



Weatherford®

Weatherford's Liner Systems **HANG TOUGH**



Well construction

- Cementing products
- Cementing services
- Drilling fluids
- Drilling tools
- Inflatable packers
- **Liner systems**
- Mechanized rig systems
- Tubular running services

Repeatedly proven in the world's toughest well construction projects, including record-breaking ultra-deep, high-angle and extended-reach liner installations.



Drilling



Evaluation



Completion



Production



Intervention

Total liner systems designed to **HANG TOUGH**

We're the only company that combines liner-hanger, cementing, drilling and tubular running products and expertise all under one roof.



You get the benefit of full planning and execution capabilities from one source—one well construction organization.

Total system compatibility is ensured because we design and manufacture every component of our liner-hanger systems and cementing equipment. We also make our own drill shoes; reamer shoes; filter shoes; and friction-reduction, diverter and torque-and-drag tools—the whole works. We even build state-of-the-art tubular running equipment to run the liners. Nobody else does that.

Record-setting performances are made possible by our totally integrated liner-hanger/running-tool/cementing systems and the expertise of our people involving all aspects of liner-job planning and installation. You can be sure that your liner will be hung at the correct depth to provide effective zonal isolation when cemented.

We understand how everything needs to interact for safe and efficient liner operations. Many clients entrust us with the planning and execution of their entire liner operation, using our full suite of services.

Our HANG TOUGH systems are record-setting:

UK

- 13,077-ft (3,986-m) extended-reach liner installed at 37,001 ft (11,278 m) MD
- Longest liner (18,233 ft, or 5,557 m)
- Lightest liner (539 lb, or 244 kg)

Norway

- Shortest liner (29.31 ft, or 8.93 m)
- Heaviest liner (782,775 lb, or 355,061 kg)

USA

Gulf of Mexico

- Extended-reach liner installed at a record 25,750 ft (7,849 m) MD
- Longest total time reaming liner to TD (120 hours, nonstop)

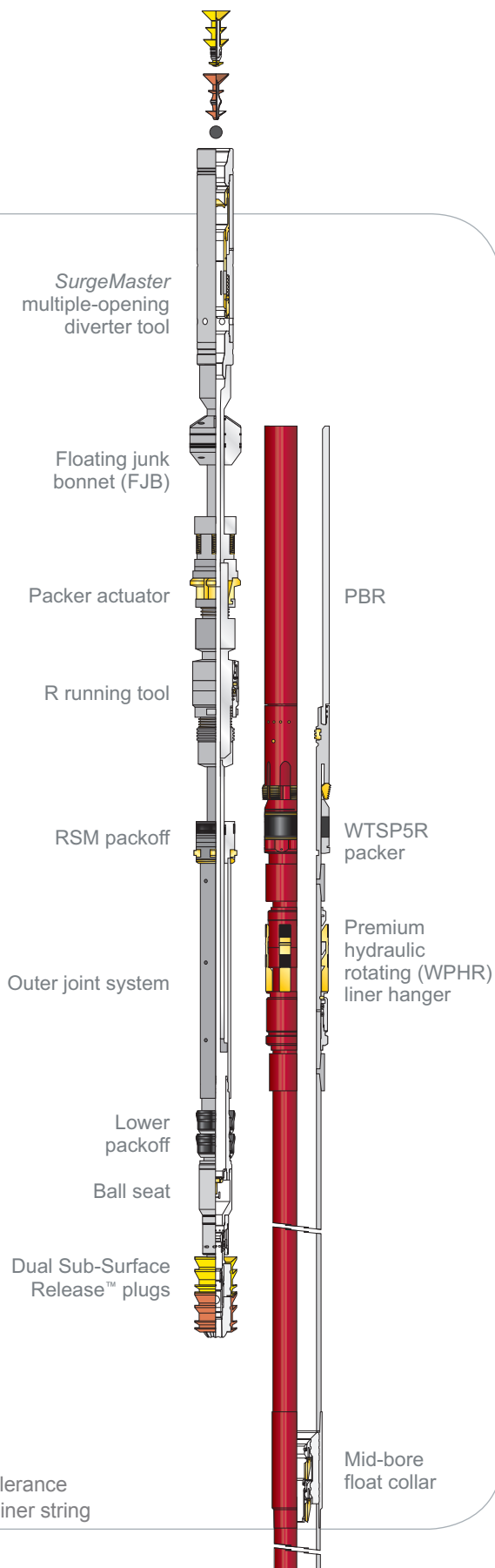
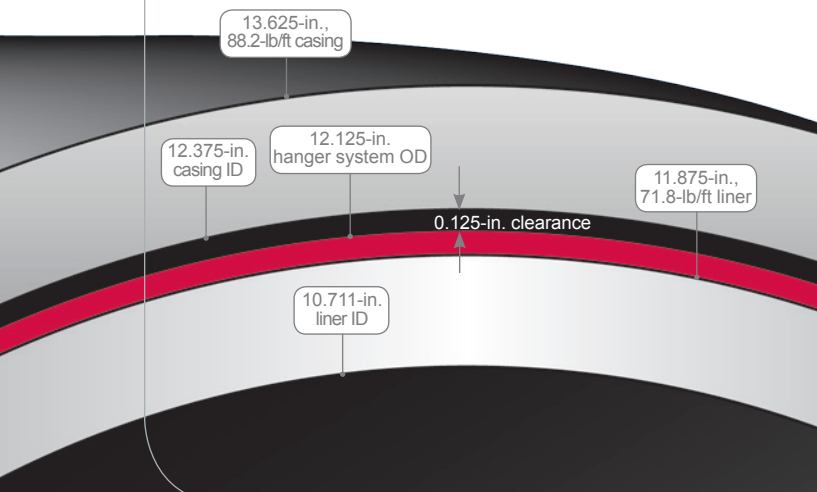
California

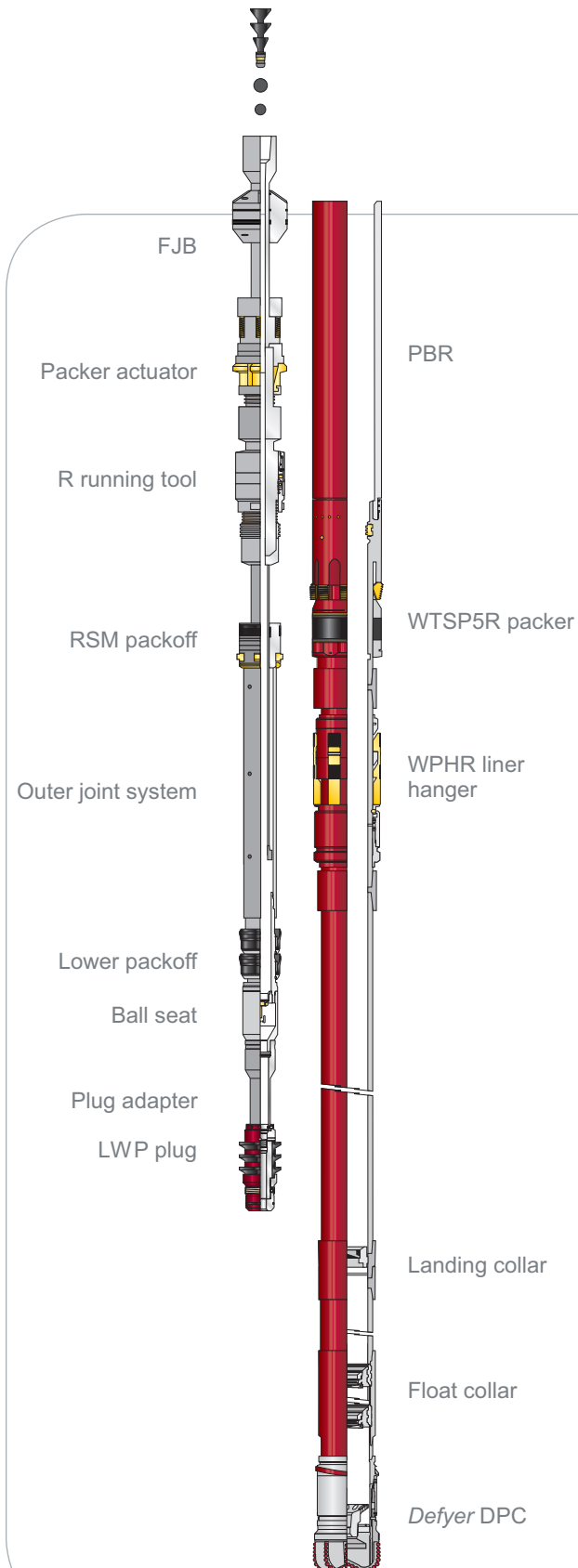
- World-record liner in an extended-reach well: 23,000 ft (7,010 m) of liner run to 30,000 ft (9,144 m) TD; 4,000 ft (1,219 m) of liner then run to 33,000 ft (10,058 m) TD—all at only 7,200 ft (2,195 m) TVD

HANG TOUGH

liner applications

The deepwater liner system reduces or eliminates surge pressures on the formation during run-in while allowing pipe to be run faster. In many deepwater wells, the casing design calls for “close-tolerance” casing strings with minimal run-in-hole clearances between the liner and the parent casing. Running the liner with the SurgeMaster™ tool above the polished bore receptacle (PBR) allows the mud to enter the shoe, pass up the inside of the liner, and enter the annulus between the drillpipe and the casing above the liner top. Upon reaching liner setting depth, the auto-fill float equipment is converted to standard float mode for the remainder of the liner installation and cement job.





The drilling-with-liner (DwL™) system

ensures that the liner reaches bottom, even if the hole sloughs, and can even eliminate the wiper trip before running the liner. DwL technology allows the operator to drill the liner into the well across depleted or loss zones or unstable formations and then set the hanger and packer in a single trip. The Defyer™ DPC series has a PDC cutting structure that converts to a drillable cementing shoe at TD. The high-torque capability of the running tools meets or exceeds most casing threads. Additionally, when picking up to make connections, the model R setting tool design prevents accidental release of the liner because of the effects of residual torque in the drillstring.



Defyer DPC

An inside look at **LINER TOOLS** with built-in reliability



Our premium WTSP5 liner-top packer and WPHR rotating hanger are critical components of the liner system. The packer is run as an integral part of the liner-hanger assembly to provide a protective seal between the liner OD and host-casing ID. The hanger has superb run-in features, such as large bypass area and high load capacity. A high torque rating makes the liner system ideal for applications such as

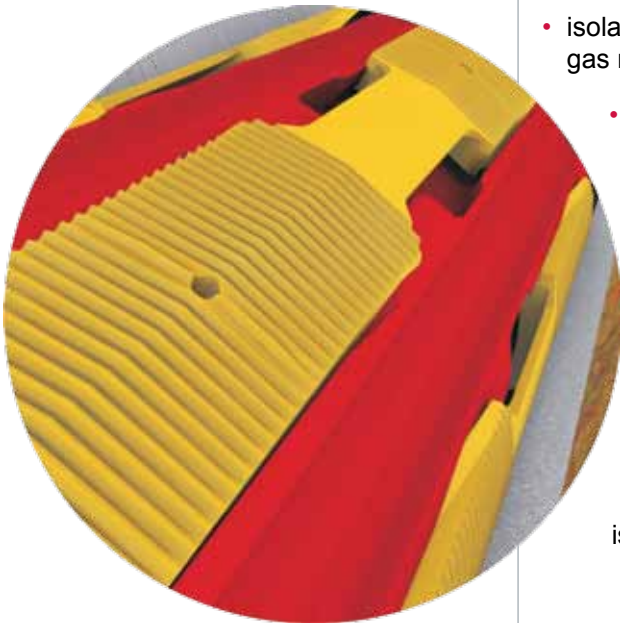
- cemented liners that can be rotated after setting;
- drill-down liners that set hydraulically;
- liners that must be reamed down.

The WTSP5 liner-top packer is mechanically set with weight after the hanger is set and cementing operations are completed. The incorporated, patented helical lock wire mechanically locks the PBR to the packer, preventing the possibility of the PBR backing off. There are many reasons to use this packer to isolate the liner top, including

- isolation of formation pressure below the liner top from the casing ID above;
- isolation of treating pressures below the liner top during fracture or acid work;
- isolation of formation fluids while the cement sets, eliminates gas migration;
- isolation of lost-circulation zones.

The liner-top packer can be used as a tie-back completion or production packer.

The WPHR rotating liner hanger has outstanding rotation/push/pull capabilities, proven in deep, highly deviated wells and in drill-down and reaming-with-liner applications. And it has the highest hanging capacity of all Weatherford liner hangers. This liner hanger is hydraulically set and is available in WPHR (rotation) and WPHS (static) configurations. Its rotating capability is critical in achieving zonal isolation during primary cement jobs.

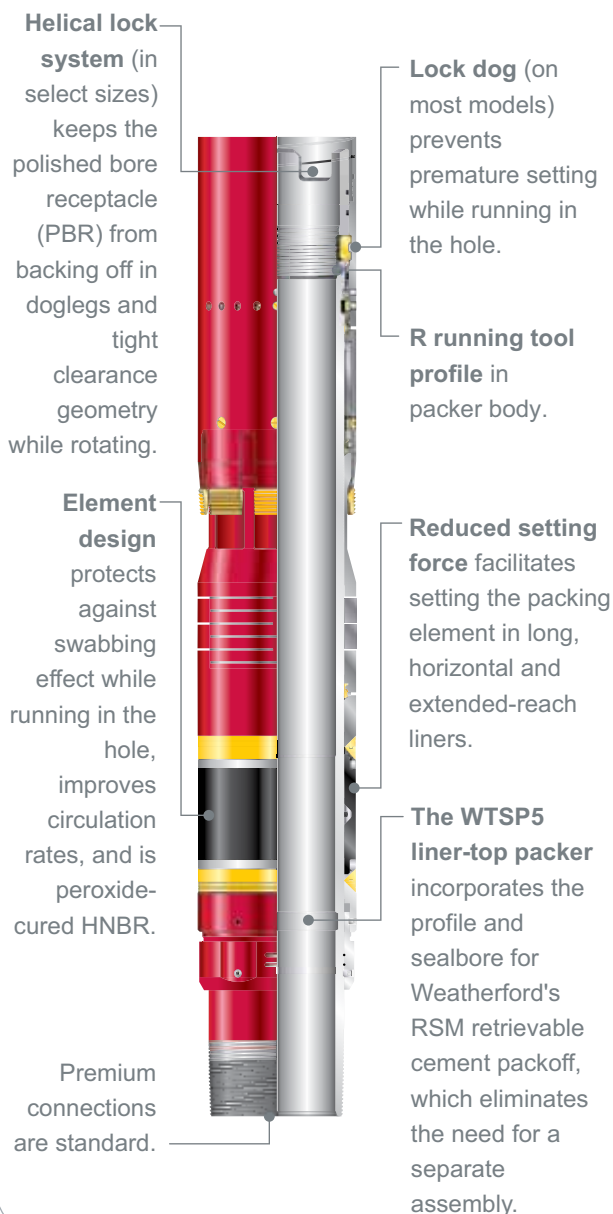




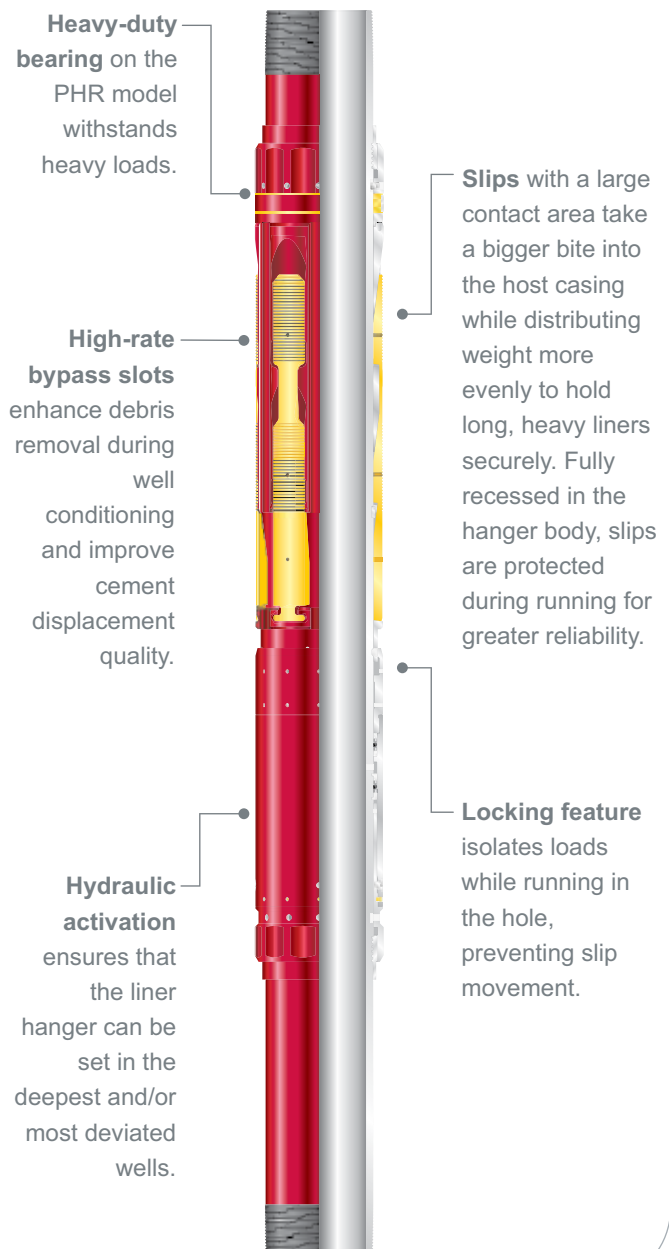
Design allows high circulation rates past the liner-top assembly for better removal of debris during well cleaning, which improves the quality of cement displacement.

Solid body ensures reliable high-torque/high-load durability.

WTSP5R1 Liner-Top Packer with R Running Tool Profile



WPHR Liner Hanger



An inside look at **RUNNING TOOLS** with built-in reliability

Patented floating junk bonnet (FJB) system floats on a cushion of fresh water in the PBR to prevent entry of debris and protects the running tools during liner run-in, hanger setting, R running-tool release and cementing. The FJB remains stationary until the packer is set to avoid debris packing off around the running tool and preventing it from releasing. And because the FJB is stationary, the drillstring can be raised to check for release without fear of debris falling into the PBR and interfering with the running tools. Competitor systems allow debris into the liner system as the string is picked up to check for release, which can cause the running tools to stick in the PBR.



The floating junk bonnet (FJB).



The FJB coming out of the well with solid drilling fluid on top.

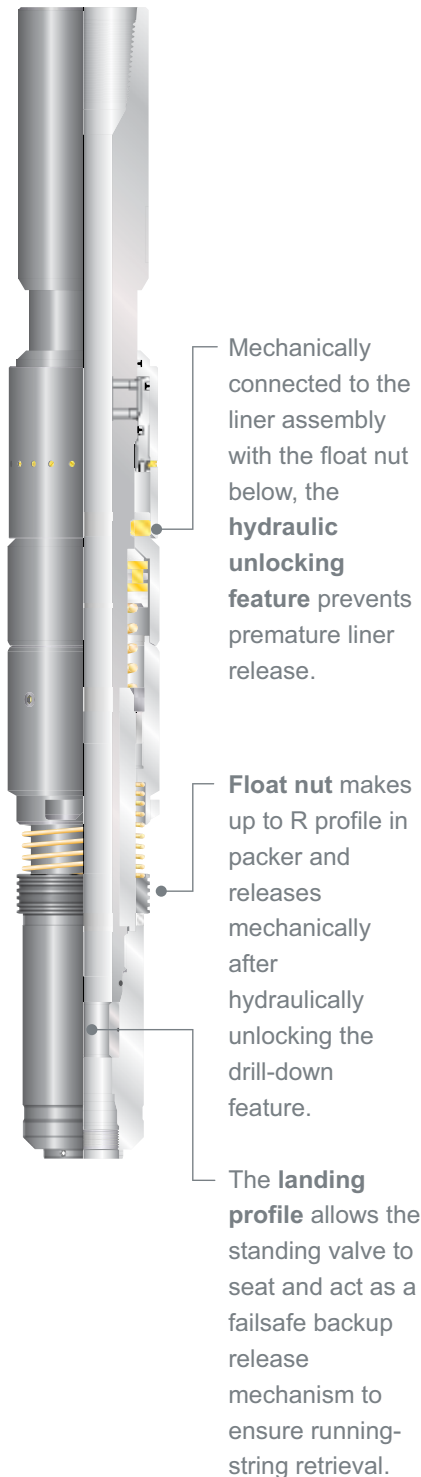


Backreaming blades cut through debris to ensure successful retrieval of liner running tools.

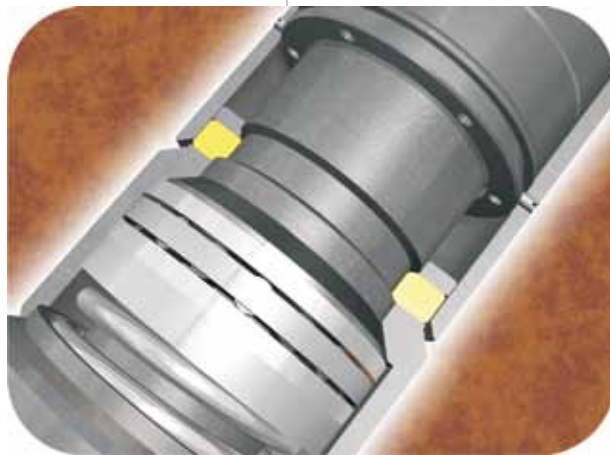
The **FJB** is built onto the setting-tool extension, where it functions as a floating, sealed barrier at the top of the PBR. The space between the FJB and the RSM packoff (not shown) creates a sealed, protected, clean fluid environment for the running tools in between.

Bypass slots equalize pressure during retrieval.

Spring sleeve facilitates removal of FJB by opening circulation path if required.



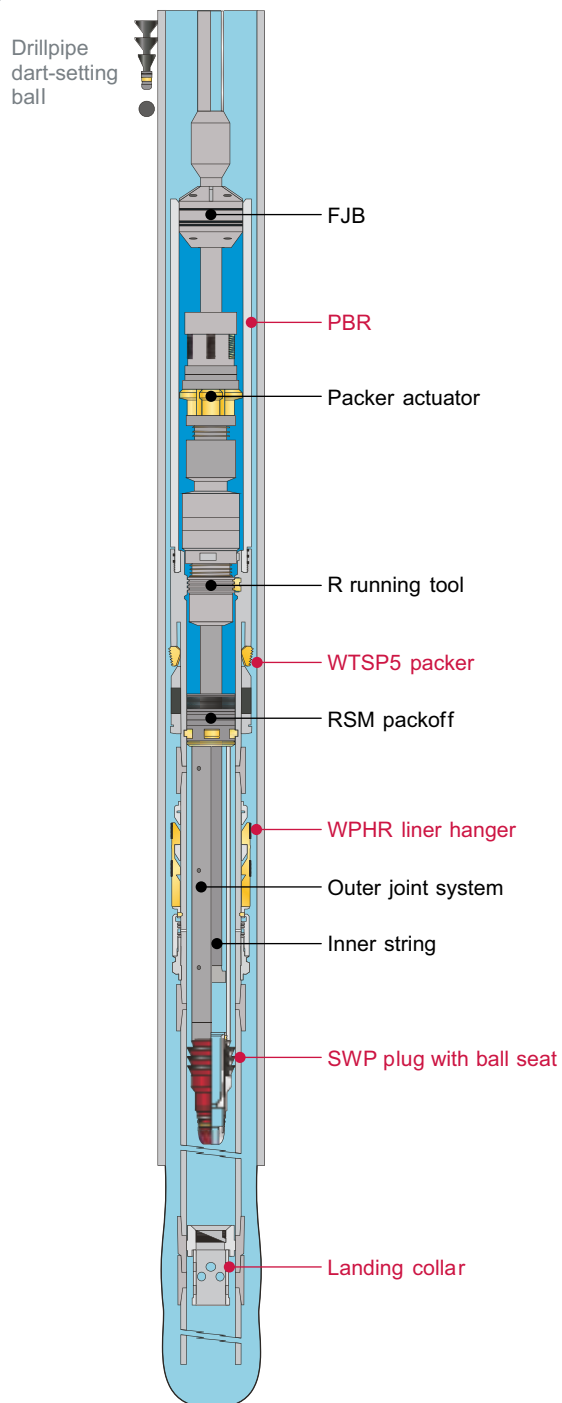
Weatherford's premium R running tool with hydraulic unlock and mechanical release eliminates dropped liners and has outstanding drill-down capability. This tool's track record includes running some of the world's longest extended-reach liners. It withstands high torque loads that exceed the capability of most premium liner connections. Using the R running tool, you can rotate Weatherford's liner systems as long as needed—in tension or compression—while running in the well, without fear of residual torque releasing the running tool and dropping the liner. The ability to rotate the liner during cementing improves the cement bond.



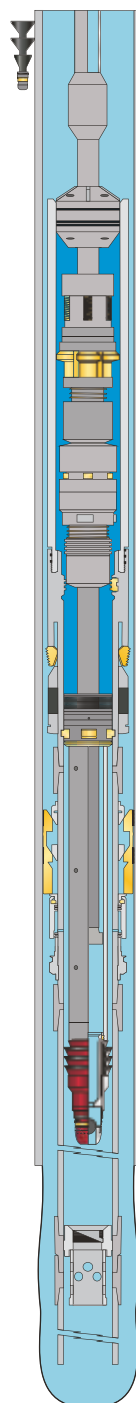
The R running tool drill-down feature prevents liners from being dropped as they are run in the hole.

How the job flows

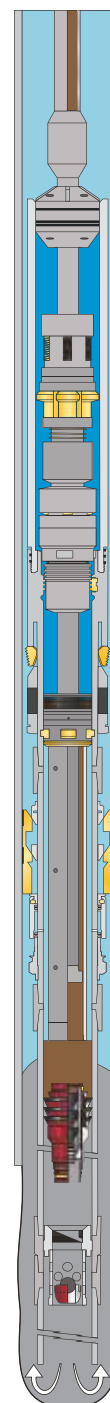
Key: **Red** denotes items that are permanent parts of wellbore.
Black denotes installation tools.



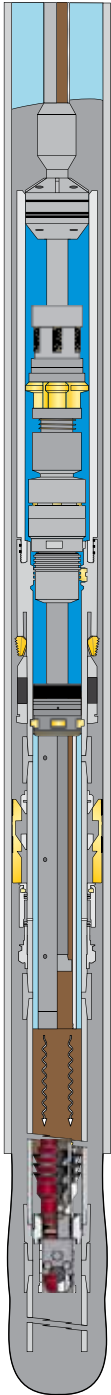
Run in the hanger assembly.



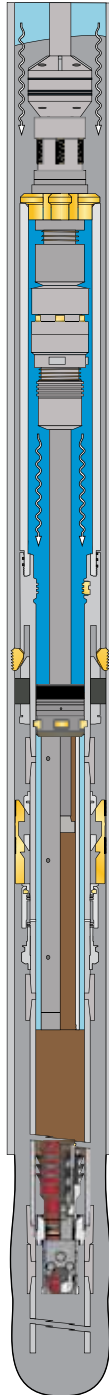
Drop ball, set the hanger and release the running tool.



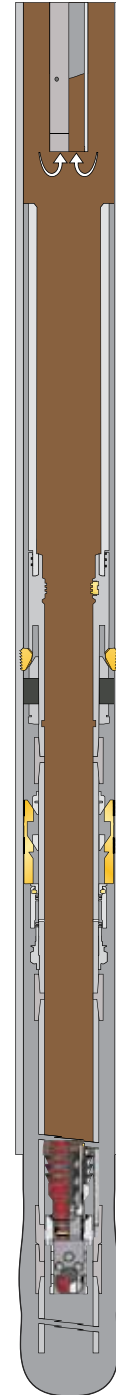
Shear out the ball. Pump the cement, drop the dart, release the plug and displace the cement.



The plug lands and latches.
Pressure-test the liner.



Set packer and pressure-test.



Reverse-circulate excess
cement and pull out of the hole.

HANGING TOUGH the world over

Zero NPT: Four large-diameter liners run deep into unstable wellbores for BP Trinidad and Tobago.

East Coast, Trinidad. Weatherford was called upon to run the largest OD production liners ever in Trinidad as an integral part of two well completions. Our quality plan covered everything from manufacturing to assembly and installation of the liners.

A25 well: Weatherford ran a 10 3/4- × 16-in. liner, using a high-pressure tieback sealbore and seal stem. A 7 5/8- × 10 3/4-in. liner was run in an unstable section to 17,070 ft (5,203 m) TD, with a 10 3/4-in. tieback and a 7-in. one-trip completion. The liner-hanger system and reamer shoe were used to rotate, wash and ream the liner 2,000 ft (610 m) to TD in 14 hours.

A24 well: Weatherford ran a 13 5/8- × 16-in., extremely long 6,095-ft (1,858-m) liner to 13,790 ft (4,203 m). A 7 5/8- × 13 5/8-in. liner was run using dual Sub-Surface Release™ cementing plugs to extend below a lower completion polished-bore receptacle. The job also involved a 10 3/4-in. tieback and a 7-in. one-trip completion.

DwL™ drilling-with-liner system saves four days of drilling in 9 5/8-in. liner.



Gulf of Mexico. A DwL system, including a 3,438-ft (1,048-m) 9 5/8-in. liner and the Defyer™ DT cutting structure, was used to drill 269 ft (82 m) of new hole and isolate a thief zone. The system saved four days of rig time versus other options considered. No mud was lost during drilling and cementing of the 9 5/8-in. casing through the thief zone—an unexpected benefit after the operator's previous experience proved the section to be extremely sensitive to mud weight. After two previous attempts to drill this interval conventionally resulted in severe losses and two plugbacks, Weatherford's DwL system helped the operator successfully complete its first liner drilling project in the Gulf of Mexico.



Two extended-reach liner-hanger systems set New Zealand records, maximize onshore gas production.

New Plymouth, New Zealand. Weatherford designed, tested and installed two liner systems in each of three onshore-to-offshore extended-reach wells, without incident, setting records for the longest well drilled in New Zealand, at 24,308 ft (7,409 m), and the longest liner ever used in that country: 10,764 ft (3,821 m). Development of the two liner systems allowed the operator to deliver its wells on time, using the optimal casing design while maximizing production and meeting all production commitments.



DwL™ drilling-with-liner system conquers unstable formation problems, saves more than US\$1 million in rig time.

Offshore Indonesia. A DwL system was designed, using a full suite of Weatherford's Nodeco® liner-hanger running tools and the Defyer™ DPC drillable casing bit, to drill a sidetrack and gain access to a valuable pay zone.

The liner was drilled down through 349 ft (106 m) of troublesome conditions, including sloughing shales, limestone and coal. Drilling continued to 10,317 ft (3,145 m) total depth (TD) while encountering losses of up to 650 bbl/hr. At TD, the Defyer DPC nose was expanded. The liner hanger was set, the cement pumped, and the liner wiper plug was bumped. The liner-top packer was then set and tested.

The DwL system saved at least three days of rig time for a total cost reduction of more than \$1 million. Unstable wellbore conditions were mitigated, and the operator reached pay after the Defyer DPC tool was simply drilled out.

Designing a liner system that **HANGS TOUGH**

Drilling and completion engineers can count on Weatherford's liner engineering expertise and total systems capabilities. We work with you to put together a Performance ProtectedSM liner system tailored to your specific objectives and well conditions.

Weatherford takes on liner-system challenges that others don't. You can take comfort in knowing that we understand how every aspect of the job fits together because we're the only people who manufacture and install total liner systems, including tubular running services.

Essential Selection Criteria

- Size, weight, grade and setting depth of host casing
- Size, weight, grade, connections and length of liner
- Setting depth of liner hanger
- Inclination of liner hanger
- Proposed trajectory of liner wellbore
- Size and weight of drillpipe
- Liner application—production or drilling
- Completion/stimulation operations after liner is installed
- Loads applied to liner hanger from the liner weight and from hydraulic operations
- Completion and/or wellbore fluids to which the liner may be exposed
- Pressure, temperatures and stresses to which liner equipment may be exposed

Liner-System Engineering and Design

Liner-system design involves many variables. The general guidelines in this brochure are meant only to enhance your understanding of the selection process. You will welcome the expertise of a Weatherford liner-systems specialist to help you work through such issues as host-casing size and weight, liner size and weight, buoyancy, and pressure/temperature and stress factors.





Job performance tracking, manufacturing quality, and training

Performance tracking approach provides best-practice data.

After every job a Weatherford service engineer enters complete job and application data into the Weatherford Performance Tracking System (WPTS): equipment run, hole conditions, depth, temperature, angle, wellbore fluids, shear pressure settings and actual shear pressures for all tools, and much more. Did the job go according to plan? Did the cementing plug bump?

The WPTS is an excellent diagnostic tool. In the event of a malfunction, we can search the records of other jobs using the same size equipment to determine whether similar malfunctions occurred and how they were addressed. The system provides valuable case histories for clients who want track records of specific equipment.



Custom manufacturing quality plans to meet your needs.

We can provide you with manufacturing plans for your specific quality requirements. To mitigate the risks of costly failures, many clients are having us build to standards above and beyond the norm. We will work with you to develop customized quality plans if required.

The Huntsville, Texas, USA, manufacturing plant is a 109,000-ft² (10,126-m²) facility focused on liner-system products and services. Additional plants are located in Caxias do Sul, Brazil (ISO 14001:2004 certified); Dubai, UAE; and Edmonton, Alberta, Canada. All locations are ISO 9001:2000 certified.



Weatherford's Huntsville, Texas facility.

Proactive training promotes performance excellence.

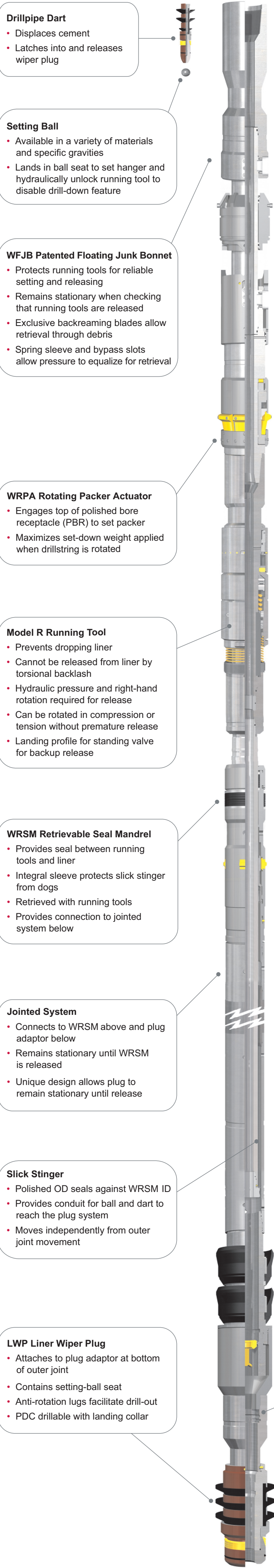
Classroom and on-the-job training, verbal and written testing, and job-performance evaluations build the competence of Weatherford's operations, engineering and manufacturing personnel.



Premium running tools.

Avoid dropped liners. Set and release liners when you want to.

Weatherford's Performance ProtectedSM liner running tools are a major factor in our track record of success. Our proprietary floating junk bonnet (FJB) and model R running tool are among many features that separate us from competitors and provide more trouble-free installations.



- Drillpipe Dart**
- Displaces cement
 - Latches into and releases wiper plug

- Setting Ball**
- Available in a variety of materials and specific gravities
 - Lands in ball seat to set hanger and hydraulically unlock running tool to disable drill-down feature

- WFJB Patented Floating Junk Bonnet**
- Protects running tools for reliable setting and releasing
 - Remains stationary when checking that running tools are released
 - Exclusive backreaming blades allow retrieval through debris
 - Spring sleeve and bypass slots allow pressure to equalize for retrieval

- WRPA Rotating Packer Actuator**
- Engages top of polished bore receptacle (PBR) to set packer
 - Maximizes set-down weight applied when drillstring is rotated

- Model R Running Tool**
- Prevents dropping liner
 - Cannot be released from liner by torsional backlash
 - Hydraulic pressure and right-hand rotation required for release
 - Can be rotated in compression or tension without premature release
 - Landing profile for standing valve for backup release

- WRSM Retrievable Seal Mandrel**
- Provides seal between running tools and liner
 - Integral sleeve protects slick stinger from dogs
 - Retrieved with running tools
 - Provides connection to jointed system below

- Jointed System**
- Connects to WRSM above and plug adaptor below
 - Remains stationary until WRSM is released
 - Unique design allows plug to remain stationary until release

- Slick Stinger**
- Polished OD seals against WRSM ID
 - Provides conduit for ball and dart to reach the plug system
 - Moves independently from outer joint movement

- LWP Liner Wiper Plug**
- Attaches to plug adaptor at bottom of outer joint
 - Contains setting-ball seat
 - Anti-rotation lugs facilitate drill-out
 - PDC drillable with landing collar

Premium liner tools.

Get to the bottom and hang tough.

Weatherford's Performance ProtectedSM liner-hanger systems are protected top to bottom against presetting and dropping, even in the harshest conditions.



- WTSP5 PBR**
- Honed ID ensures effective seal surface for tie-back seal stems
 - Proprietary lock wire prevents backoff during drill-down
 - Chamfered lead facilitates re-entry
 - Houses and protects running tools

- WTSP5 Liner-Top Packer**
- Exclusive lock dog prevents setting while running in hole
 - Cannot be set until running tool is released*
 - Unique design allows high circulating rates
 - Standard one-piece HNBR element with XYLAN[®] coated backup rings and body lock ring
 - Internal profiles for setting tool and WRSM packoff
 - High-torque one-piece body with premium connections
 - Beam spring maintains setting force in dynamic conditions

- WPHR Hydraulic-Set Rotating Liner Hanger**
- Unique lock dog prevents setting while running in hole
 - Excellent drill-down capabilities
 - Slips are nitrided to ensure setting in all casing grades and recessed for protection while running in hole
 - Bearing allows rotation during cementing
 - Large slip area allows high hanging capacity
 - Large bypass area allows high circulating rates
 - Setting cylinder rotationally locked to body
 - High-torque one-piece mandrel with premium connections

- Mechanical Ball Seat**
- Erosion-resistant steel construction enables high circulation rates and excellent sealing capabilities
 - Integral lower packoff provides a positive seal between the running string OD and liner ID
 - Durable rubber swab cups are oil, gas and abrasion resistant

- WLC Landing Collar System**
- Catches setting ball and seat
 - Latch-down mechanism for wiper plug
 - Anti-rotation design enhances plug drillout
 - PDC drillable

*All features not available in all sizes.



HANG TOUGH Liner Systems

Find out more about Weatherford's **Performance ProtectedSM** total liner systems.
See how we can help you install a liner system that will **HANG TOUGH**.

Contact your Weatherford representative, or visit
weatherford.com/hangtoughliners.



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