SAGE

Deepwater Pipeline Energy Corridor from the Gulf region to India.

Petrotech New Delhi

November 3rd 2010

SAGE

Middle East to India
Deepwater Pipeline

The SAGE Project – Key team members

Mr. T.N.R. Rao	▪ Former Petroleum Secretary, Govt. of India and "Architect of the Oman-India Pipeline" ▪ Chairman of the SAGE Advisory Board ▪ Founder Chairman, Hydrocarbons Education & Research Society, Indian School of Petroleum ▪ Founder Chairman – University of Petroleum & Energy Studies
Subodh Jain	▪ Director: INOX-AIR PRODUCTS Ltd. ▪ Director: South Asia Gas Enterprise PVT Ltd ▪ Director: Siddho Mal & Sons, New Delhi ▪ Former Senior Advisor to original Oman-India Pipeline team
Peter M Roberts	▪ Director: South Asia Gas Enterprise PVT Ltd ▪ Managing Director: VerdErg Ltd, London ▪ Former Project Director of original Oman-India Pipeline ▪ Former Director Project & Construction Services at JP Kenny and Managing Director INTEC (UK)
Dr Herman Franssen	▪ Senior Consultant to SAGE ▪ Member of the SAGE Advisory Board. ▪ President, International Energy Associates, USA ▪ Former Economic Advisor to the Oman-India Pipeline project ▪ Former Economic Advisor to the Sultanate of Oman, Ministry of Petroleum
Ian Nash	▪ Business Acquisition and Operations Director, Peritus International (UK) Ltd. ▪ Managing Director INTECSEA (UK) Ltd. ▪ Engineering Manager for MEDGAZ FEED. ▪ Engineering Manager (Saipem Inc) for Canyon Express design EPIC. ▪ Project Manager (SASP UK) for Europipe 2, 42-inch 650 Km Gas Trunkline detailed design.
Dr Alastair Walker FRS	▪ Leading International Expert on Marine Pipeline Engineering ▪ Senior Consultant to SAGE ▪ Member of the SAGE Advisory Board ▪ Professor Emeritus, University of Surrey UK ▪ Visiting Professor, University College London

The SAGE Project – Key Partners

MOUs/Agreements to Co-operate in developing SAGE have been signed with:

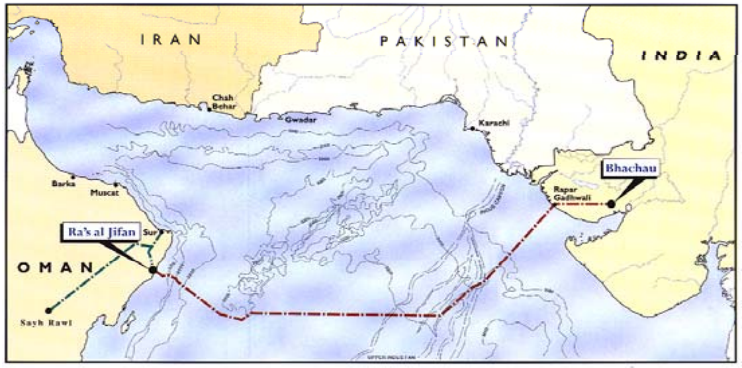
- Oman Ministry of Oil and Gas
- GAIL
- NIGEC
- Engineers India Ltd
- INTECSEA Engineering (UK) Ltd.
- Saipem spa Milan
- Heerema Marine Contractors, Leiden.
- CORUS steel, UK
- WELSPUN
- FUGRO GeoConsulting Ltd.UK
- Det Norske Veritas, Oslo

History

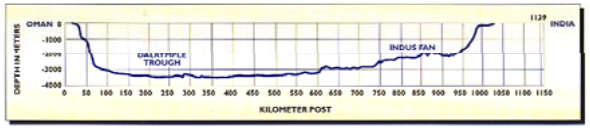
SAGE will build on the extensive study of the deepwater route from Oman during the mid 1990's. $65 million was spent developing the technology, performing detailed FEED and soliciting, receiving and evaluating competitive construction bids.

This work is now strengthened by studies undertaken since 2006 by SAGE and by the major body of industrial deepwater pipelay experience over the last decade. The route will reach down to around 3,400 meters and will be just over 1,100km in length.

A major study of a similar line to Gujarat from Iran was more recently undertaken by Saipem for GAIL and NIGEC which showed the feasibility of such a system.



Subsea Route and Sea Bottom Profile



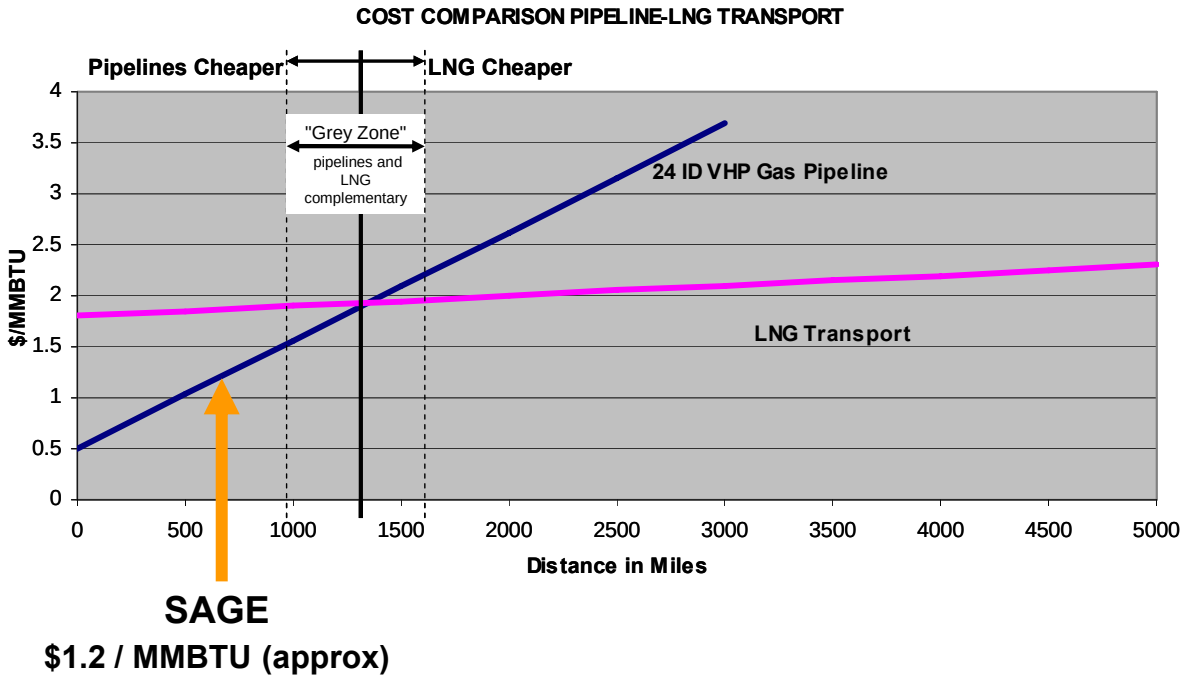
History

- Pipelines generally transport natural gas at a lower cost than LNG over distances up to around 2100Km.
- Transport of Iranian gas by offshore pipeline to anywhere in India lying to the South and West of Jaipur (approximately) can provide a shorter, more direct route than by overland pipeline.

SO why haven't numerous offshore gas pipelines from Iran to Western India been built over the last 30 years, either along the coast or across the deep water of the Arabian Sea, to complement Middle East LNG supplies as a lower-cost base-load source of clean energy?

ANSWER:

- A shallow conventional coastal route to India involves laying a pipeline across the Indus Canyon which is extremely challenging, technically, even today.
- Until recently, the geo-politically attractive direct route across the Arabian Sea was too deep but experience with new lay-barges now makes it practical as well as highly attractive economically.



History

Technical Risk Issues facing the project in 1995:

- Pipe mill upgrades needed to manufacture linepipe.
- Lack of lay vessel with enough tension capability. Conversion work needed to lay pipe to 3,500m water depth.
- Incomplete understanding of seismic activities and mitigation methods – mudflows, fault lines & slope failures.
- No qualified deepwater pipeline repair system was available.

However even in 1995, 15 years ago:

- These were not considered to be fatal impediments by the industry and three competitive bids were received and evaluated before the gas was re-assigned elsewhere.

Building on Previous Experience

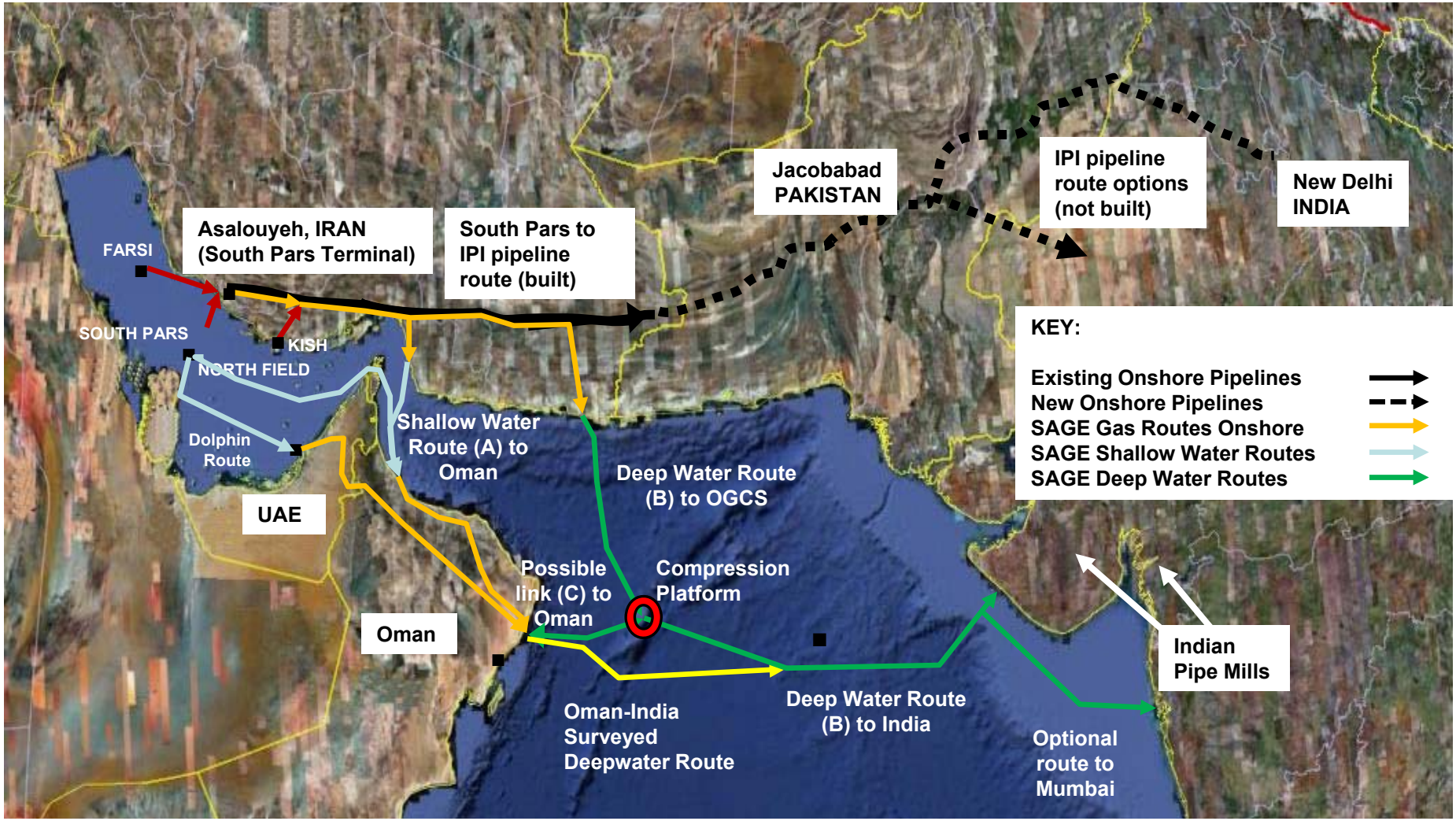
What makes SAGE's Risk Profile lower now?

- New generation, large lay vessels ready to build.
- Several mills can manufacture pipe, particularly in India.
- Era of damaging cost escalation appears to be over.
- New and improved design methods for free-spanning and geo-hazards have been developed.
- Better positioning capabilities are now available during pipelay to avoid seabed hazards.
- Deepwater repair systems are now available.
- New testing and commissioning philosophies developed by SAGE with DnV permits use of 28-inch pipe.

Government Awareness

- Presentation Petroleum, Power and Fertilizer Ministries in December 2007, 2008 and 2009.
- Indian Secy. of Foreign Affairs: Meetings and full support.
- H.E. Dr. Rumhy, Oman Oil & Gas Minister, agreed in principle to give "Right of Way" and other clearances to SAGE on 28th March 2009 in presence of Indian Ambassador. MOU between Oman & SAGE signed. Oman follow-up meetings in 2010 including on September 4th.
- Written confirmation from Qatar Energy Ministry that SAGE is on the "Waiting List" for gas.
- Principles of Cooperation signed with GAIL Summer 2009.
- MOU with NIGEC October 2009 permitting gas swaps.
- Extensive ongoing discussions with Turkmen and Indian Governments in 2010 for access to Turkmenistan gas.

Summary of Potential Routes to India



NOTES:

1. **The proposed routes shown are chosen to minimise crossings of third party countries which can be a source of construction delay, political risk and additional tariff costs.**
2. **All of these routes (if link (C) is built) will permit and benefit from co-mingling of gas supplies to Oman and India.**

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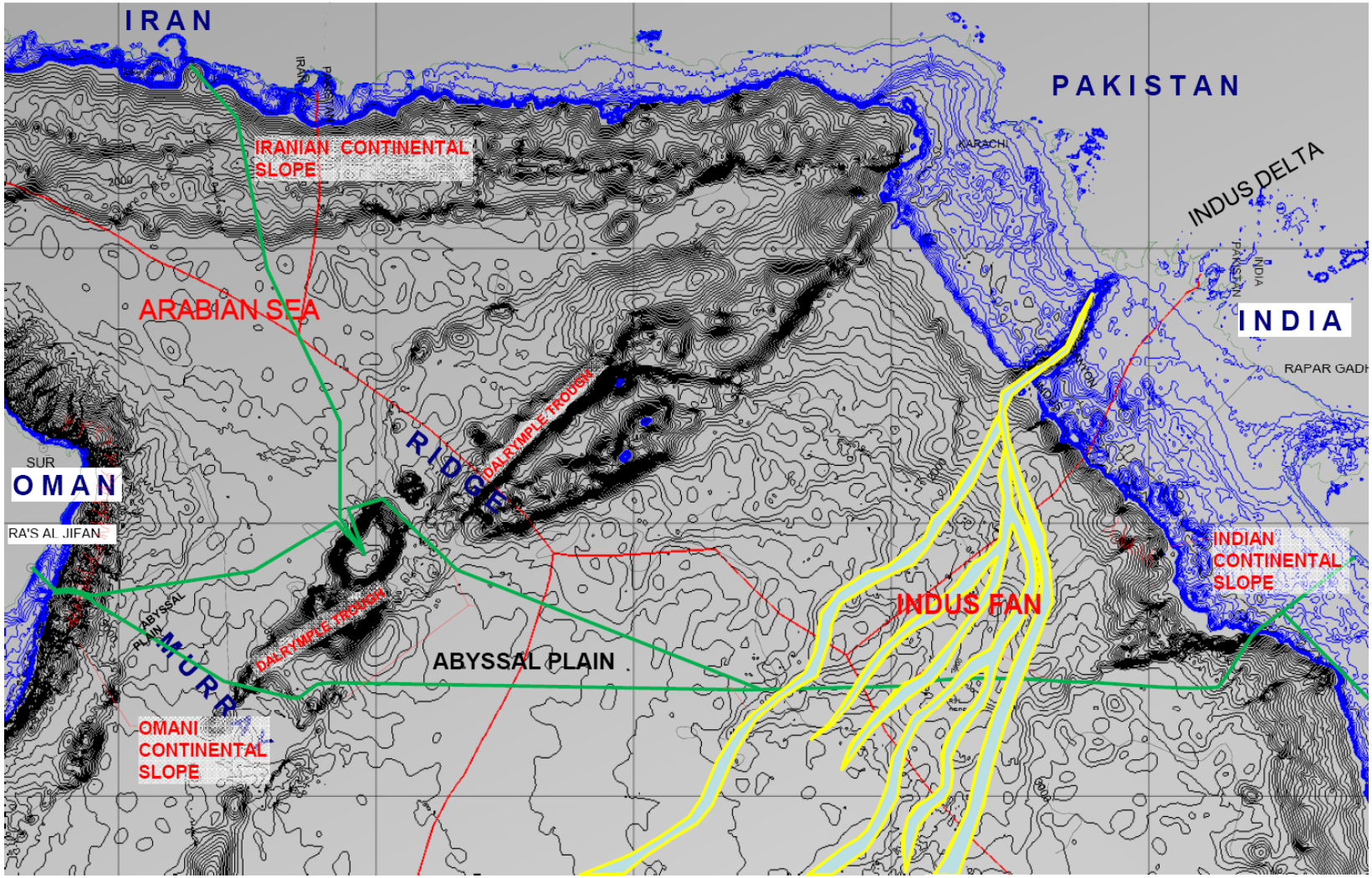
Deep Water Routes to India



Possible route direct from gas export landfall via Compression Platform on Sea Mount. Two shorter, smaller lines laid by existing barges can be used on this route. Note there is no 3rd Party Jurisdiction crossing.

The route stays to the South to avoid expensive, difficult crossings of the Murray Ridge and Indus Fan.

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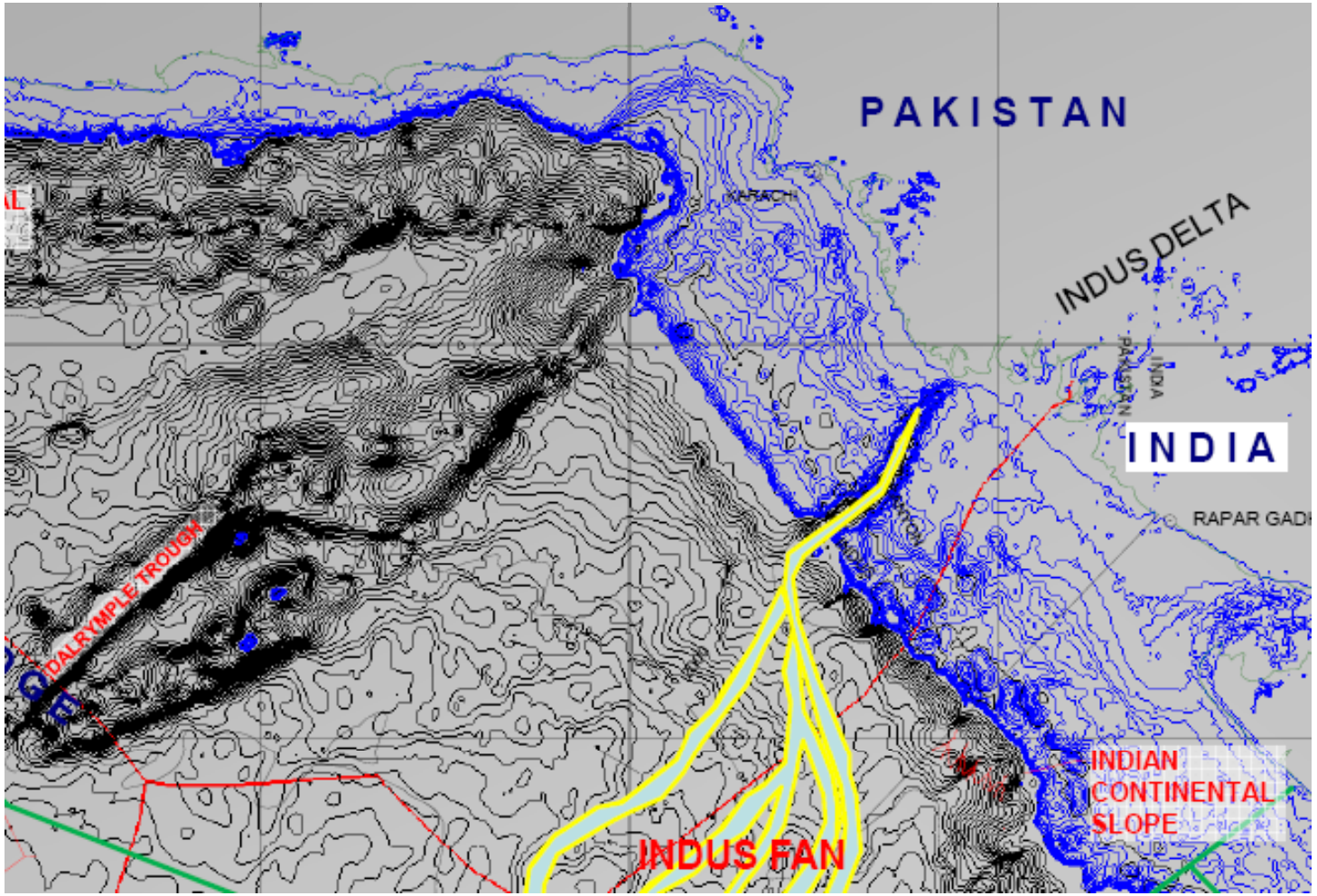
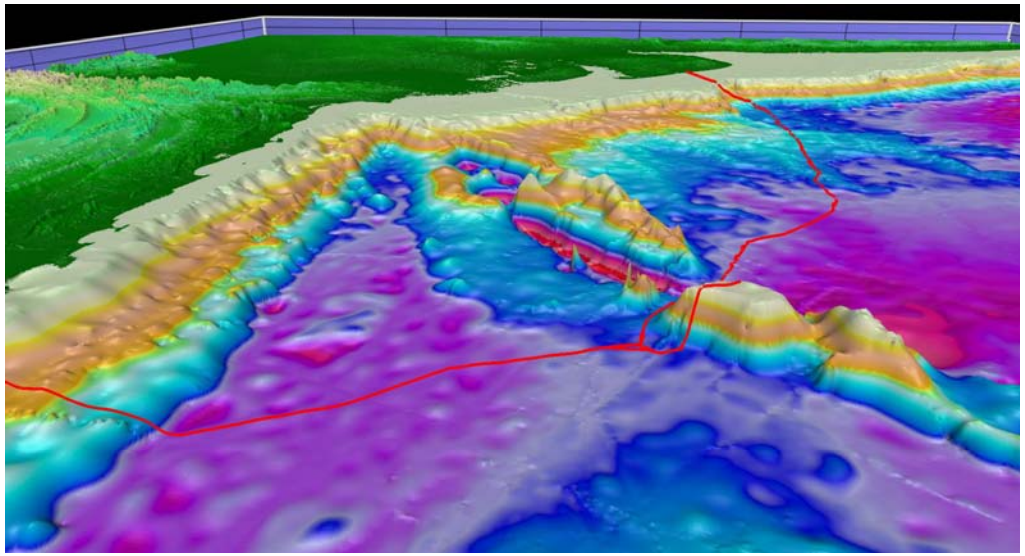
Shallow Water -Indus Canyon Crossing



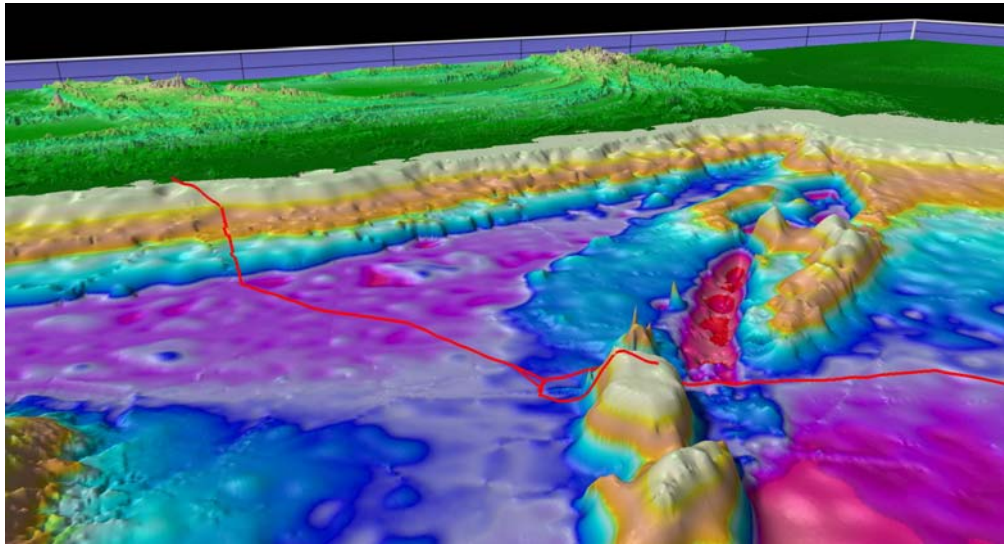
Crossing the Indus Canyon is the main technical impediment to a shallow water coastal route. It is deep, turbulent and can change location. Directional Drilling of multiple lines beneath it may be theoretically possible but remains a high risk solution.

Seamount Compression Station Location

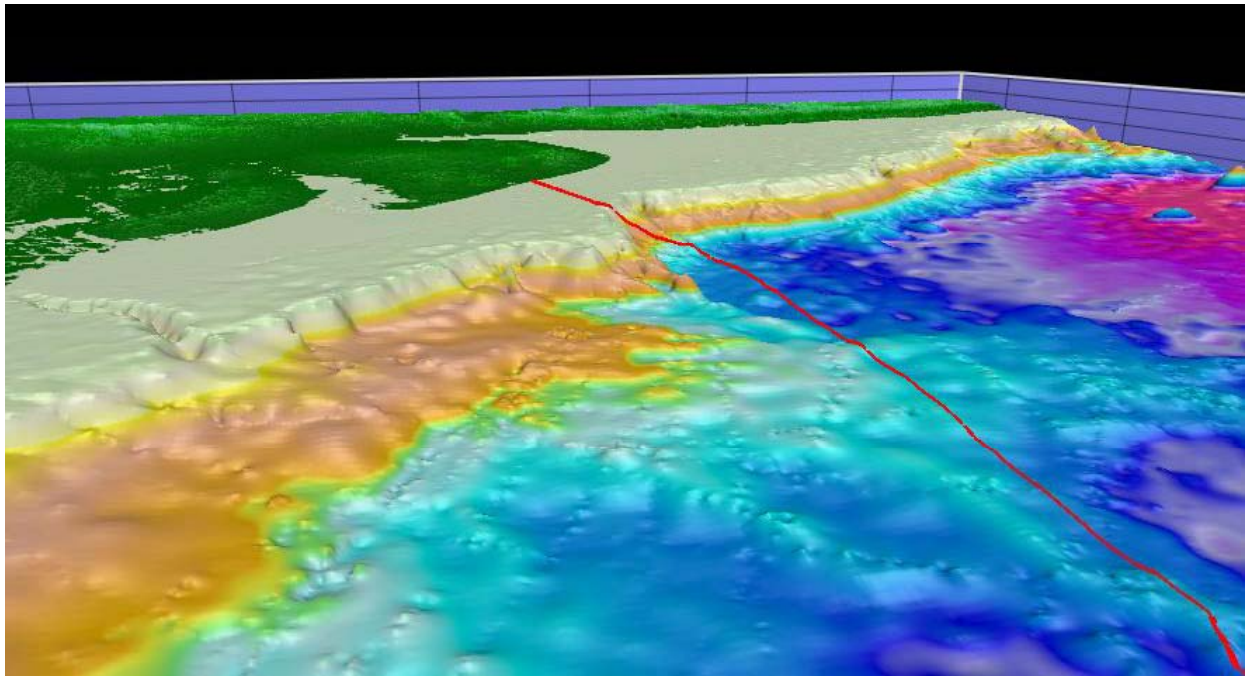


- The seamounts at the South-West end of the Murray Ridge present a near-ideal location for an in-line Compression Platform.
- These remarkable features reach to within 300m of Sea Level, as shown.

- Several examples of platforms in this water depth exist.
- Max Slope 20deg on Northern side similar to Landfalls.
- The Compression Platform will be outside of all Territorial Waters but within helicopter supply range.

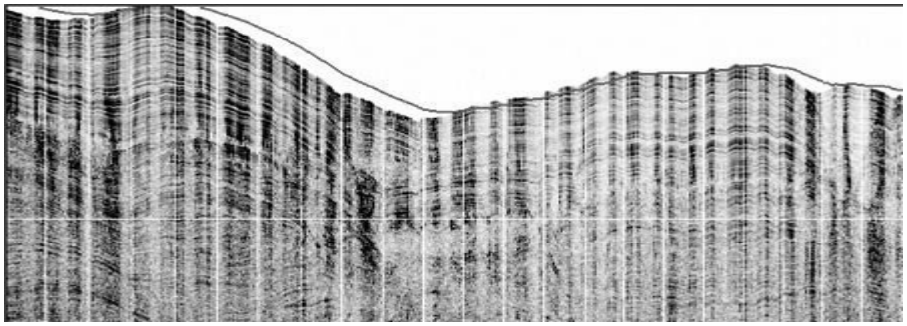


Indus Fan Upper Canyon



- The Indus Fan is formed in a 2500m thick pile of sediment covering the greater part of the Arabian sea.
- It was formed by the Indus river which drains the local topography from the western Himalayas and feeds the erosional outwash into the Arabian Sea
- The Indus is comparable in size and discharge to the Mississippi and is one of the major geological features of the Indian Ocean.

Chirp Image from the upper canyon showing large scale slumps of rapidly accumulated muddy turbidite



Courtesy of Indus Delta and Shelf Survey, Cruise NERC 64PE300 of the RV Pelagia, 10th December 2008 to 7th January 2009

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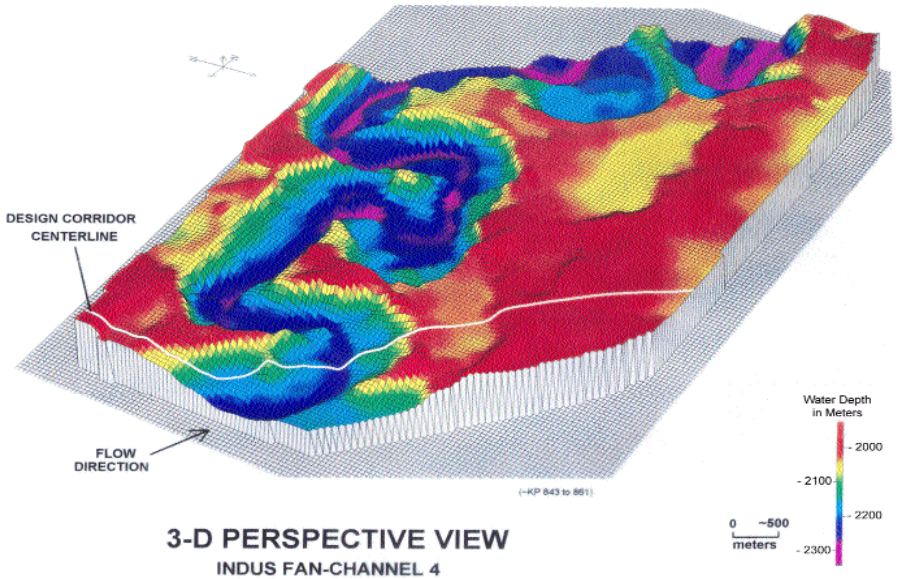
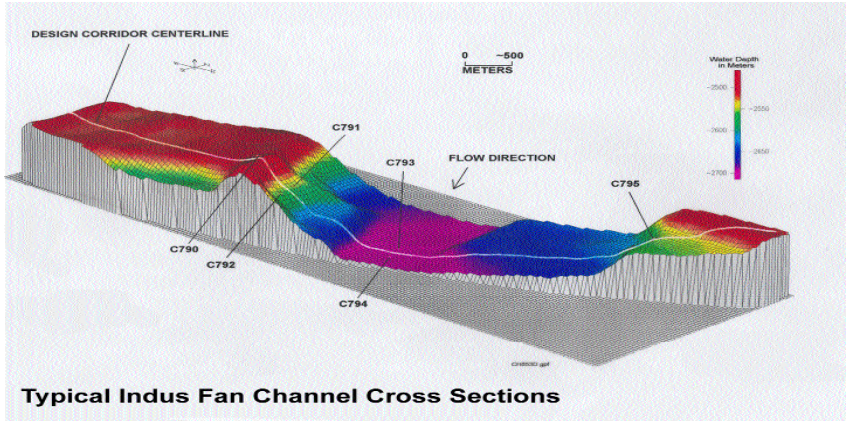
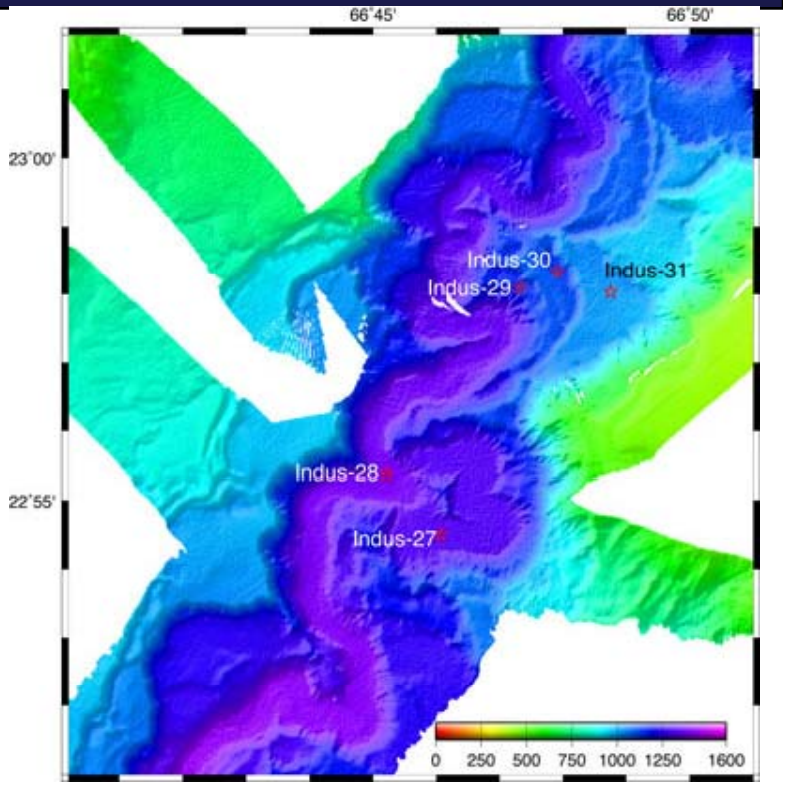
Indus Fan Crossing



3-D PERSPECTIVE VIEW
INDUS FAN-CHANNEL 4
CHART PH1-107



Typical Indus Fan Channel Cross Sections



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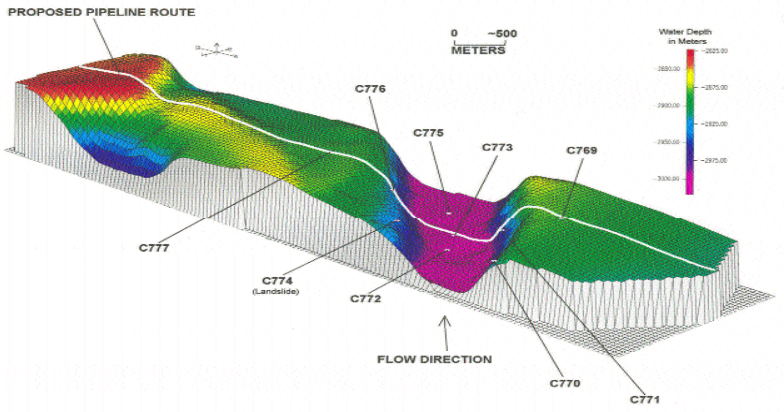

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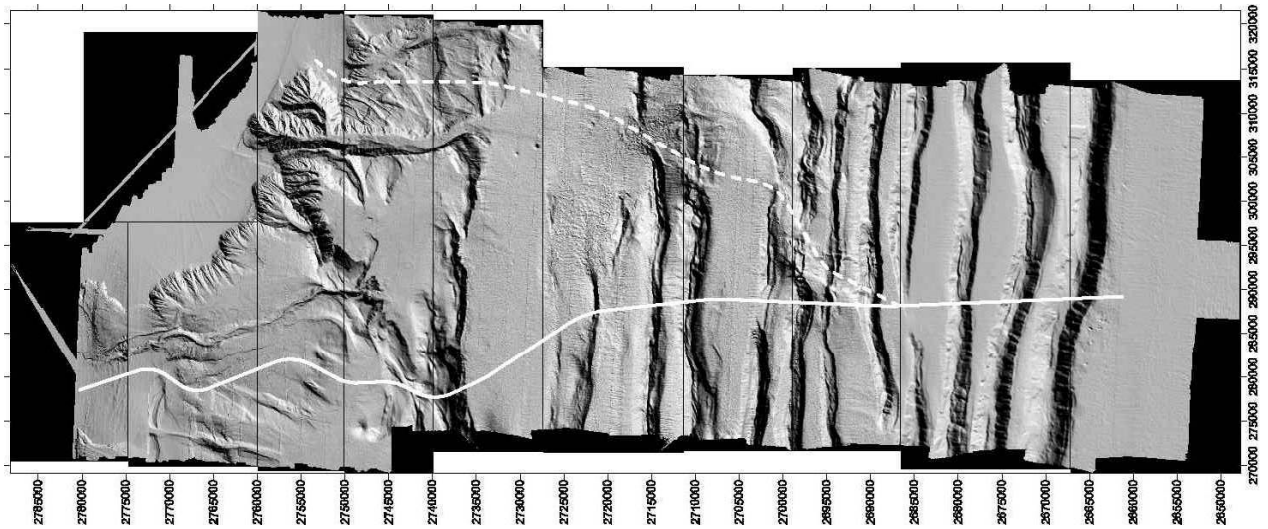
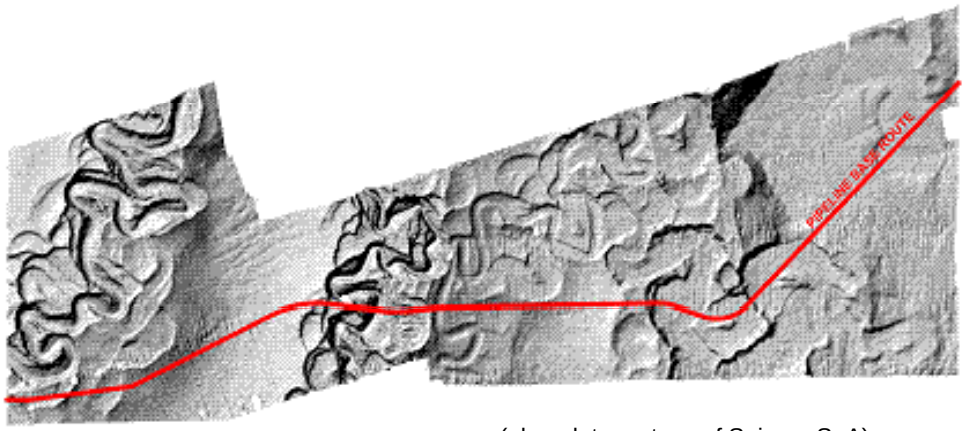
Seabed Features Along Deep Water Route

Iran Shelf Break – Possible Routes from Chabahar area.



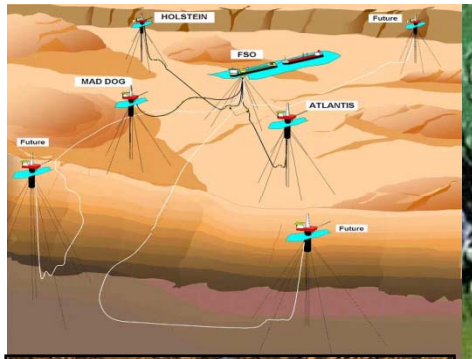
(plan plot courtesy of Saipem SpA)

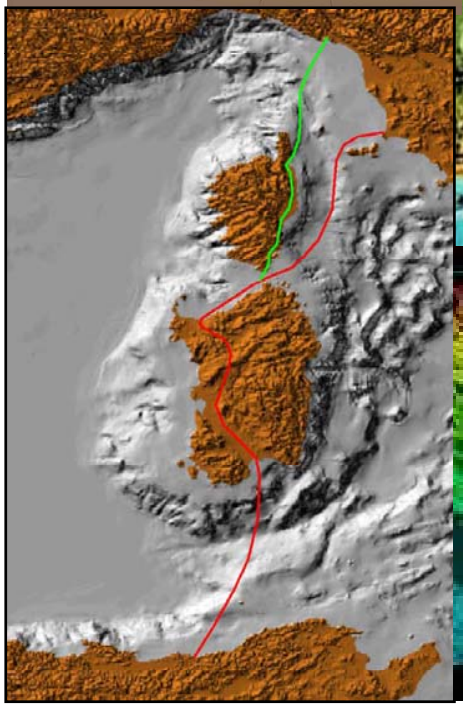
Indus Fan Channel 4.

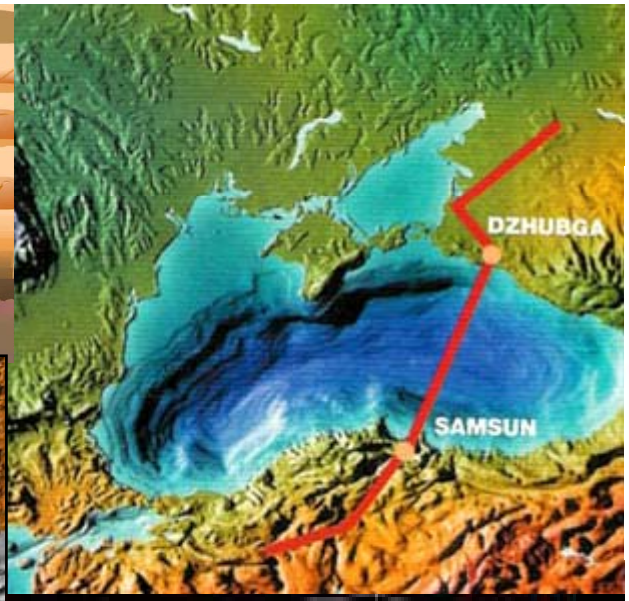


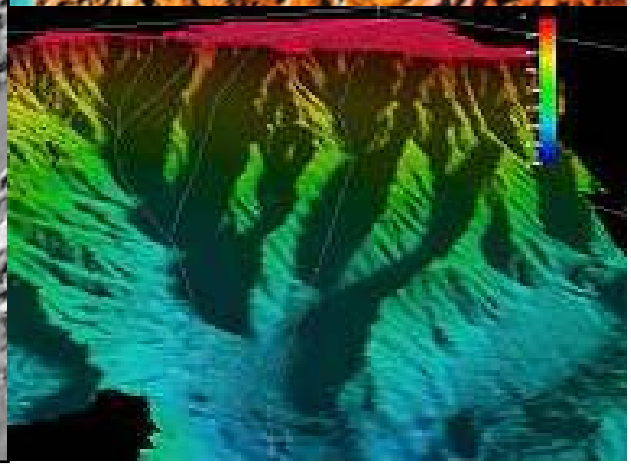
(plan plot courtesy of Saipem SpA)

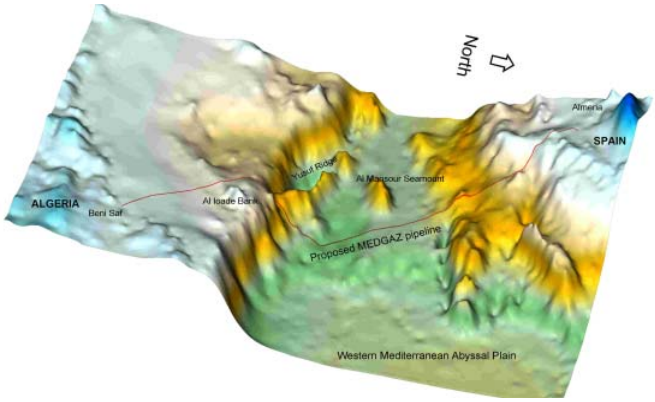
Example Deep Water Pipelines





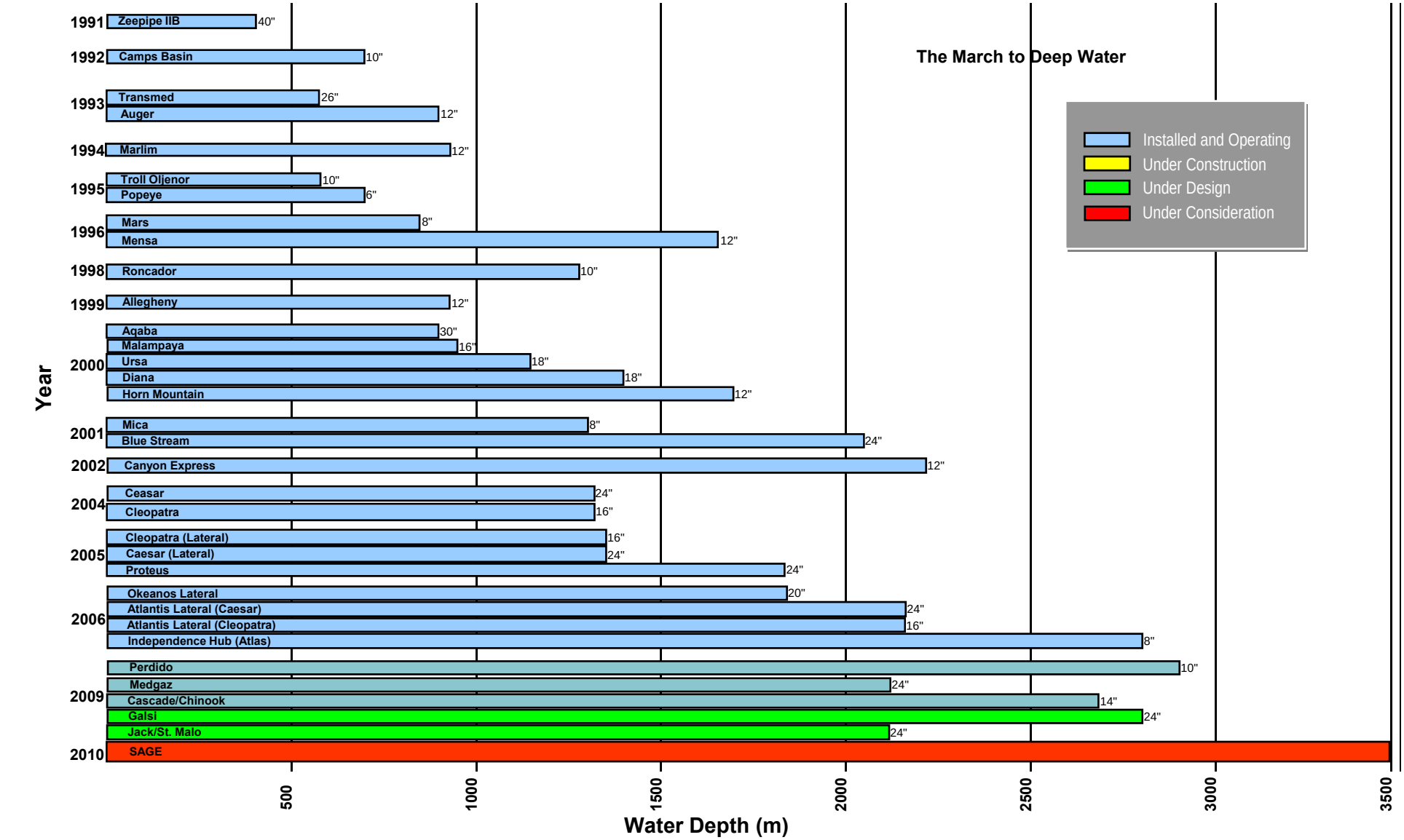






- Oman-India Pipeline
- Bluestream
- Mardi Gras
- MEDGAZ
- Cascade-Chinook
- Perdido
- Galsi

Deepwater Pipelay Progression



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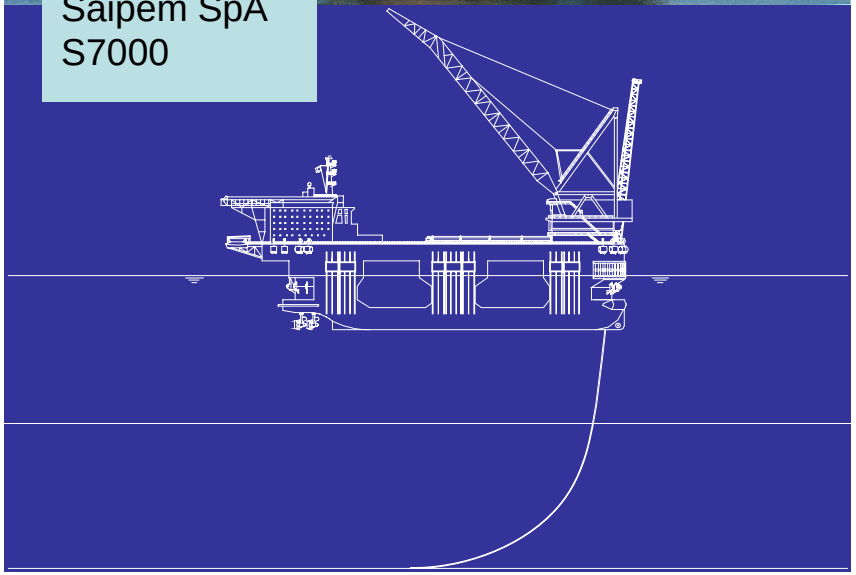
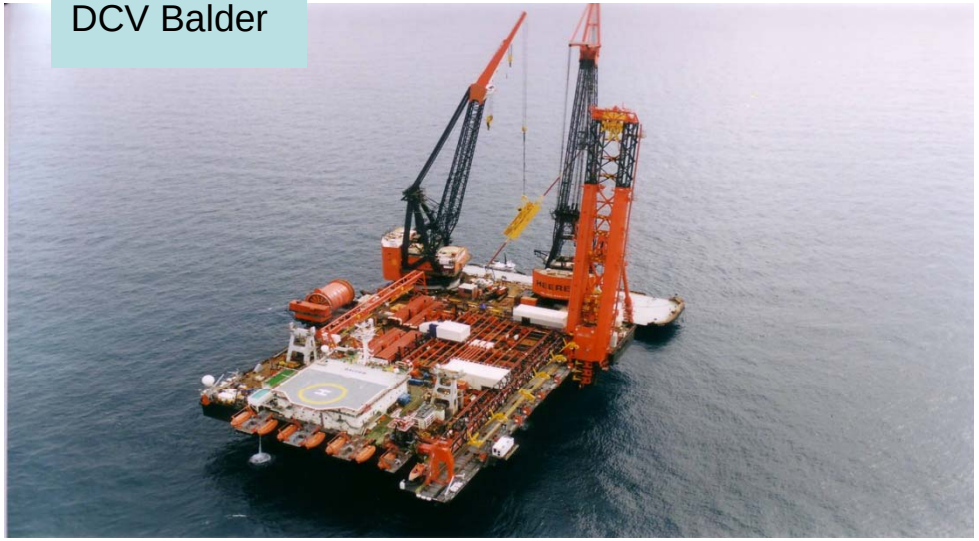
Current J-Lay Vessels

Saipem SpA
S7000



Heerema LV
DCV Balder



Saipem CastorOne - J-Lay Vessel

CastorONE - under construction

- J-Lay and S-Lay.
- Tensioners - 2000t top tension
- Length - 290m, Breadth - 39m
- Transit speed - 14 knots
- Designed to lay SAGE pipe to 3500m
- Welding Stations - 2 welding stations on triple joints.
- Weathervanes in J-Lay for all-year lay.
- DPS3 redundant dynamic positioning.
- Accommodation for over 702 persons.
- Pipe Diameters up to 48”

Saipem spa

- Saipem spa has confirmed that the SAGE deepwater pipeline is feasible and can be installed into water 3500m deep using its new laybarge CastorONE, currently in construction.
- Saipem was a leading contributor to the line pipe Quality Management Workshop convened by DnV for SAGE.
- An MOU under which Saipem will join the SAGE Consortium has been signed.

Allseas Pieter Schelte S-Lay Vessel

Pieter Schelte - under construction

- S-Lay.
- Tensioners - 2000t (4x500t)
- Length - 382 m, Length - 370 m
- Transit speed - 14 knots
- Accommodation - 571 men
- Dynamic positioning - LR DP (AAA)
- Stinger length - 170 m (558 ft)
- Total installed power - 95 MW
- Pipe diameters - From 6” to 68” O.D.
- Welding stations - Double joint factory with 5 line-up & 2 welding stations. Mainline with 6 welding stations for double joints, 1 NDT station and 6 coating stations

ALLSEAS Group S.A.

- Contract awarded June 2010, to Daewoo Shipbuilding and Marine Engineering Co., Ltd., Korea.
- The detail design of the vessel has been completed.
- Long-lead items, such as the power generation equipment and the thrusters, were ordered in March 2007.
- Delivery of the completed vessel is foreseen for 2013.

HMC New Deep Water Pipelay Vessel

HMC New Vessel - under construction

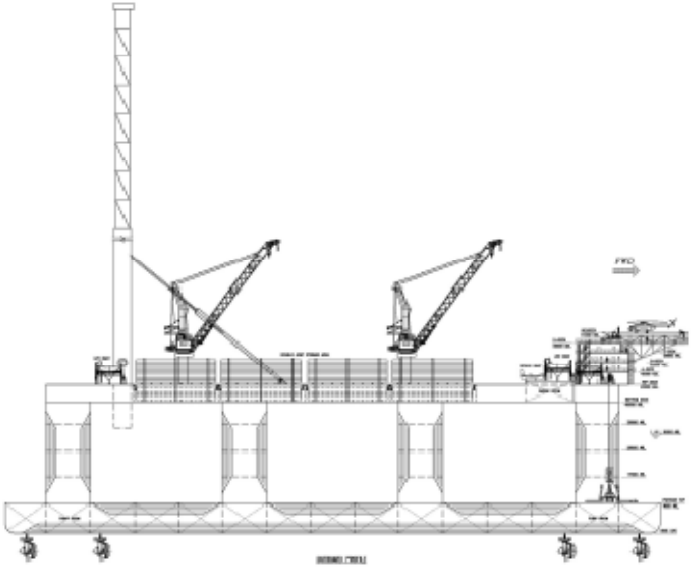
- J-Lay. & Reeling
- Tensioners - 2000t
- Maximum pipe payload is 4,500 metric tons.
- Length - 210m
- Transit speed - 14 knots
- Accommodation - 289 men
- Dynamic positioning - DP Class 3
- Designed for Pipelay to 3500m

Heerema Marine Contractors.

- Contract awarded July 2010, to Daewoo Shipbuilding and Marine Engineering Co., Ltd., Korea.
- The detail design of the vessel has been completed.
- Long-lead items, such as the power generation equipment and the thrusters, were ordered in March 2007.
- Delivery of the completed vessel is foreseen for 2013.

SAGE-Owned Pipelay Vessel (No Cranes)

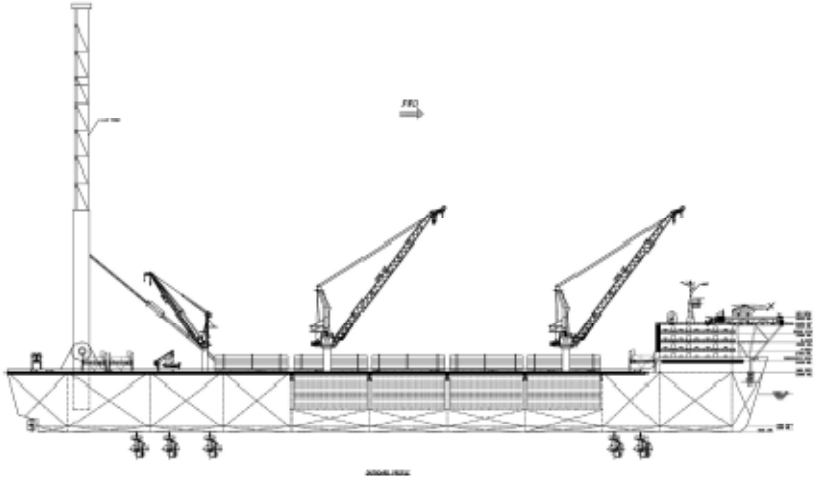
Dimensions & Displacements (Semi Hull)



DECK BOX

Length of main deck	175 m
Width of main deck	90 m
Depth of deck box	5 m

Dimensions & Displacements (Ship Shape)



Length Overall	264m
Breadth molded	44m
Breadth Extreme	46.5m
Depth	20m

CAPEX for any such barge is around $850m.

SAGE would need to set up full PMC team - but multiple lines possible for a corridor.

Line Pipe Feasibility Summary

Heavy Wall Line Pipe manufacture:

- **DnV** has formally confirmed the SAGE pipe size and manufacturing Heat Treatment process to be safe.

The work has shown that it is possible to document that a 28" OD pipeline with a 42mm nominal wall thickness made of DNV-SAWL-450 F (steel having a SMYS of 450MPa) exposed to light heat treatment to have sufficient safety level.

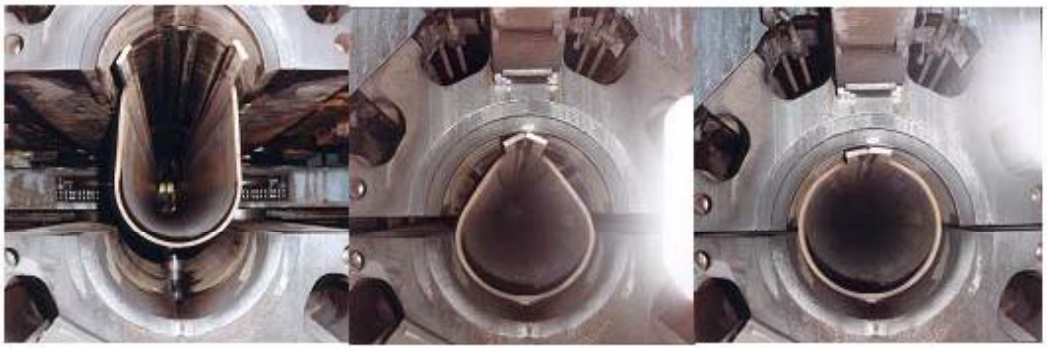
MANAGING RISK

Workshop: DNV Offices, Høvik, Oslo, **Date:** 16/17-1-08,

- **DNV:** Kim Mork, Leif Collberg, Kristoffer Aronsen, Olav Aamlid
- **CORUS:** Peter Tait, Technical Manager Energy, Mark Fryer Mgr–Develop. & Tech. Support Richard Freeman Manager – Business Development
- **C-FER Technology:** Duane DeGeer Manager, Offshore Pipelines
- **University of Texas:** Professor Stelios Kyriakides,
- **Saipem Energy Services:** Enrico Torselletti, R&D Project Man., Luigino Vitali, Mgr, Advanced Tech. Solutions
- **SAGE:** Professor Alastair Walker F.R.S.

- **SAGE has established this pipe can be manufactured by Indian Pipe Mills.**

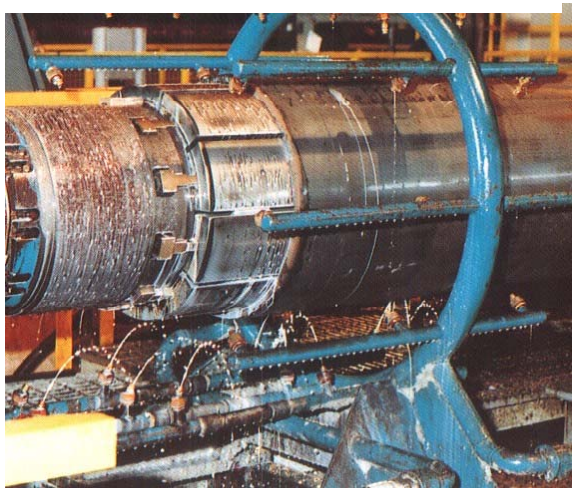
Corus Tubes Deepwater Track Record

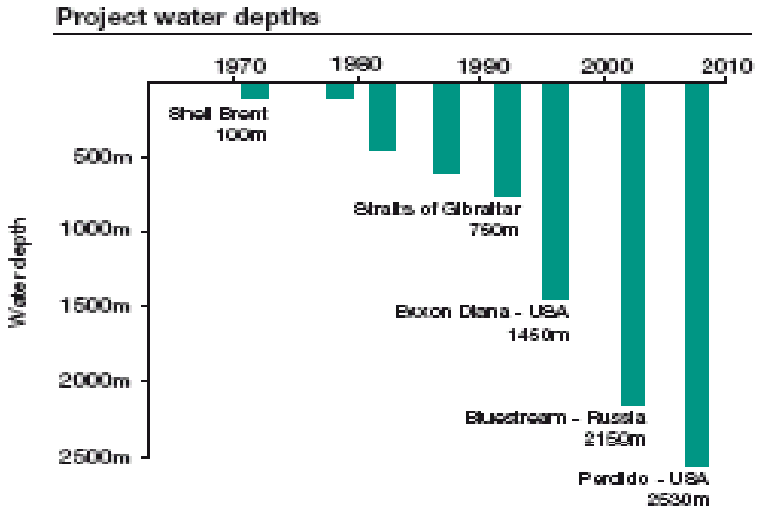


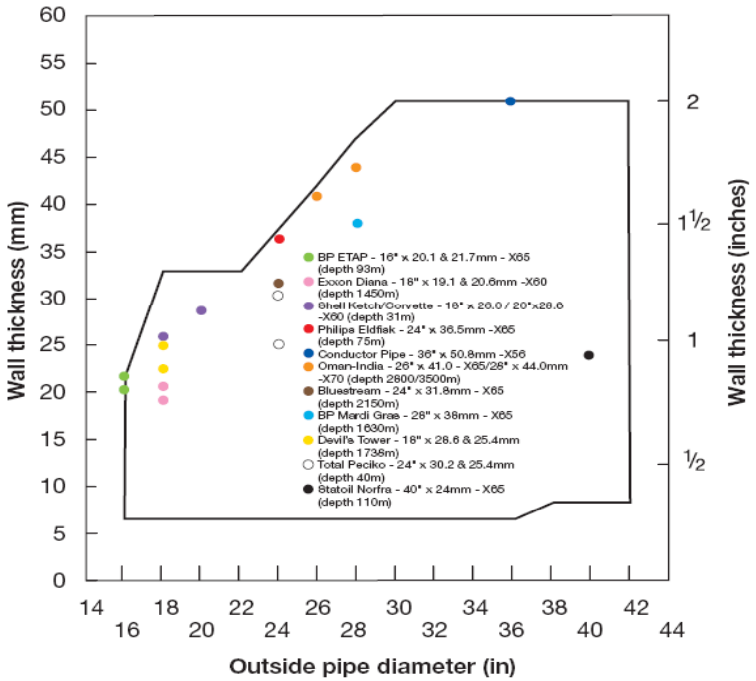
World Strongest : "O" Press

Max Pressure force : 50,000t

Corus Tubes UK UOE Mill has the strongest tooling in the world ensuring the required roundness and material compressive strength necessary for ultra-deepwater line-pipes







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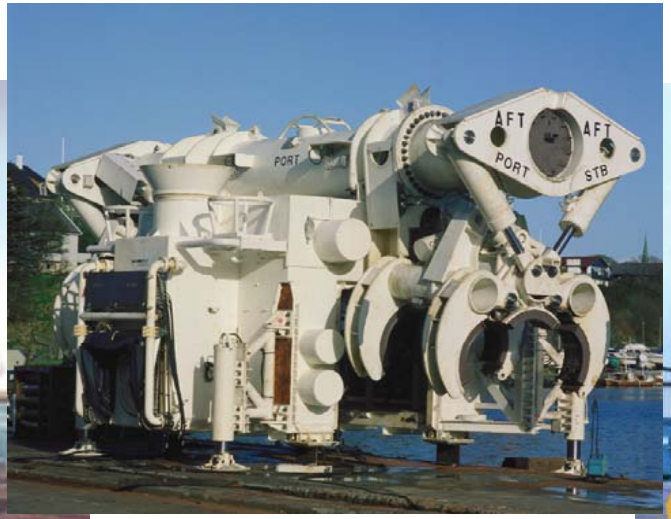
Deepwater Pipeline Repair Equipment

- No deepwater large diameter pipeline has ever required in-situ repair, nor is it statistically likely that a repair will be required during the lifetime of the pipeline
- However, within the last 5 years, deepwater pipeline repair systems have been designed, constructed, tested and commissioned for operational use for large diameter, high pressure gas pipelines
- Diameter range available today for large diameter is 16-inch to 28-inch OD
- Water depth rating available today is 3,050 m (10,000 ft): only nominal extension needed.
- The use of advanced diverless remote equipment to repair a line takes time, and leads to consideration of redundancy such as multiple SAGE lines will provide.



Assessment of Risk Levels

Data from Oman India

Zone	Calculated Failure Probability	'Safety' Level
Oman Shelf	9.81×10^{-2}	0.04
Oman Shelf Break	2.87×10^{-4}	14.0
Upper Oman Slope	9.18×10^{-4}	4.4
Lower Oman Slope	1.44×10^{-3}	27.8
Abyssal Plain (Oman Side)	1.56×10^{-4}	25.6
Murray Ridge*	2.69×10^{-3}	14.9
Dalrymple Trough*	5.37×10^{-3}	7.4
Abyssal Plain (Indian Side)	6.60×10^{-4}	6.1
Indus Fan (Excl. Ch. 1, 2, 4)	4.27×10^{-4}	9.4
Indus Fan Channel 1	2.17×10^{-4}	18.4
Indus Fan Channel 2	3.09×10^{-4}	12.9
Indus Fan Channel 4	7.27×10^{-4}	5.5
Lower Indian Slope	1.96×10^{-4}	20.4
Upper Indian Slope	3.22×10^{-4}	12.4
Indian Shelf Break	1.15×10^{-3}	3.5
Indian Shelf	9.86×10^{-2}	0.04

Note:
"Safety" Level means "how much safer than acceptable is it?"

What does this tell us?

- The deepwater environment is an outstandingly safe, protective and benign location for a gas pipeline.
- The only areas requiring mitigation are the conventional shallow sections near the beach at each end, similar to any other pipeline, where trenching and rock-dumping are conventionally applied. This protects the pipeline against anchors and fishing activity.
- The risk from Sabotage is insignificant.

Recent and Current Activity

- Peritus International has been appointed as the SAGE Project Development Consultant and has developed the Development design Basis memorandum for future work and regularly updates the Project Development Schedule.
- Peritus International has completed a Wall Thickness and Flow Assurance study and an updated Quantified Risk Assessment is under way.
- INTECSEA/Worley Parsons is completing an onshore and offshore Gas Compression Facilities study and cost estimate.
- Fugro has commenced a route Metocean and Geohazard Review
- Study of SAGE-owned Lay Barge is complete.
- Saipem is preparing Construction Risk input to update the project Risk Model.
- DnV input - SAGE Economic Upgrade by introducing Heat Treatment into pipe mill Quality Control techniques. DnV will be asked to prepare a report to show All-Risk Insurance is available at normal rates when risk Model updated.
- SAGE Technology being shared with Indian & UK Pipe Mills under guidance from Prof. A Walker FRS.
- JAI-Associates International has prepared 30-year Gas Price Scenarios - to be built into the SAGE Economic Model.
- Ernst & Young has just completed its Commercial and Financial Feasibility Study.
- Gas sourcing discussions continue in confidence.

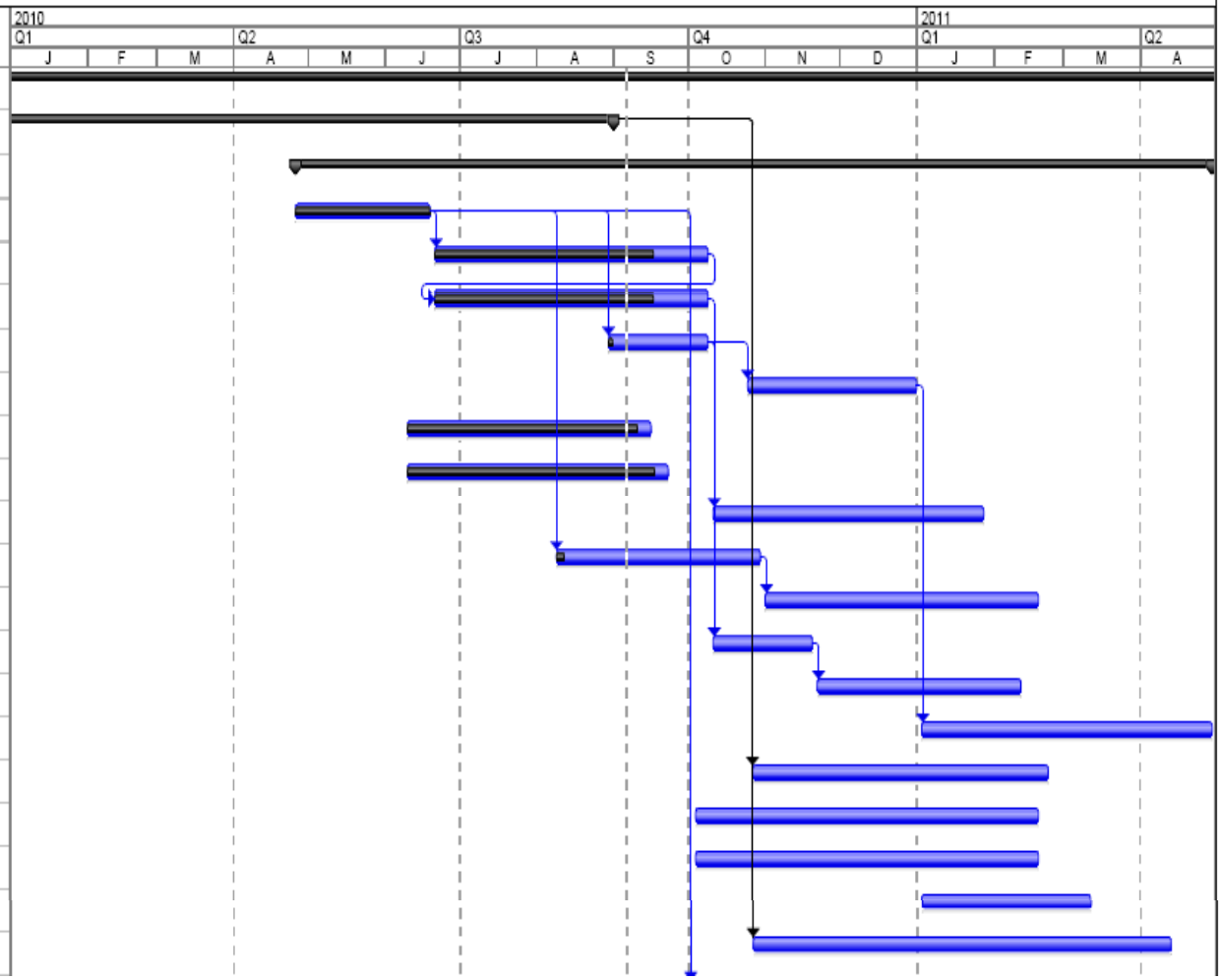
2010 Project Development Schedule

SAGE
Middle East to India Deepwater Pipeline

SAGE
Middle East to India Deepwater Pipeline
Development Schedule

Peritus

ID	WBS	Task Name
1	1	SAGE Project
2	1.1	Project Launch
6	1.2	Feasibility Studies
7	1.2.1	Establish Project Design Basis Memorandum (PERITUS)
8	1.2.2	Onshore Compression Study (INTECSEA)
9	1.2.3	Offshore Compression Study (INTECSEA)
10	1.2.4	Pipeline Routing optimisation - Phase 1 (FUGRO)
11	1.2.5	Pipeline Route Corridor Desk Study - Phase 2 Geohazards (FUGRO)
12	1.2.6	Pipeline Mechanical design Confirmation (PERITUS)
13	1.2.7	Pipeline Flow Assurance Confirmation (PERITUS)
14	1.2.8	Riser and Subsea By-Pass definition (PERITUS)
15	1.2.9	Quantified Risk assessment (Update of Oman-India) (PERITUS)
16	1.2.10	Insurance Risk Review (DNV)
17	1.2.11	Survey Definition and scope of work (FUGRO)
18	1.2.12	Define Survey ITT and tender (PERITUS)
19	1.2.13	Environmental Statement (METOC/FUGRO/INTECSEA)
20	1.2.14	Establish no Hydrotest principle (DNV)
21	1.2.15	Pipeline Intervention Review (PERITUS)
22	1.2.16	Vessel & Equipment Capabilities review (PERITUS)
23	1.2.17	Emergency Repair Equipment Review (PERITUS)
24	1.2.18	Examine the effect of moderate heat treatment (CORUS/WELLSPUN)



November 2010

Conclusions

- A deepwater pipeline from the Gulf Region of the Middle East to India is now technically feasible.
- Multiple sources for pipe manufacture and installation now exist and SAGE has become commercially feasible in recent years.
- There is around 2000 TCF of gas in the Gulf region - one such pipeline requires 8 TCF for 25 years of operation.
- Over the short distance from the Middle East to India, SAGE will deliver gas at a transportation cost much less than for LNG.
- The deep ocean is a benign environment for pipelines. A deepwater pipeline from the Gulf region to India has a highly favourable Damage Risk Profile. It is almost impossible to sabotage.
- The route stays South of third party Territorial Waters also making the geo-political Risk Profile very attractive.
- Multiple pipelines forming an "Energy Corridor" installed to match India's growing appetite for gas will lead to further improvement in the already attractive system availability.
- "Learning Curve" cost benefits will also be achieved through multiple lines; a SAGE-owned locally-fabricated Installation barge may be commercial.
- SAGE is Technically and Commercially feasible, low-cost, low-risk and upwardly scaleable. SAGE is a compelling Value Proposition.