

SUPER BAILS:

A practical solution
for managing risk
during locked to
bottom operations

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& David Cree. September 2017.



ABSTRACT

The following paper presents a new and practical solution for managing risk during locked to bottom operations on a mobile offshore drilling rig. AME have developed an innovative product; the Super Bails, with a focus on the practicality of the deployment and use of the equipment.

The basic concept for the Super Bails was to create a simple replacement for standard offshore bails (elevator links) that could provide instant backup compensation in the event of failure of the rig primary system.



BACKGROUND

Offshore work on a floating drill rig involves operations where the work string is physically connected to the seabed. (Commonly referred to as 'locked to bottom' or 'pinned to seabed'). During these operations the drill rig utilises a motion compensation system to account for rig heave and tidal changes.

During standard drilling operations the consequence of the failure of the compensator system is limited, however during operations when hydrocarbons are introduced into the string and the drill rig is locked to bottom there is potential for a Major Accident Event. These operations include well interventions, work overs, completions and well testing.

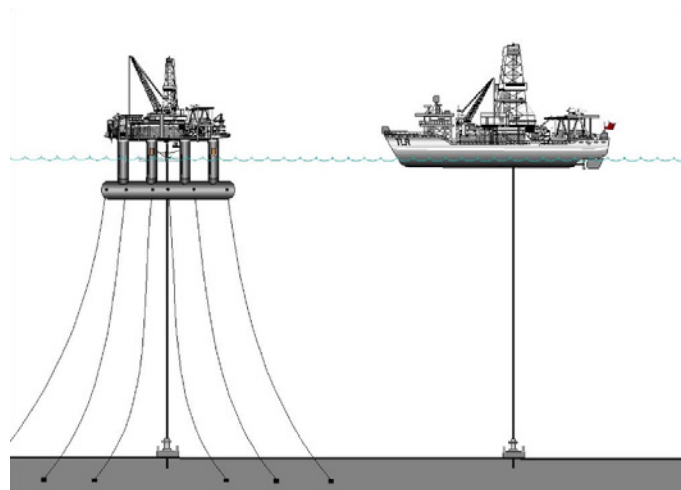
The compensator system controls tension in the work string. In the event of a compensator lock-up or failure, the rig will continue to heave potentially over-tensioning or buckling the work string. This could result in uncontrolled equipment in the derrick or a significant hydrocarbon release.

Rig compensator lock-up or failure can be caused by a multitude of sources, depending on compensator type. Identified failure modes include, but are not limited to: MRU failure, PLC card/software errors, electrical issues (including rig black or brown-out), sensor failure, hydraulic failure or leakage, pneumatic failure, valve malfunction or accidental activation, mechanical failure and human error.

The frequency of such failure is hard to define as the consequence during non-"locked to bottom" operations is much less severe and under reported. There has been a history of known failures and lock-ups in both active and passive compensators (Nardone et al, 2016).

While the likelihood of an occurrence remains low, industry experience has shown that failure does occur and the consequence has the potential to be significant.

Operators, rig owners and regulatory bodies are increasingly aware of the risk of failure of the primary compensator and often incorporate a back-up heave compensation system to mitigate the risks.



Acronyms

AHD: Active Heave Draw-works

API: American Petroleum Institute

ALARP: As Low as Reasonably Practicable

CCTLF: Compensating Coiled Tubing Lift Frame

CT: Coiled Tubing

DNVGL: Det Norske Veritas Germanischer Lloyd

DST: Drill Stem Test

MAE: Major Accident Event

MODU: Mobile Offshore Drilling Unit

MRU: Motion Reference Unit

NOPSEMA: National Offshore Petroleum Safety and Environmental Management Authority

PCE: Pressure Control Equipment

PLC: Programmable Logic Controller

PLT: Pressure Logging Tools

RAO: Response Amplitude Operators

SFT: Surface Flow Tree

TD: Total Depth

TLF: Tension Lift Frame

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may allow a MODU which was previously unsuitable for a certain campaign to comply with an operator or regulatory authority's requirements

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EXISTING SOLUTIONS

At the time of writing there are several solutions to provide back-up compensation available in the market. In general these can be broken down into two main types.

Large complex systems that provide protection for both over and under tension

These solutions are large and difficult to handle. Thus transportation costs are significant and the time to rig up and down adds considerable cost to each well. The activation and reset relies on either complex valves, sensors or human activation that brings with it increased risk of the system not functioning when required in an emergency.

Smaller simpler systems that only provide over tension protection.

These solutions only protect the string from over tension and fail to provide support during the downward part of the heave cycle. This leaves the string susceptible to buckling and also means that equipment above the drill floor is unsupported both vertically and horizontally creating risks to personnel and equipment. They provide short term protection and normally require the well to be shut in after activation.






THE PRACTICAL SOLUTION

After consultation with the oil and gas industry AME determined that a gap in the market existed for a practical solution that could provide all the required functionality for **managing risks during locked to bottom operations within a simple and compact design.**

The basic concept for the Super Bails was to create a **simple replacement for standard offshore bails (elevator links) that would provide instant backup compensation if the rig primary system failed.**

For the original concept AME targeted an aggressive set of development goals, which included:-

- A self-contained unit with no external accumulators or high pressure piping / hoses.
- Standard bail ends to interface with existing rig equipment complete with threaded connectors and API certification.
- Tension and compression protection: 12ft extension and compression to accommodate rig heave and tide movements.
- A completely passive system that does not rely on valves, sensors or human intervention for activation or reset.
- A sleek outer design without hang-up points.
- No requirement for rig services for operation.
- A system that would not affect the driller's standard operations.
- No additional deck equipment required to support operations.
- A completely weldless solution
 - Welding high tensile steel is inherently more problematic
 - Minimises inspection regime
 - Simple change out of parts for maintenance
- No valves within the system that could affect the unit operation in any position.
- An internal mechanical lock to limit stroke during rig up if required in derricks with limited head room.
- An internal anti recoil system that could not affect operation.
- Zone rated wireless communication back to drillers shack.
 - No cabling in derrick
- Produce equipment that would be familiar to handle for the rig floor crew.
 - Rig up procedure similar to standard bails
 - Save critical path rig time.
- Being road transportable without permits
 - Allows for cost effective fast mobilisation
- Using existing industry proven technology, as much as possible, in an innovative way to guarantee offshore success
- Achieving full DNV design certification to API 8C and DNVGL-OS-E101.
- Meeting the requirements of API17G / ISO 13628-7.



“ The Super Bails have proved to be the simplest and best solution for backup passive compensation I’ve worked with

Atwood Osprey OIM

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DESIGN, MANUFACTURE AND TESTING

The AME team conducted an extensive review of potential manufactures and eventually selected a European company with significant experience in the design and manufacture of heave compensators, within the oil and gas sector, who also had a track record of delivering products to meet all of DNVGL’s stringent requirements.

Test facilities were also identified in Europe to allow testing of components, both standalone and when incorporated as a full system.

AME engineers were present for the full duration of manufacture and testing. This allowed the project team to monitor manufacture, perform load tests, witness pressure testing and ensure compliance with AME’s QHSE system.

Extensive testing was carried out to refine the anti-recoil system design during this process. The test facilities were also used for full load testing of all the units and mechanical locks.

On completion of load testing the units were shipped to a drilling facility in Scandinavia to undergo full function testing. This included cyclic testing and a high load anti-recoil release test.

CERTIFICATION

DNVGL were engaged to provide full certification of the units to: -

- API 8C: Drilling and Production Hoisting Equipment; and
- DNVGL-OS-E101: Drilling Plant.

This included the following:

The final units have a full DNVGL product certificate.

SUPER BAILS TECHNICAL SPECIFICATION

System load rating: 500 ton (1000 kips)

Stroke length: ± 12 ft (extension/retraction)

Operational length: 50ft

Transportation: DNVGL 2.7-3 baskets

Min. Design temperature: -20°C

Certification body: DNVGL

Rig services required: Nil

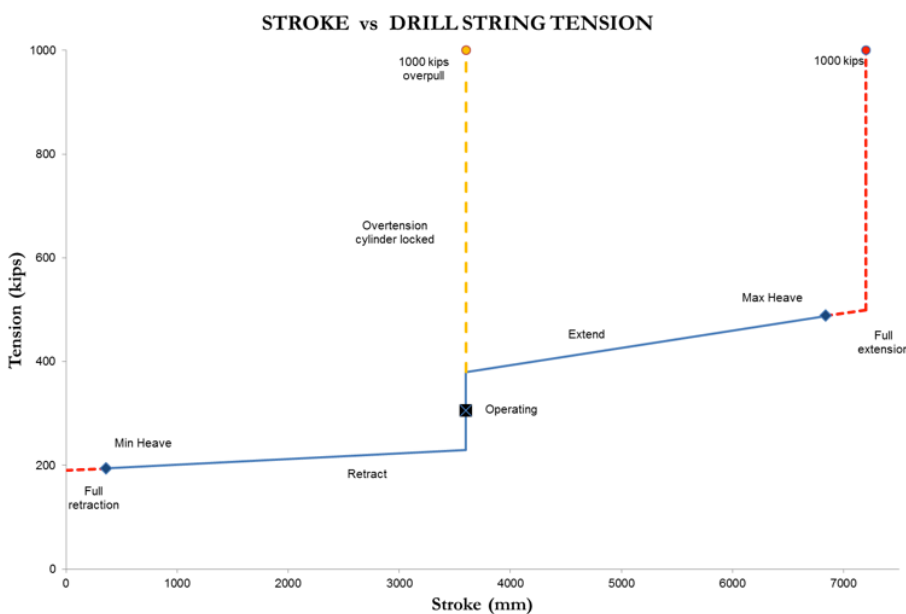
FINAL PRODUCT

The final product consists of a pair of Super Bails incorporated between an upper and lower spreader beam as shown in the image to the right.

This set up provides a working area between the bails for well intervention equipment (wireline, coiled tubing, etc) and PCE.

Each Super Bail consists of dual hydraulic cylinders and internal accumulators. End connections are typically standard elevator links (API bails). The different characteristics between the upper and lower cylinder allows for an operational working window to exist with one cylinder fully extended and the other fully retracted. This working window allows for the Super Bails to act as a completely passive system with automatic activation providing complete over and under-tension protection.

The graph below shows the typical set up for the Super Bails. It defines the relationship between tension and stroke and clearly shows the operating window. This window ensures that the Super Bails do not stroke until a predetermined tension is reached. The dotted line shows the unit being operated with or without the mechanical lock engaged.



FINAL PRODUCT

The simple rig-up follows the typical steps with which the rig personnel install standard bails. This allows for minimal critical path time during installation, saving up to 24 hours per well of rig time compared to more complicated systems.

The simple design of the Super Bails requires minimal technicians for the rig-up, operation and rig down, reducing costs and freeing up critical bed space on the rig during flow back operations.

The Super Bails are fully commissioned prior to rig up and once installed in the derrick are ready for use: again minimising critical rig time.

The units allow the rig crew to operate their own primary systems, with which they are familiar, and the Super Bails do not interfere with these systems in any way.

The Super Bails do not rely on manual intervention, sensors or valves to activate or reset. By removing potential failure modes the reliability of the system is greatly improved.

Through the integration of over-tension and under-tension (compression/buckling) protection, the Super Bails system provides the rig crew sufficient time to troubleshoot and address most causes of compensator failure and bring the primary system back online. In the event that the primary system can't be brought back on line

the Super Bails provide time for the rig crew to shut-in the well in a controlled method and not as an emergency.

Should a planned or unplanned subsea unlatch, or string failure occur' an internal anti-recoil system has been incorporated within the design of the system. The purpose of this system is to ensure a controlled retraction of the Super Bails.

In summary the Super Bails have been designed with practicality in mind. They are simple, safe, reliable and easy to rig-up. Most importantly they provide an additional layer of protection to mitigate risk during locked to bottom operations.

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The AME Super Bails were safe and easy to rig-up, the lift and rigging plans that came with the system were easy to read and worked as drawn. Everything interfaced exactly as planned and we were able to operate the active heave draw-works and rig equipment as per normal. The AME engineers who were on site were fully aware and competent in the use of the Super Bails.

The Super Bails have proved to be the simplest and best solution for backup passive compensation I've worked with.

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Overall, we found the Super Bails to be cost effective, fit for our purpose, and very straight forward to use.

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Customer well test engineer



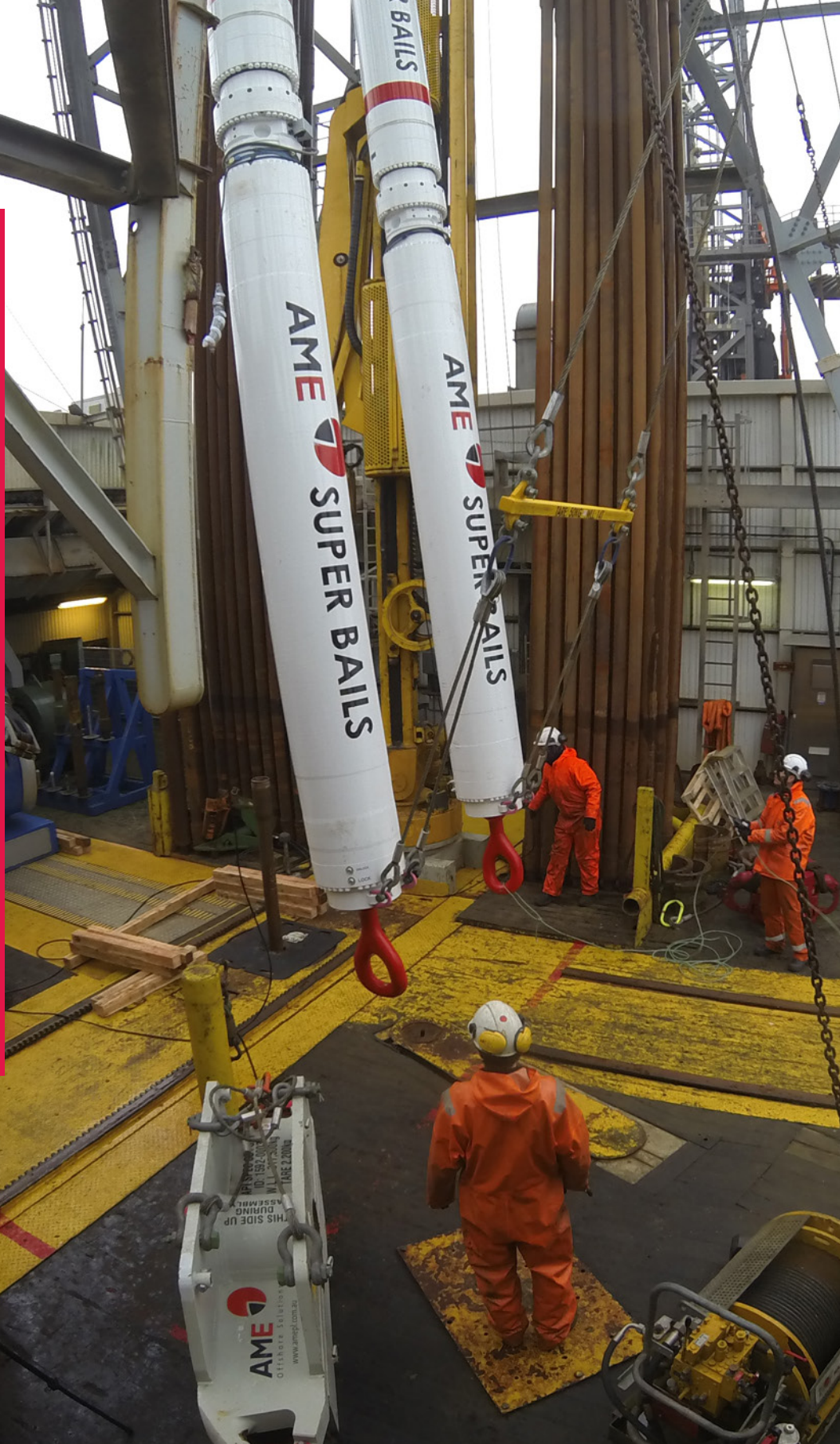
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The Super Bails behaved exactly as required both during on-line function testing and throughout the operation as a whole. Picking them up and laying them down was as quick and easy as with a pair of 50ft rigid bails.

Overall, we found the Super Bails to be cost effective, fit for our purpose, and very straight forward to use.

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Customer well test engineer.



FIRST PROJECT

The first offshore project for the Super Bails was for Conoco Phillips DST campaign in the Barossa Field in the Timor Sea utilising the Atwood Osprey in May 2017. A detailed account of this project can be found in the case study by *Jim Matthews (Conoco Phillips Senior Drilling Supervisor)*.



SUPER BAILS FEATURES

Over-tension Protection (12 feet)	✓
Under-tension Protection (12 feet)	✓
Anti-Recoil System	✓
String tension retained after activation	✓
Completely weldless solution	✓
No deck infrastructure required	✓
No derrick infrastructure required	✓
Minimal wellsite crew	✓
Simple rig-up	✓
Completely passive system able to function with external loss of power	✓
Free of external high pressure hoses or exposed piping	✓
Zone rated wireless communication	✓
Condition monitoring system with alarms	✓
Fully code compliant	✓
Can be used with active heave systems	✓
Can be used with passive heave systems	✓
Can be used as Primary Compensator	✗
Field tested and proven	✓
Interfaces with third party wireline & coiled tubing PCE	✓

