WELLS ABANDONMENT ACCELERATED

DEVELOPMENT OF A SINGLE-TRIP, CASING-ON-DECK SYSTEM

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ORIGINAL INSIGHT
## Why Perform Casing Recovery?

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<tr>
<td>Cased Hole Sidetrack</td>
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<td>Open Hole Sidetrack</td>
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<tr>
<td>Sustained Annulus Casing Pressure (SACP) Remediation</td>
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</table>
THE CASING RECOVERY TOOLBOX

Casing Recovery Toolbox

Long String Recovery
(Pulling from Casing Hanger)

TRIDENT® System

Short String Recovery
(Pulling Casing stump)

TITAN® System

LONG STRING

SHORT STRING

LONG STRING

SHORT STRING
LONG STRING TRIDENT®
SINGLE-TRIP CUT & PULL SYSTEM
TRIDENT FUNCTIONALITY = TRIP REDUCTION

**STANDARD OPERATION**
- Run #1: Bit stabilization, Clean out/Dress cement
- Optional: Run and set Bridge Plug, Inflow Packer
- Run #2: Knife stabilization, Cut casing
- Run #3: Stop Sub, Bumper Sub, Casing spear, Pack-off

**ARDYNE OPERATION**
- Run #1: Packer, Casing Anchor, Cut casing, Clean out/Dress cement
- Tool operation:
  - Tension activated (100k)
  - Flow actuated (200 psi)
  - Pressure activated (drop ball 1400 psi)
TRIDENT System example operation

- **STEP 1**: Run in hole
- **STEP 2**: Dress cement
- **STEP 3**: Tag
- **STEP 4**: Testing
- **STEP 5**: Relocate
- **STEP 6**: Cut casing
- **STEP 7**: Circulate
- **STEP 8**: Relocate
- **STEP 9**: Pull casing

- **30" Conductor**
- **13 3/8" Casing**
- **9 5/8" Casing**
32% TIME SAVINGS ON CUT & PULL OPERATION

TRIDENT Single-Trip Cut and Pull System saves rig time and eliminated handling of 2 BHA’s

**Dressing Cement**

**32% Time Saving vs Conventional Operation**

**TRIDENT™**
- Enabled cement plug drilling: 3 meters
- Weight tested cement plug with 10 tons.
- Completed casing cut at 740mMD
- Enabled circulation of annular gas
- Recovered casing to surface from hanger - 27mMD

The TRIDENT System saved the client 2 trips, and 32% of planned rig time.

**THE OPERATION**

A North Sea operator wanted to perform a slot recovery operation on a platform well in a safe, efficient and cost-effective manner. Planned operations included drilling the top of a cement plug, verifying hard cement, cutting the 9 5/8” casing at 740mMD, and recovering the string of 9 5/8” casing. The operation would require 3 trips in hole with conventional technology.

**THE SOLUTION**

TRIDENT™ was deployed to perform the required operation in a single trip. TRIDENT™ was fitted with a roller cone drill bit to drill the top of the cement plug and weight test to verify hard cement plug. TRIDENT™ Cutter was activated and a successful cut was conducted in 6 minutes. TRIDENT™ Packer was engaged and annular gas was circulated out through the annulus outlet on the wellhead. After relocating the TRIDENT™ Anchor below the casing hanger, the casing was recovered to surface. All operations were conducted in a single trip.

TRIDENT Animation [HERE]
TRIDENT® SYSTEM SAVES 14.5 HOURS RIG TIME

TRIDENT delivers 46% efficiency gain in P&A casing recovery operation

**SINGLE TRIP FUNCTIONALITY - Dress, Test, Cut, Circulate and Pull**

- Tag / Dress cement as required to 7,630ft – verify Top with 10K set down weight
- Set Anchor & Packer to positive test cement plug
  - Inflow test functionality available if required
- Reposition assembly to cut depth, set anchor and applied 50K overpull to put casing in tension and cut casing at 4,090ft
- Set Tension Set Packer above cut to circulate
- Verify casing free – with pressure and overpull
- Reposition to top of stump and reset TRIDENT Anchor
- Retrieve casing to surface from 2,234ft

= 14.5 hours rig time savings

**THE OPERATION**

A North Sea operator conducted a permanent P&A operation on a fixed installation. The well had previously been temporary abandoned by setting a cement plug and recovering the 9 5/8” casing down to 2,234ft. Casing was preferred to be cut in tension due to potential free standing stump.

**THE SOLUTION**

TRIDENT™ conducted the operation in a single run. Initial dressing and tagging of cement plug was conducted prior to relocating to cutting depth. With the TRIDENT Anchor set, sufficient overpull was applied to stretch the casing and the cut was completed in 2min. An attempt to circulate the annulus was conducted, but debris was blocking the annulus. Verification that the casing was free was conducted by increasing the overpull on the TRIDENT Anchor and movement was seen with pressure dropping off. Relocating the anchor to the top of the casing stump and recovered the casing to surface.

For more information on the TRIDENT System click [HERE]
Resetting the standard – 23% efficiency gain

Anchor Setting in both 9 5/8” & 10 ¾” Casings

TRIDENT™ Anchor and Packer delivers a 23% efficiency gain on routine Cut & Pull operation

3.6 hours rig time savings on simple Cut & Pull operation

- RIH to 3,255 ft depth and cut 9 5/8” casing with TRIDENT Anchor set.
- Lifted casing 4ft to verify casing was free.
- Released Trident and pulled up to casing hanger at 600ft.
- Anchored Trident in 10 3/4” and set Packer with tension to circulate annulus fluid out of hole.
- Recovered casing to surface.

THE OPERATION

The TRIDENT Single-Trip casing recovery system was deployed on a Semi-Submersible rig in the North Sea, to perform a routine cut and pull operation on 9-5/8” x 10-3/4” casing. The operation could have been conducted with conventional equipment in two runs, but the TRIDENT System’s integrated and upgraded packer and anchor performed in a single trip, saving significant rig time even on this routine operation.

CONTINGENCY FUNCTIONALITY

TRIDENT Anchor
1. No need to reposition marine swivel if additional cuts are required.
2. No spear space-out requirement for additional cuts if conventional spears were run.

TRIDENT Packer
3. Ability for high pressure test in 9 5/8” with TRIDENT Packer
SHORT STRING
TITAN®
SINGLE-TRIP
CUT, JACK & PULL
SYSTEM
DOWNHOLE HYDRAULIC JACKING VS PULLING CASING FROM SURFACE

**Conventional pull of casing**
- At Surface: Rig pull 410 tons
- Friction Losses
  - 2,168 metre: 130 tons applied on the fish (no movement)

**TITAN System pull of casing**
- At Surface: No pull required
- Friction Losses
  - All forces created downhole
  - 2,168 metre: Up to 650 tons applied on the fish (pull free)

Settled Solids around casing

Recovered with TITAN System
TITAN System Example Operation

**STEP 1**
Run in hole & Take Pull with rig

**STEP 2**
If No Go set Anchor and Jack

**STEP 3**
If No Go RIH & Cut Deeper

**STEP 4**
Pull back & Take Pull with Rig

**STEP 5**
If No Go Set Anchor and Jack Casing and recover

Repeat steps 3, 4 & 5 As required Without coming Out of the hole
SHORT STRING
TITAN®
CASE HISTORY
COST EFFECTIVE OPENHOLE CASING RECOVERY
The TITAN™ System delivers a 41 hour time efficiency in open hole casing recovery

TITAN SYSTEM
The TITAN System unifies casing cutting and recovery with a downhole hydraulic power tool, in a single trip operation. The downhole adaptability of the TITAN System ensures and maximises the recoverable casing in challenging circumstances by utilizing the pulling capacity of the hydraulic power tool with added repeatable casing cutting capability.

THE OPERATION
The TITAN System was deployed on a semi-submersible rig in the North Sea for a slot recovery operation where the operator required the 9 5/8” casing to be pulled approximately 50m below the 13 3/8” shoe into the openhole. Experience from the field has shown that it has frequently not been possible to recover casing from the openhole using conventional methods.

THE SOLUTION
The TITAN System is Ardyne’s latest patent pending casing recovery technology

Enabling Open Hole Side-Track

TITAN – Cut, Jack & Pull in a single trip
**SINGLE TRIP SEQUENCE - 41 HOURS SAVED**

Breakdown of operational sequence for single trip operation with TITAN System

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rig pull with 250 tonnes - no go</td>
</tr>
<tr>
<td>2.</td>
<td>Activate TITAN and pull 433 tonnes - no go</td>
</tr>
<tr>
<td>3.</td>
<td>Relocate to cut casing</td>
</tr>
<tr>
<td>4.</td>
<td>Rig pull with 230 tonnes - no go</td>
</tr>
<tr>
<td>5.</td>
<td>Activate TITAN and pull 433 tonnes - no go</td>
</tr>
<tr>
<td>6.</td>
<td>Relocate to cut casing</td>
</tr>
<tr>
<td>7.</td>
<td>Rig pull casing free with 247 tonnes</td>
</tr>
<tr>
<td>8.</td>
<td>Recover casing to surface</td>
</tr>
<tr>
<td>9.</td>
<td>Recover remaining pieces</td>
</tr>
<tr>
<td>10.</td>
<td>Open hole sidetrack</td>
</tr>
</tbody>
</table>

**TITAN – Cut, Jack & Pull in a single trip**

Enabling Open Hole Side-Track
RESETTING THE STANDARD FOR OPENHOLE CASING RECOVERY
The TITAN® System - repeatable on demand casing cutting and jacking capability in a single trip

TITAN SYSTEM
The TITAN System unifies casing cutting and recovery with a downhole hydraulic power tool, in a single trip operation. The downhole adaptability of the TITAN System ensures and maximises the recoverable casing by utilizing the pulling capacity of the hydraulic power tool with added repeatable casing cutting capability in a single trip.

THE OPERATION
The TITAN System was deployed on a semi-submersible rig in the North Sea for casing recovery operation where the operator required 400ft of 9 5/8” casing to be pulled from the openhole. Having the TITAN System deployed means immediate action can be taken when conventional methods are ineffective.

THE SOLUTION
The TITAN System not only maximises recoverable casing, it reduces tripping distance, BHA handling and overall trips; saving hours from your operation, improving safety and reducing costs. The TITAN System gives total flexibility on sequencing of repeated jacking and cutting operations in a single trip as it is not reliant on single-use ball drop activation or pipe manipulation. The TITAN System’s capabilities are available on-demand with the tension-activated ALO-Valve, and mechanical of flow activated TYPHOON® Spear enabling multiple cutting and Jacking in a single trip.

TITAN - Cut, Jack & Pull in a single trip
Rock to Rock Cement Plug
TITAN – Cut, Jack & Pull in a single trip

Rock to Rock Cement Plug
CEMENTED CASING RECOVERY
A Proven Alternative to Casing Milling

TITAN® SYSTEM

The TITAN System unifies casing cutting and recovery with a downhole hydraulic power tool in a single trip operation. The downhole adaptability of the TITAN System ensures and maximises the recoverable casing by utilizing the pulling capacity of the hydraulic power tool with added repeatable casing cutting capability in a single trip.

THE APPLICATIONS

<table>
<thead>
<tr>
<th>WELL STAGE</th>
<th>DRIVER</th>
<th>SURFACE UNIT</th>
<th>REQUIREMENT</th>
<th>TITAN SOLUTION</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workover</td>
<td>Well integrity</td>
<td>Rig or Rigless</td>
<td>Sustained annulus casing pressure issues</td>
<td>Restore well / casing integrity by recovering leaking casing / external patch &amp; re-cement</td>
<td>No milling / smart</td>
</tr>
<tr>
<td>Brown Field</td>
<td>Re-entry / Workover</td>
<td>Rig</td>
<td>Slot Recovery Sidetrack Barrier placement (depth)</td>
<td>Open Hole Sidetrack - potential hole size enables by pulling casing below the shoe</td>
<td>Rock to Rock Barrier</td>
</tr>
<tr>
<td>P&amp;A</td>
<td>Permanent barrier plug installation</td>
<td>Rig or Rigless</td>
<td>Casing removal for barrier placements (depth)</td>
<td>Recovering casing in settled annular solids</td>
<td>No BOP Cleaning</td>
</tr>
</tbody>
</table>

SINGLE STRING RECOVERY

DUAL STRING RECOVERY

<table>
<thead>
<tr>
<th>TITAN System</th>
<th>DownHole Power Tool</th>
<th>ALO-Valve</th>
<th>TYPHOON® Spear</th>
<th>Mud Motor</th>
<th>Casing Cutter</th>
<th>Taper Mill</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUNS</td>
<td>750+</td>
<td>200+</td>
<td>170+</td>
<td>Industry Standard</td>
<td>Industry Standard</td>
<td>Industry Standard</td>
</tr>
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TITAN® System - Patent Pending WO2018033473
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