Ultra-Deepwater Production Systems Technical Progress Report

September 30, 2000 – September 30, 2001

E. T. Cousins Conoco, Inc. Houston, Texas

Title Page

Report title: Technical Progress Report-Annual

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Doe award number: DE-FC26-00NT40964
Submitting Organization: Conoco Inc.
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Houston, Texas 77252
Significant subcontractor: Kvaerner Oilfield Products Inc.

Disclaimer:

Abstract:

This report includes technical progress made during the period including presentations made in person at the Tulsa DOE office and progress of the feasibility engineering study completed through May of 2001. Much of the early feasibility design activity included detailing the project scope for installation of a sub-sea processing unit in deep water in the Gulf of Mexico. Along with this feasibility level of design it was learned that no major technical gaps were evident that would impede progress of equipment selection based on the design result. A feasibility design document was produced during this period, which details the technical functions and system design for this sub-sea system. Further work during this period included economics and reservoir engineering modeling of one of the potential installation sights.

Table of Contents:

List of Graphical Materials:

- **Technical progress presentation made to Tulsa DOE office in May 2001. 27 pages**
- **Summary cost sheet**

Introduction:

The report herein is a summary of technical progress of the project to demonstrate ultra deepwater hydrocarbon production methods applicable to deep and ultra deepwater field developments in the Gulf of Mexico and other like applications around the world. The importance of this work is based on the advancement of technology, which will enable development, and exploitation of reserves in ultra- deep, remote areas beyond the capabilities of conventional technology. Reserves in these areas can add significantly to reducing the United States dependence on foreign oil supplies.

Executive summary:

PROJECT PLANNING:

The first task is to plan the overall project activities including staffing of engineering functions, set up of accounting and reporting requirements, communications systems and procedures and budget monitoring.
Division of detailed work tasks among participants, setting of design review frequency and logistics considerations for meetings between USA locations and Norway office locations was also planned here. Refinement of scope of work and plan adjustments based on findings was anticipated.

SPECIFICATION:

Once the site for equipment installation was selected the actual environmental conditions for operations helped determine specifications of materials, pressure regimes, corrosion considerations, life of operations requirements, well and reservoir related fluid pressure and chemistry. All applicable design codes and operating regulations are identified and included in the specification selection. Any newly developed equipment will need to meet qualification requirements that are recognized in United States operating environment and internationally as appropriate. Engineering peer review of this phase was done required to ensure quality of assessments.

DESIGN:

Design is based on scope and specification for area of operation. Design will be iterative based on results of reservoir modeling, hydraulic modeling of pipeline systems, nodal analysis of well fluid pressure losses from reservoir face to sales point. Some trade off studies were performed to test effectiveness of initial design and to maximize safe operations, economy of operations and /or speed of delivery and installation. Other considerations based on fluid analysis and pressures affected pipeline pigging frequency, control systems and intervention frequency. Well performance predictions were completed to help determine intervention frequency and effect robustness of mechanical systems. Reliability modeling will also be a factor in design of planned maintenance and spares philosophy. Weather analysis was included in production uptime estimates and its impact on economics of recovery.

DESIGN REVIEW:

A formal peer review to test design and model results with experienced oilfield development engineers and equipment manufacturing experts was held with a resultant base design improvement added. Following this peer review design changes will be considered and added as appropriate. Documentation of these proceedings will be added to the project file.

Experimental:

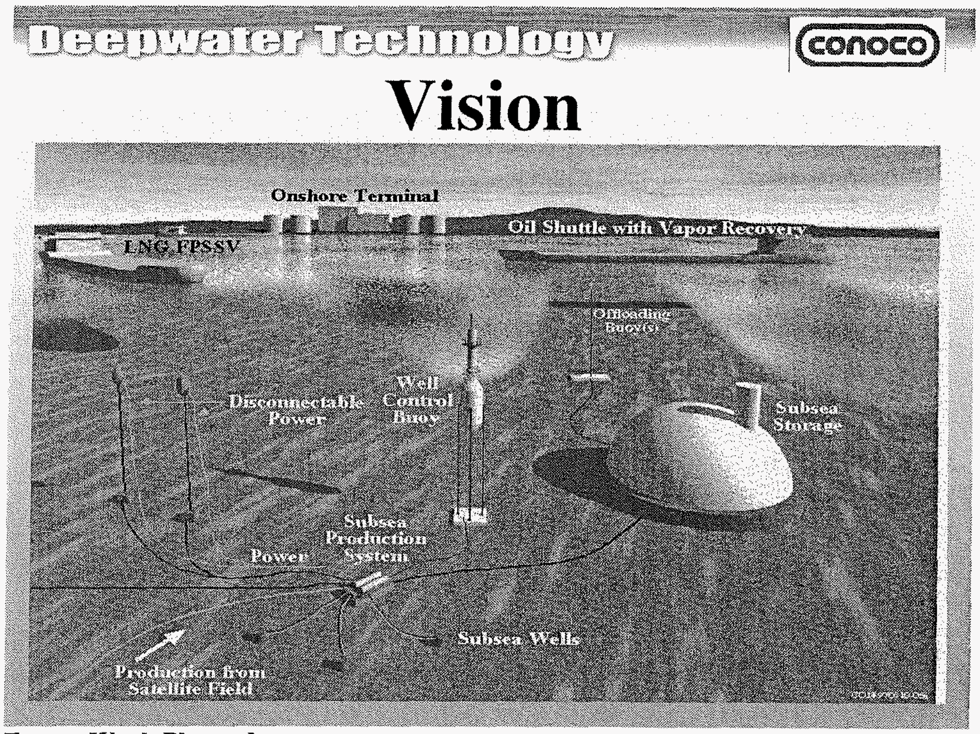
The front end engineering work completed in this phase of the project did not reveal any significant technical gaps in the system design concept. The original project budget anticipated some possible new development work would be required but all sub-sea system requirements were sourced with currently available technology and no new equipment development was required. This helped to reduced the scope of work and resultant cost for this early phase of activity. Due to the resulting design and sourcing determinations no experimental work had to be done.

Experimental and Operating Data: Not applicable.
Data Reduction: Not applicable.

Hypothesis and Conclusions:

At this stage the feasibility or conceptual engineering was established and no technical gaps identified. The feasibility report document was reviewed during a formal engineering peer review completed in Houston, Texas with some 30 engineers from Conoco inc. and Kvaerner Oilfield Products in Norway. Feasibility designs were presented and defended during the peer review and improvements to designs were captured. Importantly it is noted that no design gaps or technical gaps were identified after the review of this system conceptual design. One major improvement for Gulf of Mexico typical deepwater reservoirs was the addition of sand removal hydrocyclones to the overall system design. At this point in time the focus of the project team's work was shifting away from the system design activity and more to the reservoir modeling, fluid chemistry and high level economic modeling. The first area of investigation for installation of the sub-sea processing unit was approximately five miles west of the Magnolia Field Development in the Gulf of Mexico. These analyses went on through the period of this progress report.

An update presentation was made in Tulsa, Oklahoma in May 2001 by representatives of Conoco, Inc. and Kvaerner. During this session explanations for the conclusions reached and forecasts of next steps were given to DOE project managers



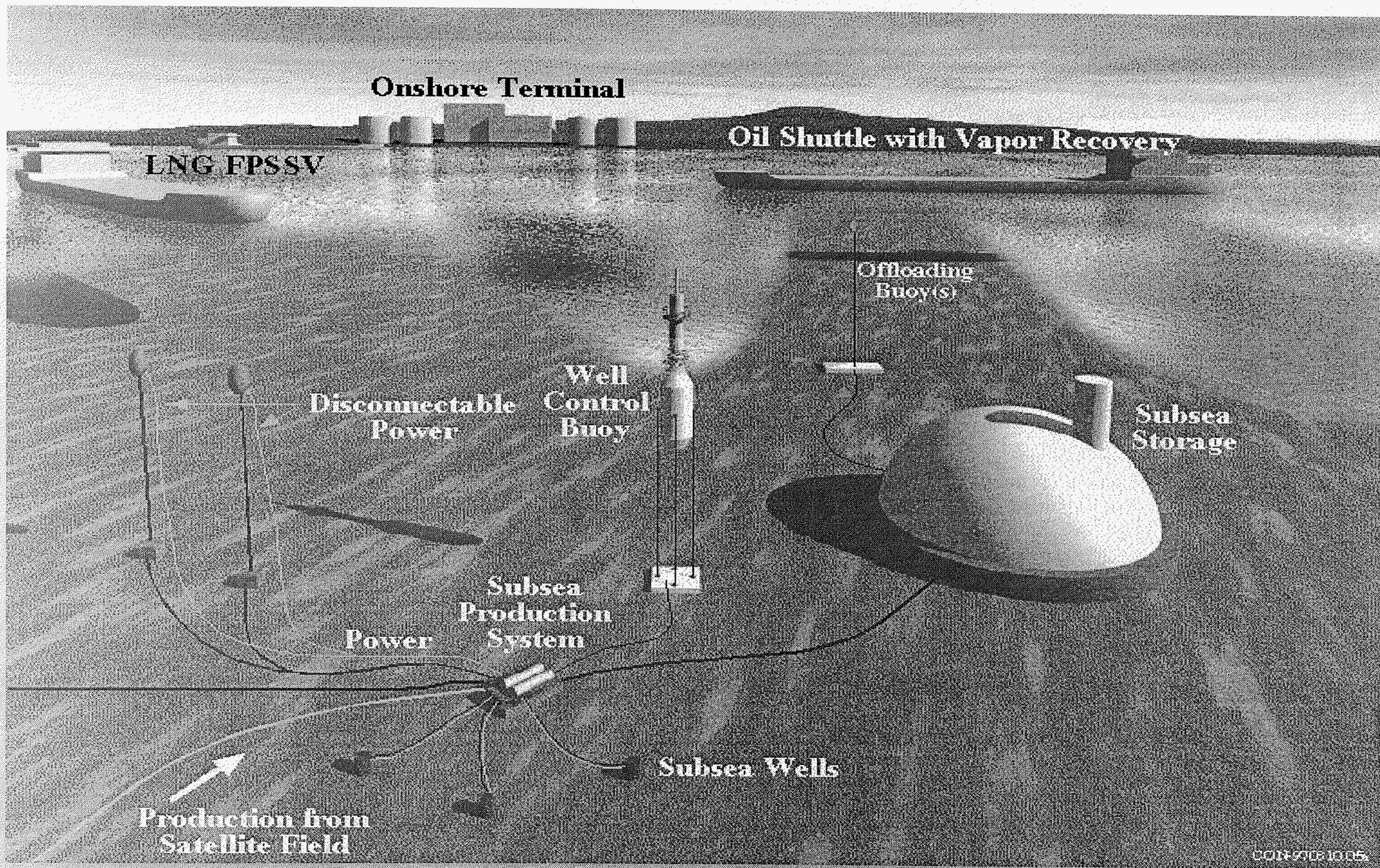
Future Work Planned:

It was explained at the Tulsa office meeting that economic modeling and more reservoir and geologic risk assessments were ongoing and that these considerations were key issues to progress into next phases of this project. Some design revisions and optimization studies identified in peer review sessions were being added in to the basic design package but these changes were relatively minor. Equipment cost,reliability assessments and deliverability were also requiring further work to reduce uncertainty for inputs to the economic model.

Deepwater Technology

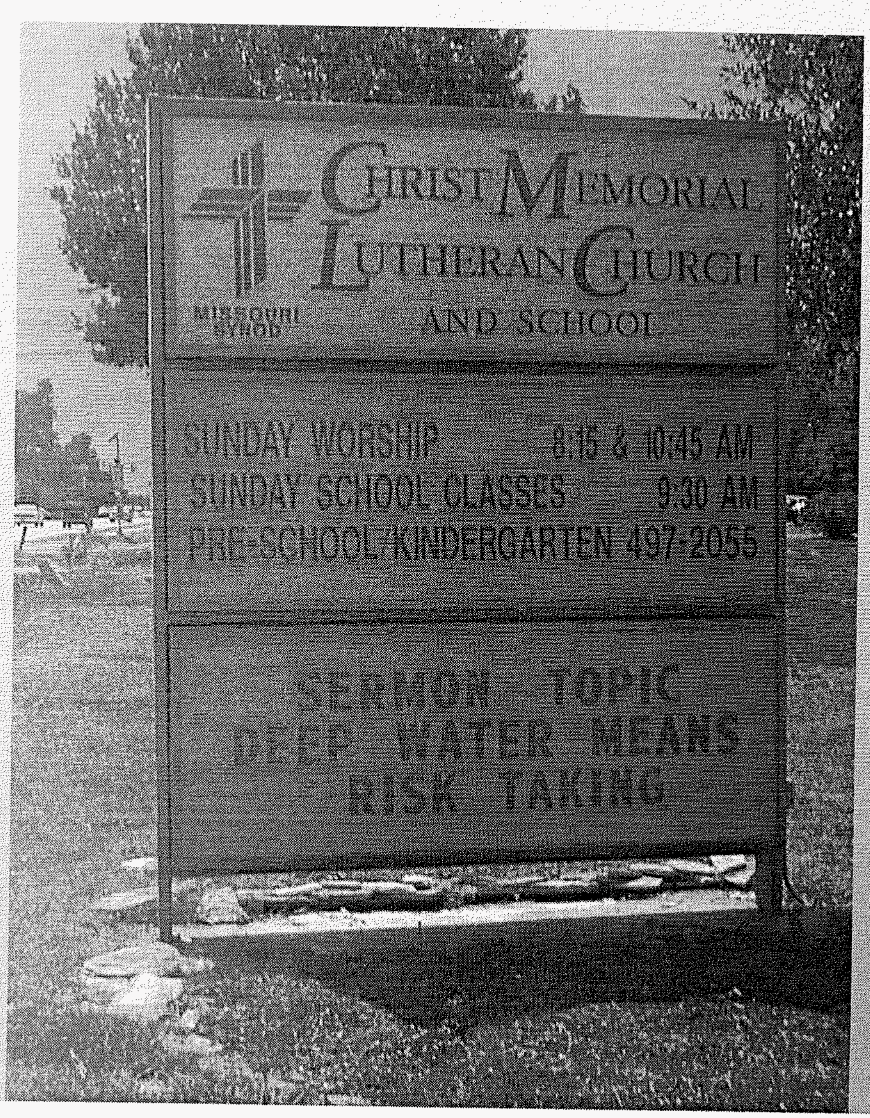
CONOCO

Vision



Deepwater Technology

1998 TD Program Highlights



- **Milestones**
  - "Frame the Gas" & LIN/LNG Quantification
  - System Integration Tools Identified
  - Global Network & Homepage
  - Riserless Drilling on Track for 2001
  - Advanced Steel Catenary Riser Understanding

Deepwater Technology

Sub-sea Separation
A deepwater development step change?

(Subsea Separation & Pumping Technology)

Eddie Cousins

Mike Choi

Rod Myers

Dr. Lloyd Brown

GOM Input:

Dan Smallwood

Keith Folse

Kvaerner:

Ove Jahnsen,et al

January 18, 2001

CONOCO

Confidential

Sub-sea Separation Vision

Be the first to develop and install reliable ultra deep sub sea processing. Create value by quickly applying this technology to deepwater discoveries which are currently sub-economic or marginal relative to conventional concepts. Leverage knowledge of technology in acquisitions. Use this enabling technology for ultra-deepwater developments.

Why Subsea Separate & Pump?

- **Key to Deepwater Vision**
  - Commercially Develop & Operate….
    - Capex Reduction of $2-4/BOE
      - Enables Small Fields to Be Economic,GOM
      - Allows Large Fields to be More Profitable
      - Facilitates Regional Hub Development
  - Unmanned Minimum Facilities….
    - Tie to Conoco's Oil Shuttling Strategy
    - Early production/reservoir appraisal tool
    - Part of Overall Deep Water Vision
  - High Rate/High Recovery Potential

High Rate/High Recovery Potential

- Reduces Back Pressure to Well
  - Enhances Productivity with Greater Drawdown
  - Increases Ultimate Recovery by reducing abandonment pressure
  - Enables Longer Distance Tie-Backs
- Eliminates Many Flow Assurance Problems
  - Multiphase Flow
  - Slugging
  - Hydrates

Deepwater Technology

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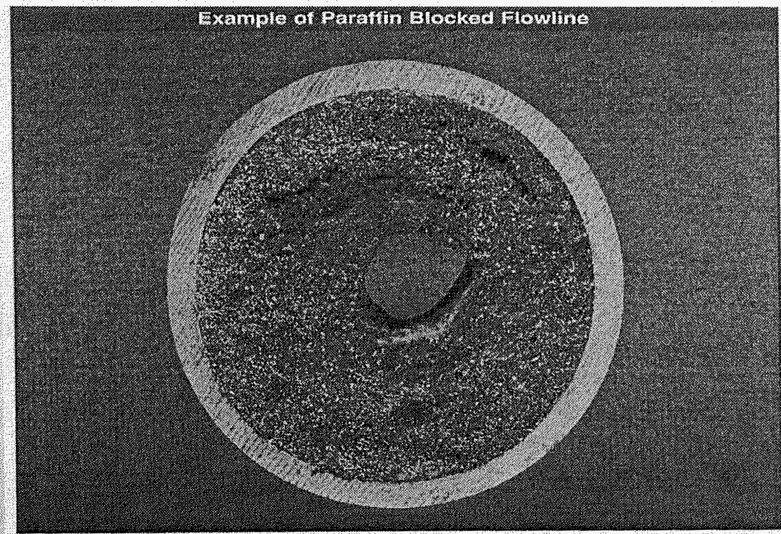
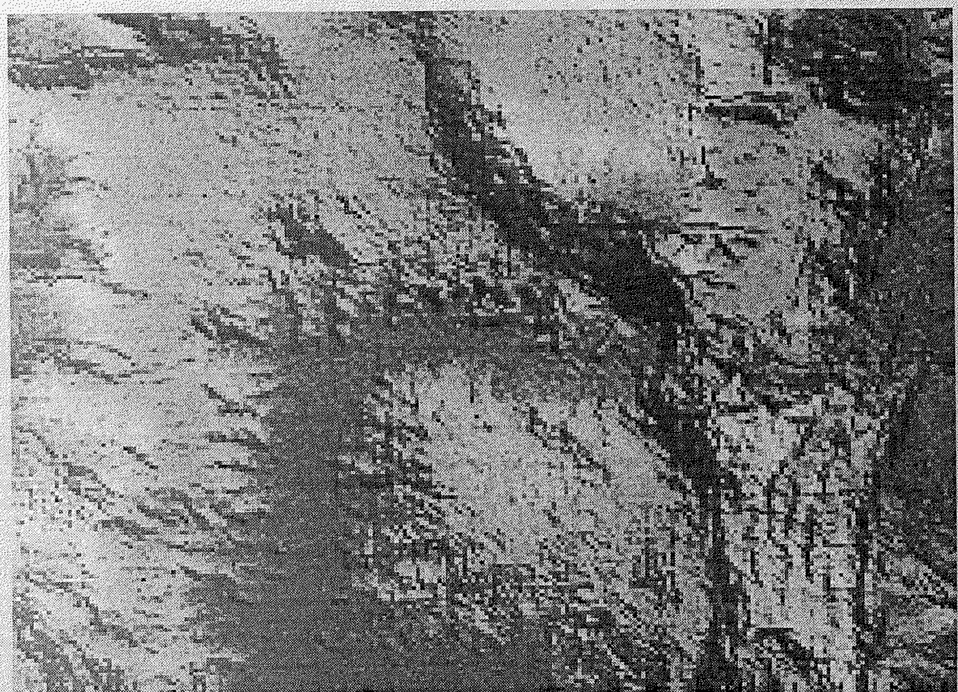
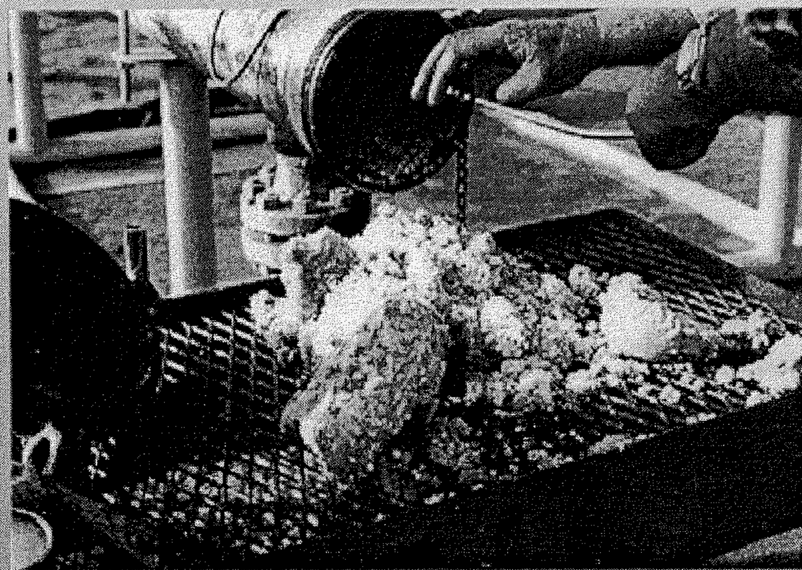
Flow Assurance

- Paraffin
- Asphaltines
- Hydrates
- Multi-Phase Flow







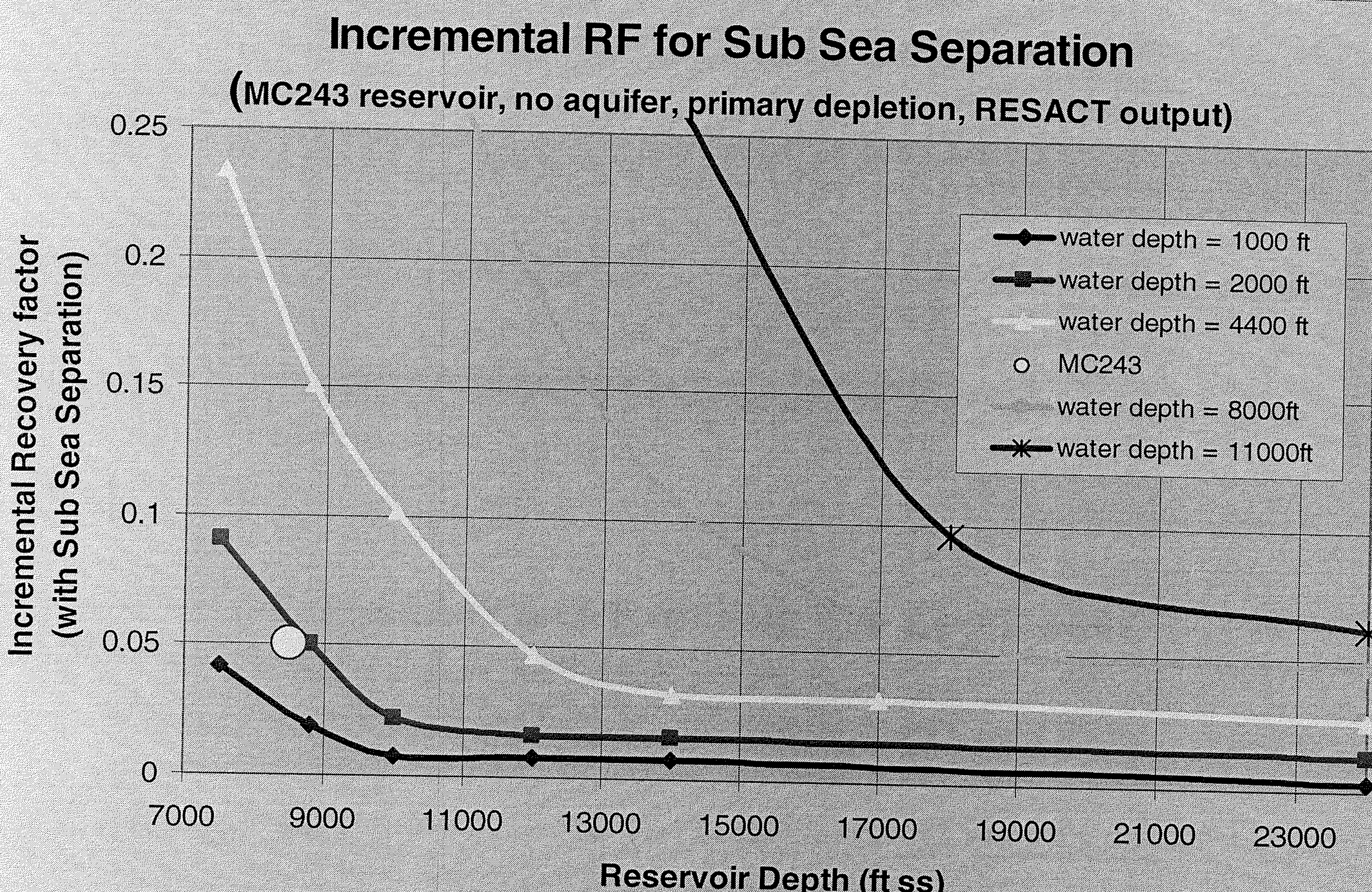
Why This Concept ?

- Best Reliability
  - Self Contained Process Modules
  - Allows Test on Surface Before Installation
  - All electric system
- Lowest Intervention Cost
  - Light Weight & Modular
  - Retrievable with light lift vessel
  - Easily Reinstalled Sub sea
- Most Flexible Configuration
  - Accommodates Changing Field Conditions
  - Process & Equipment Upgrades

Sub sea Separation

- Recovery increase occurs when
  - water depth is very large
  - reservoir depth is relatively low
  - reservoir has little internal energy (i.e. no aquifer)
- Rate increase occurs when
  - back pressure from hydrostatic head is reduced
  - fluid is separated at seafloor avoiding pressure drop and slugging of multiphase flow
- Realizing either of the above can be very significant (5% RF, 10% acceleration for example)

Sub sea Separation



Evaluation Assumptions

- **<u>Compared Mini-TLP vs. sub sea separation developments</u>**
- 4400' WD
- 9000' Depletion Drive Reservoir
- 15, 000 BOPD SS wells
- 15 MMBO recovery/well
- 50 Mile Tieback
- 1.25 $/BOE processing fee
- Host upgrades

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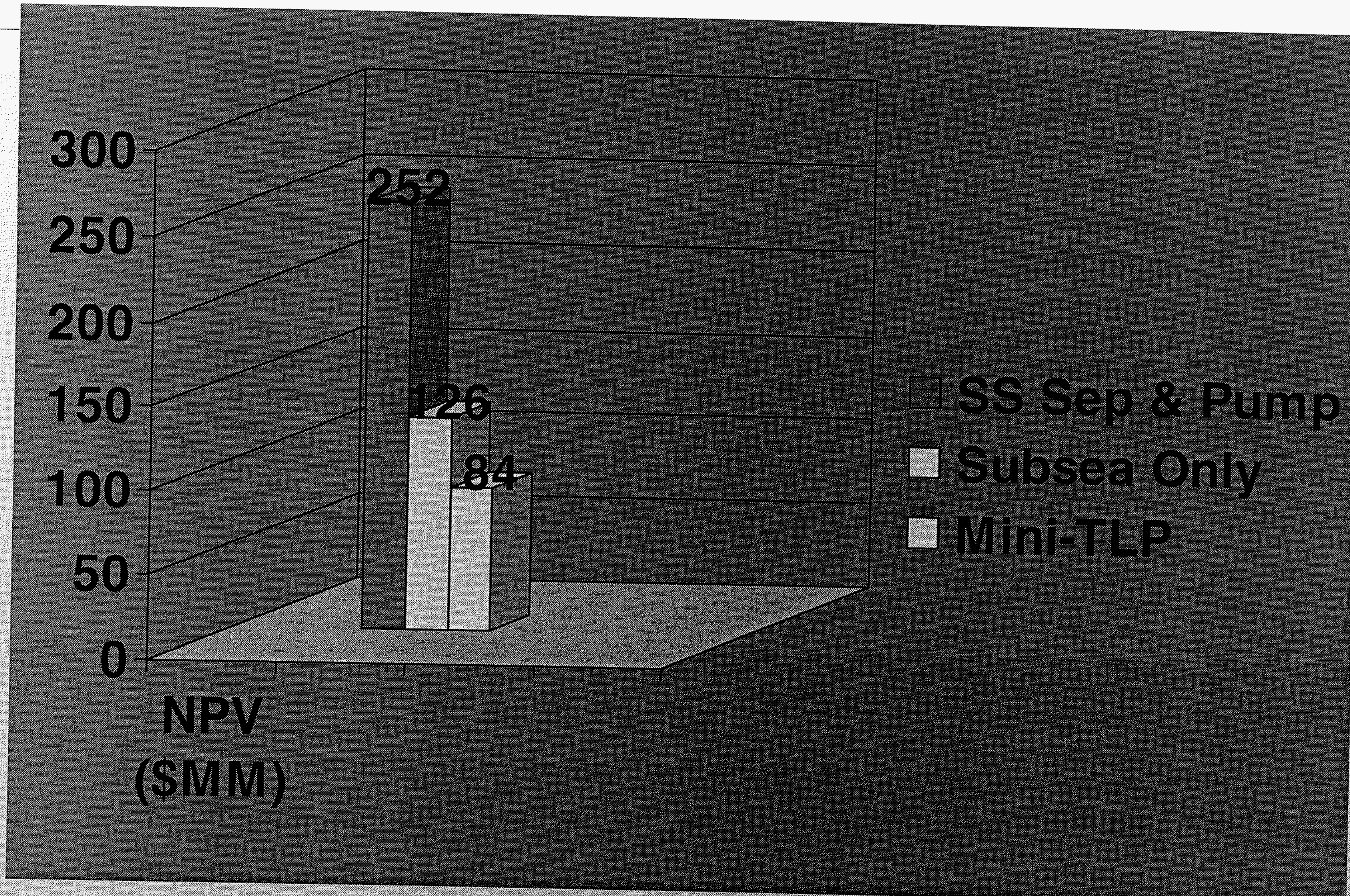
NPV Comparison - 50 MMBO Case



Capex Comparison by Category

SS Sep & Pumping		Mini-TLP	
Drilling	$120	Drilling	$120
Subsea	$155	Subsea	$167
Sep/Pump	$ 22	TLP	$118
Power Umbil.	$ 24	Topsides	$ 24
Host Upgrade	$ 30	Host Upgrade	$ 30
Abandonment	$ 9	Abandonment	$ 9
Total	$360	Total	$468

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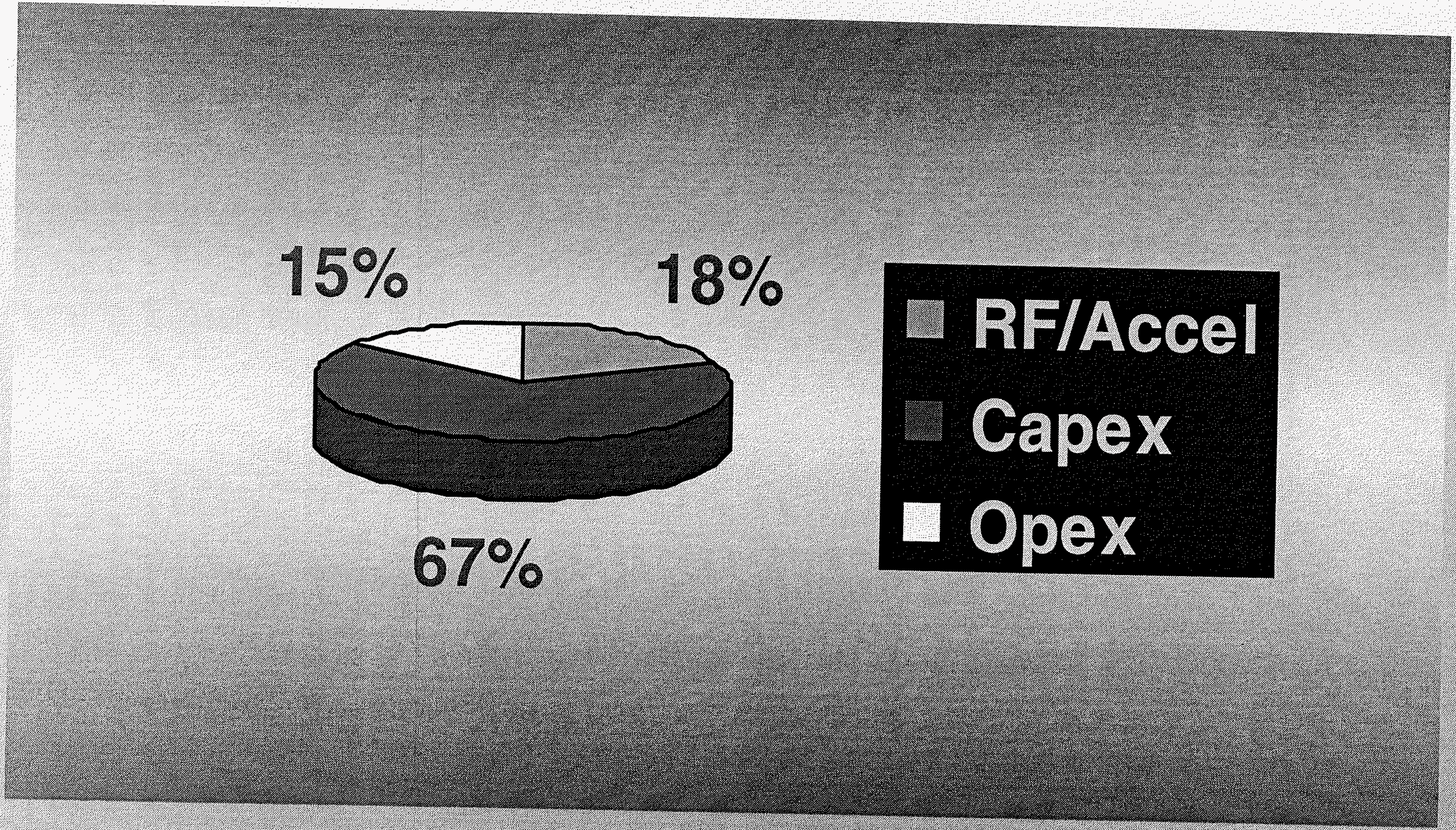
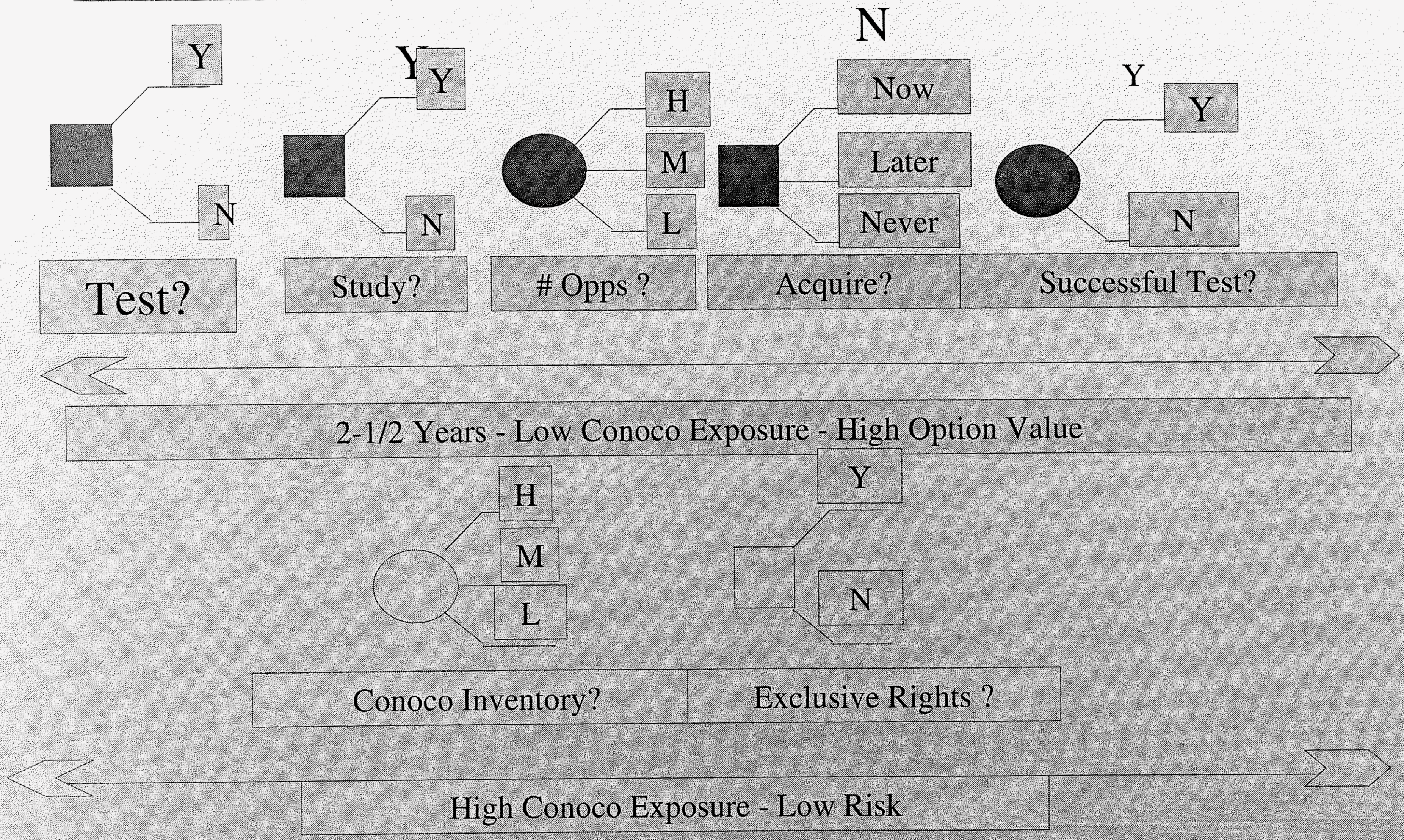
What is $170 MM incremental value attributed to?



Decision & Risk Timeline



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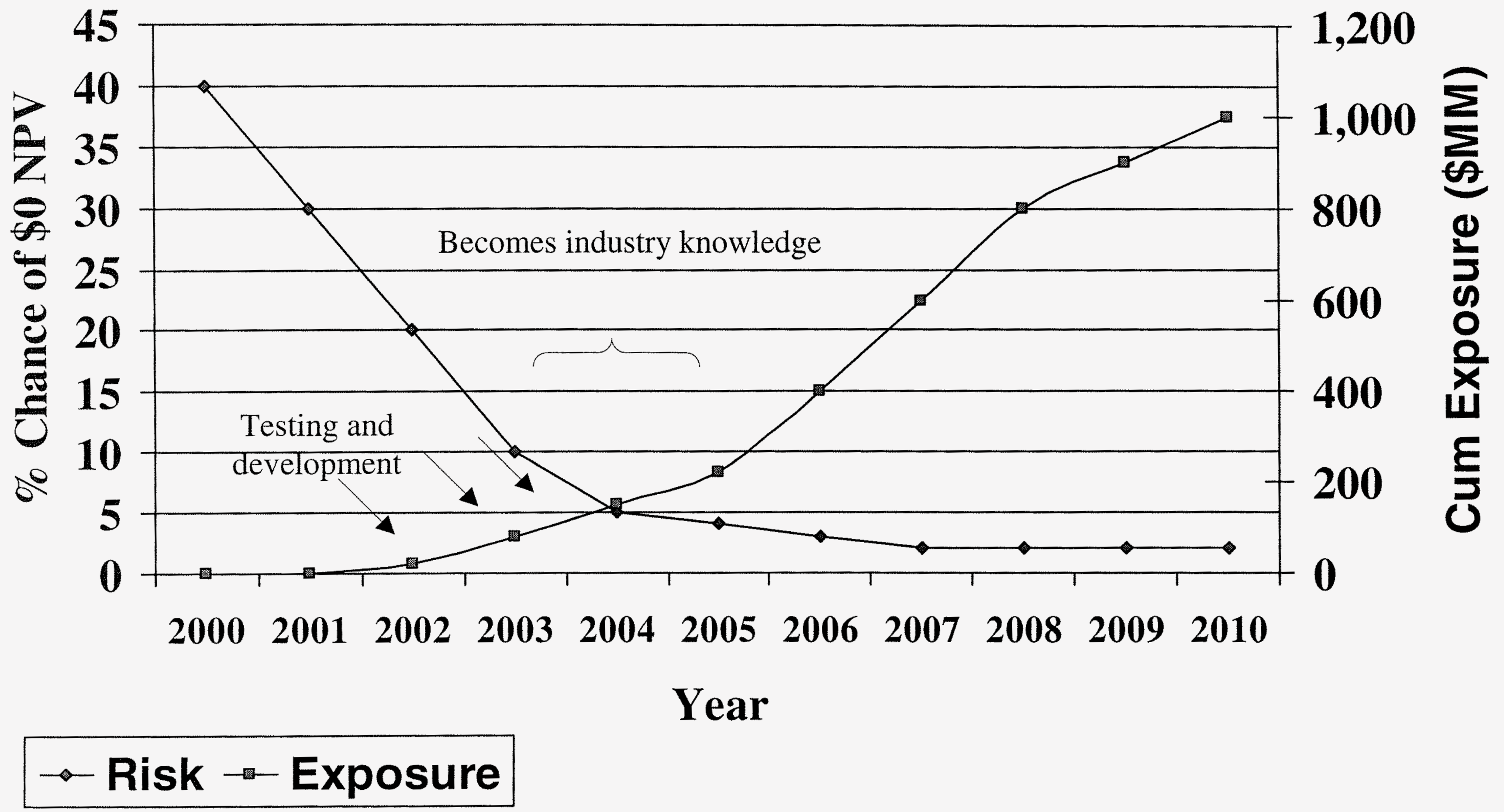
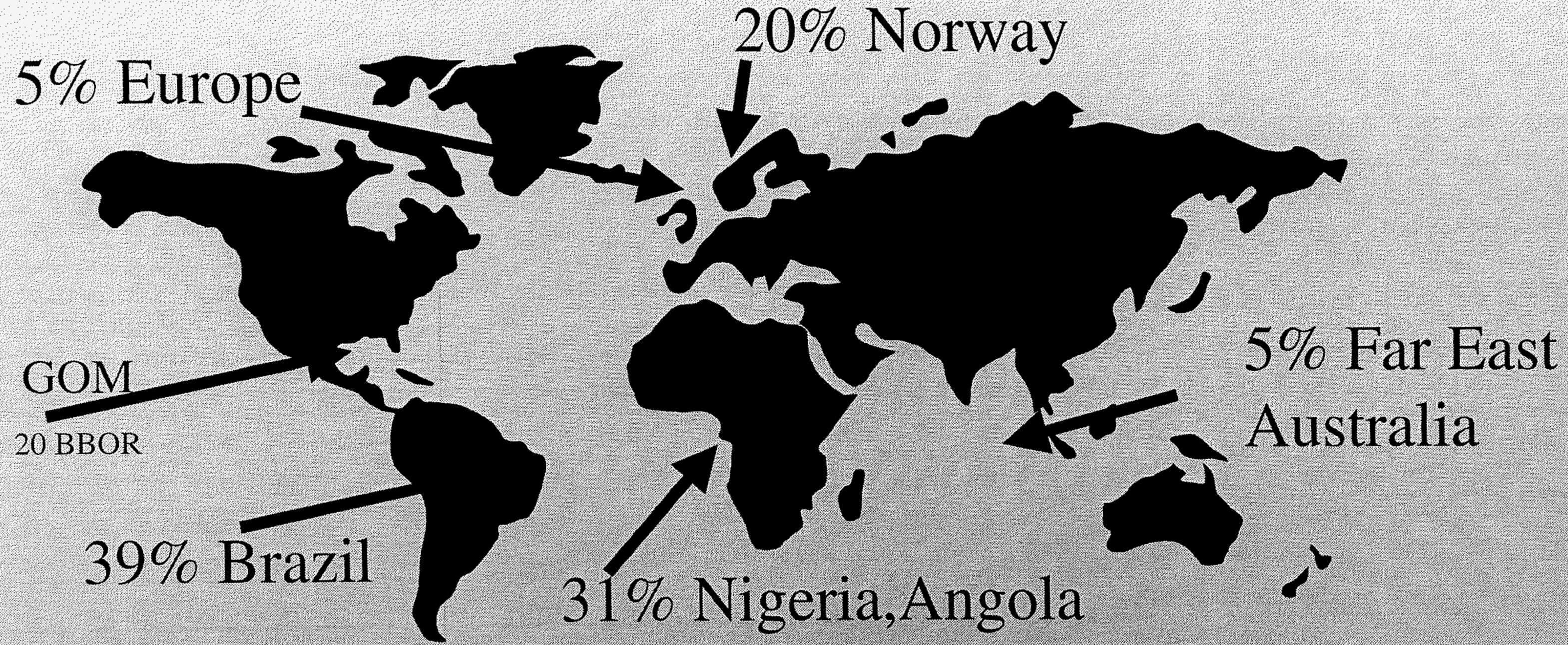
Sub sea Processing Risk vs. Exposure



Deepwater Technology

Global Applications

2.9 Billion BO discovered in water >1000' today



- USA-45% wells encounter hydrocarbon, 3.9% large enough to develop>1000' WD

Next Step

- Long Term Demo with Full Well Stream
  - Flow Surges, Emulsion, Solids, etc.
  - Sub sea Under Real Oil Field Conditions
  - Number of Intervention Cycles
    - Identify & Resolve Weak Links & Points of Failure
    - Develop Repair & Maintenance Procedures
    - Reconfigure Module to Prove Flexibility
- Robust hardware Is Not Enough
- Faultless System Integration Is Required
  - Marry Process/Control Engineering & Separation Technologies with Sub sea Hardware

Funding Estimate

- Phase 1
- DOE $2.0 MM
- Conoco/Kvaerner $4.0 to 8.7MM
- Total $6MM to $10.7MM
- Phase 2
- DOE $10MM???
- Conoco $120MM???
- Kvaerner $10MM???

Resources

Screening Study

(Phase I - 6 months)

Resv. Engr.

Geoscientist

Drilling Engr.

Infrastructure Engr.

Investment Appraiser

Field Test

Approximately 2 yrs

Project Mgr.

Resv. Engr - 0.25

Project Engr - 2

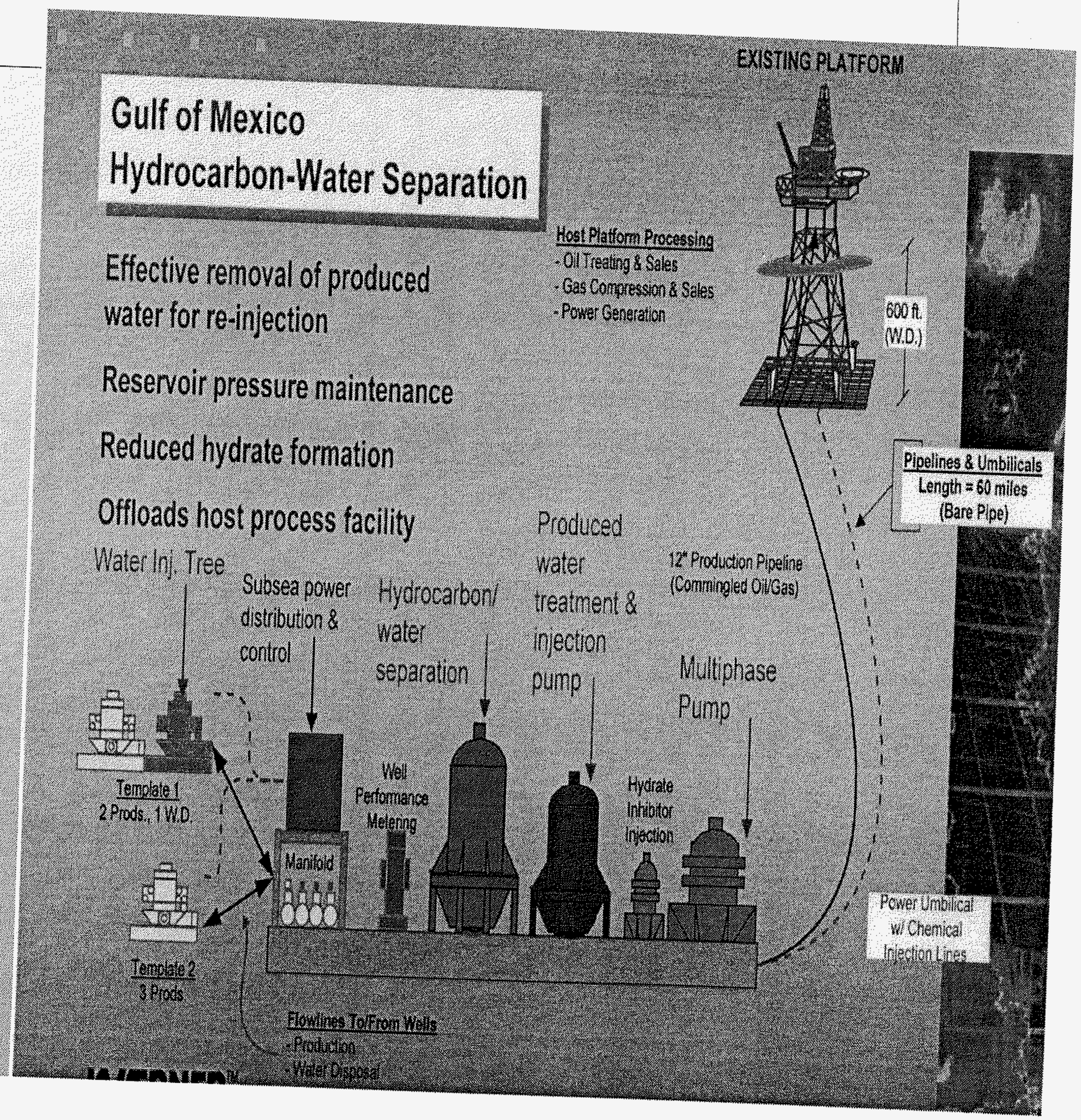
Operations/Coord -1

Planning/Acctg - 1

(Pd from project funding)

Kvaerner as Partner

- Leader in Technology
- Currently allied other research
- Willing to invest and take risk along with Conoco for win-win
- Significant engineering force for task



Deepwater Technology

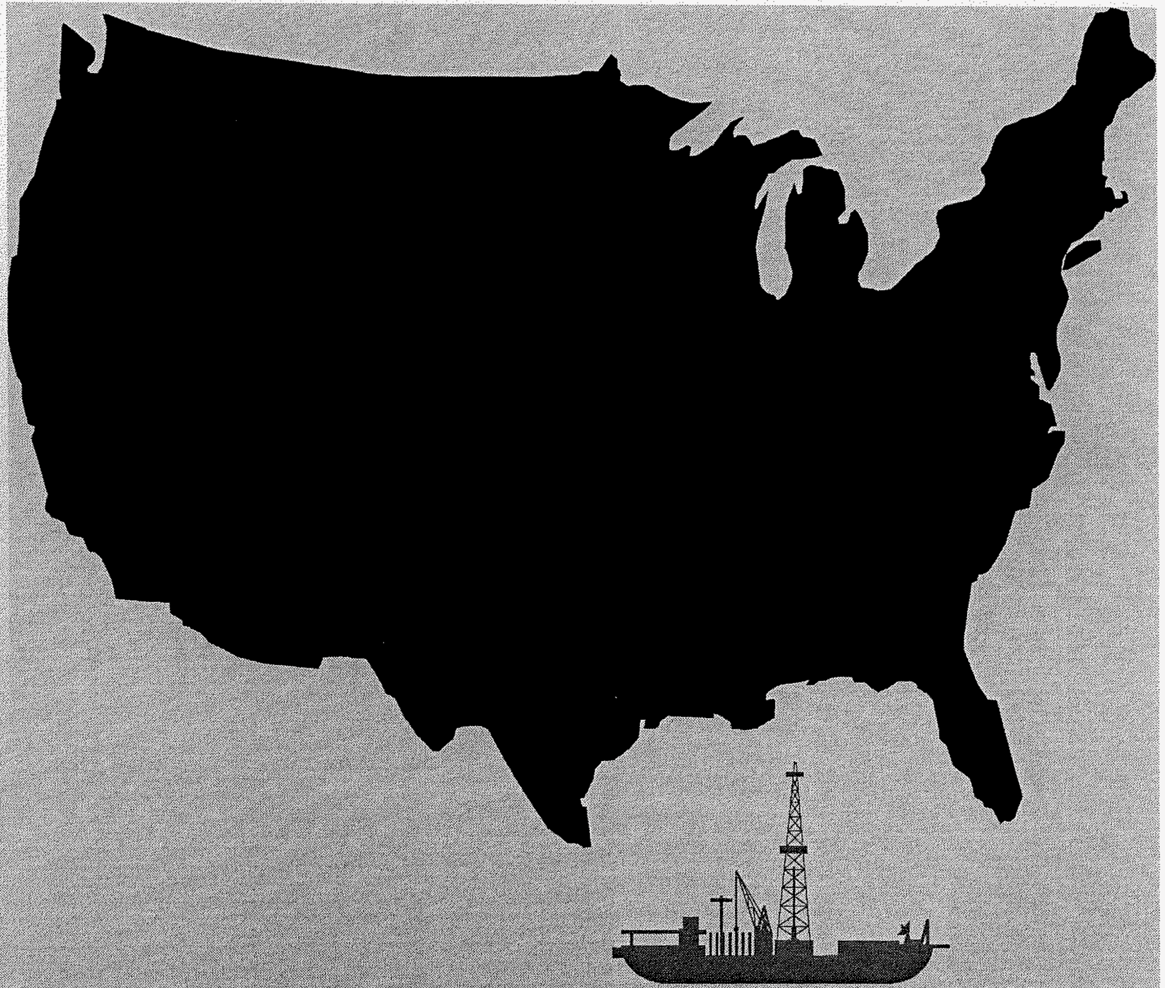
DOE as Partner

Technology accelerator/through risk mitigation

Link to newly declassified technology

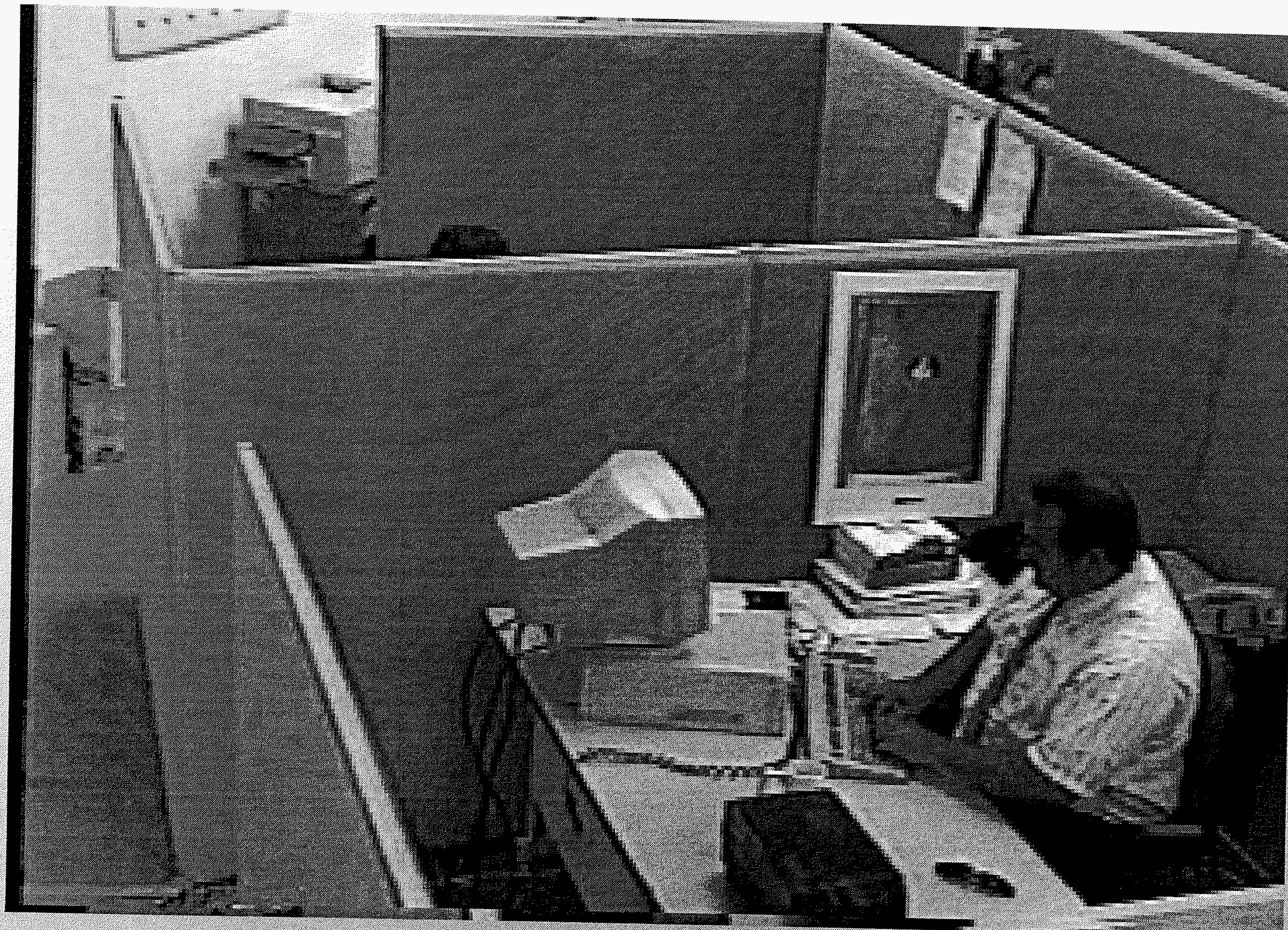
Aligned with private industry due to energy national security concern and bottom line leveraged research $$$ to treasury

Gain/distribute knowledge on environmental benefits



Conoco is Pioneering Towards 10,000 Feet of Water

Deepwater Technology



Break Time!

Expectations/Conoco Perspective

Specific examples:Phase one deliverables:System design and function description,components identified,size weight,associated schedule

+/-30% cost estimate meeting design criteria

List of trade off studies for phase II and development items for phase II and plan or description of how to accomplish this

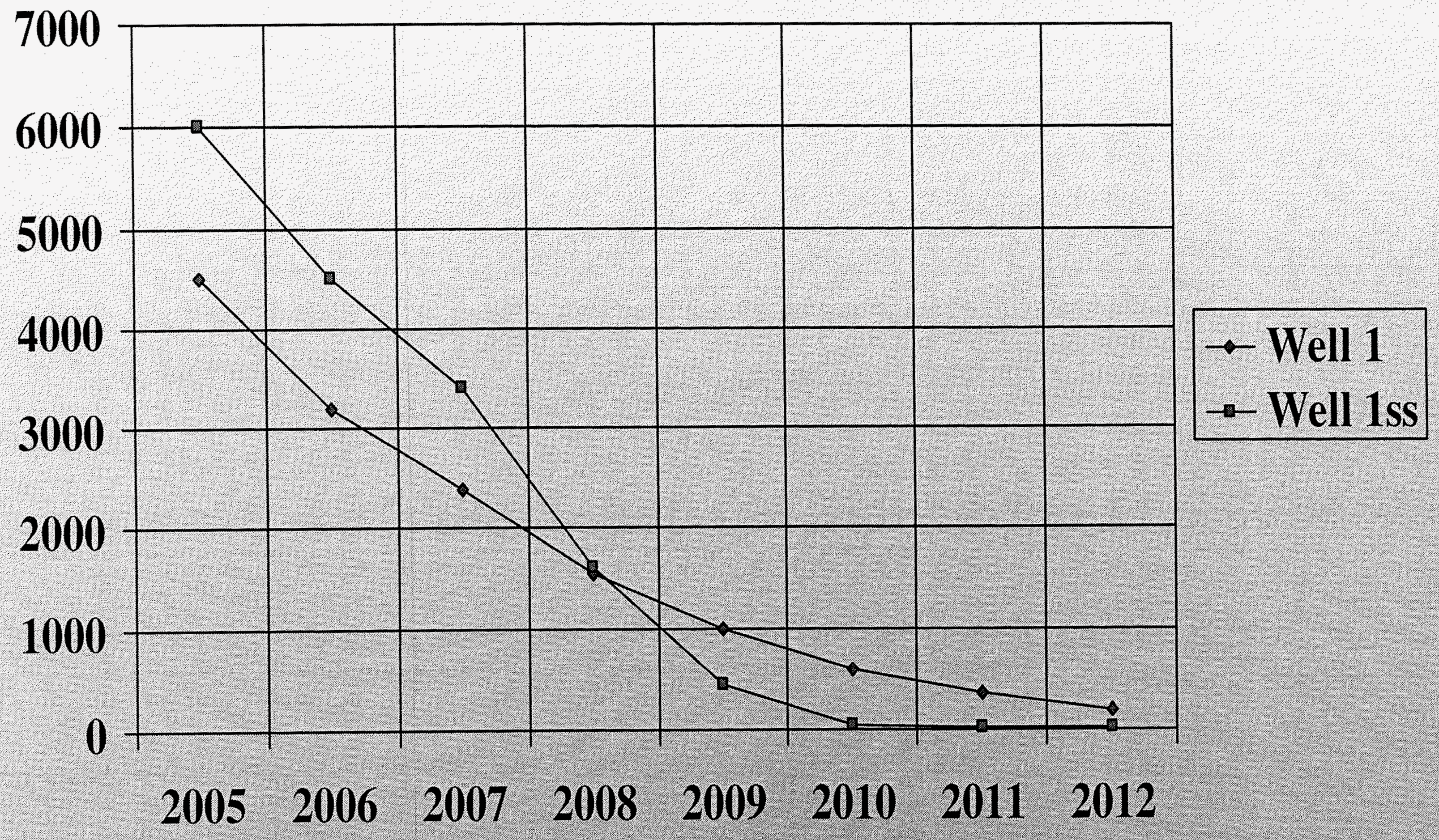
As much detail on the above from vendors

General principles: Teamwork, knowledge sharing, communications effectiveness, limits on some confidential data,mutual trust/benefit relationship

Headliners: Pigging philosophy,chemical injection,equipment range - ability, reliability as a system

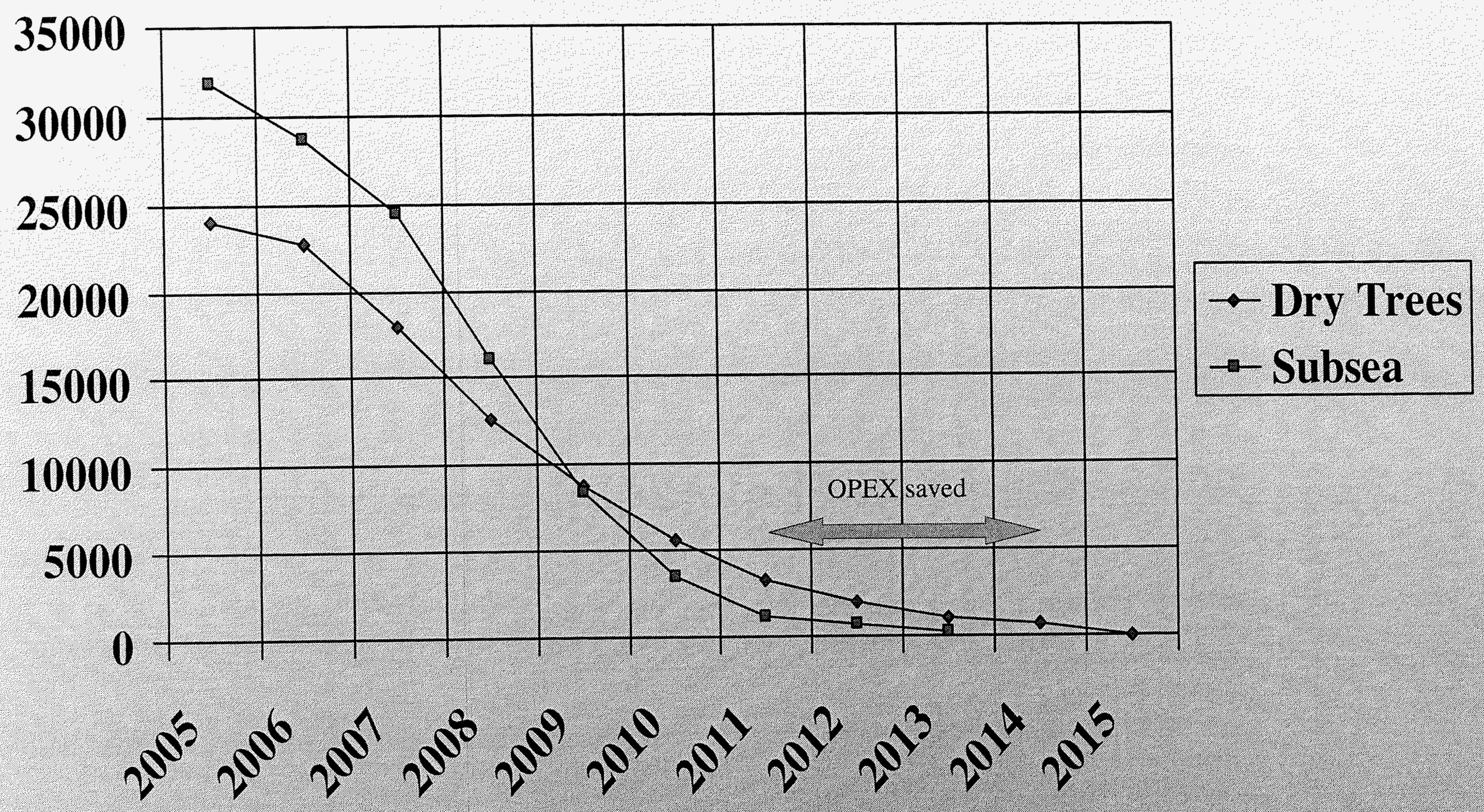
Deepwater Technology

Typical Well # 1 Flowstream



Deepwater Technology

Tie-back Composite Flow Streams



Invoice Summary Sheet: DEFC2600NT40964

1.	October 2000 to June 2000	Total Cost Incurred	$494,797.28
		Conoco Inc.	$324,458.78
		Kvaerner(10/2000to 4/26/2001)	$170,338.50
		DOE reimbursed	$164,932.43
		DOE Balance	$1,835,067.57
2.	June 2000 to September 2001	Total Cost Incurred	$281,471.40
		Conoco Inc	$42,594.59
		Kvaerner (4/27/01 to 6/29/01)	$238,876.81
		DOE reimbursed	$93,823.80
		DOE balance	$1,741,243.77
3.	October 2001 to August 2002	Total Cost Incurred	$361,784.72
		Conoco Inc.	$361,784.72
		DOE reimbursed	$120,594.91
		DOE balance	$1,620,648.86

*Note: There is one invoice for Kvaerner costs through the end of 2002 for approximately $53,000 of which $17,666 approximately should be invoiced. This may still be in the mill somewhere but this should be the last invoice bringing the total DOE balance to date of approximately $1,602,982.86. I will follow up here to verify that last invoice.