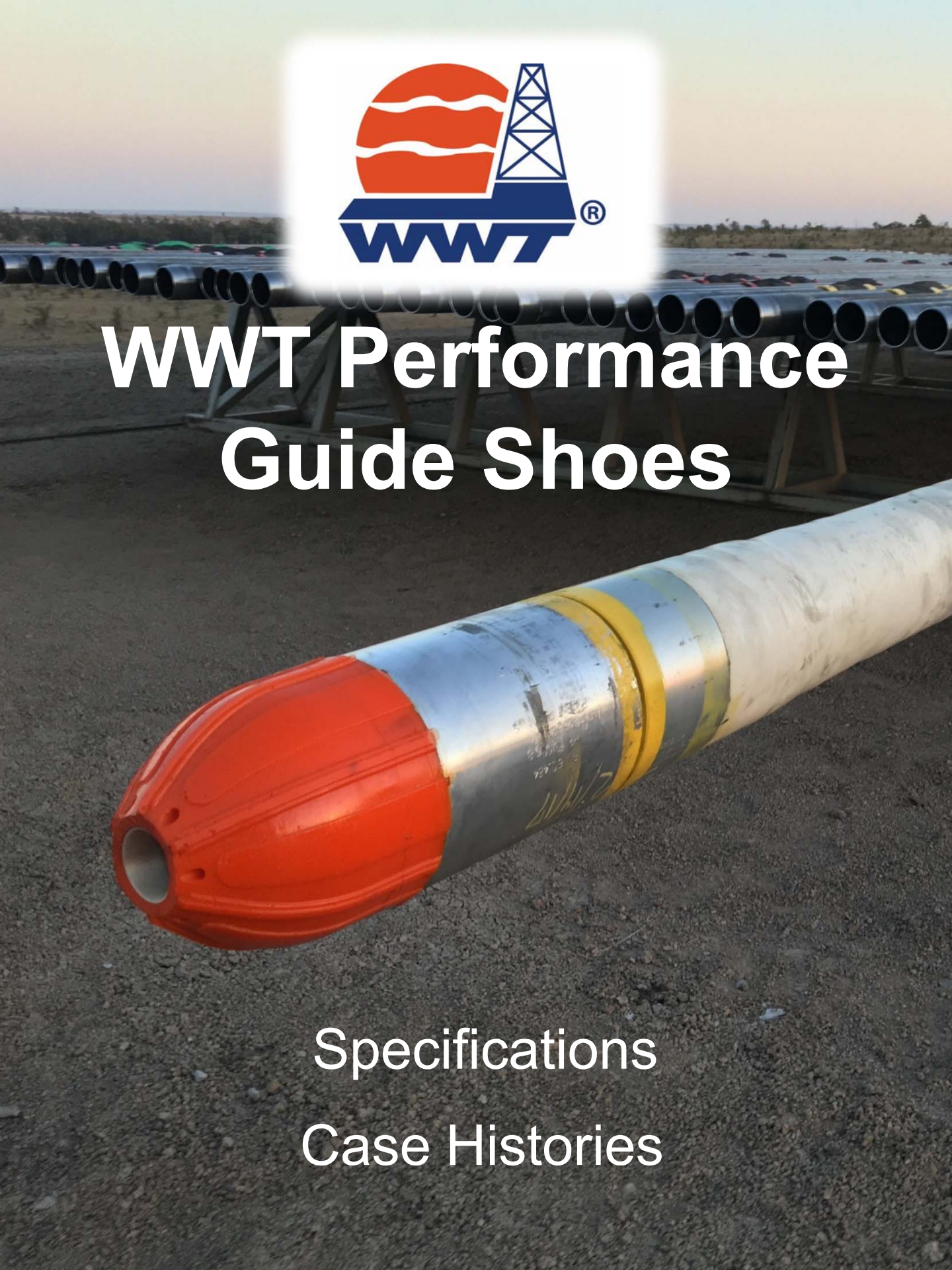

WWT Performance Guide Shoes

Specifications

Case Histories

Performance Casing Guide Shoes

WWT's guide shoes are operator focused solutions to address any casing running challenge.

WWT FlexShoe™

Composite flexible, strong guide shoe. Ideal for speeding up casing runs in directional, horizontal, and deepwater wells. Reduces casing end loads by up to 90%, resulting in less buckling and reduced drag.

WWT JetGuide™

Powerful jetting shoe with up to 30x more force than normal jetting and guide shoes. Speeds up casing runs by quickly washing through cuttings, debris, and salt or tar zones. Fail-safe design with large centerline nozzle that opens for cementing or if jets are plugged. Standard and eccentric models available.

WWT JetReam™ / WWT ReamGuide™

A new cost-effective approach to reamer shoes specifically designed for challenging casing runs. Effective reamer design has no metal in drill-out path providing efficient and fast drill-outs. JetReam also includes additional features to assist washing through tight spots with high-velocity jets.

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WWT FlexShoe™

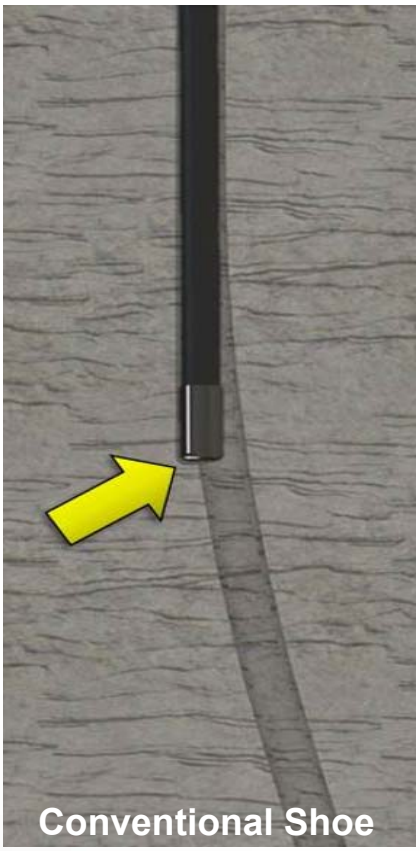
Features, Advantages and Benefits

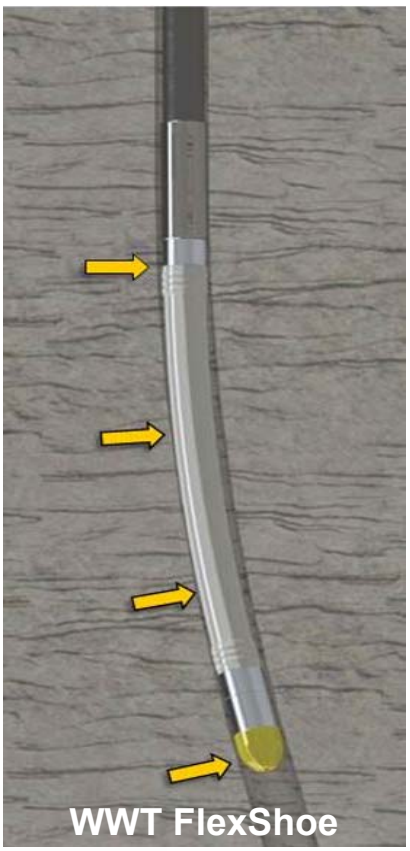
WWT FlexShoe™

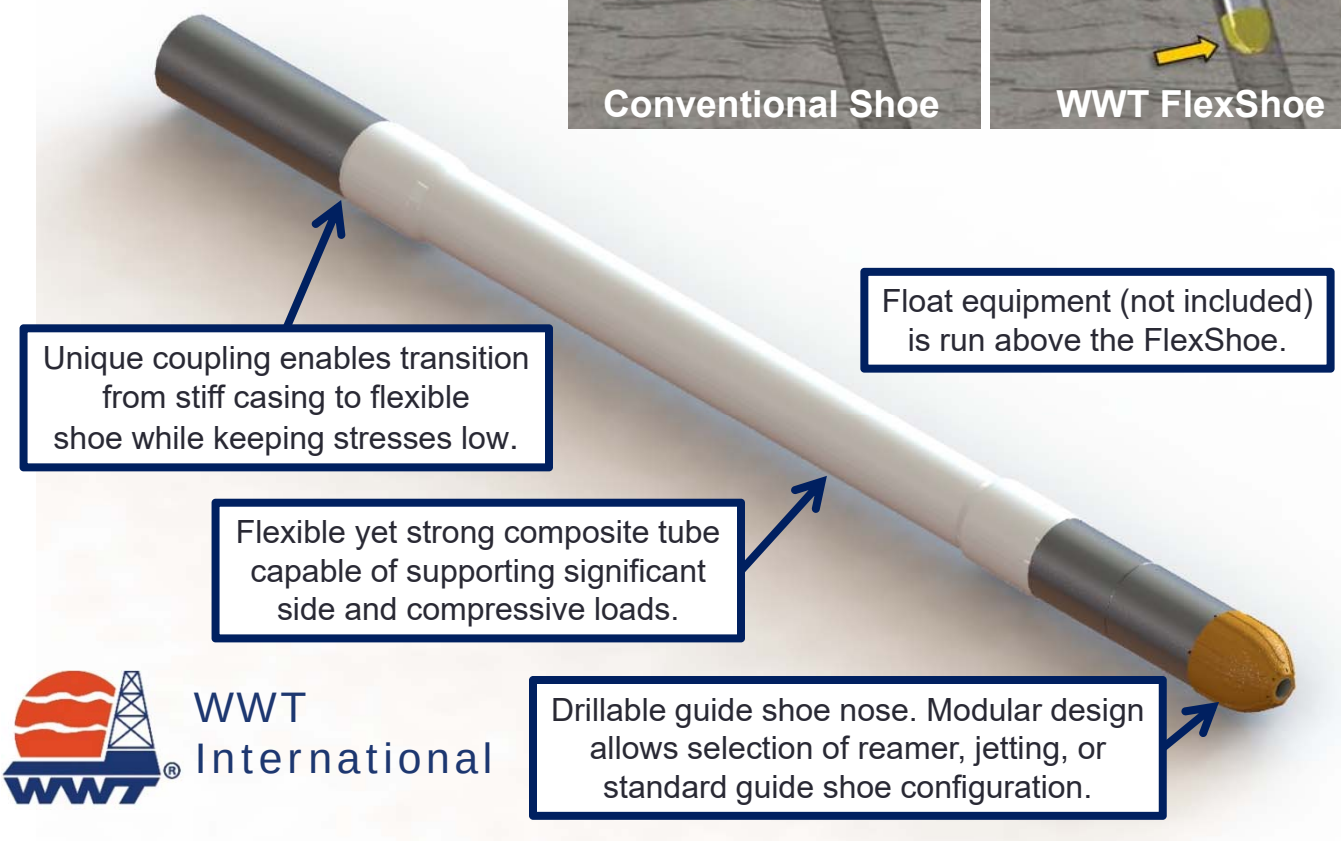
The WWT FlexShoe™ reduces casing end loads up to 90%, requiring less force to traverse casing across dog-legs. The innovative patented design reduces casing running risks, allowing operators to land casing at the intended target depth.

Conventional Shoe

With a conventional shoe, stiff casing has a large side force concentrated at the leading edge of the casing string. This increases the risk of sticking casing in open hole. The large yellow arrow represents side force required to bend casing around a build section, ledge, or wellbore deviation.







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WWT FlexShoe™

Strong, Flexible Guide Shoe

Specifications

FLX Model	450	550	700	758	958	1075	1175	1338	1400	1600	1800
Casing Size (inches)	4-1/2	5-1/2	7	7-5/8	9-5/8	10-3/4	11-3/4	13-3/8	14	16	18
OD (inches)	5-5/8	6-3/4	8-1/4	8-3/8	11-1/4	11-7/8	12-3/4	14-1/4	14-1/4	16-1/4	18-1/8
ID (inches)	3-7/8	4-7/8	6-1/8	6-3/4	8-3/4	9-7/8	10-7/8	12-1/4	12-1/4	14-5/8	16-5/8
Length	8	8	10	10	12	12	12	12	26	32	32

* Other sizes available upon request. Length is approximate and varies depending on connection, etc.

Features and Benefits

- Downhole-proven composite section is strong and durable, but also 10 times more flexible than steel.
- Guides casing past doglegs, ledges and soft formations.
- Reduces end loading by up to 90%, resulting in less drag and buckling when running casing.
- Casing can be rotated with WWT FlexShoe installed.
- Casing is cemented through the tool and easily drilled out.
- Patented design provides a low-stress transition from rigid casing to flexible shoe.
- Compatible with floats and other casing running equipment, including premium connections.
- Ideal for deepwater operations, extended reach drilling and horizontal wells
- Modular design. Choose from standard, jetting, and reamer shoe configurations.

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WWT JetGuide™

High Velocity Failsafe Jetting Shoe

Specifications

JetGuide Model	450	550	700	758	958	1075	1175	1338	1400	1600	1800
Casing Size (inches)	4-1/2	5-1/2	7	7-5/8	9-5/8	10-3/4	11-3/4	13-3/8	14	16	18
Max OD (inches)	5-3/8	6-1/4	8-1/4	8-3/8	11-1/8	11-3/4	12-1/4	14-1/2	14-1/2	16-1/4	18-1/8
Minimum TFA* (in^2)	2.1	2.1	5.1	5.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1

*TFA in. With jetting feature TFA out is reduced until opening centerline at predetermined flow rate.

Features and Benefits

- Effective
  - Wash through cuttings with up to 30X more hydraulic force compared to other guide shoes.
  - Available in standard and eccentric models.
- Safe
  - Converts to full-open center bore for cementing or if jets are plugged.
- Efficient
  - Easily drilled out. No metal in drill out path.
  - Much lower cost than reamer shoes, but can be just as effective in many cases.
- Modular
  - Increases the effectiveness of the WWT FlexShoe, or can be used as stand-alone product.
  - Float installed above shoe.

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WWT JetReam™

Drillable Reamer & Jetting Shoe

Specifications

JetReam Model	450	550	700	758	858	958	1075	1175
Casing Size (inches)	4-1/2	5-1/2	7	7-5/8	8-5/8	9-5/8	10-3/4	11-3/4
Reamer OD (inches)	5-3/4	6-3/4	8-3/8	8-3/4	9-3/4	11-1/8	11-3/4	12-1/4
Minimum TFA (in^2)	2.1	2.1	5.1	5.1	7.1	7.1	7.1	7.1

*TFA in. With jetting feature TFA out is reduced until opening centerline at predetermined flow rate.

Features and Benefits

- Effective
  - Patented embedded ceramic cutting elements provide effective reaming and movement of cuttings.
  - Ring of powerful jets help wash through cuttings and debris. Large center nozzle opens if needed.
- Durable
  - Rotate casing to ream down through trouble zones or past obstructions.
  - Tough polyurethane body with aluminum frame and ceramic cutters.
  - Steel frame and cutters on 4-1/2” and 5-1/2”
- Efficient
  - Fast drill-out with PDC or rock bits. Little or no metal in drill-out path.
  - Cost effective.
- Modular
  - Works well with the WWT FlexShoe.
  - Float installed separately above shoe.

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WWT ReamGuide™

Drillable Reamer Shoe

Specifications

ReamGuide Model	450	550	700	758	858	958	1075	1175
Casing Size (inches)	4-1/2	5-1/2	7	7-5/8	8-5/8	9-5/8	10-3/4	11-3/4
Reamer OD (inches)	5-3/4	6-3/4	8-3/8	8-3/4	9-3/4	11-1/8	11-3/4	12-1/4
Minimum TFA (in^2)	2.1	2.1	5.1	5.1	7.1	7.1	7.1	7.1

Features and Benefits

- Durable
  - Rotate casing to ream down through trouble zones or past obstructions
  - Tough polyurethane or cement composite body with aluminum frame holding cutters.
- Effective
  - Patented embedded ceramic cutting elements provide effective reaming and movement of cuttings
- Efficient
  - Made from aluminum and polyurethane or cement composite.
  - No metal in drill-out path in most cases.
  - Cost effective.
- Modular
  - Works well with the WWT FlexShoe.
  - Can be used as a stand-alone product.
  - Float installed separately above shoe

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US Patent number 9,702,197

WWT FlexShoes Save Several Hours per Well on 9-5/8” Casing Run and Drill-Out

Operator tests WWT FlexShoe with ReamGuide to help run casing in an area with history of difficult casing runs.

Location: Asia
Well Type: Offshore, Directional Well
Objective: Help 9-5/8in casing run to bottom quickly and efficiently.
Solution: WWT FlexShoe w/ReamGuide
Results: Smooth casing run to bottom.

Well Basics:

- Directional well with 9-5/8” casing set in tangent at 40 to 55deg inclination.
- Max dog-leg severity of 8.5°/30m in the build section.
- Target casing setting depth for all wells in this series were 300-600m, with one well at 1300m. FlexShoe runs had target depths of 450-500m.
- Soft formations, fast casing runs.

WWT FlexShoe in Action

Two WWT FlexShoes were run as an evaluation on a series of seven wells that were batch-drilled in nearly identical conditions.

The runs with the WWT FlexShoe were chosen because these runs were perceived to be the most challenging, with shallow builds, highest planned dog-leg severity, and highest inclination.

The FlexShoe runs went smoothly, with no noticeable drag and no rotation, reaming, or washing required to reach target depth.

The two runs with WWT FlexShoes were also the fastest casing runs, with an average time savings of nearly 5 hours per well for running casing and drilling out the shoe track.

Drill out through the FlexShoes and ReamGuides went smoothly, and were on average a bit faster than the other shoe tracks using normal reamer shoes due to the easy-drill design of the FlexShoe and ReamGuide.

Two 9-5/8” FlexShoes with ReamGuide, ready to go.

Chart comparing casing run times with and without the WWT FlexShoe.

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WWT JetReam Succeeds in the Permian

Operator Identifies WWT JetReam as a Solution After History of Difficult Casing Runs in the Area.

Well Basics:

- Horizontal well with 9-5/8" casing set at bottom of vertical section.
- Target depth approx. 8,900ft.
- JetReam set up to open centerline at 13bpm (550gpm).
- History of difficult formation and wellbore stability problems frequently results in casing-running difficulty.

JetReam in Action – Running Casing

- The operator has tried numerous guide shoes and reamer shoes without finding an ideal solution.
- The WWT JetReam was called out after the operator expected difficulties in running 9-5/8" casing.
- Clean run to 7,300ft, then casing started taking weight due to formation.

JetReam in Action - Reaming

- JetReam effectively reamed through approx. 400ft and10hrs+ of hard reaming with 10 to 30klbs WOB.
- Customer reported that the JetReam appeared to be just as effective as other more 'aggressive' reamer shoes.
- JetReam continued with jetting and occasional reaming to TD.
- Successful casing run. Reamer and jetting feature effective throughout the run.

JetReam in Action - Cementing & Drill-out

- Customer converted centerline at pre-set flow rate for cementing.
- Drill out was reported to be much faster and easier than competing reamer shoes that have been run on these wells.

Location: Texas, USA
Well Type: Land, Horizontal Well
Objective: Run 9-5/8in casing through difficult formations.
Solution: WWT JetReam
Results: Successful casing runs.

WWT JetReam, showing reamer blades surrounding jetting nozzles. Centerline nozzle opens when needed.

Example of WWT JetReam reaming structure, with embedded ceramic cutting structure. Notice drill-out path is clear for fast drill-out.

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WWT FlexShoe with JetGuide Helps 5-1/2in Casing Quickly Reach Target Depth in Queensland Australia

Operator Identifies WWT FlexShoe as a Possible Solution to Casing Running Difficulties.

An operator drilling shallow directional wells through coal had experienced multiple wells with inefficient casing runs as a result of ledges and wellbore instability. These were not able to be mitigated through normal means, so the WWT FlexShoe with JetGuide was used to help improve efficiency when running production casing.

Well Basics:

- Wellbore instability and ledges in coal and other formations.
- Directional 'S' shape wells with approx. 35deg inclination and 5deg/100 DLS.
- 9 5/8in casing to approx. 700m
- 7-7/8in OH to 1200m

WWT FlexShoe Guides Casing to Bottom

The WWT FlexShoe, model FLX-550, was made up to a joint of casing and raised onto the rig floor using the automated pipe handling system. At surface, the WWT JetGuide feature was tested at 100gpm, demonstrating the jetting force of the high velocity nozzles.

The 5-1/2 inch casing was run through the drop section with no drag or tight spots. This same zone had caused substantial difficulties and down time on several previous nearby wells.

At 10m off bottom, some wellbore instability debris was encountered. The driller picked up off bottom, and the JetGuide helped to quickly start moving through the debris at a flow rate of 150gpm. After quickly moving down, on the next joint, the centerline nozzle converted, and circulation was increased to 200gpm to continue moving the fill/debris out of the hole, enabling casing to quickly reach target depth. Washing through 10m of fill took only a few minutes.

Location: Queensland, Australia
Well Type: Land, 'S' Shape
Objective: Run production casing though difficult formations.
Solution: WWT FlexShoe w/ JetGuide
Results: Casing run to bottom quickly.

Photo showing WWT FLX-550 with JetGuide before being moved to the catwalk and lifted to the rig floor with the automated pipe handling system.

Photo showing the JetGuide high velocity flow at 150gpm. This was used to quickly wash though fill at the bottom of the hole.

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WWT FlexShoe helps 18in Casing Reach Bottom Efficiently

Operator Identifies Running Large Diameter Casing in High Inclination Wellbores as Significant Risk

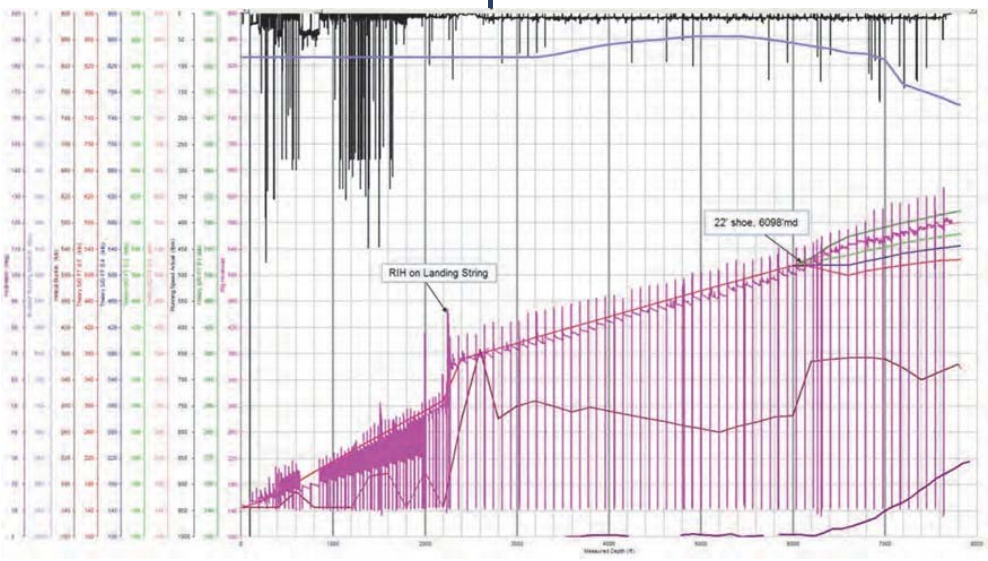
Operator experiences increased risk of casing running difficulties with large diameter casing run through build sections and into higher inclination wellbores.

- 18in casing set at 29° inclination.
- Max DLS of 2.7°/100ft.
- 2000ft of open hole with very soft formation.

WWT FlexShoe Guides Casing to Bottom

Using a FLX-1800, the casing was run to bottom without any significant drag. The cement job and drill out were also completed without any significant difficulties.

Location: Gulf of Mexico
Well Type: Deepwater
Objective: Run Casing in High Inclination Wellbore
Solution: WWT FlexShoe
Results: Casing run to bottom with no significant drag.



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WWT FlexShoe with JetGuide Helps 4-1/2in Liner Run Through Window in Oman

Operator Identifies WWT FlexShoe as a Possible Solution to Help Liner Run Through a Sidetrack Window in Oman

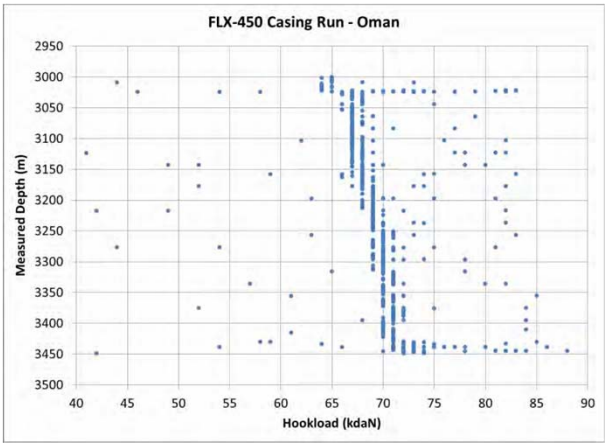
Well Basics:

- Window milled through 7in casing at 3050m MD.
- Directional well with approx. 15deg inclination and 12deg/100ft dog-leg at the sidetrack point.
- 5-7/8in OH to 3450m MD

WWT FlexShoe Guides Liner to Bottom

The WWT FlexShoe, model FLX-450, was picked up and run in the hole without difficulty. The 4-1/2in casing was run through the window without any noticeable drag. The casing was also run to TD without any drag or tight spots, as seen on the hookload chart below. There were no issues circulating mud, LCM, or cement through the FlexShoe.

The company man reported that the FlexShoe worked as expected, and that the liner got to bottom without issue.



Hookload chart from the casing run. Notice the smooth trend, with no drag as the casing and shoe ran through the window at 3050m MD.

Location: Oman
Well Type: Land, Directional Well
Objective: Run 4-1/2in liner though window.
Solution: WWT FlexShoe
Results: Smooth casing run to bottom.

Photo showing WWT FLX-450 being lifted to the rig floor.

Photo showing the FLX-450 being run through the rotary table.

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WWT FlexShoe – Running 7in Casing in the Permian

Running Casing

As part of an initial evaluation of the WWT FlexShoe, a major operator ran a FLX-700 on the bottom of the 7-inch casing on one of two nearly identical horizontal wells drilled from a pad in the Permian Basin in Texas.

The FLX-700 helped guide the 7-inch casing to section TD near the bottom of the curve at 85° inclination. The curve contained maximum dog-leg severity of 20°/100ft, with a typical build rate of 15°/100ft.

The casing run went perfectly, with no rotation required, and max set down weight of 50kips in one isolated area within the curve. By comparison, the other well on this pad required more than 150kips set down weight to get past a similar area.

Helped by a quick and smooth casing run, the well set a new record for this major operator in this field at the time the 7-inch casing was set on bottom.

Cementing and Drill-Out

Cementing and drill-out did not present any problems. Less time was spent drilling out through the WWT FlexShoe than in drilling out the float equipment above the WWT FlexShoe. The cement within the tool and bottom nose section of the tool drilled quickly. There were no signs of wear or damage while drilling the subsequent 5000ft+ of 6-1/8-inch horizontal production section through the WWT FlexShoe.

The operator reported that they were happy with the performance of the tool, and as a result of this run, approved the tool for use in deepwater operations.

Location: Permian Basin, Texas
Well Type: Horizontal Well
Objective: Efficient run and drill-out of 7-inch casing.
Solution: WWT FlexShoe
Results: Complete success.

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WWT FlexShoe Provides a Smooth Run in the Permian

Background

An operator in the Permian looked to the WWT FlexShoe to help improve efficiency when running 7 inch casing.

To help evaluate the performance of the WWT FlexShoe, the operator ran a FLX-700 on the bottom of the 7-inch casing running through the curve on a horizontal well drilled from a pad in the Permian Basin in Texas.

Casing Run

The FLX-700 helped guide the 7-inch casing to section TD near the bottom of the curve at approximately 11000ft MD and 80° inclination.

The casing run went smoothly, with no rotation required.

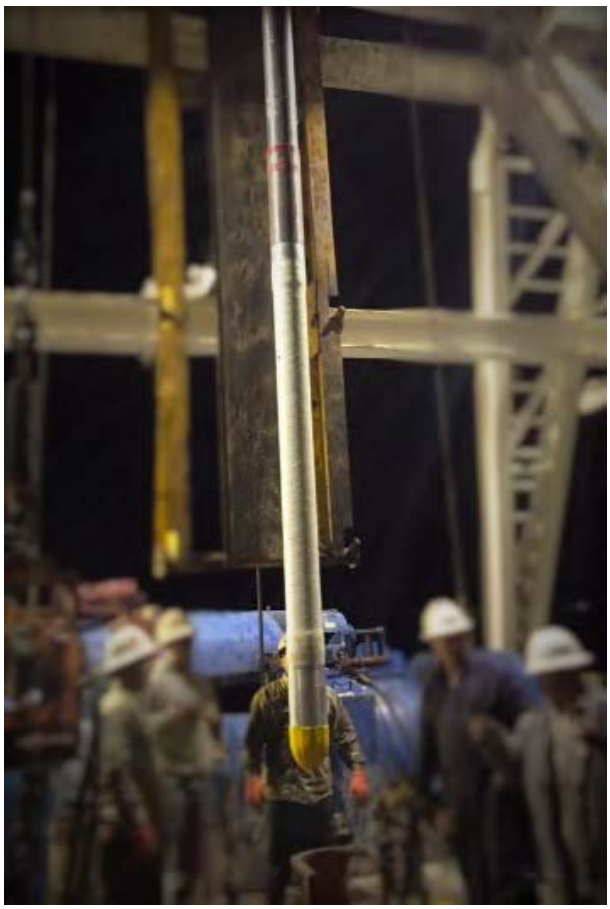
Drill Out

Cementing occurred normally through the WWT FlexShoe. There were no problems drilling out through the shoe. The bit tracked down the FlexShoe centerline, and drilled more smoothly than the float equipment above the FlexShoe.

What's Next

The operator plans to implement the use of the FlexShoe on additional rigs in the area as a means of increasing efficiency and reducing downtime when running intermediate casing.

Location: Permian, TX, USA
Well Type: Horizontal
Objective: Run 7" Casing
Solution: FLX-700
Benefit Seen: Smooth run.



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WWT FlexShoe Guides 5-1/2in Liner Through Open Hole Sidetrack in Wyoming

Unique tool guides casing into low-side, open hole sidetrack regardless of orientation.

Well Basics:

- Low-side sidetrack drilled in horizontal open-hole section at approx. 14,500ft MD.
- TD of approx. 20,000ft MD
- Horizontal well with curve at 10,000ft MD at location of 9-5/8" shoe.
- 13deg/100ft max dog-leg in the curve.
- 8-3/4" Open Hole.
- 240°F Bottom Hole Temperature.

WWT FlexShoe Guides Liner into the Sidetrack on the First Attempt.

A sidetrack-configured WWT FlexShoe, model FLX-550 ST, was picked up and run at the bottom of the casing. This FlexShoe uses a small amount of weight at the end of the FlexShoe, deflecting the shoe down into a low-side sidetrack without the need to orient the casing while still maintaining effectiveness as a guide shoe.

The WWT FlexShoe guided the 5-1/2" casing into the low-side sidetrack KOP on the first pass and without any noticeable drag. The casing then continued to TD without any problems.

WWT FlexShoe and Casing Floatation Equipment

The WWT FlexShoe worked well with the casing floatation equipment used on this well. Because the WWT FlexShoe can minimize loading when running past ledges and other downhole obstructions, it can reduce the need for working the string when rotation may take time and generate substantial torque, and circulation/washing casing down is not an option.

Location: Wyoming, USA
Well Type: Land, Horizontal Well
Objective: Run 5-1/2in casing into open hole sidetrack on the first attempt.
Solution: WWT FlexShoe ST
Results: Smooth, efficient casing run.

Image of the FLX-550 ST 'sidetrack' configuration, showing steel connection downhole of the composite FlexShoe.

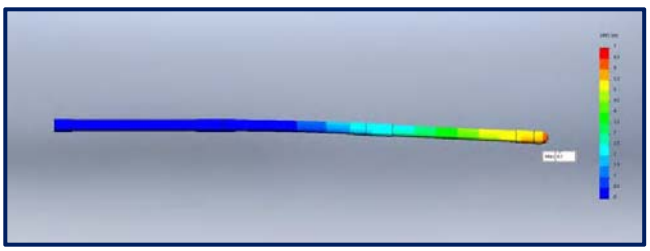

Image of FEA analysis showing approximately 6" downward deflection in a horizontal wellbore. This allows the shoe to locate and enter a low-side sidetrack regardless of casing orientation.

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WWT FlexShoe helps 4 ½” Casing Get to Bottom

Operator Identifies High Dog-Leg Section

While drilling a horizontal well in West Texas, surveys identified dog-leg severities up to 29°/100ft. The operator had experienced casing running difficulties with higher than normal dog-legs in the past and decided to run WWT’s FlexShoe to see if the flexible guide shoe could traverse the challenging deviations.

WWT FlexShoe Guides Casing to Bottom

The WWT FlexShoe was installed below the customer supplied float and did not create any handling challenges.
Using a FLX-450 with the poly nose, the 4-1/2” casing was run to bottom without any significant drag or difficulties. No drag seen through the severe dog-legs in the build section as seen on previous wells.
The customer was able to circulate and cement with lower pressures than a conventional shoe, possibly due to better resistance to cuttings plugging up the nozzle.
15-20k lbs of weight was able to be set down on FlexShoe without any problems and optimal TD was reached quickly and without any problems.

Location: Permian Basin (Texas)
Well Type: Horizontal
Objective: Run 4-1/2in casing in through severe dog-legs.
Solution: WWT FlexShoe
Results: Casing run to bottom.

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WWT FlexShoe helps 16” Casing Get to Bottom in Deepwater GOM

Operator Identifies Significant Risk Running Large Diameter Casing in High Inclination Wellbores

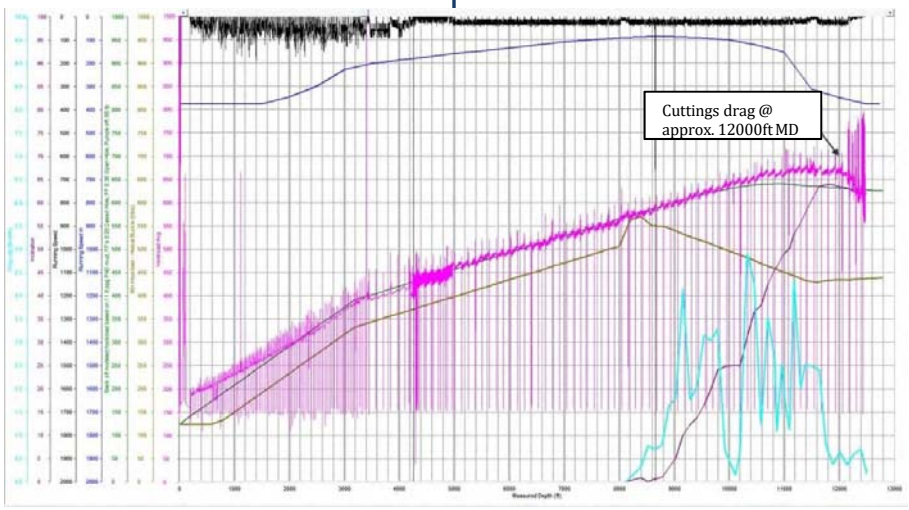
Operator identified an increased risk when using large diameter casing while running into higher inclination wellbores.

- 16” 97ppf Casing with WWT FlexShoe
- Casing run to approx. 13000ft MD
- Max inclination of approx. 65°, with max DLS 5°/100ft.
- Casing ran through build and into tangent section with no noticeable drag, other than some cuttings drag required washing down the last 200ft.
- OH friction remained significantly less than 0.3 until washing down at end of run.

WWT FlexShoe Guides Casing to Bottom

A WWT FLX-1600, was assembled with a float collar and shipped offshore. The FlexShoe led the 16” casing all the way to bottom and easily across the 5°/100ft DLS problem area. The cement job and drill out were also completed without any significant difficulties.

Location: Gulf of Mexico
Well Type: Deepwater
Objective: Run 16” Casing in High Inclination Wellbore
Solution: WWT FlexShoe
Results: Casing run to bottom.



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WWT FlexShoe

Frequently Asked Questions

Can the WWT FlexShoe be rotated?

Yes. The tool is strong and designed to transmit torque. In structural testing, a 7" FlexShoe failed at 16,000ft-lbs, and a 5" tool failed at 8,000ft-lbs.

What about rig handling?

Rig handling has proven to be similar to most casing joints. WWT ships the tool pre-made to a pup joint and normally include certified slings. The pup joint is then set in the slips and made up just like any other joint of casing. See TSI032 for more information.

Can WWT FlexShoe be shipped with a float?

All WWT Guide Shoes are typically shipped without a float, but WWT can make up to a customer supplied float collar above the tool, or WWT can supply Guide Shoes with floats.

Can WWT use someone else's shoe or reamer on the bottom of the WWT FlexShoe?

The WWT FlexShoe and WWT Guide Shoes are designed to work together as a system.

Can WWT ship it with a different shape nose, such as an offset guide-shoe shape?

The answer is yes, WWT has standard, offset, and reamer noses that can work with the WWT FlexShoe to improve performance of the tool.

What about cementing and drill-out?

WWT has features to ensure a quick and efficient drill out, and reports from the field support that drill out of the FlexShoe is often as fast or faster than other types of guide shoes. See TSI032 for our recommendations and best practices for drilling out the FlexShoe.

Can a reamer or other component pull up against the shoe?

Yes. The shoe can take a considerable amount of load, both up and down.

Will the FlexShoe sag against the low side of the well and dig into ledges?

Compared to steel, the FlexShoe is very flexible, but given the light weight and relatively short length, it will not sag significantly downhole. The tool is neutrally buoyant in moderate weight drilling fluids.

Can WWT make the FlexShoe with built in centralizers?

Given the short length of the FlexShoe, operators have found that they have achieved excellent cement job quality with a centralizer installed immediately above the FlexShoe. A centralizer is not required on the FlexShoe itself.

What effect does the FlexShoe have when performing FIT / leak off test?

The process is the same as any other shoe track. Drill out new formation and perform the test. Operators have not had any issues performing FIT / leak-off tests.

Will I sidetrack out the side of the shoe when drilling out?

The FlexShoe is strong and wear resistant enough to allow the bit and BHA to easily drill out of the shoe, with the path of least resistance down the center of the FlexShoe when drilling cement. The FlexShoe can experience wear if a heavy bit or reamer is rotated inside the FlexShoe for extended periods.

What kind of load and pressure can the FlexShoe take?

The tool is a guide shoe, not a pressure boundary. It is designed to be open to the wellbore and to leak rather than hold pressure. With that said, it is strong, and will withstand a considerable amount of pressure and load without damage. See WWT TSI032 for specific load and pressure limitations.

Can WWT use the FlexShoe with a casing floatation system?

Since casing is normally run without the ability to circulate, the WWT FlexShoe can be very beneficial when floating casing. The FlexShoe works very well with casing floatation systems, and can complement these capabilities. The FlexShoe is installed below any floatation / float equipment.

Does WWT require service personnel on site when running the tool?

WWT recommends a service person be on site for the first couple runs to ensure smooth operations, and to educate rig personnel about the abilities and operations of our tools, but a dedicated service hand is generally not required.

Can the FlexShoe be made with any connection type?

The WWT FlexShoe has been designed to easily adapt to most standard and premium casing connections, but a strong, shouldered BTC (buttress) or stub acme connection is standard. All sizes from 4-1/2” to 11-3/4” are designed to thread into a standard BTC pin connection. Since the FlexShoe connection is at the shoe, a premium connection is not normally required, but premium connections and crossovers are available upon request. Note that premium connections can add considerably to cost and lead time.

What if I’m interested in another size WWT FlexShoe that is not listed on the spec sheet?

WWT can make a WWT FlexShoe in almost any size. Please contact us to discuss the application and WWT can provide a quote.

Can the WWT FlexShoe work in HP / HT wells?

The standard WWT FlexShoe product line can handle temperatures to 275F. Contact WWT if a WWT FlexShoe is needed for higher temperatures.

WWT International

For additional information and contacts,

visit www.wwtinternational.com

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