Decommissioning Joint Industry Project [JIP] Proposal
Phase II: Plugging in the POWER TOOLS

Submitted by Endeavor Management

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BACKGROUND

There is a demonstrated need for both technical progress and innovation in all other non-technical aspects of the decommissioning industry. The number of offshore wells in both shallow water and deep water increases yearly, while at the same time, regulatory pressures force heavier financial burdens on operators and decommissioning of non-producing fields.

During this time of change in the industry, Endeavor Management executed a Subsea Decommissioning Joint Industry Project [JIP] in early 2016. The JIP was initiated as a result of recurring questions arising from a 2014 Petrobras-funded study by Endeavor Management on subsea decommissioning benchmarking and best practices worldwide. Featuring a stellar cast of Member Companies, both operators and service providers, this JIP was entitled "Stocking the Decommissioning Tool Kit." Eleven issues were studied, varying in focus from economic tools and comparisons, to state-of-the-industry technical surveys.

The 2016 JIP was favorably received by not only the 12 JIP Member Companies, but also the decommissioning industry as a whole. However, even as the results of the JIP – hereinafter called "Phase I" – were published to the industry, the industry was evolving. Three distinctive trends, two of which were regulatory-related, emerged in the year 2016 for decommissioning operators:

- The U.S. regulatory need for operators with offshore wells to commit to certain financial safeguards such as bonding in order to protect taxpayers.
- BSEE investigations into regulations affecting the abandonment of pipeline and flowline related equipment on the deep seabed. (Is there a way to demonstrate, consistent with regulatory requirements, a transparent, scientifically defensible, and systematic approach to offshore decommissioning that maximizes ecological and human use benefits to the public while managing site risk and cost?)
- The continuing realization that effective decommissioning involves decisions which affect safety and the environment for long, geologic time frames. This dawning enlightenment illuminates nearly every area of the industry, but none so much perhaps as well Plugging and Abandonment (P&A).

SITUATION

After the Phase I JIP was completed, Endeavor Management has become aware of potential breakthroughs – from both industry and academia - in an area of intense interest to the decommissioning industry:

> The existence of a tool for evaluating and making decisions regarding overall environmental impacts and benefits of decommissioning activities. Note this includes not only human impact on the environment but also the environment's impact on humans. This comparative assessment tool is called NEBA, Net Environmental Benefits Analysis, and can provide a transparent, systematic, and scientifically defensible yardstick of measurement for analysis and decision-making relative to environmental issues. [Please see "ABOUT NEBA" below]

Although the Phase I JIP provoked discussion in many areas, two issues from the Phase I JIP have resonated with Member Companies and general industry people alike:

- The potential for use of resins as a primary means of zonal isolation in well P&A. Resins offer game-changing improvements over cements in many well situations and have potential to become the primary barrier mechanism for the long-time frames sought in decommissioning and P&A. However, they suffer from two disadvantages, both of which can be remedied with reasonable industry effort:
    - Resins can be custom-formulated to a myriad of uses. This is at once their advantage as well as their downfall: It takes industry-wide education to know how to effectively formulate the many options, and the industry is woefully under-educated at this point.
    - Resins have not been systematically tested to prove their long-term durability in well situations downhole. Even though this is also true of cements, it still would be wise for the industry to undertake such a resins testing program. There are reports of plans for testing epoxy resins by companies in the industry. It would be a good first step to also define the game plan for testing the other major resin types.
- A study was performed in Phase I dealing with the deep seafloor [greater than 3000ft / 1000m] environment. While this work can only be viewed as a first step toward understanding of the issue, early indications pointed toward this possibility: It may well be the best thing for many pieces of subsea equipment [PLETs, PLEMs, SUTAs, and other field-development hardware] to leave them in place ["in-situ"] for abandonment. There are several reasons for this, and they run somewhat counter to the public's common sense. Of course, this may not apply for every locale in the world, but it may well apply in a large number of areas across the world including the Gulf of Mexico, North Sea, and Southeast Asia including Australia. However, the data set supporting this theory is small; the theory is as yet unproven; the science behind it needs to be more fully supported with evidence. To achieve progress towards this goal, the following are proposed for Phase II:
    - Conduct NEBA pilot evaluations for various types of offshore decommissioning projects to demonstrate the ecological and human use net benefits associated with allowing offshore infrastructure to remain in place relative to alternative remediation and/or removal.
    - Pursue with the industry a means to unlock existing seafloor data in appropriate water depths by releasing older or mature project data from the shackles of Tight Hole restrictions, NDAs, and other contract requirements that have been made less important by the passage of time.
    - Propose a plan for the common storage and access of deepwater seafloor data for use by the industry to advance environmental causes; hopefully such data will support the emerging theory on in-situ abandonment.
    - Develop a means for future deepwater seafloor data to be gathered in opportunistic fashion with as little cost to the industry as possible.

ABOUT NEBA

Why is the concept of NEBA so potentially powerful for the Decommissioning industry? After all, some might say, isn't it simply one of several Comparative Assessment Tools in use for making decisions

relative to the environment? There are several answers to such a question, and a brief introduction to NEBA is in order.

Within the field of practical environmental analysis, the methodology of Comparative Assessments [CA] is not new. And, there is not a single universal tool that companies use to achieve Comparative Assessments. NEBA is one tool that can be used to perform a CA; there are others. However, there are some factors that make NEBA especially worthy of consideration for any person or company needing to make environmental decisions in the offshore decommissioning context:

- NEBA is a "best-in-class", groundbreaking tool with a long history of development and beneficial improvements. Its origins were in the 80's as an ad hoc response to a catastrophic oil spill. Decisions needed to be made as to how to restore beaches, seaside habitats, and marine life with best results. This intense effort started out as a learning process, developed under intense pressure, for how to make the best possible decisions about environmental issues, and then evolved into NEBA.
- From these early beginnings, some of the personnel involved in developing this tool kept on top of its progress, eventually producing the sophisticated NEBA system.
- While there are other tools available, NEBA has been described by environmental insiders as a Ferrari in comparison with compact sedans, but with a reasonable price tag and reliable results.
- NEBA enables effective decision making in consideration of all of the five classical areas to consider for decommissioning, including:
    - Possible habitat contamination / pollution
    - Cost to perform the environmental work
    - Worker safety and health exposure risk
    - Technical feasibility
    - Effects on human activity such as fishing/trawling and navigation
- NEBA makes most effective use of its methodology. A key unit of measure in NEBA's comparative assessments is called an "Ecosystem Service Unit." It is not a unit of any currency; rather, it is a unit of comparison that allows ***effective, repeatable, and consistent*** comparison between the various areas of interest listed above.
- Previous use of NEBA for decision-making has demonstrated the simple and easily-interpreted comparison summaries, which give powerful direction to managers and decision-makers. Decisions made using the NEBA tool have proven to be plainly scientifically-based, defendable, rational, common-sense and easily communicated.
- The three NEBA pilot evaluations within this JIP Proposal have been carefully chosen to give the maximum benefit to Member Companies. The Deepwater GoM study will have application to many other projects with minimal duplication of effort. The North Sea jacket example will show the dramatic common-sense results of wise comparative assessment using the NEBA tool under OSPAR regime, and will spur lively discussion between the industry and its regulators. The North Sea study on subsea kit in shallow water will powerfully show the differences in the recommended environmental course of action between:
    - Jacket and accompanying subsea kit, even when at the same location and in identical water depth
    - Subsea kit in shallow water versus similar equipment in deep water

STRATEGY FOR PHASE II: "POWER TOOLS"

If the Phase I Decommissioning JIP was a metaphorical "Tool Kit" in which many subjects were studied, think of Phase II as a set of "Power Tools" which can be ever more useful to the industry, offering tangible means for the industry to:

- Gain better predictability for decommissioning costs, and be able to credibly demonstrate these cost predictions to regulators. This issue can result in real savings to operators in the form of reduced financial obligations.
- Demonstrate the ability to evaluate the environmental aspects of oilfield subsea decommissioning work in a systematic fashion, in a way that is credible, objective, and repeatable for both operators and regulators. This issue can result in badly-needed clarification of the environmental obligations that operators face as they move forward with decommissioning plans. As such, this could result in significant reductions in decommissioning costs while demonstrating greater benefits to the public.
- Advance the onset of resin use for long-term zonal isolation by taking the first step toward their widespread adoption. This issue can result in a positive step change for the industry in the effectiveness of its P&A efforts.
- Implement measures for the common acquisition and storage of deep seafloor environmental data for use by the industry to support reasonable regulations for its governance. This issue can enable the solidification of now-evolving environmental concepts regarding removal of oilfield equipment from the deep seabed.

THE ISSUES

Predicting Decommissioning Costs

1. Develop cost estimates for subsea component decom in the Gulf of Mexico in order to respond to the Proposed Financial Regulations for Decommissioning Liability from BSEE / BOEM.

Environmental Evaluation: The Use of NEBA

2. Net Environmental Benefits Analysis [NEBA]: What, Why, and How
3. Performing a NEBA for a Deep-Water Field in the Gulf of Mexico
4. Modifying Existing NEBA Regimes to Develop Consistent Environmental Regulations

Resins for Well P&A: Taking the Next Steps

5. Developing a Game Plan to define Long-Term Resins Durability Testing. Given that there are current efforts to prove Epoxy Resins' long-term durability within the industry, this plan will lay out the Game Plan for other major types of resins.

Collaborating on Environmental Data

6. Industry Plan for Deep Seafloor Environmental Data

Environmental Evaluation: Further Use of NEBA to Illustrate its Flexibility and Power

7. Performing a NEBA for a Shallow-Water Platform in the North Sea
8. Performing a NEBA for a Shallow-Water Field Subsea Kit in the North Sea

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 evaluation of the ideas generated. The goal of this JIP is to develop the expected subsea decom costs in the GoM in Issue 1, define and apply NEBA in specific locations in Issues 2,3,7,8; develop an industry strategy and test plan for the evaluation of resins in Issue 5, and determine possible scenarios to deal with environmental data related to recovery vs. leaving subsea hardware in-situ in Issue 6.

Stage 1 Issues Definition

Proceed with Issue definition as follows:

- The Member Companies [MCs] will be asked to nominate Subject Matter Experts [SMEs} to assist in the technical definition and provide comments and guidance as the Issues Teams move toward solutions. These SMEs will serve as technical reps for the MCs.
- It is not mandatory for a Member Company to have SMEs but it would be beneficial.
- From this point forward in this Proposal, when “Member Companies” are mentioned it is presumed that the Member Companies may include – or not include - their own SMEs in the transactions of the Project as they see fit.
- Endeavor will generate documentation in which each Issue listed above is expanded and further defined. The effects of the Issues will be analyzed by the Member Companies to obtain input relevant to the successful study of the issue in question.
- 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 (Technical) Kickoff Meeting and solicit comments. The concepts identified in these meetings will be used in Stage 2. It is planned that these meetings will be organized on an Issue-by-Issue basis, travel and logistics permitting.
- For Issue 5, this Stage 1 Kickoff meeting will result in nomination by Member Companies of their best SMEs for providing input to the development of a Resin Long-Term Testing Game Plan.
- For Issue 1, this Stage 1 Kickoff meeting will result in agreement on the tasks to be evaluated for best chance of acceptance by regulators; regulatory participation by BSEE is planned in this step.

Stage 2 Finding Solution Concepts

- Endeavor will seek possible solutions from within the JIP Member Companies and their SMEs, from service providers and from within Endeavor’s skilled team.

- For Issue 1, Endeavor proposes to work with both SMEs within the group of Member Companies and experts within the BSEE / BOEM regulatory organization to arrive at areas of clarification with regard to cost prediction for financial liability purposes.
- For Issue 2 and 4. Endeavor advisors will provide the needed information.
- For Issue 3, 7 and 8, a NEBA will be performed for each of the proposed locations (i.e., case studies) to demonstrate the approach, its value, and where it fits within respective regulatory processes.
- Issue 4 will provide, in concert with the development of the NEBA case studies, an in-depth review of existing regulatory regimes and a demonstration as to how environmental regulations incorporate NEBA considerations, or can be adapted, and/or developed to encompass this approach.
- For Issue 5, Endeavor will seek not only SMEs to help generate deliverables for approval, but will also seek the highest-caliber SMEs to provide input into an effective plan for resins testing.
- For Issue 6, Endeavor proposes to work with SMEs within the Member Companies and Endeavor advisors.
- When each Issue has been documented, Endeavor will meet with the JIP Member Companies collectively for open discussion regarding these Issues. Since several of the Issues are related to one another, it is expected that when appropriate the Issues will be reviewed as a common group.

Results Review/Final Review: Report, with Deliverables

- The results of Stages 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 Issue 1. Relative to Issue 1, BSEE / BOEM are planned to be included whether or not they are official JIP Members. 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 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 each nominate a single-point contact to monitor progress and to coordinate with its SMEs. Endeavor proposes to report progress on a "by Stage" basis.

All scopes in this proposal in Phase 2 total $1,485,000., which presumes 15 participating companies at $99,000 per company. If the total number of Member Companies who join Phase II is less than 15, the number of Issues can be reduced. This set of commercial terms is of course subject to the level of interest shown by the industry and the number of companies interested in signing on; terms may be adjusted based on feedback from interested parties.

Each JIP Member Company will be billed half of their total amount at project kick-off and the other half after the draft Final Report is issued. If more than 15 Member Companies join the JIP, the additional funding will be used for other related study with input from the Member Companies. The Member Companies will be notified in advance if the project requires additional hours due to significant changes in project scope, etc. Additional work requiring more funding per Member Company would only occur if approved by unanimous approval of the JIP Member Companies.

The above proposed price of $ 99,000 per Member Company includes:

- Stage 1 summary defining each of the identified Issues confronting the subsea decom industry, in draft form for review by the Partners.
- 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 proceed with the studies using feedback gained from the Stage 1 meetings.
- Stage 2 report in draft form outlining – for each of the Issues 1 through 8 – recommended concepts and preliminary deliverables for solution to the Issue under consideration.
- 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 deliverable report by the addition of Stage 2 Member Company feedback to the draft report for each issue. Report will be provided to each Member Company in PDF format including all appendices and attachments.
- 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 Member Company participation is confirmed. Stage 1 will be ready for review in approximately 8 - 10 weeks after award date, subject to completing the meetings with Member Companies. Stage 2 will be ready for review approximately 12 weeks after the last Stage 1 review meeting is completed. The Stage 3 final report will be delivered 4 weeks after final comments are received from Stage 2. Therefore, the total time to complete this Phase II JIP is estimated to be about 6 months. This schedule is preliminary and will be affected by the sequence and manner in which the JIP comes together; in other words, how and when the Member Companies come on board.

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
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We look forward to working with you on this project.

Sincerely,

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PLUGGING IN the POWER TOOLS

Decommissioning Industry JIP Proposed PHASE II
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Issue 1: BSEE-Required Liability Financial Safeguards: MORE-ACCURATE PREDICTION

Background

In recent years within the Gulf of Mexico [GoM] region, the US government regulatory body BOEM has imposed financial safeguards on operators. These safeguards result in various combinations and levels of bonding, insurance, and other protections against estimated decommissioning liability for wells and facilities in the region. This economic review is focused on subsea infrastructure and subsea trees. It will not cover fixed or floating platforms.

Food for Thought

While the requirements for financial protection have caused a shift in the economics of offshore fields, there is the possibility that costs assigned by BSEE, BOEM's enforcement arm, can be examined in order to reduce the scope and methods by a significant degree, yet still provide protection to taxpayers. The reason for this is that in many cases the financial requirements are based on assumptions that are too conservative to accurately reflect the manner in which the decommissioning industry plans to do business.

Recommendation

Utilizing a user-customizable Model developed for the Decommissioning industry, provide regulators method descriptions and activity durations for those industry practices planned for future decommissioning. The model can vary unit rates and contingency assumptions to enable BSEE regulators (at BSEE discretion) to adjust liability costs assigned to operators.

How to Best Advance the Decommissioning Agenda

Demonstrate the difference between industry proposed practice and BSEE assumptions regarding how the industry decommissions facilities in deepwater by:

- Revising the assumption that each well P&A will require a separate vessel mobilization. It is in the operators' best interests to minimize execution risk by P&A of as many wells as the operator can reasonably bundle on any given mobilization, so industry practice is to avoid single-well projects whenever possible. This practice would remain even after a bankruptcy.
- Reasonably and credibly estimate costs for common elements of offshore decommissioning that more accurately reflect experience.
    - For subsea trees and wellheads
    - For pipelines, flowlines, umbilicals and other infrastructure elements.
- Develop costs for pipeline segments.
    - Use industry database to quantify counts of pipeline risers, static lines, umbilical risers, and seabed umbilicals.
    - Use Cost Modeling tool to estimate realistic flush / disconnect / laydown costs.
- Use the Modeling Tool to compare the cost aspects of the various NEBA cases on an apples-to-apples basis.

PLUGGING IN the POWER TOOLS

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Issue 2: Net Environmental Benefits Analysis [NEBA]: WHAT, WHY, and HOW

Background – Net Environmental Benefits Analysis (NEBA): What, Why, and How

For decades, the industry has been developing fields using subsea wells at breakneck pace as well as in ever deeper water depths. As these fields age, it now falls on the industry to effectively plan and execute the decommissioning of these fields. This not only involves the wells themselves, but all of the infrastructure required to fully exploit the fields. As decommissioning efforts move toward ever-deeper environments, it is time for the industry to evaluate and compare risks for alternatives to plan for decommissioning and beyond.

Food for Thought

There is a comparative assessment system within the environmental field called Net Environmental Benefits Analysis [NEBA] that allows the ecological and human use benefits and costs of a given set of decision alternatives to be compared. A NEBA is used to systematically analyze the effects of human actions on the environment while considering the environmental value that competing actions provide to humans. Such analysis can usefully quantify non-monetary environmental impacts in addition to economic impacts. Applying a NEBA has proven to allow planners in other decision-making areas and industries to focus in on "least overall harm" solutions to environmental questions and decisions. That is, maximize benefits to the public while managing site risk and cost.

Recommendation

There is an ever-growing need for decommissioning science and decision-making tools, both business and regulatory, to deal with a large inventory of aging subsea infrastructure. NEBA presents a science and economics-based tool to address this situation. However, there is a great deal of groundwork still to be done, including technical, legal, and regulatory, to evolve NEBA from a tool that is being used in the decommissioning space on an ad hoc basis to an overall effective decommissioning liability management scheme, i.e., one which is generally and routinely accepted by regulators to support decision-making.

The current decommissioning environment provides several opportunities to use NEBA to evaluate decommissioning alternatives for particular assets.

How to Best Advance the Decommissioning Agenda

This particular Issue will provide an educational short course for the Decommissioning industry in the use of NEBA as an evaluation and decision-making tool, including an explanation of how NEBA has been developed and is now being applied.

PLUGGING IN the POWER TOOLS

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Issue 3: APPLICATION of NEBA to DEEPWATER DECOMMISSIONING

Background

This issue is focused on the application of NEBA to deepwater fields, applicable worldwide.

Food for Thought

There are many benefits of the use of NEBA as a systematic tool for evaluation of the impacts of oilfield decommissioning work. Perhaps one of the most impactful of these benefits is the use of NEBA for planning and evaluation of deepwater decommissioning. There are several reasons for this which include:

- The ecology and benthic properties of deepwater are generally quite different from shallow water and are therefore worthy of their own, separate environmental analysis.
- Decommissioning work in deeper waters is still in its very early stages. The use of a systematic, repeatable, defensible, objective method such as NEBA can therefore be viewed as a tool that can help planners from the very beginning of the worldwide deepwater decommissioning effort.
- Since vast areas of deepwater benthos of the world's oceans appear to be quite similar to one another, an effort to perform NEBA on such areas could easily benefit the industry by identifying "least overall harm" for decommissioning deepwater equipment.

Recommendation

While decommissioning will produce several opportunities for the use of NEBA, this particular issue will deal with the application of NEBA for deepwater fields and seafloor equipment. This Issue will focus on a NEBA for subsea hardware in the deepwater U.S. Gulf of Mexico. It is expected the outcome will be generic so that all Member Companies can use the results in discussions with BSEE.

How to Best Advance the Decommissioning Agenda

This issue will educate the decommissioning JIP Member Companies on the use of NEBA for deepwater fields and installations.

- How to scope a NEBA for deepwater
- What is different in NEBA impacts and considerations between shallow and deep waters
- Carrying out a sample NEBA for each of the various types of deep water equipment in the U.S. Gulf of Mexico:
    - Subsea Well P&A
    - Subsea Trees and Wellheads
    - Pipelines, flowlines, risers, and appurtenances such as PLETs, PLEMs, manifolds
    - Umbilicals and appurtenances such as SUTAs and flying leads
    - Other typical field development equipment such as moorings and subsea structures

PLUGGING IN the POWER TOOLS

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Issue 4: EVALUATE HOW TO MODIFY OR AUGMENT TARGET REGULATORY REGIMES FOR DECOMMISSIONING IN SELECTED JURISDICTIONS TO INTEGRATE NEBA

Background

This issue will deal with regulatory impediments and opportunities to advancing NEBA for decommissioning decision-making within the regulatory sphere.

Food for Thought

While NEBA has been deployed in various other environmental decision-making contexts to allow for informed business and regulatory decision-making, it is in its pilot study phase in the offshore decommissioning space, and is not yet endorsed by the various regulatory regimes governing decommissioning throughout the world. Varying regulatory approaches are at play across various exemplar jurisdictions. Yet, integrating NEBA and doing so consistently across jurisdictions promises an opportunity for maximum liability management for individual assets as well as multi-jurisdiction asset portfolios. However, to move NEBA beyond an ad hoc decommissioning tool, it will need to be acceptable to and accepted by regulatory decision-makers. Crafting the appropriate regulatory modifications necessitates a thorough understanding of the existing regimes and the opportunities within those regimes, either by modification, interpretation or augmentation, to integrate NEBA.

Recommendation

Document the regulatory regimes in place or developing with respect to offshore decommissioning in the following target jurisdictions: North Sea and U.S. Gulf of Mexico. Evaluate how these regimes, individually, may be modified to implement NEBA. Evaluate how these regimes currently allow for the integration of NEBA, insofar as they do, and the ways in which they may be modified to allow for NEBA in a way optimal to consistent, predictable, science-driven decision-making with respect to decommissioning of offshore assets.

How to Best Advance the Decommissioning Agenda

This issue will educate the JIP Member Companies on the state of the regulatory regimes with respect to decommissioning in the North Sea and U.S. Gulf of Mexico. It will look at how NEBA may be deployed on an ad hoc basis in decision-making for particular assets and also, more broadly, how these regimes may, individually, be modified to integrate NEBA into the default decision-making process. It will also look at opportunities for syncing across regulatory regimes.

PLUGGING IN the POWER TOOLS

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Issue 5: Use of Resins for Plugging and Abandonment: TAKING THE FIRST STEP

Background

There is great potential for use of resins as a primary means of zonal isolation in well P&A. Resins offer game-changing improvements over cements in many well situations and have potential to become the primary barrier mechanism for the long-time frames sought in decommissioning and P&A. However, resins have not been systematically tested to prove their long-term durability in well situations downhole. Even though this is also true of cements, it will be beneficial for the industry to undertake a resins testing program. The big problem here is that little effort has been expended to plan for and set up any of this work. The work itself will be a sizeable task.

The effort mentioned in the summary above is no doubt a large one, but by no means is it daunting. This study proposes to deal with this large amount of work as follows:

- The best way to make steady progress is to break up this large effort into discrete pieces, each of which makes a positive step forward. Bearing in mind the old proverb that a long journey starts with a simple first step, where should the First Step take us? Issue 5 proposes to take that First Step, which is to develop a game plan for effective long-term testing.

Food for Thought

There is a general lack of confidence by the oil and gas industry and related regulatory bodies concerning proof that resins will provide a barrier for the very long-time frames necessary after well P&A. While it is true that there has not been a cohesive, systematic program to prove the long-term (hopefully dealing with geologic time frames) performance of resins, many in the industry might be surprised to know that no such study has ever been done on cements either. There is indeed much more data out there on cements, but it has been done piecemeal over the years. Most of the impetus for use of cements by the Oil and Gas industry results from tradition and familiarity, not science.

The decommissioning industry is benefitting from a spirit of collaboration in recent years, partly due to the fact that decommissioning economics result in no gain for the operator, only liability. This inspires operators who have decommissioning obligations to seek as many common answers and advancements as possible.

Those who know the dramatically different ways that resins interact with the various well components can tell us of the many ways that resins can effect a positive “step change” in the reliable sealing of well barriers. Suffice it to say that there is general agreement among cementing experts that resins will seal problematic well interfaces differently and much more effectively than cements – “IF” these better seals can be trusted for the time frames necessary in permanent well P&A.

Recommendation

With the above in mind, there is no better time to move toward removing that big "IF" from this situation. It becomes apparent that a subject ripe for industry collaboration is to determine the scope of work and associated "price tag" for a thorough, scientific study of the long-term durability of resins as effective sealing barriers in oil well P&A application.

How to Best Advance the Decommissioning Agenda

The focus of this Issue is to do the most basic planning for a formal estimate to define the scope and cost for a scientific, systematic set of tests to prove the long-term performance of resins under downhole well conditions. This would involve the following list, all predicated on the presumption that a limited number of resin types, combined with a limited number of common well conditions, would cover a majority of the market for resins. As a common-sense analogy, this combination of resin types and well conditions - if well-chosen - would result in market coverage similar to the 80/20 rule. In other words, 20% of the scenarios involving resin types vs. well conditions would hopefully end up accounting for 80% of the possible market opportunities; this of course will be proven out as the JIP progresses.

1. With the ability to formulate so many custom resin compounds, narrow down the choices: Determine (and review) a representative set of test compounds, limited in number, that would help assess the most-likely-utilized range of compounds to be utilized in the field.
2. Assure that the test procedures chosen would simulate the widest reasonable range of common well conditions, including chemical environment, wellbore fluids, temperatures, H2S or CO2, various formations, etc.
3. Generate the best possible methods to simulate and accelerate the aging process for the resin types chosen.
4. Obtain feedback from the Member Company Subject Matter Experts on resins.
5. Produce a chart that summarizes the most common resin types to be used vs. the most common wellbore situations. When reviewed and approved by the Member Companies of the JIP, this chart would summarize the nominal set of tests to be performed as the "first phase" of resin durability testing for the industry.
6. The results would include a discussion of the subjective prediction of how much of the market will be truly covered by the scenarios chosen; will the results meet the 80/20 rule or will they be closer to 65/35 or some other ratio. *Note that the intent here is for resin experts to generate a set of resin types vs. wellbore situations with the goal to obtain good benefit for the cost and effort expended.*
7. This Issue 5 report would be the best First Step toward the ultimate goal of gaining widespread acceptance for the use of resins in decommissioning and within the general oilfield.
8. Acknowledging that there are individual company efforts in durability tests of Epoxy resins underway, this Issue would focus on the several other major types available for oilfield use.

PLUGGING IN the POWER TOOLS

Decommissioning Industry JIP Proposed PHASE II
Revision 1, June 9, 2017

Issue 6: Environmental Benefits of In-Situ Deepwater Hardware Abandonment: GATHERING MORE EVIDENCE

Background

Recently BSEE took up the subject of regulations related to the removal of deepwater pipeline hardware and appurtenances such as PLETs, PLEMs, sleds, etc. in water depths greater than 3000 feet. In response to this action, the JIP contributor Coastal Environments, a California company, studied the true nature of the sea floor in deep water.

Of course, not all of the seafloor worldwide is contiguous; therefore, none of the statements that follow apply to 100% of the deep seafloor. However, large areas are as follows:

- The deep-sea is defined by cold temperatures, high pressures, and virtually no light.
- The deep-sea floor is seemingly barren, resembling the surface of the moon. However, deep-sea life is incredibly diverse and dynamically linked to oceanographic processes near the surface.
- In the rare spots that hard substrate (such as rock) exists, sea life is found in greater abundances than in the surrounding background areas.
- These areas can be very still, with zero current or water movement of any sort. As a result, following a disturbance it could take decades to restore a deep-sea environment to its equilibrium.
- Pipeline accessories placed on the deep seabed provide precious new habitat of hard substrate. The evidence found so far shows that diverse life tends to congregate on and around this substrate.
- The bulk of the evidence found so far implies that:
    - Removing established substrate destroys habitat that was desperately scarce before it arrived.
    - The localized environment may take decades to recover from disturbances created by removing equipment, especially equipment employing mud mats.
    - Said disturbances will have a negative impact on the majority of water filtering marine organisms existing in the area due to mud ingestion.
- Although the science based on evidence found so far seems to point in a particular direction, the volume of this evidence is small. Much more data is needed to formalize the picture of the deep-sea environment.
- There is substantial oilfield data (ROV surveys, etc.) available for deepwater environments in various regions; however, much of this data is tied up with MSAs, NDAs, tight hole restrictions, and the like.
- Data is not published.
- Based on the limited evidence found to date, it appears that in some cases, the best policy would be to NOT remove these items from the deep seabed.

Food for Thought

For several reasons, more evidence will be needed to tip the scales of scientific and public opinion toward the view that leaving subsea equipment "in situ" might be the best policy to follow in deep waters. These reasons are:

- The evidence available is simply too small in volume to draw sweeping conclusions at this time.
- The properties of the deep seabed are so different from the common man's gut perception that much evidence will be needed to help educate and prove these differences.
- Additional studies need to be spread across the globe to add geographic diversity to this evidence, or they need to be more concentrated in the area pertinent to JIP members.

After thinking on this evidence, the preliminary conclusion to which it points is striking. To recommend that the best way to enhance an area's environment is to leave oilfield equipment in place, goes against common practices in place in most areas of the world. It also conflicts with the common man's best instinct: How many of us grew up being taught to leave a place 'cleaner than you found it?' As a result, the existing evidence needs to be more fully and completely augmented before it is educationally presented to the public.

Recommendation

Increase the amount of data available for environmental study in two ways:

- Approach operators and pertinent service providers for existing data, which would generally take the form of ROV surveys of oilfield installations in deep water;
- Review available data and categorize for database management purposes;
- Take every opportunity available to add new data as field opportunities permit.

How to Best Advance the Decommissioning Agenda

For the use of existing data:

1. Ask the Member Companies, and possibly other operators, to waive, when possible, the confidentiality restrictions on their related environmental data.
2. There should be many deepwater projects in which environmental data, considered confidential when the project was in development, is now less proprietary due to the project being at or near end-of-life. Seek out these projects and see if confidentially restrictions can be waived.
3. Ask operators to edit their data to allow environmentally valuable data to be published; keeping delicate or confidential data secure.

For gathering new data:

Collaborate as an industry to survey areas of common interest.

1. Develop a protocol for information gathering, so that JIP Member Companies can continue to collect and add data to the data repository.

Where to keep all this data?

1. Determine how to set up a repository for deepwater environmental survey data for the common use of the industry. This would likely be best within an academic institution affiliated with marine or oilfield interests.
2. Propose and obtain industry agreement on a system to allow use of this data in controlled fashion. To do this it should be presumed that agreement between JIP Member Companies will indicate a good chance of success for agreement within the industry as a whole.

PLUGGING IN the POWER TOOLS

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Issue 7: A NEBA for DECOMMISSIONING a SHALLOW WATER PLATFORM

Background

While one focus on the use of NEBA will involve their application to deepwater fields worldwide, it is acknowledged that a huge amount of decommissioning still remains in shallow waters in all regions.

Food for Thought

The many benefits of the use of NEBA as a systematic tool for evaluation of the impacts of oilfield decommissioning work can also apply to shallow water installations. In addition, the ecology and benthic properties of shallow water are generally quite different from deeper water and are therefore worthy of their own, separate environmental analysis.

Recommendation

While this situation will produce several opportunities for the use of NEBA for decommissioning, this particular issue will deal with the correct application of NEBA to shallow water installations. A representative shallow water asset has tentatively been chosen and a 'case study NEBA' in its entirety will be performed for a platform in the North Sea.

How to Best Advance the Decommissioning Agenda

This issue will educate the decommissioning JIP Member Companies on the application of NEBA for platforms in shallow water fields and installations, specifically a steel piled jacket.

- How to scope a NEBA for shallow water.
- What is different in NEBA impacts and considerations between shallow and deep water.
- Carrying out a NEBA for a selected shallow water development. The selected jacket in the North Sea recently completed an ROV integrity survey which included specific wide-angle views at each depth, from seabed to sea level, to document the sea life present.
- This data is a key input to NEBA to quantify the marine life counts by species, by depth. This data will be used to establish the commercial and recreational value of marine life using each part of the structure for habitat, and the corresponding long-term impact of loss of each part of that habitat if removed.
- NEBA discounts the long term "ecosystem service flows" from each impact and benefit to contribute to the overall "net benefit" of each abandonment scenario, relative to alternative scenarios.
- The NEBA will also consider the potential condition of the cuttings piles associated with the platform and their relation to the platform.

PLUGGING IN the POWER TOOLS

Decommissioning Industry JIP Proposed PHASE II
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Issue 8: A NEBA for DECOMMISSIONING SHALLOW WATER SUBSEA KIT

Background

Applicable Worldwide - The infrastructure associated with an offshore field [fixed platform or floating production unit] can include a variety of structures that provide significant ecological and associated human use value. These structures can include pipelines, umbilicals, subsea trees, moorings, production risers and flowlines, piled structures, plus others. In some cases, the decommissioning of these structures is separated within regulatory guidance, for example, in the North Sea where decommissioning of the platform is separate from the decommissioning of the other subsea structures. The goal of this case study is to understand and demonstrate the value, both ecologically and socially, that the variety of shallow water subsea structures contribute to human well being. In this case, the NEBA will evaluate a variety of decommissioning options for shallow water subsea structures.

Food for Thought

The many benefits of the use of NEBA as a systematic tool for evaluation of the impacts of oilfield decommissioning work can also apply to shallow water installations and not just jackets. In addition, the ecology and benthic properties of shallow water are generally quite different from deeper water and are therefore worthy of their own, separate environmental analysis. In looking at the overall makeup of subsea oil field areas, the infrastructure as a unit serves to provide an ecological conservation area/zone that in turn supports human well being (e.g. by protecting fish stocks from overfishing and providing for commercial and recreational fishing). The combined value that oil field infrastructure provides should not be ignored and as such, decommissioning options should be evaluated to maximize benefits to the public while minimizing risk and cost.

Recommendation

While this situation will produce several opportunities for the use of NEBA for decommissioning, this particular issue will deal with the correct application of NEBA to shallow water subsea equipment. The representative shallow water asset has been chosen and a 'case study NEBA' in its entirety will be performed for the subsea structure associated with the North Sea platform to be evaluated in Issue 3.

How to Best Advance the Decommissioning Agenda

This issue will educate the decommissioning JIP Member Companies on the application of NEBA for subsea structure in shallow water fields and installations.

- How to scope a NEBA for subsea infrastructure in shallow waters.
- What is different in NEBA impacts and considerations between shallow and deep waters.
- Carrying out a NEBA for a selected shallow water development. The asset selected is the infrastructure associated with the North Sea jacket mentioned above.
- ROV data is a key input to NEBA to quantify the marine life counts by species. This data will be used to establish the commercial and recreational value of marine life using each component

of the subsea structure for habitat, and the corresponding long-term impact of loss of each part of that habitat if removed.

- NEBA discounts the long term "ecosystem service flows" from each impact and benefit to contribute to the overall "net benefit" of each abandonment scenario, relative to alternative scenarios.

PLUGGING IN the POWER TOOLS

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Project Team Bios

Bruce Crager, Executive Vice President, Expert Advisory Group – Endeavor

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, Decommissioning Team Lead, JIP Phase II Project Manager – Endeavor

Keith Caulfield has extensive experience in both the upstream and downstream oilfield arenas. This includes design and operational experience in offshore deepsea structures and equipment such as subsea wellheads and trees. He is author or co-author 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. Keith spent several years in the Decommissioning field for TETRA Technologies, handling projects in both shallow and deepwater decommissioning and well intervention. Keith is the Decommissioning Team Lead for the Endeavor Management's Expert Advisory Group.

ISSUE 1: Financial Saferguards: More Accurate Prediction

Issue Lead: TSB Offshore, Inc.

Since 1987, TSB Offshore, Inc. (TSB) has been recognized as a leader in the oil and gas industry for providing decommissioning consulting and abandonment project management services, including project planning, abandonment liability estimates, detailed project studies and project execution. TSB provides customized support and highly detailed planning for the decommissioning liability evaluations of onshore and offshore assets around the world. Our field and operations expertise, specialized proprietary software applications, and proven assessment methodologies are combined to ensure accurate estimating and precise execution. TSB Offshore's decommissioning services include Liability Cost Studies, Project Management, Planning and Permitting, Acquisition and Divestiture Support, Project Scheduling and Cost Risk Assessment.

ISSUES 2,3,7,8: Net Environmental Benefits Analysis [NEBA] and Pilot Case Studies

Issues Lead: Joe Nicollette, Partner – Environmental Planning Specialists, Inc. [EPS]

Joseph Nicollette has over 30 years of experience in the environmental consulting field with a focus on the Oil and Gas Industry. He is a Partner, Senior Principal, and Ecosystem Services Practice Leader at Environmental Planning Specialists, Inc. [EPS]. He provides strategic advice and oversight for projects to help balance the risks, benefits, and tradeoffs associated with competing alternatives (e.g., remedial cleanup, decommissioning, oil spill response actions and tactical plans, development options and permitting, etc.)

Joseph is recognized for his demonstrated contributions in developing the NEBA approach, which supports environmental decision-making strategies that provide the greatest net environmental benefit to the public while managing site risks and costs (i.e., an environmental cost-benefit analysis approach). He co-authored the first formalized NEBA framework recognized by the United States Environmental Protection Agency (USEPA), the USEPA Science Advisory Board (USEPA SAB), the National Oceanic and Atmospheric Administration (NOAA), and the Australian Maritime Safety Association (AMSA).

Joe has led the development of quantitative NEBA applications for offshore decommissioning as part of the comparative assessments for subsea structure for well fields in the Gulf of Mexico, Australia, and the North Sea. These have included a multi-Platform, a Floating Production and Storage Offloading (FPSO) facility, and an analysis of specific subsea components for another well field.

ISSUE 4: Targeting Regulatory Regimes to Integrate NEBA

Issue Lead: Tom Campbell, Managing Partner – Pillsbury Winthrop Shaw Pitman, LLP

Thomas A. Campbell, managing partner of the Houston office of Pillsbury Winthrop Shaw Pitman LLP and the leader of Pillsbury's Crisis Management team, counsels enterprises facing financial and reputational losses amid crises.

Tom's ability to help clients craft a multidisciplinary response to a crisis—typically involving public relations, government relations and litigation—reflects the extensive regulatory work experience he has gained in both private practice and public service. As general counsel of the National Oceanic and Atmospheric Administration, he played a key role in the U.S. government's response to the Exxon Valdez oil spill crisis. A generation later, he helped a part-owner of the Macondo well cope with the Deepwater Horizon accident.

<u>Representative Experience</u>

- Leading the crisis management team that advised a 10 percent leaseholder of the Macondo well on a $1 billion settlement related to the 2010 Deepwater Horizon oil spill in the Gulf of Mexico.
- Serving as a client team leader for Teck Metals Ltd. in a historic cross-border contamination case involving claims of discharges in Canada affecting the Columbia River in the United States. Teck won a landmark victory in the Ninth Circuit Court of Appeals in July 2016.

Professional Highlights

- Led the federal assessment of the natural resource damage claim for the Exxon Valdez spill, and, after playing a key role in its negotiation, signed the $1 billion settlement on behalf of the U.S. government.
- Experience testifying before Congressional committees and participating in White House and cabinet level briefings.

ISSUE 5: Resins vs. Cements for Plug and Abandonment [P&A]: Taking the First Step

Issue Lead: 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 6: Benefits of In-Situ Abandonment: Gathering More Evidence

Issue Leads: Emily Callahan and Amber Jackson, Project Scientists – Coastal Environments

Key Content: Dr. James Gibeaut – Harte Research Institute, Texas A&M University - Corpus Christi

Emily Callahan

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.

Amber Jackson

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).

Dr. James Gibeaut

Dr. James Gibeaut is the Endowed Chair for Coastal and Marine Geospatial Sciences at the Harte Research Institute for Gulf of Mexico Studies (HRI) at Texas A&M University – Corpus Christi. He earned a B.S. in geology from Ohio State University, a M.S. in coastal geology from the University of Rhode Island, and a Ph.D. in Marine Science from the University of South Florida. He is a coastal geologist who uses optical, radar, and lidar remote sensing, GIS, and field surveys to measure and understand coastal change. He has studied shorelines in a variety of locations including Rhode Island, Florida, Texas, Alaska, Honduras, Venezuela, Brazil, and Saudi Arabia. Currently, his main research focus is modeling the effects of relative sea-level rise and storms on coastal systems and projecting future change. His Coastal and Marine Geospatial Lab at HRI is also developing web applications and scientific data repositories for the dissemination of research results.