Downhole Sand Control Components

Introduction

Halliburton offers a complete line of retrievable and permanent sand control completion equipment. Sand control tools are available for applications from the shallow land well to the multizone, high-angled offshore well. These tools incorporate the latest technology for FracPac™ systems, high-rate water packs, cased and openhole gravel packs, extended reach, horizontal cased, multizone, and openhole completions.

Halliburton Versa-Trieve® packers, multi-position tools, and accessories are used in completions worldwide. This section is dedicated to components of standard Halliburton completion systems.

Each tool is designed at Halliburton’s major technology centers in Carrollton, Texas and Singapore with the completion system in mind. Extensive checks made during tool development ensure proper function and operation. Additional checks are made with mating tools to ensure compatibility. SolidWorks® computer modeling is used in the design to check function and operation on difficult geometry. Detailed drawings are produced from an engineer’s computer model, and revisions to drawings are controlled throughout all manufacturing locations worldwide through a system meeting ISO 9001 requirements. This, combined with continuous feedback from our service personnel, provides for a consistent level of quality in all Halliburton Sand Control tools.

*SolidWorks is a registered trademark of Dassault Systèmes SolidWorks Corp.
Sand Control Packers for Multi-Position Systems

Versa-Trieve® Packers—VTA, VBA, VCA, VCH, VDA, VBS, VGP, VGH, VSA

Versa-Trieve® packers are retrievable production packers designed for intermediate and high-pressure well applications. Numerous features in these compact packers incorporate the production features of permanent packers plus the added feature of retrievability. External components are easily millable if conventional release is not possible. Versa-Trieve packers can be either hydraulic- or wireline-set and are designed to be retrieved by a pulling tool with a straight pull of the tubing. When hydraulically set, Versa-Trieve packers are ideal for deviated or directional wells where it is difficult to run mechanical-set packers.

Applications
Versa-Trieve packers can be used in a variety of applications:
- Gravel pack
- High-rate water pack
- Ex-tension Pac™ service
- FracPac™ service
- Horizontal completion assemblies
- Production sealbore packer
- Suspending guns for tubing-conveyed perforating
- Stimulation

Features
- Packers can be run, set, and retrieved without any tubing rotation in most cases.
- The hydraulic setting mechanism is contained in the setting tool, reducing the number of potential leak paths left down hole.
- Scoop-head design saves time by providing a guide for landing seal units and accessories.
- Spring-loaded, case-carburized internal locking slips maintain maximum element compression.
- Multi-durometer element package is designed to seal against high and low pressures and against casing irregularities. (Standard nitrile or optional Aflas® element packages are available. Special packer and element designs exist to suit high-pressure applications.)
- Element mandrel design on the VTA packers provides a positive means of locking the upper components to the slips. (The element mandrel allows for the full setting force to be applied to the elements and slips during setting operations. If milling operations are required, the upper components will not spin.)

*Aflas is a registered trademark of Asahi Glass Co., Ltd.
• Lower anchor lug allows torque to be transmitted through the packer during running and pulling operations.
• Bi-directional case-carburized slips or a barrel slip hold the packer securely against well pressures in all casing grades (including V150) from above and below.
• Location of the slips beneath the elements simplifies releasing and retrieval. Debris is kept off the slips.
• A flow-isolated, C-ring release mechanism locks the packer in the set position until located and unlatched by the retrieving tool. Pushing through tight spots is safer than with traditional collet-release mechanisms.
• Packer is designed for simple release and retrieval.

Versa-Trieve® packers are available with the following top sub configurations:
• Versa-Latch® assembly
• upper sealbore assembly (VSA, VBS)

Threaded bottom subs are provided as a separate item for running gravel pack flow subs, sealbore extensions, or tubing tailpipe of varying types and sizes. The -Z designates the packer has no bottom sub.

**VCH and VGH Packers**

The VCH packer is a VCA packer specially designed for use with the HPT heavy hang weight soft release tool. The VGH packer is a VGP packer designed for the HPT tool.
VGP Packers

The Halliburton large bore Versa-Latch® gravel pack (VGP) style packer is an integral part of the Versa-Trieve® packer family of tools. It provides a larger bore than the VTA packers (in a given casing size and weight) by eliminating the element mandrel while still retaining many of the features of the Versa-Trieve packer line. Because the element mandrel is eliminated, the lower element retainer is pinned to the packer mandrel, and an additional set of anti-rotation pins has been included for ease of milling. The VGP packer also includes a top snap guide for collet locations.

Upper Sealbore VSA Versa-Trieve® Packer

For applications where a larger bore is required through the seal assembly, Halliburton can provide an upper sealbore packer head design that has a larger ID than the packer mandrel and can accept a short seal assembly and Versa-Latch® locator.

Weight-Down Versa-Trieve® and PGP Packers

All packers described previously can be provided as weight-down packer designs for weight-down squeeze and circulate gravel packing and FracPac™ systems. Weight-down packers use the slots in the top sub and setting sleeve. These slots align when the packer is in the set position. This provides a flow path for return fluids during a gravel packing operation or pressure monitoring during a FracPac™ system operation.
Thermal Versa-Trieve® Packer

The thermal Versa-Trieve® packer is designed with a high-temperature elastomer package and o-rings, providing a packer suitable for extremely high temperatures. The elements are made of materials suitable for service where operations such as steam injection and "huff ‘n’ puff" exist.

Sealbore and Millout Extensions

Halliburton packer sealbore extensions extend the polished surface below the packer. This enables the use of longer sealing units to compensate for tubing contraction or elongation. The extensions are available in standard 8-, 20-, and 24-ft (2.44-, 6.10-, and 7.32-m) increments.

Halliburton millout extensions provide a large ID below the packer sealbore or sealbore extension, which allows a single-trip packer milling/retrieving tool to be used when tubing is run below the packer assembly.

PGP Permanent Sealbore Packer

The PGP packer is a Perma-Series® permanent packer that has been modified so it can be run on the multi-position tool. The packer has an upper setting sleeve and a longer bottom sub with a thread that is compatible with standard flow subs and closing sleeves. The PGP packer has the benefit of withstanding higher pressures and temperatures than the retrievable Versa-Trieve family of packers but must be milled out when workover operations are required. Additional features and benefits of this packer are outlined under the Perma-Series sump packer.
<table>
<thead>
<tr>
<th>Casing Size</th>
<th>Casing Weight</th>
<th>Packer OD</th>
<th>Packer Bore</th>
<th>Production Seal Assembly ID</th>
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<td>kg/m</td>
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<td>in.</td>
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### Versa-Trieve® Packers

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Sand Control Sump Packers

Sump packers are typically used in combination with sand control systems. The sump packer is usually set with electric wireline and is normally considered a permanent installation. The packer is set below the perforations and is used for depth correlation of the production screen to the perforated interval.

The sump created below the sump packer provides a trap for debris that settles after perforating and for lost tools to fall through. Also, the sump allows logging tools to be lowered past the perforations so the entire interval can be surveyed for future operations.

Any one of the Halliburton sealbore packers can be used as a sump packer. The packer may need to be a special version to mate with the sump seal unit or indicating collet.

Wireline-Set Perma-Series® Sump Packers

Halliburton wireline-set Perma-Series® packers are effective, differential production packers for single or multizone completions. These permanent packers may be electric-wireline or hydraulic set on the workstring. They are also designed to leave the packer bore free of all setting devices and maintain a large fluid bypass area through the packer. Operating envelopes—graphical representations of the safe combination of differential pressure and applied tubing loads—are available for most Perma-Series packers.

Setting Adapter Kits

Halliburton adapter kits are designed to be attached to the packer and set with either a DPU® downhole power unit, conventional explosive-type wireline setting tool, or a hydraulic setting tool. When the setting tool is activated, the setting adapter kit sets the packer. When the prescribed setting force is applied to the packer, the setting pins in the wireline adapter kit separate to release the setting equipment from the packer so it can be retrieved.
Wireline-Set Perma-Series® Sump Packers

- Special Shear Arrangement
- Receiving Head
- Upper Internal Slips
- Case-Carburized Upper Slips
- Lower Internal Slips
- Triple-Seal Multi-durometer Elements
- Metal Backup Shoes
- Case-Carburized Lower Slips

Perma-Series® Wireline-Set Packer

HAL10407

HAL10408

HAL11714

Sump Packer

Short Versa-Latch® Receiving Head

Versa-Latch® Receiving Head

Plain Bottom Sub

Sealbore Extension Thread

Tubing or Millout Extension Thread
### Wireline-Set Perma-Series® Production Packers

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*Thread type and size control seal unit ID
**Upper Ratch-Latch™ head style only
Intelligent Setting Tools

DPU® Downhole Power Unit – Intelligent Series Tool

The Halliburton DPU® Downhole Power Unit Intelligent (DPU-I) series tool provides unsurpassed reliability and quality assurance in setting wellbore devices such as plugs and packers. The rig-safe, non-explosive electro-mechanical DPU-I tool expands well intervention capabilities beyond the conventional tools. By generating a slow, precisely controlled linear force with real-time feedback, this tool optimizes setting and helps ensure maximum performance of a well completion even in the most hostile well environments.

The subsurface device (plug, packer, etc.) is attached to the DPU-I tool, which can be deployed on e-line, slickline*, or coiled tubing*. The stroke length, setting force, and rate at which the force is applied during the setting operation are displayed in real time for quality assurance purposes. The slow, controlled setting motion maximizes sealing and anchoring of the wellbore device especially in hostile and high-angle wells. When the designated setting force is achieved, the DPU-I tool separates from the subsurface device and can be retrieved from the well.

The DPU-I tool motion control and high linear force provides an alternative to jointed pipe or coiled tubing well interventions. At the well site, it can be easily adapted to set or retrieve devices based on intervention requirements.

Applications

- New completions or workover operations requiring setting or retrieval of wellbore devices such as packers, sand control sump packers, bridge plugs, whipstocks, retrievable bridge plugs, subsea tree plugs, straddles, patches, and cement retainers
- Plug and abandonment or pipe recovery operations on e-line or slickline
- Mechanically punching holes in tubing for circulating kill fluid or installing remedial through-tubing gas lift capabilities
- Mechanical intervention with subsurface flow control or completion devices such as circulating sleeve or internal control valves
- Adaptable to wireline tractor conveyance for deepwater and/or high-angle well interventions
Features
- Offers more setting force (up to 100,000 lb/ft) than conventional explosive setting tools without the added danger of using explosives
- Multiple tubing/casing intervention options from 2 3/8 to 13 3/8 in.
- Industry-leading design offers dependable operation in any well environment up to 30,000 psi and 400°F
- Robust hardware and electronics capable of withstanding high-impact loads encountered during well intervention operations
- Slow, controlled application of force enables sealing elements and anchoring devices to conform to the wellbore

Benefits
- Can improve safety and reliability through non-explosive operation
- Helps reduce completion costs by saving time
  - Single flight heli-lift compliant for rapid deployment
  - Radio silence operations not required
  - Disruption of the cathodic protection system during operations not required
  - Military or governmental escort not required
  - Offshore explosive storage magazine not required
  - Redressing between operations not required
- Assurance on quality of setting wellbore devices provided by real-time feedback of setting force, stroke length, and displacement rate
- Intervention versatility enabled by dual setting and retrieving capability
- Conveyance flexibility with solutions on e-line, slickline, and coiled tubing
- Setting force and hydrostatic pressure rating meet ultra-deepwater well completion requirements
### DPU® Downhole Power Unit – Intelligent Series Tool

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<th>OD</th>
<th>Pressure Rating</th>
<th>Temperature Rating*</th>
<th>Set/Retrieve Force</th>
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*400°F (204°C) available with flask.
**eRED® Electronic Remote Equalizing Device**

The eRED® valve is a retrievable, computer-controlled ball valve that can be repeatedly opened and closed by remote command. There are no connections to surface and no interventions are required to operate or communicate with the valve. It is deployed below either a lock or bridge plug and can be used as a downhole barrier or flow control device. With each use of the eRed valve, an intervention is eliminated from the operation—dramatically reducing rig-time and associated risks.

The valve has integrated pressure and temperature sensors to monitor well conditions and is pre-programmed to either open or close whenever a specified condition (known as a trigger) is detected. The triggers use a variety of well parameters including ambient pressure, temperature, time, or surface-applied pressure. Each time a trigger is detected, the eRED valve will react by either opening or closing as per its instructions. This process can be repeated time-and-time again without any form of intervention.

**Applications**

Any application where a wireline plug is used can be replaced by an eRED valve, achieving the same results but without repeated interventions, saving on rig-time and associated costs and risks. Often, more than one eRED valve is deployed in a single operation, multiplying the benefits. The valve can also be incorporated into the multi-position gravel pack service tool for use in high angled to horizontal wellbores for packer setting, thereby eliminating the need for dropping a packer setting ball.

- Packer setting device
- Deep-set barrier in extended reach or horizontal wells
- Shallow-set for tree testing and change out
- Completion deployment as the annulus short string plug
- Liner deployment with external swellable elastomer
- Barrier in temporary abandonments or light well intervention operations
- Barrier in TCP gun firing and stimulation operations
- Self-actuating flow control device
- Shut-in tool for pressure buildup tests with reduced interventions

**Features and Benefits**

- Remotely operated time-after-time – Removes multiple wireline runs from operations, saving time, money, and helping reduce risk
- Long battery life – Operational for at least 10 months for use in temporary abandonment operations or as a flow control device

- Run open or closed – Providing flexible deployment options and well control
- Extensive run history – Extremely reliable, field-proven technology used by the world’s major oil producers
- No dedicated personnel required – Reduces the number of operations personnel, saving costs and helping reduce risk

**Control By Remote Command**

By applying a defined pressure for a defined time at surface, the operator can activate the Pressure Window Trigger. This allows direct communication to the eRED valve so it can be remotely operated. For example, applying 1,000 to 1,500 psi for 10 minutes could instruct the eRED valve to open. The eRED valve will ignore any pressure applied outside the defined values. This means pressure can be applied to tubing (for tubing integrity tests, packer setting, etc.) without risk of inadvertent activation.

Onboard data analysis allows the eRED valve to distinguish its own commands from other external factors such as naturally fluctuating hydrostatic or reservoir pressure. This enables the valve to behave as planned even if the downhole conditions change unexpectedly.

**Independent Operation**

A range of other triggers consisting of ambient well pressure, ambient well temperature, and a timer are also available. These triggers are used to provide a pre-programmed sequence for the eRED valve to follow without any input from the surface.

All the different trigger types can be used independently or in conjunction with each other to build more elaborate instructions. For example, the eRED valve could be set to close when it detects bottomhole flowing pressure lower than 1,000 psi but only after 100 days downhole. In addition, the Pressure Window Trigger can be used to manually cancel or override any trigger or permanently lock the eRED valve in its current position.
Hydraulic Isolation Packers

The Halliburton hydraulic-set isolation packer has no slips to anchor it in the casing. It is typically used to isolate discrete zones of a producing interval and is run as part of a continuous completion assembly that contains a packer with slips to anchor the string.

In multizone wells, such as a STMZ™ single-trip multizone assembly, the isolation packer isolates the production to prevent producing from more than one zone at the same time. The packer is set at a point below the piston of the packer applying hydraulic pressure. Pressure forces the piston up, shearing the driv-lok pins in the internal slip housing and expanding the elements outward to the casing ID. To retrieve, a straight upward pull on the tubing string is required. This packer has no casing slips, and it is necessary that another means of anchoring the tubing be provided.

Features
The packers isolate production to prevent multiple zones from producing simultaneously.

Slipless Hydraulic-Set Packer
The slipless hydraulic-set packer provides economical zonal isolation for multizone systems.

Features
- Set with applied pressure
- Multi-durometer element package with metal backup system

Benefits
- Low-cost isolation packer
- Highly reliable setting
- May include sealbore
ZoneGuard® SR (Short Radius) Packer

The ZoneGuard® SR packer is designed for situations where tight radius well conditions are anticipated. It uses a multi-durometer element package with a unique backup and deployment system to deliver unsurpassed sealing performance in a wide range of openhole conditions. The design includes an anti-preset feature to help protect against premature packer setting during running operations.

The packer can be used for zonal isolation in formation control, selective stimulation, and fracturing applications. It is run as part of the completion string and can be set either hydraulically with plug set below or with an isolation straddle tool when plugging is not possible.

Applications
- Openhole applications (horizontal or vertical)
- Water shutoff
- Gas shutoff
- Stimulation
- Production testing
- Isolation
- Selective production
- Stage cementing

Features
- Small running OD
- Compact length for short radius well conditions
- Anti-preset feature
- Multi-piece/multi-durometer element package
- Adjustable setting shear value
- Internal locking system
- Long-term isolation reliability
- Hydraulically set plugged tubing and isolation straddle

Benefits
- Selective production management in horizontal wellbores
- Reliably control inflow or injection within selected wellbore sections
- Ideally suited for near-gauge conditions requiring higher differentials

<table>
<thead>
<tr>
<th>ZoneGuard® SR (Short Radius) Packer</th>
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<tr>
<td><strong>Maximum Metal OD</strong></td>
</tr>
<tr>
<td>in.</td>
</tr>
<tr>
<td>5.65</td>
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ZoneGuard® HE Packer

The ZoneGuard® HE packer is designed for situations where a high-expansion sealing element is required and large variations in hole gauge diameter are anticipated. It uses a multi-durometer element package with a unique backup and deployment system to deliver unsurpassed sealing performance in a wide range of openhole conditions. The packer can be used for zonal isolation in formation control, selective stimulation, and fracturing applications.

The ZoneGuard HE packer is run as part of the completion string and can be set either hydraulically with plug set below or with an isolation straddle tool when plugging is not possible. The packer contains a hydrostatic assist feature, which helps maintain positive pressure on the packer at all times.

Applications
- Openhole applications (horizontal or vertical)
- Water shutoff
- Gas shutoff
- Stimulation
- Production testing
- Isolation
- Selective production
- Stage cementing

Features
- Small running OD
- Large element expansion capabilities
- Multi-piece/multi-durometer element package
- Adjustable setting shear value
- Internal locking system
- Long-term isolation reliability
- Hydraulically set plugged tubing and isolation straddle
- Hydrostatic assist allows positive pressure on element

Benefits
- Selective production management in horizontal wellbores
- Reliably control inflow or injection within selected sections of the wellbore
- Wide range of openhole isolation capabilities with one packer design

ZoneGuard® HE Packer

<table>
<thead>
<tr>
<th>Maximum Metal OD</th>
<th>Minimum ID</th>
<th>Minimum Bore Hole</th>
<th>Maximum Bore Hole</th>
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<td>in.</td>
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<td>8.000</td>
<td>4.88</td>
<td>8 1/2</td>
<td>11 1/2</td>
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</table>
ESTMZ™ Enhanced Single-Trip Multizone Completion System – Isolation Packer Options

The ESTMZ™ system design makes a conventional packer test on an individual isolation packer difficult to achieve. As a result, three isolation packer options are available. Two options are adaptations of existing hydraulic-set production packers and were selected on their field-proven reliability history. The dual element packer provides the added feature of testing between the element packages after packer setting. All three packer designs address the forces induced by thermal cooling and ballooning during frac treatment. Each packer design provides zone-to-zone isolation and anchors the screen between zones.

Dual Element – Testable Isolation Packer

A testable high-pressure retrievable hydraulic-set isolation packer was developed for use with the ESTMZ system. The 9 5/8-in. packer design includes two separate element packages that enable the packer to be tested between the element packages after the packer is set. All isolation packers are simultaneously set and tested. The packer is retrieved by applying a straight pull to the ESTMZ assembly.

Single Element – Isolation Packer

The HPH packer is a single element high-pressure hydraulic-set retrievable packer adaptable for use with the ESTMZ system as an isolation packer. The packer is based on the reliable hydraulic-set production packer. The packer is retrieved by applying a straight pull to the ESTMZ assembly.

Single Element – TNT Packer

The TNT packer is a high-pressure retrievable sealbore production packer adaptable for use as an isolation packer in the ESTMZ system to provide zone-to-zone isolation. The TNT packer is a cut-to-release design.
Tieback Receptacle

This liner/screen running tool is used in openhole completions to run screens or liners. The tool allows the screen or a perforated liner such as a CAPS™ liner to be run in using a multi-position tool-type hydraulic setting tool without being attached to a packer. The screen is made up to the lower end of the screen running tool. The hydraulic running tool connects to the running tool as it would a packer and is run in with the tubing string.

Features and Benefits

- Lower cost than Versa-Trieve® packer
- Same hang weight capabilities when run on the multi-position tool
- Sealbore to connect to upper completion assembly
- Top sub to latch and retrieve the assembly
- Simple design and operation
- Can be used to run CAPS™ liners prior to running the packer and screen assembly
Flow Sub and Closing Sleeve Extensions

Both the MCS and MFS assemblies require upper and lower extensions. Upper extensions provide spacing between the slurry exit ports and the bottom of the packer for the various gravel packing positions. The lower extension covers and protects the multi-position tool seals, which extend below the crossover ports, from damage during transportation to the rig site. It is generally larger than the blank pipe. These extensions are specified by the Halliburton technical representative to meet the conditions present in specific well completions. Different lengths, strengths, metallurgy, and erosional resistance levels are required to meet tool positioning, FracPac™ system collapse pressure resistance, material corrosion, and flow erosion requirements of the completion design.

MFS Ported Flow Subs

MFS multi-position flow subs are made up to an extension below the Versa-Trieve® packer. The multi-position tool packs off in both the packer mandrel and the polished bore section of the flow sub, which is below the slurry exit ports, to allow the gravel to be directed through the ports and around the outside of the screen. Carefully placed slurry exit holes optimize the distance between the slurry flow ports and lower honed bore for minimal dead space during packing and limit casing erosion during high velocity FracPac system slurry flow. Upon completion of the gravel pack, the ports should be isolated by installing a production seal assembly with an extension such that the seal assembly seals in the lower polished bore below the slurry exit ports. This prevents production of pack sand and formation sand back through the ports.

MCS Closing Sleeves

MCS multi-position closing sleeve assemblies provide casing annulus-to-tubing isolation for FracPac system, gravel pack, and horizontal completions. These sleeves are used in the following applications:

- Stacked gravel packs or frac packs
- Stack packs with upper sealbores
- Assemblies with short sections of blank
- Completions with fluid loss concerns or mechanical fluid loss devices
- Wells prone to kicks during tubing trips
- When seals will not be installed in the packer

The flow ports, like the MFS assembly, have been specially configured and tested to limit casing erosion during high-rate FracPac system operations. The unique closing sleeve collet arrangement holds the sleeve open during packing operations when the service seal unit is installed and holds the sleeve closed when the service seal unit is removed. These positioning collets do not drag on the polished bore. This minimizes closure forces and damage that can occur to the sealing surface while shifting the sleeve if collet fingers drag across the sealing surface. The sleeve has an enlarged ID to allow for easy passage of seals without contacting the sleeve. The sleeve is shifted by a self-releasing, positive-positioning tool installed on the washpipe below the service seal unit. Its field-proven, positive-shift mechanism provides assurance the sleeve is shifted after packing. The shifting tool releases on the slotted ring of the MCS sleeve that also maximizes flow bypass around the multi-position tool during packing. If necessary, the closing sleeve may be reopened and reclosed by simply lowering or raising the shifting tool through the sleeve.
High-Rate MCS Sleeves

Critical Service MCS Sleeve with Quadra™ Seals

Halliburton’s critical service MCS closing sleeve incorporates Quadra™ seal technology, which was developed for use in sand control applications. Quadra seals provide increased erosion resistance, lower stabbing forces, and greater resistance to seal damage during sleeve closure and opening. The new sleeve uses bonded elastomer seals that are molded onto the sleeve. In comparison, the conventional design uses multiple o-rings.

Halliburton’s MCS closing sleeves provide for circulation and isolation in gravel pack, FracPac™ system, Red Zone®, and Beyond Red Zone® operations. The design provides large flow ports for circulation during fluid displacement and washing. A collet arrangement holds the sleeve open during washing operations and holds the sleeve closed when the washpipe is removed. The sleeve is shifted by a self-releasing, positive positioning tool installed on the washpipe. If necessary, the closing sleeve may be reopened and closed by simply lowering or raising the shifting tool through the sleeve.

Features and Benefits

• Utilizes Quadra seal technology
• Uses bonded elastomer seals molded onto the sleeve
• Provides circulation and isolation in gravel pack and FracPac system operations
• Provides large diameter flow ports for circulation during fluid displacement and washing
• Collet arrangement holds sleeve open during washing operations and closes sleeve when washpipe is removed
• Increased erosion resistance
• Sleeve can be reopened and closed by simply lowering or raising the shifting tool

High Shifting Force MCS Sleeve

For applications where the closing sleeve may be exposed to tools running through the ID of the assembly, a high shifting load MCS sleeve has been developed.

Both designs provide unique features that improve the reliability of the MCS closing sleeve in critical applications. High shifting force sleeves with Quadra seals are recommended for applications where a seal assembly will not be run.

Beyond Red Zone® Sleeves

When the crossover mandrel is fitted with Halliburton’s highest rated Beyond Red Zone carbide sleeve design, this special Beyond Red Zone design optimizes the exit flow profile and protects the inside of the casing from erosive wear that occurs at high rates of flow. The Beyond Red Zone sleeves are tested and proven to provide industry-leading performance ratings.
Fluid Loss Control Devices

Halliburton leads the industry in fluid loss control solutions. From the proven ceramic flapper valves and ShurShot® ball dropper to the AIS systems and high-end valves like the FS2 valve, Halliburton delivers the correct solution.

### Mechanical Fluid Loss Device Features

<table>
<thead>
<tr>
<th>Fluid Loss</th>
<th>Positive Isolation</th>
<th>Hydraulic Opening Pressure Up</th>
<th>Hydraulic Opening Bleed Down</th>
<th>Multiple Device Openings</th>
<th>Multiple Mechanical Actuation</th>
<th>Wall Suspension</th>
<th>Single Selective</th>
<th>Upper Zone/Dual Production</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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### Mechanical Fluid Loss Device Casing Size Availability

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<td>AIS with Hydraulically Activated Sliding Side-Door® Device</td>
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</table>
Frangible Flappers

Halliburton EGF expendable ceramic flappers and CB frangible metal flappers are designed to control fluid loss after gravel packing. They may also be run as an integral part of the packer assembly on horizontal completions for fluid loss control. The flapper design provides flapper protection during all service operations. Two versions of the preclosure flapper protection feature currently exist. One version is an internal flapper prop sleeve that is shifted and released by a shifting tool. The other is a removable sleeve that is pinned in place. It props and protects the flapper in the open position for running and service operations, then is removed by a no-go sub attached to the washpipe as the service tools are pulled from the well.

Both designs prevent washpipe, dragged through the flapper assembly, from coming in contact with the flapper. The wellbore is reopened by breaking the flapper. This can be done by slickline in vertical wells, by reeled tubing in horizontal wells, or by an extension of the production tube on the bottom of the production seal assembly.

Materials were chosen to provide an extremely dense material which would fall to the bottom after being broken even in heavy completion brines, yet would break into fragments. Impact-type loads shatter the ceramic material. A metal flapper design is available for pressure expend operations. The frangible metallic flapper is calibrated for fracture pressures within a known fracture pressure.

Features
- Integral part of packer assembly for horizontal completions
- Fully retractable

Benefits
- Control fluid loss after gravel packing
- Prop sleeves protect against premature breakage
- Prevents washpipe from contact with the flapper

Frangible Ceramic Flapper
(Internal Prop Sleeve Version)

<table>
<thead>
<tr>
<th>Casing Size</th>
<th>Flapper Expanded ID Ceramic</th>
<th>Flapper Expanded ID Metal</th>
<th>Housing OD* Ceramic</th>
<th>Housing OD* Metal</th>
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</table>

*These dimensions are for reference only. Refer to the design specifications of the specific item to obtain the actual OD.
ShurShot® Ball Dropper and Catcher Assemblies

The Halliburton ShurShot® ball dropper fluid loss control device uses the proven technology of a collet catcher sub to provide post-gravel pack fluid loss control. A ball is attached to and later dropped from a running tool onto the collet catcher assembly, located in the blank pipe above the screen, thus sealing off the packed interval. The running tool is located on the end of the washpipe string. As it is pulled through the collet catcher assembly, a shoulder on the running tool engages a sleeve in the collet catcher assembly that pulls the collet fingers into a closed position. Additional tension shears the pin holding the ball in place and allows it to fall and seal off on the closed collet fingers. Once the production tubing is in place, pressuring up on the tubing causes the ball to be expended into the rathole. Sizes compatible with the most common screen basepipe sizes are available.

Features

• Rugged – Unlike frangible flappers, the ShurShot fluid loss control device is not susceptible to damage during shipping or handling.
• Debris resistant – Well debris stacked on top of the ShurShot fluid loss control device cannot prevent pressure from reaching and expending the ball.
• Clean – ShurShot fluid loss control device ball is discharged to the rathole once the fluid loss control device is deactivated.

Benefits

• Reliable installation and activation
• Easily deactivated without intervention
• No debris to plug up the subsea choke

Three types of ShurShot assemblies exist:

• STD – Single upper sleeve ShurShot assembly
• USR – Provides fluid loss control as the ball is dropped; used for high loss rate and low bottomhole pressure wells
• Stackable – Uses a collet to actuate the assembly; for stacked completion applications
### ShurShot® FCD Assemblies

<table>
<thead>
<tr>
<th>Casing Size</th>
<th>Ball Size</th>
<th>FCD Type</th>
<th>Housing ID (Expanded)</th>
<th>Housing ID (Run)</th>
<th>Housing OD</th>
<th>Screen Size</th>
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<tbody>
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<td>in.</td>
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<td>mm</td>
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<td>4.625 Shifter</td>
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<td>4.665</td>
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</table>
FS2 Fluid Loss Isolation Barrier Valve

For efficient asset management, Halliburton’s FS2 fluid loss isolation barrier valve provides a reliable, interventionless solution for fluid loss control during well completion, eliminating potential formation damage.

The FS2 valve isolates the formation below the uppermost gravel pack packer before the upper completion has been installed and can be utilized in frac pack, gravel pack, and standalone screen applications. The valve provides a reliable means of:

- Preventing fluid loss to formations after completing gravel pack operations
- Isolating formations during up-hole operations throughout life of the well
- Helping to reduce costs on subsea or deep wells through the use of interventionless technology
- Use as a barrier in a well suspension system

The closure device is a proven, high-performance ball mechanism that provides a positive bi-directional seal in brine and oil-based mud environments. The debris-tolerant, non-translating ball design eliminates unnecessary movement within the mechanism during opening and closing operations, allowing operation in debris-laden environments.

Optimum FS2 valve placement is normally below the gravel pack or liner hanger assembly. Washpipe, located on the bottom of the service tool, is extended through the valve. A collet shifting tool is attached to the end of the washpipe, which on retrieval closes the valve, immediately isolating the formation and allowing inflow or positive pressure-testing above the ball. Remote actuation in the form of hydraulic pressure cycles is then used to open the valve after upper completion installation.
Features and Benefits
- Initial valve closure achieved when washstring/collet is retrieved through the valve.
- Bi-directional sealing mechanism provides a fully tested downhole barrier.
- Unlike nitrogen pre-charged systems, the fluid spring indexing mechanism eliminates well-specific setup and enhances long-term suspension capability.
- One-time remote activation achieved by the application of pressure cycles, eliminating the need for well intervention.
- Activation piston provides increased opening force (up to 200% increase over previous FS valve designs).
- Improved fluid management helps ensure valve operation in debris.
- Increased differential opening capability.
- Design provides unlimited mechanical opening/closing of valve. Indexing system is unaffected by changes in hydrostatic pressure, making it suitable for use in wells with fluid loss.
- Valve opens on pressure bleed down, minimizing the risk of surging the formation.
- Full bore ID maximizes production and allows access to the formation.
- Design incorporates enhanced debris exclusion features.
- Mechanical shifting profile incorporated within design.
- Sealed actuation mechanism helps prevent control system contamination.
- Cycling mechanism isolated from debris in the wellbore.

Qualification Testing
Each FS2 valve is subjected to extensive qualification testing during prototyping. In addition to rigorous discrete component level testing, a full valve test program designed to help ensure reliable performance in well conditions is carried out. Testing includes:
- Remote opening at maximum rated temperature
- Differential opening capability test
- Collapse testing at maximum rated temperature
- Multiple remote open tests in debris

Qualified in accordance with the requirements of ISO 28781.

Options
- Available to suit 7-in., 7 5/8-in., 9 5/8-in./9 7/8-in., and 10 3/4-in. casing
- Ball differential rating up to 10,000 psi (689.5 bar)
- Collapse rating up to 15,000 psi (1034.2 bar)
- Burst rating up to 12,000 psi (827.4 bar)
- Temperature rating to 350°F (176.7°C)
- Increased differential opening capability
IB Series Mechanical Fluid Loss Isolation Barrier Valve

The IB series mechanically activated fluid loss isolation barrier valve provides a reliable, mechanical solution for fluid loss control during well completion, eliminating potential formation damage. Initially designed for electric submersible pump (ESP) applications, the IB valve provides a means of isolating the formation below the uppermost gravel packer before the upper completion has been installed and can be utilized in frac pack, gravel pack, and stand-alone screen applications.

For sand control applications, the IB valve is run into the well (ball open) below the uppermost gravel pack packer as an integral part of the gravel pack assembly. The washpipe, located on the bottom of the gravel pack service tool, is extended through the valve. A collet shifting tool is attached to the end of the washpipe. On washpipe retrieval, the collet shifting tool closes the ball isolating the formation and allowing inflow or positive pressure testing. The lower sandface completion and reservoir is isolated by the closed ball in the IB valve, which permits safe installation of the upper production completion.

The valve is opened mechanically using a collet shifting tool attached to the end of the upper completion. The closure device is a proven, high-performance ball mechanism that provides a positive bi-directional seal in brine and oil-based mud environments. The debris-tolerant, non-translating ball design eliminates unnecessary movement within the mechanism during opening and closing operations.

The IB4 valve can be considered the base design. The collet shifting tool opens the ball mechanism while passing through the valve. This eases space out concerns and provides maximum flexibility.

The IB5 fluid loss device provides the collet shifting profile of the IB4 valve but also includes a secondary larger ID shifting profile. Utilizing the secondary profile allows the valve to be opened and closed while maintaining the ID through the valve. The IB5 valve is ideally suited for use in stacked frac pack completions where a reduced ID may be a concern.

Features and Benefits
- Initial valve closure achieved when washpipe/collet is retrieved through the valve
- Bi-directional sealing mechanism provides a fully tested downhole barrier
- Improved fluid management helps ensure valve operation in debris
- Design provides unlimited mechanical valve opening/closing
- Full bore ID maximizes production and allows access to the formation

Qualification Testing
Qualified in accordance with the requirements of ISO 28781.

Options
- Ball differential rating up to 10,000 psi (689.5 bar)
- Collapse rating up to 15,000 psi (1034.2 bar)
- Burst rating up to 12,000 psi (827.4 bar)
- Temperature rating to 350°F (176.7°C)
Hydraulically Activated Sliding Side-Door® Circulating Device

The hydraulically activated Sliding Side-Door® circulating device provides a means to open a zone to production without intervention when running a releasable or fixed AIS system in underbalanced applications.

Features and Benefits

- Opens via a single pressure cycle; opening occurs after the bleed-off cycle
- Capable of opening numerous valves simultaneously
- Adjustable activation pressure prevents premature actuation when stimulating an upper zone
- Flow area through the ports is equal to or greater than the flow area through the bore of the sleeve for full bore flow circulation
Twin-Flow Absolute Isolation System

The Twin-Flow Absolute Isolation System (AIS) system is a sand control fluid loss isolation system designed for use in multizone applications and especially suited to SmartWell® system completions. The Twin-Flow AIS uses a concentric string to isolate the screen interval after the packing operations are completed. Above the concentric string is a mechanical hydraulic sub-assembly that seals off the annular flow and is opened hydraulically after the completion tubing has been installed. This system has proved effective in stacked zone completions.

Where fluid loss and downhole flow between zones presents a problem for fluid loss flappers or chemical fluid loss methods, the Twin-Flow AIS and the original AIS system are proven and reliable solutions.

AIS Features and Benefits
- Provides zone isolation and zone access
- Can be used with SmartWell system completions
- Saves intervention to open a zone to flow
- Isolates a zone until flow is desired
- Provides a secondary mechanical means to open and close the valve
- Incorporates gravel pack washpipe as the isolation string
- Saves time
- Effective in stacked zone completions
- Offers proven and reliable solutions in fluid loss isolation

Currently, there are three types of Twin-Flow AIS:
- Twin-Flow AIS-SH (Shearable)
- Twin-Flow AIS-SC (Single Cycle)
- Twin-Flow AIS-LS (Liquid Spring)

Twin-Flow AIS-SH (Shearable)
The Twin-Flow AIS-SH is a pressure shearable version of the Twin-Flow valve. This version opens when annulus pressure is applied to shear the screws. A shifting profile is incorporated in the ID as a backup opening feature.

Twin-Flow AIS-SC (Single Cycle)
This tool design opens when applied annulus pressure is bled off after reaching activation pressure. It is designed to minimize pressure-related formation shock.

Twin-Flow AIS-LS (Liquid Spring)
The Twin-Flow AIS-LS fluid control device is designed for use in multizone applications and especially suited to SmartWell completions or multizone completions. It protects a zone from fluid loss and allows separate production between the upper and lower zones. The tool is run in the closed position and kept in the closed position until the upper zone is completed and ready for production. The tool works in conjunction with a liquid spring module that responds to tubing pressure and only opens after 10 to 12 pressure cycles—with no time limit for actuation. This provides the option of testing the tubing before the AIS-LS activates and opens.

External differential pressure across the tool has no effect on the indexing mechanism. The system can also be opened manually with tubing pressure applied to a plug or test tool set in the Twin-Flow profile. Some can be closed with a B shifter.

AIS-LS Features and Benefits
- Suited for SmartWell system completions
- Works in conjunction with liquid spring module
- Option of tubing testing before AIS-LS activates and opens
- Protects the zone from fluid loss
- Allows separate production between upper and lower zones
- Can be opened manually

Fixed and Conventional AIS Components
Fixed AIS systems include an internal concentric string attached at the top of the blank with a three-way crossover and a lower set of seals generally stabbed into the sealbore in the lower seal assembly. The washpipe does not move during packing operations and is not retrievable.

A slimline DuraSleeve® Sliding Side-Door® circulation and production device is run in the internal string to take fluid returns during gravel packing operations as well as act as a production sleeve later. An additional DuraSleeve Sliding Side-Door device can be run at the top of the washpipe to provide additional production capability and minimize pressure drop.

Three-Way Adapter/Crossover
Fixed AIS assemblies use a three-way crossover to connect the inner string, blank pipe, and lower extension.
Twin-Flow AIS-SH
Shearable

Twin-Flow AIS-SC
Single Cycle

Twin-Flow AIS-LS
Liquid Spring Version
Accessory Tools

Indicator Collars and Adapters
Optional indicator collars are assembled to the blank pipe as part of the gravel pack completion assembly. Indicator collars provide a sized restriction in the blank pipe for the MPC indicator collet to engage. The relative position of the multi-position tool service seal unit crossover port, when the collet engages the collar, can be seen on the weight indicator on the rig floor. These collars can be configured to indicate in either tension or compression.

MSJ Shear Joints
MSJ multi-position shear joints are used between the packer assembly and screen/blank assembly. The MSJ shear joint allows retrieval of the packer assembly before washing over and retrieving the screen/blank assembly. Shear value can be adjusted in 10,000-lb (4535-kg) increments with a minimum recommended shear value of 40,000 lb (18 143 kg) for tools used in 7-in. (177.80-mm) and larger casing. The MSJ shear joint, with a stroke of 12 in. (304.80 mm) after shearing, is recommended to allow for settling and compaction forces during and after gravel packing. Shorter shear joint designs exist for use where length is critical. Shear values should be adjusted to suit anticipated heavy completion weights and high drag forces during running.

Compaction Joints
A compaction joint allows for compaction of the gravel pack and shear of the shear joint without allowing fluid flow to bypass the screen. The 12-in. stroke shear joint is the recommended length. If compaction occurs, the screen may move downward, creating large tensile forces between the anchored packer and the gravel packed screen.

O-Ring Subs and Stingers
Halliburton o-ring subs and polished stingers are typically used to provide a temporary seal between the end of a washpipe and the sump packer seals below the screen or between two screen sections to provide upper and lower circulating positions. They can be used anywhere a stabbing type seal is required but are not intended for long-term service because of the possibility of the o-rings washing out with flow as it is assembled.

O-ring subs are tubular components that have tubing or casing threads and generally have box x pin threads (without couplings) typically of the same size and same type threads. Internal to the o-ring sub is a controlled ID with one or more o-ring grooves. O-rings are generally installed in these grooves at the time of completion assembly. The polished stinger is typically threaded on the upper end and has an extended length surface along the OD of the part that mates with an o-ring sub of the mating size.

MUS Makeup Sub
The Halliburton makeup sub provides a quick, non-rotational means to make long screen assemblies. It is used to connect two separate pieces of equipment without having to torque through the assemblies. The makeup sub is separated and installed on the desired equipment. When the equipment is assembled, the cap is made up into the coupling and locked into place using set screws. The inner mandrel and bottom sub have locking lugs that enable the makeup sub to be torqued through after it is assembled.

The makeup sub speeds rig assembly and minimizes the risk of washpipe unscrewing during concentric strings make up.
Downhole Sand Control Components

- Indicator Collar with Collet
- MSJ Shear Joint
- Compaction/Shear Joint Assembly
- O-ring Sub with Polished Hanger
- Makeup Sub
Long Space-Out Travel Joint

Spacing out production tubing and landing the tubing hanger on subsea completions is very challenging. Variables such as well depth, water depth, deviation, and rig heave add to the complexity of the space-out operation. The extremely high rig rates in deepwater environments make it imperative the first attempt to land the production tubing string be successful. The most efficient means of spacing out in these adverse conditions is essential to job success.

To address these subsea space-out issues, Halliburton has developed the Long Space-Out Travel Joint (LSOTJ). The travel joint is designed to telescope downward in response to a timed application of a compressive load created when the production seal assembly is landed into the sealbore packer. The LSOTJ collapses as the production tubing is lowered, allowing the subsea tubing hanger to land in the wellhead.

There are two versions of the LSOTJ design—Continuous Sealing (CS-LSOTJ) and Non-Continuous Sealing (NCS-LSOTJ). The CS-LSOTJ version is designed for dual-zone selective completions and intelligent well applications. The CS-LSOTJ maintains flow and pressure separation of the zones once the tubing is landed. The NCS-LSOTJ version used for single-zone and multi-zone commingled completions has initial pressure integrity for pressure testing but provides communication to the casing once the travel joint strokes.

Features and Benefits

- Simplifies space-out calculations required to install production tubing in subsea completions
- Reduces concern over shearable type travel joints, while pushing through blowout preventers (BOP) or liner tops
- Continuous and non-continuous sealing designs
- Collapses after a timed compressive load
- Positioned between production packer and the uppermost gravel-pack packer
- Economical and simple travel length adjustment
- Limitless travel length capability
- Can be locked and unlocked multiple times
- Hydraulic “soft” release without rotation or shearing pins
- Pressure integrity in run position allows downhole testing of equipment
- High load carrying capability
- Includes a safety contingency release
- Compact modular design
DepthStar® TRSV
SmartWell® Completion
CS-LSOTJ
Upper Seal Bore
CS-LSOTJ
Upper Versa-Trieve® Packer
Twin Flow AIS

Run In – not landed into GP Packer
Start-to-Release – landed into GP packer, downward travel initiated, subsea hanger not landed
Released/Stroking Downward – travel downward until subsea hanger landed
Re-Latch – pulling production tubing
Seal Assemblies

Halliburton seal assemblies for permanent and retrievable sealbore-type packers act as a seal between the tubing string and the packer. If components will be exposed to corrosive fluids, the seal’s standard alloys may be plated for extra protection or manufactured from corrosive resistant alloys.

A Halliburton seal assembly consists of three major components:

- locator
- molded or premium seal units
- muleshoe guide, collet, or production tubing

No-Go Locators

No-go locators are used with packers with the short Versa-Latch® type receiving heads. These locators provide a positive locating stop for the tubing at the packer. These locators can be provided with the correct spacing between the no-go and seals because the lower end is machined to accept either molded seals or premium seal units.

Versa-Latch® Seal Assembly

The Versa-Latch locator is a locating and latching assembly that connects the end of the tubing to a Versa-Trieve® VTA, VCA, and VGP style packer. It is released through rotation. The proprietary latching thread provides excellent debris tolerance and enhances its ability to rotationally or straight-shear release. Locators exist that provide either a rotational release or a combined rotational and straight-shear release. Specialized assemblies exist that protect the threads when run into the well. For more information, see your local Halliburton representative.

No rotation is necessary to install the Versa-Latch seal assembly. It is a positive latch system that minimizes seal movement in the well. Right-hand tubing rotation is used to disengage the Versa-Latch assembly. It may be relatched or pulled with the tubing for redress operations. The straight-shear Versa-Latch assembly can be disengaged by either rotation or straight pull.
**Seal Units**

Halliburton offers molded, crimp, and premium seal units. Molded and crimp seals are recommended for applications in which the seal will be going in and out of the sealbore. Premium seals are ideal for applications requiring the seal units to remain in the sealbore.

All seal units are designed for easy field redress.

The geometry of the seals enables them to provide more positive seal as they are subjected to higher pressures and temperatures. Many types of seal units are available, and others can be designed to fit specific needs.

The standard MSN or MSF molded seal units are designed with a high-modulus rubber compound (nitrile or Fluorel® element) bonded to two metal backup shoes. The shoes are designed to pressure-energize the seals, increasing differential pressure so the element seals more tightly. These seal units have proved effective in wells with highly abrasive fluids and in wells when the unit must be set and released many times.

Premium seal units are vee-packing seal systems of either elastomeric or plastic materials with a plastic and metal backup system. The lips of the v-ring are designed to have an initial interference fit with the sealbore. The lips respond to pressure increases by flexing outward. Various backup material combinations can be used with each vee-packing seal to make it suitable for different temperatures and pressures.

Crimp seals, in combination with centering rings and debris barrier rings, can be fitted on very long seal mandrels, which eliminates threaded connections typically used on successive chevron stacks. The crimp seal consists of a rubber seal ring fitted to a groove on the seal mandrel. The seal is retained to the groove by a metal ring crimped over the seal. It is available in various elastomers and can be fitted with anti-extrusion backup rings.

**Quadra™ Seal Units**

Quadra™ seals exhibit reduced seal friction, improved sealing capabilities, increased temperature ratings, and excellent sand abrasion resistance.

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**Seal Lubricant**

Halliburton seal lubricant is a special-purpose lubricant used to protect sealbore seals and other packer accessory elastomers. It retains much of its room-temperature consistency at a wide range of temperatures, is odorless, and is resistant to many chemicals. Seal lubricant is serviceable from -40°F to 500°F (-40° to 260°C), has excellent resistance to water and oil, low volatility, and resistance to melting or hardening with prolonged exposure to high temperatures.

The lubricant is available in an 8-oz container, which is sufficient to protect and lubricate two standard packer sealbore seal units, and in 1-gal quantities.

*Fluorel is a registered trademark of Dyneon, LLC.*
Self-Aligning Muleshoe Guides

Self-aligning muleshoe guides allow the end of the guide to rotate and orient with the liner top without rotation of the tubing. This tool is recommended in wells where tubing rotation is difficult or may damage downhole tubing accessory items. The self-aligning muleshoe guide should be considered in dual-string completions, tubing installations with multiple control lines, and for horizontal completions.

Muleshoe Guides

Muleshoe guides provide a means to guide the end of the tubing away from the casing wall, then enter liner tops or the packer bores. The length of the muleshoe varies with the application from centralization to seal guide and protection to flow isolation sleeve.

Collet muleshoe guides combine the features of the muleshoe with an indicator collet to provide a surface indication of the packer seals entering or leaving a packer bore. Push-through and no-go type collets are available for indication on the packer or a special ID sub below the packer.
Downhole Sand Control Service Equipment

Downhole sand control service tools are designed for use with the Versa-Trieve® packer and multi-position tool system.

**Sand Control Versa-Trieve® Packer / Multi-Position Tool Systems**

**Setting Tool System**

The Halliburton multi-position gravel pack tool is a key component of a number of the sand control tool systems. In the squeeze position, it establishes the flow paths necessary to squeeze fluid into the formation. In upper and lower circulating positions, it circulates fluid across the formation interval, through the screen, then back up the tubing/casing annulus. In the reverse circulating position, it circulates reverse fluids down the annulus and back up the tubing. It can also be used to circulate down the tubing to spot fluid in place. These positions are used during tubing cleaning, acidizing, and sand slurry placement stages and are required to place and circulate fluids to achieve an optimal gravel pack. Raising and lowering the multi-position tool relative to the packer provides these changes of flow path.

Versa-Trieve packers are set with the multi-position tool which has a hydraulic setting mechanism. When the multi-position tool is installed into the packer, the multi-position tool lugs expand to engage the packer-guide tube and act to prevent premature packer setting caused by drag on the outside components of the packer. These lugs transmit tensile forces from the packer to the multi-position tool and retract only after the setting piston has begun to stroke down. The multi-position tool is designed so the shear pins between the packer and multi-position tool (packer setting pins) are not stressed during the running-in of the packer, screen, and blank bottomhole assembly.

**Standard Multi-Position Tool Piston Areas**

<table>
<thead>
<tr>
<th>Bore (in)</th>
<th>Piston Area (in²/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.55</td>
<td>10.89/70.26</td>
</tr>
<tr>
<td>2.75</td>
<td>10.89/70.26</td>
</tr>
<tr>
<td>3.25</td>
<td>12.28/79.22</td>
</tr>
<tr>
<td>3.88</td>
<td>12.28/79.22</td>
</tr>
<tr>
<td>5.00</td>
<td>21.71/140.06</td>
</tr>
<tr>
<td>5.500</td>
<td>21.71/140.06</td>
</tr>
<tr>
<td>6.00</td>
<td>21.71/140.06</td>
</tr>
<tr>
<td>8.500</td>
<td>40.00/258.06</td>
</tr>
</tbody>
</table>

*Run-in lugs supporting bottomhole assembly. No loading of shear pins.*

*Double-check the tool engineering data sheet for the correct tool piston area. These numbers are for reference only.*
Setting Tool System—Packer Setting Operation

The packer is set by dropping a ball down the workstring after the packer assembly has been run and located at the proper depth. After the ball has gravitated to or has been pumped onto the ball seat, pressure is applied to the workstring. Pressure enters the cylinder of the multi-position tool and forces the piston down, shearing the start-to-set screws in the multi-position tool. Once these screws are sheared, the piston begins to move down, allowing the lugs to retract and the setting load to be transferred to packer setting pins. Further movement forces the packer guide tube downward, causing the packer slips to expand outward, engaging the casing wall and compressing the packer elements. The internal slips of the packer retain this setting movement and related force. The large piston area of the multi-position tool permits adequate setting force to be achieved with low-setting pressures. The packer is fully set when the packer-setting shear pins, holding the multi-position tool to the packer, shear at a pressure above the start-to-set pressure. At this point, the multi-position tool is free from the packer. The ball seat must be expended into the sump of the crossover sub, or the ball must be reversed, for packing to begin.

A non-shearing secondary ball seat is provided in most multi-position tools. It is designed for a larger, low-density aluminum ball and permits the setting procedure to be completed in the unlikely event that the primary seat shears prematurely. The secondary ball must then be reverse-circulated out.

When extremely high running loads are encountered, as occurs in horizontal wells or long intervals, the Acme threaded packer top sub (VTA, VBA, VCA, VGP, or AGP packer) may be run with a threaded multi-position tool locator, or a VGH or VCH packer can be run with an HPT setting tool. This provides additional weight-carrying and setting capabilities since the weight of the assembly is not pulling on setting pins as it sets. Packer and setting tool combinations can be provided for high torque or tension capabilities and in some cases, for both capabilities.

Other setting options include an isolation sleeve for the hydraulic setting ports, a ball reversing option for the FracPac™ system, and variations of the setting procedure for one-trip systems.
Multi-Position Tools

Halliburton multi-position tools allow the Versa-Trieve® gravel pack assembly to be run and set hydraulically to perform single-trip gravel pack operations. The Halliburton multi-position service tool carries the gravel pack assembly downhole and sets the packer. Once the screen assembly is positioned across the perforated interval, a ball is dropped down the workstring. Pump pressure is applied to set the Versa-Trieve packer and release the multi-position tool. Increased pump pressure expends the ball and seat into the sump of the crossover, opening the flow path below the packer. Two primary tool versions are available to provide for differences in completion objectives, operating location, and downhole conditions. The four-position tool has the following gravel pack positions:

- Squeeze
- Lower circulating
- Upper circulating (above the telltale)
- Reversing (circulating above the packer)

Weight-down positioning is possible in both squeeze and circulate positions.

Halliburton multi-position tools consist of a hydraulic setting piston and service-seal assembly.

Benefits

- No rotation is required.
- Anti-preset lock mechanism prevents premature sets.
- Multi-exit ported flow sub with specially designed port areas allows for more even distribution of pack material, less gravel crushing, and low pump pressure.
- A range of tool designs exist for medium to high flow rate capabilities.
- The large piston area allows for lower setting pressures.
- Modular design allows for conversion to the weight-down, extended length (floating vessel), FracPac™ system operations, washdown, or one-trip perforate/pack configurations.

The multi-position tool used for large volume high-rate FracPac system treatments and water packs has a slightly different design. The ball must be reversed after the packer is set to provide an unobstructed flow path during the high-velocity flow. Larger flow areas in these tools limit erosion, and a specially designed crossover sub withstands long pumping stages at the highest rate.
HPT Setting Tool
The HPT setting tool is a heavy hang weight setting tool that has a straight pick up to release from the packer once the packer is fully set. It is used with VCH packers which are a special version of the VCA packer. It can also be used with VGH packers which are similar to the VGP packers.

Applications
• ESTMZ™ completions
• Can be used to replace the existing hydraulic section

Features
• Hang weight is carried on the setting tool lugs, which thread into the packer top sub for increased tensile load capacity.
• Torque may be applied through the setting tool and packer while running in the well.
• Hang weight is independent of the packer setting pins.
• Straight pull “soft” release from the packer.
• Weight down applied while setting pins shear.
• Two steel shear pins retain the clutch in place. Drill out the two pins and rotate the setting tool out of the packer.
• Currently available in 9 5/8-in. 6.00 bore.

Benefits
• Changes in hang weight will not cause early release from the setting tool and a less than optimum set of the packer
• No need to rotate off the packer to get high load capabilities
• Simpler setting operation
• No “slingshot” action when the packer shears free of the setting tool
• Easy to control operation on a floating vessel
• Easier redress of backup equipment
• Field-proven functionality
Reverse Position Indicators
Reverse position indicators are assembled to the lower end of the multi-position tool to provide a positive surface indication of a single downhole tool position. A multi-position shear ring (MSR) positive indicator consists of a snap ring held in place with a shear ring. Once the packer is set, the multi-position tool is raised until the MSR snap ring engages the bottom end of the honed bore below the packer. This normally occurs at the reverse position but may be arranged to indicate other positions. To release the MSR ring, an upward pull on the workstring shears screws to cause the shear ring and snap ring to move downward. The snap ring collapses into a recess, allowing the multi-position tool to be pulled upward through the honed bore.

Reverse Ball Check Valve
Reverse ball check valves control fluid loss from the annulus to the formation when the multi-position tool is in the gravel pack circulating and reverse positions. The slotted seat allows a metered fluid amount to escape past the ball, limiting buildup of pressure differential and preventing a hydraulic lock that swabs the formation as multi-position tool is raised.

Actuated Reverse Ball Check Valve
The actuated reverse ball check valve is assembled above or in place of the reverse indicator on the multi-position tool. The ball is held off-seat during running of the gravel pack tools, packer setting, and gravel packing operations. Shearing the reverse indicator pulls the ball onto seat at any time after the packer is set to stop fluid loss during the job. This tool reduces problems of swabbing the formation during tool manipulations and provides a means to monitor screen annulus pressure when in the circulating position. The weep tube provides metered fluid loss control.

MPC Collet Indicators
Multi-position collet (MPC) indicators are assembled below the multi-position tool as part of the washpipe assembly. Collet indicator collars are made up as part of the gravel pack blank assembly at predetermined locations to indicate various circulation positions when the multi-position tool is raised and lowered.

Multi-Acting Ball Check
The multi-acting ball check (MABC) allows flow from the annulus to the formation when in the weight-down position and closes when the multi-position tool is raised to allow tubing to be reversed out. This tool provides a reliable means of opening the back side flow path for frac pack operation pressure monitoring. Weep tubes of varying lengths can be provided to minimize swabbing in varied well conditions.
**ROC™ Reverse-Out Check Tool**

The Halliburton ROC™ reverse-out check tool is attached to the lower end of the multi-position tool and can be used in most gravel packing systems. The ROC tool allows for packer testing, pressure maintenance when closed, and acts as a reverse-out check valve or shifting tool. The ROC tool is designed with large flow ports to minimize pressure drop. The large collet on the ROC tool is a MCS shifting tool and shifts the ROC tool open or closed as it engages the positioning nipples. The collet also provides a high snap load indication when pulled through a positioning nipple.

**Features and Benefits**

- Can be used in most gravel packing systems
- Collet provides high snap load indication when pulled against positioning nipple
- Allows for packer testing and pressure maintenance
- Acts as a shifting tool
- Large flow ports minimize pressure drop
- Acts as a reverse-out check valve
Positioning Tools

MCP Closing Sleeve Positioning Tools
Multi-position collet-type positioning (MCP) tools are self-releasing positioning tools installed below the multi-position tool. The positioning tool uses 90° shoulders to positively engage the inner sleeve of a mating MCS closing sleeve. The fluted release ring on top of the MCS sleeve or the lower honed bore below the MCS sleeve causes the positioning tool to release the inner sleeve only after the sleeve has been fully shifted. If necessary, the closing sleeve may be reopened and closed by simply lowering or raising the positioning tool through the sleeve. These tools can also be used to shift the internal sleeve of the EGF expendable flapper valve to allow the flapper to close.

MKP Lug-Type Self-Releasing Positioning Tools
Lug-type self-releasing positioning tools function in the same way as the MCP positioning tools to open and close sleeve-shifting devices. They have the advantage of passing through smaller restrictions than the MCP positioner and are recommended for horizontal applications where the tool must be pulled through long sections of pipe and screen. In addition, these tools have a safety shear release to be used if they are unable to shift a sleeve.
Straight-Shear Packer Plugs
Halliburton straight-shear packer plugs are designed to land and latch into a Versa-Trieve® or Perma-Series® packer top sub, seal from above and below, and be released through tension. The plugs can latch into Versa-Latch® threaded top sub designs. Equalization of the plug occurs as the retrieving overshot engages the plug. An optional rotation release is possible on the Versa-Latch threaded-plug design after equalization. The plug is equalized while stabbing into the packer.

Straight-Shear Plug Running Tools
Straight-shear plug running tools are pinned to the top of the straight-shear plug and can be run on tubing, wireline, or coiled tubing. Once the plug is landed in the packer, the pin is sheared, releasing the plug and closing the bypass to seal off from above and below.

Straight-Shear Plug Retrieving Tool
Straight-shear plug retrieving tools are designed to pull the straight-shear packer plug. Refer to the design specifications of the plug being used for the retrieving tool.
ShurMAC™ Collet
The weight-down reciprocating system provides the ability to maintain weight on the packer in both the squeeze and circulating position without closing the blowout preventer (BOP). Most weight-down systems have only a single weight-down position. With the addition of the ShurMAC™ collet to the weight-down tool, weight-down can be maintained in multiple positions.

Optionally this system can incorporate a reverse ball that is on seat in the reverse position but fully open when weight is on the tool in the circulating position for live annulus monitoring.

The proprietary ShurMAC collet allows the tool to be shifted between squeeze and circulating positions multiple times. Tubing set-down weight is supported by the ShurMAC collet in the circulating position.

Features
- Able to maintain weight on packer in squeeze and circulating positions without closing the BOP
- Can choose between weight-down circulating and squeeze mode while assembly is in the well

Benefits
- Safety – The ShurMAC collet design improves knowledge of tool position during the job
- FracPac™ system treatment improvement – Having live annulus capability when possible allows for better job placement
- Casing burst prevention – Having the ability to switch to squeeze mode when necessary can prevent casing over-pressure

Monobore ShurMAC Collet
The monobore ShurMAC collet is designed to work in multizone applications where the packer and MCS sealbores are the same ID as the indicator coupling ID.
Single-Acting Weight-Down Collet
Single-acting weight-down collets provide a single pass through the restriction into either the squeeze or circulating position for multiple position options. With a single restriction, a multi-acting collet, and a single-acting collet or slip-type stroking device is used. Using collets to locate position in single-zone systems provides the shortest and most reliable way to achieve confidence the tool is in the correct position.

Washpipe
The washpipe is attached to the gravel pack service tool and run inside the screen. The washpipe serves two functions. First, it provides a return fluid circulation path that can be spaced out at the very end of the screen interval. This path forces the proppant slurry to flow to the lowermost screen before bridging in the screen-casing annulus.

The second function of the washpipe is to prevent the proppant carrier fluid from flowing to the outside of the screen. Loss of fluid from a proppant slurry can cause premature and rapid bridging to occur, especially in high-density proppant concentrations. A number of studies have indicated the pipe diameter should be at least 80% of the screen basepipe ID.
Horizontal Well Completion Components

The components discussed below can be used in a wide variety of configurations to meet your horizontal well completion objectives.

All-Metal Down-Jet Shoe

This simple spring-loaded, acid-resistant, check valve design can be made in single or double valve side-port down-jet shoe configurations for washdown and circulating operations. An all-metal design, when made from corrosion resistant alloys, provides additional corrosion resistance where acid attack is a problem and long-term serviceability is important. An open shoe with isolation flapper valve or isolation sleeve can be used for reverse circulation.

Makeup Subs

Makeup subs provide a quick, non-rotational means to make up the packer assembly to long screen assemblies. The makeup sub provides full torque capabilities through the tool when assembled with the Acme threaded collar. This tool speeds rig assembly and minimizes the risk of washpipe unscrewing during the makeup of concentric strings or thread galling.
Screen

The screen is a critical part of the success of the horizontal well. Selection of a screen should be based upon the level of filtration required and the mobility of the formation sands. Once well characteristics and objectives are known, a Halliburton representative can help you select an appropriate screen. Reference Section 4 Screens for more information about screens offered by Halliburton.

Packer Test Assembly

Part of the MPW service tool, the packer test assembly is used to maintain pressure on the formation of an openhole horizontal gravel pack completion while the packer is run, set, tested, and prepared for gravel packing. This assembly prevents isolation of the formation from both tubing and annulus pressure at any time in the completion, addressing the potential problem of pressure loss in the formation which results in losing the filter cake. The pressure maintenance assembly, which is run with ports in the open position, has positions that are open-closed and then opened again to achieve the objectives. Before testing, the service tool is raised and the test assembly is shifted to the closed position, allowing the packer to be tested down the annulus. Pressure is then increased to shear pins and reopen the tool so circulation is again possible. When the packer test assembly is used, the MPW tool will also have a special tapered seat assembly in the bottom of the crossover and will utilize an actuated reverse ball seat below the packer test assembly.

Screen Isolation Device

The screen isolation device is a washpipe-deployed plug used to permanently isolate a lowermost screen and shoe after the gravel pack. When the gravel pack is complete, it is set in a sealbore above the lowermost screen by a straight pull and is locked in place by internal slips. The running tool is released by tension. During initial screen running operations, the plug is placed into a lower sub-assembly with a latch looking upward. Once the screen is in the well, the washpipe is run with a mating Versa-Latch® receiving head on bottom and is stabbed and latched into the plug assembly.

Locator Nipple

The locator nipple is used to provide a receptacle for the screen plugging device. It is attached to the top of the lowermost screen of a horizontal gravel pack completion.
Inverted Washpipe Seal System

The inverted washpipe sealing system is used with long polished stingers on the washpipe. The seal housings are located at each screen joint or multiple screen joints. The workstring is moved to position, the stingers across two housings, and the treatment is pumped out a ported sub between the stingers.

Washpipe Latch Assembly

The washpipe latch assembly is generally used to connect two sections of washpipe in a gravel pack system. The lower half of the assembly is made up to an assembly within the well or at the bottom of the screen, such as a cup packer washing assembly. The upper half of the latch assembly is made up to the washpipe. The upper half is run on the washpipe and latched into the lower half. Right-hand rotation will tighten the latch threads. Molded seals on the latch assembly provide a seal between the workstring and the cup packer.
Horizontal Crossover Reversing Tool

The horizontal crossover reversing tool is part of the 1062C™ horizontal completion system. The tool provides the means to circulate and reverse fluids during the horizontal well completion. Circulation is accomplished by pumping through the annular gap and around the crossover exit ports. This keeps the spring-loaded ball check on seat. Reverse circulation is achieved by pumping down the annulus, through the ports and upward, to force the spring-loaded ball check off its seat to return fluids up the workstring.

Horizontal Packer Running Tool

Multi-position tool-type horizontal packer running tools with isolation sleeve provide the means to run and set Versa-Trieve® packers in a horizontal completion assembly. The hydraulic isolation assembly allows pressure to be applied to wash the completion into place without exposing the hydraulic piston and setting pins to hydraulic pressure. Specialized tools are available for high running loads, and many have torque-through capabilities.

Washpipe Swivels

Washpipe swivels expedite makeup and allow for safer operations on the rig floor. Use of the swivel allows the end of the service tool extending from the packer assembly to be made up to the washpipe without rotation of the packer.

Swellpacker® Systems or Inflatable Packer Assemblies

Swellpacker® systems or inflatable packer assemblies may be used to isolate openhole intervals. The inflatable packer can be set after the Versa-Trieve® packer. If more than one inflatable packer is used, each packer can be set and tested individually.

Swellpacker systems will set over time when exposed to well fluids. For a complete description of Swellpacker system options, see Section 4 Swell Technology in the Completion Solutions catalog.

Consult your Halliburton representative for assistance in selecting the correct packer for your well application.
Horizontal Gravel Pack System with Upstream/Downstream Differential (UDD) Valves

The Halliburton upstream/downstream washpipe differential (UDD) valve is run as part of a horizontal openhole gravel pack completion on the washpipe and is spaced within a restriction in the screen. The valve responds to the differential pressure created by fluid friction across the valve length. As the fluid volume that passes within the restriction between the OD of the valve and the ID of the restrictor tube increases, pressure differential increases, and the valve opens. The valve will shift open when the differential pressure exceeds the pressure at which the valve is set to open. When it is opened, the fluid returns are diverted through the valve and up the remaining length of washpipe, through the service tool return path, and back up the annulus to the surface. By shortening the return flow path, the differential pressure across the openhole horizontal interval is reduced, allowing the packing operation to continue to completion without the pressure reaching a critical fracturing pressure (that would terminate the packing operation).

Features and Benefits

- Reduces circulation pressure increases resulting from beta wave formation
- Operates on flowing friction pressure differential
- Upstream to downstream differential
- Not sensitive to hydrostatic
- No seals on the valves or washpipe—close fit only, reduces sticking
- Provides a sleeve check valve to stop fluid pressure from escaping from tubing to annulus
- Adjustable for the expected differential
- Control of differential pressure in the openhole interval
- Enhances normal alpha-beta wave deposition during the packing operation
- No seals external to the valve to stick in sealbores
- Internal to external pressure integrity after opening to allow circulation to bottom for acid washing
- Able to apply internal pressure to set inflatable packers after actuation
- Simple, rugged construction
- Single moving sleeve for operation
- Flow grooves on OD to minimize chances of sticking with sand/fines during retrieval
- Large flow ports to minimize backpressure during gravel packing
- High-pressure check valve to allow single-trip gravel packing and setting inflatable packers
**FracPac™ System Completion Components and Service Tools**

**High-Rate and High-Volume Tools**
Halliburton has a multi-position tool designed to place high volumes of proppant reliably at the high rates and pressures necessary to achieve fracture design parameters. The tools have been extensively tested to verify erosion capabilities and characteristics with varying rates, volumes, and proppant materials. This testing has identified which tools are suited to particular jobs.

Three crossover designs exist:
- Intermediate service tool with large flow areas for gravel packs and lower volume high-rate water packs
- High-rate tool with a carbide erosion sleeve for the most severe conditions
- Ultra high-rate Beyond Red Zone® tool for the most severe jobs

Critical areas of these tools have been analyzed using finite element analysis in conjunction with pressure cycle testing.

These tests were performed above the rated pressure calculations to assure long-term success in FracPac™ system operations.

Flow erosion can also present a problem in the upper extension, flow sub, and casing when extremely large jobs are pumped at very high rates. Halliburton has performed tests to simulate this erosion and has designed tools to survive the job and protect the well casing.

**MCS FracPac System Closing Sleeve Assemblies**
Halliburton MCS FracPac system closing sleeves provide all the features of the MCS closing sleeves with the additional benefit of high flow rate and volume capabilities. Each sleeve is carefully designed to cause minimum flow erosion to the closing sleeve and production casing while minimizing fines generation at maximum slurry velocity. Special sleeves are required for Beyond Red Zone FracPac system applications.

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*Distributions of fluid velocity magnitude, volume fraction of proppant, and proppant velocity magnitude in the crossover tool*
FracPac™ Service Casing Extensions and Blank Pipe

In high-rate water pack (HRWP) or FracPac™ system treatments, sufficiently high differential pressures occur during the screenout of the casing/blank annulus to collapse blank pipe made of lightweight, low-strength materials. For this reason, the casing extensions and any other blank pipe located below the closing sleeve or perforated extension of the completion assembly are part of the completion design.
Versa-Trieve® Packer Retrieving Tool

Versa-Trieve® retrieving tools are used to retrieve Versa-Trieve packers. To retrieve the packer, the retrieving tool is run on a workstring, stung into the packer bore, and latched into the Versa-Trieve packer. Once latched, the tool locates the packer’s release sleeve and moves it upward, allowing the packer to be released. Additional upward movement of the workstring releases the sleeve and moves the packer mandrel up, which permits the packer slips to retract and the packer to be retrieved.

No rotation is necessary in the pulling operation. To release the pulling tool from the packer, only a 1/4 turn to the right is needed on the J-latch-type locators. Additional rotation (six to eight turns) is required to release from the Versa-Latch® locator from the packer top sub.

Benefits
- No rotation required for pulling operation
- Straight-through ID allows washing down to the packer
- Easy to release with 1/4 turn on lug-type tools (VRT type), and six to eight turns on a Versa-Latch tool (VRA or VRB type)
- Rugged lug-type design engages the release sleeve
**Schematic 1—Engaging**
- After the tubing and seal assembly have been removed, a Versa-Trieve® retrieving tool is lowered into the packer until the locator no-goes on the packer top sub. An upstrain on the workstring (a) verifies that the retrieving tool is latched into the packer and shears the locator to the mandrel shear pin (b).

**Schematic 2—Releasing**
- With the retrieving tool properly latched to the packer, the workstring is slacked off until the retrieving tool begins to take weight. An upstrain applied to the retrieving tool allows the lugs of the retrieving tool (c) to engage the packer release sleeve. Continued upstrain will shear the shear pins (d) in the release sleeve, allowing the release sleeve (e) to move upward and toward the release ring (f).

**Schematic 3—Retrieving**
- Additional upstrain shears the pins (g), causing the lugs of the retrieving tool (c) to retract. Upward movement of the packer’s mandrel causes the shoulder (h) to raise the element mandrel (j) and top wedge (k). The top wedge is pulled out from under the slips and pulls on the slip carrier, which pulls the slips off of the lower wedge (l). The shoulder (m) catches the lower edge and supports the tailpipe below the packer.