



Dual String Section Milling Technology

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Endura[®] Dual String Section Mill (DSSM)

Product Development & Offshore Case Study

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Decom North Sea Conference, Aberdeen AECC 24th May 2017

| AGENDA

- Introduction and Technology Background
- DSSM Overview
- Operational Procedure
- Onshore Testing
- Offshore Field Trial – Case Study
- Conclusion
- Questions

CROSS-SECTIONAL BARRIERS - CONSIDERATIONS

UK WELL ABANDONMENT GUIDELINES

- Permanent Barrier with full Cross-Sectional Seal

WELL CONDITIONS

- Annular / Annuli content:
 - Is there Cement? How Much? What Quality is it?
 - Are there Moveable solids?
 - Sustained annular pressure?
- Depth of zone to be isolated?
- Hole Deviation?
- Age of Well? Date Suspended? Last Intervention / Work Over?

SURFACE EQUIPMENT

- Rig v. Rigless
- Space available – Equipment and Accommodation (POB)
- Loading Restrictions
- Torque Capacity
- Swarf Handling Equipment
- Logging Equipment Available/Planned

CLIENT REQUIREMENTS / ABANDONMENT PHILOSOPHY

- Well Abandonment Philosophy
- Barrier Testing / Plug Acceptance Criteria
- Previous Experience with relevant Technology & Tools
- Available Well Data

TECHNOLOGY / METHODOLOGIES

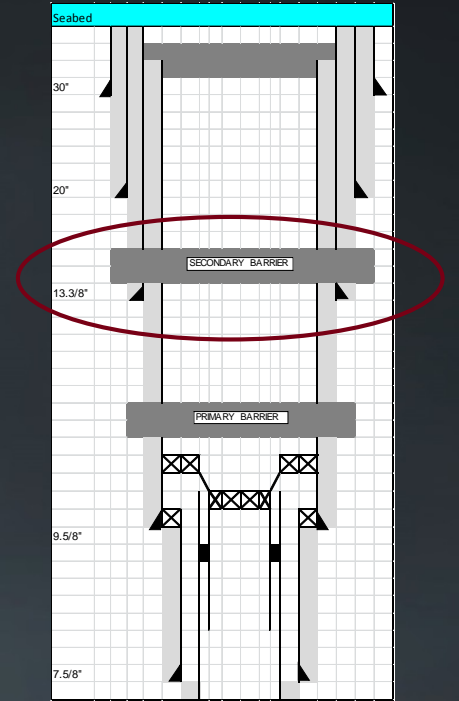
- Section Milling
- Casing Cut & Pull
- PWC / Plug & Perf.
- Other – Technologies under development.....



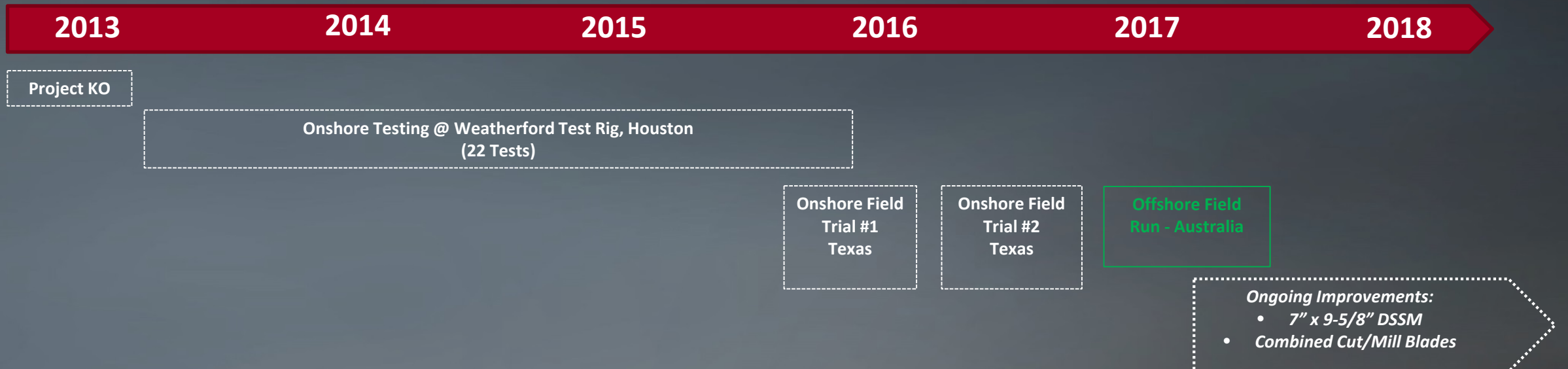
DSSM - INTRODUCTION & BACKGROUND

Purpose of the Tool

- To establish a window for setting a Permanent Cross-Sectional barrier during permanent Well Abandonment operations,
- To Section Mill a window of 13-3/8" casing string through a 9-5/8" restriction.



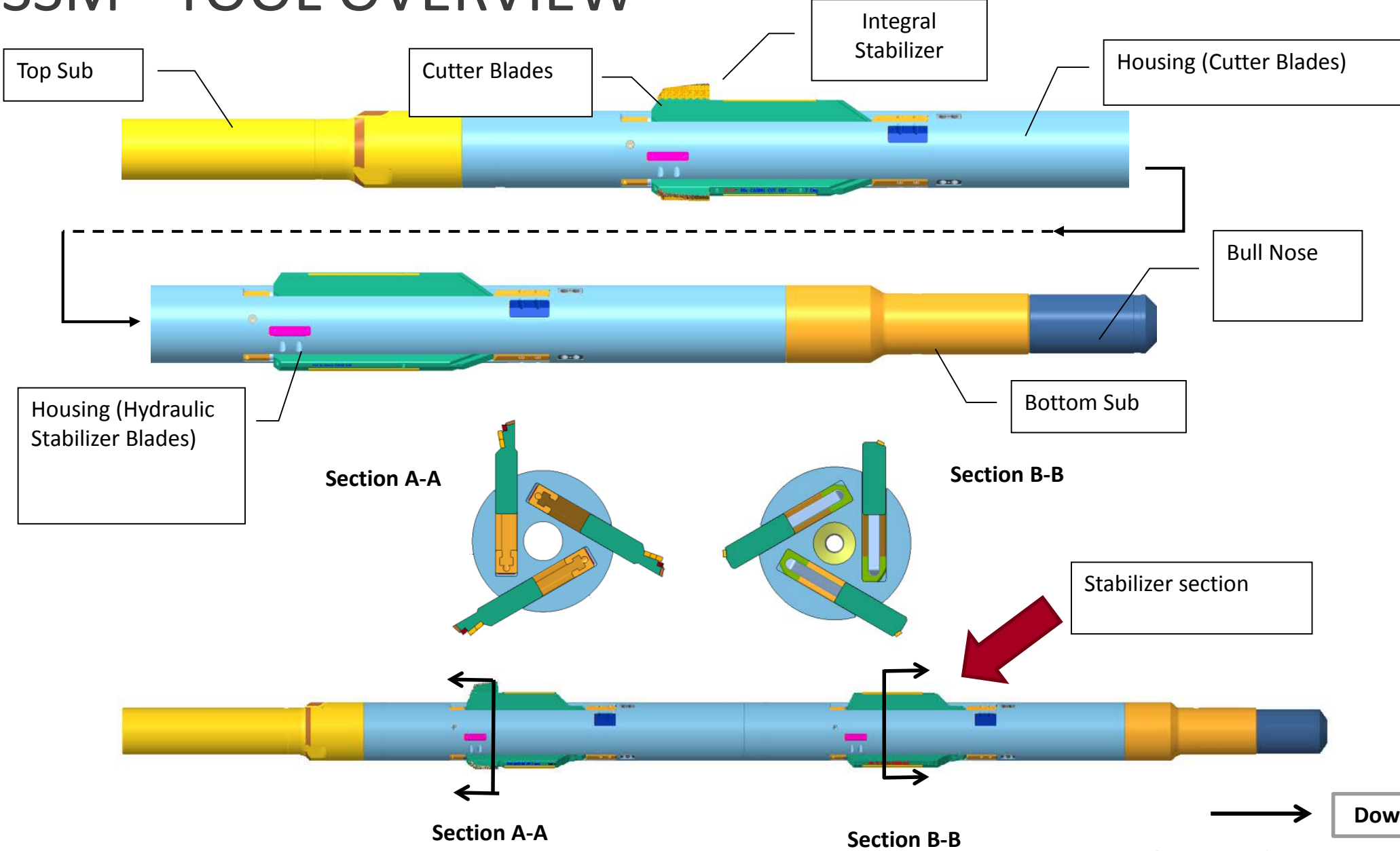
DSSM Development



DSSM - OPERATIONAL SEQUENCE

- Firstly, a standard 9-5/8" Section Mill is used in order to create the initial window in the 9-5/8" casing.
- Milling the two adjacent strings independently is done due to:
 - Handling the amount of swarf from both strings would be extremely challenging.
 - The knife sweep required would be much larger to account for eccentricity casing strings and casing couplings.
 - The possibility of the inner string moving in the milling operation if not bonded.
- On the 1st run the DSSM will perform the cut out of the 13-3/8" casing with special cut out blades and mill until these blades are consumed.
- On the 2nd run the DSSM will perform the milling operation with the 13-3/8" length of full gauge cutting structure.
- On all DSSM runs, the expandable hydraulic stabiliser gives full gauge stabilisation bringing the BHA to the well center for optimum centralisation, stabilisation and enhanced milling performance.
- Centralization is extremely important feature in all milling operations
- ***Link to DSSM video...***

DSSM - TOOL OVERVIEW



DSSM – ONSHORE TESTING



Endura® DSSM going through the Rotary Table during Testing

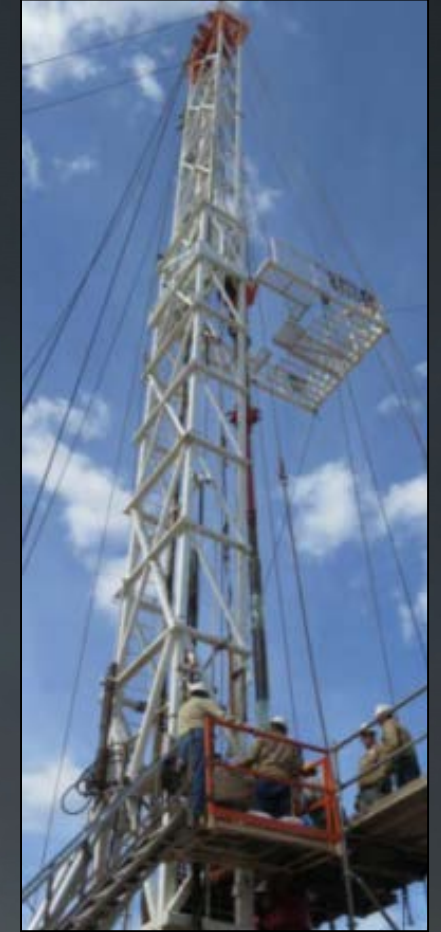
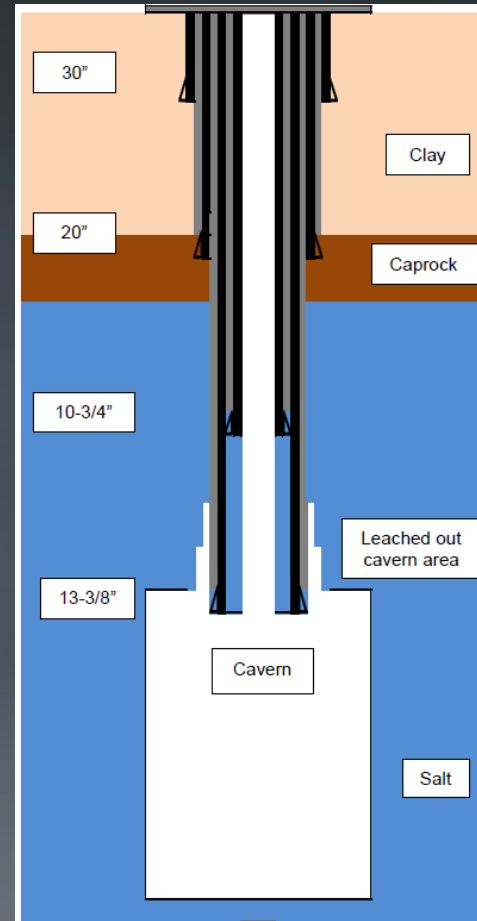
Overview

- We have conducted 22 rig tests from September of 2013 thru January 2016. Testing has been done on Weatherford Test Rig # 1 at our R & D facility in Houston, Texas
- Test Depth approximately 1,000 ft.
- Section milled both 9-5/8" and 13-3/8" Casings
- Tests included a variety of downhole conditions:
 - With cemented and un cemented annulus
 - Eccentric or concentric casing conditions.
 - Cutting out and milling in both casing sizes
 - Cutting out in the 13-3/8" coupling with 14-3/8" OD
- Testing included various carbide insert attack angles to achieve the optimum performance and manageable swarf



DSSM – ONSHORE FIELD TRIALS

- Successful field trial in a gas storage well going through 10-3/4" casing. Cut out and milled 15 ft. of 13-3/8" casing and coupling until the tail pipe dropped into the cavern.
- Second Field trial was successfully completed in a gas storage well going through 10-3/4" casing. Cut out and milled 38ft of 13-3/8" 96ppf.



Pre-Abandonment Well Schematic and Land Rig from Case Study #1, Salt Dome.

DSSM – OFFSHORE CASE STUDY

Project Background

- Offshore Location: Australia
- Well Type: Platform
- Rig Type: Jack Up
- Date: January 2017
- Objective: In a challenging offshore well, our customer required a 100ft permanent barrier to be installed at 820ft to 920ft MD inside 9-5/8” 47ppf and 13-3/8” 53.5ppf casings.
- Considerations: Several years previously, the customer had performed a top-up cement job on the 9-5/8” x 13-3/8” annulus which prevented the casing being cut & pulled conventionally.

As a result, the customer deemed the only way to gain sufficient access to be able to section mill the 13-3/8” casing would be to Pilot Mill the 9-5/8” casing and then Section Mill the 13-3/8” casing.

Typical Timing Estimate - Pilot Mill 9-5/8” & Section Mill 13-3/8” Option	
Cut & Pull ~30ft section of 9-5/8” casing	0.21 days
Pilot Mill 9-5/8” casing from 30ft to 920ft MD	8.63 days
Section Mill 100ft window of 13-3/8” casing 810ft to 910ft	2.20 days
TOTAL CUMULATIVE RIG TIME	11.04 days

DSSM – OFFSHORE CASE STUDY

Weatherford Approach

- An A-1 section mill was used to remove a 115ft section of the 9-5/8” casing, facilitating a clean, usable window.
- The Weatherford Endura® Dual String Section Mill (DSSM) was deployed offshore for the first time, reaching TD and performing the cut out of the 13-3/8” casing successfully.
- The DSSM was then run back in hole d/w the milling blades, removing a further 98ft of the 13-3/8” casing.

The Result

- A 100ft Cross-Sectional Permanent Barrier successfully achieved, in full compliance with the customers internal Well Abandonment guidelines and local Australian Oil & Gas Regulations.
- **4.9 DAYS OF RIG TIME SAVED PER WELL**

Actual Well Timing based on Weatherford Endura® DSSM	
Section Mill 9-5/8” Casing, 118ft window (Including Tripping, Milling & Hole Cleaning)	2.89 days
Section Mill 13-3/8” Casing with DSSM, 100ft window (Including Tripping, Milling & Hole Cleaning)	3.25 days
TOTAL CUMULATIVE RIG TIME	6.14 days



CONCLUSIONS

- Establishing a Cross-Sectional Permanent Barrier is one of the most, if not the most, crucial aspect of the Well Abandonment process.
- There are a multitude of variable factors which drive the various Tools, Technology and/or Methodologies utilised today in Well Abandonment operations.
- The Weatherford Endura[®] DSSM is one of these Tools - and is now a fully commercialised Product with a proven track record onshore and offshore.
- Ongoing developments will improve the DSSM performance in the near future; primarily combined cut out/milling run and a smaller Tool for 7" x 9-5/8" Well Configuration.
- As it stands, there is not a '*one size fits all*' approach..... whether there ever will be, is very much open to interpretation and opinion...

QUESTIONS? Q&A THANK YOU WEATHERFORD

WEATHERFORD Q&A

THANK YOU

Weatherford

ANSWERS ? Q&A

ANSWERS YOU THANK QUESTIONS Q&A

QUESTIONS? ANSWERS THANK YOU

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