

DML Comprehensive Mud Logging Instrument

Science & Technology Management Department

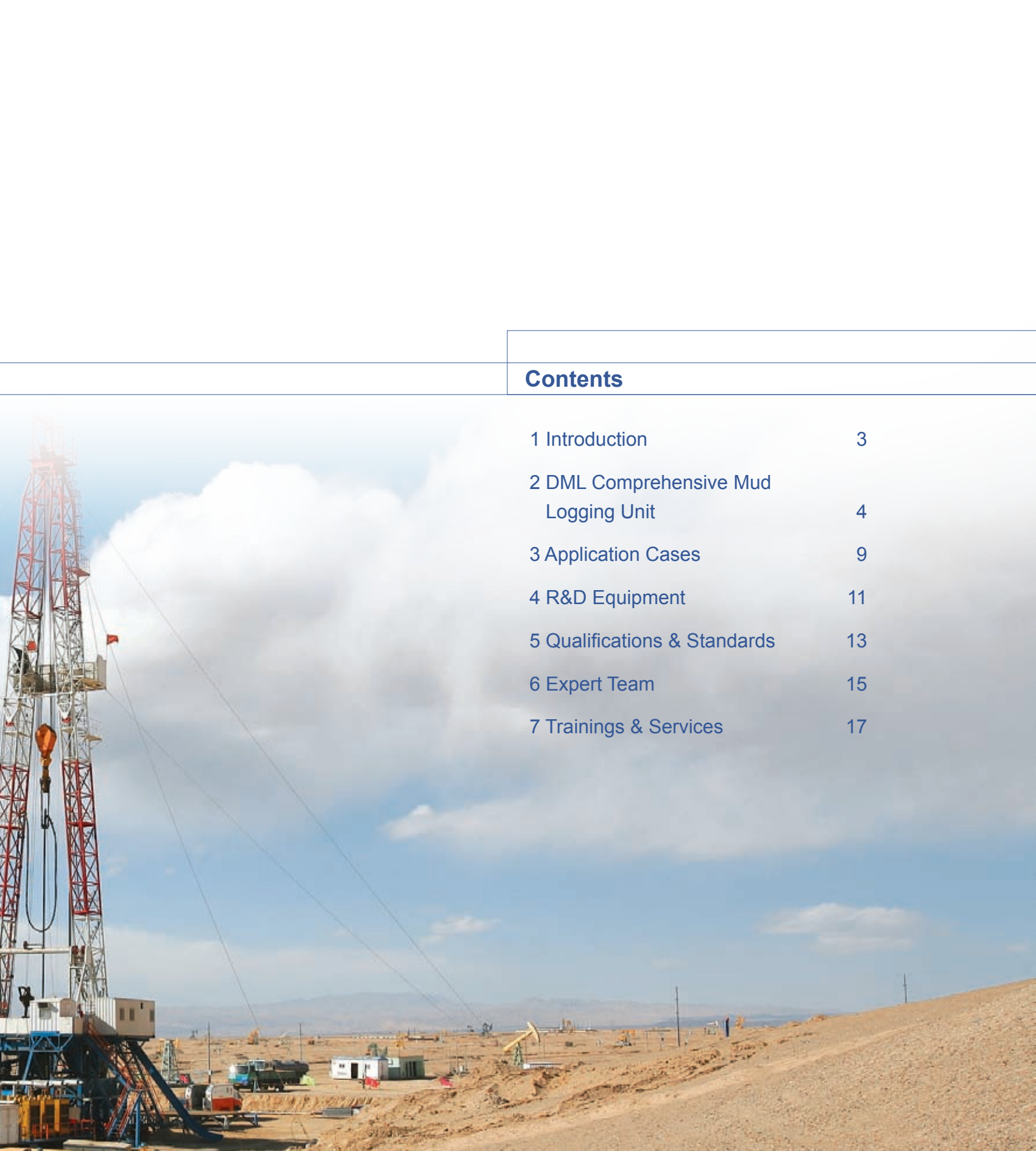
■ 2013



CHINA NATIONAL PETROLEUM CORPORATION

*DML Comprehensive Mud Logging
Instrument*

*——“Swift Horse” for Measurement and
Mud Logging of Oil and Gas Wells*



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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.

[DML Comprehensive Mud Logging Instrument](#) is one of representatives for major innovations of CNPC.

CLEAN ENERGY SUPPLY FOR BETTER ENVIRONMENT

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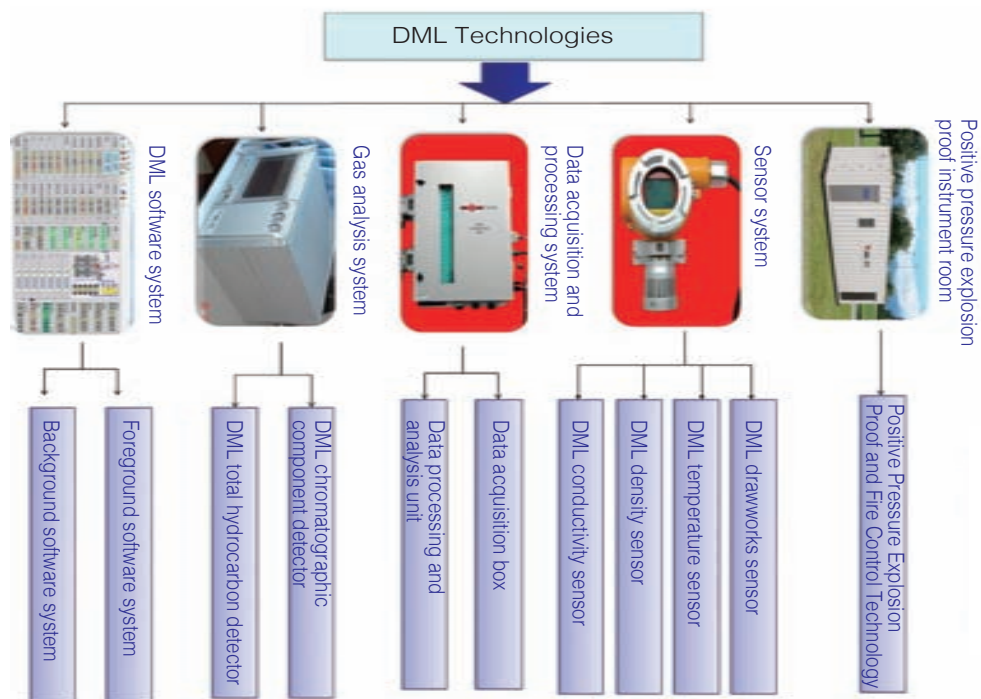
INTRODUCTION

The DML comprehensive logging Instrument (DML) is a comprehensive mud logging system that was developed independently by CNPC and reaches the international advanced level. The DML can be used to accurately monitor and record relevant data in real time in the drilling process, thus providing powerful guarantee to optimizing drilling parameters, predicting and analyzing engineering accidents, improving drilling efficiency, reducing operation cost and discovering and protection hydrocarbon reservoirs. The DML is an essential comprehensive monitoring tool in drilling operation.

The DML integrates multiple advanced technologies such as Fast Chromatographic Technology,

Real Time Remote Data Transmission Technology, Combined Field Geologic Analyzer Application Technology, etc. and is the center of field integrated information interpretation and evaluation. 16 patent technologies have been formed from the DML. The DML has obtained DNV (Det Norske Veritas) positive pressure explosion-proof acceptance certificate and passed API system certification.

The DML is applicable to oil and gas exploration and development sites in hazardous areas including land, desert and offshore drilling platforms, etc. and is extensively applied in China's oilfields and over ten countries and regions including Brazil, Iran, Indonesia, Venezuela, etc.



2 DML COMPREHENSIVE MUD LOGGING UNIT

The DML consists of mainly positive pressure explosion proof instrument room, sensor system, data acquisition and processing system, gas analysis system and DML software.



Outside drawing of the DML



Inside view of the DML

Item	Domestic professional manufacturer	DML
Operating system interface language	Windows 2000 in Chinese and English; application software in Chinese	Windows 2000 or higher version; SQL Server2000 database software; application software in multiple languages including Chinese, English, Spanish, etc., which can meet the needs of various users
Channel and acquisition rate	32-channel analog, 4-channel digital, expandable, acquisition rate 10Hz	32-channel analog, 8-channel digital, expandable at random, acquisition rate 100Hz
Gas analysis system	FID (hydrogen flame technology); Air compressors and hydrogen generators required; many auxiliary devices, low safety	There are three sorts of chromatographs: (1) Agilent CP-490 chromatograph: using the micro-cell thermal conductance technology (micro-cell thermal conductance assessor and micro-chromatographic column); (2) Agilent 450GC chromatograph: using the FID (hydrogen flame ionization detector) technology; (3) DML chromatograph: using the FID (hydrogen flame ionization detector) technology. μ-TCD (micro-cell thermal conductance technology) uses inert gas (He) as the conductor, thus reducing auxiliary equipment and the cost of operation and maintenance.
Chromatographic analysis cycle	Over 1min, partly less than 1min	15~30s
Sensor	Homemade, partly imported	Imported with original packaging
Data storage	Single server and single hard disk	Automatic backup with dual servers and dual hard disks to provide powerful guarantee to data security; Single server and single hard disk

2.1 Positive Pressure Explosion Proof Instrument Room

The positive pressure explosion proof instrument room uses the positive pressure explosion-proof design, conforms to IE-C97-13 specifications and API standards, has passed DNV certification, integrally reaches DNV A0 ZONE1 level and is applicable to multiple complex environments such as land, offshore, desert, etc.

(1) The fire retardancy conforms to SOLAS A0 level.

- Gate: A60 level;
- Emergency escape door: A60 level;
- Inner door: B15 level;
- Observation window: A60 level.

(2) The positive pressure explosion proof instrument room uses a continuous positive pressure ventilation structure.

(3) The explosion proof power control system has functions such as combustible gas detection, indoor pressure monitoring, flow monitoring, temperature detection, smoke detection, emergency cutoff, bypass operation, etc.

(4) Indoor and outdoor cables are connected using MCT on a sealed basis.



Positive pressure explosion proof instrument room



Explosion proof power control system

2.2 Sensor System

The DML sensors can be used to acquire multiple parameters such as depth, pressure, pump stroke, torque, flow rate, drilling fluid, pit volume, H₂S, etc. and calculate 100 parameters in real time and can be self-defined according to field operating conditions. At present, there are 2 types of sensors such as wired and wireless ones.

All sensors use the highest configuration at present and have high precision and good stability, and their protective level reaches IP68.

Wired sensor series

Wired sensors have strong immunity from interference and high data accuracy, are connected using quick connecting devices, convenient for field installation and maintenance.



DML drawworks sensor DML temperature sensor DML density sensor DML conductivity sensor

Wireless sensor series

Wireless sensors use new wireless sensing network technologies and realize two-way wireless data communication with low power consumption, low cost and low complexity. Wireless sensors can reduce the installation labor intensity of field data acquisition cables and equipment, also radically eliminate the hidden trouble such as artificial damage of plenty of data cables arranged in complex well site environments, meet mud logging site requirements to the greatest extent possible and realize automatic, wireless and intelligent mud logging.



DML wireless temperature sensor



DML wireless conductivity sensor

2.3 Data Acquisition and Processing System

The data acquisition and processing system uses advanced separation fence technologies, are resistant to lightning stroke and interference, improves the anti-interference capability and safety of the DML and ensures its stability and safety in a complex environment.



Separation fence



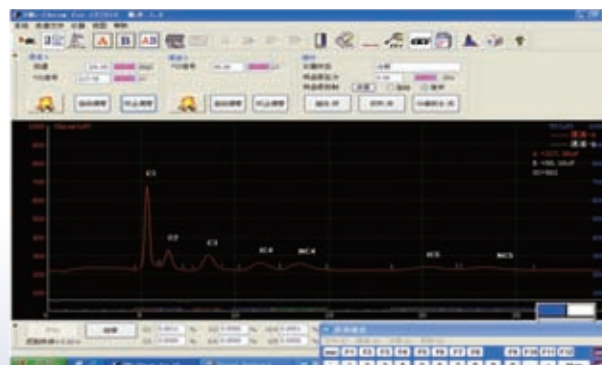
Data acquisition box

2.4 Gas Analysis System

The DML gas analysis system developed and manufactured by CNPC has independent intellectual property rights can be used to analyze multiple components such as C1-5 etc. within 30s. The gas analysis system has good chromatographic analysis repeatability and high precision and its minimum detection concentration reaches 10mL/L.



DML fast chromatograph



DML chromatogram software

2.5 DML Software System

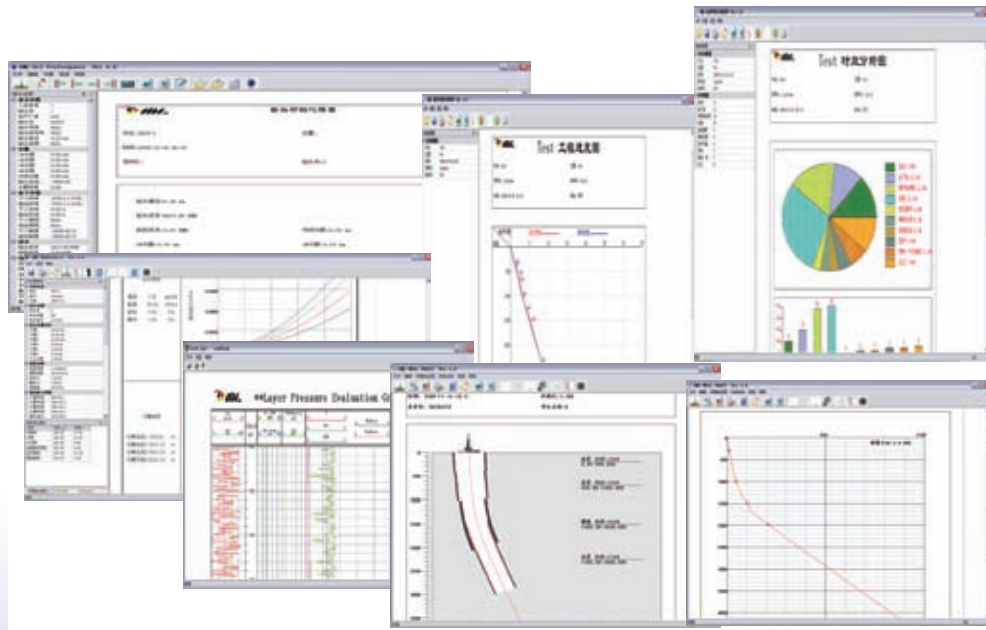
The DML software system consists of data acquisition software package and data processing software package and uses Windows operating environment and modular structure design to improve long-time running reliability. The software system has 3 language versions including Chinese, English and Spanish and realizes conversion of metric units, British units and self-defined units.

- Flexible outputs;
- Panorama reappearance of mud logging process;
- High stability of modular design;

- WITS standard well site information center;
- Plentiful application software;
- Chinese, English and Spanish versions meet international service requirements.

DML application software package

Provide a complete set of mud logging data processing solutions involving hole deviation report, gas logging interpretation, time efficiency analysis, bit report, engineering drawing, formation pressure analysis, real time hydraulics optimization, etc.



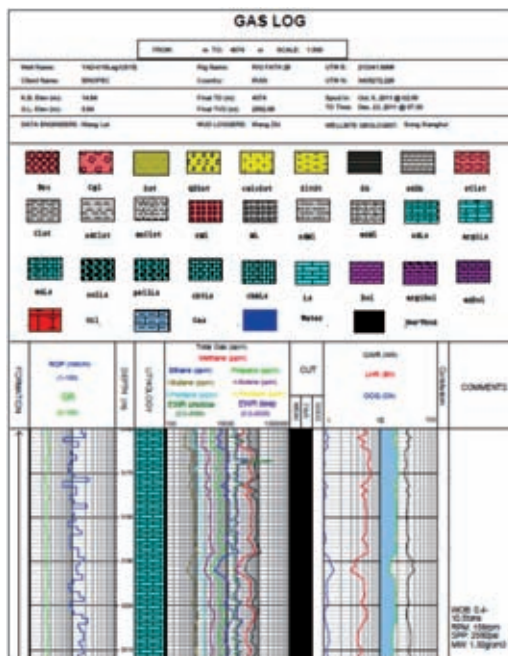
DML Application software package

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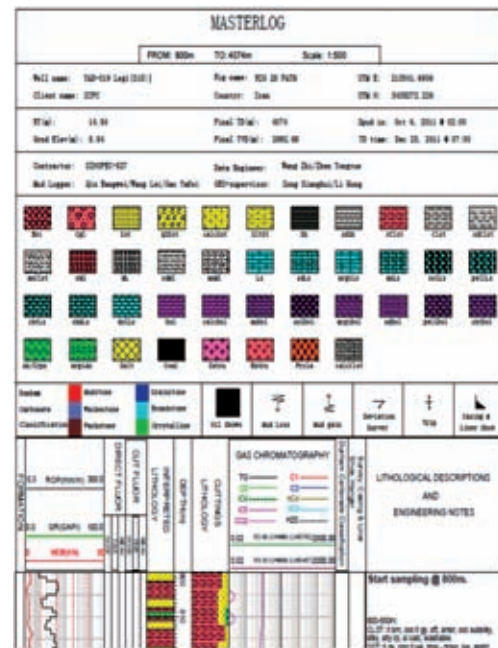
APPLICATION CASES

3.1 Well YAD-019 Leg1 (S15) in Iran

The DML was used in mud logging services in well YAD-019 Leg1 (S15) in Iran in Oct. 2011. In the whole drilling operation period, the DML had good working performance, realized accurate monitoring, acquired complete data and was appreciated highly by Party A.



Gas logging diagram



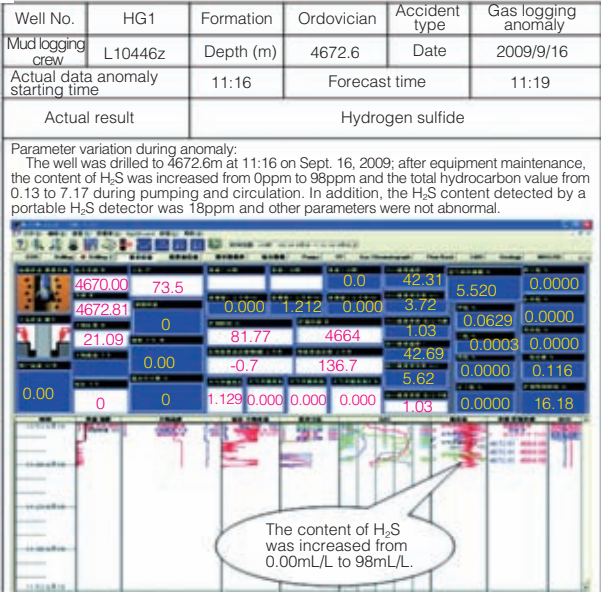
Comprehensive logging diagram

3.2 Well HG1

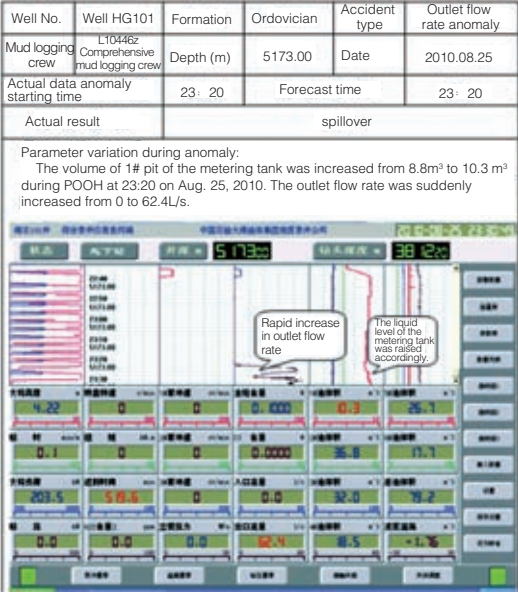
The DML was used in field mud logging of well HG1 on Sept. 16, 2009. The well was drilled to 4672.6m at 11:16. After equipment maintenance, the content of H_2S was increased from 0 to 98mL/L, the total hydrocarbon value was increased from 0.13 to 7.17, and the H_2S content detected by a portable H_2S detector was 18mL/L during pumping and circulation. After finding H_2S through mud logging monitoring, automatic alarming and anomaly forecast were given in time.

The volume of 1# pit of the outlet metering tank was increased from 8.8m³ to 10.3m³ during POOH at 23:20 on Aug. 25, 2010. The outlet flow rate was suddenly increased from 0L/s to 62.4L/s. Overflow lalarming occurred and an anomaly forecast was given in time.

APPLICATION CASES



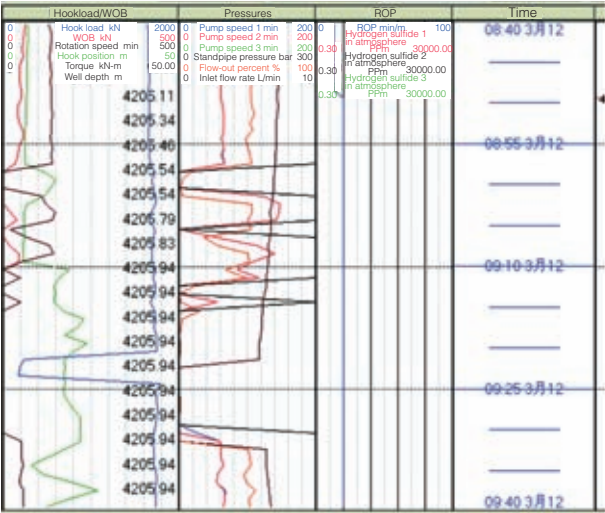
Well HG1 Hydrogen sulfide anomaly



Well HG101 spillover

3.3 Well LG7-11 in Tarim in Xinjiang

The DML was used in field mud logging of well LG7-11 in Tarim Region in Xinjiang on Mar. 12, 2009. The well was drilled to 4205.94m at 08:42, the pump stroke number was increased from 60 to 66, and the standpipe pressure was not increased but was slowly decreased from 21.3MPa to 20.4MPa; the well was circulated for observation; later on, POOH was conducted and we found that the drill pipe was pierced.



Comprehensive logging diagram of well LG7-11

Anomaly forecast notice					
Well No.	LG7-11	Formation	K	Anomaly type	Drilling tool piercing damage
Mud logging crew	507# crew	Well depth (m)	4205.94	Date	
Actual data anomaly starting time		Forecast time			
Actual result		Drilling tool piercing			
Variation of abnormal parameters:					
When the well was drilled to 4205.94m at 08:42 on Mar. 12, 2009, the pump stroke number was increased from 60 to 66, the standpipe pressure was decreased from 21.3 to 20.4, the pit volume was not changed, and parameters are not changed abnormally.					
Proposed treatment measures:					
Continue to observe the variation of pump strokes and standpipe pressure, POOH and check drilling tools.					
Proposed treatment measures taken:					
Yes					
Forecaster	Wang Ping	Drilling crew	70521	The technician of the drilling crew	

Well LG7-11 anomaly forecast notice

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SCIENTIFIC RESEARCH EQUIPMENT

CNPC has a prefect equipment R&D, manufacturing and service system, software development laboratories and hardware laboratories. Professional personnel carry out software design, machining and assembling of components and parts, etc. In addition, CNPC also has inspection organizations, professional test personnel and good detection equipment, and all products are strictly inspected and tested according to standards.



DML Manufacturing Base



Assembling and manufacturing of products



Detection and commissioning of products



After-sales supporting and training



Exhibition hall of DML series products

List of Main Instruments and Equipment for Testing

Instruments and equipment	Specification and model	Remarks
Electric vibration tester	ES-6	Vibration simulation requirements: 5~25Hz, sine; acceleration amplitude 7.84m/s²; frequency sweep time 4.0min/times; test time larger than 10min Impaction requirements: Acceleration amplitude 98m/s²; pulse duration 6ms±1ms; 3 times, semi-sine wave, non-working state Temperature and humidity simulation requirements: Ambient temperature -20℃ ~60℃ ; relative humidity no higher than 95%
Walk-in high and low temperature thermal-humidity alternating instrument	GDW/JB-1.4m	
	LJ-IV	
Intelligent digital pressure calibrator	CST2003	
Insulation tester	1508	
Digital grounding resistance tester	4105A	
Digital multi-meter	FLUKE-789	
Digital temperature and humidity meter	WS2080B	
Digital three-purpose meter calibrator	D030-G	
Sensor testing meter	LJ-II	
Clamp meter calibrator	D030-Q	
Digital leakage current clamp meter	2413F	
Mud density calibrator	3NX1	
DC resistance box	ZX25a	
Forcing off screw torque sensor calibrator	LJ-III	
Oscillograph	CS-4135	
Digital precision pressure gauge	CST2008	

5 QUALIFICATIONS & STANDARDS

CNPCC has been certificated by ISO9001, ISO14001, CB/T28001 and HSE systems, guarantees quality, health, safety and environment in technical services and has formed a whole set of industrial and professional specifications. CNPCC has obtained totally 16 patents and DNV positive pressure explosion-proof acceptance certificate and passed API system certification.

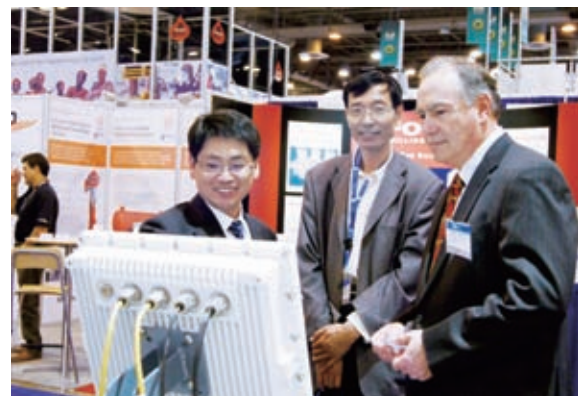




DML mud logging series products launch conference



the ninth China International Petroleum and
Petrochemical Technical Equipment Exhibition



the Offshore Technology Conference (OTC) in 2010

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EXPERT TEAM



Tao Qinglong Technical expert, senior engineer. He has long been engaging in R&D of mud logging equipment.
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Chen Yuxin Engineer. He has long been engaging in field logging services for 13 years. He is responsible mainly for R&D of new products and technical support work.
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Ji Hailin Engineer. He has long been engaging in field logging services for 11 years. He is responsible mainly for R&D of new products and technical support work.
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Li Huaiyu Engineer. He has long been engaging in field logging services for 10 years. He is responsible mainly for R&D of new products and technical support work.
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TRAININGS & SERVICES

CNPC has professional training and service teams and works out relevant training plans according to different demands of users. There are multiple service means, including explanation at assembling sites, demonstration at operation sites, simulation system demonstration, etc., and one-package services including in-plant services, simulation and field training can be realized. A well site simulation system has been designed and manufactured. Combining software with hardware, the system is used to simulate actual drilling operation conditions and train actual operating personnel visually.

A perfect after-sales service system has been established. CNPC has professional technical personnel “on-call” round the clock and can provide remote technical support and diagnosis and solve product problems effectively in time. CNPC has established project departments in Changqing, Xinjiang and Hainan in China and foreign countries and regions such as Iran, Venezuela, etc., assign personnel who provide services in residence throughout the year, and can rapidly provide common spare parts and shorten the service period.



Simulation laboratory



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