ASSESSMENT OF DEEP WATER PIPELINE REPAIR IN THE GULF OF MEXICO

SEMI-ANNUAL PROGRESS REPORT

February 4, 1999

Prepared By:

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# TABLE OF CONTENTS

I. INTRODUCTION ................................................. 3

II. METHODOLOGY ............................................... 3

III. HISTORY OF DEEP WATER PIPELINE REPAIR .............. 4

IV. OVERVIEW OF INFORMATION GATHERED TO DATE .......... 4

V. PROJECTION OF FUTURE PROJECT ACTIVITIES .............. 7

VI. CONCLUSION .................................................. 8

APPENDIX A - SAMPLE DATA BASE

APPENDIX B - HISTORY OF DEEP WATER PIPELINE REPAIR SYSTEMS

APPENDIX C - PROJECT SCHEDULE
I. INTRODUCTION

The report contained herein presents the semi-annual progress of the Assessment of Deep Water Pipeline Repair in the Gulf of Mexico project as awarded to Project Consulting Services, Inc. (PCS) by U.S. Department of the Interior Minerals Management Service (MMS) on July 1, 1998. The project scope includes the practical assessment of currently available technology in deep water pipeline repair considering historic system performance, technological strong points, and technological weak points. The final deliverable of the project is a report that provides recommendations to push the current technology and to fill the gaps in existing technology. The final report shall also include any incidental design and operational issues relating to deep water pipelines as discovered during the course of the project.

This progress report presents the following information:

- Methodology adopted by PCS to fulfill our final objectives
- Historical background relating to deep water pipeline repair
- Overview of the information gathered by PCS to date
- Projection of future PCS activities for the upcoming year

This progress report is intended to convey preliminary project information that will allow the MMS to understand the work completed to date, the work in progress, and the emphasis for upcoming tasks. Several exhibits in the form of tables are included in their preliminary form and provide a large quantity of information gathered from all facets of the industry. PCS intends to further develop these exhibits during the course of the project so that they or the information they contain can be included in the final report in the most effective format.

II. METHODOLOGY

The initial focus for the project was making contact with the industry leaders in deep water pipeline repair technology. From July 1998 – December 1998, the primary direction was introducing the project to suppliers, service companies, and operators who have interests in the deep water Gulf of Mexico. These companies were generally receptive to these inquiries and were eager to share and exchange information. The initial success of our investigation resulted in invitations to meet with key individuals that have been involved in deepwater pipeline repair from its inception in the early 1970’s. We accepted every opportunity to meet with these industry pioneers both in the New Orleans and the Houston areas. These meetings produced leads, both domestically and abroad, to the individuals who are currently focused on deep water pipeline repair. During the course of our research, there were several entities that were reluctant to share information for proprietary reasons, however efforts are being made to determine a general overview of their objectives as it relates to deep water pipeline repair.

Additional sources of information being pursued include the Internet, OTC proceedings, and topic specific conferences. These sources have yielded information on the current industry status
of deep water pipeline repair as well as several leads on currently available technology. There
are still plans to attend several conferences that focus on deep water pipeline repair.

Creation of a data base is in progress which will facilitate the tracking and recording of each
contact or publication that is researched during the course of the project. This data base is being
designed to be a working document for use during the research effort as well as a reporting tool
that will be incorporated into the final report upon project completion. A sample of the data base
contents is contained in Appendix A. Since this is a working document, it is anticipated that the
database format will evolve as more information becomes available, therefore the final format
may differ significantly.

III. HISTORY OF DEEP WATER REPAIR TECHNOLOGY

For the last twenty years oil and gas producers in the Gulf of Mexico have pressed aggressively
into deep waters in the Gulf of Mexico, and in the last several years the pace of drilling and
development in deep water has accelerated. The oil and gas industry has developed new
approaches and new technology to meet the challenges of deep water work. The industry is
continually introducing new technology including many new designs for offshore production
platforms, new marine construction equipment, and techniques for installing pipelines and risers
in deep water.

Deep water has been defined as water depths beyond the reach of deep diving, which is generally
below 1,200 feet. In these depths all work must be accomplished remotely and without direct
intervention by a diver. Therefore, all repair work must be accomplished using a combination of
specialized equipment, tools, and procedures. All work on the seafloor must be performed by
remotely operated vehicles (ROVs). Alternative repair methods include pipeline recovery to the
surface, the subsea installation of repair clamps and the removal and replacement of damaged
sections of pipe on the sea floor. Pipeline recovery to the surface can present as much difficulty
as seafloor repair scenarios because remote intervention is still required for tasks such as pipe
cutting and pipe manipulation. Repair clamps are generally viewed as temporary fixes that may
require deration of the pipeline until permanent repairs can be completed.

Almost thirty years ago, pipeline operators were just beginning to realize the difficulties
associated with deep water pipeline repair. Our initial research has yielded a preliminary history
of deep water repair programs referenced back to 1973. A preliminary summary is included in
Appendix B for reference. The information contained within the summary is from one source,
therefore follow up is in progress to verify the accuracy of the data.

IV. OVERVIEW OF INFORMATION GATHERED TO DATE

The discussions held with the contacts made from July 1998 to December 1998 were primarily
focused on acquiring information about the current readiness of the industry to provide
equipment and services for a pipeline repair in the deep water regions of the Gulf of Mexico.
The ensuing discussions led to topics dealing with not only Gulf of Mexico readiness but also
worldwide readiness in general. Deep water repair technology had established a history in the North Sea and Mediterranean out of necessity many years before there was a need in the Gulf of Mexico. It is not surprising that there are currently only two complete systems in existence capable of repairing deep water pipelines, and these systems reside in the North Sea and the Mediterranean areas.

During an interview with BP Exploration, Inc. (BP), Project Engineer Mr. Jim Riley, stated that BP has an interest in the current state of readiness of deep water pipeline repair capabilities in the deep water Gulf of Mexico. One hypothetical scenario considered by BP was a large damaged pipeline section below diver depths resulting in a total pipeline shut-in. The time required to repair the pipeline to its original operating conditions was estimated at eight (8) months. This included time to mobilize equipment from Europe, procure the mechanical connectors, fabricate repair spools, and develop the tools required to cut, clean, and prepare the pipeline for the repair.

The scenario described above poses a large financial risk to any deep water pipeline operator. The costs associated with repairing the damaged pipe includes not only the costs of the repair itself. They also include the deferred revenue associated with an extended duration shut-in. The repair equipment required for such a task is limited to large dynamically positioned vessels with large work-class ROVs. The mobilization and operation of a large vessel to perform such a repair can be costly. Despite the risk involved with operating a deep water pipeline, operators have pressed forward with projects extending well beyond diver depths in the Gulf of Mexico.

It has been inferred that operators proceed under the assumption that risk of deep water pipeline damage is mitigated by virtue of being in deep water. This assumption may have merit. Assuming a pipeline is stable on-bottom and has been properly designed, installed, and operated, there is little that can affect the integrity of a pipeline in deep water other than a direct impact from a heavy object. Damage potentials that exist in shallow waters including vessel anchors, commercial fishing, and the effects of tropical storms are virtually eliminated. For example, almost all construction vessels operating in deep water are equipped with dynamic positioning (DP) systems that allow the vessels to maintain station without the need for anchors.

Though risk of pipeline damage may be mitigated in deep water, there is a general interest among pipeline operators to develop contingency plans in case the need for deep water pipeline repair arises. Outlined below is an overview of the various processes, entities, and issues associated with the repair of a deep water pipeline:
Deep Water Pipeline Repair Process

The process of repairing a pipeline in deep water breaks down into several functional topics:

1) Survey and Identification of Damage
2) Selection of Marine Support Equipment
3) Removal of Damaged Pipe
4) Pipe Preparation
5) Installation of Hardware
6) Testing and Commissioning.

The types of companies that provide these services and equipment are touched upon in the following discussions:

Pipe Lay Contractors

As expected, all of the deepwater pipe lay contractors in the Gulf of Mexico are interested in pipeline repair as a logical extension of their current capabilities. PCS is in regular contact with these companies and has discussed deepwater repair scenarios with them on several projects over the last few years. We plan to stay abreast of their capabilities during the course of this project.

ROV and Support Services Contractors

ROVs are used in all phases of deepwater pipeline repairs. All of the proposed methods, equipment, and procedures which have been proposed for deepwater pipeline repair, without exception, employ ROVs. The ROVs which can perform the multiple functions proposed are "work-class" ROVs. These ROVs represent a set of ROVs of a certain size, power, and depth capability. PCS has contacted all of the companies which currently operate work-class ROVs in the Gulf of Mexico, including:

1) Oceaneering International, Inc.
2) Sonesub, Inc.
3) SubSea International, Inc.
4) Stolt Comex Seaway Inc.
5) Canyon Offshore, Inc.
6) Global Industries, Ltd.
7) Cal Dive International
8) Racal

These eight (8) companies all claim they have the capability to provide ROV services in support of deepwater pipeline repair, limited only by the availability of their ROVs at the time. Many of these companies also offer one or more ROV support vessels, some of them dynamically-positioned. Most of the ROV operating companies have been involved in deepwater offshore
construction of production platforms and pipelines, and they offer operational experience and specific engineering services in support of deepwater pipeline work.

Existing Deep Water Pipeline Repair Equipment

While many types of equipment, tools, and procedures exist in the Gulf of Mexico for deepwater pipeline repairs, there is no single, complete system in the Gulf of Mexico at this time. As mentioned above, there are two complete deepwater repair systems in the oil and gas industry worldwide today. A set of pipeline handling frames and associated equipment are built by Statoil. The control systems and ROV interfaces for this equipment are engineered and manufactured by SubSea International. Recent reports indicate that this system is in storage in Stavanger, Norway. The second system is owned by Saipem and operated by its ROV operating subsidiary Sonsub. This system is located either in Italy or Norway. In both cases, these are large systems which can only be transported by sea. However, their operational and control systems can be transferred directly to systems which could be built and made available in the Gulf of Mexico.

Connectors and Related Equipment

There are at least five major manufacturers of pipeline connectors and related equipment which are actively marketing their equipment for deepwater pipeline repairs. These companies include:

1) Cameron
2) Oil States/Hydrotech
3) FMC
4) Big Inch Marine Systems
5) ABB Vetco

PCS has interviewed these five companies, four of them in person. In addition, there are other manufacturers that offer products for deepwater pipeline repairs, such as Morgrip and Drilquip.

V. PROJECTION OF FUTURE PROJECT ACTIVITIES

We estimate that Phase I of the project is 53% complete bringing total project completion to approximately 38%. This is based on the updated project schedule that can be found in Appendix C. The research performed to date has revealed a wealth of information sources yet to be explored including companies developing new technology both domestically and overseas and custodians of existing technology located exclusively overseas. The remainder of Phase I is to be spent meeting with and establishing new leads, visiting the developing and existing technology, and following up with previous contacts as required. Current efforts include scheduling interviews with Shell Deep Water Development Systems, Inc. (Houston), Stolt Comex Seaway, Inc. (New Orleans), LTS (Houston), Shell International Exploration & Production (Netherlands), SNAM/Saipem/Sonsub (Houston and Milan), and Statoil (Stavanger).
Phase II tasks, which consist primarily of data evaluation, are slowly being implemented over the next several months. We anticipate Phase II to officially begin in May 1999. Phase II activities include dedicating more resources towards the development and maintenance of the database and to the sorting of information for detailed analysis. We plan to use the results from the completed analysis as a basis for the final report which is scheduled for completion in December 1999. We are anticipating follow up research extending throughout the project duration due to scheduling of events such as technology conferences and availability of key contacts within the industry.

VI. CONCLUSION

The industry response has been positive to our inquiries to the current state of technology in the deep water Gulf of Mexico. Most of the companies we have interviewed, including service companies, equipment manufacturers, and pipeline operators, either expressed an interest in developing deep water pipeline repair technology or currently have some technology available. We do note that many components exist, or the technology to commercially manufacture the components exist, however there is no single entity that can offer a complete repair system beyond diver depths in the Gulf of Mexico. The components of such a system, in general, are job specific, meaning that tooling and equipment developed for one pipeline repair may not applicable to another. Deep water repair is a costly proposition for pipeline operators to consider, however the risk of damage is prompting the deep water operators to initiate further development of the technology.
APPENDIX A

SAMPLE DATA BASE

Prepared by Project Consulting Services, Inc.
### Minerals Management Service

**Assessment of Deepwater Pipeline Repair Capabilities**

#### DATABASE

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Company Type (Developer/ Operator) (O=Engineering Consulting Firm)</th>
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<th>City</th>
<th>State</th>
<th>ZIP</th>
<th>Contact</th>
<th>Title</th>
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</tbody>
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#### Contact Information:

- **ABB**
  - Brian Taylor, Sr. Sales Rep
  - 504-552-1653

- **Atlas Service USA, Inc.**
  - 504-222-4014 or 504-222-4022

- **BP Exploration**
  - 281-597-4287

- **Camin Sonix Offshore**
  - 713-690-2704

- **ConocoPhillips Engineering & Construction**
  - 713-838-4603

- **DeepWater**
  - 713-239-1230

- **Exxon**
  - 713-456-4220

- **Halliburton**
  - 281-591-4223

#### Website:

- BP Exploration
  - bpexplorationusa.com

- ConocoPhillips Engineering & Construction
  - cpengineering.com

- DeepWater
  - deeptech.com

- Exxon
  - exxon.com

- Halliburton
  - halliburton.com

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**PRELIMINARY WORK IN PROGRESS**

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**Project Consulting Services, Inc.**

**PCN Job No. 98120**
APPENDIX B

HISTORY OF DEEP WATER PIPELINE REPAIR SYSTEMS
<table>
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<tr>
<th>Item</th>
<th>Date</th>
<th>Sponsor</th>
<th>Depth</th>
<th>Scope of Work</th>
<th>Type/Participants/Status/Comments</th>
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<tbody>
<tr>
<td>1</td>
<td>73-76</td>
<td>Exxon</td>
<td>4,000'</td>
<td>Repair 36&quot; pipe</td>
<td>JIP/16. Report 76-77. Conceptual only, predated work</td>
</tr>
<tr>
<td>2</td>
<td>74-77</td>
<td>Shell</td>
<td>3,000'</td>
<td>Repair 36&quot; pipe</td>
<td>JIP/6. Report 77. Conceptual only. Submersible catamaran carrying all tools, repair devices, spoolpieces, etc.</td>
</tr>
<tr>
<td>3</td>
<td>77</td>
<td>Statoil</td>
<td>1,500'</td>
<td>Repair 36&quot; pipe</td>
<td>Several concepts commissioned. Hydrotech designed/d/built subsea frame for installing mechanical connectors using 1 Atm. Suit.</td>
</tr>
<tr>
<td>4</td>
<td>81-83</td>
<td>Gulf Oil</td>
<td>8,000'</td>
<td>Size not defined</td>
<td>JIP/4-6. Preliminary design completed; fabrication drawings not funded. System based on use of ROVs, mechanical connectors, existing equipment</td>
</tr>
<tr>
<td>5</td>
<td>84-86</td>
<td>SNAM</td>
<td>2,000'</td>
<td>20&quot; spoolpiece</td>
<td>Part funding by THERMIE. Hardware constructed. Modules and frames used to perform separate functions, i.e. cutting, concrete removal, etc. Connections used cold-forging system.</td>
</tr>
<tr>
<td>6</td>
<td>88-90</td>
<td>Hydrotech/</td>
<td>2,000'</td>
<td>Repair 20&quot; pipe</td>
<td>Joint Venture, attempted JIP, dissolved for lack of interest. System based on ROVs, mechanical connectors, subsea equipment.</td>
</tr>
<tr>
<td></td>
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<td>Sonsub</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>92-99</td>
<td>Sontsub/</td>
<td>3-10,000'</td>
<td>Repair 26&quot; pipe</td>
<td>Part funding by THERMIE. ROVs perform all functions — cutting, concrete removal, etc. X-Loc connectors used. Tested at 1,200'. Tested in Norway 97-98.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Saipen/</td>
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<td>Snamprogetti</td>
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<td>8</td>
<td>94-99</td>
<td>Statoil/</td>
<td>2,000'</td>
<td>Repair 24&quot; pipe</td>
<td>Funded by Troll Oil Pipelines, Haltenpipe. Successful field test. ROV operated, uses mechanical connectors, 16&quot; pipe repair capability.</td>
</tr>
<tr>
<td></td>
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<td>NorskHydro</td>
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</tr>
<tr>
<td>9</td>
<td>95-99</td>
<td>Major</td>
<td>not defined</td>
<td>Repair clamps for</td>
<td>Hydrotech clamps, ROV installed. Tested remotely operated mechanical connectors.</td>
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<tr>
<td>10</td>
<td>92-99</td>
<td>Texaco</td>
<td>All pipe lay depths</td>
<td>All pipe diam.</td>
<td>JIP/18+. Proprietary. Concept is retrieve pipe to surface and weld on ends, lower to seafloor and install jumper. Studying pollution control. No equipment constructed.</td>
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<tr>
<td>11</td>
<td>96-99</td>
<td>SNAM/Saip</td>
<td>3,300'</td>
<td>Repair 20&quot;/26&quot; pipe</td>
<td>Connectors, cold forging, spoolpiece sched for testing 97. Cutting, cleaning, frames scheduled for testing 98.</td>
</tr>
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Ref: HO Mohr Z0053452.doc
APPENDIX C

PROJECT SCHEDULE

Prepared by Project Consulting Services, Inc.
### Task Summary

**Project:** Assessment of Deep Water Pipeline Repair in the Gulf of Mexico

**Date:** February 04, 1999

#### Task List

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<thead>
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<th>ID</th>
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<td>Project Completion</td>
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<td>Sat 1/1/00</td>
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<td>0 days</td>
</tr>
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#### Milestone Status

- **Qtr 3, 1998:**
  - Milestone 1: Complete
  - Milestone 2: In Progress
- **Qtr 4, 1998:**
  - Milestone 3: In Progress
- **Qtr 1, 1999:**
  - Milestone 4: Complete
- **Qtr 2, 1999:**
  - Milestone 5: In Progress
- **Qtr 3, 1999:**
  - Milestone 6: In Progress
- **Qtr 4, 1999:**
  - Milestone 7: In Progress

#### Project Summary

- **Split:**
  - Milestone 8: In Progress
  - Milestone 9: Complete