



ProMILL System

The Evolution of Wellbore Integrity Solutions (WIS) Well Abandonment Technology

This technical article highlights the portfolio of WIS technologies used in the Plug and Abandonment (P&A) process.

Installed in 1977, the Dunlin Alpha was a four-legged platform, constructed on a Concrete Gravity Base Substructure with a steel box girder modular support frame. It was located in the UKCS license Block 211/23 in the Northern North Sea (East Shetland Basin).

The structure stood in 151m [495 ft] of water and was over 200m [656 ft] high from the seabed to the top of the drilling derrick. Production started in 1978, and over 522 million barrels of oil were produced over its lifetime. In 2015, production ended, and the decommissioning phase began. The platform topsides removal was concluded in June 2022.

With **45 wells** safely plugged and abandoned over a **5-year** period, several technologies evolved or were developed to improve operational efficiency while preserving wellbore integrity during the abandonment process.

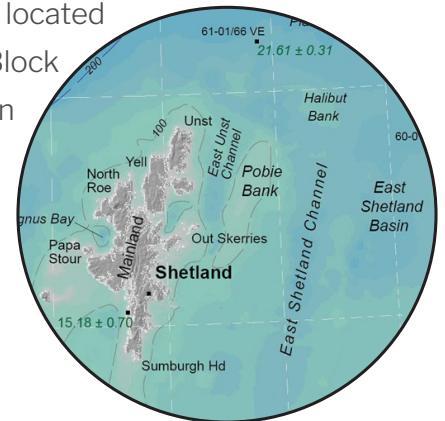




Figure 1
ProMILL
System

Scope of Work and Key Requirements

- Establishment of multiple barriers inside 9 $\frac{5}{8}$ inch and 13 $\frac{3}{8}$ inch casing and rock-to-rock zonal isolation of the production reservoirs.
- Efficient cut and recovery of 9 $\frac{5}{8}$ inch and 13 $\frac{3}{8}$ inch casings.
- Advanced section milling, including:
 - ROP optimization, reliability in high angle wellbores with extended interval lengths, centralizers and collars.
 - Simultaneous underreaming to enable rock-to-rock isolation.
 - Options also included concurrent bridge plug conveyance and setting.
- High capacity, downhole jacking system, spear and expandable anchoring mechanism to mitigate risks and aid casing and conductor recovery operations.

Technology Implementation

The use of **ProMILL System** technology (Fig. 1) dominated the campaign, delivering advanced milling and underreaming capabilities to enable “rock-to-rock” solutions. **Over 12,000 feet of casing was section milled using the ProMILL System** during this project.

- **WavEdge** and **TruEdge** cutting structures were developed to increase durability and improve ROP. This contributed to an improvement in milling performance over the life of the project. (Fig. 2)
- Cutting structure development included, fundamental research in materials science (Fig. 3), structure geometries (Fig. 4), dynamic simulation modeling and full-scale laboratory testing (Fig. 5).
- The ProMILL High Ratio Underreamer (HRU) with application specific cutter arms ensured that the rock interface was prepared for the barrier plug.
- An optional bridge plug in the milling and underreaming BHA offered greater efficiencies.

Milling Performance Improvement

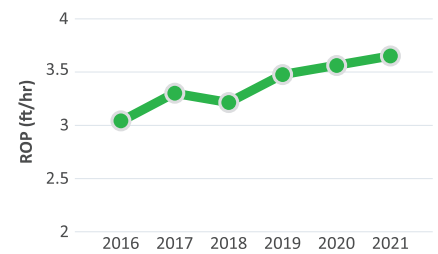


Figure 2

Conductor recovery also presented unique challenges, such as:

- Risk mitigation for known weak, corroded, or parted connectors.
- Dimensional variations, differing casing weight per foot or internal conductor diameter restrictions at the connectors.

A heavy duty, 16 inch diameter **Pipe Cutter** was widely used to perform both 20 inch casing and 30 inch conductor cuts.

A **High Deflection Spear** was successfully introduced to pass through diameter restrictions and pull parted and weak conductors with connectors from the bottom.

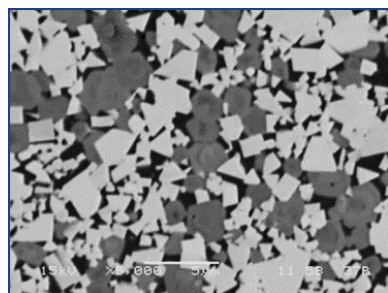


Figure 3 Materials Science

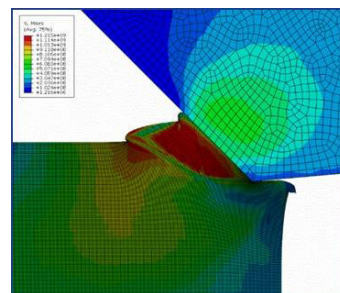


Figure 4 Geometry Analysis



Figure 5 Full-Scale Testing

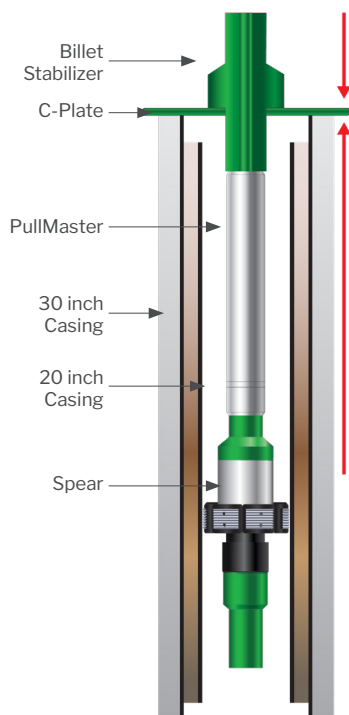


Figure 6
For further information, reference this Performance Bulletin "A Customized PullMaster System with Large Scale Deflection Spear Applied in a North Sea Conductor Recovery Operations"

The **PullMaster Jacking System** was deployed in a unique configuration to recover the 20 inch X 30 inch conductors that could not be recovered using conventional techniques. This system was rated to greater than 1 million lbs. (Fig. 6)

An innovative **Expandable Conductor Anchor** was designed and delivered as a rapid response contingency item during the project. The expandable conductor anchor was designed to pass through the 20 inch casing in its retracted position, and expand to securely retain the 30 inch conductor. (Fig. 7)

Best Practices

Over the 5-year duration of this project, the local team provided focused support to continually improve performance and efficiency for the services provided. Best practices incorporated included:

- Rigorous pre-job planning and risk assessments
- Pre-job data review and post-job analytics
- Brief/debrief of personnel involved
- Capturing and sharing lessons learned



Figure 7

Acknowledgments:

Wellbore Integrity Solutions wishes to thank **Fairfield Energy** for their permission to publish this technical article. Dunlin Alpha Platform photos are courtesy of Fairfield Energy.



OPERATIONAL EFFICIENCY

Reduced Safety Risk



ZERO
HSE SAFETY
EVENTS[†]

78 DAYS
SAVED[†]



4,680
METRIC TONS
REDUCTION

Equivalent CO₂ Emissions:



911
HOMES



ELECTRICITY FOR **1 YEAR**



11.6
MILLION
MILES DRIVEN



1,619
TONS OF WASTE
RECYCLED INSTEAD
OF LANDFILLED



> 97%

SERVICE
QUALITY
SCORE[†]

[†] WIS Activities

Source: United States Environmental Protection Agency (EPA)



Dunlin Alpha Platform

Project Highlights



45 wells
abandoned
over **5-years**

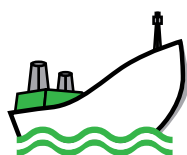


43,000
employee work
hours on the rig

78 total days[°]
saved over the life
of the project



570
shipments
made, with
3,190
individual tools shipped



\$16 million
customer realized
cost savings



An **industry first[°]**
single trip milling
footage of
200 feet of
13 3/8 inch casing
was achieved



A total of
>470
casing cutting, milling
and conductor recovery
jobs were performed:
– **288 individual** casing
cutting applications
– **56 dual string** casing
cutting applications



Over **120 section**
milling runs using
ProMILL technology
85% of milling
runs completed in a
single trip, with
over 100ft average
interval length



An excellent
service
reliability
score[°] of
> 97%
was achieved
during the
campaign

[°] WIS Activities

wellboreintegrity.com

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 **Wellbore Integrity**
SOLUTIONS