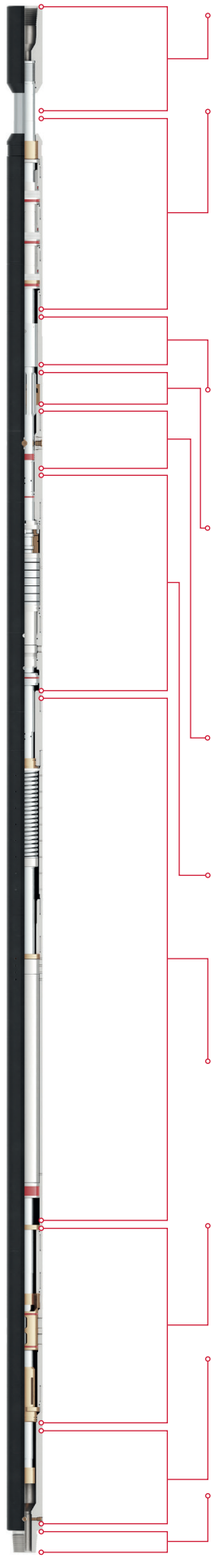
Technical Features



Premium Connection Sub
HydroVolve HAMMER can be dressed with any standard or premium threaded connection, removing the need for cross-overs.

PolyVolve Swivel Module
The POLYVOLVE swivel allows high pulling forces to be applied to the stuck-object via the HAMMER device whilst allowing the rotation required to operate the INFIFNTY engine to deliver the HAMMER impact.

POLYVOLVE is a modular, stackable, polymeric thrust bearing swivel capable of withstanding ultra-high thrust forces whilst rotating for extended periods in extremely hostile conditions.

POLYVOLVE delivers a proven and unrivalled thrust load bearing capability, is impervious to wellbore fluids and debris and can operate comfortably at high temperatures.

Jar Head
HydroVolve HAMMER features a conventional linear jarring mechanism which allows both upward and downward jarring to be delivered through the 'Jar Head', providing operators with an extra level of comfort and confidence.

Drive Spline
A precision high-torque drive spline provides the torsional drive force required for both drilling operations and fishing tool manipulation.

The drive spline is disengaged in the Active mode for HAMMER operations but self-aligns into re-engagement when the HAMMER is returned to Hibernate mode. The drive spline remains engaged in the down-jar mode.

Pressure Relief Module
A pressure relief module is fitted to the HAMMER to prevent over-pressuring of the HAMMER during operation thus preventing potentially excessive HAMMER forces from being delivered through the HydroVolve HAMMER to the stuck object.

Mechanical Mode Selector Module
The mechanical mode selector module allows the operator to switch between the three modes: Hibernate, HAMMER-Active and Down-Jar.

This is a mechanical trigger device with the UP-STROKE and DOWN-STROKE trigger values being pre-set prior to deployment.

HAMMER Module
The HAMMER module houses the HAMMER mass, the anvil and the return spring.

The Hammer is powered into striking contact with the anvil using the INFINITY engine. The HAMMER is returned to its starting position by the spring.

HydroVolve INFINITY Module
The HydroVolve INFINITY module is the power source used to propel the HAMMER mass to generate the vibro-impact. HydroVolve INFINITY uses the drill pipe rotation to open and close the inlet and exhaust valves to allow pressurised fluid within the drill string to propel the HAMMER mass.

Flow Management Module
A flow management module is fitted to the lower portion of the HAMMER. This allows the correct pressure and flow regime to be diverted into the INFINITY depending upon the application. This can either be an arrangement of flow chokes or may optionally include the EvoFLO ball-valve module.

Premium Connection Sub
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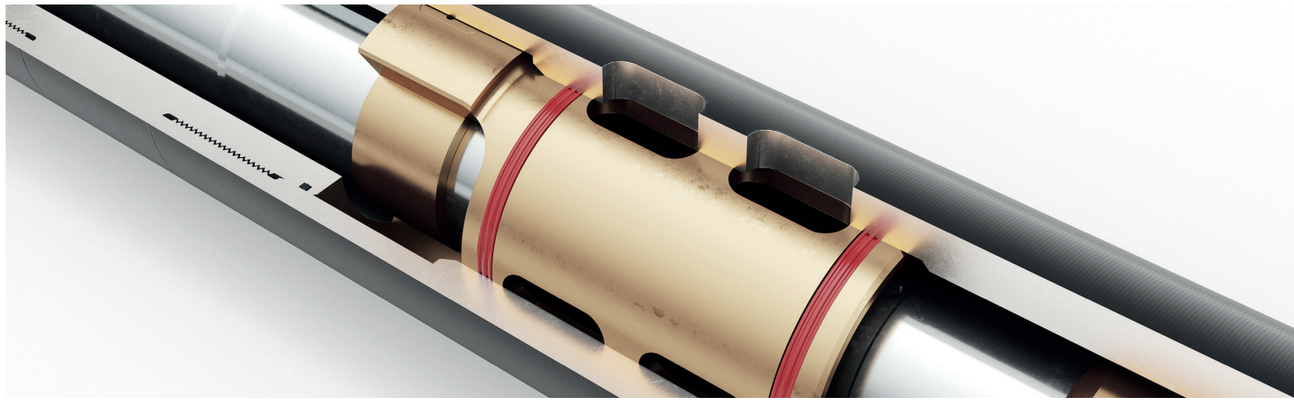
Case History

HydroVolve



HydroVolve HAMMER

Qualification test | Field trial in drilling jar mode

HydroVolve HAMMER is the world's most powerful, most controllable and most versatile stuck-object extraction system. It is simple, rapid and robust and is operated and controlled instantly using only conventional rig systems.

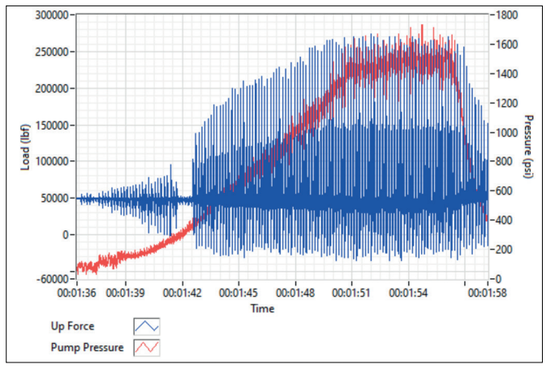
It is the superior alternative to jars in the BHA for preventing and remedying stuck-pipe incidents, and is the ideal solution for fishing interventions and planned plug and abandonment (P&A) operations.

Real Results

- Step change in magnitude of extraction energy demonstrated during proof testing
- Up to **3000 times** more extraction power than standard jars evidenced
- 4-3/4" HydroVolve HAMMER deployed successfully across three wells in an extensively drilled notoriously unstable formation.
- Deployed with premium, state of the art $3M MWD/LWD/rangefinder rotary steerable system
- Delivered fastest ever successful bottom hole assembly (BHA) recovery – twice!
- Recovered stuck and fully packed-off BHA in two successive wells
- Recovered stuck BHA both times within 3 minutes of impacting versus typical 6 days of conventional jarring
- All impact delivered downhole with no jarring force visibly transmitted to surface
- Post-impact derrick inspection not required saving ~6 hours rig time
- Full BHA communication confirmed to LWD/MWD/Steerable system: drilling operations continued without pulling out of hole (POOH) saving 2 days rig time and full MWD/LWD/system redress
- Achieved the longest drilled interval ever recorded in extensively drilled basin.
- 30% weight reduction over jar/heavyweight/accelerator package significantly lightening BHA and extending the drilling envelope
- Recorded > 270 circulating hours
- Recorded > 167 on-bottom drilling hours
- High volumes and concentrations of loss control material (LCM) pumped without detriment to operation or extraction impact capability

Testing at HydroVolve drilling test centre: 550Tonne (1,200,000lbf) push-pull test rig, 120RPM Drive @ 13.5kNm (10,000ft.lb) Torque, 350Bar (5000psi) Flow Loop.

4.75" HydroVolve HAMMER qualification test: 50,000lbf overpull, 60rpm pressure vs impact



"We are excited about the step change the hammer evidenced in reducing flat time of stuck pipe recovery operations in our notoriously unstable coal seams"

Senior Drilling Engineer

4.75" HydroVolve HAMMER field trial in drilling mode: coal seam gas drilling, Queensland, Australia

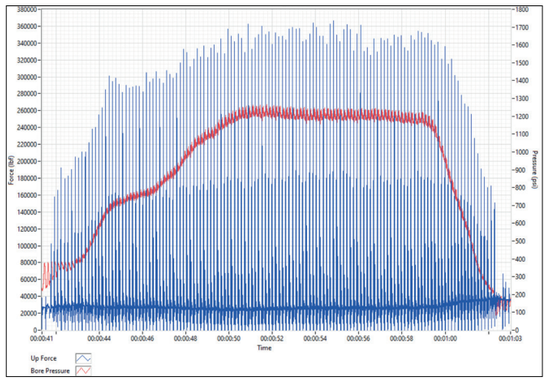
HydroVolve HAMMER was deployed as part of a complex rotary steerable system (RSS) drilling bottom hole assembly (BHA) with advanced rangefinder technology used to intersect laterals in highly fractured unstable coal seam gas formations in high step out horizontal wells.

The HydroVolve HAMMER inclusion in the BHA enabled the design of a shorter and lighter BHA to extend the drilling envelope and allow geo-steering to go on to set a field record lateral section length in 6-1/8" hole.

The HydroVolve HAMMER evidenced excellent durability and reliability in arduous conditions:

- Total on-bottom drilling time: 167 hrs
- Total circulating time: 293 hrs
- Largest dog leg severity: 10.8 degrees
- High stick-slip drilling environment
- Extensive back-reaming prescribed to condition wellbore
- Frequent loss control material (LCM) treatment pills pumped through HydroVolve HAMMER to manage drilling fluid loss rate while drilling through formation fractures.
- Highly successful in freeing stuck BHA where traditional jars fail to operate due to insufficient weight transfer

8.25" HydroVolve HAMMER qualification Test: 30klbf overpull, 90rpm pressure vs impact



Each HydroVolve HAMMER variant is extensively tested for durability and to determine the output characteristics and performance across the range of operating parameters:

- Overpull
- RPM (impact frequency)
- Flowing Pressure vs impact force

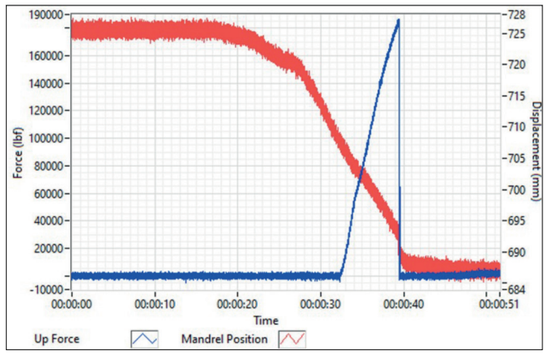
Pictured left is a sample performance chart with 30,000lbf overpull applied at 90rpm with pressure ranging from 0-1200psi

8.25" HydroVolve HAMMER shear demonstration test: 60rpm pressure vs impact

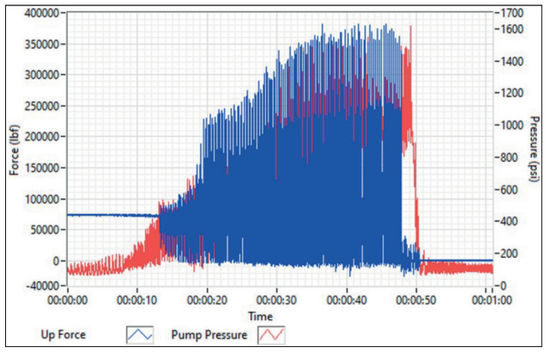
As part of a customer qualifiaction and demonstration test, the immense HydroVolve HAMMER power output was evidenced by shearing ultra-heavy duty shear pins in a bespoke shear fixture.

A single shear pin was calibrated to fail at 180,000lbf on a double-plane shear test. Two pins were then fitted to the shear fixture to deliver a total ultimate shear force requirement of 360,000lbf.

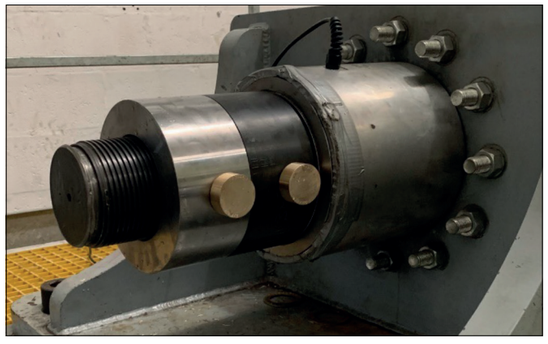
An overpull of 75,000lbf was applied through the HydroVolve HAMMER whilst rotating the string at 60RPM. Pump pressure was then increased in the string to ~1000psi whereby high frequency (4hz) impact and constant overpull delivered a combined force of 360,000lbf to successfully shear both pins within a few seconds. The test was declared a tremendous success by the customer.



Single-pin shear calibration shear: 180,000lbf



Double-pin shear test: 75,000klbf overpull, 360,000klbf impact shear



Single-pin shear calibration shear: 180,000lbf

Double-pin shear test: 75,000klbf overpull, 360,000klbf impact shear