EXPLORING THE DARK

Pierre Boyde, Commercial and Business Development Director of DEEPOCEAN

presents

Development Of The World's Most Advanced Trenching System: RT-1

14 March 2013

Introduction

Brief Company Overview

RT-1 Development History and Design

RT-1 Overview

Experience 2009-2010

- North Sea Trials
- Piggyback Pipe Trenching off Irish Coast
- North West Shelf Trials

RT-1 Look Ahead

Brief Company Overview

Key Company Statistics

Corporate Information:

- Group Head Office: Amsterdam
- In business since early 1990's
- Number of employees: ~1,000

Fleet Details:

- Owned vessels: 7
- Chartered vessels: 9

Subsea or Mission Equipment:

- Trenchers & Ploughs: 17
- Remotely Operated Vehicles: 22
- Mattress Installation Lifting Frame: 1
- Module Handling System: 1

Company Overview

Installation: installation of components in subsea oil & Gas fields and wind farms

Seabed Intervention: use of trenchers and ploughs to excavate soil, mud or rock areas for subsea field development

Inspection, Maintenance & Repair: recurring activities to support the operability of subsea infrastructure

Survey & Seabed Mapping: use of observation-class ROVs to visually survey, inspect and map terrain prior to the installation of new subsea production systems (wells, pipelines, templates) and to assess pipeline conditions

Decommissioning: the removal of infrastructure at the end of a subsea field's life

RT-1 Development History & Design

DeepOcean identified: ‘there was an industry need for cost-effective tool to stabilise planned natural gas trunklines as of the and flow in Australian North West Shelf’

In 2006 DeepOcean committed to build RT-1.

Detailed Design and Build
carried out by Soil Machine Dynamics

The RT-1 concept was developed after:

- Extensive review of available NWShelf Geotechnical data
- A series of design reviews
- 40% scale model trials

RT-1 (original specification) Overview

Operating Depth	500msw
MaximumTrench Depth	2m – current configuration
Trench Profile	45 degree wall ‘V’ trench
Dimensions LxWxH	22.5x13x9.6m
Weight in Air	140-200mt, depending on configuration
Pipe Handling	2 triple roller cradle assemblies, 65mt lift each
Buoyancy	up to 100mt
Pipe Size	1.5m overall outside diameter
Power	2,300kW : - 1,050kW to cutter assemblies; - 320kW to dredge pumps; - 700kW to jetting pumps

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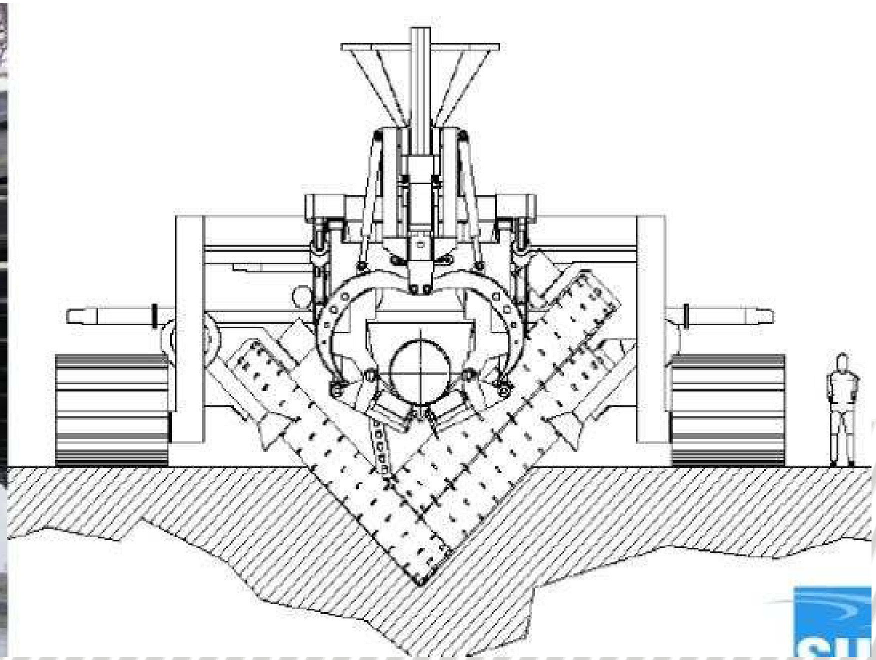
Operational History

August 2009 – Full Scale Trials – North Sea

October 2009 – 11.5km Piggyback Pipe Trenching – Ireland

March 2010 – Full Scale Trials – North West Shelf, Australia



Full Scale Trials – North Sea

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8th – 16th August 2009 off Coast of Northumberland

Geotechnical –

- Flat featureless seabed identified as being composed of sands over soft silts or fine sands.
- No trials specific data, soils data (e.g. VC/CPT) collected during the trials phase.

Performance –

- Trench slope angles ranged between 30-38°, allowing progress rates of up to 350m/h, whilst still retaining a good trench (1.9 - 2.0m) depth. **<u>(200% faster and than could be achieved with ploughing technique in these soil conditions and 70% less fuel burn)</u>**
- In sands, vehicle forward speeds limited not by vehicle power or cutter performance, but by the capacity of the dredge pumps to clear an open trench.

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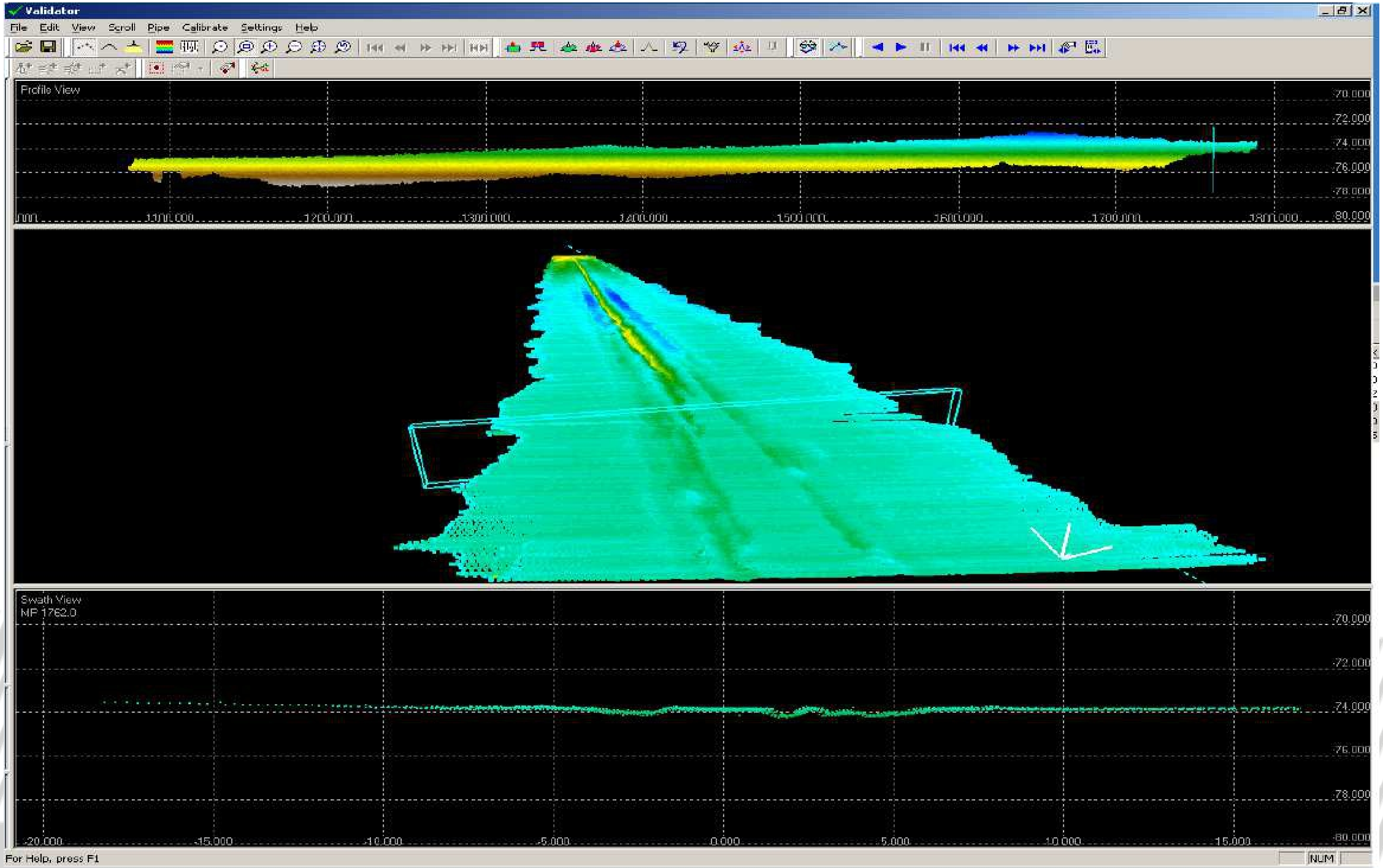
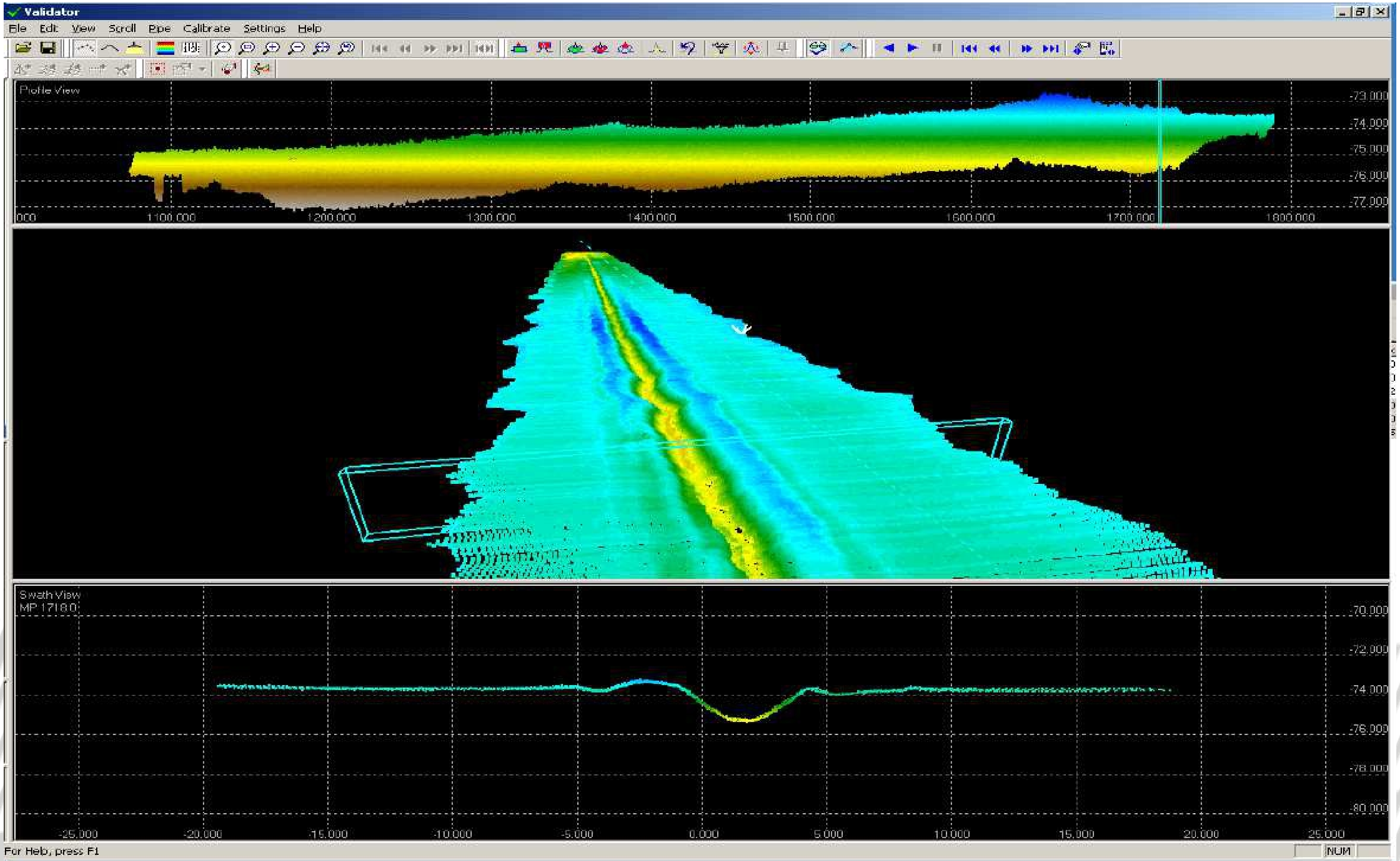
Full Scale Trials – North Sea

MBES Data ‘Screen Grab’ – Start Transition In



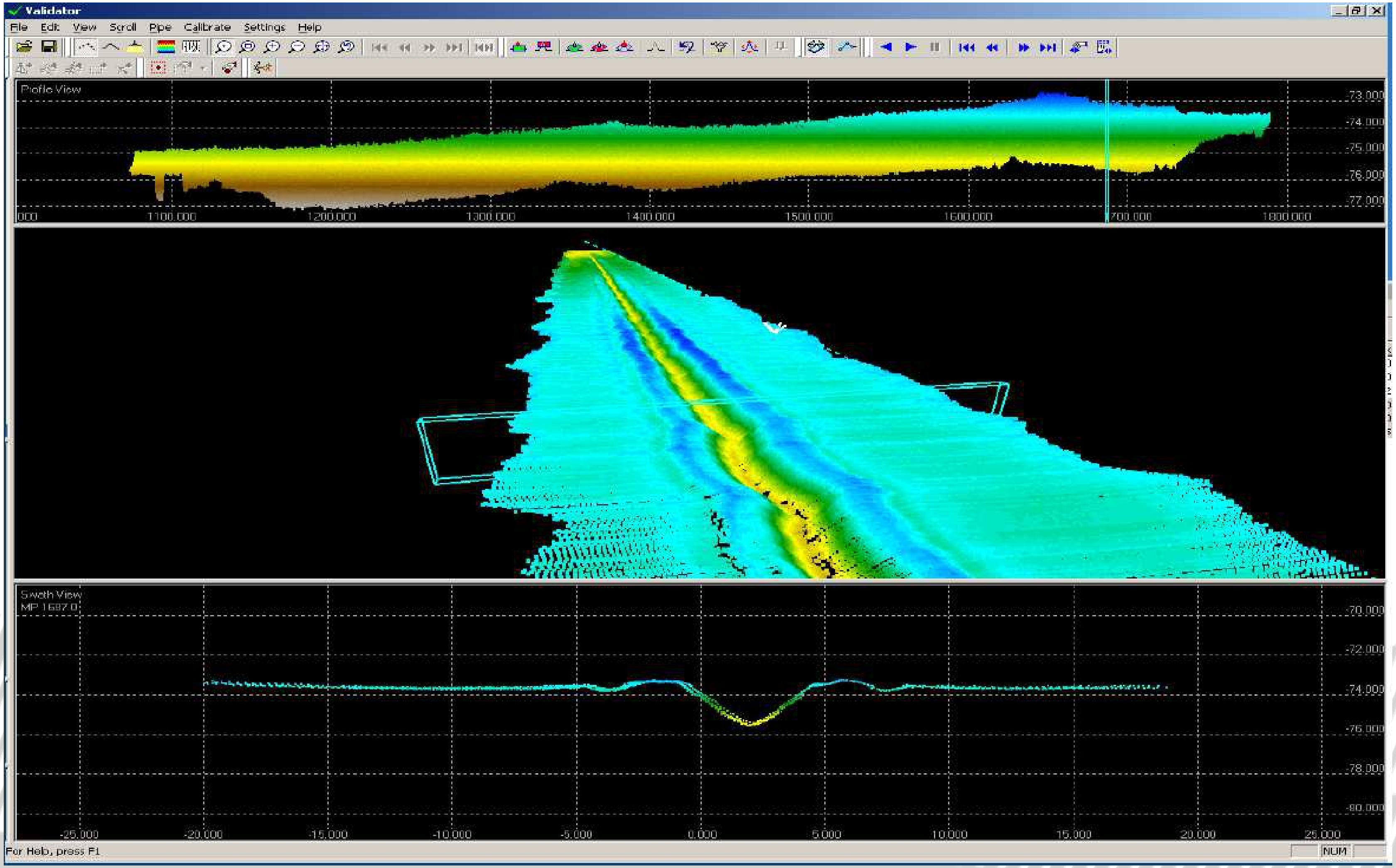
Full Scale Trials – North Sea

MBES Data ‘Screen Grab’ – Cutter 1 & 2 100% - Trench Depth 1.9m



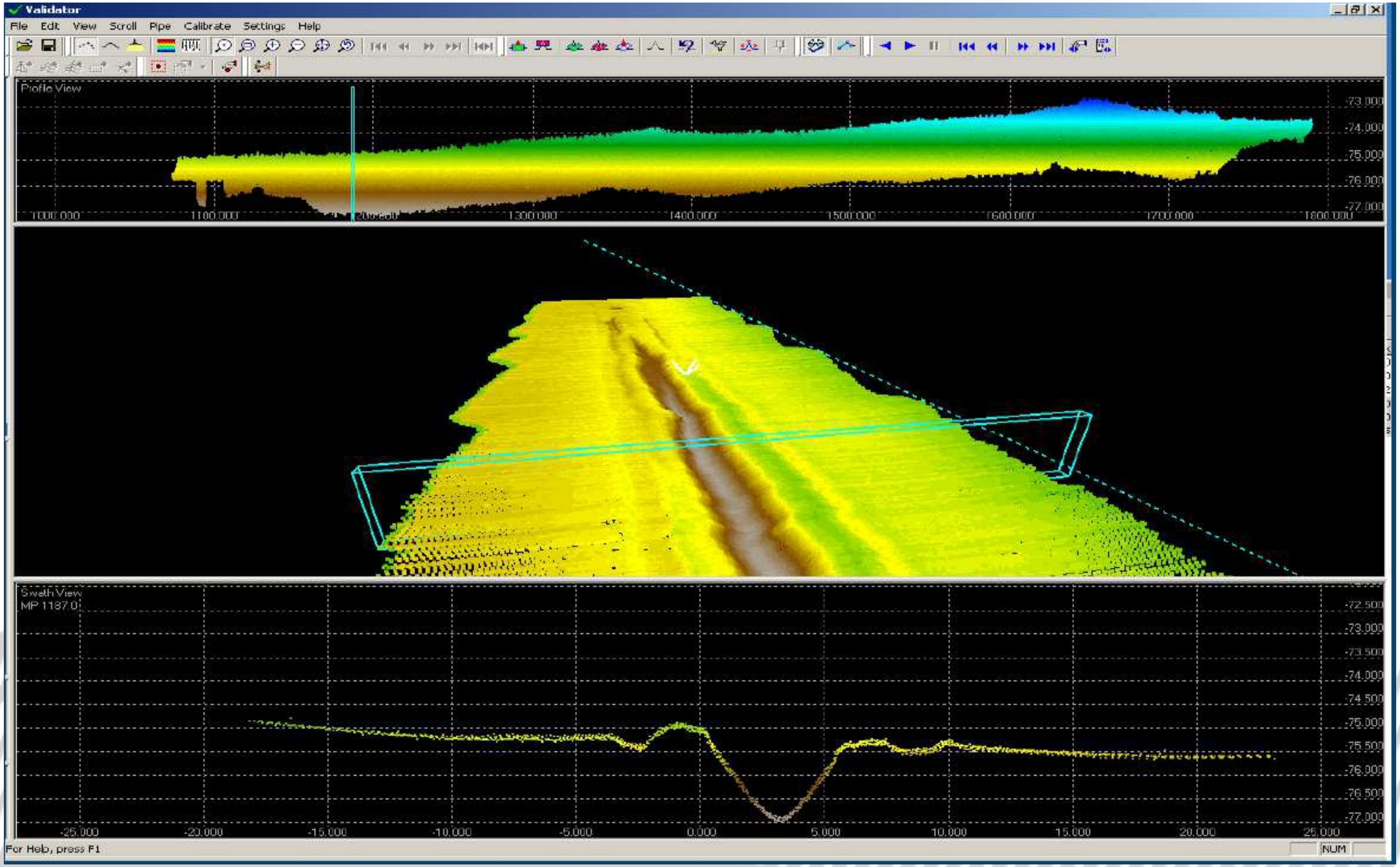
Full Scale Trials – North Sea

MBES Data 'Screen Grab' – Fully Graded in – Trench Depth 2.0m



Full Scale Trials – North Sea

MBES Data 'Screen Grab' – Start of Grade out – Trench Depth 1.6m



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Trenching Contract - Ireland

October 2009 – Trenching

SOW – Approx 11.5km trenching 20” / 10” piggyback pipe – DOL 0.6m

Geotechnical –

- Medium dense to very dense fine to medium sands
- Rock out crop

Performance –

- Trench slope angles as low as 20°
- Reduced forward speed to <100m/h trenching, driven by aft dredge pumps performance to excavate fine sands

Trenching Contract - Ireland

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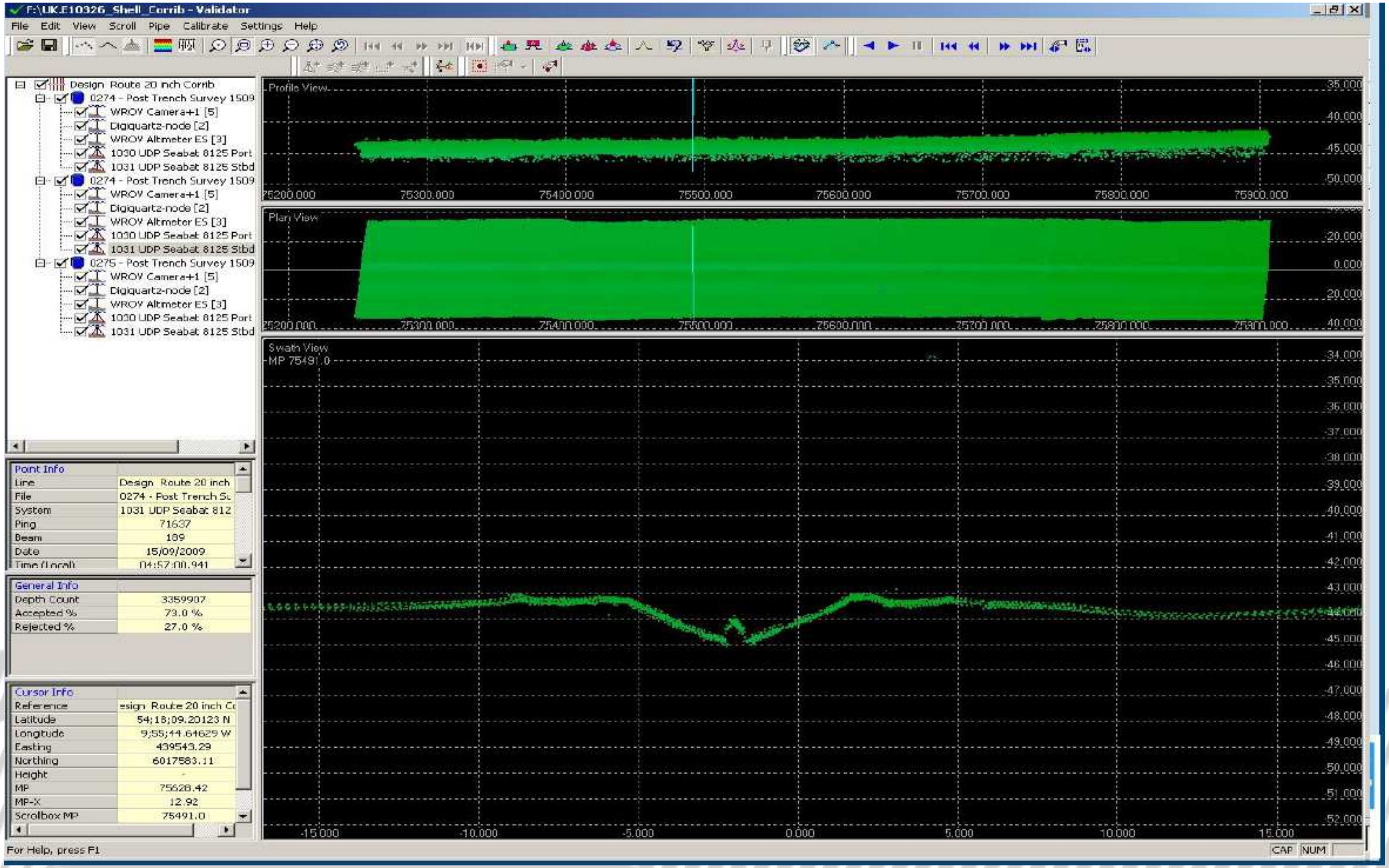
Survey Data ‘Screen Grab’ – Typical Trench Profile



March 2010 – Trenching

OBJECTIVE:

- Assess RT-1 performance in the “worst case” soil types present at trial site;
- Provide data for the creation of a model for assessing RT-1 future performance on other projects across the NW Australian Shelf;
- Monitor the environmental impact upon the marine environment of RT-1 trenching operations in terms of noise and turbidity.

Trenching Trial – North West Shelf

Geotechnical – 4 Trench Trials conducted:

Trench 1:

Intermittent veneer ofl ow velocity (<1,600m/s) unconsolidated sediments less than 1m thick overlying high velocity (1,900-3,000m/s) weak to well cemented sediments.

Trench 2:

Veneer (less than 1m thick) of non to weakly cemented sediments (<2,100m/s) overlying moderately cemented sediments (2,500-3,000m/s). Three cores showing weak to strong cemented material at surface & within the trench depth at all three locations.

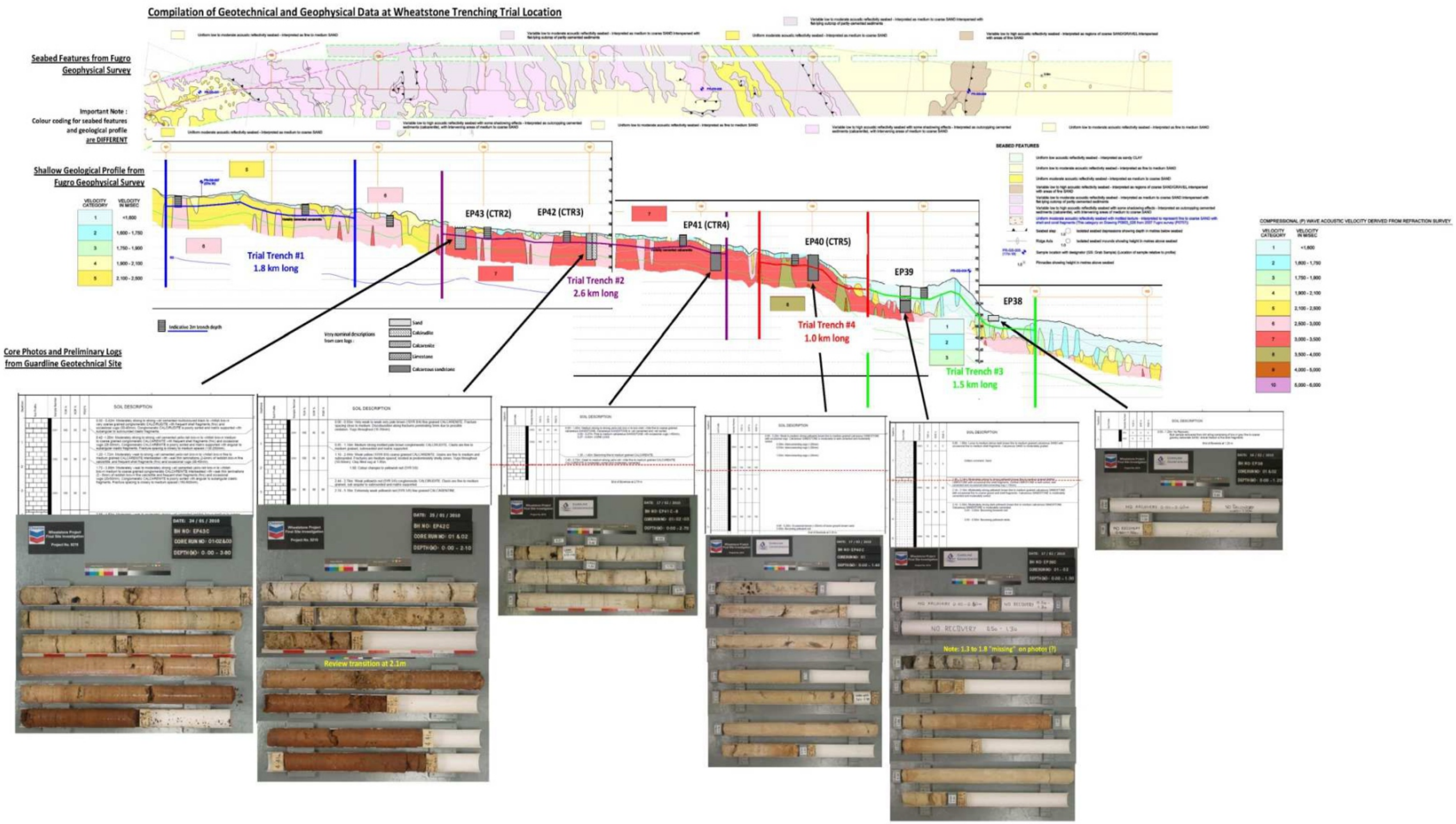
Trench 3:

Unconsolidated sediments (v <1,750m/sec) up to 6m thick overlying cemented sediments (,1750-3,000m/sec). Two cores indicate loose to medium dense sand over moderately strong to strong cemented material.

Trench 4:

Seismic velocities indicate veneer of low velocity material (<1,900m/sec) overlying high velocity material (2,100-4,000m/sec). One core indicating weak to moderately strong sandstone throughout the trench depth.

Trenching Trial – North West Shelf



Trenching Trial – North West Shelf

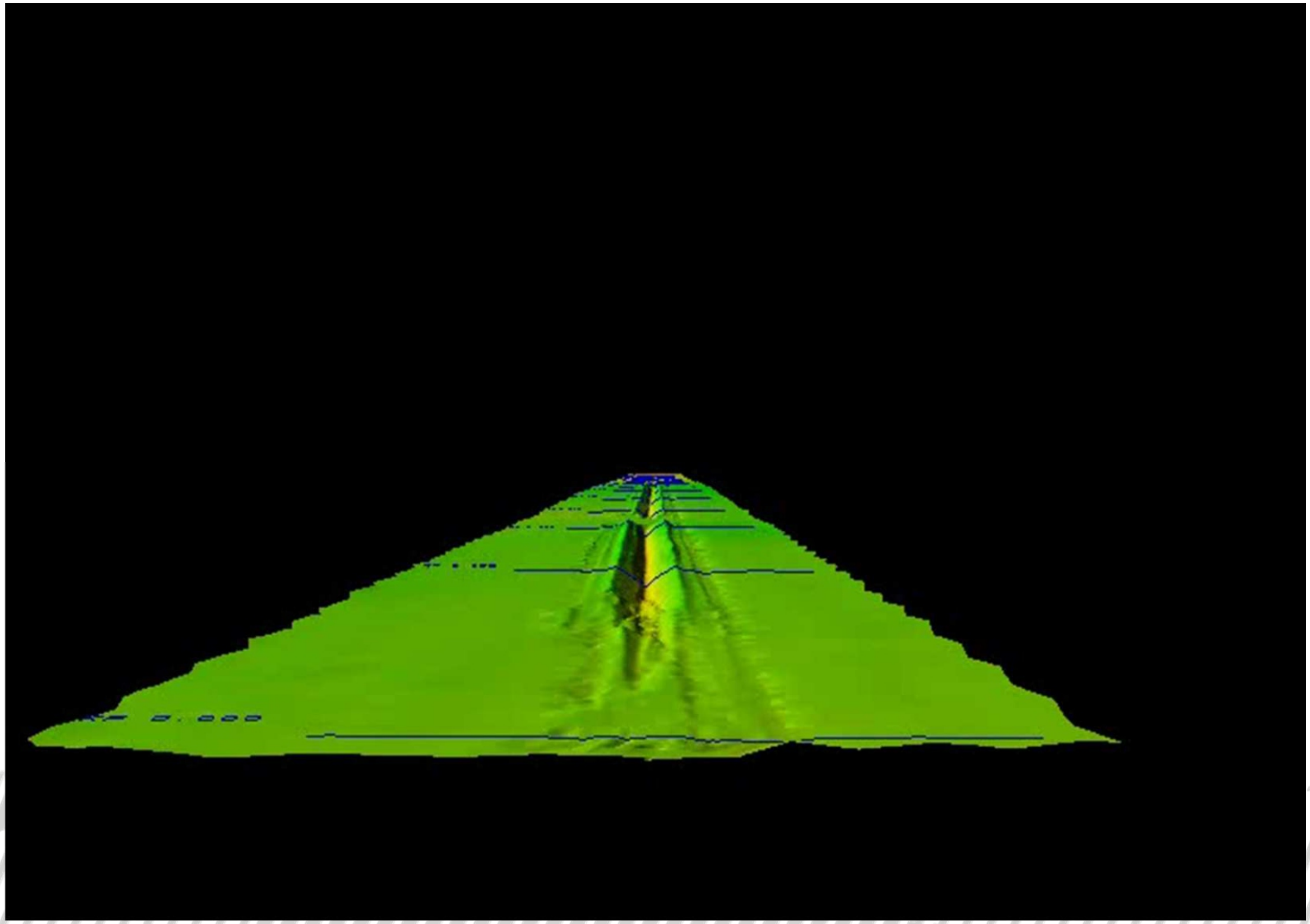
Performance:

An attempt has been made to correlate the available seismic refraction data with the seabed as described in the cores.

Table below is an attempt to correlate seismic velocity vs. performance

Indicative Seismic Velocities (m/sec)	Trench No.	Dive No.	Progress Rates (m/h)	Trench Depth (m)	Seabed Type
<1,750 (low)	3	8	110 - 230	2.0	Sands
1,750 – 2,500 (medium)	1	1 & 2	60- 100	2.0	Weak to moderate weak cemented material
	2	12 & 13			
	4	9			
2,500 – 3,500 (medium-high)	2	14 & 15	10 - 50	0.5 - 2.0	Moderately strong cemented material
	4	10			
3,500 – 4,000 (high)	4	11	Trenching not possible with current configuration	0.0	Sandstone

North West Shelf results: fly-through video



Trenching Trial – North West Shelf

Conclusions:

- In material with a low seismic velocity (< 1,750m/s, sands) a 2m trench depth was achieved (114m/h, driven by environmental monitoring restrictions).
- In material with a medium seismic velocity (1,750-2,500m/s, moderately weak cemented) a 2m trench depth was achieved (60-100m/h).
- In material with a high seismic velocity (10-15% of the route, >2,500m/s, moderately strong cemented) RT1 was not always able to create a 2m trench depth (13-28m/h). However along Trial Trench #2 a 2m trench was achieved in materials with a seismic velocity up to 3,500m/s.
- An 'ultra' hard ground cutting system has now been designed that would be able to cut systematically in materials of high seismic velocity (up to 3,500 m/s)

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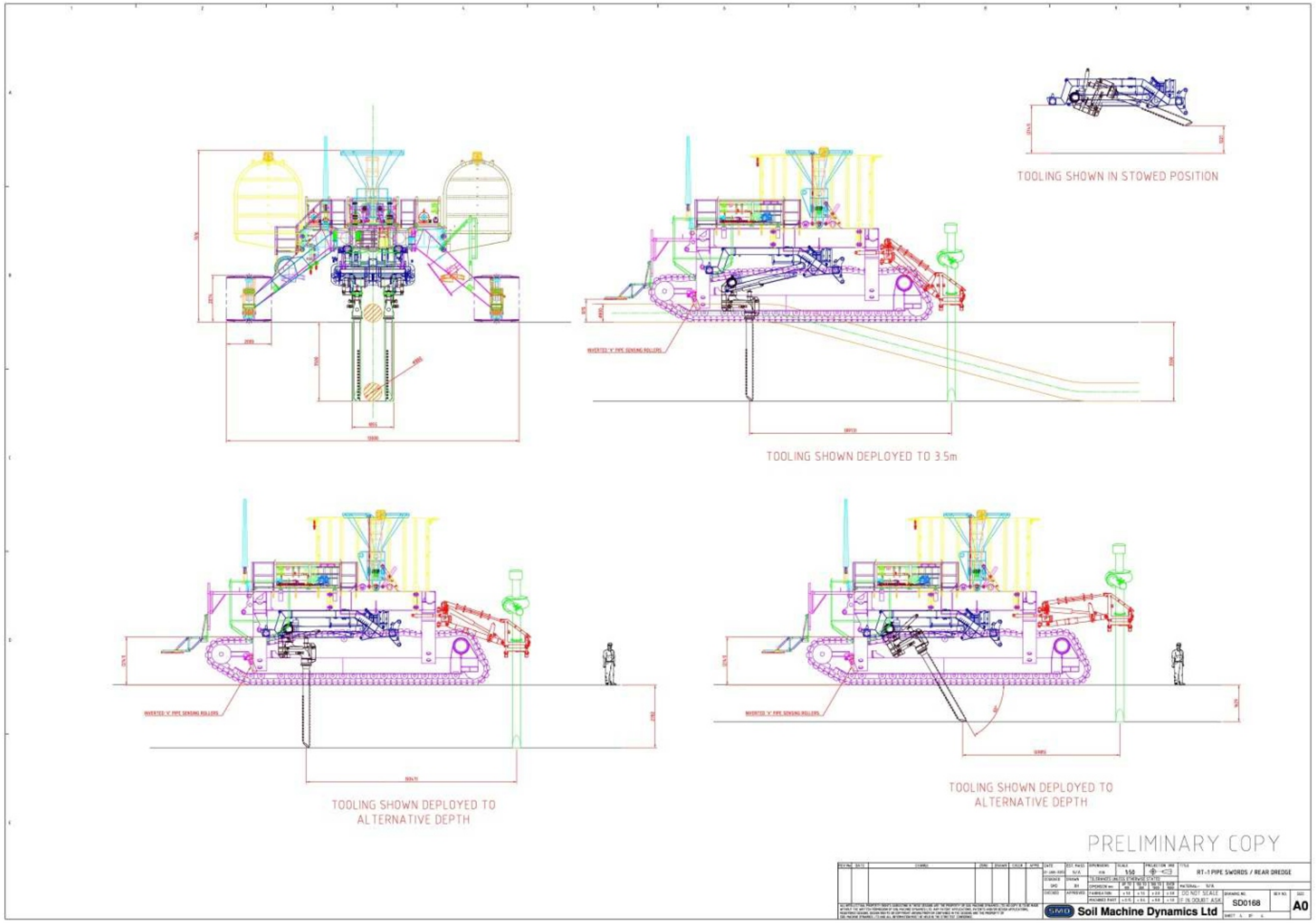
NEW RT-1 permanent home: Havila Phoenix

Havila Phoenix - Operational Q1 2014

Havila Phoenix

Multi-Role Flex Lay, Trenching, Construction Support
DPII
LOA x Breadth 125m x 23m (Vessel will be lengthened by 15m in winter 2013)
140 POB
2000te Carousel ; up to 4000 Te deck load.
250te and 20te AHC Subsea Cranes
250te AHC A-Frame
Industry Leading RT1 & Q1000 Trenching Spread

NEW RT-1 Pipeline Jetting Mode



Pipe Line Jetting Configuration	RT-1	UT-1
Max Trench Depth	3.5m	3.0 m
Max Product Diameter	1500mm	1000 mm
Max Available Jet Pump Power	1900 kW	1500 kW
Max Available Dredge Pump Power	360 kW	N/A

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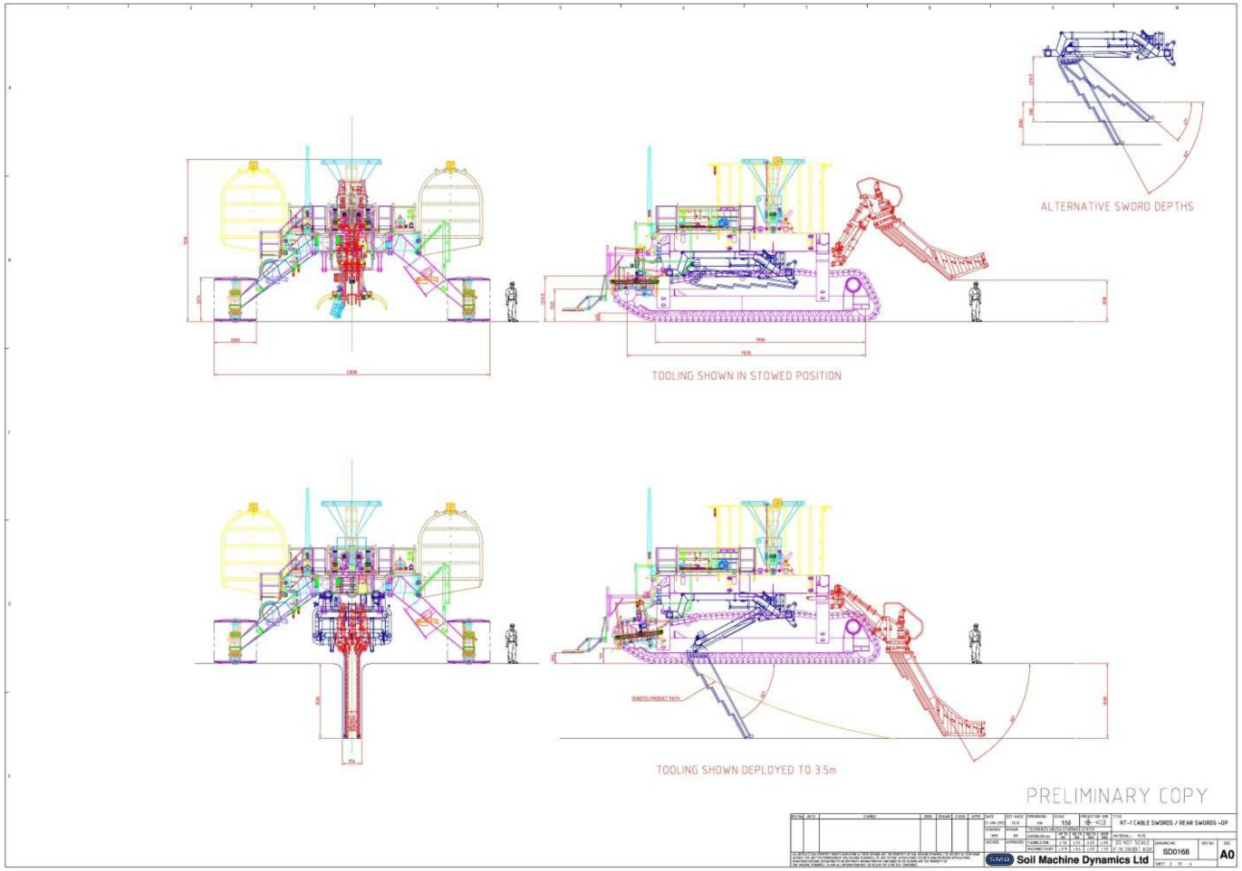
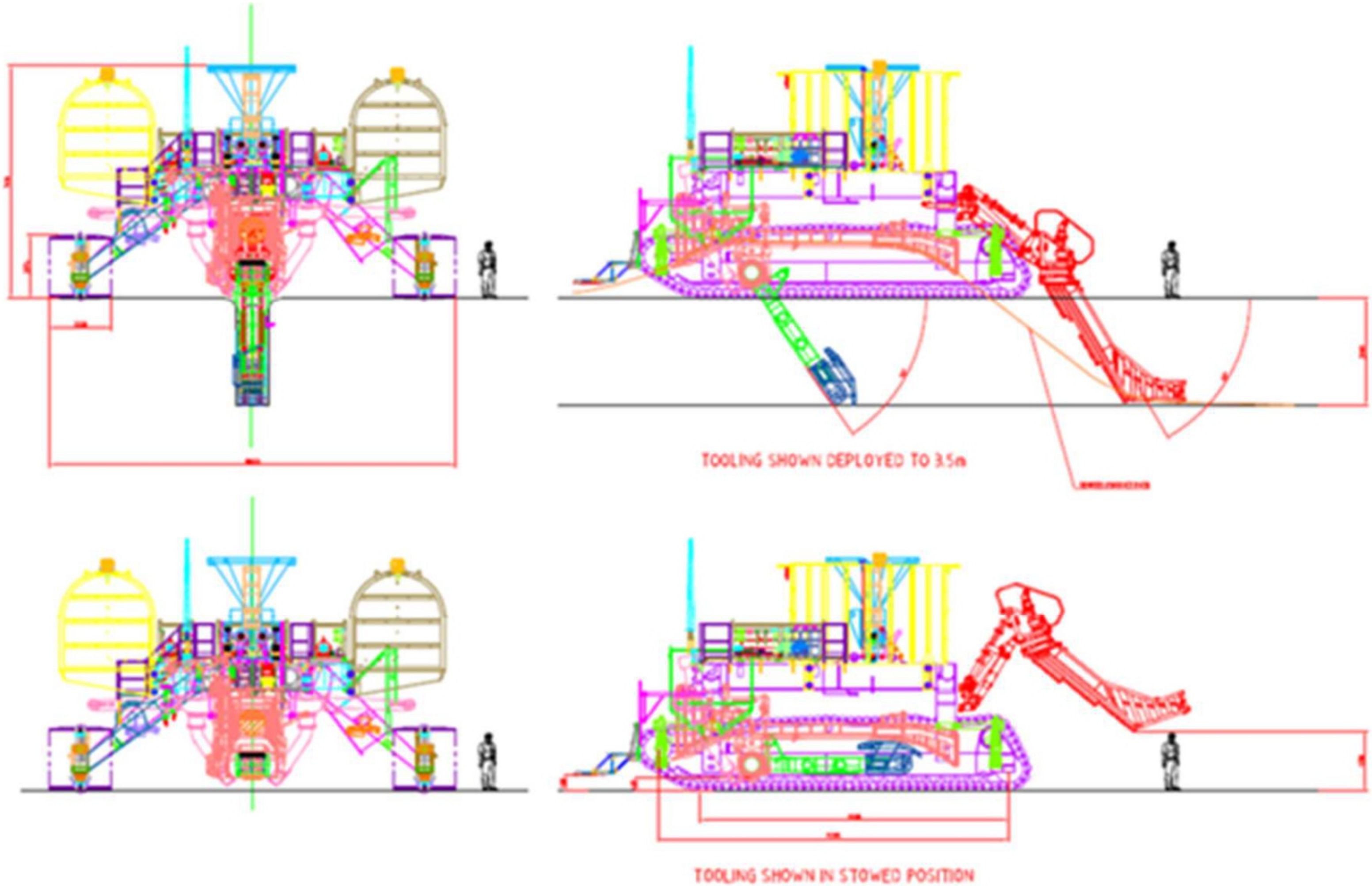
NEW Deep Cable Trenching Mode - jetting



Cable Trenching Mode	RT-1	UT-1
Max Trench Depth	3.5m	3.5 m
Max Jetting Power Forward Jet Legs	1200 kw	750 kW
Max Jetting Power Backwash legs	700 kW	750 kW

NEW Deep Cable Trenching Mode - cutting



Any questions?

Thank you