E&P SOUND & MARINE LIFE PROGRAMME

Joint Industry Programme on E&P Sound and Marine Life - Phase III

Request for Proposals Number: JIP III-16-01

Determining the Environmental Impact of Marine Vibrator Technology

Release Date: 2nd September 2016

Introduction

This Request for Proposals (RFP) seeks proposals to conduct a desk-top study which will further improve understanding of the potential environmental impact and/or benefit of marine vibrator technology. Building upon previously completed JIP work on this topic, this study will use available source measurements from a variety of marine vibrator designs (including prototypes) in order to evaluate the potential environmental impacts of marine vibrator technology. These impacts could include those which might call for further investigation due to the nature and magnitude of the risk potential identified in this preliminary study.

The research called for in this RFP is required to meet the information needs of the above JIP, specifically Research Category 1 ***Sound Source Characterisation and Propagation*** - see www.soundandmarinelife.org website.

The Proposals being requested must address the Proposal Description, Proposal Features, and Project Deliverables detailed below.

Organisations submitting Proposals should also adhere to the Application Procedure and Critical Dates set out below. In addition, the Terms & Conditions referred to in the RFP shall apply.

Application Procedure

To respond to this RFP, please follow the relevant instructions given on the **Funding** page of the JIP website. Proposals should refer to the above RFP number and should be submitted electronically to info@soundandmarinelife.org.

Those organisations submitting Proposals should refer to the **outline contract** on the JIP website. This sets out the terms & conditions under which any contract will be carried out under the management of the International Association of Oil & Gas Producers (IOGP). In particular, attention is drawn to the specific term relating to management of health, safety, security and environment aspects of a contract. All IOGP contracts have such a section, but the specific wording that will appear in this section depends on the type of activity (desk-top study, field work, etc) to be conducted.

Critical Dates

Proposals are due by: **Friday 7th October 2016**

We will confirm receipt of proposals. If you have not received confirmation of receipt of your proposal within 1 week of the above deadline, please contact John Campbell at IOGP (Tel +44 (0) 20 3763 9707; e-mail info@soundandmarinelife.org. The review of proposals will aim to conclude within 2 months of the submission deadline, after which applicants will be notified by the JIP.

Preference will be given to proposals that will lead to project completion within 6 months of contract award.

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Background

Several projects have been launched in response to growing interest from a number of organizations and individuals to provide an alternative source technology to compressed air source. These projects aim to help make available alternative source technology that may contribute to reducing potential impacts of underwater sound on marine life associated with geophysical data acquisition, whilst maintaining Health, Safety and Environment (HSE) standards and the current level of quality of geophysical data produced.

The JIP is aware of the range of alternative source technologies and source methods currently under development; however, for the purpose of this RFP the alternative source technology of specific interest is the marine vibrator technology applicable to geophysical acquisition. The JIP has previously commissioned a desk-top study (accessible via http://www.soundandmarinelife.org/libraryfile/1596) which completed an environmental assessment of marine vibrator technology using a set of hypothetical source characteristics compared to a conventional compressed air source array. The outcomes of this study suggested that the use of marine vibrator technology compared to conventional compressed air source arrays would be expected to influence the following aspects related to potential impacts on marine life:

Potential Risk of Auditory impairment: While phenomena like TTS and PTS (temporary and permanent auditory threshold shift) are typically modelled as an equal energy trade-off between amplitude and duration, the rapid pressure changes of an impulse signal like a compressed air source may have greater potential to impair hearing than a lower amplitude signal with longer pressure rise and fall times. It is therefore possible that the lower levels and longer signal duration of alternative sound sources may have a lesser auditory impact than any potential impact from the higher peak pressures of compressed air sources.

Disturbance: There are no specific data on the responses of any marine animals to marine vibrator sources. If animal responses are most directly related to received pressure level, then responses to marine vibrator sources (with lower source pressure levels) should be considerably reduced relative to a conventional compressed air source. If animal responses are more directly related to received energy level, then responses to marine vibrators and compressed air sources might extend to similar distances. Other factors that need to be considered are the time/frequency structure of the signal, the movements or "behaviour" of the source platform during data collection (e.g. stationary versus mobile), and the hearing sensitivity of the species of concern.

Masking: Little is known about the effects of intermittent masking by low frequency anthropogenic sounds on marine animals in the wild; however, this is a subject of increasing concern within the environmental community.

As stated above, there are now several projects that can provide field-executed source measurement data for alternative sound sources in order to enable comparison with traditional seismic survey operations. While actual systems may vary, a comparison of the general, typical source characteristics of the so-called "next generation" marine vibrators and a conventional compressed air source array is shown below:

	COMPRESSED AIR SOURCE	VIBRATOR
Useful seismic bandwidth (Hz)	5-100	
Highest emitted frequency (Hz)	>3000	150
Lowest emitted frequency (Hz)	5	5
Peak Pressure Level	50 to 80 bar @ 1 m (downward direction)* 2 to 5 bar @1m (horizontal direction)	Less than 1 bar @ 1 m
Emission duration	50 ms (at source)	5 s (sweep in towed mode) 30 s (stationary mode)

* *50 to 80 bar @ 1m is a nominal PPL value for the downward direction, in practice source levels at 1m (or even 2 m) vertically below the array still have a significant horizontal component in them due to the dimensions of the array. In the horizontal direction, where the guns are not synchronized the peak pressure level will be close to that of a single airgun 2 -5 bar @ 1 m.*

Differences in sound pressure rise time, frequency bandwidth and peak source levels could have a significant influence on potential impact to marine life. There are also additional variables specific to marine vibrator source signals, such as sweep characteristics and harmonics that should be included in any assessment of potential impact. It is also important to assess the influence of other factors such as, sound source depth of deployment, tow speed or potential for use of multiple arrays.

Description of Proposals being Requested

This assessment will require establishment of a team that brings together expertise on acoustics, geophysical exploration sources, data quality and acquisition methods, and the biology of marine mammals, fish and invertebrates. The team should have demonstrated experience with Environmental Assessment within the oil & gas industry.

Details on the source output characteristics and operational restrictions for Marine Vibrator technology will be provided to the successful bidder by the JIP. JIP will provide contact details of the companies currently known to be involved in the development of Marine Vibrator technologies for use during geophysical surveys and will assist the selected bidder, if necessary, in acquiring the necessary Marine Vibrator source measurement data for use in this study. JIP will also be able to assist in the provision of single and cluster compressed air source measurements for comparison.

The IOGP E&P Sound and Marine Life JIP is requesting proposals for a desk-top data analysis and comparison study which address each of the following:

1. Define multiple comparable operating scenarios in order to facilitate received sound level propagation modelling for marine vibrator vs. traditional compressed air source array:
    - Operating scenarios should be developed for the following:
        a) Transitional zone (e.g. middle east/Asia)
        b) Shallow water (e.g. North Sea)
        c) Deep water (e.g. Gulf of Mexico)
    - Operating scenarios must, as a minimum, take in to account the following conditions: water depth, water temperature, seafloor bathymetry, depth of deployment, tow speed, use of multiple sources, desired bandwidth (including harmonics), and sweep characteristics.
    - A suggestion of operating scenarios to be assessed has been included in **Appendix A**; however, the bidder should feel free to offer alternatives, with justification for the choice. Final operating scenarios will be defined by bidder and agreed by JIP.

2. Perform propagation modelling using a source model with characteristics derived from available recorded source measurement data for the previously defined operating scenarios in order to support a technology comparison of the sound fields generated by each of the different sources. JIP requires completion of each of the following consecutive steps:

    a) Measured source data (for both marine vibrator and compressed air source) should be used to calibrate the source model for input to the propagation model.
        - Ideally the data should include frequency, amplitude, volume, standard Meta data and set-up/environmental conditions.
        - Particle motion should also be estimated, if possible.

    b) Sound propagation modelling, predicting sound level variation (expressed as SEL – Sound Exposure Level) with distance from the source, should be completed using recognised propagation modelling method types[1] (e.g. Parabolic Equation or Wave Number) in order to predict the received levels (RL) of both sources as a function of bearing, distance and depth in the water column. The selected model should take in to account best available site-specific information related to environmental factors that could affect propagation and attenuation of the noise source. Propagation modelling should be carried out for all operating scenarios.
        - Specifications, frequency ranges, assumptions and limitations of the propagation algorithms should be clearly explained.

    c) Animal exposure modelling should be completed, taking in to account animal movement and behaviour, in order to derive an estimate of the number of marine mammals which could be exposed to sound energy over a 24-hour period for each scenario. Animal exposure results should be assessed according to exposure criteria defined by established and commonly adopted guidelines (Southall et al. 2007 or Finneran and Jenkins 2012). Bidder should also consider relating findings to evolving regulatory criteria. Final selection of the specific exposure criteria will be agreed between bidder and JIP prior to project commencement.

3. Evaluate and identify potential impact of and differences between marine vibrator and compressed air source(s) for each of the operating scenarios in order to identify the key source outputs and operating conditions which could influence environmental impact:

    - Minimal source properties to be evaluated include – rise time, peak pressure, bandwidth (including harmonics), signal duration/duty cycle, depth of deployment, tow speed, sound pressure levels, received pressure levels, acoustic intensity (received energy level), spectral content (peak spectral value and drop off), cumulative and instantaneous SEL.
    - Assessment should include evaluation of the following potential impacts: auditory impairment, disturbance, masking[2], with the option for additional other proposer-defined mechanisms of impact.
    - Assessment should include potential impact evaluation on the following receptors: major hearing categories of marine mammals (i.e., low-frequency cetaceans, mid-frequency cetaceans, high-frequency cetaceans, pinnipeds in water, and sirenians), turtles, fish and invertebrates (both pelagic and benthic).
    - Assessment should include evaluation of modelled results vs. exposure criteria defined by established and commonly adopted guidelines (Southall et al. 2007 or Finneran and Jenkins

[1] Standard sound propagation modelling does not properly cover the low frequency sound energy that propagates through the strata below the sea floor. This limitation should be addressed in the report.

[2] Assessment should take in to account spatial release from masking, time domain release from masking, out-of-band listening, critical ratio metrics, and phenomena such as signal duration and repetition rate (duty cycles) and co-modulation release from masking.

2012). Bidder should also consider relating findings to regulatory criteria and final criteria will be agreed between contractor and JIP prior to project kick off.

4. Provide recommendations for further research to improve knowledge and understanding on the potential impacts of alternative source technology on marine life:
    - Recommendations should be linked to the operating scenarios (or operating conditions of scenarios) and/or specific receptors (or hearing group).
    - Recommendations should consider feasibility in relation to cost, tools and availability of technology.

Throughout, statements made in the assessment should be supported by relevant citations from the technical and scientific literature.

In addition to preparation of draft and final reports (as per deliverables below), the selected bidder should take in to account (in budgeting and resources planning) the potential for developing a peer-reviewed paper or manuscript (including the cost of open access to a publication), participation at a relevant conference which may include a Sound & Marine Life JIP programme review meeting and involvement in the production of a non-technical factsheet for this project.

Desirable Features of Proposals

Responses to this RFP should address each of the following (see also **RFP Response Format** page of website):

a) A detailed scope of work to prepare and provide the deliverables detailed below.
b) A detailed work plan to show how the terms of the contract will be met.
c) Timeframe for completion of project and significant milestone events during the project.
d) A detailed cost estimate in US dollars, which includes:
    - Support for travel in order to related company representatives or others with expertise in this subject area;
    - Page charges associated with peer-reviewed publication and potential cost of open access to the full published articles;
    - Assumptions to support the cost estimate; and
    - Any contingencies to address unknowns.
e) A list of personnel to be involved in the project and their qualifications, and their proposed role in this project.
f) Researcher experience in this area and previous work.
g) Where appropriate to the project, a discussion on how you manage animal care and use in your proposed work (*see also Application Procedure above*)
h) An overall proposal summary (one paragraph).

Project Deliverables

Project deliverables shall include:

a) **Monthly Progress Reports** that summarise the work conducted, tasks planned for the coming month, amount spent (vs budget), and forecasts a spend plan for the duration of the project. The specific reporting formats will be determined following contract award.
b) **Draft and Final Project Report** to include:
    1. A report detailing overall study, results and recommendations (as outlined in description of proposal)
    2. A separate data set of modelling outputs (provided in native format).
c) **One or more manuscripts** submitted for publication in a peer-reviewed journal.

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Terms & Conditions:

By submitting a proposal to JIP, the potential contractor accepts the terms and conditions set out in this RFP. This RFP does not commit the JIP, through IOGP, to contract for any supply or service and the JIP shall not be deemed to have accepted any proposal submitted by any potential contractor unless and until a duly executed written agreement is in place and then only for such scope as specifically identified in the written agreement. The potential contractor acknowledges that IOGP and the JIP participants may accept or reject any proposal for any reason whatsoever. The JIP may decide to fund a study in part or as a whole.

Those responding to this RFP are advised that the JIP will not pay for any costs incurred in preparation of a response to this invitation, including without limitation costs and expenses of attending meetings and worksite visits related to this RFP.

All correspondence and documentation associated with this invitation will be in English. Submissions and information will not be shared with other potential contractors.

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APPENDIX A – Potential Operating Scenarios

	Transitional Zone	Shallow Water	Deep Water
Survey Type	2D	3D	3D
Survey Area	600 km^2	750 km^2 (30x25 km)	1500 km^2 (30x50 km)
Track Length	25 km	25 km	50 km
Line Spacing	5 km	500 m	500 m
Shot Point Interval	25 m	25 m	25 m
Representative Area	Middle East/Asia	North Sea	Gulf of Mexico
General Water Depth	2-15 m	75-100 m	2,000-3,000 m
Scenario Water Depth	7 m	95 m	2500 m
Source Tow Depth	2 m	5 m	5 m 10 m 20 m (mar vib only) 30 m (mar vib only)
Operating Mode	Stationary 2 knots tow speed	4 knots tow speed 5 knots tow speed	4 knots tow speed 5 knots tow speed
Single Array	Yes	Yes	Yes
Simultaneously Operating Arrays	Yes	Yes	Yes
Vibrator Sweep Mode	Linear Up	Linear Up Pseudo Random	Linear Up Pseudo Random
Compressed Air Source Configuration	1,000 in^3	3,900 in^3 5,110 in^3	3,900 in^3 5,110 in^3
Seabed Conditions	As per literature	As per literature	As per literature
Sound Speed Profile	As per literature	As per literature	As per literature
Surface Conditions	Reflection Coefficient - 1	Reflection Coefficient - 1	Reflection Coefficient - 1