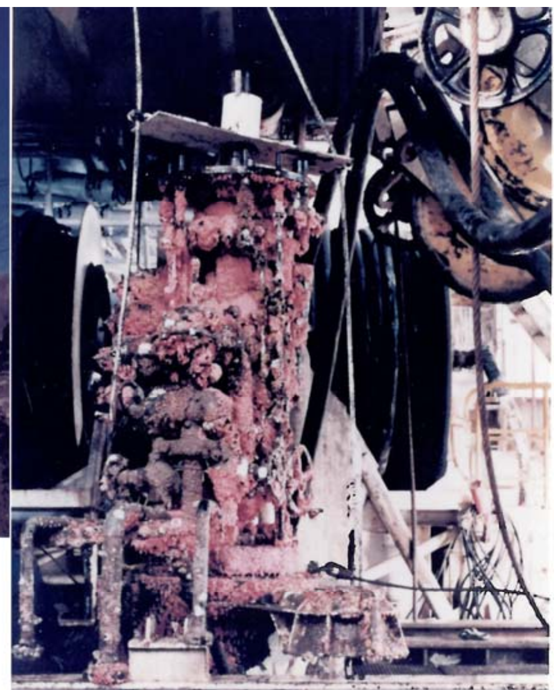
Joint Industry Project [JIP] Proposal
Issues Facing the Subsea Decommissioning Industry

Submitted by Endeavor Management
June 30, 2015
Rev2 March 30, 2016

Caliente State #2 wellhead, circa 1964



20 years later

Endeavor Management
2700 Post Oak Blvd. P + 713.877.8130
Suite 1400 F + 281.598.8895
Houston, Texas 77056 www.endeavormgmt.com

Endeavor

Proprietary and Confidential Material

The ideas, pricing, and terms of this proposal are the property of Endeavor Management. We respectfully request that the information not be disclosed or distributed to anyone outside the requesting companies or their parent companies, without the express written permission of Endeavor Management.

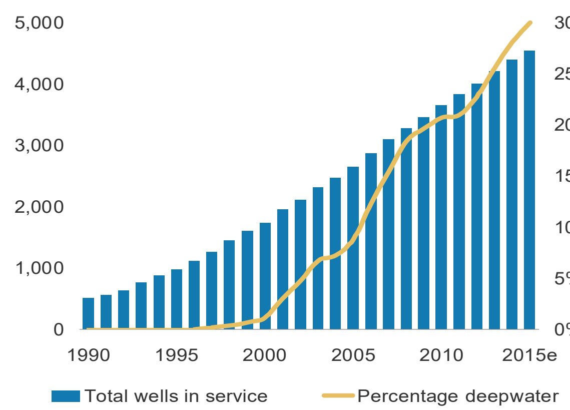
Background

In the late 1980s, the offshore oilfield industry was moving rapidly into deep water. Large fields had been discovered in several areas of the world in waters that presented big engineering challenges to the industry. Over the course of the next decade, these challenges were met and overcome. As the decade of the 1990s matured, the industry steadily came up with innovative ideas that transformed fundamental challenges into proven solutions.

The subsea decommissioning industry stands at a crossroads today similar in many ways to the situation described above. While the decommissioning industry has solved many of the unique technical problems that are inherent in subsea decommissioning work, there are several challenges that face the industry as a whole. Finding solutions to any one or more of these challenges can dramatically improve the economics, safety, and efficiency of subsea decommissioning.

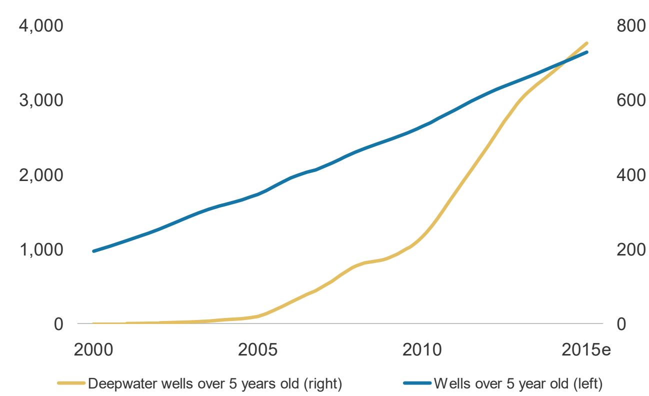
There are approximately 4500 subsea trees on the seafloor worldwide as shown in Figure 1. This number is growing by about 400 to 500 trees per year and the percent of trees in deepwater is now almost a third of the installed trees. The age of the existing subsea wells becomes greater with the passing of time   Figure 2 shows the trees which are more than 5 years old and deepwater trees have become a significant portion of the total. All of these subsea wells, independent of water depth, will need to be plugged and abandoned (P&A) in some fashion in the future. In addition, the associated subsea infrastructure of flowlines, risers, umbilicals, manifolds and connecting hardware will need to be flushed of hydrocarbons and recovered or abandoned in place.

Figure 1



Source: Company Data, Morgan Stanley Research estimates
Note: We are assuming a well is decommissioned after 20 years

Figure 2



Source: Company Data, Morgan Stanley Research estimates

Situation

There is no better time than the present for the pursuit of solutions to the most pressing Issues facing the decommissioning industry. These Issues are difficult but solvable. In addition, there is emerging legal opinion relative to the length of time that operators and owners are liable for their wells and the related facilities. As this time frame becomes longer and longer, it behooves the industry to view these technical challenges as industry-wide challenges as opposed to challenges to be met on a company-by-company basis.

The Issues: Each one of these receives further discussion within the appendices.

A. Perform an economic valuation of the various types of intervention vessels related to costs vs. abilities, including subsea well P&A
B. Evaluate the economic feasibility of creating a “near-MODU” in intervention/P&A capability for a ‘bargain price’
C. Consider resins vs. cements for P&A
D. Evaluate flowline flushing options and best fluid recovery methods
E. Investigate cement bond logging through multiple casing strings
F. Investigate alternative means of cutting casing and tubing for P&A activities
G. Evaluate ways to access, or remote evaluation of, outer annuli in subsea completions
H. Identify additions or modifications to future wellheads / trees / subsea hardware which will assist future decommissioning work
I. Identify methods to measure NORM, mercury and arsenic remaining in components due to production fluids, and best practices to remove or deal with these contaminants
J. Report on the current state of riserless, deep water coiled tubing intervention systems.
K. Ecological benefits of in situ subsea hardware in abandonment strategy in water depths up to 7000 ft.

Project Objectives

Endeavor Management proposes to provide leadership in identifying and developing concepts to address these Issues. We will serve as a focal point in generating and obtaining concept ideas to deal with each of the Issues listed herein, and will provide evaluations of the ideas generated. The goal of this JIP is to develop the economic model for P&A vessel options for Issue A, a cost prediction for Issue B, cost trade-offs for Issue C and to identify possible solutions for the other Issues, including identification of service providers and manufacturers who can supply these solutions.

Phase 1 Issues Definition
Proceed with Issue definition as follows:

- Endeavor will generate a PowerPoint summary in which each Issue listed above is expanded and further defined. The effects of the Issues will be analyzed to specify their effect on operations, schedule, economics, safety, and other areas of interest.
- This summary will then be sent to the JIP Member Companies in draft form for review.
- Endeavor will review this information with the member companies in a joint meeting and solicit comments. The concepts and companies identified in these meetings will be used in Phase 2. Whether this is achieved via a large common meeting on multiple Issues or a set of smaller individual meetings on specific Issues remains to be determined.
- For Issues A, B and C, this Phase 1 joint meeting will result in agreement on the tasks to be evaluated for each of those economic evaluation efforts.

Phase 2 Finding Solution Concepts

- Endeavor will seek possible solutions from within the JIP Member Companies, from service providers and from within Endeavor's skilled team.
- Issue A has a defined scope in the appendix which will result in an economic model related to different types of intervention vessels.
- Issue B seeks to answer an economic question. It shall be presented in the form of a predicted CAPEX along with the calculation of possible resulting day rates.
- Issue C will be evaluated by building an economic model for several example downhole activities comparing cement to resin. These might include multiple examples of the P&A of a subsea well.
- For Issues D through K, Endeavor seeks to find concepts with potential to be a technical solution for each of the Issues included within the final scope of this study. Within reason, the more concepts the better. Endeavor will provide a preliminary evaluation of the solutions with advantages/disadvantages listed and discussed.
- When all Issues have been documented, Endeavor will meet with the JIP Member Companies collectively for open discussion regarding these Issues.

Phase 3, Report, with Deliverables

- The results of Phase 1 and 2 will be revised to reflect the comments and discussion obtained via the review meetings. The findings will be documented to the JIP Member Companies as will the economic models and comparisons for Issues A, B, and C. Each Issue summary will include recommendations for follow-on evaluation after this JIP, as appropriate.
- Publish the report to all JIP Member Companies, along with a summary presentation
- In order to stimulate industry involvement in solving these Issues, Endeavor will present a summary of the findings at appropriate conferences and industry gatherings and publish in industry publications.

Assumptions and Constraints

Endeavor Management will provide professionals with appropriate backgrounds to facilitate and participate in the reporting and review process and share their knowledge and experience. The JIP Member Companies will share sufficient information about their technical requirements, operational experience to date, future needs, service company offerings and related information so that the Endeavor advisors can develop informed assessments of the current status of the industry and most likely solutions for each Issue. Endeavor will establish guidelines with the Member Companies to outline when and how the information within the scope of this study will be discussed or disclosed (a) between JIP Member Companies, and (b) to any party outside the JIP Member Companies.

Professional Fees and Expenses

This work will be performed on a lump sum basis. Endeavor has allocated a fixed number of man-hours for each Issue and will adjust the hours between Issues if one area needs less work and another needs more work during this JIP effort. It is presumed that the Member Companies will nominate a single-point contact to monitor progress. Endeavor proposes to report progress on a bi-weekly basis. The proposed JIP cost is a total of $ 708,000. This includes expenses such as travel to Houston for meetings for Endeavor personnel who live out of the Houston area.

Each JIP participant will be billed half of their total amount at project kick-off and the other half after the draft Final Report is issued. All invoices are due in 30 days. The cost per participant is expected to be $ 59,000 based on 12 participants.

The Member Companies will be notified in advance if the project requires additional hours due to significant changes in project scope, etc. Additional work would only occur if approved by unanimous approval of the JIP Member Companies.

The above proposed price of $ 59,000 per Participant includes:

- Phase 1 summary defining each of the identified Issues confronting the subsea decom industry, in draft form for review by the Member Companies.
- Review and comment in an open discussion for each of these Issues in a meeting format. In the spirit of a Joint Industry Project, Endeavor recommends a common meeting for each Issue. These may be combined on related Issues.
- Endeavor will follow-up on specific possible solutions identified in the Phase 1 meetings to gather more information.
- Phase 2 report outlining – for each of the Issues D through K – recommended concepts for solution to the Issue under consideration, if one or more exists.
- Review and comment in an open discussion for each of these proposed solutions in a meeting format for each Issue. These may be combined on related Issues.

- Completion of the overall report by the addition of Phase 2 information/solutions to the initial information gathered in Phase 1. This includes the economic model of Issue A related to vessel evaluation, as well as cost / economic data related to Issues B & C.
- Preparation of a report summary in PowerPoint format for use as follows:
  - One E-copy to each Member Company for internal use.
  - Presentation of the report summary at appropriate shows, conventions, conferences, and industry publications by Endeavor and/or the JIP Member Companies.

Time Frame

Endeavor proposes to start the work as soon as JIP Partner participation is confirmed. Phase 1 will be ready for review in approximately 6 weeks after award date, subject to completing the meetings with member companies. Phase 2 will be ready for review approximately 8 weeks after the last Phase 1 review meeting is completed. The Phase 3 final report will be delivered 4 weeks after final comments are received from Phase 2.

Contact

Should you have any questions or need additional information regarding this proposal, please contact either:

Keith Caulfield at 832-670-4635 or at kcaulfield@endeavormgmt.com
Bruce Crager at 713-459-1215 or at bcrager@endeavormgmt.com

We look forward to working with you on this project. Please sign below to show acceptance of this proposal.

Sincerely,

J. Keith Caulfield
Operations Advisor, Decommissioning JIP Study Team Lead
Endeavor Management

Signatures

Submitted by: Endeavor Management	**Accepted by:** (company name)
Signature:	**Signature:**
Printed Name: J. Keith Caulfield	**Printed Name:**
Title: Decommissioning JIP Study Team Lead	**Title:**
Date:	**Date:**

ISSUE A
SUBSEA DECOMMISSIONING ISSUE A SUMMARY:
Economic model for Intervention Vessel Options

Concise Summary of Issue A to be Addressed

There is much available data regarding intervention vessels and their capabilities. The goal of this initiative is to assemble the information into a usable format, enabling reasonable cost-benefit analysis of the options on the market. This will include performing selected intervention/P&A tasks using three options:

- Light well intervention vessel with no riser
- A vessel with a small bore intervention riser
- MODU with full subsea riser system including subsea BOP

Background and Overall Methodology

Various intervention vessels offer differing intervention capabilities. There are now enough different vessel options for a customer to choose from that it can be difficult to assess the best value for the money relative to the task at hand. This initiative will analyze three generic vessel types.

The three vessel types to be considered are a Dynamically Positioned (DP) vessel with riserless well intervention (RLWI), a DP vessel with a small diameter rigid riser or use a MODU with a drilling riser. Endeavor will develop a model stating the activities required for specific well intervention tasks and developing costs for each of the three vessels and their specific well intervention systems. This comparison would be built into a decision analysis model showing the assumptions such as dayrate for each vessel, number of hours for each task, etc. These assumptions can be modified to run various cost comparisons between the three vessel options.

Discussion: Problems Encountered by Current State of the Industry

The industry is new enough such that this type of study has not been performed. This is due to 2 primary factors:

- The capabilities of the several vessels on the market have recently come into focus.
- Pricing is now maturing into a more-predictable science.
- Technology has evolved allowing more to be done downhole without a MODU.

Proposed Scope: Methodology for Economic Study, Issue A

Phase One

- Define a representative listing of wellbore related TASKS for the life cycle of a well from ON DISCOVERY to P&A.
- Categorize these representative tasks as RESERVOIR [multiple vs. single zones, etc.], MECHANICAL, REGULATORY/ SAFETY RELATED.
- Request representative wellbore schematics from JIP Member Companies or JIP Member Companies' Clients to support the defined TASKS.
- Build a WELL INTERVENTION TABLE of these activities based on activities which can be done riserless with a DP vessel, with a small-diameter riser + DP vessel, or with MODU.
- Review the WELL INTERVENTION TABLE with JIP Member Companies at the Phase 1 review meeting.

Phase Two

- Develop PROCEDURES for the key activities for the three vessel types as defined by the WELL INTERVENTION TABLE.
- Develop TIME BREAKDOWNS for these procedures for all three types of vessels.
- Build COST MODEL based upon current spread costs and market rates + contingencies.
- Review COST MODEL and draft Final Report with JIP Member Companies at a convenient time soon after it is completed.

Phase Three

- Put the COST MODEL into a Decision Analysis [DA] format so that the assumptions and activities can be modified and rerun.
- Ensure the COST MODEL is easy to use so that it can be presented to JIP Member Companies for their future use.

Deliverables

The deliverable for this portion of the JIP will be an Issue-specific final report and a model which will include:

1. WELL INTERVENTION TABLE
2. PROCEDURES for key tasks
3. TIME AND COST to perform each of these tasks with the various vessel types under study
4. DA Model which allows modification to the assumptions and data, and is designed to be user-friendly.

ISSUE B
SUBSEA DECOMMISSIONING ISSUE B SUMMARY:
Is it Feasible to Provide MODU Capabilities for a Substantially Lower Price?

Concise Summary of Issue B to be Addressed

The best way to minimize risk when doing intervention work is to use the best tool for the job in all circumstances - especially considering unforeseen circumstances - which is a MODU. The drawback is high cost.

Background

The decommissioning industry has worked for years to establish the paradigm in which routine intervention work in deepwater can be done "from the back of the proverbial boat." This is an admirable goal, because using a MODU for all intervention tasks results in costs so high as to skew the economics of intervention work. However, there is one major utility in using a MODU: it offers all of the "tools" (wireline, coil tubing, ability to run drill pipe, full well control systems) which might be needed to deal with any unplanned event that might occur in an intervention situation. While expensive, this offers much comfort. Boat-based systems have many tools, but not all of those listed.

Many companies are offering "back of the boat" intervention systems at this time, and they are impressive feats of engineering. If you could say one thing about these systems it might be that as time passes, they all add capabilities such that they move towards the capabilities of a MODU.

What if a way could be found to give the industry MODU capabilities for "back of boat" pricing?

Discussion: Problems Encountered by Current State of the Industry

This initiative addresses the fundamental economic equation that governs intervention and decommissioning work: that the lowest-risk tool for the job (a MODU) is also by far the highest-cost method for the job.

If that equation can be altered in favor of more MODU capabilities for a lower cost, it could open new doors for deepwater intervention work.

Deliverables

This Issue will be defined by the following:

1. A report defining the method used to achieve a "lower-priced MODU"
2. A summary of approximate CAPEX required to make such a vessel operational
3. A calculation, most likely user-adjustable, to determine day rate based on this CAPEX

ISSUE C
SUBSEA DECOMMISSIONING ISSUE C SUMMARY:
Resins vs. Cements for Plug and Abandonment [P&A]

Concise Summary of Issue C to be Addressed

Cement has long been the standard of the industry for sealing annuli, especially for drilling new wells. However, there are several areas in which cement falls short in performance downhole. Although resins and their derivatives are viewed as expensive on a per-barrel basis, their different performance characteristics and shorter set-up time may make their use a relative bargain when viewed in the long term time frame needed for permanent P&A.

Background

Cementing is the time-honored method of drilling new wells. As the art of P&A has grown, cement remains the standard choice for most P&A work. However, resins have several areas in which their performance surpasses cement. These areas include:

- Filling in tight spaces between pipes that are off-center
- Sets up faster, saving rig time
- Channeling
- Voids
- Bond to casing
- Ability to accommodate future downhole pipe movement

However, the use of resin is still much in the minority in the market, primarily due to the perception that it is expensive.

Discussion: Problems Encountered by Current State of the Industry

Given that resins are viewed as new, different, and expensive, this study will assess the economics of using them from a long-term perspective that best fits P&A applications. In short, investigate how resins really compare to cement when the cost of the entire operation is considered.

Deliverables

1. A report listing the technical and practical advantages / disadvantages of various resins versus cements for PA work
2. An economic study of the "all in" costs of doing selected P&A tasks using resins versus doing the same tasks with cement

ISSUE D
SUBSEA DECOMMISSIONING ISSUE D SUMMARY:
Flowlines, Flushing, Taking Effluent, Disposal, Etc.

Concise Summary of Issue D to be Addressed

Evaluate options for flushing subsea components (flowlines, risers, umbilicals, flying leads, jumpers, manifolds) before recovery or abandonment. Determine best fluids for flushing and best practices related to treating the flushed fluids to deal with hydrocarbons and contaminants.

Background

All subsea components need to have hydrocarbons removed as part of the decommissioning process. The subsea tree and downhole tubing and casing are normally cleaned after recovery. Flowlines, umbilicals and subsea components such as manifolds are normally flushed while in place on the seafloor. These are sometimes recovered but may also be abandoned in place.

This initiative will investigate BSEE requirements for fluid compatibilities and pressures to preserve flowlines remaining on the seabed. It will include an evaluation of optional processing methods for flushing fluids and hydrocarbons remaining in tubing, flowlines, manifolds, jumpers and associated equipment.

Discussion: Problems Encountered by Current State of the Industry

Seawater is the common fluid for this service but other additives are sometimes used to improve the cleaning process and deal with contaminants. These additives should be listed and the benefits/negative Issues should be identified for all. There are a number of alternatives for cleaning the flushing fluids and these need to be evaluated. In addition, some of these additives may need to be removed before disposal of the flushing fluid back to the sea. Processing options for this removal will be identified. The issue of trapped hydrocarbons in the "layers" of flexibles will also be addressed.

Deliverables

1. A report summarizing the challenges of flushing, along with some potential methods and equipment that can possibly advance the state of best practices involved.
2. A list of possible alternative flushing fluids, mixes, and additives along with the primary pros and cons of each.

Special Note: See Issue H1

Issue D *deals with cleaning/flushing of pipelines and subsea infrastructure in existing subsea fields. Issue H 1 examines the concepts which might be added to future subsea systems to improve the abandonment process in the future.*

ISSUE E
SUBSEA DECOMMISSIONING ISSUE E SUMMARY:
Cement Bond Logging through Multiple Casing Strings

Concise Summary of Issue E to be Addressed

Drilling offshore wells, as done by multiple operators with differing philosophies, results in wells with varying cement conditions within the annuli between casing strings which makes every annulus in every well different. This fact is exacerbated by poor or nonexistent record keeping.

Background

In a subsea well, any annulus beyond the production annulus [space between production tubing and production casing] is generally inaccessible from either inside or outside the subsea wellhead. In an ideal world, the cement job in each annulus would overlap the cement job from the prior string. This ideal is not adhered to in a large number of wells. And, in a string where the optimum elevation of cement is reached, there may be quality of placement Issues such as porosity, voids, channeling, etc.

This situation results in the inability to trust the status of any annulus. Currently the only way to evaluate an annulus is to perforate or cut the inner wall of the annulus, usually casing, and evaluate what happens next.

Cement Bond Logs [CBLs] are very common, and they are quite useful. They offer the ability to back-check the quality and the elevation of the cement in an annulus. Unfortunately, a CBL can only be counted on to examine one annulus at a time. In other words, a CBL can only “see” through one wall of casing.

Discussion: Problems Encountered by Current State of the Industry

When entering a completed well, it is important to know as much as possible about every annulus in the well, not just the innermost one. Current bond log technology can assess the innermost cemented annulus only, and this is only if the tubing has been pulled from the well.

This study seeks to determine the current status of tools and downhole capabilities related to Bond Logging or locating cement in more than one annulus at a time, with the ultimate goal of inspecting all annuli in a well from inside the production tubing.

Deliverables

1. A report on the current status of the industry in determining the location and quality of cement in the annuli of existing subsea wells through multiple tubing/casing strings.

ISSUE F
SUBSEA DECOMMISSIONING ISSUE F SUMMARY:
Cutting of Subsea Casing and Tubing Strings: Alternatives

Concise Summary of Issue F to be Addressed

The best solution for plugging a well is to cut out casing and seal the entire wellbore “rock to rock”. In order to minimize cutting and pulling casing strings, an efficient method of cutting through all existing tubing, casing strings, control lines and power cables is required. This capability would be particularly useful if it could be performed from an intervention vessel, as opposed to a MODU.

Background

Current practice to ensure proper cement plugs are set is to cut tubing, downhole control lines/power cable, and casing strings. The section above the cut is normally removed from the wellbore. An alternative is to mill windows in the casing in order to circulate cement and plug the well, referred to as a “squeeze”. This method is not always successful. All of these activities require multiple trips and cost rig time.

Discussion: Problems Encountered by Current State of the Industry

The industry needs a low cost solution to cut control lines/power cables and cut through all tubing and casing strings. This would allow a true rock to rock cement plug be set with a minimum recovery of downhole components and minimize vessel time and the related cost.

Deliverables

1. A report on the current state of the industry to minimize the number of trips to cut through tubing and multiple casing strings as well as cutting downhole control lines and electric cables in the production annulus.

ISSUE G
SUBSEA DECOMMISSIONING ISSUE G SUMMARY:
Access to, or Remote Evaluation of Outer Annuli

Concise Summary of Issue G to be Addressed

Existing subsea wells predominantly have no access to any annulus outward of the production annulus. However, there can easily be conditions in any or all of these annuli that need to be addressed during decommissioning of the well. The annuli need to be evaluated and any problems mitigated.

Background

The method of construction of subsea wells (casing hangers stacked up within a high-pressure wellhead housing) prohibits access to the annuli between any of the casing strings. The only currently-proven way to analyze the conditions (pressure, flows of any kind) in any of the annuli of an existing well is to breach the casing from the inside by perforating, cutting, or milling, and then react to what happens. There are means to perforate more than one casing string at a time, but troubleshooting the evidence becomes far more difficult when multiple regions are open at once.

However, assuring that there are no problems within any of the annuli is very important in any P&A situation.

Discussion: Problems Encountered by Current State of the Industry

Annuli present great problems for intervention and especially P&A work. Due to widely varying cement quality, shallow flows or gas, spotty well records, and simple lack of accessibility, every single annulus must be viewed with some degree of suspicion until its condition is proven.

Endeavor plans to identify concepts leading to the ability to determine conditions within well annuli without destroying the casing as a barrier. This is expected to be in one of two ways:

- Determine ways of remotely sensing the conditions in the annuli
- Find another way into the annuli from outside or inside

Deliverables

1. A report documenting current industry capabilities and design efforts to allow sensing, in existing wells, of conditions in annuli without access, while maintaining annuli pressure integrity. This will include input from Endeavor personnel who have experience on this topic.

Special Note: See Issue H2

Issue G *deals with accessing, or sensing, annuli within existing subsea wells. Issue H2 separately examines the possibility that future subsea equipment can be developed to mitigate this problem in future wells.*

ISSUE H
SUBSEA DECOMMISSIONING ISSUE H SUMMARY:
Features needed in New-Manufacture Subsea Systems to Aid Future Decommissioning

Concise Summary of Issue H to be Addressed

One cause of the current state of technology within the subsea decommissioning industry is that subsea wells and subsea production equipment have historically not been engineered with decommissioning in mind. Now that the needs of decommissioning are becoming apparent, it is the time to spur the wellhead, tree, subsea equipment, manifold, umbilical and flowline/pipeline manufacturers to add features to aid the decommissioning effort in the future.

Background

Of the Issues outlined in the pages previous, two likely candidates to be greatly helped by installing equipment with new features are as follows:

- **Issue D**: Subsea system flushing, dealing with effluent, regulatory requirements and compliance for existing subsea systems
- **Issue G**: Annulus access to outer annuli of existing subsea wells

Discussion: Problems Encountered by Current State of the Industry

Issue H1 (related to "existing subsea systems" Issue D): Current subsea hardware designs are focused on installation and long term operational requirements. There is usually little consideration given to decommissioning of these components. Possible improvements could include flushing ports, monitoring points for contaminants, and ongoing monitoring programs for contaminants. Flexible components such as flexible pipe and specific lines in umbilicals, such as chemical injection, are difficult to flush because hydrocarbons can be contained in the "layers" of the pipe or umbilical and these hydrocarbons are released after the pipe is flexed, even though the line was already flushed. Also, plugged flowlines that cannot be cleared can create regulatory and procedure concerns about abandonment issues. Clearing plugs in flowlines, and the processes required to do so, would also be a point of discussion with BSEE.

Issue H2 (related to "existing wells" Issue G): Some of the reasons that subsea annuli are inaccessible is that the typical subsea wellhead (a) contains most if not all of the casing hangers for the well, and (b) is not penetrated by any feature through the all-important thick-wall pressure boundary, the subsea wellhead wall. Another major factor is that the prime area that might be used for access to all of the annuli is at the bottom of the high-pressure housing, "swallowed up" within the 30- or 36-inch surface casing housing.

Regardless of these problems, there is need for a device that would somehow fulfill the following:

- Seal reliably for the life of the well across several annuli
- Allow selective access to each of the annuli from the sea floor at a future date
- Said access point to survive cementing/jetting the 30- or 36-inch string and all drilling and completion activities
- Device to satisfy 2-barrier requirements
- ROV stab or access presumed

Deliverables

1. A report with suggested modifications to existing subsea production hardware - or systems - which would improve decommissioning tasks. This will include possible ways to add these improvements and pros/cons of each modification.

Special Note: Issues beyond H1 and H2

While these are two leading areas in which study is being done herewith, it is recognized that there are many areas in deepwater OEM equipment capable of being improved relative to ease of decommissioning. Endeavor intends to capture any such ideas that arise during this JIP and report back to the member companies with a list of all ideas worthy of further investigation.

ISSUE I

SUBSEA DECOMMISSIONING ISSUE I SUMMARY:

Methods to detect, measure and remove volatile metals/contaminants remaining in subsea equipment and downhole components

Concise Summary of Issue I to be Addressed

The earlier that one can detect volatile metals (mercury and arsenic) as well as NORM (Naturally Occurring Radioactive Materials) in the decommissioning process, the better. Early detection allows measures to be taken to deal with these contaminates before they cause cumulative exposure effects on worker health and safety and complicate decommissioning operations. In addition, these substances must be handled and disposed of in safe and effective fashion based on final disposition (i.e., continued use such as for high value equipment or metals recycling).

Throughout the oil and gas industry, the impact of mercury and arsenic in produced hydrocarbons is becoming more of an emergent issue. This includes unconventional resource plays (shale gas and coal bed methane plays) but also for conventional plays as they near the end of their economic production and as process systems require decommissioning.

Produced mercury ultimately contaminates hydrocarbon processing equipment and transportation systems (i.e., production platforms, gathering platforms and subsea pipelines). The dismantling, removal and disposal of which presents unique challenges and risks to decommissioning personnel and to marine ecosystems. Global conventions provide guidance for decommissioning of oil and gas facilities in international waters, but specific regulations with regard to residual mercury concentrations in production systems (either as scale or complexed in the grain boundary of metals) is not currently available.

Oil and gas companies across the globe are faced with significant decommissioning challenges including but not limited to operators in the Gulf of Mexico and the Gulf of Thailand. Particular attention should be considered in decommissioning strategies for process systems previously or currently exposed to mercury contaminated hydrocarbon streams. Two key considerations required for development of safe decommissioning strategies (including decontamination) are: 1) an understanding of the nature and distribution of mercury along with depth profiles in pipelines and process equipment and 2) consideration of mercury decontamination goals, such as establishment of criteria for measuring performance and completion of the decontamination.

Assessment

Decommissioning pre-planning should consist of attempts to determine the extent and type of contamination present in subsea components, pipelines and process systems. This study will discuss methods of sampling and analysis of process streams during production and in situations where production has been shut-in.

Chemical Decontamination in Preparation for Reuse or Decommissioning

The study will consider chemical decontamination planning and the determination of objectives and establishment of measurement performance criteria. Criteria that might be applied to pipeline decontamination are not strictly established or based on existing regulatory requirements. Some may be based on regulations such as decontamination for disposal or recommendations and conclusions from an environmental impact assessment. Most criteria applied to decontamination efforts are based on those established by companies for safe decommissioning and thus related to safety and environmental impact.

The study will identify temporary measures for systems that may go back into service after some period of time as well as those needed for permanent decommissioning of production systems (subsea pipelines/hardware that will be abandoned post decontamination and subsea components which are recovered for metals recycling). This is in part, because most chemistry that is used to oxidize or otherwise remove contaminants from the scale oxide layer and into the steel profile is not suitable for use in equipment going back into service

Endeavor and alliance partner PEI will identify the current state of technology and solutions today required for the many complex mercury, arsenic and NORM decommissioning issues facing the industry tomorrow and in the near future.

Deliverables

1. A report documenting the current status of the industry in measuring the amount of mercury, arsenic and NORM in place before beginning subsea decom and subsea well P&A activities. The report will also provide information on methods to deal with these metals and contaminants prior to recovery and then after bringing components to the surface for reuse or disposal.

ISSUE J

SUBSEA DECOMMISSIONING ISSUE J SUMMARY:

Current Status of Riserless Deepwater Coiled Tubing Intervention

Concise Summary of Issue J to be addressed

This initiative will research and gather information on the current state of riserless, sometimes referred to as open water, coiled tubing intervention systems. For this study, riserless coiled tubing pertains to a system that operates from a vessel and has the capability to intervene within a subsea wellbore without the use of a riser from the vessel to the subsea tree.

Background

Historically, subsea well intervention operations have been limited due to the high costs of MODU based systems. The advent of riserless well intervention (RLWI) vessels have opened the door for more cost effective intervention options. However, these RLWI based systems are currently limited to slickline and electric wireline operations. A coiled tubing system would dramatically improve the services available on a RLWI vessel, bridging the gap between RLWI and intervention riser systems. This system can also be run from a MODU without the use of a drilling riser and subsea BOP. By providing a conduit through which fluids can be pumped, a wide range of intervention-based services could be conducted using a cost effective vessel. However, there are several technical challenges facing riserless coiled tubing intervention systems, some of which include:

- Vortex Induced Vibrations on the coiled tubing
- High cycle fatigue, coiled tubing reliability
- Disconnect / drive off concerns
- Wellbore fluid return handling
- Vessel deck space, need for custom vessels

Discussion

Currently, there are no coiled tubing riserless based systems operational. However, there have been many companies who have developed preliminary designs as well as several companies currently pursuing an economic system. This initiative will summarize the current status of systems in development, supporting services, as well as address the challenges that will face these systems. A general discussion of the ongoing methods being used to overcome these technical challenges as well as how the success of these methods will be monitored will be included. Additionally, the potential services that can be employed by riserless coiled tubing systems as it pertains to decommissioning and general well intervention will be included, such as the ability to perforate and squeeze upper annuli, wellbore cleanouts and well fluid circulation operations.

Deliverables

This Final Report will provide for the following:

1. Summarize current status of subsea coiled tubing intervention systems and related products and services
2. Discuss concept challenges and benefits for the operator including potential in-well service capabilities.
3. Identify anticipated vessel requirements based on conceptual and current designs

SUBSEA DECOMMISSIONING ISSUE K SUMMARY:
Benefits of in situ Subsea Hardware Abandonment

Concise Summary of Issue K

There have been multiple studies done on a variety of topics regarding the ecological benefits of subsea structure, however, very little has been done to summarize and focus this research into a concise format from which regulators and industry can make decisions regarding the complete or partial decommissioning of deep water subsea hardware.

The goal of this proposal is to assemble and summarize the available relevant research and literature into a report that details the ecological value to leaving subsea hardware such as pipeline terminations and manifolds on the seafloor in water depths up to 7000 ft. The focus will be on the GOM in water depths greater than 3,000 ft. as there exists, for water depths less than 3000 ft. significant amounts of global and GOM data plus existing BSEE approvals, based on ecological benefits, to "Decom-In-Place" subsea equipment in less than 3,000 ft. water depth. Existing data for water depths less than 3000 ft. will be used to baseline Marine Life on "Decom-In-Place" subsea equipment and then compare existing or to be collected Marine Life bio mass data in water depths greater than 3000 ft.

Background

When production from a subsea field ceases, the subsea hardware between the subsea trees and the host must be flushed. In shallow water, subsea structures are usually recovered unless they are below the seafloor, such as pipelines and umbilicals, are normally recovered. In deeper water, stakeholders must come to an agreed upon understanding in regards to whether leaving these bottom structures in place serves the economic and ecological goals better than recovering these structures. This initiative will evaluate the ecological values associated with allowing deep subsea hardware to remain in situ on the seafloor.

Decommissioned subsea hardware which is left in place may potentially enhance biological productivity, improve ecological connectivity, and facilitate conservation/restoration of deep-sea benthos (e.g. deep-water corals) by restricting access to fishing trawlers. Although comparatively rare in the deep ocean, benthic reefs are critical to ecosystem function, and have become progressively limited by human activities. Pipeline terminations, manifolds and other hardware found on the seafloor may provide additional habitat in the form of complex hard substrata and thus an opportunity to create and enhance deep-sea artificial reef complexes on unprecedentedly large scales. In addition, recovery of existing hardware might be detrimental to any corals and marine life which were proliferating from these structures since their original installation.

There is however, the potential for negative impacts which could include physical damage to existing benthic habitat due to undesirable alterations in marine food webs, facilitating the spread of invasive species, and releasing contaminants as the structure corrodes with time.

Our principle investigation will involve a summary report of the available research regarding the topic of deep sea benthic utilization of in situ sea-floor hardware and a summary, methodology and scope for topics requiring additional research in order to finalize a more definitive and comprehensive ecological review.

In addition, an effort will be made to locate existing reports documenting corals and marine life which are already being supported by deep water subsea structures.

Proposed Scope: Benefits of in situ Subsea Hardware Abandonment, Issue K

Stage One

- Task work will begin on Wednesday, March 30th, 2016.
- Summarize all available research on the topic of deep sea benthic utilization of in situ sea-floor hardware
- Request existing documents from Member Companies to identify existing benthos on subsea structures in depths greater than 3,000 feet. This could include finished reports such as Case Studies, EIA Reports, and White/Positon Papers related to the ecological impact to marine life due to the "Decom-In-Place" of subsea equipment in greater than 3000 ft. water depth. This could include any documentation which the Member Company considers to have valid evidence related to this subject. These reports are needed by April 13th so they can be included in the draft report.

Stage Two

- Joint discussions with JIP Member Companies Subject Matter Experts (SMEs) to support the research summary conclusions and data gaps.
- Draft submission of report on April 22nd, 2016.

Stage Three

- Submission of final ecological report and summary scope for future research investigations, including considerations gathered from discussions with SMEs.

Deliverables

The deliverable for this portion of the JIP will be an issue-specific final report which will include:

1. A report detailing the literature reviewed and the ecological value of leaving subsea hardware on the seafloor in water depths of up to 7000ft
2. Recommendations, methodology and scope for topics requiring additional research in order to finalize a more definitive and comprehensive ecological review.
3. Recommendations of additional work beyond the scope of this initiative which will include an estimate of time and cost for topics requiring further research
4. Presentation at the final meeting with all Member Companies

APPENDIX A
SUBSEA DECOMMISSIONING PROJECT
BIOGRAPHIES – SUBJECT MATTER EXPERTS

Bruce Crager – Executive Vice President, Expert Advisory Group
Bruce Crager is Executive Vice President of Endeavor Management and leads the firm's group of Expert Advisors which have a focus on Offshore, Subsea, and Marine activities. He has 40 years' experience in offshore drilling and production, primarily in management positions. This has included significant experience evaluating and providing all types of field development solutions, particularly those based on floating production systems and subsea production equipment. Bruce joined Endeavor in 2010 and is responsible for the development of an experienced team to support clients in the areas of strategy development, organizational change/development, decision analysis, and in technical areas such as field development planning and operational improvement. Since joining Endeavor, Bruce has consulted for many clients, including Addax Petroleum, Afren, Audubon Engineering, Barra Energia, Cal Dive, Cameron, ENI, Maersk Oil and Gas, Petrobras, Pemex, Ridgewood Energy, Shell, and VAALCO Energy. Bruce holds a BS in Ocean Engineering from Texas A&M University and was selected as a Distinguished Graduate of TAMU's Zachary Department of Civil Engineering in 2008. He also holds a MBA from the University of Houston, has co-authored 4 patents, and has written numerous technical and management articles.

Keith Caulfield – Operations Advisor, Decommissioning JIP Study Team Lead
Keith Caulfield has extensive experience in both the upstream and downstream oilfield arenas. This includes design experience in offshore and deepsea structures, pressure vessels, and oilfield mechanical engineering, such as subsea wellheads and subsea trees. He is named on four US patents or patents pending. He has management experience in offshore field development, environmental processing, drilling tools, subsea equipment refurbishment, and subsea well intervention. He knows fabrication and manufacturing processes and systems, and has set up three separate engineering departments in startup situations. He has run workshop operations for both manufacturing and rental tools.

ISSUE A: Economic model for Intervention Vessel Options
SME: Tom Stroud – Senior Advisor
Tom Stroud has over 30 years of drilling and management experience in both the international and domestic oil and gas arena. His extensive global background includes the successful execution and management of drilling projects in Mexico, Venezuela, United Kingdom, Netherlands, Middle East, Southeast Asia, Africa, Canada, New Zealand and the Gulf of Mexico (deepwater). Tom was previously Vice President at Halliburton with responsibility for Directional Drilling and Logging While Drilling (LWD/MWD) products and services, a business that Tom was instrumental in spinning off from Halliburton as PathFinder Energy Services. Tom served as the first President of PathFinder. Tom holds a Bachelor of Science in Petroleum Engineering from the Louisiana State University (1977) and is a member of Society of Petroleum Engineers and American Association of Drilling Engineers.

SME: Jerry Lieberman, PhD – Senior Advisor

Dr. Jerry Lieberman has assisted clients for more than 18 years making major strategic decisions and planning their implementation. Working in diverse industries, including oil & gas, IT, manufacturing, and automotive, he has helped leadership teams develop and implement strategies for oil field development, technology selection, cost reduction, new work processes, IT services, new product development, and new business models. His focus has been to help clients make and implement major, value decisions in spite of uncertainty and ambiguity. This includes facilitating clear structuring of the problem and alignment of the stakeholders, bringing strong analytical skills for development of a quantitative understanding of business value creation, developing the story and communication of business value to stakeholders, providing planning/strategic guidance for strategy value realization, managing the project team, and maintaining relationships and clear communications with senior level management. This results in integrating the value story with needed actions for implementation. His skill sets include probabilistic financial modeling, problem framing/structuring, facilitation, interviewing, and developing cogent presentations. His most recent work has been consulting in the oil & gas and IT industries, but he also has extensive prior marketing and planning experience at the Director level in the auto industry.

SME: Wendell Olivier – Senior Advisor

Wendell Olivier is an upstream technical advisor on exploration and asset development projects with emphasis on organizational capability, technical optimization, and project execution. Wendell has 35 years' experience with Gulf/Chevron, Addax Petroleum, and Dripping Rock Oil and Gas Consulting in nearly all major producing regions around the world. His areas of upstream E&P expertise include the U.S., Middle East, Latin America, Far East, Africa and Europe. He held various technical and managerial positions with Gulf/Chevron for 27 years, followed by 5 years as a senior manager with Addax, and 3 years as an independent Consultant. Wendell has broad oil and gas exploration and production experience including: global exploration and new venture evaluation, reservoir management, conventional and unconventional resource evaluation, geological and geophysical evaluation, annual budget preparation, and reserves reporting. Nearly 20 years of experience in international exploration/production projects. He holds a Bachelor of Science in Geology from Nicholls State University and Master of Science in Geology from Idaho State University.

ISSUE B: Is it Feasible to Provide MODU Capabilities for a Substantially Lower Price?

SME: Jitendra Prasad – Senior Consultant

Jitendra (JP) Prasad has over 40 years of experience in design and fabrication of mobile offshore drilling units including Jack ups, Semi-Submersibles, Drill ships, Lake Maracaibo Drilling Barges & Swamp Drilling Barges. Design TLP/SPAR. He has over 8 years of experience managing several companies, providing leadership and solutions to clients. He has extensive experience in designing, procurement, fabrication, contract negotiation for projects in Oil & Gas sector as well as enhancing existing rigs to upgraded capacity. Additionally, he has extensive experience in designing offshore platform – transportation, launch/upending and in-situ analysis including strength, fatigue for platform subjected to wave, wind and seismic loads. Moreover, he has experience in riser and mooring system design and selection of equipment. JP was an integral part of the original team designing the SEDCO 700, SEDCO 600 and MSVs. He led the team converting the Noble's submersibles rigs into ultra-deepwater semi-submersibles and has led many teams for designing, procurement, fabrication and commissioning new and converted drilling equipment for the offshore industry.

ISSUE C: Resins vs. Cements for Plug and Abandonment [P&A]
SME: Mike Cowan – Senior Advisor

Mike Cowan has 38 years' experience working for operator (31 yrs.) and for an integrated service company (7 yrs.) in well construction and production technology, with a unique blend of operations, engineering and research skills. His specialties include Cementing (primary), loss circulation (primary), drilling fluids, well stimulation, profile control and coatings. He holds 50+ U.S. Patents in cementing, zonal isolation, loss circulation, coatings, expandable tubulars, drilling fluid additives and chemical wellbore lining/strengthening and over 12 pending patent applications. Mike's capabilities include: innovate, develop, deploy and support technology from R&D to the well; develop and implement strategy for IP, commercialization, and deployment, manage global drilling fluids and cementing business, develop relationships with third parties for commercialization and deployment; lead and contribute to multi-discipline problem solving technical teams; analyze complex data sets and develop algorithms and correlations for decision-support and technology transfer; and training courses -- develop and teach advanced technical courses in primary and remedial cementing, loss circulation, innovation.

ISSUE D: Flowlines, Flushing, Taking Effluent, Disposal, etc.
SME: Julie Ingram – Senior Consultant

Julie Ingram is highly experienced in the offshore and energy industries, including offshore pipeline design and installation, business development, engineering management, and project management. She provides a broad base of world-class experience and knowledge in the areas of subsea and project management, including a specialized focus on the design, engineering, manufacture, and installation of flexible and rigid pipelines and all associated hardware. Her current clients include Alpha Petroleum Services, providing support to AWE Limited and Sonde Resources; and Alpha Deepwater Services, providing support to Pemex. She gained extensive project management experience during her 12 years' tenure at Technip. Julie earned a Master of Science in Mechanical Engineering from University of Houston and a Bachelor of Science in Mechanical Engineering from University of Texas.

SME: Jay Hachen – Senior Consultant

Jay Hachen has over 40 years' experience managing onshore and offshore operations and projects, both domestically and internationally. He has deep experience in conceptual design and project strategy for deepwater projects aimed to optimize risk, cost, and schedule. Capabilities include the management of projects from concept development through start-up. He is a qualified expert advisor for vendor qualification, specification, bidding, evaluation, and award of contract, in addition to contract negotiation and management. He has extensive hands-on experience for full asset life cycle including decommissioning. He holds a Mechanical Engineering degree from Rensselaer Polytechnic Institute.

ISSUE E: Cement Bond Logging through Multiple Casing Strings

SME: Tom Stroud – Senior Advisor (bio listed Issue A, above)

SME: Lawrence Rogers – Senior Advisor

Lawrence Rogers has over 43 years of experience of well logging experience, both for onshore and offshore operations. This includes conducting field logging operations, managing logging operations, interpretation of both open hole and cased hole logging results, both domestically and internationally, consulting with operators in the design of proper logging programs for evaluation, completion, and workover operations. He has been involved in developing applications for logging services, developing interpretation models for open and cased hole logs, and assisted in designing better field techniques and procedures, especially for pulsed neutron and cement evaluation services. He is also experienced in computer aided interpretations and has taught in the Schlumberger learning centers. Lawrence worked for Schlumberger for over 41 years before becoming a consultant. He received his Bachelor of Science in Mechanical Engineering from Lamar University in 1972 and has co-authored three SPWLA technical papers.

SME: James Wakefield – Senior Advisor

Jim Wakefield has over 34 years' experience in the oil and gas industry. He brings senior level expertise to projects including strategic planning, offshore subsea development, engineering and operational support, production management, and project evaluation. Operations engaged range from well completion/workovers, normal and abnormal pressure frac-packs, HPHT completions, subsea completions and international drilling. He has worked on rigs such as land, platform, semisubmersibles and drillships in water depths up to 2800 m. Jim's vast international involvement has been in Algeria, Australia, Columbia, Cote d'Ivore, Gulf of Mexico, Kurdistan, Malaysia, New Zealand, Nigeria, and Tunisia. He is a registered Professional Engineer in Louisiana and received a Bachelor of Science in Petroleum Engineering from the Colorado School of Mines in 1981.

ISSUE F: Cutting of Subsea Casing and Tubing Strings: Alternatives

SME: Tom Stroud – Senior Advisor (bio listed Issue A, above)

SME: Robert Colwell – Senior Advisor

Robert Colwell has over 14 years of experience comprising of both engineering and operational management in drilling and completions and is a licensed professional engineer in the State of Texas. Robert has worked both conventional and unconventional projects as a supervising engineer and as a field engineer. Projects include those in deepwater (GOM and Angola, Africa), shelf GOM, Louisiana inland waters, Pinedale anticline in Wyoming, Haynesville shale in North Louisiana and the Eagleford shale around College Station, Texas. Robert holds a BS degree in Petroleum Engineering from Montana Tech of the University of Montana.

SME: James Wakefield – Senior Advisor (bio listed Issue E, above)

ISSUE G: Access to, or Remote Evaluation of Outer Annuli

SME: Bob Helmkamp – Advisor

Bob Helmkamp has over 30 years' experience in the E&P business, developing oil and gas fields in a variety of environments. He has particular expertise in subsea developments. His far-reaching project management experience includes various engineering management roles in subsea systems, overseeing subsea hardware, flow assurance, project delivery, subsea controls, and umbilicals groups. For several years, Bob was Shell's Global Subsea Engineering Discipline Leader. In this role, he was responsible for defining and building the subsea skill-pool within the global organization. Bob also has experience in production, completions, and well surveillance in onshore fields. This includes experience working in stream-flood projects in California, and oil and gas fields in midcontinent USA. For the past 13 years, Bob has travelled extensively in support of projects and personnel outside of the United States. His primary areas of major project delivery include Nigeria, Malaysia, and Brazil.

SME: Vince Vetter – Project Advisor

Vince Vetter is an experienced executive leader (35+ years) with P&L responsibility. Some of his positions include Senior Vice President – Australia and New Zealand; Vice President – Marine Pipeline Systems; Vice President – Subsea Systems. He has managed departments of project managers and consulting / project / design / manufacturing engineering, and also QA & QC groups and has expertise in subsea production systems as well as hands-on experience with the design and installation of subsea equipment, drilling tools and systems, pumps, valves and oilfield tubulars.

ISSUE H: Features needed in New-Manufacture Subsea Systems to Aid Future Decommissioning

Issue H1 (related to "existing subsea systems" Issue D)

SME: Julie Ingram – Senior Consultant (bio listed Issue D, above)

SME: Jay Hachen – Senior Consultant (bio listed Issue D, above)

Issue H2 (related to "existing wells" Issue G)

SME: Vince Vetter – Project Advisor (bio listed Issue G, above)

SME: Bob Helmkamp – Advisor (bio listed Issue G, above)

ISSUE I: Methods to detect, measure and remove volatile metals/contaminants remaining in subsea equipment and downhole components

SME: Ron Radford – Operations Advisor

Mr. Radford has over 19 years of environmental consulting, remediation and industrial experience, providing services for energy and commercial clients with a primary focus on the energy sector. He has managed multi-task, multi-discipline industrial projects and regulatory programs for energy clients, negotiating favorable agency compliance with various regulatory agencies. His experience includes business development, project estimating (Construction Link™ Estimating Software) and proposal development, project scheduling, project management, and contract administration. He served as Vice President of Operations for Measurement and Monitoring Solutions, LLC (MMS) (recently purchased by PEI) where his team was responsible for researching and developing chemistries for the removal and suppression of mercury and mercury vapors associated with hydrocarbon processing systems. He is responsible for managing projects/programs including remedial construction, facility decontamination, regulatory compliance programs, chemical cleaning, toxic metals sampling and analysis, technology evaluations, and remediation technology development. Recently, Mr. Radford has been involved with various energy sectors and has provided services to upstream, midstream and downstream energy clients both on-shore and off-shore developing toxic metals and mercury management solutions and chemical decontamination processes for surfaces, equipment, and hydrocarbon processing systems. He has extensive experience providing comprehensive toxic metals management services for energy clients, managing sampling and analysis programs along with managing chemical cleaning and chemical recovery programs at gas compressor stations, midstream plants, pipeline distribution networks, and refineries. Other recent experience includes several recent geo-construction and remediation projects that include cap construction, demolition, wastewater treatment, stabilization, and cell construction.

SME: Darrell Gallup, PhD – Senior Consultant

Dr. Gallup has over 36 years of experience in the petroleum industry. His experience is in production optimization, production chemistry, production geochemistry, oil and gas production, flow assurance, geothermal production water treatment and environmental consulting. He is an internationally recognized authority on mercury and selenium. His "hands on" problem solving and process development philosophy (Laboratory → Pilot → Demonstration → Commercialization) has delivered an impressive track record of success in solving complex process chemistry and engineering problems. He has been employed by Texaco, Unocal and Chevron, and is currently consulting to the petroleum and geothermal industries. Dr. Gallup is the author of 58 USA patents and many foreign counterparts. He has published 89 technical papers and 5 book chapters.

ISSUE J: Methods to detect, measure and remove volatile metals/contaminants remaining in subsea equipment and downhole components

SME: Jason Skufca – Project Advisor

Jason Skufca has 20 years of experience in well intervention working for both a Baker Hughes and ConocoPhillips. His expertise in coiled tubing spans conventional and unconventional completions, deepwater, and drilling. His global work experience includes projects in the US, Canada, Argentina, Brazil, Australia, Venezuela, Mexico, UK, Norway, Indonesia and Poland. Jason is well respected in the coiled tubing community, having served as Senior Chairman of the international board of directors for the Intervention and Coiled Tubing Association, ICoTA. Additionally, Jason serves on the SPE committee for the national ICoTA conference held annually in Houston. He holds a BS degree in Civil Engineering from Texas A&M University.

ISSUE K: Ecological Value Summary of an in situ Subsea Hardware Abandonment Strategy

SME: Emily Callahan – Project Scientist, Coastal Environments

Ms. Callahan is a Project Scientist at Coastal Environments, with expertise in ecological evaluations of offshore resources, kelp forest and lagoon restoration projects and studies, and biodiversity baseline management studies. She has worked in the field of environmental consulting for over 4 years and conducted both international and domestic environmental impact assessments for governmental agencies and private sector clients, her key industry of expertise is in offshore oil and gas development and decommissioning. Ms. Callahan has had diverse marine and terrestrial field sampling as well as monitoring program experience including over 400 miles of contiguous sediment core and biota sampling in support of sediment and biological investigations for British Petroleum. During her time at

Scripps Institution of Oceanography she conducted a rarity analysis of fish survey data for the REEF volunteer survey project- this analysis was used to present a comprehensive picture of the rarity and distribution of select species in the tropical Western Atlantic. Prior to her graduate studies at Scripps Institution of Oceanography, she worked as a field technician on the BP 252 Oil Spill in the Gulf of Mexico. This is where she witnessed first-hand the destruction and devastation wrought by an oil spill. However, it is also where she learned of a unique silver lining to the reality of offshore oil and gas development, the Rigs to Reefs program – a program that worked to preserve the ecosystems thriving beneath the surface. She is a PADI certified Dive Master and an AAUS Scientific Diver with over 1000 hours of logged dives.

SME: Amber Jackson – Project Scientist, Coastal Environments

Ms. Jackson is a Project Scientist at Coastal Environments, specializing in ecological evaluations of offshore resources. She is an oceanographer from Scripps Institution of Oceanography dedicated to the study of the ecological and economic value of re-purposing offshore structures as artificial reefs. Ms. Jackson's expertise is unique, using technology to facilitate to intersection of science and communication. A former Ocean Curator at Google, she engineered and launched intelligent map layers in Google Maps that distill and relate complex concepts in ocean science for a variety of audiences. She also assisted in the construction of the virtual seafloor found in Google Earth by collecting, analyzing and editing multi-beam bathymetry and acoustic backscatter data from NOAA's National Geophysics Data Center (NGDC).

SME: Hany Elwany, Ph.D. – Engineer, Oceanographer, Hydrologist, Coastal Environments

Dr. Elwany is founder of Coastal Environments, a unique multidisciplinary oceanographic and engineering consulting firm comprised of more than thirty experienced, independent professionals who work as a team and specialize in a variety of interrelated technical services. Dr. Elwany has extensive experience with nearshore oceanography, coastal processes, coastal engineering, and estuarine dynamics. He was the principal investigator for the physical oceanographic program of one of the largest environmental studies ever conducted on the U S west coast (at San Onofre). He has conducted in-depth studies of Nile Delta erosion, particularly since the construction of the Aswan Dam. His experience also includes projects involving optimization, numerical modeling, structural dynamic analysis, design of offshore structures, and data analyses, simulation, and dynamic modeling of ocean and coastal conditions. As an educator, both at Liverpool and Alexandria Universities, he taught courses in dynamics, statistics, numerical analysis, computer applications, and maritime engineering.