

Directional Drilling Technologies



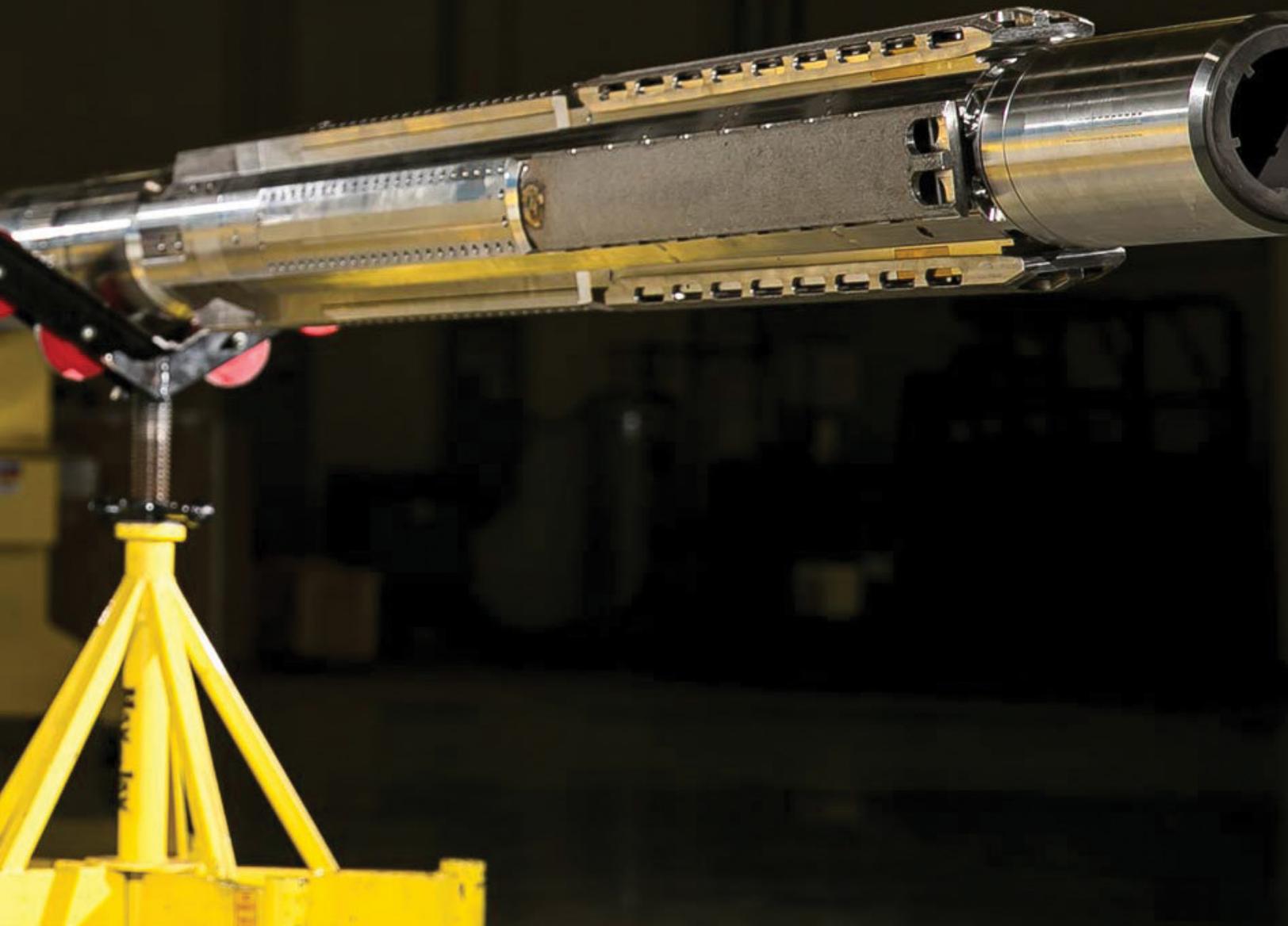


NOV is the leading independent supplier of directional drilling tools and technologies to the energy drilling industry.

With a portfolio including vertical monitoring tools, measurement-while-drilling (MWD)/logging-while-drilling (LWD) technologies, and rotary steerable systems (RSS), we enable directional drillers around the world to reliably deliver wells on plan.

All of our directional drilling tools are available through a variety of commercial models, and we enable our customers to maintain tools themselves to ensure they can be cost effectively deployed.

As a focused directional drilling technology developer and manufacturer with access to world-leading research and development (R&D) facilities, we are solely focused on designing, manufacturing, and supporting our directional drilling customers with the tools they need to successfully compete.



Vertical Monitoring Tools

We offer the broadest range of fit-for-purpose vertical monitoring and survey-on-connection tools in the industry under our Teledrift™ and FloTool™ product lines. These tools provide a cost-effective alternative to conventional MWD or wireline-deployed survey tools when drilling vertical sections. The tools can be run without dedicated rigsite supervision, and we offer remote access to survey data.

With a legacy dating back more than 30 years, the Teledrift and FloTool products are known worldwide for their simplicity and reliability.

Inclination tools

- **ProDrift™ tool** – ideal for harsh or high lost-circulation material (LCM) environments
- **FloDrift™ tool** – ideal for high-temperature applications or where fast surveys are required

Inclination and azimuth tools

- **ProShot™ tool** – ideal for harsh or high LCM environments
- **FloSurvey™** – ideal for high-temperature applications or where fast surveys are required

Inclination, azimuth, and tool face

- **ProPulse™ tool** – ideal for vertical control applications where steering may be required



FloDrift tablet (left), FloSurvey tool (middle), and FloDrift tool (right)





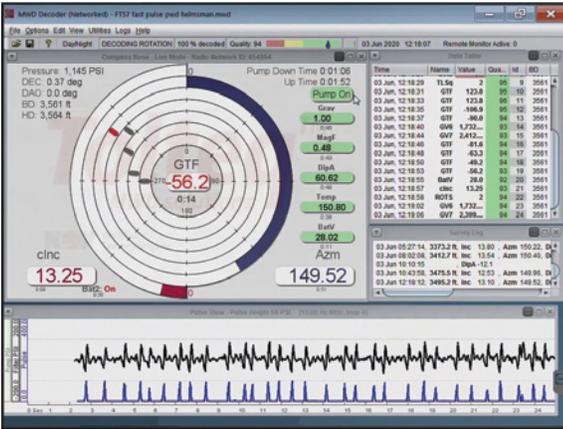
MWD

The Tolteq™ iSeries platform is our probe-based, mud-pulse MWD product line. As a modular platform based on the legacy Tensor design, the iSeries platform provides directional drillers with significant flexibility to configure and deploy the tools in a wide variety of applications. With more than 600 tools sold and in use in 15 countries (as of January 2020), the Tolteq Series MWD platform is a proven, reliable MWD solution for directional drillers.

Tolteq MWD tools are offered in both legacy retrievable design with a bottom-mount pulser or in a fixed, top-mount pulser configuration that provides several benefits, including:

- Enables gamma and directional measurements closer to the bit
- Provides higher LCM tolerance and stronger pulse amplitude
- Rigidly mounts the MWD toolstring for increased shock and vibration resistance

Tolteq iSeries MWD tools are available either as a ready-to-deploy kit or as individual modules. All Tolteq modules are rated to 347°F (175°C) and 20,000 psi, ensuring they can be used in the widest variety of applications.



GUIDE display (top),
and SureMate centralizer (bottom)



- Directional module (iDM)
- Retrieval pulser (iTPM)
- Retrieval pulser with integrated gamma sensor (iPRGM)
- Top-mount pulser (TMP)
- Ruggedized gamma module (iRGM)
- SureMate™ centralizers
- GUIDE rig floor display and decoder
- Unmanned configuration (TruVertical)



Tolteq directional module



Tolteq TMP with pressure-while-drilling module

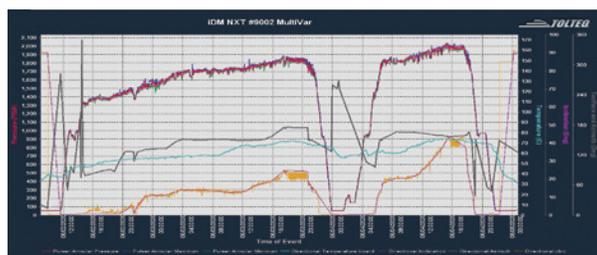
NXT

Released in 2019, iSeries NXT products enable Tolteq owners to offer additional services and capabilities. With continued development leveraging our world-leading R&D facilities, directional drillers can be assured that the iSeries platform will remain the leading independently manufactured MWD solution.

- Advanced directional module (iDM NXT)
- Fast pulsers (TMP NXT and iTPM NXT)
- Pressure while drilling (optional on TMP)
- Intelligent rotary pilot valve pulser (iRPV)



All Tolteq modules include the patented **ToolTracker™** system, which provides users the ability to track usage and downhole conditions on each individual module. This data is presented visually and archived, which enables customers to proactively manage their repair and maintenance cycles across the lifetime of the module.

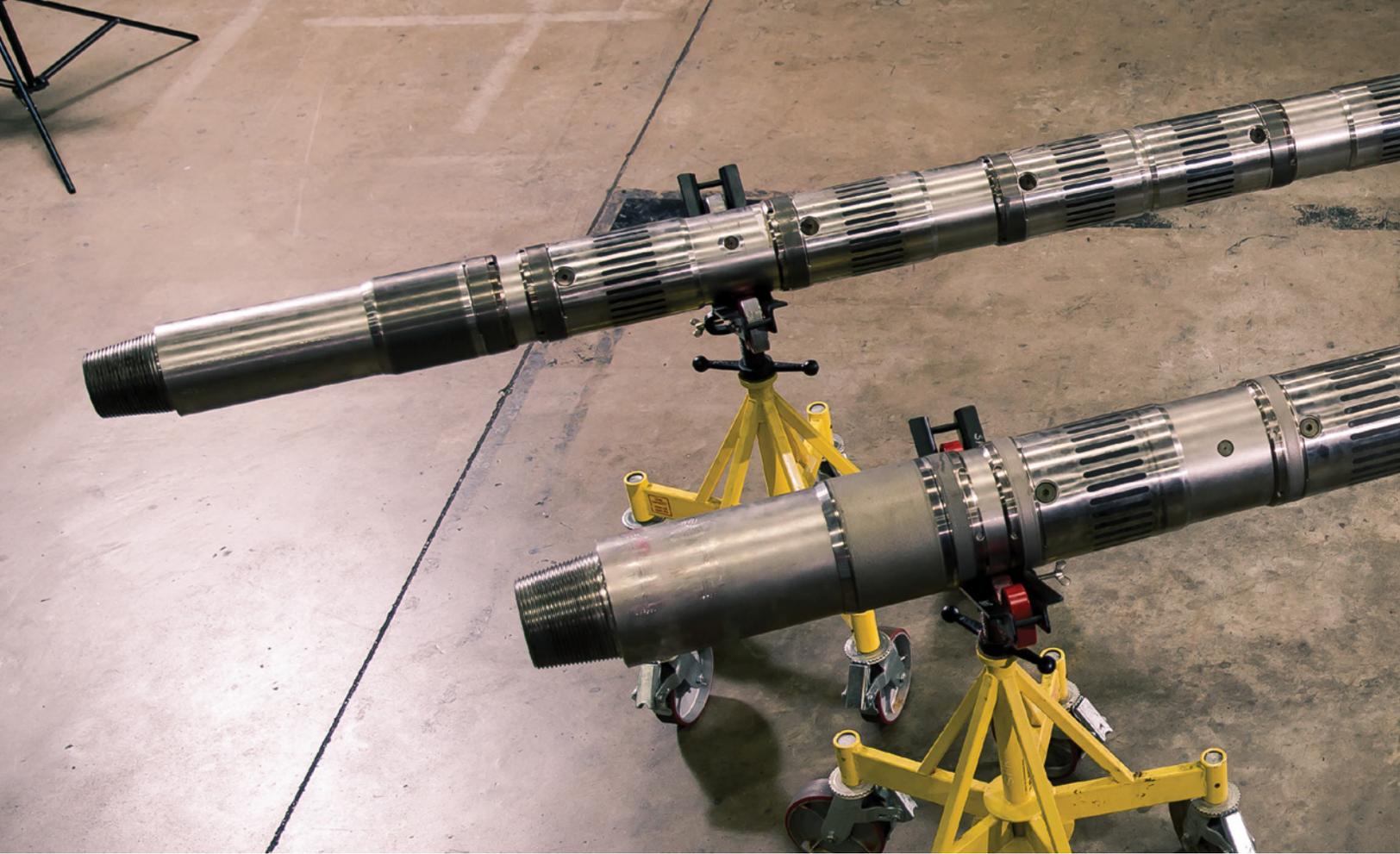


ToolTracker visualization tools



MWD electronics module

We are one of the only MWD suppliers that manufactures its own directional sensors, which are the core part of any MWD tool. These directional sensors are also available in standard Tensor-compatible versions for use with legacy MWD tools.



LWD

Our portfolio includes a suite of tools that provide the commonly required LWD measurements, including azimuthal gamma and resistivity. Using the Tolteq MWD platform, these tools provide formation data in real time as well as in memory. With independent access to these critical measurements, directional drillers can now expand their capabilities and offerings into new and higher tier markets.

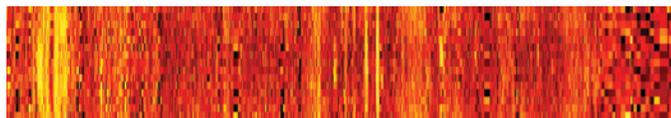
The **symmetric propagation resistivity (SPR)** tool provides eight different borehole-compensated formation resistivity measurements, using two transmitter spacings combined with dual frequencies to provide a complete picture of the formation resistivity for geosteering or formation evaluation purposes.



SPR tool

The Tolteq iSeries azimuthal gamma-ray (iAZG) measurement module can be used as part of the iSeries MWD string. The tool measures gamma-ray counts in 16-sector measurements with up to 4-quadrants available for real-time transmission.

The **Tolteq iSeries near-bit sub (iNBS)** tool is a short sub that can be installed directly between the drill bit and motor. This battery-powered tool provides azimuthal gamma and inclination measurements from directly above the drill bit and enables faster detection of formation beds and ultimately more accurate and productive geosteering. The iNBS tool transmits this at-bit data to a receiver probe installed in the Tolteq string, where it is packaged and pulsed to surface together with other MWD data.



Azimuthal gamma log



iNBS tool

RSS

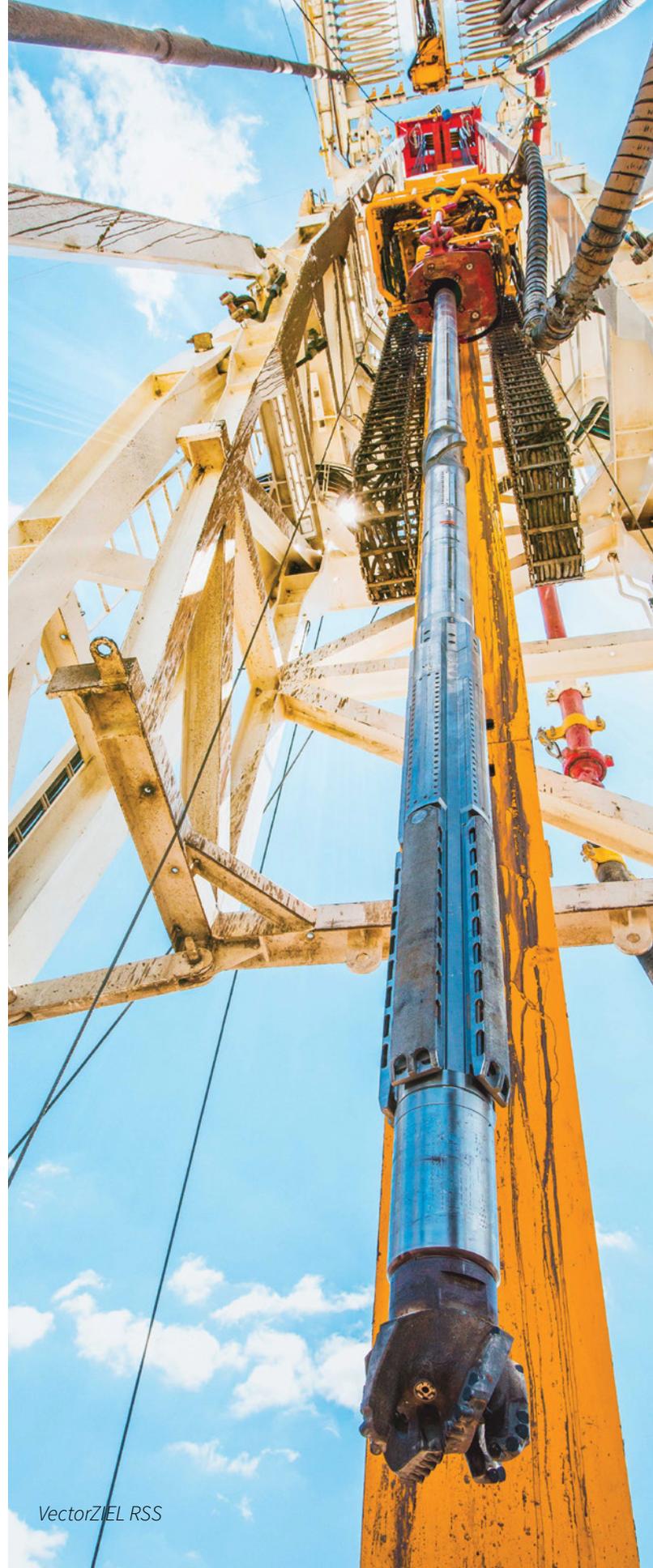
Given the technology's ability to drill wells faster and more precisely, RSS technology has become a standard requirement in many directional drilling operations around the world. We have invested in developing RSS to ensure that directional drillers have access to this critical technology, and we offer two RSS technologies based on the industry-preferred "push-the-bit" steering method.

- **VectorEXAKT™ RSS** – precise vertical control for large diameter sections
- **VectorZIEL™ RSS** – advanced system with integrated MWD/LWD for directional and horizontal sections

The VectorEXAKT RSS provides precise vertical control in hole sizes ranging from 12¼ to 17 ½ in. The system functions autonomously and uses precise, near-bit inclination sensors to maintain verticality, enabling directional drillers to drill vertical sections faster by eliminating the need for time-intensive slide drilling. The sensors and steering system are located in a slow-rotating housing that isolates them from harmful drillstring vibrations and minimizes wear on the external elements, making the tool ideal for hard or abrasive applications.

Using these integrated sensors and pulser, the near-bit inclination and gamma data is available in real time. The VectorEXAKT RSS is the most precise vertical drilling tool on the market, and with the option to run below a motor, the system provides directional drillers with the confidence and ability to achieve the highest ROP possible without sacrificing verticality.

The VectorZIEL RSS enables directional drillers to drill complex 3D well profiles in hole sizes ranging from 6 to 13¾ in. The system uses hydraulically activated steering ribs located in a slow-rotating housing to push the bit in the desired direction and is powered by an integrated mud turbine. Using integrated near-bit inclination and azimuth sensors along with a closed-loop control system, the VectorZIEL RSS delivers the desired well trajectory with limited interaction required. Tool reliability is enhanced since the sensors and critical steering elements are located in the slow-rotating housing, which is insulated from the harmful effects of stick-slip and other torsional vibrations.



VectorZIEL RSS



VectorZIEL 600 RSS

When combined with an integrated pulser, MWD sensors, and a patented calibration system, the VectorZIEL RSS is the only tool on the market that can provide accurate near-bit survey measurements in real time. An automated flow-bypass downlinking system enables steering adjustments to be made quickly and reliably with the click of a button. The VectorZIEL RSS is available with optional azimuthal gamma and resistivity measurements, ensuring our customers can operate in almost all markets globally.

We offer the Vector RSS for sale and rental with various options for maintenance to meet your needs, including training and equipment to enable customer-performed repair and maintenance and OEM maintenance at one of our worldwide service centers.

With a legacy dating back more than 30 years and multiple world-class R&D facilities, directional drillers can be assured that our Vector RSS will reliably deliver the well's directional objectives today and into the future.

	VectorZIEL	VectorEXAKT
Design	Push-the-bit, non-rotating housing	Push-the-bit, non-rotating housing
Tool Sizes (inches)	4¾ (400), 6¾ (600), 8 (800)	8 (800), 9 (900)
Maximum build rate	6-10°/100ft	N/A
Near-bit-measurements	Inclination, azimuth, gamma	Inclination, gamma
Max RPM	400	400
Integrated MWD	Yes	Yes
LWD integration capable	Yes	No
Real-time feedback	Yes	Yes
Closed-loop steering control	Full	Full
Downlink	Flowrate bypass (automatic)	Not required

Key Vector RSS specifications

Global Experience

NOV and our legacy companies are experienced in supporting our customers' successful directional drilling projects on all six continents. Our technologies have been deployed in more than 30 countries, and our experience is demonstrated by several key statistics (as of May 2020).



● Technologies Deployed

- | | |
|------------|---------------|
| Algeria | Mexico |
| Argentina | Niger |
| Australia | Nigeria |
| China | Oman |
| Colombia | Pakistan |
| Ecuador | Peru |
| Egypt | Poland |
| France | Russia |
| Gabon | Saudi Arabia |
| Germany | South Africa |
| India | Tunisia |
| Indonesia | Turkey |
| Iraq | UK |
| Japan | Ukraine |
| Kazakhstan | United States |
| Kenya | Vietnam |
| Kuwait | |

● NOV R&M Facilities

- Bogota, Colombia
- Dubai, UAE
- Gelsenkirchen, Germany
- Houston, TX
- Oklahoma City, OK
- Oktabrisky, Russia
- Tianjin, China
- Williamstown, PA

More than
600

Tolteq MWD tools deployed
across 16 countries

More than
80

Vector RSS products manufactured with
60-plus wells tracked across 14 countries



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