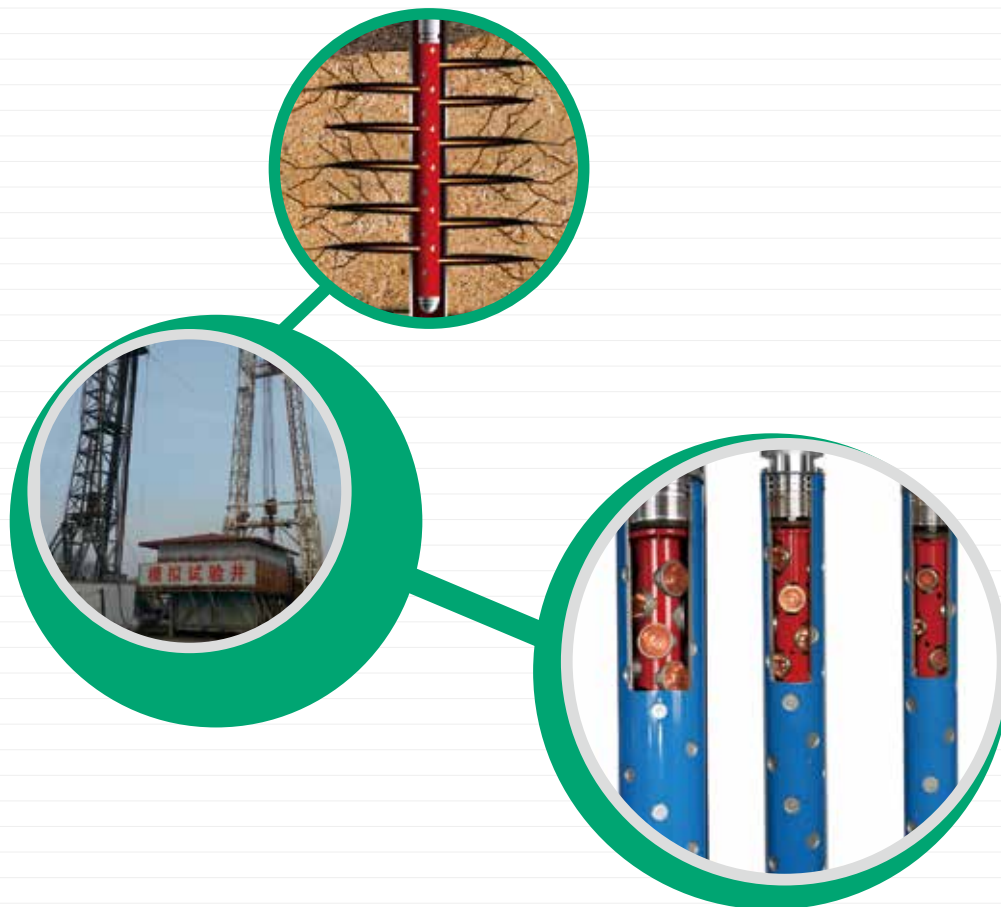


# BH-MPP Multistage Pulse Perforation Technology

Science & Technology Management Department, CNPC

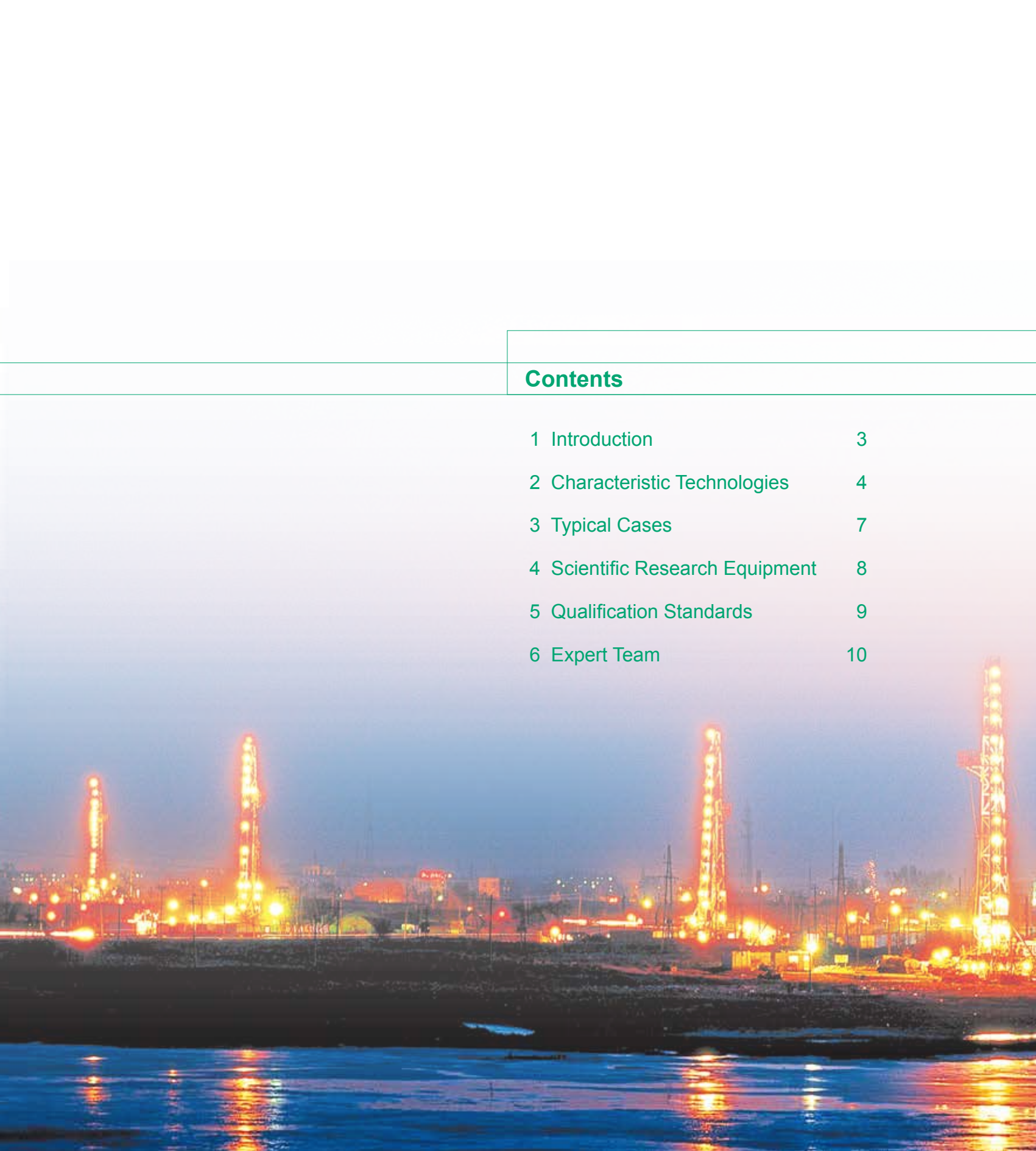
2015



CHINA NATIONAL PETROLEUM CORPORATION

*BH-MPP, A golden Key to Opening Reservoirs  
and Making Formations in Near Well Bore  
Zones be Smoothly Connected with Well Bore!*





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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 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.

**BH-MPP multistage pulse perforation technology** is one of representatives for major innovations of CNPC.

## OFFERING ENERGY SOURCES, CREATING HARMONY



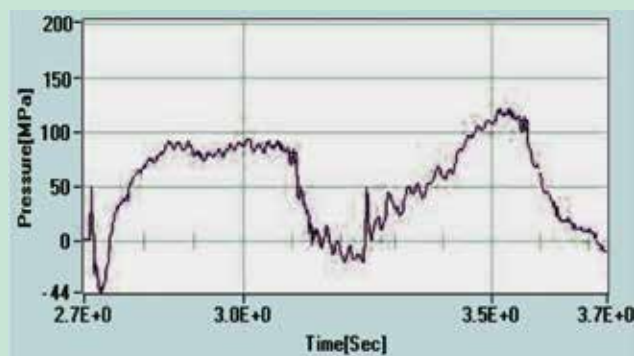
# 1

## INTRODUCTION

BH-MPP multistage pulse deep-penetration shaped charge perforator is a brand new perforation technology designed and developed by CNPC and integrating ultra-deep penetration and fracturing in order to increase the recovery ratio of reservoirs with medium to low porosity and medium to low permeability. Different from any other previous perforation methods, the technology reasonably combines multistage fracturing powders with perforating charges, controls sequential combustion of multistage powders, and generates 3 continuous pulse peak pressures dynamically acting on

formations, thus achieving the purpose of plugging removal, fracture making, fracture extension and fracture enlargement. The technology can greatly improve formation percolation conditions in near-well bore zones and increase oil well deliverability.

BH-MPP multistage pulse deep-penetration shaped charged perforator has been applied in onshore oilfield such as Tarim, Changqing, Jidong, Dagang, etc. as well as offshore oilfields including CNOOC Bohai, Zhanjiang, etc. for over 200 wells-times successively.

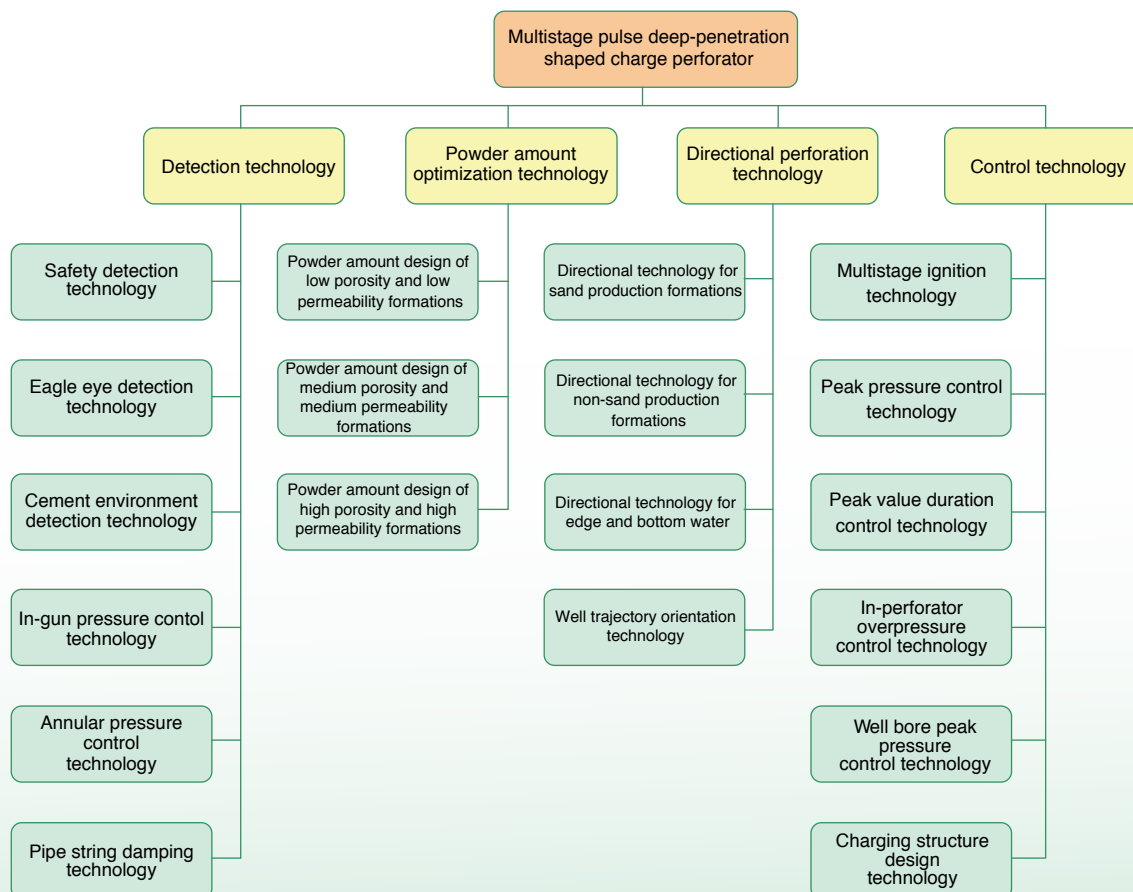


# 2

## CHARACTERISTIC TECHNOLOGIES

BH-MPP multistage pulse deep-penetration shaped charge perforator has obtained 1 invention patent and 4 utility model patents, and multiple characteristic technologies have been formed,

including tubing conveyed multistage negative pressure perforation, multistage ignition, well bore protection, pressure relief protection in perforator, digital design system for fracturing powders, etc.



Block diagram of multistage pulse deep-penetration perforator

## 2.1 Main Functions

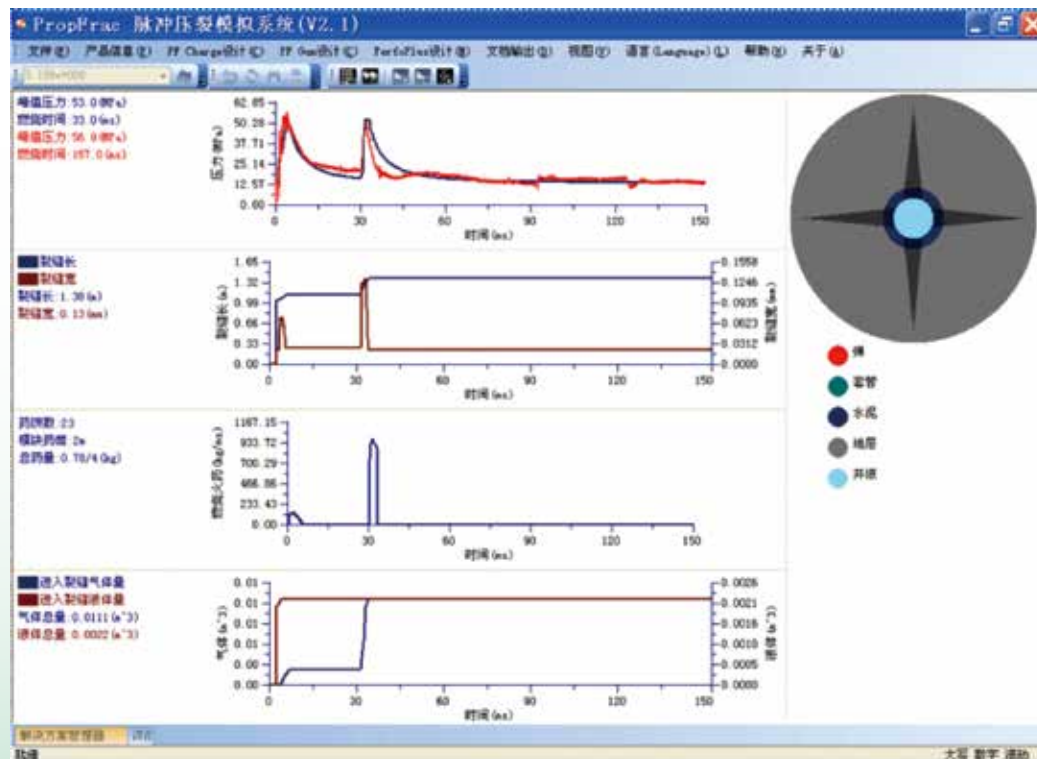
- Improve the percolation conditions of perforation compaction zones.
- Clean perforation channels.
- Eliminate formation pollution.
- Improve the formation flowing conditions in near-well bore zones, connect undisturbed formations, and increase well deliverability.

## 2.2 Key Technologies

The multistage pulse deep-penetration shaped charge perforator generates multiple pulse pressure

peak values in well bore. Therefore, it is needed to control each stage of pulse peak pressure, thus acting on perforation channels and formations on staged basis and achieving the purpose of increasing well deliverability.

- (1) Multistage ignition technology
- (2) Peak pressure control technology
- (3) Peak value duration control technology
- (4) In-perforator overpressure control technology
- (5) Charging structure design technology
- (6) Matching technology for multistage pulse synergistic powder digital design software



## 2.3 Technology Series

- 102 + two-stage powder 13/16 perforations /m;
- 127 + two-stage powder 13/16 perforations /m;
- 178 + two-stage powder 13/16 perforations /m;
- Temperature resistance: 180°C/48h;
- Pressure resistance: 105MPa;
- The depth of fracture making and extension is larger than 3m.



178-model perforator

127-model perforator

102-model perforator



# 3

## TYPICAL CASES

### 3.1 Good application effect of multistage pulse deep-penetration shaped charge perforator in the same reservoir group

Well QKXX is a shutdown well of CNOOC. During commingled production of Minghua and Shahejie Fm. in 2003, fluid supply was insufficient and thus the well was closed. After perforation operation with 127-model multiple stage deep-penetration shaped charge perforator in Aug. 2008, the maximum daily fluid production was  $159\text{m}^3$ , and the maximum daily oil production  $128.85\text{m}^3$ ; after four months, the daily oil production was stabilized at  $42\text{m}^3$ .

### 3.2 Application effect of multistage pulse deep-penetration shaped charge perforator improved by 300% in the same reservoir group of adjacent wells

(1) Comparison of perforation effects in the same

fault block and the same reservoir group in Guan-XX block.

Multistage pulse deep-penetration perforator was used in 7 wells such as GA etc.;

Conventional perforator was used in other wells such as GB etc.;

The average daily production of the 7 multistage pulse perforation wells is 2.06 times that of the wells in the block and the water cut of the 7 wells has been decreased by 21%.

(2) Well QXX-X and well QXX are located in the same block and their perforation horizon is identical.

The multistage pulse deep-penetration shaped charge perforator was used in well QXX-X;

A conventional 89-model perforator was used in well QXX;

After multistage pulse deep-penetration shaped charged perforation, the oil production of well QXX-X is 3 times that of the adjacent well.

# 4

## SCIENTIFIC RESEARCH EQUIPMENT

### Perforation Technology Research Office

It can be used to study and design perforation technologies for ultradeep wells, complex wells, horizontal wells, etc. and to design various perforating appliances.

### Perforating Equipment Machining Center

It has a complete set of CAD/CAM aided design system and CNC machining center and can complete machining and matching of various perforating appliances.

### Perforating Equipment Test Base

It can test various perforating guns, perforating charge steel targets and concrete targets.



# 5

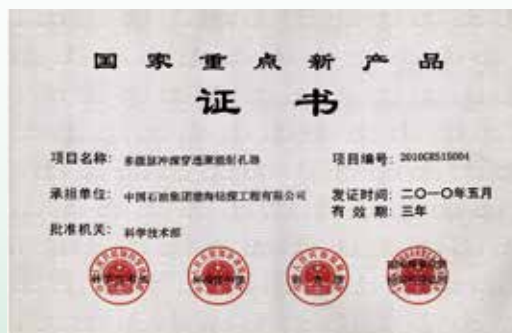
## QUALIFICATION STANDARDS

### Patents

1. A tubing conveyed multistage perforation negative pressure device (invention patent: patent No.: 00123755.1)
2. A multistage pulse perforation peak pressure control valve (invention patent: patent No.: 200620148043.5)
3. A multistage pulse deep-penetration perforator (invention patent: patent No.: 200420047523.3)
4. A multistage pulse perforating gun with dual blind holes (invention patent: patent No.: 201020685609.4)
5. A perforating gun body with pressure relief hole packer (invention patent: patent No.: 200620148044.X)

### Rewarding

1. Grade III CNPC science & technology advance prize;
2. National key new product certificate issued by the Ministry of Science and Technology;
3. Grade III science and technology advance prize of Tianjin City;
4. Science and technology entrepreneurship prize of Bohai Drilling Engineering Company Limited.



# 6

## EXPERT TEAM



**Chai Xiyuan**

Technical expert, professor level senior engineer. He is engaged mainly in technical research on logging, interpretation and evaluation, perforation, etc. He has taken charge of completing the study of the project “Multistage Pulse Deep-Penetration Shaped Charge Perforator”.

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**Zhang Weishan**

Technical expert. He has been engaged in perforation and completion engineering research and management work for 30 years and has taken charge of completing the study of the scientific research project “Multistage Pulse Deep-Penetration Shaped Charge Perforator”. He has obtained 5 patents.

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**Liu Qingdong**

Technical expert. He has been engaged in perforation engineering research work for 30 years. He is the main researcher of the project “Multistage Pulse Deep-Penetration Shaped Charge Perforator” and has obtained 3 patents.

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**Wei Chunyin**

Technical expert. He has been engaged in perforation engineering research work for 20 years. He is the main researcher of the project “Multistage Pulse Deep-Penetration Shaped Charge Perforator” and has obtained 3 patents.

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**Liu Fangyu**

Technical expert. The technologies such as “constant azimuth perforation”, “composite perforation”, “dynamic negative pressure perforation” and “perforation scheme optimization” he taken charge of and participated in all have reached international advanced level. He was awarded with multiple provincial and ministerial prizes. He has obtained 1 invention patent.

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**Pan Yongxin**

Technical expert in detonation theory study and perforator design and manufacturing process. He has successively taken charge of or participated in completing the study of projects such as “127-model perforator development”, “research on well perforation stimulation technology”, “research on matching technologies for 89-model and 102-model perforators resistant to high temperature and high pressure”, etc. He has obtained 1 invention patent.

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