilling platforms and 85% utilization with operating platforms. Seven platforms realized a drilling footage of more than 10,000 meters. Our vessels provided service for 4,217 working days, with the vessels of 4,000HP or higher duty utilized by 79.3%.

In 2015, our Offshore Engineering Ltd. (CPOE) completed a total drilling footage of 131,000 meters in the Bohai Sea, Yellow Sea, and the Persian Gulf. The company spudded 59 wells, completed 33 wells, and provided downhole operations for 28 well-times, acid fracturing and sand control for 81 layer-times, and formation testing in six layers.

With improved support provided by the Qingdao offshore engineering construction base and the Tangshan production support base, CPOE commenced construction of MWP4 and FWP5 engineering packages for the Russian Yamal Project at the Qingdao base in January 2015. By the end of 2015, FWP5 was completed and MWP4 proceeded smoothly. Following these packages, CPOE won the bidding for MWP10A and FWP1D engineering packages and contracted reels for MWP8 and spray painting for MWP1 as part of the Yamal Project, becoming the subcontractor involved in most engineering packages in the project.

Petroleum Equipment Manufacturing

Thanks to the "Made in China 2025" plan, our petroleum equipment manufacturing business underwent greater structural adjustment. It has been transformed and upgraded from sheer production to integrated business of product R&D, manufacturing, sales, and service offering. In addition to emphasizing core and advantageous categories of drilling equipment, recovery equipment, petroleum steel pipes, and power units, we sped up the R&D and industrial manufacturing of new high-end products, thereby increasing the percentage of high value-added products and optimizing product portfolio. We actively expanded the international market and improved the layout of our overseas marketing network. Our petroleum materials and equipment were exported to 81 countries and regions.

Progress in the R&D of petroleum equipment included the following: intermediate results were achieved in the research on the automatic handling system of deep-water rigs and strings; the first domestically made automatic rig with 7,000m string was put into use; the prototype of the Model 2500 fracturing truck passed the industrial test; 27 sets of 105MPa well-control outfits for fracturing and extraction of shale gas were applied; BJC-I premium connection casings passed downhole testing; X80-grade Φ1422×21.4mm longitudinal submerged arc welded pipes and spiral submerged arc welded pipes were produced for 1,000 tons on trial; field tests of 52MPa natural gas compressor commenced; and the integrated V-type compressor passed the industrial test.

Major equipment projects saw smooth progress. We made steel pipes for a natural gas processing plant and transportation pipeline in Tanzania by following a scientific plan based on the world-leading design principle of "skid-based stations and modular plants". Our standard was for premium steel pipes, higher than that in the technical specifications of the owner's order. Subsea pipes with anchors were locally made in facilities established in Tanzania. The second batch of 16 rigs supplied to UAE National Drilling Company (NDC) was delivered, and manufacturing of 14 rigs for Venezuela commenced.

We beefed up overseas market development. In 2015, we were awarded contracts to supply 10 rigs to Turkmenistan, the third batch of 12 fast-moving desert rigs (a total of 39 rigs), to NDC of the UAE, 64,000 tons of SSAW pipes to Saudi Aramco, and 110,000 tons of piling tubes to Port Said in Egypt, as well as electric submersible pumps on a rental basis to Block 3/7 in South Sudan.

We actively conducted joint venture cooperation and collaboration with foreign enterprises. We improved the manufacturing level of hydraulic drilling rigs by setting up a JV with Herrenknecht AG and elevated the technical performance of domestically made fracturing equipment by cooperating with Schlumberger. Also, we cooperated with other international manufacturers and set up manufacturing plants overseas. Major projects, including the construction of a steel pipe plant in Kazakhstan proceeded as planned.

Construction of MWP4 engineering package of Yamal LNG project