Middle East to India Deepwater Gas Pipeline

December 2007

SAGE

CONTENTS:

Introduction

Project Features

SAGE

- Deep sea gas pipeline infrastructure project
- Middle East to India with geo-political neutrality
- Common carrier – tariff based
- Attractive opportunities for Indian investors to move up the value chain
- Market price for gas at custody transfer point
- World class development team including Heerema Group ensures confident execution

Key Issues

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SAGE is a family of high-capacity offshore pipelines to deliver natural gas from the Gulf Region to India, taking advantage of the unparalleled deepwater pipeline experience of the Heerema Group over the last decade.

- SAGE has a conservative design, well inside current technology guidelines. The pipelay industry has continued to reach into ever deeper water until today, Heerema's new pipelay barge is specified to work beyond 3500m.
- 31.5 million Standard Cubic Meters per day from each line (1.13BCFD)
- SAGE establishes a natural gas "Energy Corridor" infrastructure system as additional lines are subsequently installed
- First Gas will be in 2012 or earlier

The Opportunity for Investors

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DEMAND:

- India's energy security requires more natural gas. Prices are rising at around $5-6 per MMBTU for domestic use, and up to $12 for fertiliser.
- Natural gas is needed to replace coal for environmental reasons in Power Generation and to replace naphtha for fertiliser manufacture.

SUPPLY:

- Over 2000 TCF gas reserves are known to exist in the Middle East. Only around 8 TCF is required for SAGE over a 20 year period.

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- "P10 - P90" project cost expected to be $2.1 – 3.4 billion for first line from Oman Coast to India. This requires tariff of around $1.1 to $1.8 per MMBTU. "Learning Curve" savings will be achieved for subsequent lines.

Resulting BENEFITS to Investors:

- Tariff share, but also investment opportunity in Downstream Power, City Gas Distribution, Fertilizer Projects and CNG systems.

Key success factors

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SAGE project has economic and technical viability:

- World class design and build consortium; low project risk.
- Route outside of Straits of Hormuz and neighbours' EEZs gives SAGE a desirable low political risk profile.
- Non-volatile, long-term bi-partisan pricing un-correlated with and complementary to LNG "spot-market" price volatility for superior financial risk profile.
- "Green Energy" benefits.
- SAGE can source gas from several Gulf countries. It forms an historic opportunity for convergence of West and South Asian regional economic interests.
- Highly successful technology update undertaken by SAGE with DnV, INTEC, Corus and others ensures the major advances in design knowledge since 1990 are applied.

The SAGE Project – Key team members

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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: 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 ▪ Director: VerdErg Engineering Ltd, London ▪ Former Project Director of original Oman-India Pipeline
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
John Stearns	▪ Vice-President, Marine Pipeline Systems, INTEC Engineering Inc., Houston ▪ Former Project Director, Mardi Gras Transportation System ▪ Former Project Manager, Canyon Express Project
Rob Narold	▪ HMC Project Manager for new barge design and construction ▪ HMC Strategic Development Advisor ▪ Sr. Proposals Manager - Manager New Product Development ▪ HMC Deep Water Product Manager
Dr Alastair Walker	▪ 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
Richard Freeman	▪ Manager, Business and Sales Development, Corus Tubes (Energy), UK.

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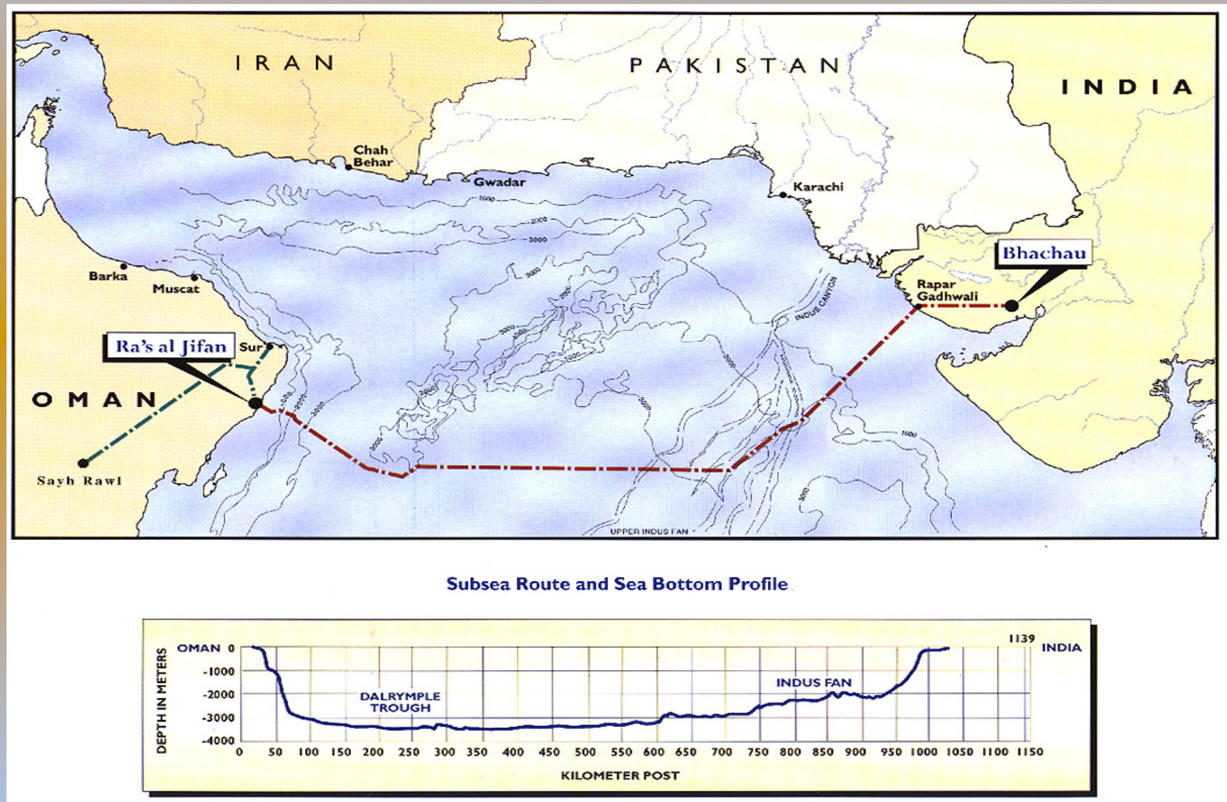
Deepwater pipeline technology was first developed over 10 years ago on the Oman-India project……..



……and has now matured

History

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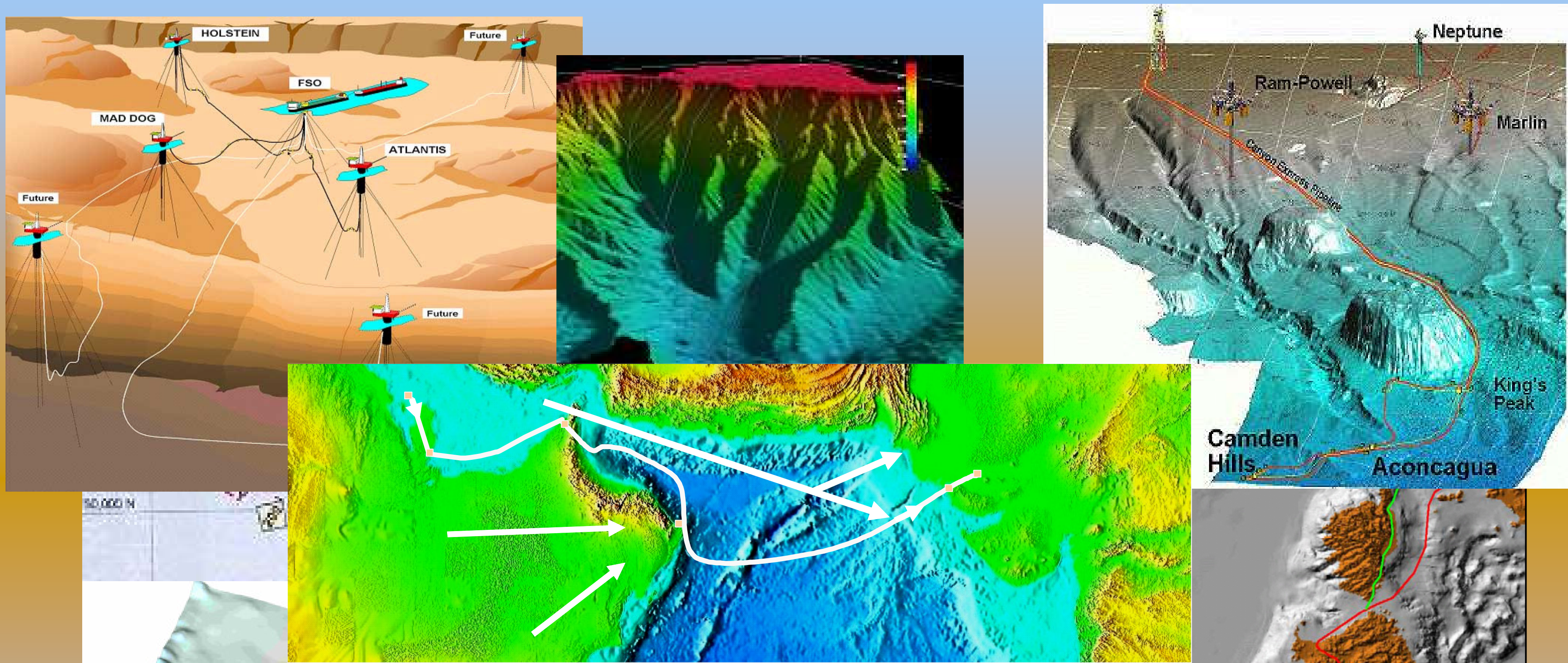
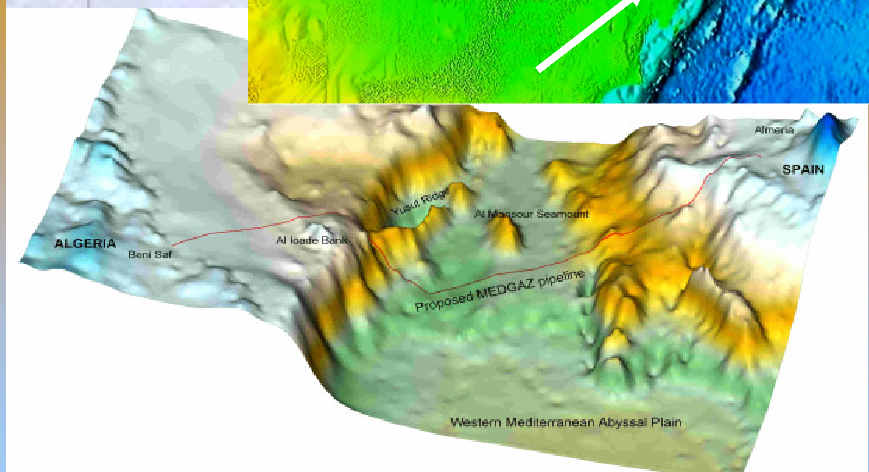
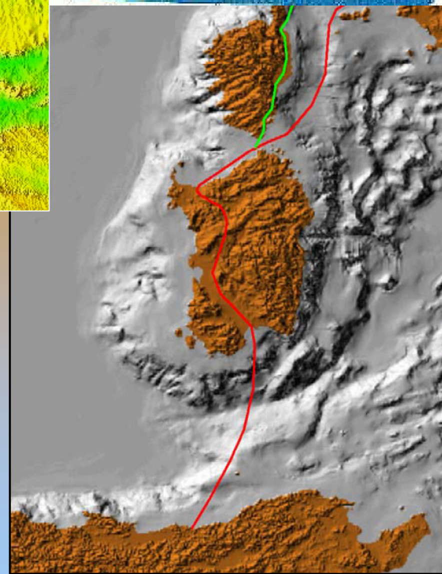




- Bluestream
- Canyon Express
- Mardi Gras
- MEDGAZ
- Galsi
- …etc
- SAGE



Indian natural gas shortfall:

The gas deficit of the Indian Power Industry is reported to be 30 to 40 MMscm per day…..

Demand for natural gas (more than 120 MMscmd) in the country has far outstripped supply (about 66 MMscmd), and there is an increasing trend of new NG demand emerging as well as conversion from existing fuels to NG[22].

…some reports put this deficit as high as 54 MMscm per day.

However, unless significant finds are made (similar to KG basin) the country will still have to deal with a domestic shortage of gas.

Source: KPMG

Indian natural gas shortfall:

- The gas deficit of the Indian Fertiliser Industry is reported to be 20 to 30 MMscm per day.
- This deficit is currently met from LNG and naphtha.
- Dow Jones reported on 21 November 2007:
  - "We are now substituting almost 20% of our gas needs with naphtha….we are talking to gas suppliers, but the gas just isn't there." (attributed to a senior executive at Indian Farmers Fertiliser Cooperative).
  - "Naphtha consumption may cross 3.2 million tonnes in the year to March 2008 compared with less than 2.7 million tonnes in the last fiscal year." (attributed to a senior official in the Ministry of Chemicals and Fertilisers.)

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India's Rising Growth Potential

- India's high growth rate since 2003 represents a structural increase rather than simply a cyclical upturn. We project India's potential or sustainable growth rate at about 8% until 2020.
- The recent growth spurt was achieved primarily through a surge in productivity, which we believe can be sustained.
- India is well-positioned to reap the benefits of favorable demographics, including an 'urbanization bonus', and a further rise in capital accumulation, in part from an upsurge in foreign direct investment.

Source: Goldman Sachs Economic Research January 22nd, 2007

India's gas consumption is expected to increase dramatically:

Exhibit 2.5: range of utilization of different fuels in 2031-32 compared to current levels

Resource	Range of Utilization of Supply Sources (Mtoe) in 2031-32	Current Utilization of Supply Sources(Mtoe)
Oil	463 – 493	116.00
Natural Gas	114 – 224	27.65
Coal	573 – 1082	184.35
Hydro	5 – 50	<1
Nuclear	3 – 89	<1
Solar	1- 4	<1
Wind	0 – 12	<1
Fuel wood	0 – 69	115.44
Ethanol	0 – 4	<1
Bio-diesel	0 – 8	<1

Source: Planning Commission, Govt of India

Source: KPMG

Gas reserves in the range of 80-160 TCF recoverable will be needed to meet these targets. Only half this may be available?

SAGE requires around 8 TCF per pipeline of Gulf Region gas

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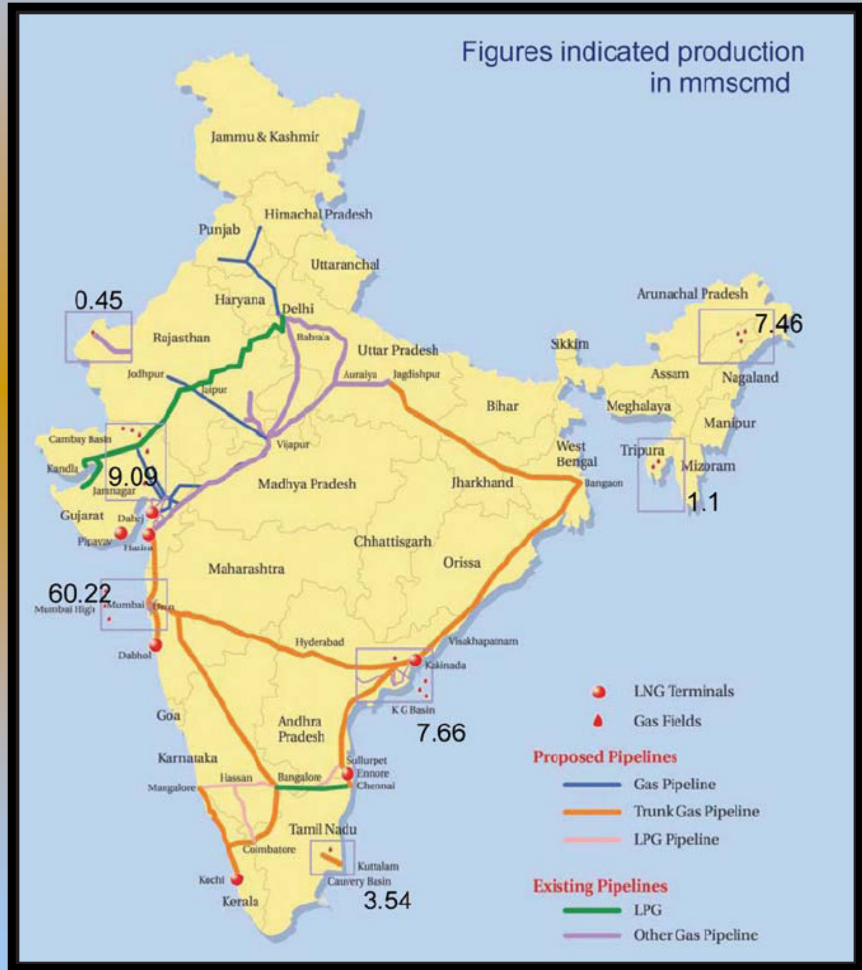
The Ministry of Petroleum and Natural Gas announced a doubling of the domestic gas distribution infrastructure on March 30th 2007:

Expressions of Interest in 5 new natural gas pipelines on a “common carrier” basis will be invited soon. The total length..will be around 5000 km…estimated investment Rs. 18,000 crore (US $4 billion)….and add to the existing network of over 5600 km.

When commissioned, capacity is expected to increase from 140 MMSCMD at present to around 280 MMSCMD.

Reported by indianpetro.com 2nd April 2007

There will be no problem selling SAGE gas



Source: KPMG

The integrity of pipelines compared to a dependence on shipping is increasingly recognised

ArabianBusiness.com

Last updated: Wednesday, 21 March 2007 14:33 UAE time

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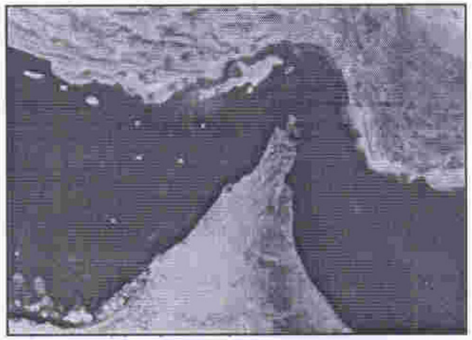
Oil pipelines to sidestep Hormuz

by Safura Rahimi on Wednesday, 21 March 2007

GCC countries are still considering oil pipeline plans that would avoid the Strait of Hormuz and possible interference in global oil shipments from Iran, according to reports.



The two pipelines will pump 6.5 million bpd of oil across the UAE.

The Strait of Hormuz - the narrow channel at the entrance of the Gulf located between Oman and Iran - ships around 40 per cent of the world's oil supply.

Iran has previously threatened to disrupt supplies if it comes under attack for its nuclear policy.

Energy Economics

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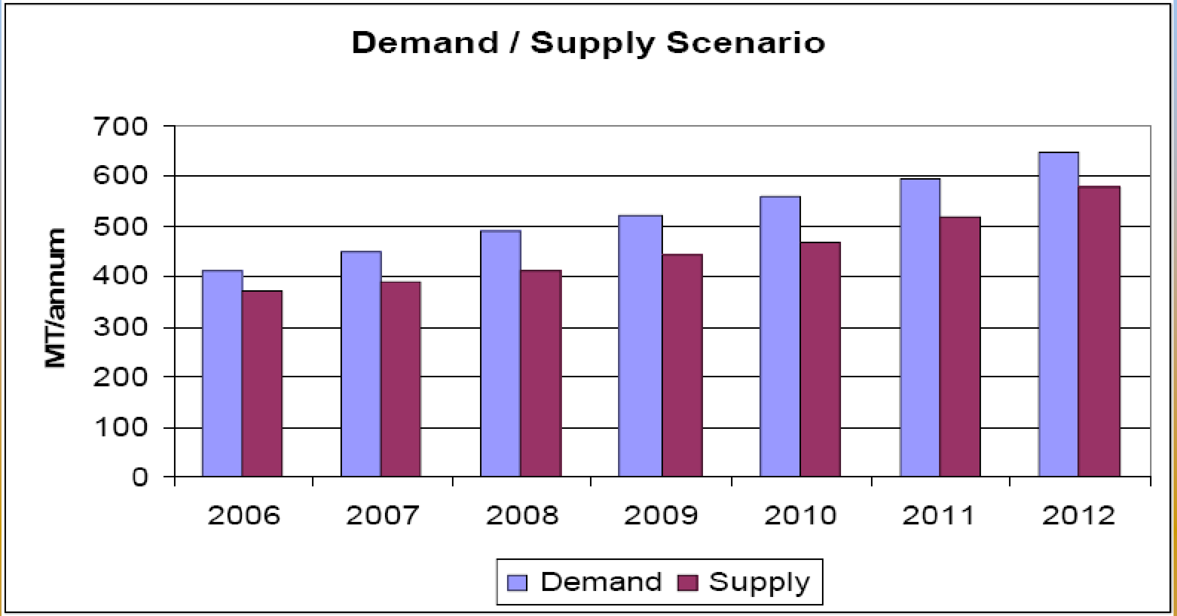
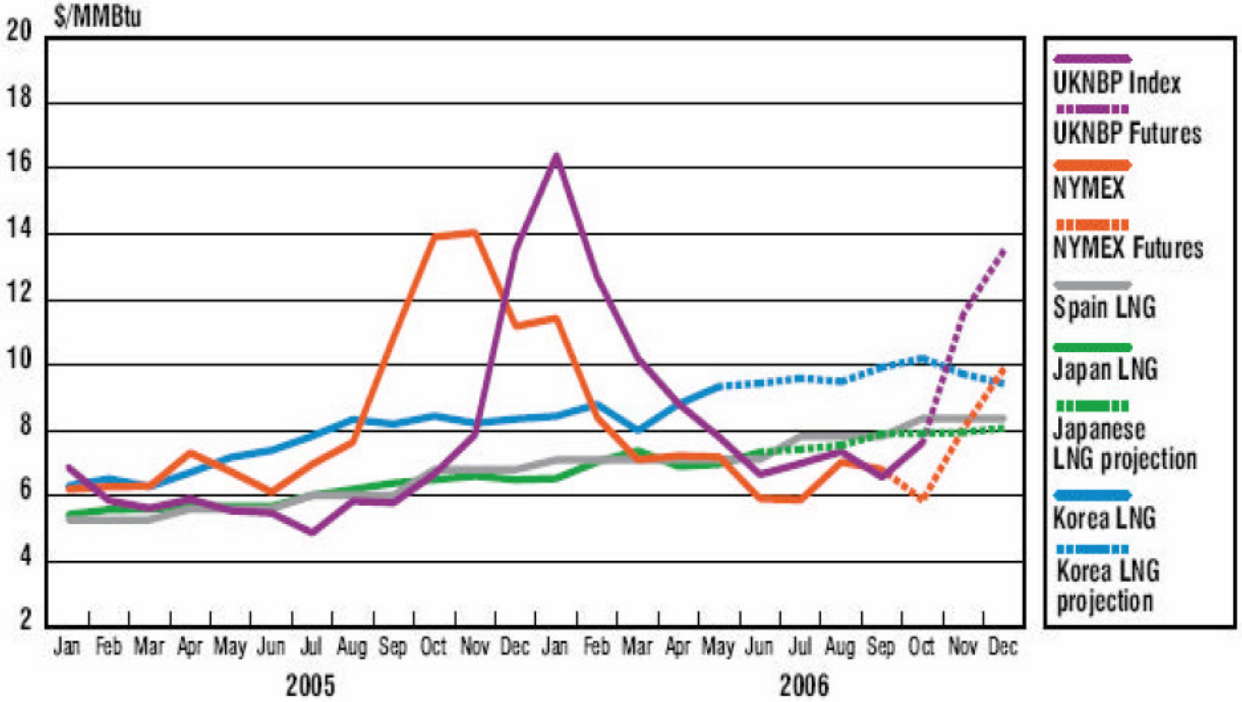


Source: Published at the Second Annual Gas Distribution Conference in New Delhi March 14th 2007, by Pankaj Wadhw, Crisil.

- **Gas at delivered prices of 6$/MMBtu expected to be competitive with imported coal based projects**

The logical "floor price" for gas FOB India may be around $6 per MMBTU.

However, India would need to compete with other more attractive markets



Source: LNG Focus, Gas Strategies

CRISIL A Standard & Poor's Company

Source: Published at the Second Annual Gas Distribution Conference in New Delhi March 14th 2007, by Pankaj Wadhaw, Crisil.

LNG prices become inherently volatile as an LNG "spot-market" establishes .

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The Government of India is recognizing the importance of private sector participation, and independent regulation in the energy sector. The future holds a lot of opportunities for international and domestic private participation.

Source: KPMG

The Government has awarded "infrastructure status" to gas pipelines, offering them tax holidays on profits for up to 10 years. The exemption has also been applied to storage facilities integrated to the gas pipeline network.

Reported by livemint.com, New Delhi, 1st March 2007

The Indian energy Marketplace is increasingly open to investment

SUMMARY

- Indian LNG import prices around $5.50 - $6.00 per MMBTU are being reported in the Indian press.
- Naphtha prices of $12 per MMBTU are reported being paid in India for fertiliser feedstock.
- SAGE will seek a tariff expected not to exceed $1.80 per MMBTU for the first line, falling thereafter towards $1.10 per MMBTU as the system grows.
- The SAGE tariff will be set by its owners, which can be the gas Buyers.
- Buyers can therefore have $3.70 to $4.80 available for gas gathering & purchase after paying the SAGE tariff
- There is a huge unsatisfied demand for natural Gas in India capable of immediately absorbing 100% of the 31.5 million standard cubic metres per day delivered by each SAGE pipeline.

Technical Context

Building on Previous Experience

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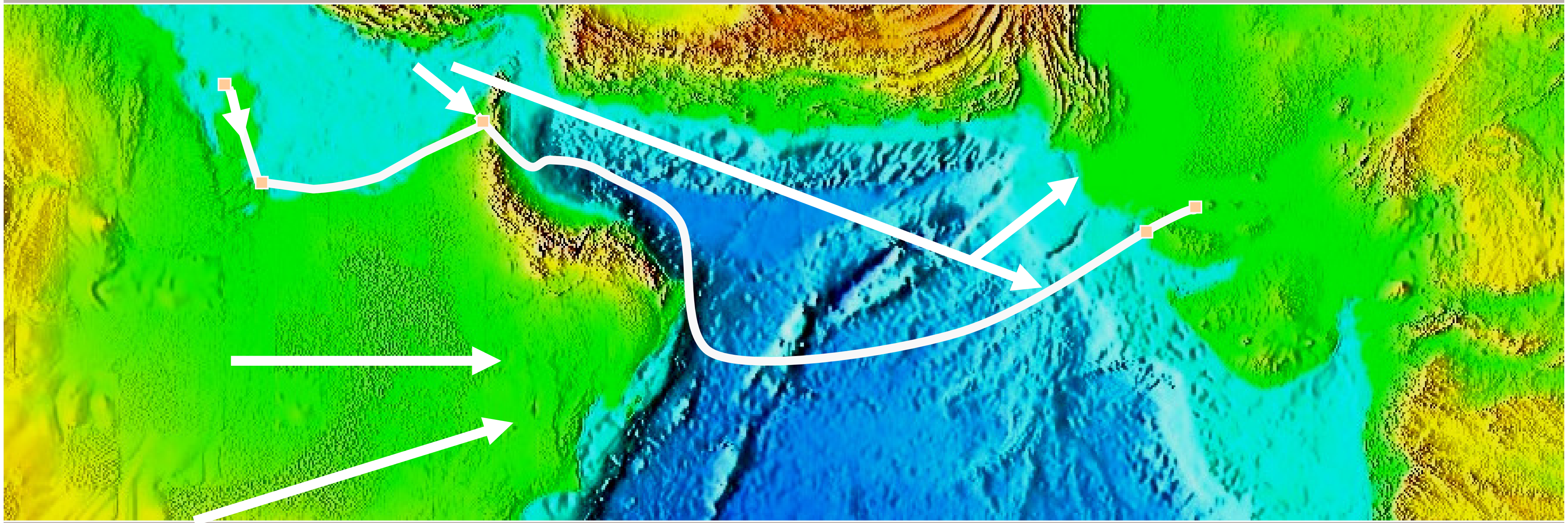
SAGE will build on the extensive development carried out by INTEC during the Oman-India Pipeline project (OIP) in the mid 1990's as well as current deepwater pipeline technology being applied by the Heerema Group in the 2000-2800m range.



The route selected for SAGE will reach water depths of around 3,500 meters and will be over 1,000km in length. Routes appropriate to all possible gas sources have been conceptually addressed. The final detailed choice of landfalls will depend on the specifics of the gas supply and purchase agreements

Building on Previous Experience

SAGE

Technical Issues facing OIP in 1995:

- Inability to manufacture linepipe to specification without mill upgrade.
- Inability to lay pipe in 3,500m water depth – lack of lay vessel with sufficient tension capability.
- Incomplete understanding of seismic activities and mitigation methods – mudflows, fault lines, slope failures, etc.
- No qualified deepwater pipeline repair system available.

Building on Previous Experience

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What makes SAGE possible now?

- Benefit of new testing and commissioning philosophies based on past years' experience - studies in progress with DnV, INTEC, Corus and others.
- New generation large Heerema lay vessel.
- 28-inch pipe now possible, delivering 31.5 MMscmd
- Several mills are capable of manufacturing pipe.
- New and improved design methods for free-spanning and geo-hazards.
- Better positioning capabilities during pipelay to avoid seabed hazards.
- New deepwater repair systems available.

the history of deepwater design technology:

Date	Details of Activity
Pre-1990	1000m is considered to be ultra-deep water. Test data are available for small diameter pipe with 12<D/t<35 and large diameter pipe for D/t>20
1994	Special test facilities in Canada and Europe are prepared for pressure collapse tests in water depths up to 5000m
1994	DNV initiates the preparation of a limit state design code based on available theory and test results
1995	Oman – India pipeline design is carried out and collapse tests are performed for 20-inch and 26-inch diameter pipe with D/t ratio about 17. The tests are carried out.. It is noted in a few test results that heat treatment during coating significantly increases the collapse pressure strength. (Total 29 tests)
1996	DNV publishes the first limit state code (DNV 1996) that includes methods to calculate the external pressure collapse pressure and provides factors to ensure specified levels of safety.
1996	Tests are carried out by TNO in Holland on four 20" dia. Pipes (Total 4 tests)
1997	Sumitomo carried tests to initiate an understanding of the causes of collapse strength improvement caused by heat treatment. (Total 3 tests)
2000	DNV revises the limit state code to incorporate the results of tests up to that date (OS-F101-2000)
2004	Full-scale tests on 18-inch pipe specimens were carried out by CORUS in the UK to validate the DNV guidance and to investigate systematically the effects of pipe manufacturing procedures and heat treatment. (Total 8 tests)
2004	As part of the detailed design of 28-inch Mardi-Gras deep-water pipeline system tests are designed by INTEC in US to enable the effects of heat treatment to be incorporated in the project pipelines, (Total 7 tests)
2005	Saipem carries out a series of tests as part of the design of the Blue Stream 24-inch pipeline across the Black Sea. The tests include pipe specimens that had been heat treated prior to testing. The increase in collapse resistance due to heat treatment during coating is included in the pipeline design calculations (Total 5 tests)
2006	Europipe carried out a series of tests on full-scale pipes and pipe material before and after heat treatment. The pipe are 28-inch and 30-inch diameter and the purpose is to provide a basis for QA procedures for project pipe to ensure the effects of heat treatment are being incorporated in the project pipe. (Total 14 tests)
2007	Nippon develop a methodology for the measurement of mechanical properties to predict collapse pressures for large diameter pipe. Tests are carried out to validate the numerical predictions using measured material properties, including the effects of heat treatment. (Total 9 tests)
2007	DNV revise the limit state code to incorporate the results from tests on heat treated pipe (DNV OS-F1010-2007)

the history of deepwater design technology:

Conclusions:

- Over 70 full-scale tests have been carried out specifically to determine the mechanics of external pressure collapse of large diameter thick-walled pipes.
- The tests and associated numerical modelling of the collapse mechanism have provided a comprehensive and sound basis for the calculations of collapse strength for detailed design project pipelines.
- The effects of heat treatment, carried out during coating of the pipe, has shown to increase significantly the collapse strength of pipe.
- The testing and research carried out continuously over 10 years has provided a sound basis on which the pipe manufacturing and coating procedures can be included in the design calculations
- The research has also provided a basis for quality procedures, i.e. the measurement of pipe and material properties during and following manufacture, to ensure the design conditions are actually met.
- The use of re-calibrated design factors specified in the limit state code ensures that the pipeline will meet internationally recognised levels of safety against external pressure.

Building on Previous Experience

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A number of activities have been initiated that are providing support to the preliminary design of the SAGE pipeline:

- DnV has been commissioned to prepare a design procedure specifically tailored for the SAGE pipeline.
- INTEC has been commissioned to carry out calculations to verify the wall thickness and gas flow rates that are currently being used in the preliminary design.
- Bodycote Testing Ltd has been commissioned to prepare and commission novel testing methods to enable the QA procedures to be carried out during the SAGE pipe manufacture and much reduce the requirement of full-scale testing.
- Corus has supported with its own development data.

DnV Activities

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Within the DnV limit state code, the effects of heat treatment may be used, provided that adequate proof exists to support this practice.

Currently the code includes a factor called the fabrication factor that has been calibrated with test results, using as-manufactured pipe specimens. The factor has a value of αfab = 0.85.

The effect of heat treatment during coating is known to improve the material properties, which implies an increased value of αfab.

DnV has delivered a Preliminary Report in which it is shown that values up to αfab = 1.0 are appropriate for heat treated pipe.

As shown in table 2-1, over, the wall thickness for the 28-inch pipe in 3500m water depth would have a corresponding wall thickness of **39.6mm.**

DnV Activities

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However, it is proposed to use a nominal wall thickness of **<u>42.7mm</u>** for the SAGE 28-inch pipeline, i.e. corresponding to a value of αfab = 0.925.

Table 2-1 Effects of increased material strength and reduced ovality

Fabrication factor α_{fab}	Minimum wall thickness	
0.85	44.6mm	100%
0.925	41.7mm	93%
1.00	39.6mm	89%

Work is continuing with DNV to re-calibrate the design factors that are incorporated in the limit state code. The re-calibration takes account of the latest data from pipe tests, material tests, manufacturing procedures and inspection and QA procedures. Corus from the UK is actively contributing to this work.

Wall Thickness Verification:

Table 1 shows example results from the INTEC calculations to evaluate the nominal wall thickness. It can be seen that the chosen value of 42.7mm corresponds to "Normal" levels of design factors and not the minimal values corresponding to the "Low" category, thus introducing a level of conservatism into the pipeline design.

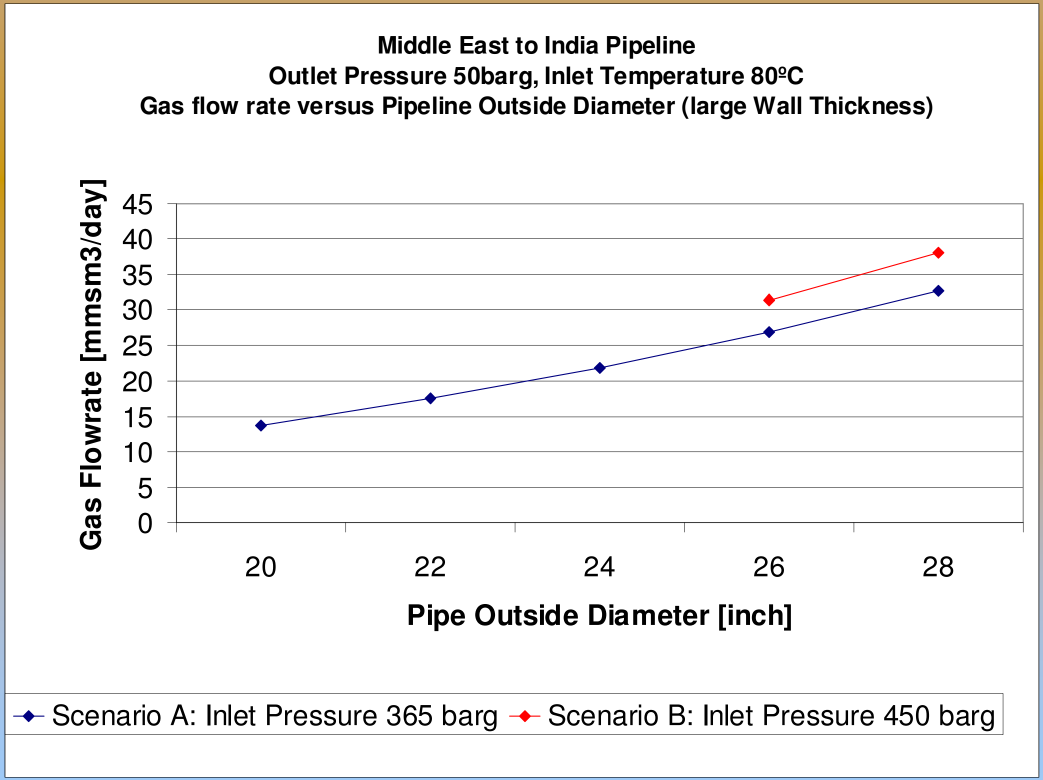
Pipeline OD	f_o = 0.5%	f_o = 1.0%	f_o = 0.5%
	Low		Normal
inch	mm	mm	mm
20”	28.7	30.4	30.8
22”	31.5	33.4	33.8
24”	34.3	36.3	36.8
26”	37.0	39.2	39.7
28”	39.8	42.1	42.7

Table 1 Results from INTEC Calculations

Gas Flow Verification:

Figure 1 shows the results for the gas flow rates corresponding to a range of pipeline outside diameter and thickness calculated as described above. The results confirm the values that are currently being used in the preliminary design of the SAGE pipeline.

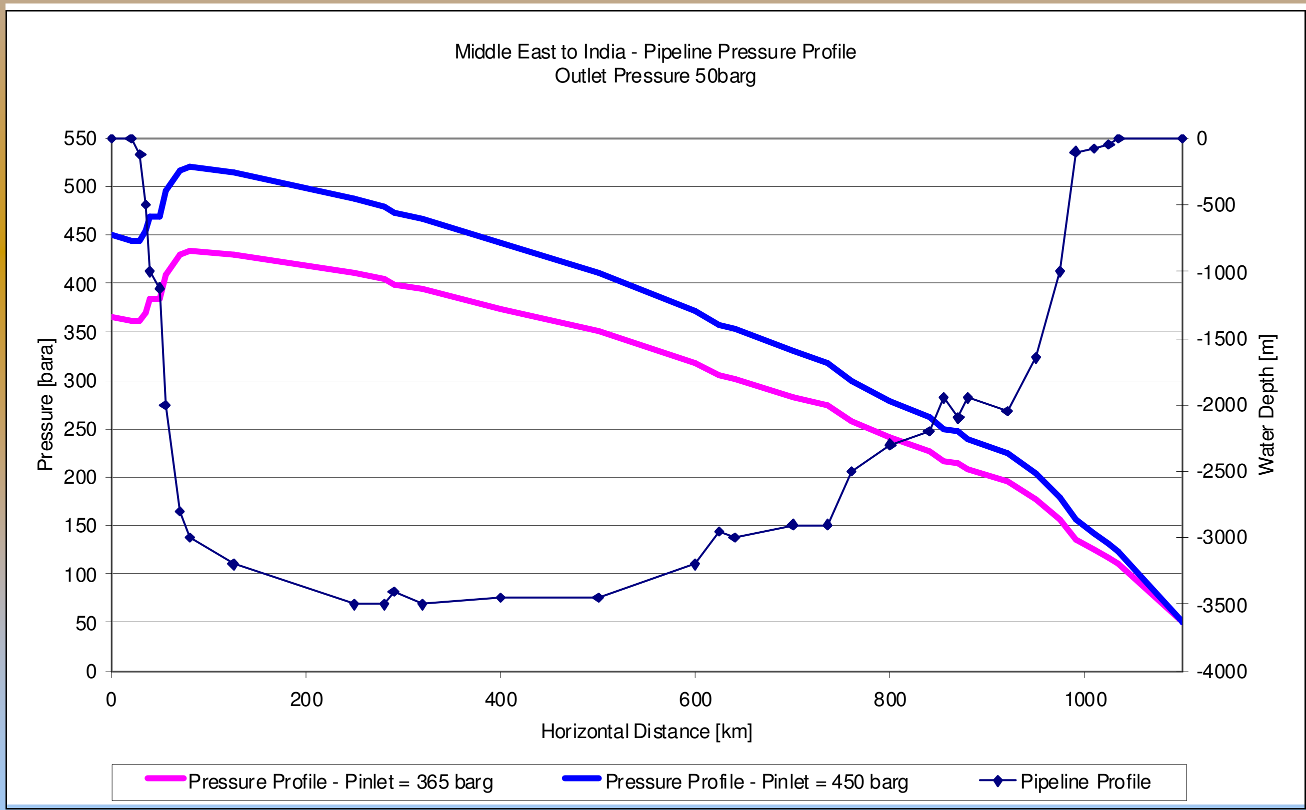
Figure 1



Gas Flow Verification:

The effect of increasing the gas inlet pressure from 365bar to 450bar is shown in Figure 2:

Figure 2



Bodycote activity

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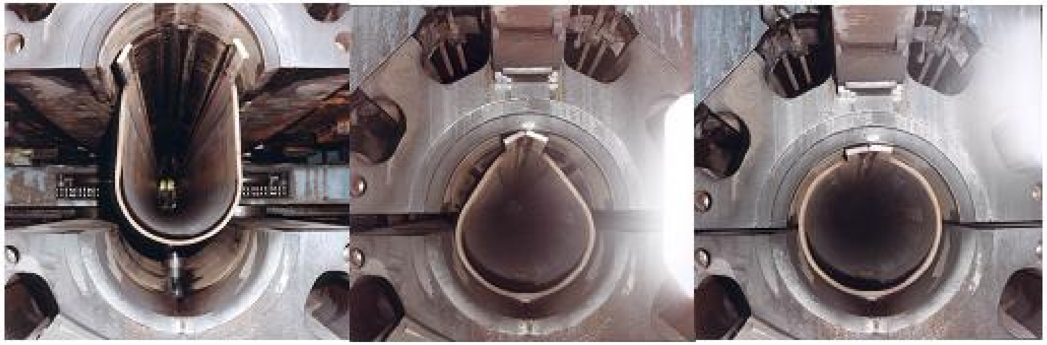
Bodycote has received from SAGE a patented method for testing pipe subjected to external pressure.

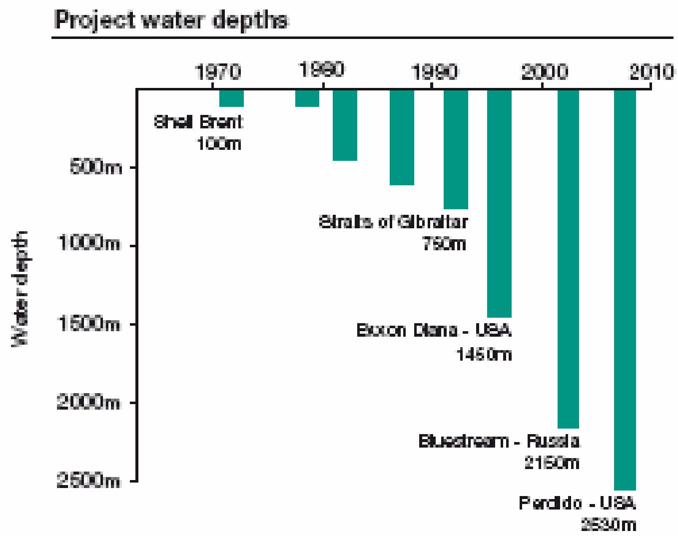
The detailed design for this has now been completed by Bodycote and machining is underway such that preliminary commissioning tests will be carried out before the end of 2007.

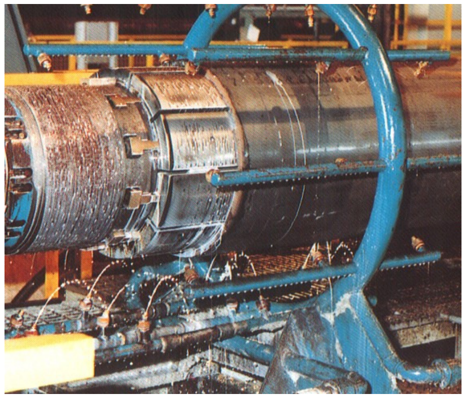
Corus Tubes – Deepwater Track record



World Strongest : "O" Press

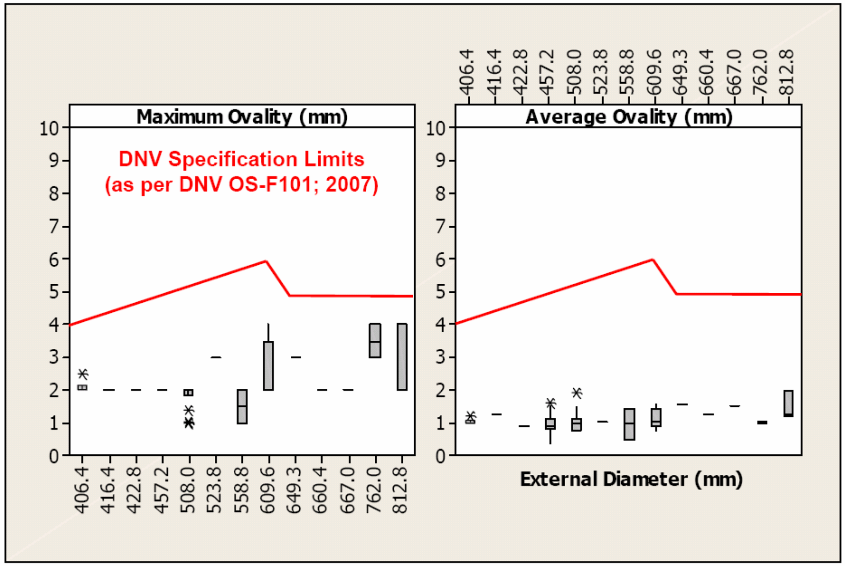
Max Pressure force : 50,000t

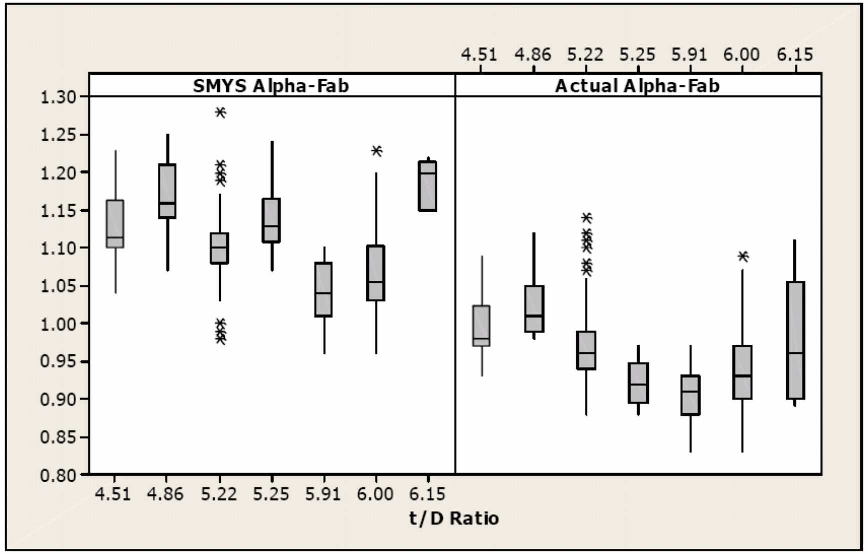


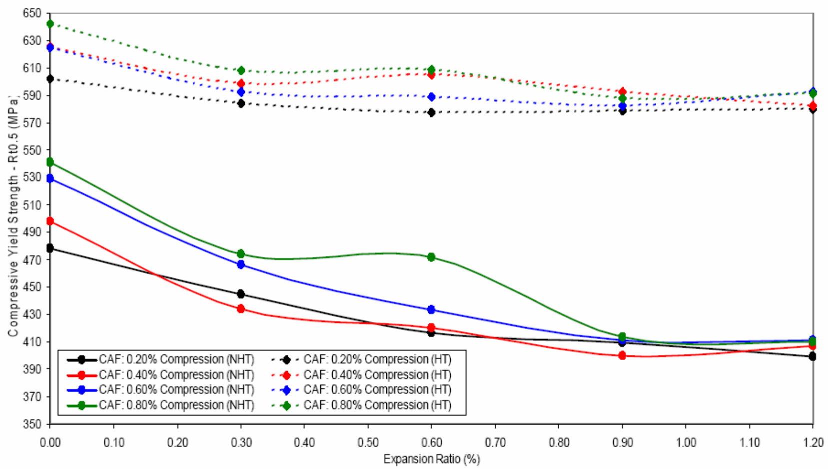


Corus Tubes UK UOE Mill has the strongest tooling in the world ensuring the required roundness and material compressive strength necessary for ultra-deepwater line-pipes

Corus Tubes – Commitment to R&D





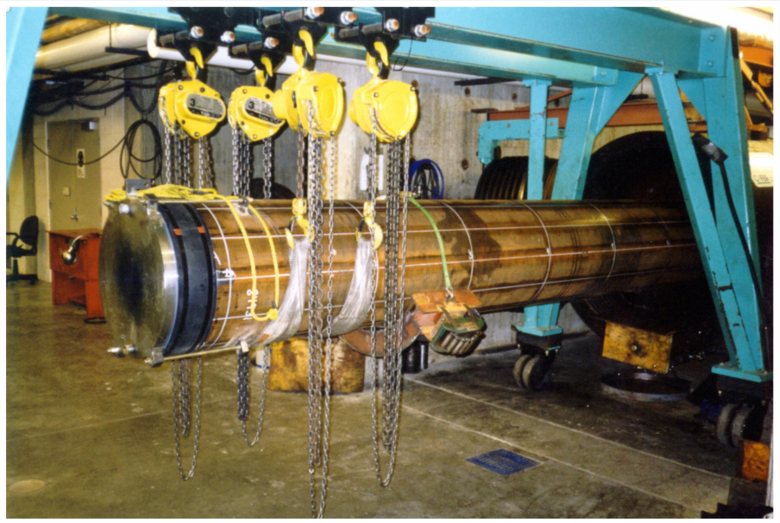


Corus R&D concentrates on exploiting the understanding of forming stresses on Deepwater performance

Relevant topics:

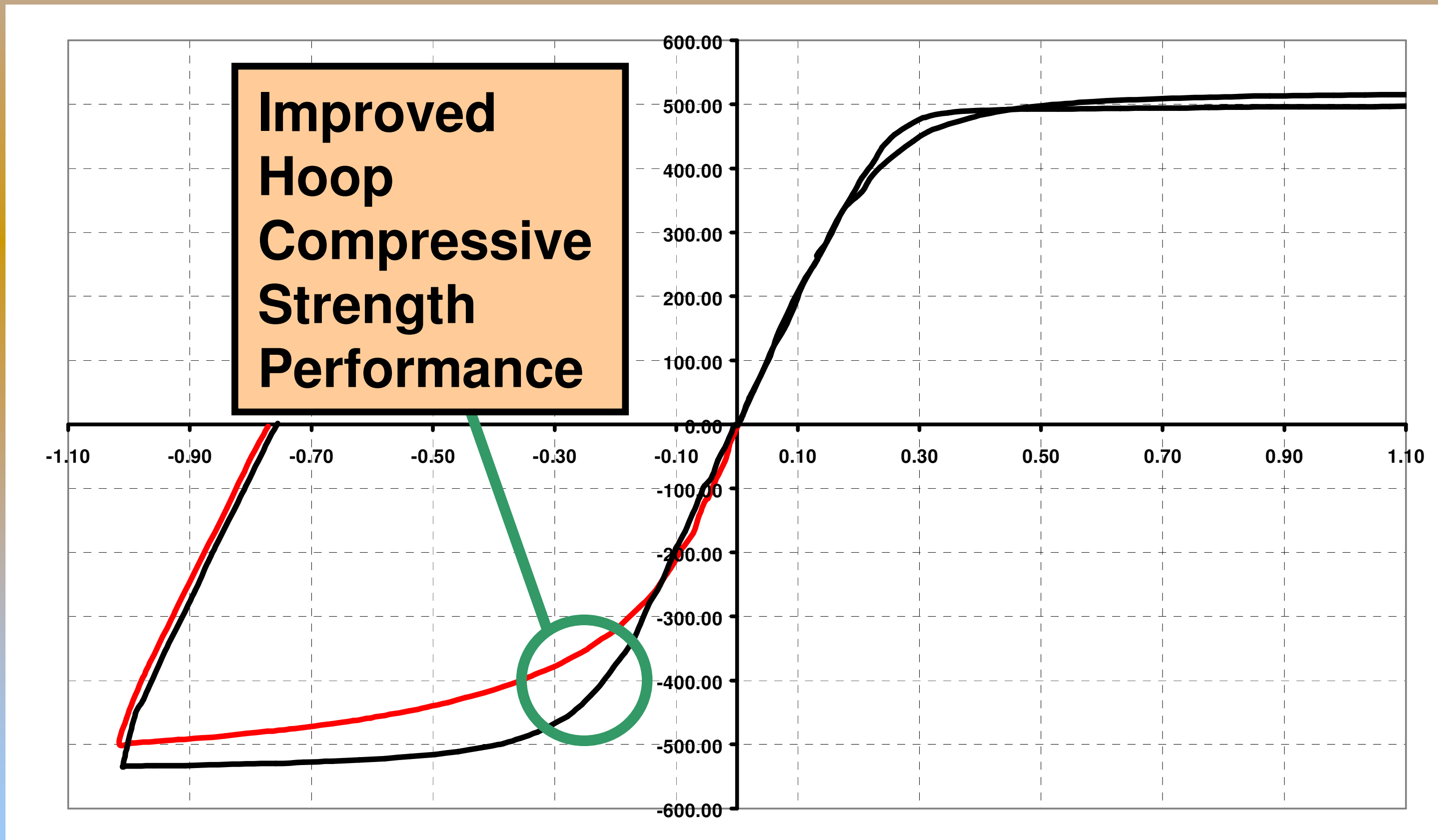
Linepipe Manufacture
Deepwater Pipelay
Testing and Commissioning
Repair
Geohazards

Why Collapse Testing?



- Verifies accurate prediction by numerical methods of strain before local buckling
- Quantifies reduced collapse capacity resulting from UOE process
- Quantifies strength recovery of thermal aging resulting in improved collapse resistance
- Validates engineering critical assessment output

- Thermal Aging for Enhanced Collapse Resistance (UOE Pipe):
- Hoop compressive strength recovery through FBE coating process, leading to enhanced collapse resistance
- Used in the bp Mardi Gras project (circa 2004-06)



INTEC ENGINEERING

Linepipe Manufacture

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Improvements Over The Last Decade Include :

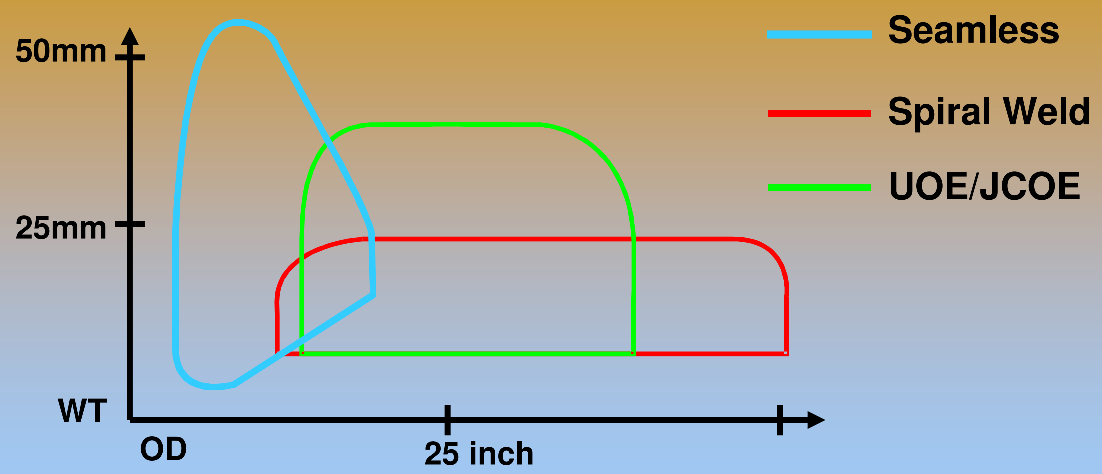
- Manufacturing Processes : introduction of the JCOE process (higher production rates), improved controlled rolling practices, stronger break presses.
- Chemistry : less impurities such as P, S, and N. Tighter control on microalloying elements such Nb, Ti and V.
- Heat Treatment : Finer grain sizes and more uniform microstructures being produced.
- Dimensional Tolerances : improvements in ovality and internal diameter.
- Mechanical Properties : fracture toughness, fatigue and tensile.
- Weldability : improvements in welding consumables for the long seam.
- NDE : increased number of probes to detect mid wall defects.

Linepipe Manufacture

Various proven methods exist for fabrication of line pipe, including:

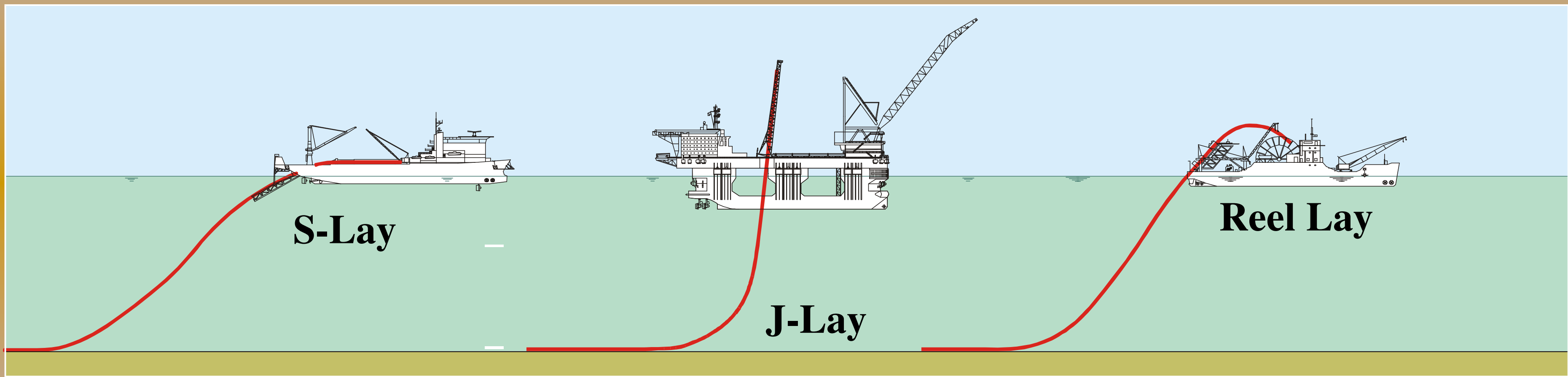
- **Seamless:** Commonly used for small diameter (< 20 inch OD) offshore lines, but mill capacity is limited for larger sizes; Poor end tolerances
- **Spiral Weld:** Commonly used for large diameter onshore applications, but suitability for offshore installation is limited by strength and welding issues
- **UOE:** Commonly used for larger diameter offshore lines; Maximum diameter and wall-thickness are mill-specific; Good tolerances on pipe ends

Ranges of Applicability:
(Indicative)



Deepwater Pipelay

General Methods of Pipeline Installation:



More details are given in the following section.

Design for Installation

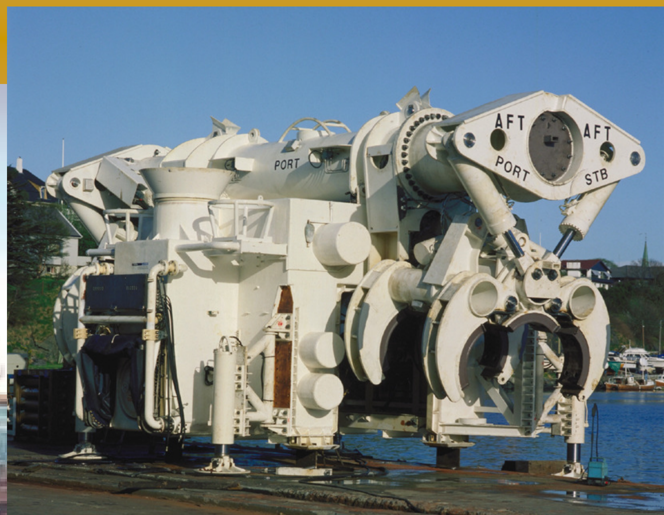
- The overall shape of the pipeline during installation must be carefully controlled to prevent damage to the pipe and its coatings. Loads experienced during installation may govern the maximum feasible pipeline diameter.
- For J-Lay, the shape of the pipe through the water column is a function of:
  - ✓ Tension: applied by the lay vessel through its propulsion and gripping equipment
  - ✓ Submerged weight of pipe: higher weight = higher tension required
  - ✓ J-lay tower geometry: controls the amount of pipe bending at the departure point of the vessel
- Potential negative scenarios during installation must also to considered
  - ✓ Pipeline flooding: in the event of a failure and flooding of the pipeline during lay, the lay vessel must be able to handle the additional pipeline weight

Hydrotesting – Pros and Cons

- Hydrotest, dewatering and commissioning is feasible for SAGE but at high cost and requires significant time.
- Today, industry accepted alternatives are available that are certified by DnV.
- Recent examples of large diameter deepwater pipelines where alternatives to hydrotesting were implemented include the Gulf of Aqaba Crossing and Enterprise Phoenix Pipeline in the Gulf of Mexico.
- SAGE is retaining DnV to develop an interpretation of its Code to permit hydrotest elimination and wall thickness refinement, balanced by additional pipe production QC.

Repair

- 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) so extension to 3,500m is a given.
- The use of advanced diverless remote equipment to repair a line takes time, and leads to consideration of redundancy such as the multiple SAGE lines provide.



Geohazards

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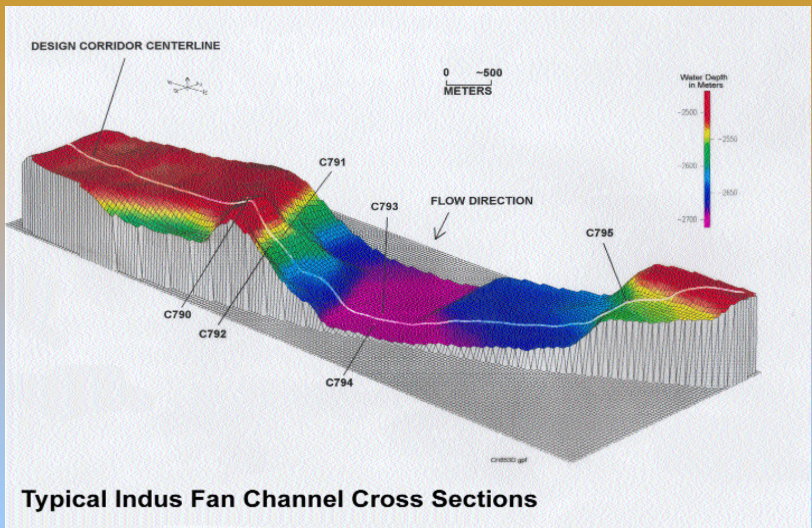
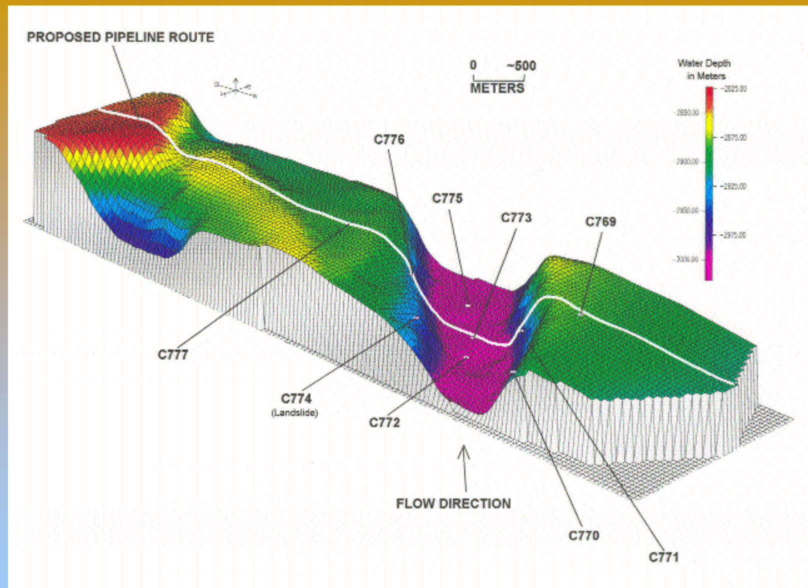
Predominantly benign seabed conditions exist between the Arabian Peninsula and India, However certain local areas exhibit challenging features:

- Indus Fan with active and inactive Submarine Channels, mud flows and steep levee banks of up to 225m.
- Oman and Indian continental shelves with recent slope failures and turbidity flows
- Seafloor faulting with active seismicity and scarps with 2 to 70m of relief.
- Areas of strong seafloor currents (approx 1 knot) with sand waves(4m high and 10m across).

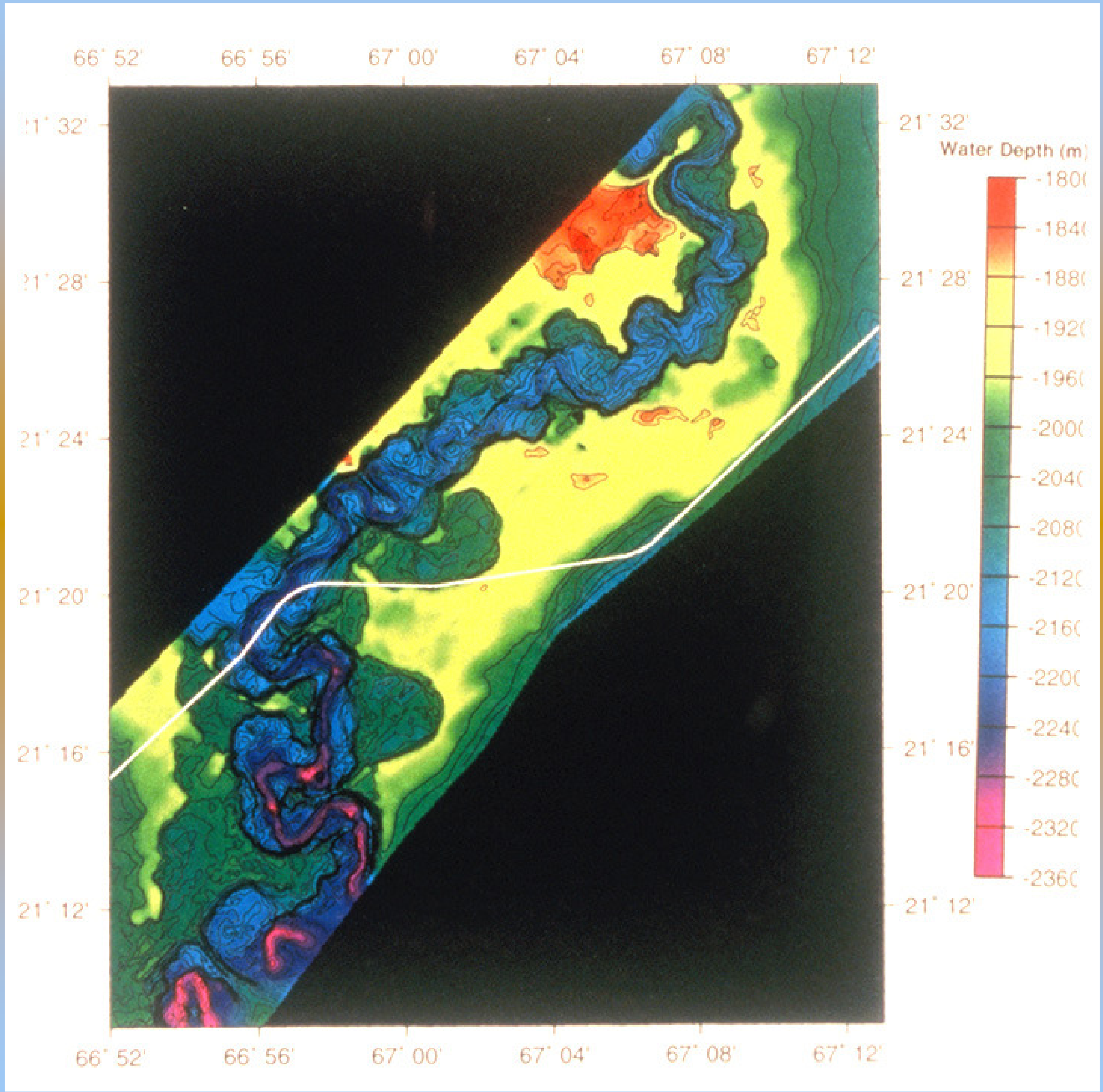


Typical Indus Fan Channel Cross Sections



Geohazards - Indus subsea channel

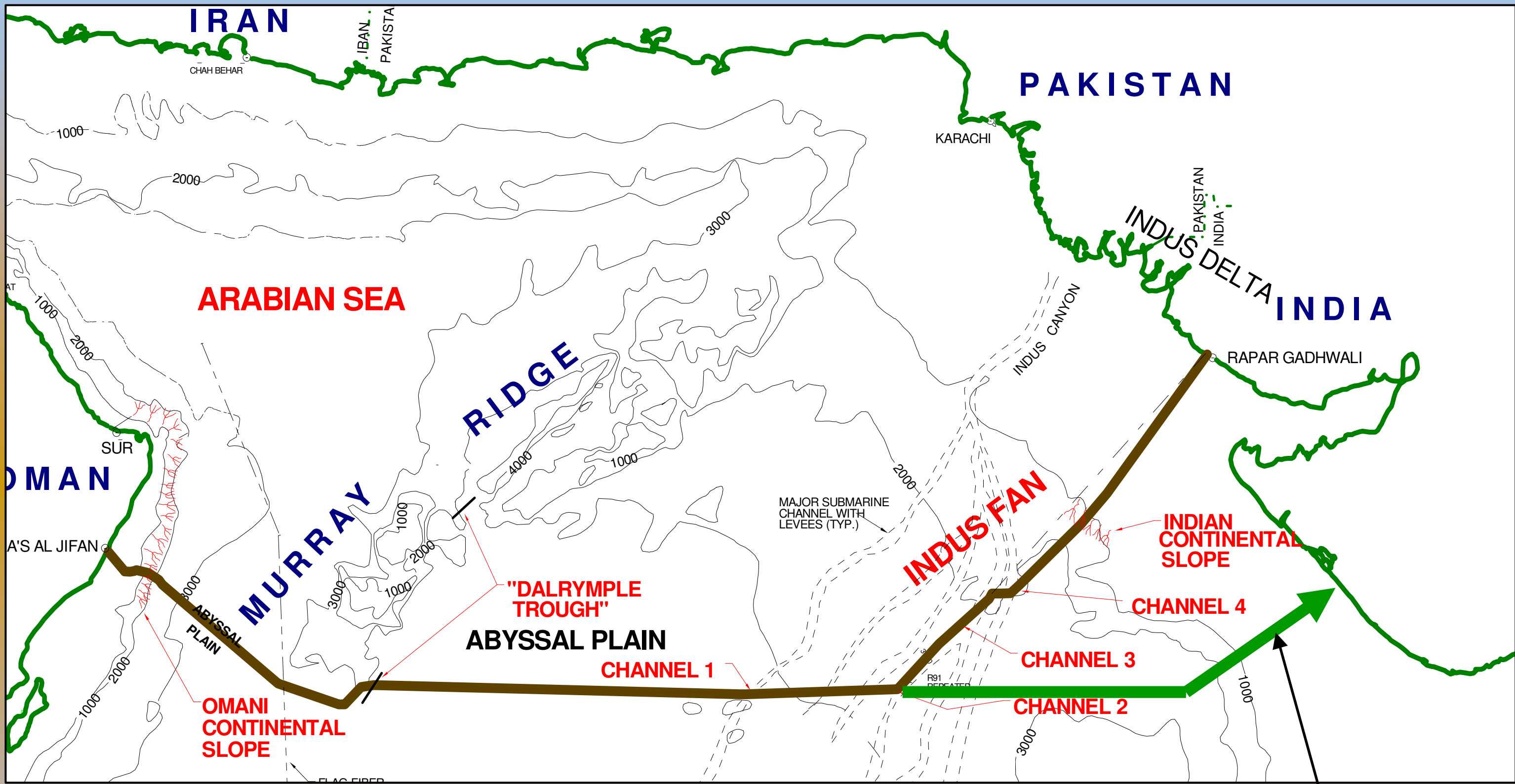
SAGE



Freespan and Seismic Activity Mitigation:

- Use heavy wall pipe (Indus fan is not in deepest water).
- Preferential route selection to avoid mud flow activity (see next slide for an example).
- Route alignment parallel to flows (see Bluestream project example).
- Eliminate hydrotest which can present critical spanning design case.
- Congo river crossing technology.

Geohazards



Possible re-route to minimise mud flow exposure in Channel 4 (also shorter)

INTEC's Deepwater Pipeline Experience in the last Decade

TotalFinaElf Canyon Express

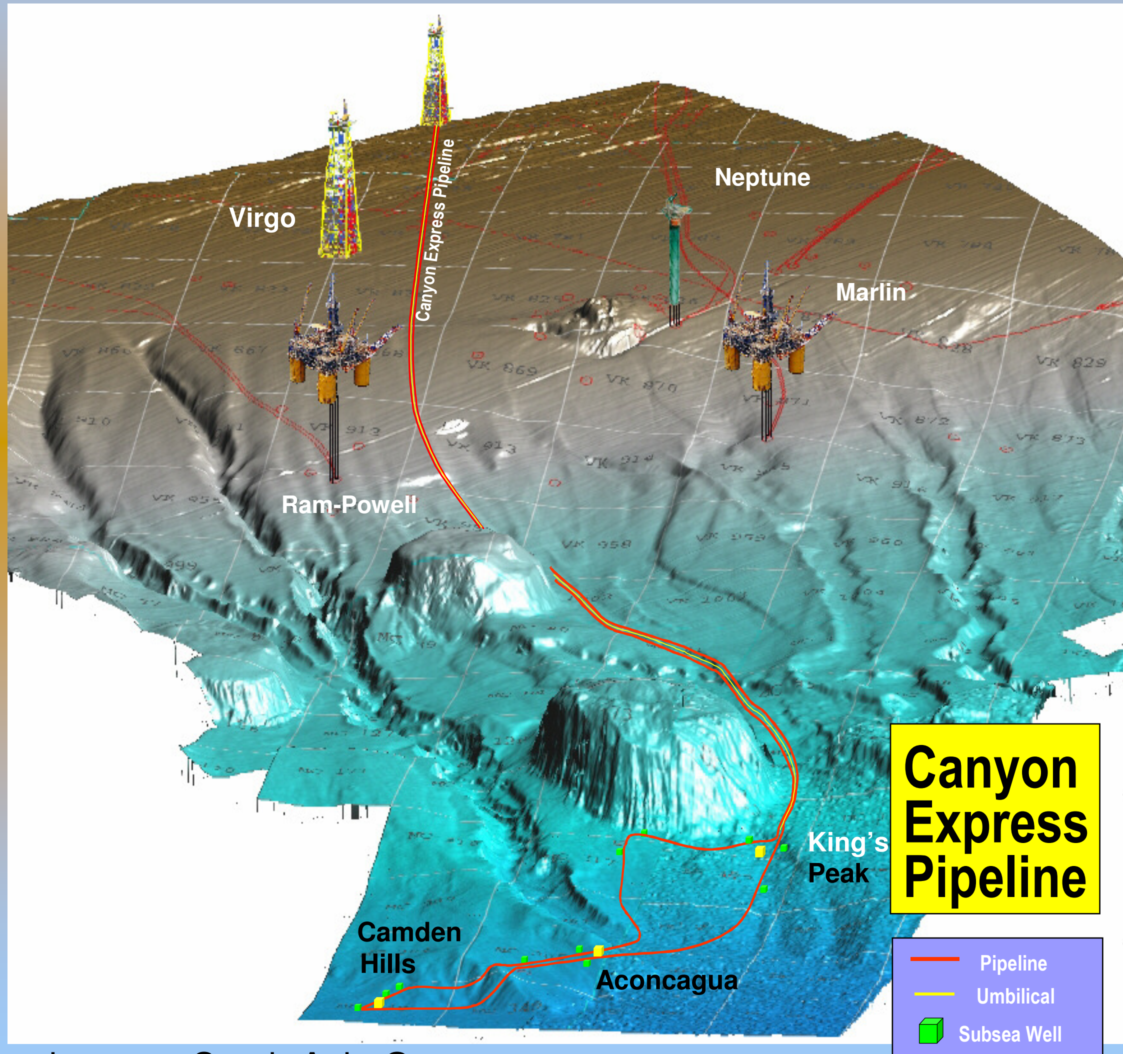
SAGE

Description

- 2 x 50 mile x 12-inch Flowlines

Project Highlights

- ✓ First Multi-Field/Multi-Operator Subsea Development
- ✓ Challenging Flow Assurance and Operability Issues
- ✓ Record 7,280 ft Water Depth and Complex Seafloor Topography

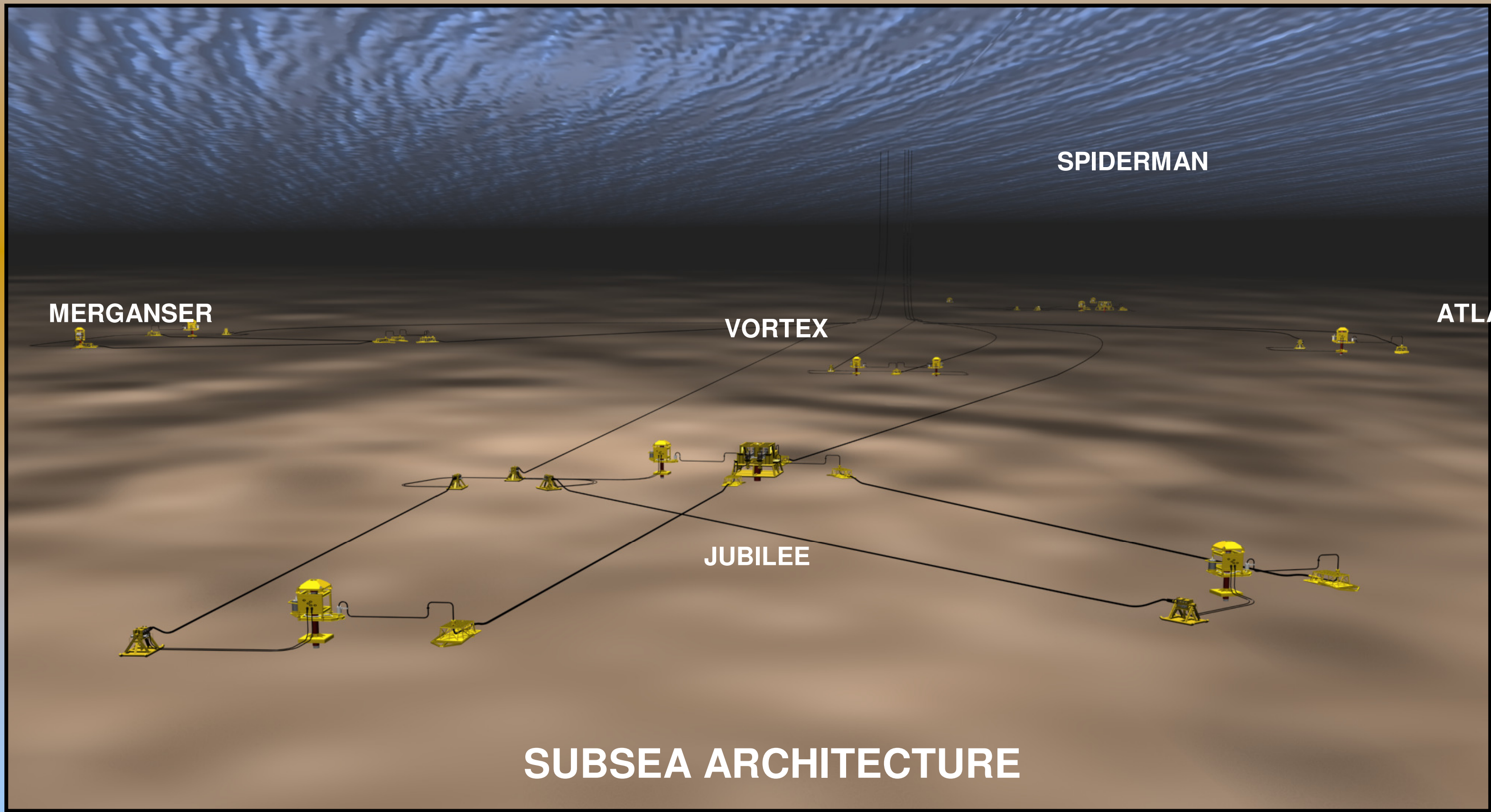


MC 920 Independence Hub Subsea

SAGE

Description

- 6 non-unitized gas fields in a single project
- 15 subsea wells producing dry gas
- Water depths between 7900 ft and 9200 ft (2804m)



BP Mardi Gras Transportation

SAGE

Southern Green Canyon

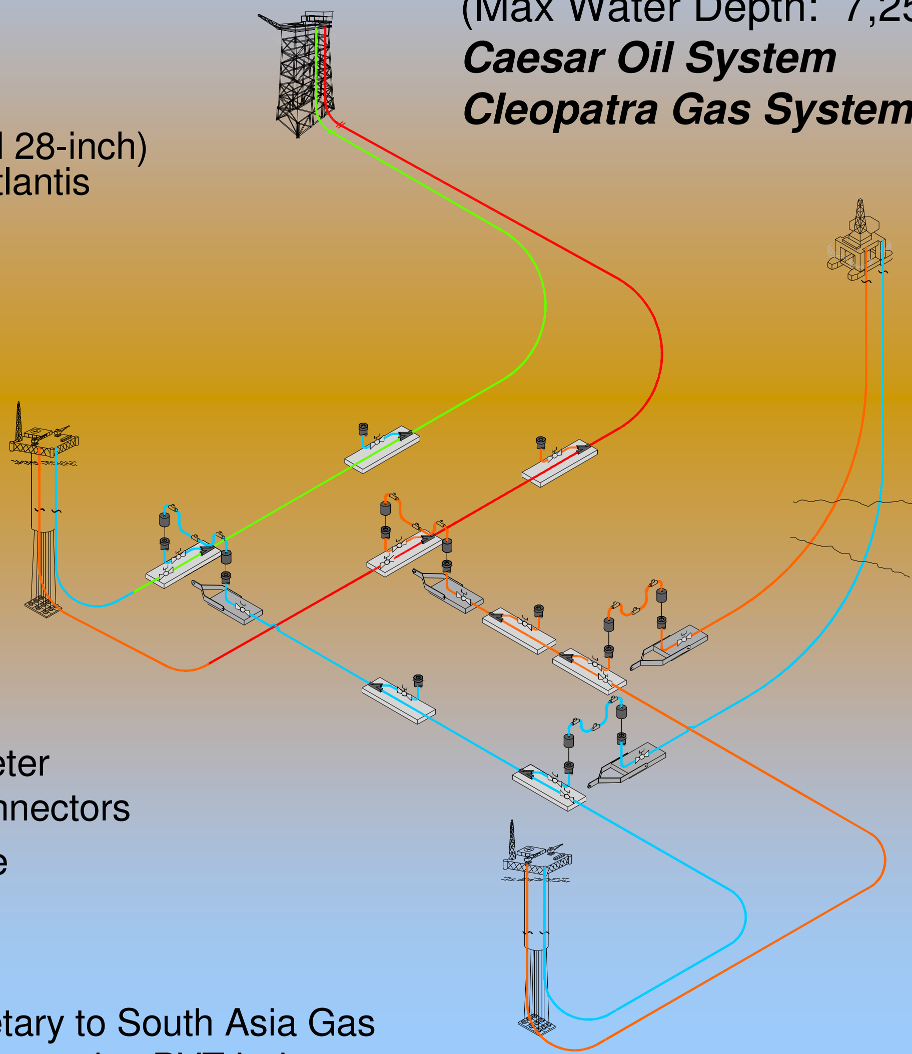
(Max Water Depth: 7,250 ft)

Caesar Oil System

Cleopatra Gas System

Description

Large Diameter Pipelines and SCRs (16- and 28-inch) for Thunder Horse, Holstein, Mad Dog and Atlantis Fields. 360 mile Total System Length.



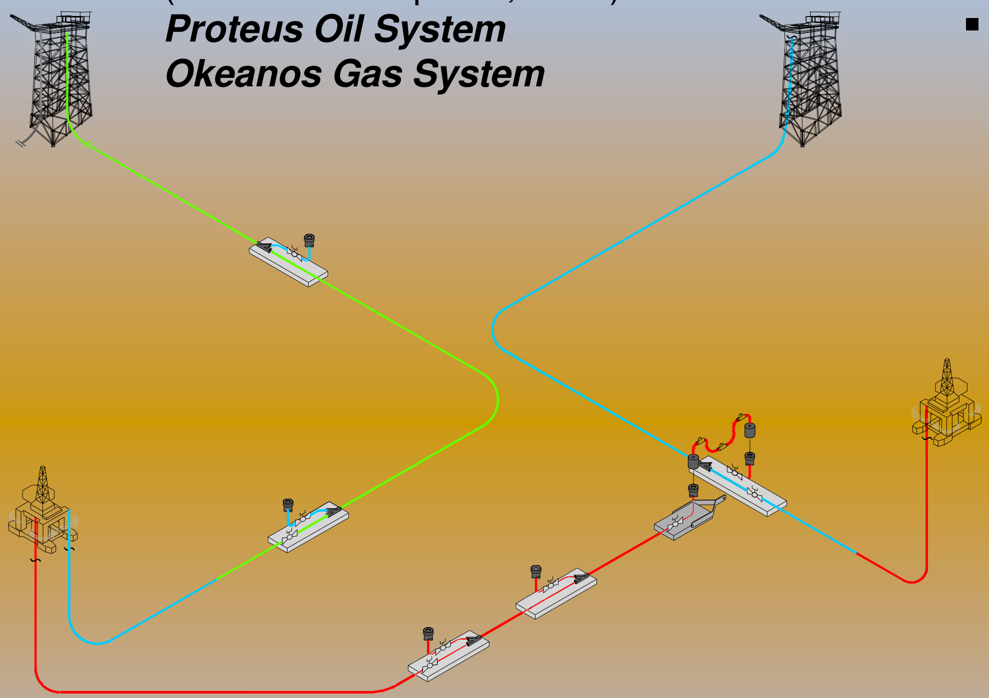
INTEC Scope of Work

- Detailed Engineering
- ITB Technical Work Scope
- Technology Development Program
  - SCR Monitoring Program
  - Weld Fatigue Testing
  - Pipeline Collapse Testing
  - Pig Development for Multi-Diameter Pipelines, Wyes, Valves and Connectors
  - Pipeline Repair and Maintenance

BP Mardi Gras Transportation

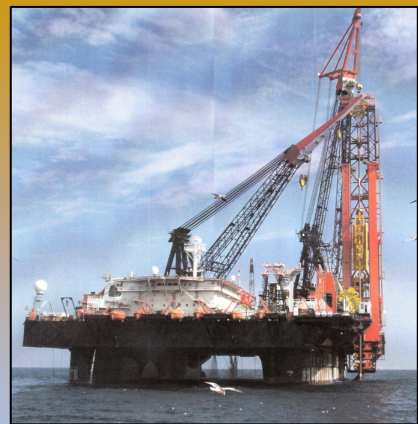
SAGE

Mississippi Canyon
(Max Water Depth: 6,300 ft)
Proteus Oil System
Okeanos Gas System



INTEC Scope of Work (continued)

- Technology Development Program
  - SCR Monitoring Program
  - Weld Fatigue Testing
  - Pipeline Collapse Testing
  - Pig Development for Multi-Diameter Pipelines, Wyes, Valves and Connectors
  - Pipeline Repair and Maintenance



Project Highlights

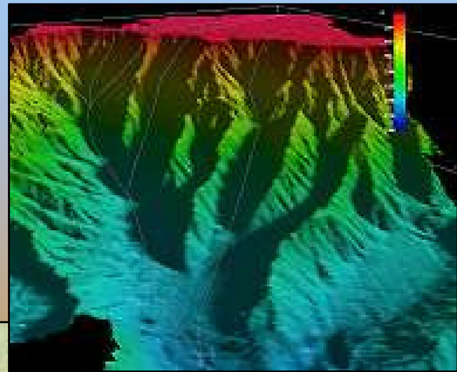
✓ Mardi Gras Consists of 5 Separately Owned Pipeline Systems

✓ Largest Diameter and Deepest Water Depth Pipeline and SCR Application

✓ Largest Diameter Flexjoint to Date

GAZPROM Blue Stream Gas Pipeline

SAGE



Description

- 24-inch x 225 mile Pipeline from Russia to Turkey
- Maximum Water Depth 6,900 ft
- H_2S Seafloor Environment

INTEC Scope of Work

- Route Survey Management
- Route Selection
- Basic Engineering
- Technology Development
- Installation Contracting

Project Highlights

- ✓ Unprecedented Seafloor Roughness
- ✓ Unprecedented D/T Pipe Design

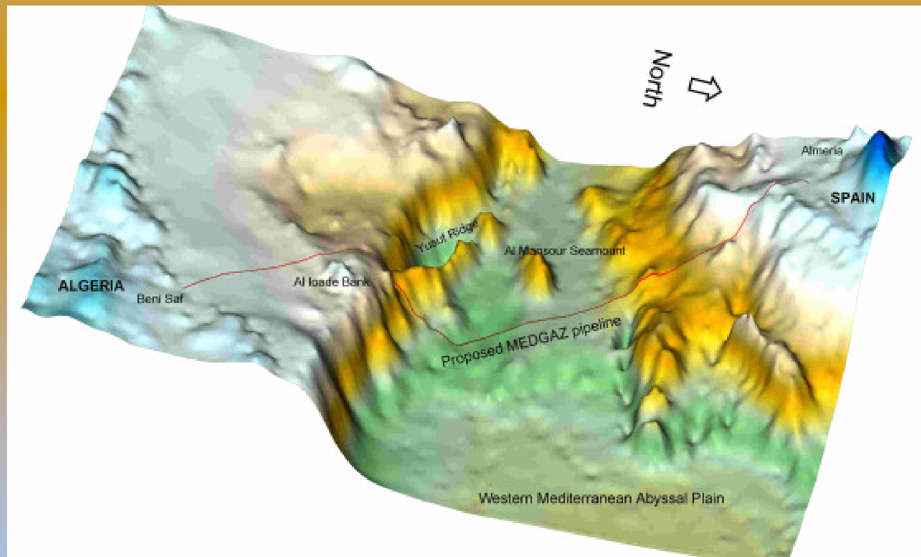
MEDGAZ Pipeline FEED

Description

8 to 16 BCM/year of Natural Gas from Algeria to Europe Across the Mediterranean Sea

INTEC Scope of Work

- FEED of the Offshore Section Including Short Onshore Sections to the Onshore Terminals
- 2 Offshore 24-inch Pipelines, Approximately 200 km Long
- Max Water Depth 2,160 m (7,100 ft)
- Pipeline Mechanical and Routing Design
- Preparation of the EPIC package
- HSE and EIA Support



Project Highlights

- ✓ Deepwater – 2,200 m
- ✓ Geo-Hazard and Seismic Risk
- ✓ Environmentally sensitive landfall (Spain)
- ✓ Multi-Office Effort Including London, Houston, Delft and BA

Galsi Project

PROJECT DESCRIPTION

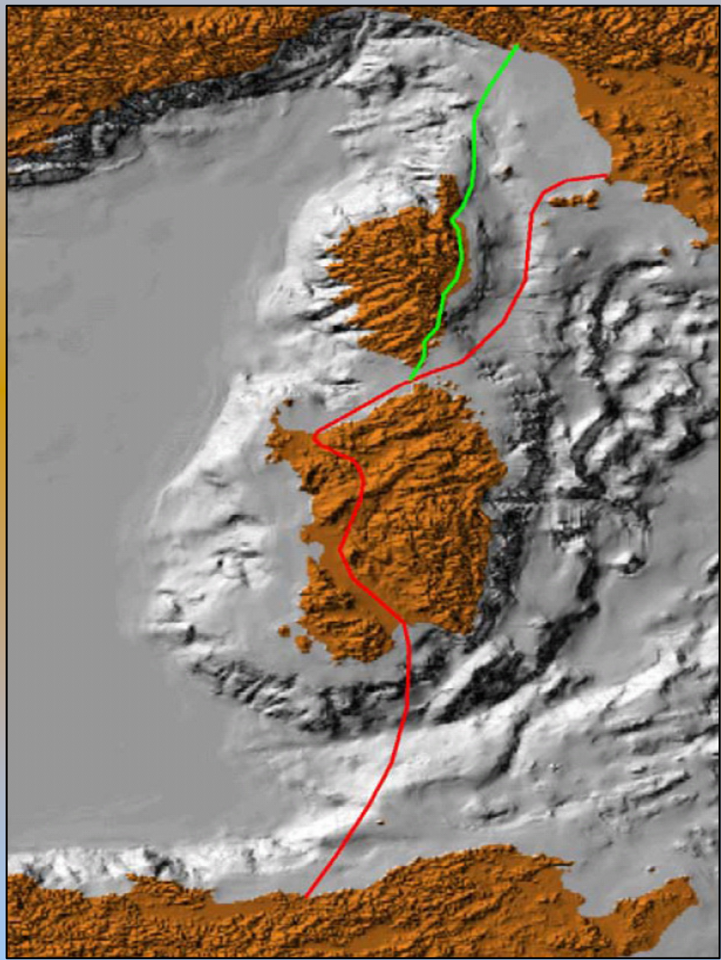
- Gas Trunkline from Algeria to Northern Italy (via Sardinia)
- The offshore pipeline is 310km long in 2800 metres water depth.
- Consortium of Sonatrach, Enelpower, & Wintershall.AG Energia.Spa & Edison

INTEC SCOPE OF WORK

- Desk study
- Management of reconnaissance survey
- Route selection
- Conceptual Design

PROJECT HIGHLIGHTS

✓ +/- 280 km x dual 24-inch to Sardinia
✓ +/- 260 km x dual 28-inch to Italy
✓ 18 BCM/Y / >200 bar



INTEC's commitment to SAGE

SAGE

INTEC has over 10 years of industry-leading experience in engineering pipelines for installation in progressively deeper water

SAGE is technically feasible.

There are no "show-stoppers" given today's technology in engineering and construction.

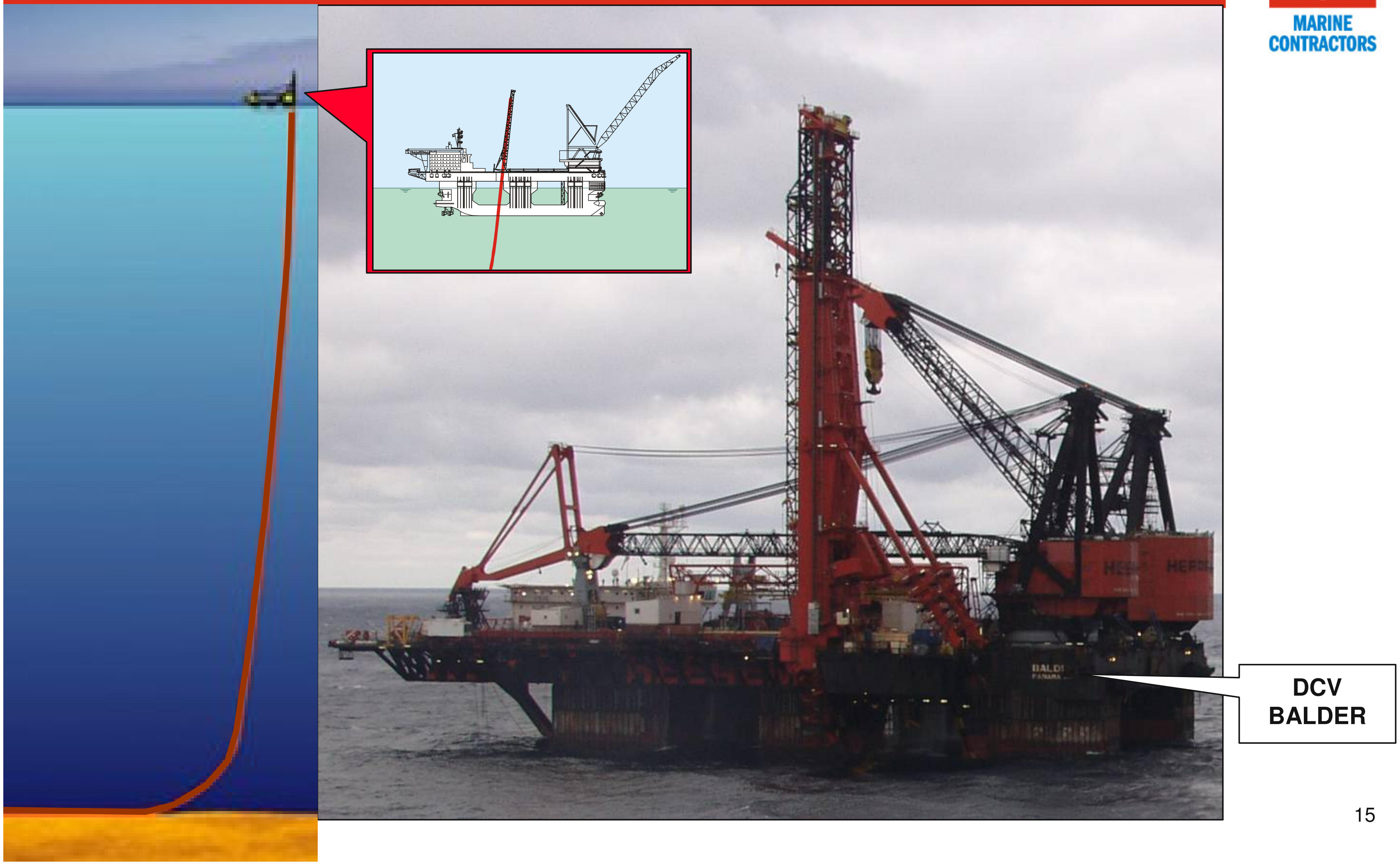
SAGE

Installation Vessel

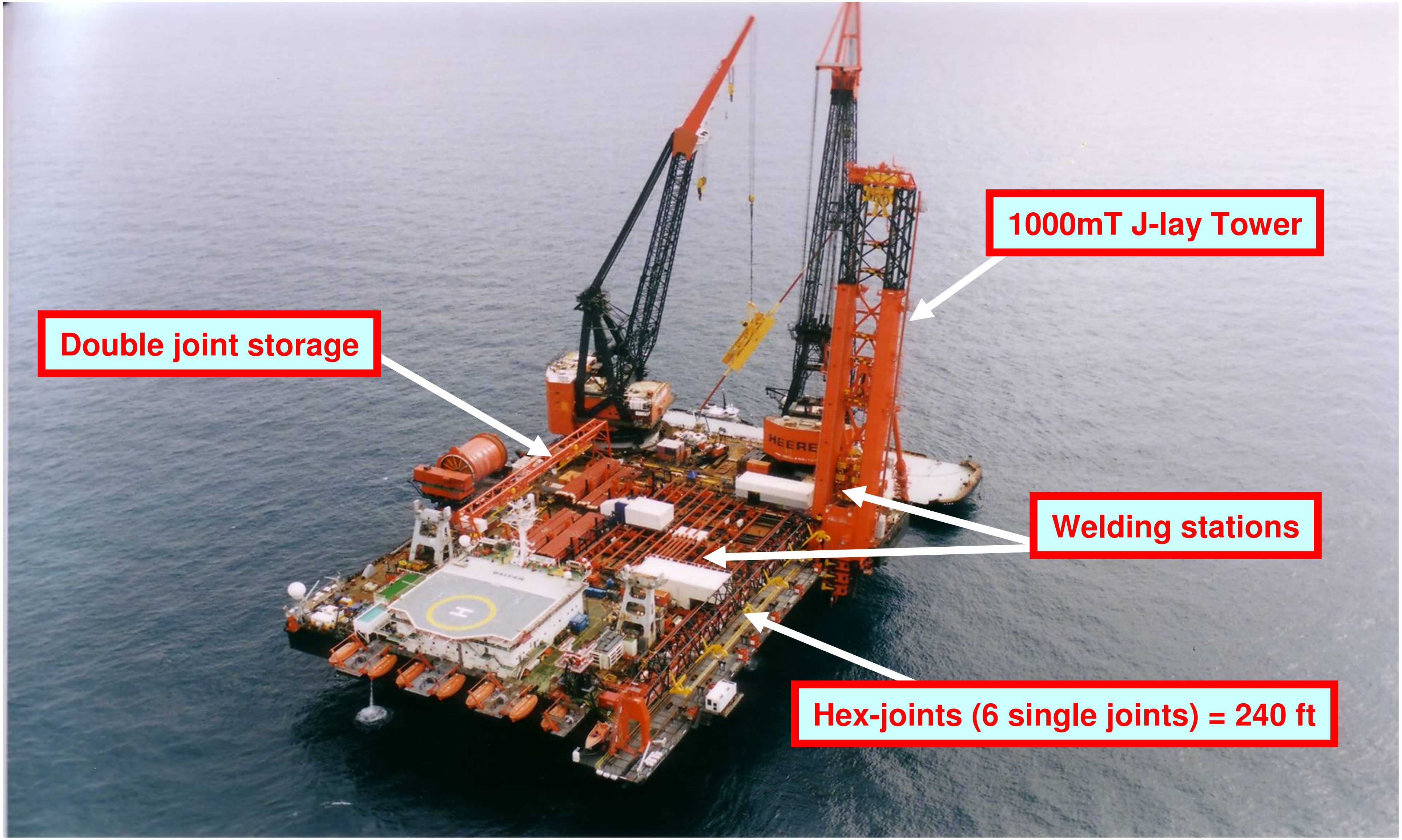
SAGE

Presentation of
HMC Capability

J-lay Method and typical vessel



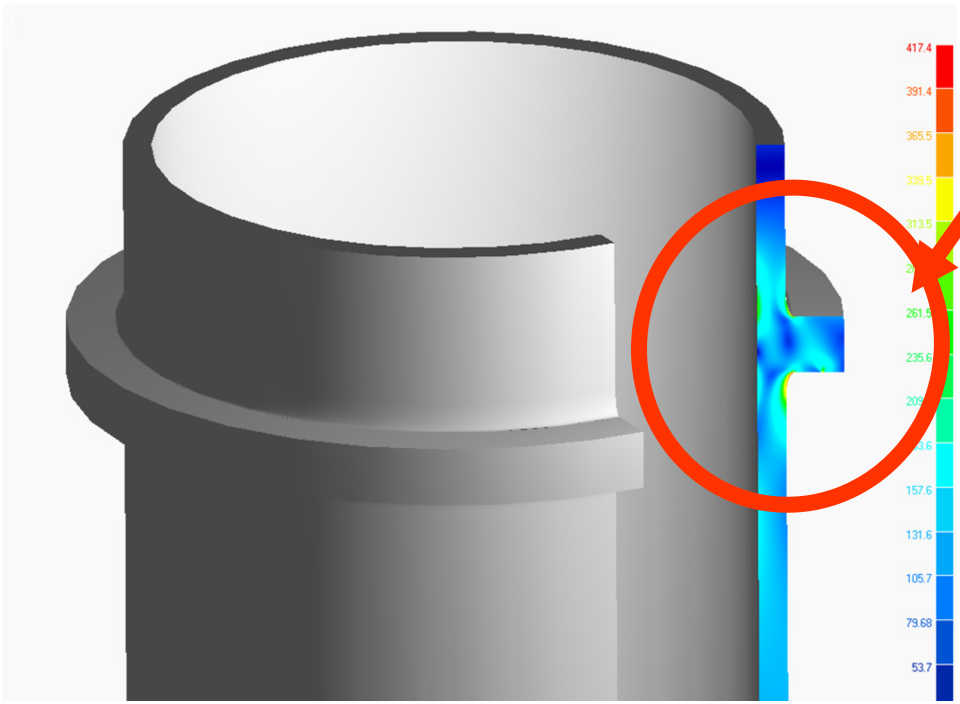
Introducing J-lay vessel "BALDER"



Pipe Handling… safety first

MARINE CONTRACTORS

High pipe tensions

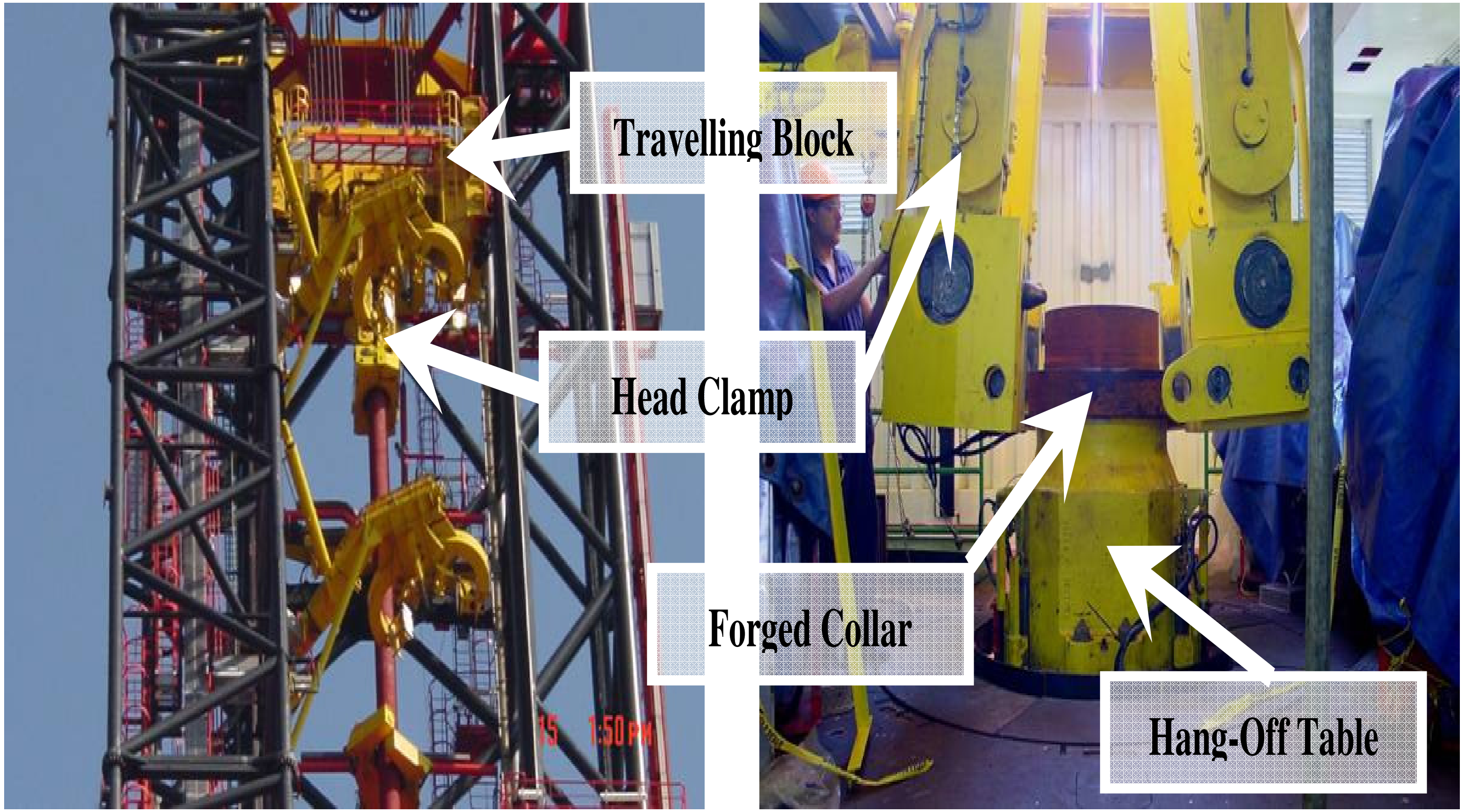


J-lay collar / buckle arrestors provide “locking” of pipeline

Deepwater Pipelay Capabilities

MARINE CONTRACTORS

Tensioning system

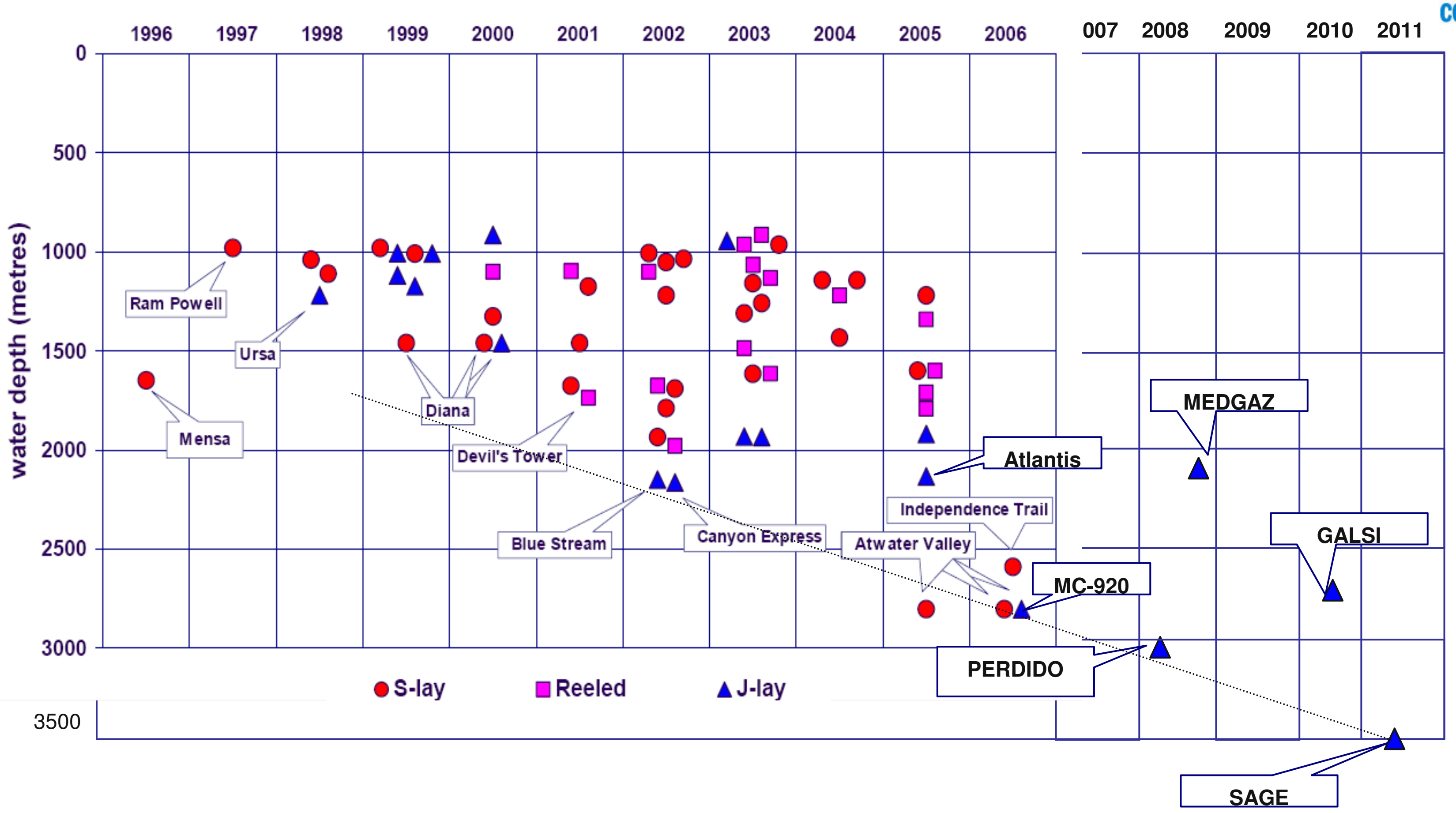


Export lines & SCR's

Pipelines installed by BALDER 2003-2005

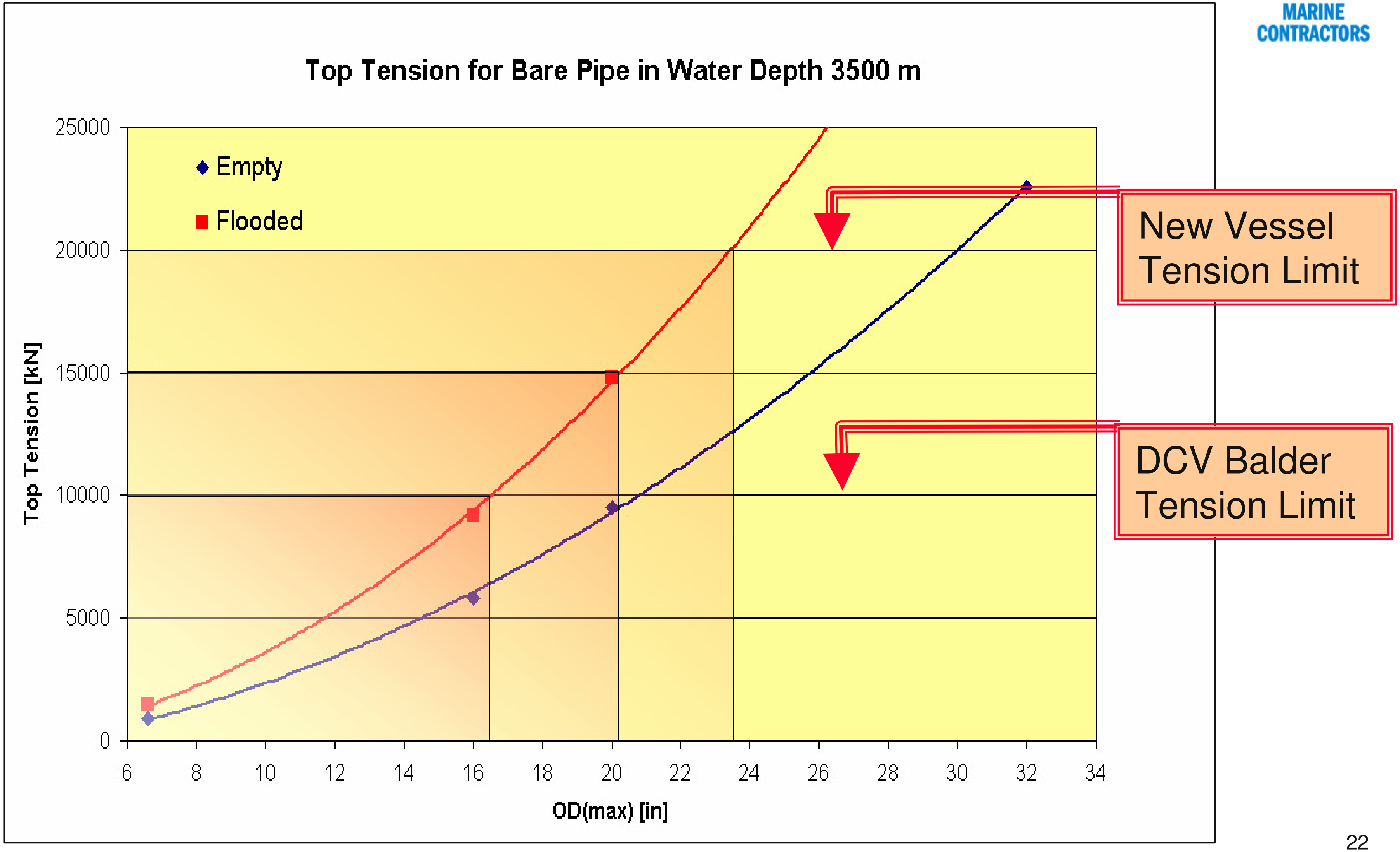
Client	Project	Area	Year	Water depth	Diameter	Type	length	Max Tension
				m	in		km	mT
Shell	Okeanos	GoM	2003	1950	24	Oil Export line	10	385
BP	Holstein	GoM	2003	1345	28	Oil Export line	42	286
BP	Holstein	GoM	2003	1353	20	Gas Export line	43	136
BP	Mad Dog	GoM	2003	1345	24	Oil Export line	33.5	233
BP	Mad Dog	GoM	2003	1348	16	Gas Export line	32	96
BP	Thunder Horse	GoM	2004	1786	28	Oil Export line	48	324
BP	Thunder Horse	GoM	2004	1815	20	Gas Export line	35.8	272
BP	Atlantis	GoM	2005	**2150**	**16 x 10**	6# Flow lines + Risers, Pipe-in-pipe	30.4	753
BP	Atlantis	GoM	2005	2198	16	Gas Export line	26	238
BP	Atlantis	GoM	2005	**2198**	**24**	Oil Export line	29	392
BP	Thunder Horse	GoM	2005	1908	8	3# Oil heavy wall flow lines and Risers	10.9	307
BP	Thunder Horse	GoM	2005	1908	12	5# Oil heavy wall flow lines and Risers	16.4	530
BP	Thunder Horse	GoM	2005	1908	10	5# Oil heavy wall flow lines and Risers	14.3	310
Shell	*Perdido*	*GoM*	*2009*	***2956***	*16 and 10.75*	*SCR's and flowlines*	*42*	*300+*

Deepwater trend towards SAGE



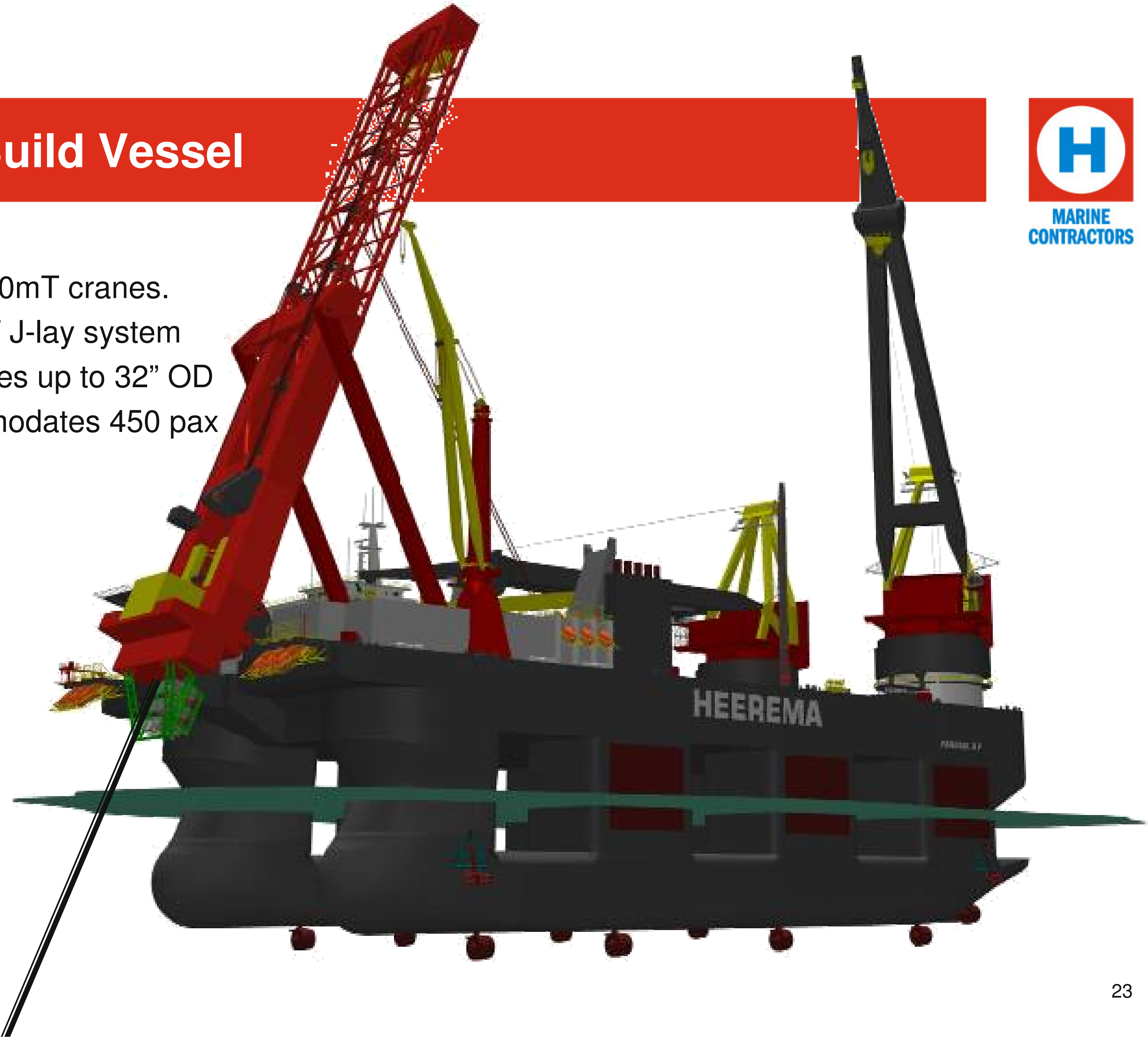
Requirement for top tension in SAGE water depth 3500m

MARINE CONTRACTORS



New Build Vessel

- 2 x 5,500mT cranes.
- 2000mT J-lay system
- Pipe sizes up to 32” OD
- Accommodates 450 pax



Intended Selling Points New Vessel

- Next Generation Semi Submersible Crane Vessel
- Highly Competitive Sailing Speed (14 knots)
- Fully redundant Dynamic Positioning System (DP Class 3)
- Optimized for operations in long ocean swells
- Large deck for (e.g.)
  - Pipe Storage
  - Multi joint preparation (72m or 96m lengths)
- Vessel cranes capacity 5,500 mT
- J-lay Speed Optimized (up to 6 or 8 km/d)
- Low emissions by clean design

Heerema Commitment to SAGE

MARINE CONTRACTORS

- HMC Mission clearly states:

By any measure, to be and to be recognized as the best offshore contractor in the world

  - For our Clients this means the best value for SAGE
  - For our Shareholder this means that SAGE needs to deliver a project return, in line with our commercial alternatives.
- Our new vessel is being designed:
  - For deepest water pipelay
  - For highest payload leading to long distance logistic efficiency
  - For operational safety
  - For entering the market in 2011
- HMC is prepared to undertake the prestigious SAGE project assuming the commercial conditions justify the commitment.

Assessment of Risk Levels

Assessment of Risk Levels provides:

- Guidance on the technical acceptance of the SAGE pipeline system
- Guidance on the technical aspects that might require further development of special protection arrangements
- Guidance on the general security and reliability of the pipeline system
- Guidance on the safe operating life of the pipeline system

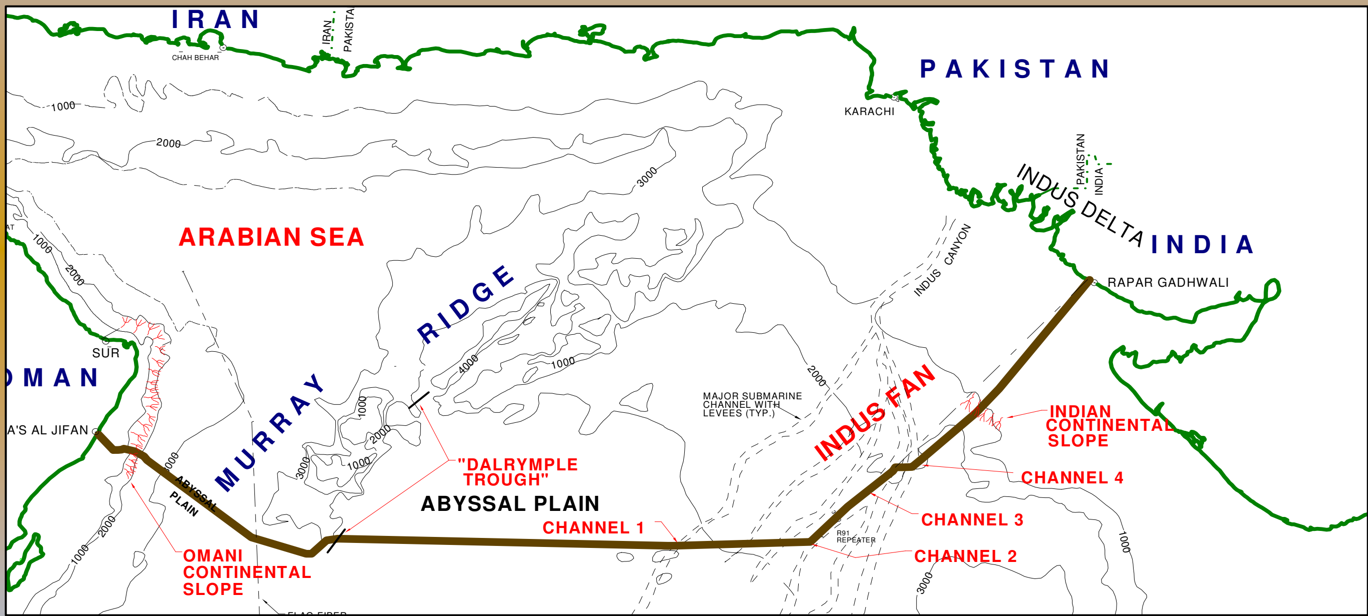
Risk Levels are directly related to:

- the route and conditions along the route
- the design operating life of the pipeline
- the hazards to the pipeline identified along the route
- the calculations of the likely frequency of occurrence of the hazards
- the evaluation of the consequences to the “limit states” of the pipeline due to the occurrence of each specific hazard
- the evaluation of the frequency of failure of the pipeline due to each specific hazard
- the comparison with internationally accepted levels of frequency of failure

Assessment of Risk Levels during Operation

SAGE

The detailed assessment of operating and installation risks requires the route for the proposed deep-water pipeline to be determined in reasonable detail. The assessment described in the next slides has been prepared using published technical information relating to the Oman-India pipeline route (1996)

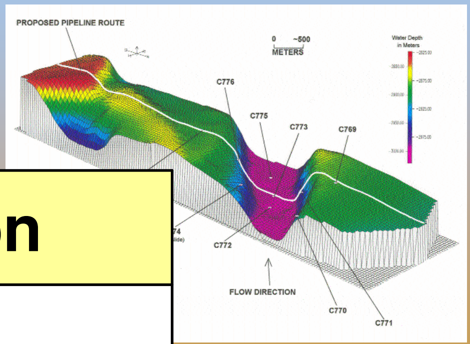


In that project the pipeline route was between the coasts of Oman and India. The risk assessment was based on extensive route surveys and on both existing and specifically gathered environmental data.

Assessment of Risk Levels during Operation

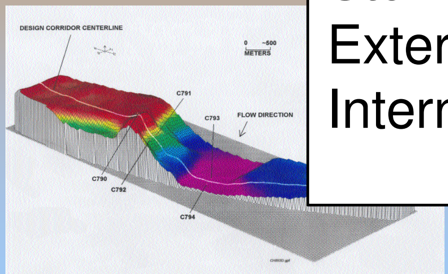
SAGE

The first stage is to identify the hazards that impinge on the operating pipeline.



These are shown in the table.

List of Hazards during Operation	
Earthquake	Off-specification Gas
Transverse Landslides	Sabotage
Landslides-Spans	Anchor Dragging
Axial Landslides	Dropped Objects
Channel Movement	Vessel Accidents
Currents	Third-party Construction
Storm/Wave	Military Action
External Corrosion	Latent Construction defects
Internal Corrosion	



Typical Indus Fan Channel Cross Sections

Assessment of Risk Levels during Operation

SAGE

The various hazards are likely to be more relevant to some parts of the pipeline route than to others. For this reason the pipeline route was subdivided into appropriate segments as shown in the table.

Zone	Kilometer Point Range	Length of Zone (km)	Water depth (m)
Oman Shelf	0-27	27	0-100
Oman Shelf Break	27-30.5	3.5	100-300
Upper Oman Slope	30.5-45	14.5	300-1100
Lower Oman Slope	45-65	20	1100-2440
Abyssal Plain (Oman Side)	65-80	15	2440-2920
Murray Ridge	80-220	140	2920-3430
Dalrymple Trough	220-285	65	3430-3540
Abyssal Plain (Indian Side)	285-600	315	3540-3230
Indus Fan (Excl. Ch. 1, 2, 4)	600-925	325	3230-2140
Indus Fan Channel 1	612-613	1	2900-2890
Indus Fan Channel 2	745-751	6	2450-2700
Indus Fan Channel 4	855-865	10	1990-2180
Lower Indian Slope	925-973	48	2180-1200
Upper Indian Slope	973-985	12	1200-500
Indian Shelf Break	986-1014	28	500-100
Indian Shelf	1014-1139	125	100-0

Assessment of Risk Levels during Operation

SAGE

The Risk Levels are assessed by comparing the calculated probability of failure of the pipeline with the internationally accepted reference levels, as presented in the DNV Pipeline Code.

These levels are:

- *a failure probability of 10^{-4} per year for the pipeline for the occurrence of a limiting ultimate state of the pipeline (e.g. collapse)*
  (i.e. acceptable level of failure probability over 40 years = 4 x 10^{-3}, or once every 250 years)
- *a failure probability of 10^{-3} per year for the pipeline for the occurrence of a limiting serviceability state of the pipeline (e.g. coating breakdown)*
  (i.e. acceptable level of failure probability over 40 years = 4 x 10^{-2}, or once every 25 years)

These levels of acceptable probability of failure were calculated by DNV using statistical data and experience from a wide range of pipeline projects over the past 20 years. The statistical approach and "Limit State" method of design embodied in the DNV Code has been applied successfully to the design and installation of <u>all</u> recent very deep water pipelines.

Assessment of Risk Levels during Operation

SAGE

The Table in the next slide shows the calculated failure probabilities of the selected sections of the pipeline route. The Table shows an inferred *'Safety Level'* for the pipeline along each of these sections in turn. When the *Safety Level* exceeds unity then the calculated probability of failure is less than the accepted value, thus providing a safety margin.

"Safety Level" is defined as the ratio:

$$\frac{\textit{DNV Limit State acceptable probability of failure for the 40 years of operating design life for the pipeline}}{\textit{calculated probability of failure}}$$

(i.e. "How many times better than acceptable is it?")

The major hazards for the Murray Ridge and the Dalrymple Trough segments of the route arise overwhelmingly from mudslides and/or turbidity flow, triggered by earthquakes and impacting the pipeline laterally. The corresponding *Safety Levels* are assessed using the Serviceability Limit State probability of failure for the specified 40 years of operating life for the pipeline (i.e. acceptable level of Failure Probability = 4×10^{-2}).

Assessment of Risk Levels during Operation

SAGE

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

Comments on the Risk Assessment - 1

- The values for the likely levels of risk have been taken from calculations carried out for the previous design, using information available at that time.
- In the intervening 10 years a great deal of advance has been made in the technical design of deep-water pipelines and much experience has been gained in the installation and operation of large diameter ultra-deep-water pipelines.
- Due to the availability of this new knowledge and experience, the levels of risk presented are very likely to be reduced for the present pipeline, i.e. the *Safety Levels* will be increased.

Comments on the Risk Assessment - 2

The levels of risks presented show that the most threatened sections of the pipeline route are those at the shore crossings. This is common with very many pipelines that have experienced many years of successful operation. The risk levels presented are for pipelines laid on the seabed and open to hazards from shipping, dropped objects and environmental loading. The most usual measures to mitigate these risks are:

- to coat the pipeline with a layer of concrete to absorb the impact damage from dropped objects, including anchors
- to bury the pipeline under a layer of seabed soil, gravel of crushed rock to prevent grounding vessel impacting on the pipeline
- to bury the pipeline in the seabed and cover with a substantial layer of rock to prevent dragged anchors impacting on the pipeline
- ensure the shore approach sections of the pipeline are included in maritime navigation maps and declare the shore crossing areas as ‘no anchoring’ zones

  - It has been found that applying a mixture of these measures successfully reduces the risks to the pipeline to acceptable levels.

Comments on the Risk Assessment - 3

Apart from the areas of the shore approaches and crossings, it can be seen, according to the levels of risk presented, that the deeper water sections of the pipeline have a minimum *Safety Level* of 3.5

Since the probabilities of failure have all been calculated for an operating life of 40 years, a *Safety Level* of 3.5 means that the pipeline would have to be in operation for 140 years (3.5 x 40 years) before the probability of failure would exceed the internationally accepted level.

This safe operating life far exceeds most other forms of structures, e.g. aircraft, bridges and even modern buildings.

Conclusion

It is concluded that the SAGE pipeline connecting the Middle East and India will be safe and reliable.

This conclusion is based on:

- the extensive analysis and risk assessments carried out along the route of the Oman-India deepwater pipeline.
- the extensive technical developments that have occurred over the past 10 years in the installation and operation of very deepwater pipelines.
- the experience of installation of very deep water pipelines during the past 5 years.
- the application of that practical experience to the current HMC design of a new pipeline installation vessel specifically for very deep water.

Summary

The SAGE Project – Key Features

SAGE

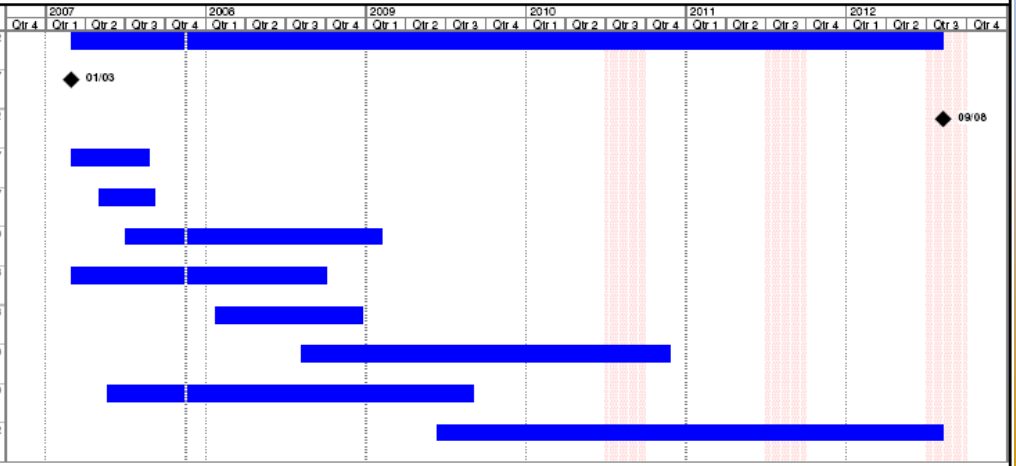
- Geopolitically neutral, regional development.
- High project local content.
- Offers investment opportunity in Indian gas use projects.
- No Major Oil Company role – SAGE is a Common Carrier.
- Blue-Chip, World-Leading design & construction "A-Team":
  - Heerema Marine Contractors and INTEC; key Partners from Day 1
  - DnV
  - SAGE Project key team members
- Long-term, High-Integrity Infrastructure Project attracting low-cost Debt.
- Equity opportunity for Gulf gas sellers and Indian buyer-side beneficiaries at high Debt to Equity ratio.
- Complementary to LNG and local Indian gas sources.

The SAGE Project – Schedule

SAGE

SAGE GAS PIPELINE FROM THE MIDDLE EAST TO INDIA

ID	Task Name	Duration	Start	Finish
1	Project Duration to 1st Gas	1420.63 days	Thu 01/03/07	Thu 09/08/12
2	Project Start	0 days	Thu 01/03/07	Thu 01/03/07
3	First Gas	0 days	Thu 09/08/12	Thu 09/08/12
4	Form PMCO	126 days	Thu 01/03/07	Thu 23/08/07
8	Acquire previous data	90 days	Thu 03/05/07	Wed 05/09/07
10	Financing	420 days	Mon 02/07/07	Fri 06/02/09
17	Front End Engineering	415 days	Thu 01/03/07	Wed 01/10/08
45	Environmental Impact Reports & Permits	240 days	Thu 24/01/08	Wed 24/12/08
51	Procurement	600 days	Wed 06/08/08	Wed 24/11/10
62	Contracting	595 days	Thu 24/05/07	Wed 02/09/09
74	Construction Pipeline	825.63 days	Thu 11/06/09	Thu 09/08/12



- design development work started March 2007
- the project schedule leads to first gas in 2012.

Project: SAGE0161007
Date: Fri 16/11/07

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone | Critical

Page 1

The SAGE Project – Why now?

SAGE

- SAGE has become commercially viable as Indian gas buying price has risen towards World levels.
- Pressing need for energy in India - gas can be absorbed.
- Technical viability as HMC builds huge new barge with twice existing capacity.
- Several pipe mills can manufacture the pipe.
- Geopolitical supply risk managed by “Outside Hormuz” route without incursion into Iranian or Pakistani waters or Economic Exclusion Zones.
- LNG global price volatility (up and down) and “spot market” risks mitigated by long-term gas supply contracts.
- Unsatisfied regional appetite for large-scale investment in regional infrastructure; lack of “good projects” like SAGE.