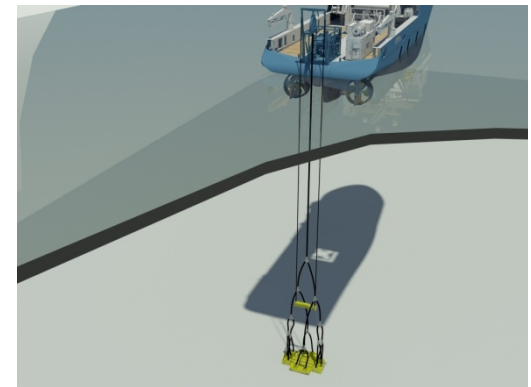
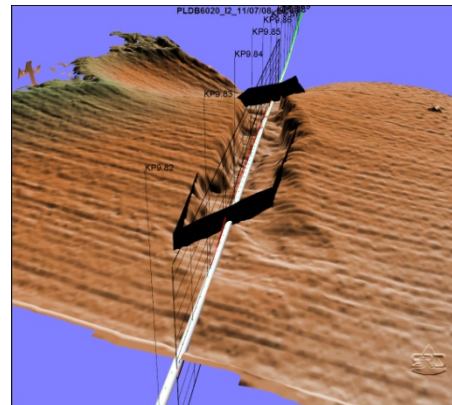


MMS Arctic Technologies Workshop

Pipeline Trenching



- Field Operations: Equipment & personnel, Integrity monitoring of plants and pipelines, ultrasonic technology, Manning of platforms & FPSOs
- Petroleum Services: G & G, Well Planning and Execution support for operators of all sizes
- Drilling Services: Wellbore Tools, Riserless Mud Recovery, Excavation and Trenching
- HQ Norway; bases in UK, US, Brazil, Canada, Russia, Azerbaijan, Kazakhstan, UAE, Egypt, Singapore, Malaysia, Australia

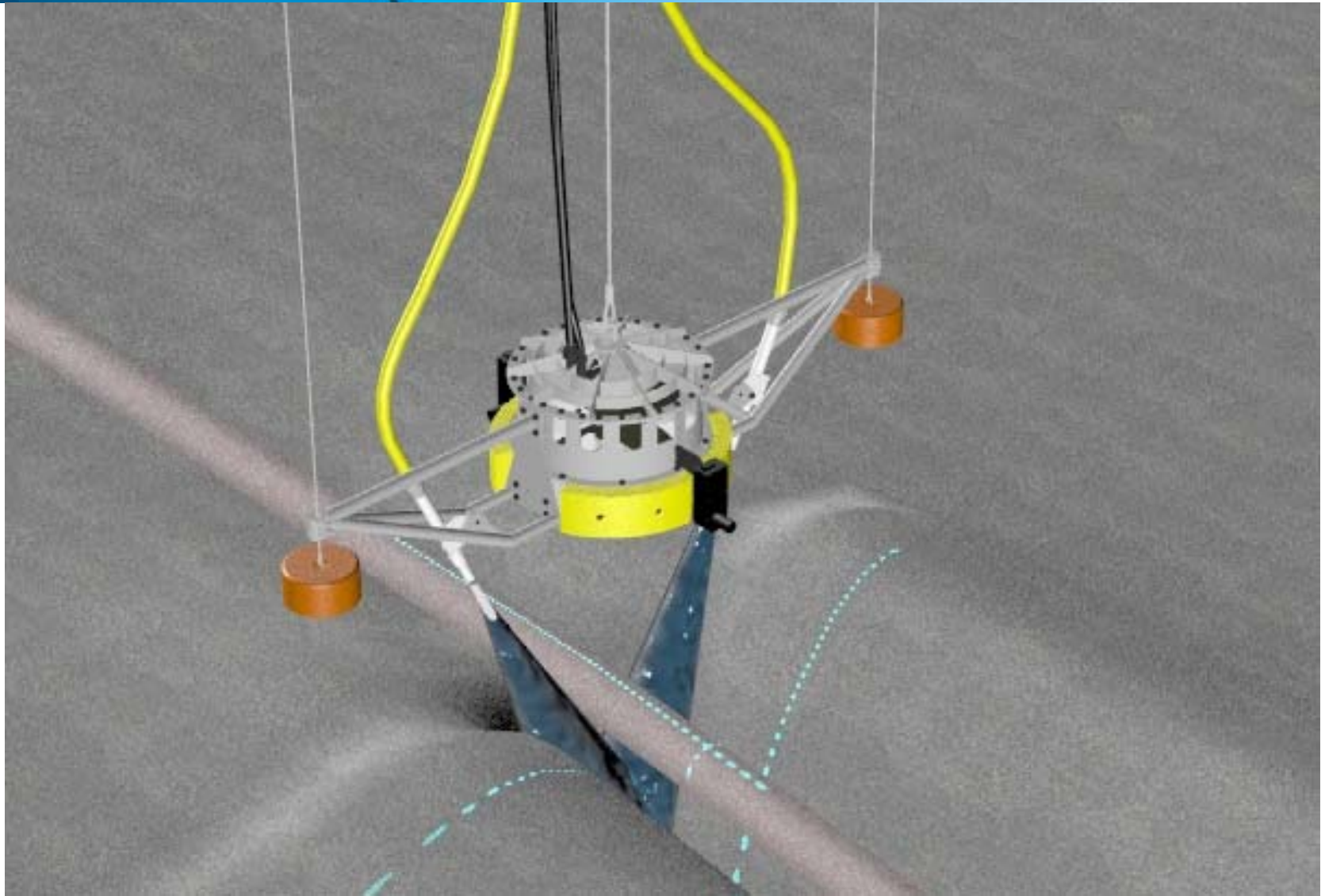
Mass Flow Excavation - SeaVator



- The use of a downward facing ship's propeller to disturb seabed sediments
- Low pressure, high volume
- Can be used with or without high-pressure jets
- Fluidising rather than digging the seabed
- No contact with seabed or seabed architecture.



SeaVator equipped With V-Jets

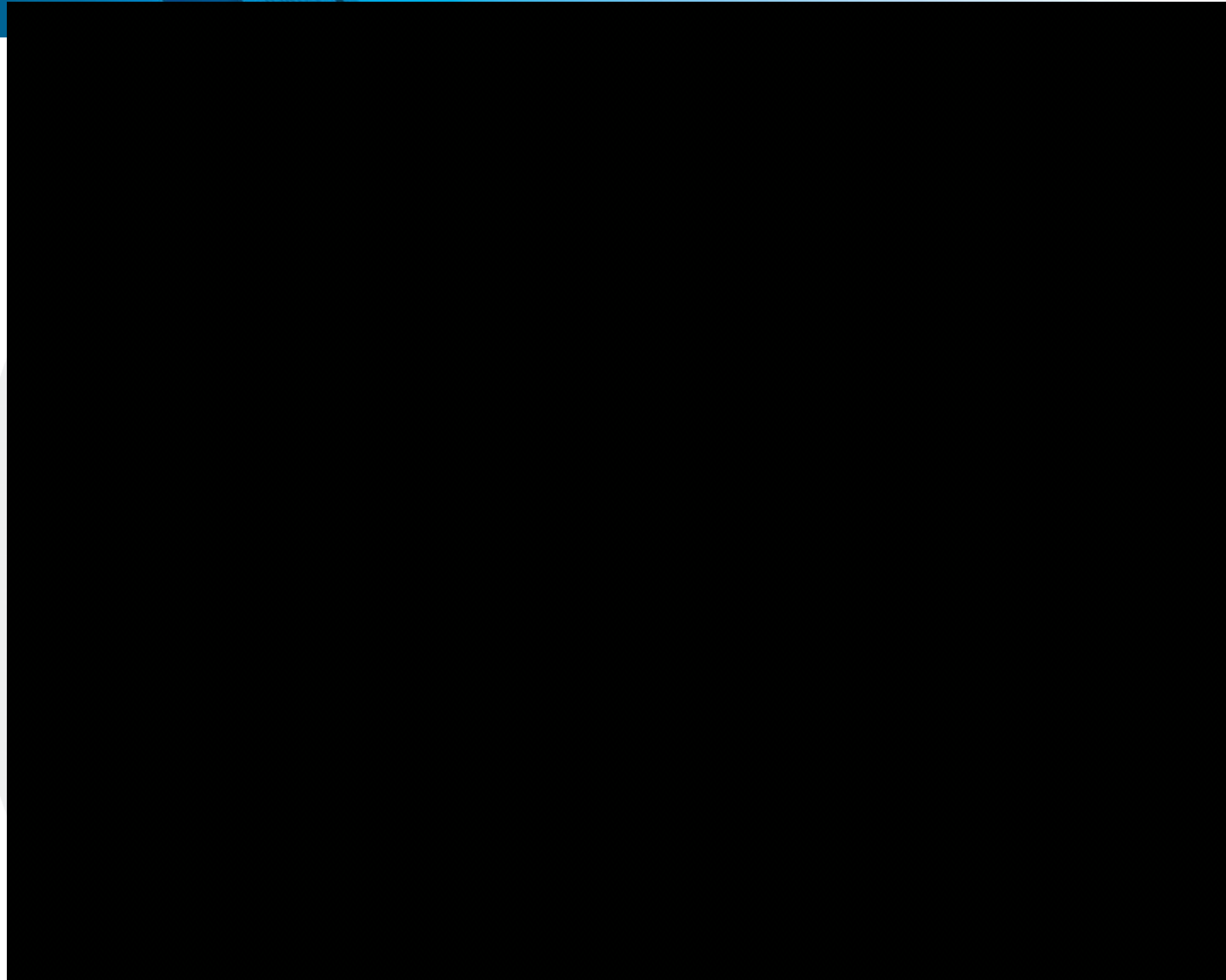


Mass Flow Excavation applications

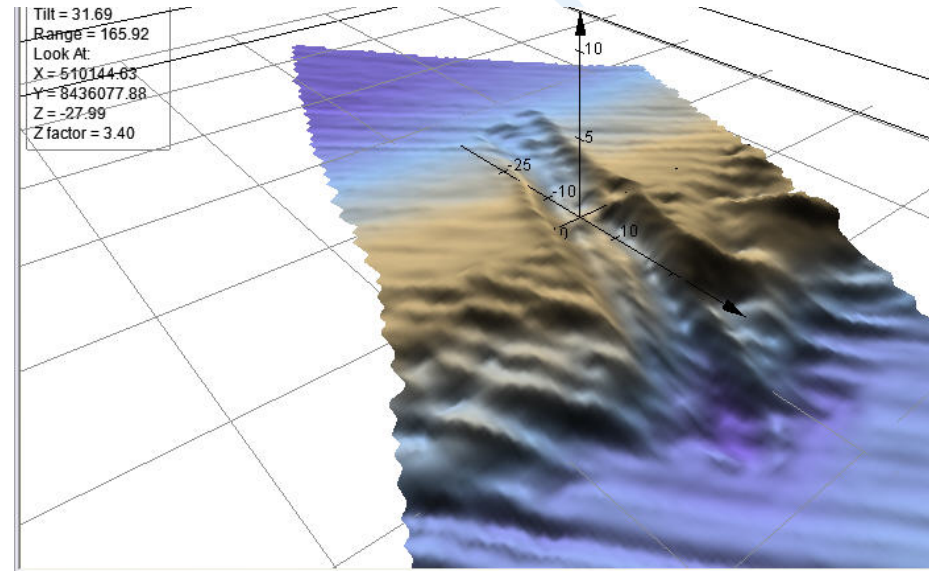
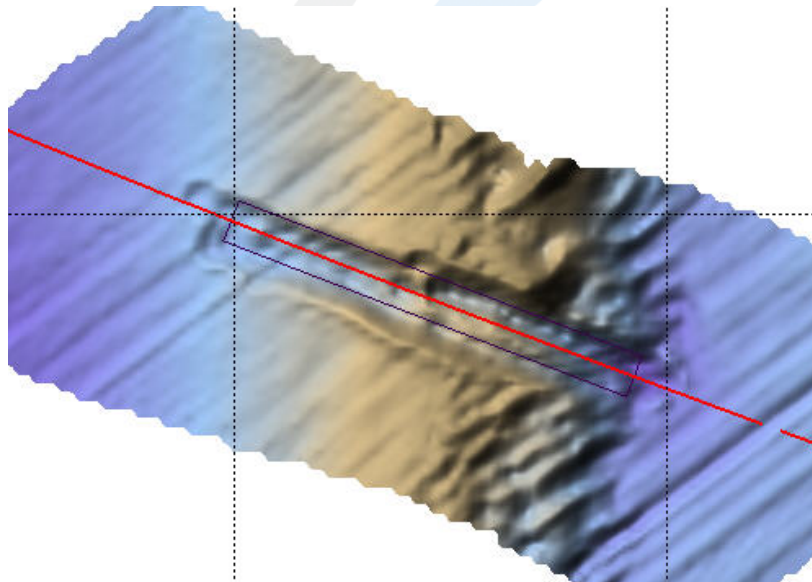


- Trenching of subsea pipelines and umbilicals
- Pipeline & umbilical route preparation
- Pipeline free-span rectification – on live lines
- Deburial and rock dump removal (1m³ : 25m³)
- Rapid location and deburial of buried equipment
- Seabed levelling and sand wave clearance
- Template clearance – sediment and cuttings removal.

SeaVator



Sand Wave Clearance



Post-Excavation 3D DTM - Plan view (left) and Isometric view (right)

Why install pipelines?



- Requirement to bring hydrocarbons to land
- Minimum manual intervention required for liquid transport
 - Reduced injury and spill risk compared to alternatives
- Minimal cost and maintenance once installed
 - Reduced operating expenditure compared to alternatives
- Robust, reliable and invisible once installed
- Well known and understood technology.

Why trench pipelines?

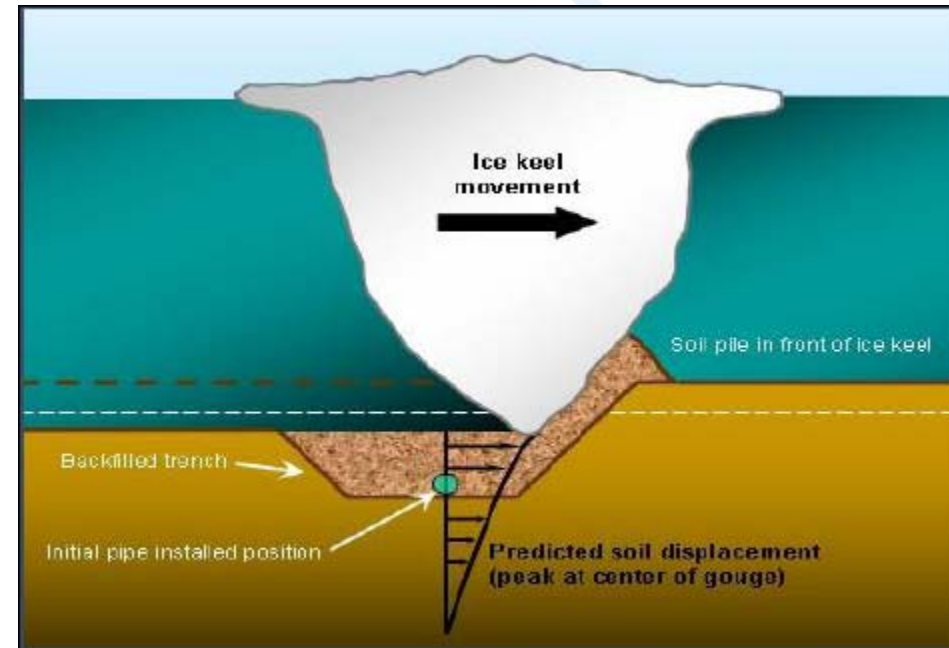


- Aesthetics
- Thermal insulation
- Trawl protection
- Anchor drag protection
- Increased stability
 - Prevents buckling with heating/cooling cycles
- Ice protection
 - Pressure ridges
 - Iceberg keels
 - Strudel scouring.

Trenching to minimise impact of ice



- Ice offers unique challenges
 - Icebergs: big, unpredictable, high momentum – keels can scour seabed even in deep waters
 - Risks from pressure ridges: hazard extends over greater area
- Pipelines are long life, linear features
 - Icebergs cannot be towed around pipelines
 - Pipelines can't be pulled off location for protection
 - Long lifespan of lines increases probability of ice interaction
- Trenching offers only realistic protection solution.



*Graphic courtesy of Mike Paulin, IMV
Projects Atlantic*

Arctic Trenching Challenges



- Priority - Environmental awareness
 - Noise
 - Tailpipe emissions
 - Interaction with wildlife
- Logistical considerations
 - Activity for supply of spares & consumables
 - Sheer soil volume to be moved in a long, deep trench
- Technical challenges
 - Trench Depth – up to 10 metres/33 ft
 - Very variable soils
- Adverse weather
 - Short ice-free window.

One Possible Solution



AGR's ClayCutter X

- Unique water jetting trencher
- Field proven in deep water
- No limit on trench depth
- Powered by state of the art water pumps
- Can be deployed from any DP vessel, including icebreakers
- Capable of sustained high excavation rates
- Effective in a wide range of soil types.

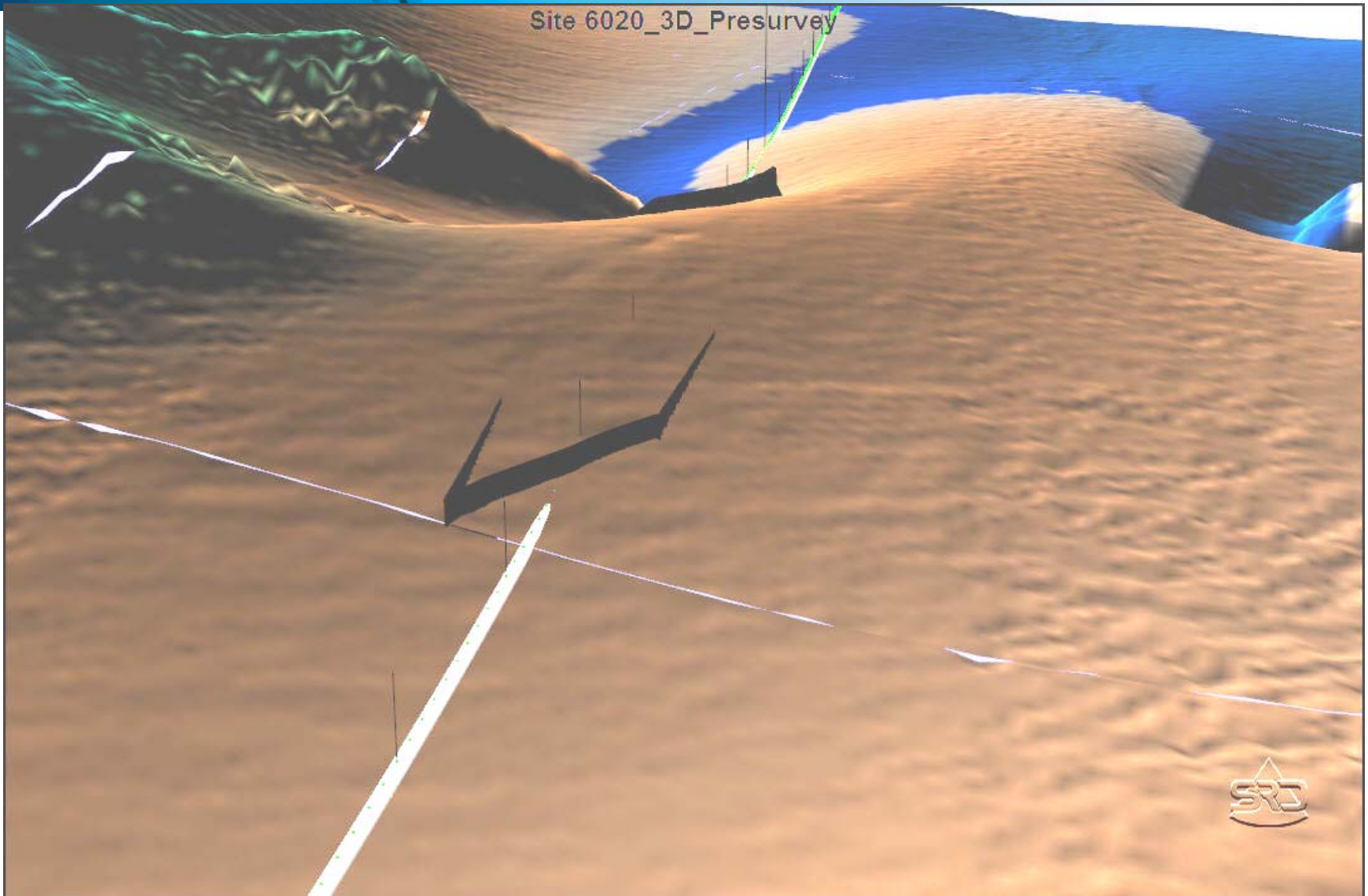


ClayCutter X :- Applicability?

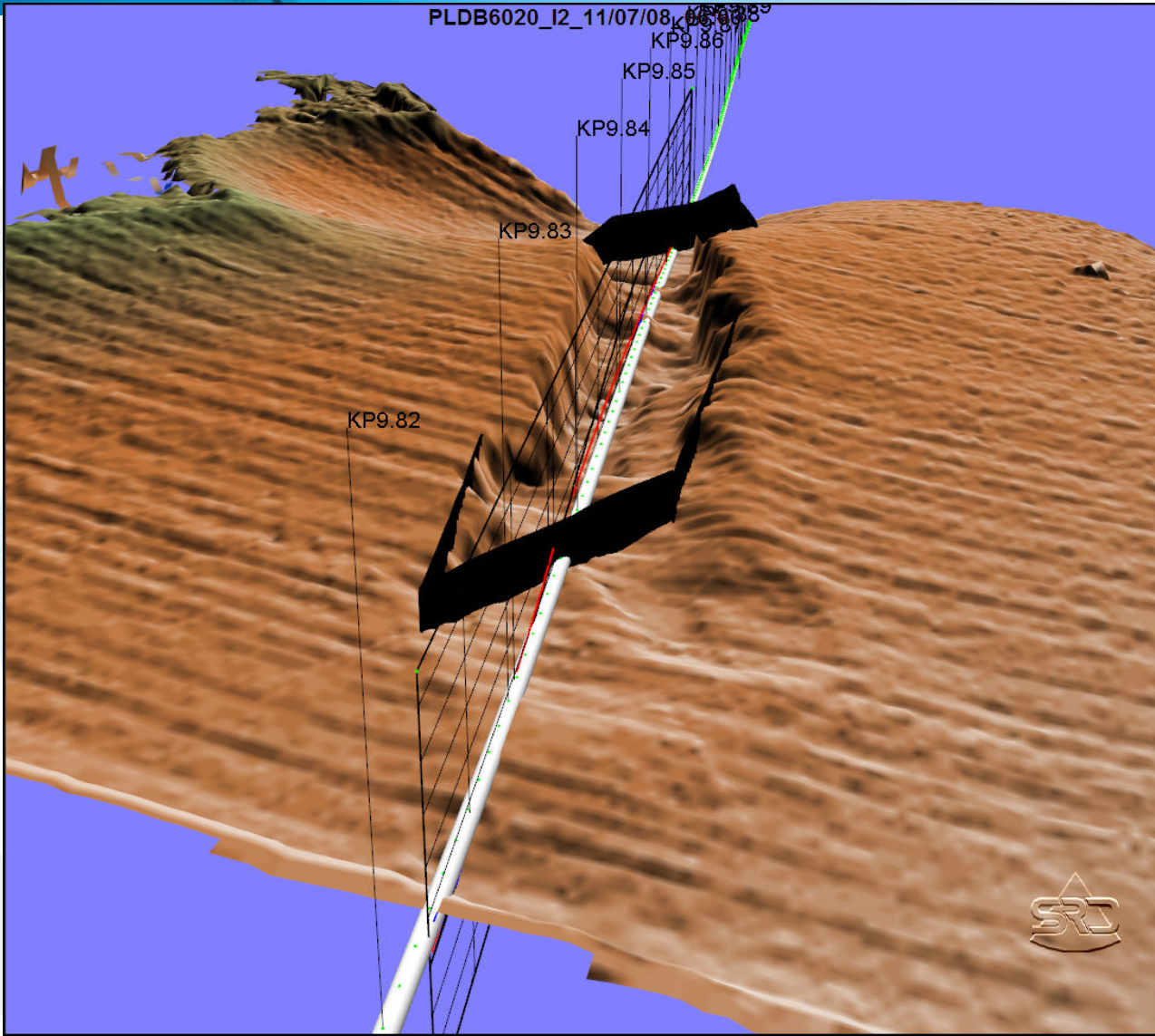


Challenge	Response
NOx, SOx emissions	Pump engines designed to run on ultra low sulphur fuel; Urea NOx scrubber an option
Wildlife interaction	Faster trenching progress shall minimise interference to indigenous wildlife
Noise, vibration	Pumps under 85 dB at one metre; drive shaft alignment within 2,000 th inch
Trench depth	No limit on trench depth with CCX
Soil variability	ClayCutter X can trench soft to very stiff clays, sands & gravels
Weather window	Tool can be deployed from icebreaker to maximise the weather window

ClayCutter :- Case Study



10 such excavation sites 3,400m³

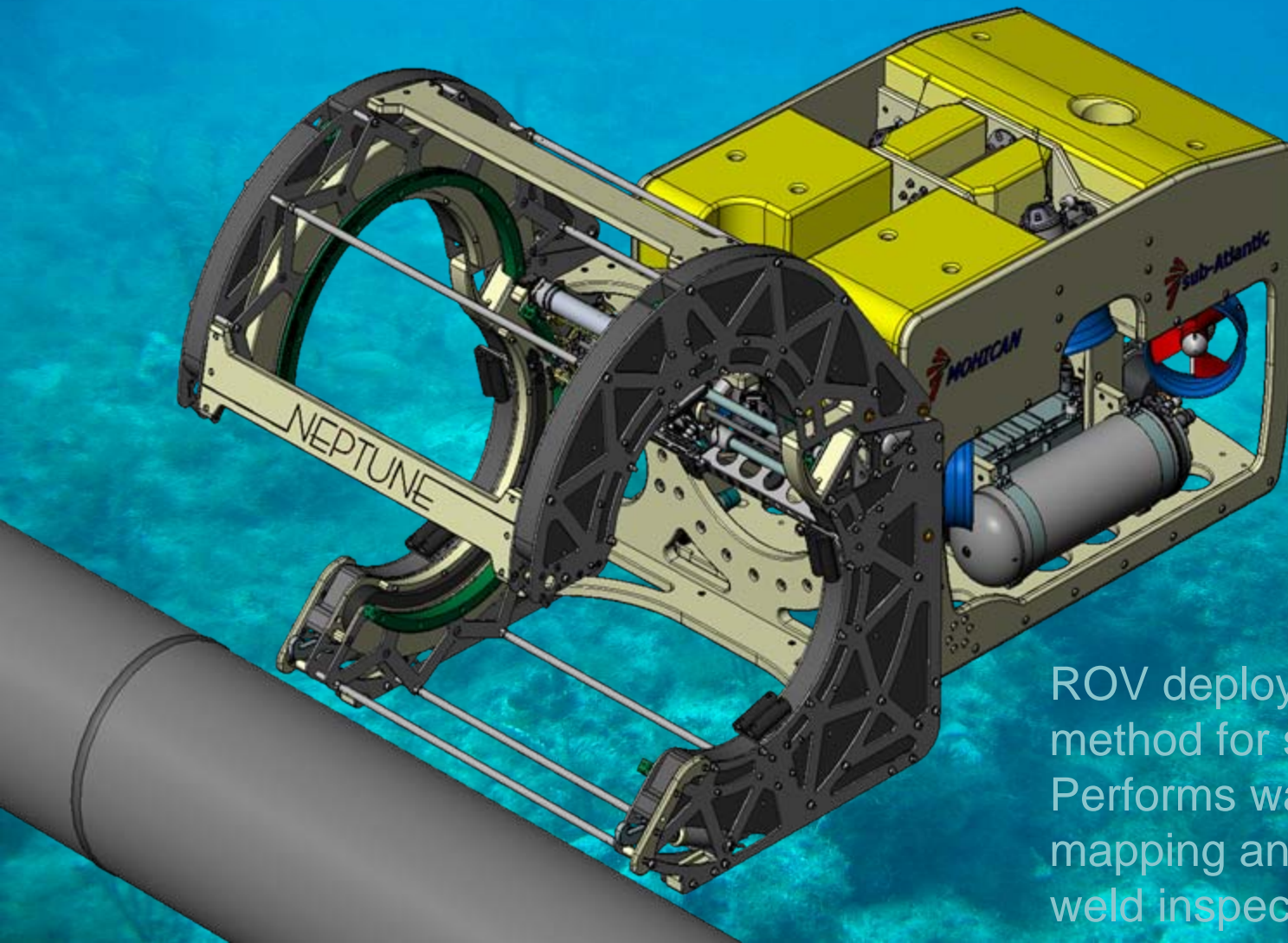


ClayCutter X benefits



- Robust design can withstand rough handling
- Works in a variety of soil types; configuration can be altered under water to suit changing soils, up to 500 kPa (10.5 ksf)
- ClayCutter X can be deployed in various configurations
- Dedicated pump set delivers power smoothly and reliably to eliminate downtime
- No limit on trench depth
- No restrictions on seabed angle with this system
- Can be deployed from vessels of opportunity around the world.

Neptune Subsea Inspection System



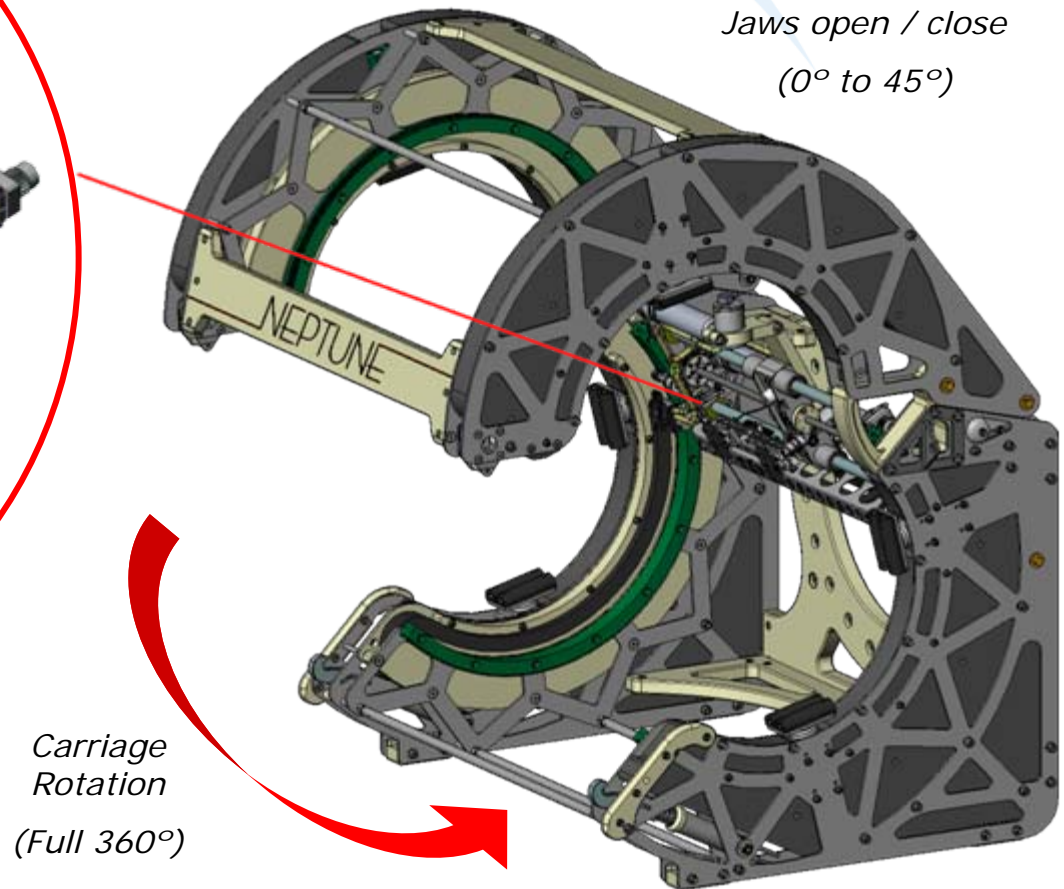
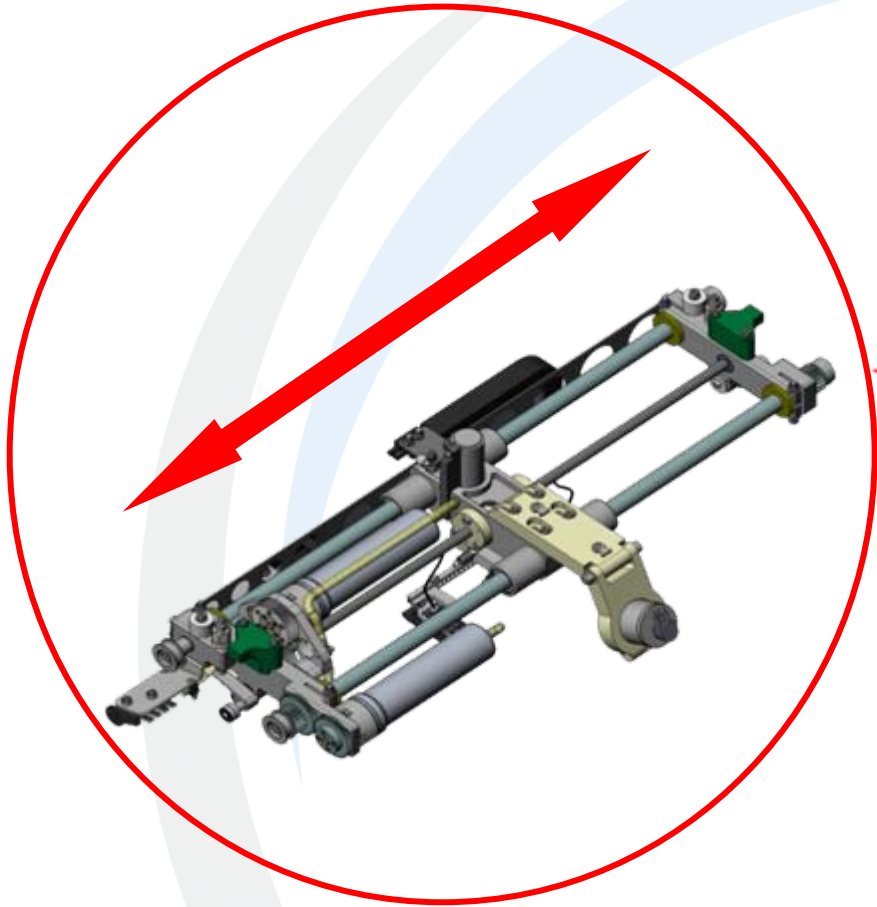
ROV deployed inspection method for subsea pipelines
Performs wall thickness mapping and volumetric weld inspection

Neptune description

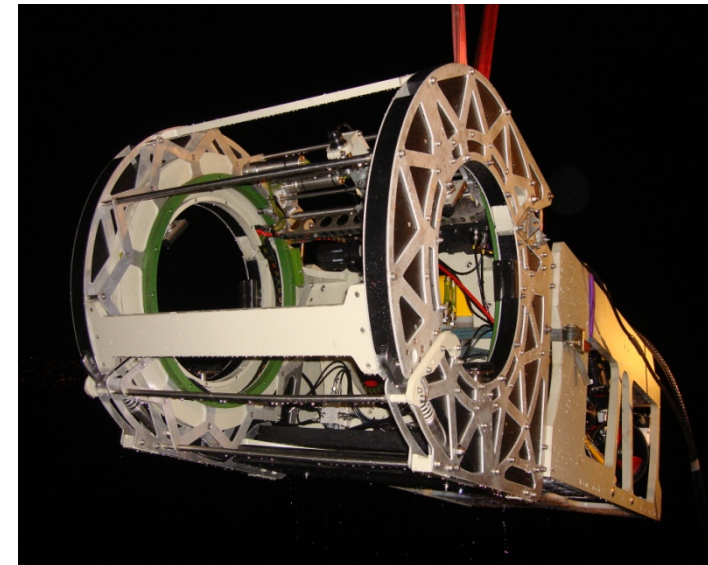
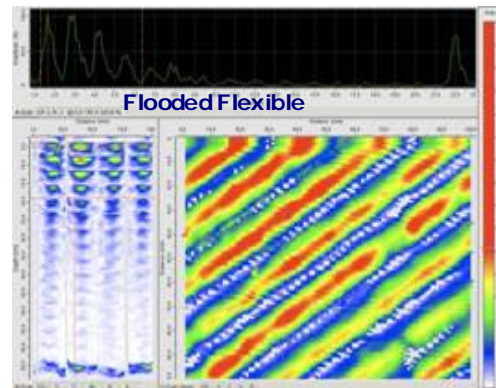
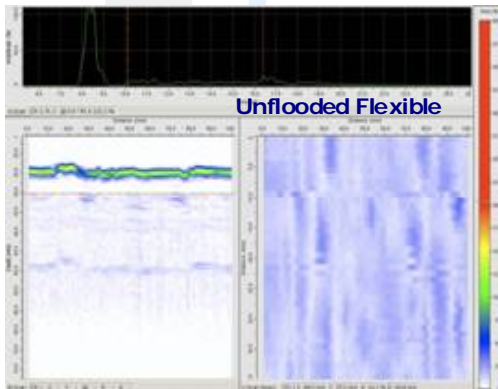


- This scanning tool, performs a full 360 degree, by 500mm long, survey of the subsea pipeline section providing high resolution, imaged and numerical data on the integrity of the welds and any reduction in wall thickness due to corrosion.
- The first Neptune scanning tool to be built has hydraulically opening and closing jaws, and powerful self centring clamps that can deal with a range of pipe sizes from 12" to 18" in diameter.
- This ROV deployed tool can provide oil and gas operators with a cost effective way of quantifying the integrity of pipelines at key points along their length avoiding the costly intervention of a saturation dive team and Dive Support Vessel.

Transducers axial movement (500mm)



- Rapid monitoring of pipelines following subsea impacts
- Platform based routine wall thickness monitoring of platform risers
- Regular monitoring of anomalous pipeline sections in lieu of remedial intervention
- Pre-inspection of pipeline hot tap areas
- Rapid verification of IP Pigging anomalies
- Flexible riser examination



Summary



- Pipelines offer a well proven, low risk, low cost, invisible solution for hydrocarbon transport
- Trenching can provide adequate protection for pipelines in Arctic areas
- Technology already exists that can meet trench depth requirements while minimizing environmental impact
- Careful pipeline and trench design may mitigate volume requirements and reduce trenching time.

AGR Subsea Ltd Contacts



John Sands

Managing Director
AGR Subsea Ltd

Dir : +44 1224 629282
Cell: +44 7736 143836
john.sands@agr.com

Michael Noble

Business Development
AGR Subsea Ltd

Dir : +44 1224 629284
Cell: +44 7825 076 860
michael.noble@agr.com