Appendix A: Seismic Survey Mitigation and Protected Species Observer Protocols

These protocols will be implemented by the Bureau of Ocean Energy Management (BOEM), the Bureau of Safety and Environmental Enforcement (BSEE), and provide guidelines to operators in complying with the Endangered Species Act (ESA; 16 U.S.C. §§ 1531-1544) and Marine Mammal Protection Act (MMPA; 16 U.S.C. §§1361- 1423h). The measures contained herein apply to all seismic surveys approved by BOEM and associated with the federally regulated oil and gas program in the Gulf of Mexico.

Background

Geophysical surveys, including the use of airguns and airgun arrays,may have an impact on marine wildlife. Many marine species are protected under the Endangered Species Act (ESA) and all marine mammals (including manatees) are protected under the Marine Mammal Protection Act (MMPA). The following Gulf of Mexico species are listed under the ESA:

ESA-listed Species common to the Gulf of Mexico
Gulf of Mexico Bryde's Whale (*Balaenoptera edeni*)
Sperm Whale (*Physeter macrocephalus*)
Green Turtle (*Chelonia mydas*) – North Atlantic DPS and South Atlantic DPS
Hawksbill Turtle (*Eretmochelys imbricata)*
Kemp's Ridley Turtle (*Lepidochelys kempii*)
Leatherback Turtle (*Dermochelys coriacea*) - Northwest Atlantic DPS
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS
Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)
Oceanic Whitetip Shark (*Carcharhinus longimanus*)
Giant Manta Ray (*Manta birostris*)
West Indian Manatee (*Trichechus manatus*)*

**Managed by the US Fish and Wildlife Service*

Note that this list can change as other species are listed/delisted, and this protocol shall be applied to any ESA protected species (and all marine mammals) that occur in the Gulf of Mexico, including rare and extralimital species.

BSEE and BOEM consult jointly with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) under Section 7 of the ESA to ensure that BOEM- or BSEE-authorized activities do not jeopardize the continued existence of ESA-listed species nor result in destruction or adverse modification of designated critical habitat. Incidental take of ESA-listed species is prohibited except as authorized pursuant to an Incidental Take Statement in the attached Biological Opinion. Incidental take of ESA-listed marine mammals cannot be exempted under the ESA unless also authorized under the MMPA. In this case, NMFS is

developing an incidental take regulation (ITR) to facilitate subsequent issuance of MMPA authorization (as applicable) to operators to authorize take incidental to seismic surveys. The proposed regulations would establish a framework for authorization of incidental take by Level A and Level B harassment through MMPA authorization (as applicable). Once an ITR and subsequent LOA is complete, the Biological Opinion and associated Incidental Take Statement may be amended to exempt take for Gulf of Mexico Bryde's whale and sperm whale, which are listed under the ESA. Following development of the ITRs, implementation could occur via issuance of MMPA authorization (as applicable and as Letters of Authorization [LOAs]) upon request from individual industry applicants planning specific seismic survey activities.

These protocols are the result of coordination between BOEM, BSEE, and NMFS and are based on: past and present mitigation measures; terms and conditions and reasonable and prudent measures identified in the attached Biological Opinion issued to the Bureaus; conditions, mitigation, monitoring, and reporting requirements identified in the MMPA ITR; and NMFS' technical memorandum on standards for a protected species observer and data management program (Baker et al. 2013). BSEE is tasked as the lead agency for compiling lessee or operator reporting data required under current Biological Opinions applicable to both Bureaus. Therefore, while BOEM is issuing these protocols, all observer reports described herein must be submitted to BSEE as well as to NMFS where specified.

In order to protect ESA-listed species and marine mammals during seismic operations, seismic operators will be required to use protected species observers (PSOs) and follow specific seismic survey protocols when operating. These measures contained herein apply to all on-lease ancillary activity surveys conducted under 30 CFR Part 550 and all off-lease surveys conducted under 30 CFR Part 551, regardless of water depth. Operators must demonstrate your compliance with these requirements by submitting to BSEE and NMFS certain reports as detailed below.

Definitions

Terms used in these protocols have the following meanings:

1. Protected species means any species listed under the ESA and/or protected by the MMPA. The requirements discussed herein focus on marine mammals and sea turtles since these species are the most likely to be observed during seismic surveys. However, other ESA-listed species (e.g., giant manta rays) are also protected and observations of them should be reported as detailed below.
2. Airgun means a device that releases compressed air into the water column, creating an acoustical energy pulse with the purpose of penetrating the seafloor.
3. Deep penetration surveys are those using a large airgun array as the acoustic source. These surveys may in some cases collect return signals using sensors incorporated into ocean-bottom cables (OBC) or autonomous ocean-bottom nodes (OBN) placed

on the seafloor. These surveys are also referred to as high energy surveys.

4. Shallow penetration surveys are those using a small airgun array or single airgun, or could include certain non-airgun acoustic sources (e.g., “boomer,” a type of sub-bottom profiler) as the acoustic source. These surveys are also referred to as low energy surveys.
5. Ramp-up (sometimes referred to as "soft start") means the gradual and systematic increase of emitted sound levels from an airgun array. Ramp-up begins by first activating a single airgun of the smallest volume, followed by doubling the number of active elements in stages until the full complement of an array's airguns are active. Each stage should be approximately the same duration, and the total duration should not be less than approximately 20 minutes for deep penetration surveys.
6. Shutdown of an airgun array means the immediate de-activation of all individual airgun elements of the array.
7. Exclusion zone means the area to be monitored for possible shutdown in order to reduce or eliminate the potential for injury of protected species. Two exclusion zones are defined, depending on the species and context. For beaked whales, *Kogia* spp., sperm whales, and baleen whales, the exclusion zone encompasses the area at and below the sea surface out to a radius of 1.5 kilometers from the edges of the airgun array (0–1,500 meters). For all other protected species, the exclusion zone encompasses the area at and below the sea surface out to a radius of 500 meters from the edges of the airgun array (0–500 meters).
8. Buffer zone means an area beyond the exclusion zone to be monitored for the presence of protected species that may enter the exclusion zone. During pre-clearance monitoring (i.e., before ramp-up begins), the buffer zone also acts as an extension of the exclusion zone in that observations of marine mammals and sea turtles within the buffer zone would also prevent airgun operations from beginning (i.e. ramp-up). The buffer zone is not applicable for contexts that require an exclusion zone beyond 500 meters. The buffer zone encompasses the area at and below the sea surface from the edge of the 0– 500 meter exclusion zone, out to a radius of 1000 meters from the edges of the airgun array (500–1,000 meters).
9. Visual monitoring means the use of trained protected species observers (herein referred to as visual PSOs) to scan the ocean surface visually for the presence of protected species. These observers must have successfully completed a visual observer training program as described below. The area to be scanned visually includes primarily the exclusion zone, but also the buffer zone. Visual monitoring of the exclusion zones and adjacent waters is intended to establish and, when visual conditions allow, maintain zones around the sound source that are clear of marine mammals and sea turtles, thereby reducing or eliminating the potential for injury. Visual monitoring of the buffer zone is intended to (1) provide additional protection to marine mammals and sea turtles and awareness and potential protection of other visual protected species that may be in

the area during pre-clearance, and (2) during airgun use, aid in establishing and maintaining the exclusion zone by alerting the visual observer and crew of marine mammals and sea turtles that are outside of, but may approach and enter, the exclusion zone.

10. Acoustic monitoring means the use of trained personnel (sometimes referred to as passive acoustic monitoring [PAM] operators, herein referred to as acoustic PSOs) to operate PAM equipment to acoustically detect the presence of marine mammals. These observers must have successfully completed a passive acoustic observer training program as described below. Acoustic monitoring is intended to further support visual monitoring in maintaining an exclusion zone around the sound source that is clear of marine mammals, in part for the purpose of reducing or eliminating the potential for injury. In cases where visual monitoring is not effective (e.g., due to weather, nighttime), acoustic monitoring may be used to allow certain activities to occur, as further detailed below.

General Requirements

1. A copy of a MMPA incidental take authorization (as applicable) and BOEM-approved Permit/Plan must be in the possession of the vessel operator, other relevant personnel, the lead PSO (see description below), and any other relevant designees operating under the authority of the MMPA authorization (as applicable) and BOEM Permit/Plan.
2. The MMPA authorization (as applicable) and BOEM-approved Permit/Plan holder shall instruct relevant vessel personnel with regard to the authority of the protected species monitoring team, and shall ensure that relevant vessel personnel and the protected species monitoring team participate in a joint onboard briefing (hereafter PSO briefing) led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, protected species monitoring protocols, operational procedures, and MMPA authorization (as applicable) and BOEM Permit/Plan requirements are clearly understood. This PSO briefing must be repeated when relevant new personnel join the survey operations before work commences.
3. The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be communicated to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

Protected Species Observers (PSOs, Visual and Acoustic)

Qualifications

1. The MMPA authorization (as applicable) and BOEM-approved Permit/Plan holder must use independent, dedicated, trained visual and acoustic PSOs, meaning that the PSOs must be employed by a third-party observer provider, may have no tasks other than to conduct observational effort (visual or acoustic), collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course appropriate for their designated task (visual or acoustic). Acoustic PSOs are required to complete specialized training for operating PAM systems and are encouraged to have familiarity with the vessel with which they will be working. PSOs can act as acoustic or visual observers (but not at the same time) as long as they demonstrate to NMFS (nmfs.psoreview@noaa.gov) that their training and experience are sufficient to perform necessary tasks. NMFS must review and approve PSO resumes accompanied by a relevant training course information packet that includes the name and qualifications (i.e., experience, training completed, or educational background) of the instructor(s), the course outline or syllabus, and course reference material as well as a document stating successful completion of the course. NMFS shall have one week to approve PSOs from the time that the necessary information is submitted by the BOEM-approved Permit/Plan holder, after which PSOs meeting the minimum requirements shall automatically be considered approved.
2. NMFS approves PSOs as conditional or unconditional. A conditionally-approved PSO may be one who is trained but has not yet attained the relevant experience, or who has attained the necessary level of experience but not in the particular region. An unconditionally-approved PSO is one who has attained the necessary experience within the relevant region. At least one of the visual and two of the acoustic PSOs aboard the vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience. One visual PSO with such experience shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. To the maximum extent practicable, the lead PSO shall devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.
    a. PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program. PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or

equivalent in the biological sciences, and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted by the BOEM-approved Permit/Plan holder to NMFS (nmfs.psoreview@noaa.gov) and must include written justification. Requests shall be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to: (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored protected species surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

Equipment

The MMPA incidental take authorization (as applicable) and BOEM-approved Permit/Plan holder is required to:

1. Provide PSOs with bigeye binoculars (e.g., 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel.
2. Work with the selected third-party observer provider to ensure PSOs have all equipment (including backup equipment) needed to adequately perform necessary tasks, including accurate determination of distance and bearing to observed protected species. Such equipment, at a minimum, shall include:
    a. Each vessel requiring PAM will include a passive acoustic monitoring system that has been verified and tested by an experienced acoustic PSO that will be using it during the trip for which monitoring is required.
    b. Reticle binoculars (e.g., 7 x 50) of appropriate quality (at least one per PSO, plus backups)
    c. Global Positioning Units (GPS) (plus backup)
    d. Digital camera with a telephoto lens (the camera or lens should also have an image stabilization system) that is at least 300 mm or equivalent on a full-frame single lens reflex (SLR) (plus backup)Radios for communication among vessel crew and PSOs (at least one per PSO, plus backups)
    e. Any other tools necessary to adequately perform necessary PSO tasks.

    Equipment specified in (a) through (g) above may be provided by an individual PSO, the third-party observer provider, or the MMPA authorization (as applicable) and BOEM-approved Permit/Plan holder but the latter is responsible for ensuring PSOs have the proper equipment required to perform the duties specified within these protocols.

Visual Monitoring

1. During survey operations (e.g., any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of two visual PSOs must be on duty and conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset).
2. Visual monitoring of the exclusion and buffer zones must begin no less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.
3. Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.
4. PSOs shall establish and monitor applicable exclusion and buffer zones. These zones shall be based upon the radial distance from the edges of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source (i.e., anytime the acoustic source is active, including ramp-up), occurrences of protected species within the buffer zone (but outside the exclusion zone) should be communicated to the operator to prepare for the potential shutdown for marine mammals (or voluntary pause for other non-marine mammal protected species [e.g., sea turtles] if being employed) of the acoustic source.
5. Visual PSOs shall immediately communicate all observations to the on duty acoustic PSO(s), including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.
6. Any observations of protected species by crew members aboard any vessel associated with the survey shall be relayed to the PSO team.
7. During good conditions (e.g., daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.
8. Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO.

Acoustic Monitoring

1. Applicants must provide a PAM plan to NMFS according to the MMPA authorization

including description of the hardware and software proposed for use prior to proceeding with any survey where PAM is required. The source vessel must use a towed PAM system at all times when operating in waters deeper than 100 m, which must be monitored by at a minimum one on duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source. "PAM system" refers to calibrated hydrophone arrays with full system redundancy to detect, identify, and estimate distance and bearing to vocalizing cetaceans. The PAM system must have at least one calibrated hydrophone (per each deployed hydrophone type and/or set) sufficient for determining whether background noise levels on the towed PAM system are sufficiently low to meet performance expectations, and must incorporate appropriate hydrophone elements (1 Hz to 180 kHz range) and sound data acquisition card technology for sampling relevant frequencies (*i.e.*, to 360 kHz). Applicants must provide a PAM plan including description of the hardware and software proposed for use prior to proceeding with any survey where PAM is required.

2. Acoustic PSOs shall immediately communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.
3. Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (acoustic and visual but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO.
4. Survey activity may continue for 30 minutes when the PAM system malfunctions or is damaged, while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring during daylight hours only under the following conditions:
    a. Sea state is less than or equal to BSS 4;
    b. No marine mammals (excluding delphinids) detected solely by PAM in the applicable exclusion zone in the previous two hours;
    c. NMFS and BSEE are notified via email (nmfs.psoreview@noaa.gov and protectedspecies@bsee.gov, respectively) as soon as practicable with the time and location in which operations began occurring without an active PAM system; and
    d. Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

Data Collection

PSOs must use a standardized data collection form, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements,

including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source. If required mitigation was not implemented, PSOs should record a description of the circumstances. At a minimum, the following information must be recorded within the interim reports:

1. BOEM Permit/Plan number;
2. Vessel names (source vessel and other vessels associated with survey), vessel size and type, maximum speed capability of vessel, port of origin, and call signs;
3. PSO names and affiliations;
4. Dates of departures and returns to port with port name;
5. Date and participants of PSO briefings (as discussed in General Requirements. 2.);
6. Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;
7. Vessel location (latitude/longitude) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
8. Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change;
9. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
10. Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions changed (e.g., vessel traffic, equipment malfunctions);
11. Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (i.e., pre-clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.); and
12. Upon visual observation of any protected species, the following information:
    a. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
    b. PSO who sighted the animal;
    c. Time of sighting;
    d. Vessel location at time of sighting;
    e. Water depth;
    f. Direction of vessel's travel (compass direction);
    g. Direction of animal's travel relative to the vessel;
    h. Pace of the animal;
    i. Estimated distance to the animal and its heading relative to vessel at

initial sighting;

j. Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified) and the composition of the group if there is a mix of species;
k. Estimated number of animals (high/low/best);
l. Estimated number of animals by cohort (adults, juveniles,, group composition, etc.);
m. Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);
n. Detailed behavior observations (e.g., number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior), including an assessment of behavioral responses to survey activity;
o. Animal's closest point of approach (CPA) and/or closest distance from any element of the acoustic source;
p. Platform activity at time of sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other); and
q. Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up) and time and location of the action.

13. If a marine mammal is detected while using the PAM system, the following information should be recorded:
    a. An acoustic encounter identification number, and whether the detection was linked with a visual sighting;
    b. Date and time when first and last heard;
    c. Types and nature of sounds heard (e.g., clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal);
    d. Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, and any other notable information.

Seismic Survey Protocols[1]

Pre-clearance and Ramp-up

The intent of pre-clearance observation (30 minutes) is to ensure no protected species are observed within the exclusion zones, and buffer zone if applicable (i.e., only when the exclusion zone is equal to 500 meters, see Definitions section for details on when the buffer

[1] This includes borehole or vertical seismic profile surveys.

zone is not applicable), prior to the beginning of ramp-up. During pre-clearance is the only time observations of protected species in the buffer zone would prevent operations (i.e., the beginning of ramp-up). The intent of ramp-up is to warn protected species of pending seismic operations and to allow sufficient time for those animals to leave the immediate vicinity. A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. All operators must adhere to the following pre-clearance and ramp-up requirements, which are applicable to both marine mammals and sea turtles:

1. The operator must notify a designated PSO of the planned start of ramp-up as agreed upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up in order to allow the PSOs time to monitor the exclusion and buffer zones for 30 minutes prior to the initiation of ramp-up (pre-clearance).
2. Ramp-ups shall be scheduled so as to minimize the time spent with the source activated prior to reaching the designated run-in.
3. One of the PSOs conducting pre-clearance observations must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed.
4. Ramp-up may not be initiated if any marine mammal or sea turtle is within the applicable exclusion or buffer zone. If a marine mammal or sea turtle is observed within the applicable exclusion zone or the buffer zone during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the zones or until an additional time period has elapsed with no further sightings (15 minutes for small odontocetes and 30 minutes for all other species including sea turtles).
5. Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Duration shall not be less than 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed.
6. PSOs must monitor the exclusion and buffer zones during ramp-up, and ramp-up must cease and the source must be shut down upon observation of a marine mammal or sea turtle within the applicable exclusion zone. Once ramp-up has begun, observations of marine mammals and sea turtles within the buffer zone do not require shutdown, or voluntarily pause for other non-marine mammal protected species (e.g., sea turtles) if being employed, but such observation shall be communicated to the operator to prepare for the potential shutdown, or voluntarily pause if being employed.
7. Ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at times of poor

visibility where operational planning cannot reasonably avoid such circumstances.

8. If the acoustic source is shut down for brief periods (i.e., less than 30 minutes) for reasons other than that described below in *Shutdown* (e.g., mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant visual and/or acoustic observation and no visual detections of marine mammals or sea turtles have occurred within the applicable exclusion zone and no acoustic detections of marine mammals have occurred. For any longer shutdown, pre-clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (e.g., BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation was maintained, pre-clearance watch of 30 min is not required.
9. Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance of 30 min.

Shutdown

For non-marine mammal protected species (e.g., sea turtles), shutdowns are not required. However, the BOEM Permit or authorized Plan and MMPA authorization (as applicable) holder may employ a voluntary pause during which the visual PSO would request that the operator voluntarily pause the airgun array for six shots if a non-marine mammal protected species is observed within the exclusion zone (within 500 meters) during active airgun use, to let the animal float past the array while it is inactive. For marine mammals, all operators must adhere to the following shutdown requirements:

1. Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source if a marine mammal is detected within the applicable exclusion zone.
2. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown, and voluntary pause commands (optional for other protected species) are conveyed swiftly while allowing PSOs to maintain watch.
3. When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs.
4. When the airgun array is active (i.e., anytime one or more airguns is active, including during ramp-up) and (1) a marine mammal appears within or enters the applicable exclusion zone and/or (2) a marine mammal (excluding delphinids) is detected acoustically and localized within the applicable exclusion zone, the acoustic source must be shut down. When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation.
5. The shutdown requirement is waived for dolphins of the following genera: *Steno*, *Tursiops*, *Stenella*, and *Lagenodelphis*.

a. If a small delphinid (individual of the Family Delphinidae, which includes the aforementioned dolphin genera), is acoustically detected and localized within the exclusion zone, no shutdown is required unless the acoustic PSO or a visual PSO confirms the individual to be of a genera other than those listed above, in which case a shutdown is required.

6. If there is uncertainty regarding identification (i.e., whether the observed marine mammal(s) belongs to one of the delphinid genera for which shutdown is waived or one of the species with a larger exclusion zone), visual PSOs may use best professional judgment in making the decision to call for a shutdown.
7. Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable exclusion zone (i.e., animal is not required to fully exit the buffer zone where applicable) or following a 30-minute clearance period with no further observation of the marine mammal(s).

Shallow penetration protocols

1. Shallow penetration surveys are defined as surveys using airgun arrays with total volume equal to or less than 400 in^3, single airguns, boomers, or equivalent sources.
2. LOA-holders shall follow the requirements defined for deep penetration surveys at § 217.184(b), with the following exceptions:
    a. PAM is not required for shallow penetration surveys.
    b. Ramp-up for small airgun arrays must follow the procedure described above for large airgun arrays, but may occur over an abbreviated period of time. Ramp-up is not required for surveys using only a single airgun. For sub-bottom profilers, power should be increased as feasible to effect a ramp-up.
    c. Two exclusion zones are defined, depending on the species and context. A standard exclusion zone encompassing the area at and below the sea surface out to a radius of 100 meters from the edges of the airgun array (if used) or from the acoustic source (0-100 m) is defined. For special circumstances (§ 217.184(b)(6)(v)), the exclusion zone encompasses an extended distance of 500 meters (0-500 m).
    d. The buffer zone encompasses the area at and below the sea surface from the edge of the 0-100 meter exclusion zone out to a radius of 200 meters from the edges of the airgun array (if used) or from the acoustic source (100-200 meters). The buffer zone is not applicable when the exclusion zone is greater than 100 meters.

Non-Airgun High-Resolution Geophysical (HRG) Protocol

Non-airgun HRG surveys are conducted in leases and along pipeline routes to evaluate the potential for geohazards, archaeological resources, and certain types of benthic communities. Non-airgun HRG sources include but are not limited to side-scan sonars, boomers, sparkers (in limited situations) and compressed high-intensity radiated pulse (CHIRP) subbottom profilers (in limited situations), and single-beam or multibeam depth sounders.

Non-Airgun HRG Surveys with Frequencies ≥180 kHz

Acoustic sources do not require detailed analyses because the frequency is outside the general hearing range of marine mammals.

Non-Airgun HRG Surveys with Frequencies <180 kHz

For all non-airgun HRG surveys in which one or more active acoustic sound sources are operating at these frequencies, the following will be required for the indicated water depths. PAM is not required for any HRG survey. No shutdowns would be required for HRG surveys. Pre-clearance watch is required for a period of 30 minutes and over a 200-m radius from the acoustic source.

Shallow-water (< 100 m)

1. Employ a minimum of one visual PSO, which may be a crew member. PSOs employed during shallow-water HRG surveys are only required during a pre-clearance period.

Deep-water (> 100 m)

1. Employ a minimum of one independent visual PSO during all daylight operations, in the same manner as was described for deep and shallow airgun penetration surveys.
2. PSOs are not required during survey operations in which the active acoustic source(s) are deployed on an autonomous underwater vehicle.

Entanglement and Entrainment Risk Reduction

All lines (rope, chain, cable, etc.) associated with geophysical surveys must be stiff, taut, and non-looping. Flexible lines such as nylon or polypropylene that could loop or tangle protected species must be enclosed in a sleeve to add rigidity and prevent looping or tangling. No excess underwater line is allowed. All equipment, especially towed apparatuses (e.g., tail buoys), shall be designed in a way as to prevent entrainment of sea turtles or other protected species.

Nodal Survey Requirements

To avoid the risk of entanglement, lessees and operators conducting surveys using ocean-bottom

nodes or similar gear must:

1. Use negatively buoyant coated wire-core tether cable;
2. Ensure any cables/lines are designed to be rigid ;
3. Retrieve all lines immediately following completion of the survey; and
4. Attach acoustic pingers directly to the coated tether cable; acoustic releases should not be used.

Reporting

1. The BOEM Permit/Plan holder shall submit interim reports (see Data Collection section for details) on the 1st of each month to BSEE (protectedspecies@bsee.gov) detailing all protected species observations with closest approach distance.
2. The MMPA authorization (as applicable) and BOEM Permit/Plan holder shall submit a draft comprehensive report to BOEM/BSEE (protectedspecies@boem.gov and protectedspecies@bsee.gov) and NMFS (nmfs.psoreview@noaa.gov) on all activities and monitoring results within 90 days of the completion of the survey or expiration of the MMPA authorization (as applicable) or BOEM Permit/Plan, whichever comes sooner, or if an issued MMPA authorization is valid for greater than one year, the summary report must be submitted on an annual basis,. The report must describe all activities conducted and sightings of protected species near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all protected species sightings (dates, times, locations, activities, associated survey activities, and information regarding locations where the acoustic source was used). The draft report shall also include geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines should include points recording any change in airgun status (e.g., when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa). GIS files shall be provided in ESRI shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data shall be made available to BOEM/BSEE and NMFS. The report must summarize the information submitted in interim monthly reports as well as additional data collected as described above in *Data Collection* and the MMPA authorization (as applicable). The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to BOEM/BSEE and NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments on the draft report.

3. Reporting injured or dead protected species:
   The MMPA authorization (as applicable) and BOEM Permit/Plan holder must report sightings of any injured or dead aquatic protected species immediately, regardless of the cause of injury or death.

   For injured or dead non-marine mammal aquatic protected species, report incidents to the hotlines listed at https://www.fisheries.noaa.gov/report (phone numbers vary by state). For reporting dead or injured marine mammals, refer to the reporting requirements specified in the MMPA authorization (as applicable), associated with the activity being conducted. The report must include the following information:

   1. Time, date, water depth and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);
   2. Relevant weather conditions (e.g., cloud cover, fog, sun glare, etc.);
   3. Name, type, call sign, and speed of the vessel during and leading up to the first sighting;
   4. Species identification (if known) or description of the animal(s) involved;
   5. Condition of the animal(s) (including carcass condition if the animal is dead);
   6. Observed behaviors of the animal(s), if alive;
   7. If available, photographs or video footage of the animal(s); and
   8. General circumstances under which the animal was discovered.

References

Baker, K., D. Epperson, G. Gitschlag, H. Goldstein, J. Lewandowski, K. Skrupky, B. Smith, and T. Turk. 2013. National standards for a protected species observer and data management program: A model using geological and geophysical surveys. Technical Memorandum NMFS-OPR-49, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration; Bureau of Ocean Energy Management, U.S. Department of the Interior; Bureau of Safety and Environmental Enforcement, U.S. Department of the Interior, Silver Spring, Maryland.

Appendix B. Gulf of Mexico Marine Trash and Debris Awareness and Elimination Survey Protocols

These protocols will be implemented by the Bureau of Ocean Energy Management (BOEM), the Bureau of Safety and Environmental Enforcement (BSEE), and operators in complying with the Endangered Species Act (ESA; 16 U.S.C. §§ 1531-1544) and Marine Mammal Protection Act (MMPA; 16 U.S.C. §§1361- 1423h).

Background

Marine trash and debris pose a threat to fish, marine mammals, sea turtles, and potentially other marine animals; cause costly delays and repairs for commercial and recreational boating interests; detract from the aesthetic quality of recreational shore fronts; and increase the cost of beach and park maintenance. As Outer Continental Shelf (OCS) oil- and gas-related activities expand into deeper waters, the number of species of protected marine animals exposed to marine debris could increase. Many marine species are protected under the Endangered Species Act (ESA) and all marine mammals (including manatees) are protected under the Marine Mammal Protection Act (MMPA). The discharge of garbage and debris has been the subject of strict laws, such as MARPOL-Annex V and the Marine Debris Act, 33 U.S.C. 1951 *et seq.*, and regulations imposed by various agencies including the United States Coast Guard and the Environmental Protection Agency.

Since OCS oil and gas operations in the Gulf of Mexico may contribute to this problem, 30 CFR 250.300(a) and (b)(6) prohibit discharging containers and other materials into the marine environment, and 30 CFR 250.300(c) and (d) require durable identification markings on skid-mounted equipment, portable containers, spools or reels, and drums, and to record and report such items when lost overboard to the District Manager through facility daily operations reports. Therefore, in accordance with 30 CFR 250.300(a) and (b)(6), exercise special caution when handling and transporting small items and packaging materials, particularly those made of non-biodegradable, environmentally persistent materials such as plastic or glass that can be lost in the marine environment and washed ashore. Increasing awareness of the problem and emphasizing offshore worker's responsibilities will help minimize the litter issue and control the unintended loss of items such as empty buckets, hard hats, shrink wrap, strip lumber and pipe thread protectors.

BSEE and BOEM consult jointly with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) under Section 7 of the ESA to ensure that BOEM or BSEE authorized activities do not jeopardize the continued existence of ESA-listed species nor result in adverse modification of designated critical habitat. Incidental take of ESA-listed species is prohibited except as authorized pursuant to an Incidental Take Statement in a Biological Opinion. Incidental take of ESA listed marine mammals cannot be authorized

under the ESA unless also authorized under the MMPA.

Marine Trash and Debris Placards

Permit holders must continue to post placards that include each of the information text boxes in Attachment 1 of this Appendix in prominent places on all fixed and floating production facilities that have sleeping or food preparation capabilities and on mobile drilling units engaged in oil and gas operations in the Gulf of Mexico OCS. Each of the placards depicted, with the language specified, must be displayed on a 5x8 inch format or larger. These signs must be displayed at line-of-sight height at or near boat landings and heliports; in mess areas; and in the recreation, training or orientation areas. One or more areas may be omitted if there is insufficient space. These notices must be referenced, and their contents explained, during any initial orientation given on the facility for visitors or occupants. Placards must be sturdy enough to withstand the local environment and must be replaced when damage or wear compromises readability.

Marine Trash and Debris Awareness Training

All OCS offshore employees and those contractors actively engaged in OCS offshore operations (e.g., wireline operators, contract lease operators, and maintenance or construction crews) should complete marine trash and debris awareness training annually.

The training for employees and contractors consists of two parts: (1) viewing a marine trash and debris training video or slide show (described below); and (2) receiving an explanation from management personnel of the lessee or designated lease operator that emphasizes their commitment to the requirements.

You may obtain the marine trash and debris training video, training slide packs, and other marine debris related educational material produced by the Offshore Operators Committee (OOC), through the OOC website at https://www.ooctraining.org/ or https://www.bsee.gov/debris. The video and slides are offered in English and Spanish versions and the video is available as a DVD or VHS tape. The video, slides, and related material may also be downloaded directly from the website.

Marine Trash and Debris Awareness Training and Certification Process

Permit holders and offshore operators must continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that the employees and contractors specified above are in fact trained. Your training process must include the following elements:

1) viewing of either the video or the slide show by the personnel specified above using one of the following methods:
   a) attendance at periodic meetings held for this purpose;
   b) as part of several scheduled training components;
   c) web-based training with email notification; or
   d) training by a third-party contractor;
2) an explanation from the management that conveys the commitment of the company to achieve the objectives of the trash and debris containment requirement;
3) attendance measures (initial and annual); and
4) recordkeeping and availability of records for inspection by BSEE.

By January 31st of each year, you must provide BSEE and NMFS with an annual report (1-2 pages) signed by a company official that describes your marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. You should send the report by email to marinedebris@bsee.gov[1].

In lieu of emailing the report, you may send a printed copy to:

Bureau of Safety and Environmental Enforcement
Gulf of Mexico OCS Region
Office of Environmental Compliance (MS GE466)
1201 Elmwood Park Blvd.
New Orleans, Louisiana 70123

Contact

Please submit any questions by e-mail to: marinedebris@bsee.gov.

[1] BSEE will forward these reports to NMFS per the requirements under this biological opinion.

Attachment 1

Marine Debris Placards

WHAT IS MARINE DEBRIS?

Marine debris is any object or fragment of wood, metal, glass, rubber, plastic, cloth, paper or any other man-made item or material that is lost or discarded in the marine environment. Marine debris may be intentionally dumped, accidentally dropped, or indirectly deposited. Whatever the source, marine debris is a direct result of human activities on land and at sea. Depending upon its composition, marine debris may sink to the seafloor, drift in the water column, or float on the surface of the sea. Certain debris, such as plastics, can persist for hundreds of years in the marine environment without decomposing.

WARNING!

YOUR ACTIONS MAY SUBJECT YOU TO SEVERE LEGAL CONSEQUENCES!

The disposal and/or discharge of any solid waste anywhere in the marine environment (other than ground-up food particles) is strictly prohibited by U.S. Coast Guard and Environmental Protection Agency regulations. THIS INCLUDES MATERIALS OR DEBRIS ACCIDENTALLY LOST OVERBOARD.

The disposal of equipment, cables, chains, containers or other materials into offshore waters is prohibited by the Bureau of Safety and Environmental Enforcement (30 CFR 250.300(b)(6)). THIS INCLUDES MATERIALS OR DEBRIS ACCIDENTALLY LOST OVERBOARD.

ATTENTION!

MARINE DEBRIS MAY CAUSE SEVERE ECOLOGICAL DAMAGE!

Marine debris discarded or lost from offshore and coastal sources may injure or kill fish, marine mammals, sea turtles, seabirds and other wildlife.

Thousands of marine animals, including marine mammals, sea turtles and seabirds, die every year from entanglement in fishing line, strapping bands, discarded ropes and nets and plastic six-pack rings. Additionally, unknown numbers of marine animals die each year from internal injury, intestinal blockage and starvation as a result of ingesting marine debris.

Marine debris fouls boat propellers and clogs water intake ports on engines thereby endangering the safety of fishermen and boaters and resulting in heavy loss of time and money.

Marine debris detracts from the aesthetic quality of recreational beaches and shorelines and increases the cost of park and beach maintenance.

ATTENTION!

SECURE ALL LOOSE ARTICLES!

NOAA Fisheries now expects petroleum industry personnel to pick up and recover any articles lost overboard from boats and offshore structures as safety conditions permit. Additionally, 30 CFR 250.300 (d) requires recording and reporting items lost overboard to the District Manager through facility daily operations reports.

Protect marine animals, as well as your valuable time and money, by doing the following to prevent accidental loss of these items:

Properly securing all materials, equipment, and personal belongings. Articles such as hardhats, life vests, sunglasses, cigarette lighters, parts bags, buckets, shrink wrap, strip lumber, and pipe thread protectors become marine debris when lost overboard.

Making sure that all trash receptacles have tight fitting lids and that the lids are used.

Providing and using secure cigarette butt containers. Cigarette butts are one of the most common forms of marine debris. Many cigarette butts contain some form of plastic and do not decompose in the ocean. Cigarette butts pose a major threat to marine wildlife as they resemble food and cause gut blockages and starvation when ingested.

Do your part to eliminate marine debris. Encourage others to be responsible about marine debris by making suggestions to secure potential marine debris on your boat or structure or by participating in a beach cleanup.

Appendix C. Gulf of Mexico Vessel Strike Avoidance and Injured/Dead Aquatic Protected Species Reporting Protocols

These protocols will be implemented by the Bureau of Ocean Energy Management (BOEM), the Bureau of Safety and Environmental Enforcement (BSEE), and provide guidelines to operators in complying with the Endangered Species Act (ESA; 16 U.S.C. §§ 1531-1544) and Marine Mammal Protection Act (MMPA; 16 U.S.C. §§1361- 1423h). The measures contained herein apply to all vessels associated with the federally regulated oil and gas program in the Gulf of Mexico.

Aquatic Protected Species Identification

Crew and supply vessel personnel should use a Gulf of Mexico reference guide that includes identifying information on marine mammals, sea turtles, and other marine protected species (i.e., Endangered Species Act listed species such as Gulf sturgeon, giant manta ray, or oceanic whitetip shark; hereafter collectively termed "other aquatic protected species") that may be encountered in the Gulf of Mexico Outer Continental Shelf (OCS). Vessel operators must comply with the below measures except under extraordinary circumstances when the **safety of the vessel or crew is in doubt or the safety of life at sea is in question**.

Vessel Strike Avoidance

1. Vessel operators and crews must maintain a vigilant watch for all aquatic protected species and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any protected species. A single aquatic protected species at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should always be exercised. A visual observer aboard the vessel must monitor a vessel strike avoidance zone (species-specific distances detailed below) around the vessel according to the parameters stated below, to ensure the potential for strike is minimized. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members (e.g., captain), but crew members responsible for these duties must be provided sufficient training to distinguish aquatic protected species to broad taxonomic groups, as well as those specific species detailed further below.
2. Vessel speeds must also be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages (greater than three) of any marine mammal are observed near a vessel.
3. All vessels must maintain a minimum separation distance of 100 meters (m) from

sperm whales, and 500 m from any baleen whale to specifically protect the Gulf of Mexico Bryde's. If a large whale species is unidentifiable, then the vessel/observer/crew should act upon their actions per these mitigations as if it is a baleen whale.

4. All vessels must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 meters from all "other aquatic protected species" including sea turtles, with an exception made for those animals that approach the vessel.
5. When aquatic protected species are sighted while a vessel is underway, the vessel should take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If aquatic protected species are sighted within the relevant separation distance, the vessel should reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This does not apply to any vessel towing gear (e.g., source towed array and site clearance trawling).
6. If a manatee is sighted, vessels associated with the project should operate at "no wake/idle" speeds within that area. Vessels should follow routes of deep water whenever possible and attempt to maintain a distance of 50 m if practicable. This does not apply to any vessel towing gear (e.g., source towed array and site clearance trawling).
7. Any BOEM/BSEE-authorized or -permitted activity occurring within the Eastern Planning Area will be subject to a step-down review with NMFS under the attached 2020 biological opinion on BOEM Oil and Gas Program Activities in the Gulf of Mexico.

The above requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of that restriction, is unable to comply.

Injured/Dead Protected Species Reporting

Vessel operators must report sightings of any injured or dead aquatic protected species immediately, regardless of whether the injury or death is caused by your vessel. If the injury or death was caused by a collision with the operator's vessel, an entrapment within the operator's equipment or vessel (e.g. moon pool), or an entanglement within the operator's equipment, the operator must further notify BOEM and BSEE within 24 hours of the strike or entrapment/entanglement by email to protectedspecies@boem.gov and protectedspecies@bsee.gov[1].

[1] BOEM/BSEE will forward these reports to NMFS ESA section 7 biologist per reporting requirements under the attached biological opinion terms and conditions.

For injured or dead non-marine mammal aquatic protected species, report incidents to the hotlines listed at https://www.fisheries.noaa.gov/report (phone numbers vary by state). For reporting dead or injured marine mammals, refer to the reporting requirements specified in the MMPA authorization (as applicable), associated with the activity being conducted. The report must include the following information:

1. Time, date, water depth and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);
2. Relevant weather conditions (e.g., cloud cover, fog, sun glare, etc.);
3. Name, type, call sign, and speed of the vessel during and leading up to the first sighting;
4. Species identification (if known) or description of the animal(s) involved;
5. Condition of the animal(s) (including carcass condition if the animal is dead);
6. Observed behaviors of the animal(s), if alive;
7. If available, photographs or video footage of the animal(s); and
8. General circumstances under which the animal was discovered.

Appendix D. Fisheries Take of Turtles

Table A- 1. Summary of Anticipated 3-year Take and Mortality Estimates for the Coastal Migratory Pelagic Resources in the Atlantic and Gulf of Mexico (NMFS 2015).

Species	Take	Total
Green sea turtle North Atlantic DPS	Total	31
	Lethal	9
Loggerhead sea turtle NWA DPS	Total	27
	Lethal	7
Kemp's ridley sea turtle	Total	8
	Lethal	2
Hawksbill sea turtle	Total	1
	Lethal	1
Leatherback sea turtle	Total	1
	Lethal	1
Smalltooth sawfish	Total	1
	Lethal	0
Atlantic sturgeon GM DPS	Total	2 (12)
	Lethal	0
Atlantic sturgeon NYB DPS	Total	4 (12)
	Lethal	0
Atlantic sturgeon CB DPS	Total	3 (12)
	Lethal	0
Atlantic sturgeon Carolina DPS	Total	4 (12)
	Lethal	0
Atlantic sturgeon SA DPS	Total	10 (12)
	Lethal	0

Table A- 2. Anticipated takes over 3-years for the Highly Migratory Species Atlantic Shark and Smoothhound Fisheries (NMFS 2012).

Sea Turtles	Non-Lethal Take	Lethal Take	Total Estimated Take
Loggerhead	48	78	126
Green	24	33	57
Leatherback	9	9	18
Kemp's ridley	15	21	36
Hawksbill	9	9	18
Marine Fish	**Non-Lethal Take**	**Lethal Take**	**Total Estimated Take**
Smalltooth sawfish	25	7	32
Atlantic sturgeon	GOM DPS = 27	GOM DPS = 9	GOM DPS = 36
	NYB DPS = 129	NYB DPS = 30	NYB DPS = 159
	CB DPS = 36	CB DPS = 9	CB DPS = 45
	SA DPS = 51	SA DPS = 12	SA DPS = 63
	Carolina DPS = 12	Carolina DPS = 6	Carolina DPS = 18
	All DPSs = 255	All DPSs = 66	All DPSs = 321
GOM = Gulf of Maine, NYB = New York Bight, CB = Chesapeake Bay, and SA = South Atlantic.			

Table A- 3. Anticipated takes over 3-years for the Southeast U.S. Shrimp Fisheries in Federal Waters (NMFS 2014).

Species	Otter Trawl Interactions, Captures, and Mortalities	Try Net Interactions**, Captures, and Mortalities	Otter Trawl and Try Net Combined Interactions, Captures, and Mortalities
Atlantic Sturgeon [31]	1710 total interactions, including 222 captures of which 27 are expected to be lethal every three years*, with DPS limits as follows: • Gulf of Maine DPS ≤ 156 interactions, including 21 captures, of which 3 are expected to be lethal • New York Bight DPS ≤ 447 interactions, including 60 captures, of which 9 are expected to be lethal • Chesapeake Bay DPS ≤ 309 interactions, including 42 captures, of which 6 are expected to be lethal • Carolina DPS ≤ 498 interactions, including 66 captures, of which 9 are expected to be lethal • South Atlantic DPS ≤ 1353 interactions, including 177 captures, of which 21 are expected to be lethal	63total interactions, all resulting in capture and of which none are expected to be lethal every three years*, with DPS limits as follows: • Gulf of Maine DPS ≤ 6 interactions all resulting in captures, of which none are expected to be lethal • New York Bight DPS ≤ 18 capture, of which none are expected to be lethal • Chesapeake Bay DPS ≤ 12 interactions, all resulting in capture, of which none are expected to be lethal • Carolina DPS ≤ 21 interactions all resulting in capture, of which none are expected to be lethal • South Atlantic DPS ≤ 51 interactions all which resulting in capture, of which none are expected to be lethal	1773 total interactions, including 285 captures of which 27 are expected to be lethal every three years*, with DPS limits as follows: • Gulf of Maine DPS ≤ 162 interactions, including 27 captures, of which 3 are expected to be lethal • New York Bight DPS ≤ 465 interactions, including 66 captures, of which 9 are expected to be lethal • Chesapeake Bay DPS ≤ 312 interactions, including 54 captures, of which 6 are expected to be lethal • Carolina DPS ≤ 519 interactions, including 87 captures, of which 9 are expected to be lethal • South Atlantic DPS ≤ 1404 interactions, including 228 captures, of which 21 are expected to be lethal
Smalltooth Sawfish	288 (105) every three years	--	288 (105) every three years

*Incidental take will be monitored based on the 3-year running totals (e.g., 2012-2014, 2013-2015)
**All try net interactions result in captures

Table A- 4. Anticipated take over three years starting in 2010 under the Gulf Of Mexico Reef Fish Fishery Management Plan (NMFS 2011).

Species	Commercial Bottom Longline Takes (Mortalities)	Commercial Vertical Line Takes (Mortalities)	Recreational Vertical Line Takes (Mortalities)	Vessel Strike Takes- All Lethal	Entire Fishery Takes (Mortalities)
Loggerhead	644 (397)[A] 623 (384)[B]	77 (23)	254 (75)	90(90)	1065 (585)[A] 1044 (572)[B]
Kemp's ridley	3 (3)	22 (7)	74 (22)	9 (9)	108 (41)
Green	3 (3)	14 (4)	45 (14)	54 (54)	116 (75)
Leatherback	3 (3)	1 (1)	1 (1)	6 (6)	11 (11)
Hawksbill	3 (3)	1 (1)	2 (1)	3 (3)	9 (8)
Smalltooth sawfish	2 (0)	2 (0)	4 (0)	0 (0)	8 (0)

[A]=anticipated in 2010-2012; [B]=anticipated for all subsequent three-year running totals (i.e., 2011-2013, 2012-2014, 2013-2015, etc.).

Appendix E. Summary of Oil Industry Discharges to the OCS Authorized by USEPA General NPDES Permits

Section 402 of the Clean Water Act authorizes the EPA to issue NPDES permits to regulate discharges into the nation's waters. EPA will issue a permit if they determine that the proposed discharges will not result in unreasonable degradation. Factors for determining unreasonable degradation can be found at 40 CFR 125.122. The EPA's review of information provided for the issuance of general permits GMG290000 and GEG460000 has not resulted in a determination of degradation of the impacted waters. These permits considered the following discharges, restrictions, and monitoring requirements:

1. **Drilling fluids/muds** – Fluids that are pumped down the drill pipe to counteract formation pressure, remove drill cuttings, cool the drill bit, and support the bore hole. They are often referred to as drilling muds due to the addition of fine-grained solids, inorganic salts, and organic additives. There are two main types of drilling fluids: water-based fluids (WBF) and Non-aqueous based fluids (NABF) which include oil based fluids (OBF) and synthetic-based fluids (SBF). Drilling fluids often contain barite which is a source of cadmium and mercury, which have been shown to bio-accumulate in marine organisms.

   Restrictions: (1) The discharge of non-aqueous based drilling fluid is prohibited, except that which adheres to cuttings and small volume discharges. Non-aqueous base fluids may be used as a carrier fluid (transporter fluid), lubricity additive or pill in water based drilling fluids and discharged with those drilling fluids provided the discharge continues to meet the "No free oil" and 96-hour LC50 toxicity limits (see below for description), and a pill is removed prior to discharge. (2) The discharge of oil-based drilling fluids and oil-based inverse emulsion drilling fluids are prohibited. (3) Drilling fluids to which any diesel oil has been added as a lubricant may not be discharged. (4) There shall be no discharge of drilling fluids to which barite has been added, if such barite contains mercury in excess of 1.0 mg/kg (dry weight) or cadmium in excess of 3.0 mg/kg (dry weight). (5) No free oil shall be discharged as measured using the static sheen test method. (6) All facilities are subject to a maximum discharge rate of 1,000 barrels per hour.

   Toxicity testing: Operators wanting to discharge drilling fluids must conduct testing to insure the effluent is not toxic to marine organisms. Discharges must meet both a daily minimum and a monthly average minimum 96-hour lethal concentration test (LC50) in which 50% of the test organisms, *Mysidopsis bahia,* must survive the effluent medium. The effluent medium must be at least 30,000 ppm in a 9:1 seawater to drilling fluid suspended particulate phase (SPP) volumetric ratio. Monitoring shall be performed at least once per month for both a daily minimum and the monthly average. In addition, an end-of-well sample is required for a daily minimum when drilling is conducted using aqueous-based drilling fluid. The type of sample required is a grab sample, taken from beneath the shale

shaker, or if there are no returns across the shale shaker, the sample must be taken from a location that is characteristic of the overall mud system to be discharged. Permittees shall report the results on the DMR using either the full toxicity test or the partial toxicity test as specified at 58 FR 12512, March 4, 1993; however, if the partial toxicity test shows a failure, all testing of future samples from that well shall be conducted using the full toxicity test method to determine the 96-hour LC50.

Monitoring: Toxicity monitoring shall be performed at least once per month for both a daily minimum and the monthly average. Monitoring for sheen shall be performed using the static sheen method once per week when discharging. The permittee shall also maintain a precise chemical inventory of all constituents and their total volume or mass added down-hole for each well.

2. **Drill cuttings** – particles of crushed rock produced by the grinding action of the drill bit as it penetrates the earth (Neff 2005). Drill cuttings are suspended in drilling fluids and conveyed up the annulus to the surface where they are removed from the fluid and disposed.

   Restrictions: No free oil as measured using the static sheen test method. Cuttings from oil contaminated drilling fluids are prohibited, including those containing diesel oil or mineral oil. Drill cuttings generated using drilling fluids to which barite has been added shall not be discharged if the barite contains mercury in excess of 1.0 milligram per kilogram (mg/kg) dry weight or cadmium in excess of 3.0 mg/kg dry weight.

   Toxicity: Drill cuttings generated using drilling fluids that do not pass the 96-hour LC50 test described above shall not be discharged.

   Sheen Monitoring: Monitoring shall be performed using the static sheen test method once per week when discharging. Monitoring of base fluids retained on cuttings shall be performed at least once per day when generating new cuttings, unless meeting the conditions of a best management practice as described in the permits.

3. **Produced water** – The water (brine) brought up from the hydrocarbon-bearing strata during the extraction of oil or gas. This can include formation water, injection water, and any chemicals added down-hole or during the oil/water separation. Since the oil/water separation process does not completely separate the oil, some hydrocarbons remain with the produced water and often the water is treated to prevent the formation of sheen. The composition of the discharge can vary greatly in the amounts of organic and inorganic compounds and may include: aluminum, arsenic, barium, benzene, cadmium, chromium, copper, cyanide, lead, mercury, nickel, selenium, silver, and zinc among others. The EPA general permits allow the discharge of produced waters provided they meet discharge criteria. Discharge volumes are variable and may range from 500-2,500 barrels per day.

Restrictions: Discharged oil and grease cannot exceed 42 milligrams per liter (mg/l) daily maximum or 29 mg/l monthly average (technology-based limits). The discharge must also be tested for toxicity on a monthly basis.

Toxicity testing: Platforms wishing to discharge produced waters will be required to test the effluent for toxicity. Test results are good for a period of 6 months.

7-day chronic toxicity testing – Tests the survival and growth of mysid shrimp *(Mysidopsis bahia)* and larval inland silversides *(Menidia beryllina)* in a series of effluent dilutions (different dilutions based on a critical dilution as determined by flow rates and the depth of discharge for each platform) in comparison to a control group. The purpose of the test is to determine the greatest effluent dilution at which no significant effect is observed between the test and the control (no observable effects concentration - NOEC). The 7-day average minimum and monthly average minimum NOEC must be equal to or greater than the critical dilution concentration. Test is to be completed at least every 6 months.

Sheen Monitoring: Monitoring shall be performed using the static sheen test method once per day when discharging when a facility is manned. Grab sampling for oil and grease analysis will be conducted once per month. Flow rates shall also be monitored once per month.

4. **Well treatment, completion fluids, and workover fluids**
    a. Well treatment fluids are any fluids used to restore or improve productivity by chemically or physically altering hydrocarbon-bearing strata after a well has been drilled. These fluids are typically added down-hole and mostly remain within the wellbore; any fractions that may escape are subject to the limitations described in the following restrictions.
    b. Completion fluids are salt solutions, weighted brines, polymers, and various additives used to prevent damage to the well bore during operations which prepare the drilled well for hydrocarbon production.
    c. Workover fluids are salt solutions, weighted brines, polymers, or other specialty additives used in a producing well to allow for maintenance, repair, or abandonment procedures. This includes packer fluids.

    Restrictions: No free oil as measured using the static sheen test method and no priority pollutants except in trace amounts (as established in the 2005 issued permit) may be discharged. Fluids must also meet both a daily maximum of 42 mg/l and a monthly average of 29 mg/l limitation for oil and grease.

    Sheen Monitoring: Sampling for the static sheen test will be done daily when a discharge occurs. Grab sampling for oil and grease analysis will be conducted once per month and should not exceed technology-based limits.

5. **Deck drainage** – Any waste resulting from deck washings, spillage, rainwater, and runoff from gutters and drains including drip pans and work areas within facilities subject to this permit. Deck drainage of the largest concern include oil and detergents, drilling fluids, and acids used during workover operations.

Restrictions: No free oil shall be discharged as determined by the presence of a film or sheen upon the surface of the receiving water. Typically these platforms are equipped with pans to collect deck drainage. The drainage is separated by gravity into waste material and liquid effluent. Waste materials are sent to a sump tank for treatment followed by disposal, recycling back to the drilling mud system, or transport to shore. Liquid effluent is discharged to the sea.

Monitoring: Visual sheen test method to be completed once per day when discharging.

6. **Sanitary waste** – human body waste discharged from toilets and urinals located within facilities subject to this permit. The volume and concentrations of these wastes vary widely with time, occupancy, platform characteristics, and operational situation. Past monthly average sanitary waste flows from Gulf Coast platforms was approximately 35 gallons per day (EPA 1993).

   Restrictions: No floating solids and residual chlorine to be maintained as close to 1 mg/l as possible for facilities continuously manned by 10 or more persons. No floating solids for facilities continuously manned by 9 or fewer persons. Any facility that properly operates and maintains a marine sanitation device (MSD) that complies with pollution control standards and regulations under Section 312 of the Clean Water Act shall be deemed to be in compliance with permit limitations for sanitary waste.

   Monitoring: Observation for floating solids shall be conducted once daily during discharge while sampling for residual chlorine shall be done once per month. If a MSD is being used, yearly testing to insure proper operation is required.

7. **Domestic waste** – Material discharged from galleys, sinks, showers, safety showers, eye wash stations, hand washing stations, fish cleaning stations, and laundries. The volume of domestic waste discharged is estimated to be 50-100 gallons per person per day.

   Restrictions: No floating solids or foam and require compliance with the requirements of 33 CFR 151. *Region 4 only*: Any soaps and detergents must be phosphate free (contain less than 0.5% phosphate).

   Monitoring: Observation for floating solids shall be conducted daily during daylight hours by visual observation of the receiving waters in the vicinity of the outfall. Observations shall be made following either the morning or midday meals at a time of maximum estimated discharge.

8. **Miscellaneous discharges** – Various discharges of relatively small, though highly variable quantities.

   a. Hydrate control fluids – used to dehydrate natural gas in deep water operations to prevent pipeline blockages. It is unlikely that these fluids will be necessary in the relatively shallow water wells of the territorial seas of Texas. If used, however, they will typically be discharged in the produced water stream and would be limited by the same restrictions.

   b. Blowout preventer control fluid – fluid used to actuate the hydraulic equipment on the blow-out preventer or subsea production wellhead assembly. These may be

discharged periodically in small quantities (67-314 barrels per day, EPA 1993) at the sea floor.

c. Boiler blowdown – discharges from boilers necessary to minimize solids build-up in the boilers, including vents from boilers and other heating systems. Based on past operations, these may be discharged at a volume of 0-5 barrels per day (EPA 1993).
d. Diatomaceous earth filter media – filter media used to filter seawater or other authorized completion fluids and subsequently washed from the filter.
e. Excess cement slurry – the excess mixed cement, including additives and wastes from equipment wash-down, after a cementing operation.
f. Mud, cuttings, and cement at the sea floor – discharges that occur at the sea floor prior to installation of the marine riser and during marine riser disconnect, well abandonment, and plugging operations.
g. Source water and sand – water from non-hydrocarbon bearing formations for the purpose of pressure maintenance or secondary recovery.
h. Uncontaminated or treated ballast/bilge water – seawater added or removed to maintain proper draft or water from a variety of sources that accumulates in the lowest part of the vessel/facility. Volumes may be expected to range from 70-620 barrels per day (EPA 1993).
i. Uncontaminated freshwater or seawater – waters discharged without contact with or addition of chemicals, oil, or other wastes.

Restrictions: No free oil, floating solids, or foam shall be discharged.
Monitoring: Observations shall be made once per week.

9. **Chemically-treated seawater and freshwater** – waters to which corrosion inhibitors, scale inhibitors, biocides, and/or other chemicals have been added and include the following discharges:

    a. Excess seawater which allows the continuous operation of fire control and utility lift pumps
    b. Excess seawater from pressure maintenance and secondary recovery projects
    c. Water released during training and testing of personnel in fire protection
    d. Seawater used to pressure test piping and pipelines
    e. Ballast water or bilge water
    f. Non-contact cooling water
    g. Desalinization unit discharge – the residual high-concentration brine discharged offshore from distillation or reverse osmosis units used for producing potable water. Past operations have discharged this at a volume of up to 238 barrels per day (EPA 1993).

    Restrictions: No free oil and the most stringent of the 3 following conditions:

        i. The maximum concentrations and any other condition specified in the EPA product registration labeling if the chemical additive is an EPA-registered product

ii. The maximum manufacturer's recommended concentration when one exists
iii. 500mg/l

Toxicity testing: 48-hr acute toxicity test will determine if an appropriately dilute effluent sample adversely affects the survival of mysid shrimp and inland silversides. The 48-hr minimum and monthly average minimum NOEC must be equal to or greater than the critical dilution concentration (determined by the discharge rate and the pipe diameter at each facility).

Monitoring: Visual sheen test shall be conducted once per week when discharging. Monitoring for toxicity will be required at least once per 6 months when discharging.

Requirements pertaining to cooling water intake structure regulations per 40 CFR Part 125 Subpart N (Requirements Applicable to Cooling Water Intake Structures for New Offshore Oil and Gas Extraction Facilities under Section 316(b) of the Clean Water Act). These requirements will limit intake velocity, minimize impingement and entrainment, and set monitoring and record keeping requirements (40 CFR 125.134 (b)(2-8)).

In addition, the new permit will also include the following improvement:
Increased ambient water monitoring requirements are replaced with well treatment fluids study.

Appendix F. BOEM Oil and Gas Program AIS vessel types

id	Level 5 type	Level 5 description
1	Aggregates Carrier	A single deck cargo vessel for the carriage of aggregates in bulk. Also known as a Sand Carrier. May be self discharging
2	Waste Disposal Vessel	A vessel equipped for the transportation, treatment and/or (now illegal) discharge at sea of waste material
3	Crane Vessel	A vessel equipped with a large crane for lifting operations
5	Mooring Vessel	A vessel equipped to assist with the mooring and/or anchoring of larger vessels. Typically it will have a frame to prevent the ropes and chains fouling on the superstructure
10	Crude/Oil Products Tanker	A tanker for the bulk carriage of crude oil but also for carriage of refined oil products
11	Shuttle Tanker	A tanker for the bulk carriage of crude oil specifically for operation between offshore terminals and refineries. Is typically fitted with bow loading facilities
12	Pipe Burying Vessel	A vessel equipped to carry small stones and aggregates and to deliver them via a flexible fall pipe system to bury pipes and cables on the sea bed
15	Trailing Suction Hopper Dredger	A vessel equipped to obtain material from the sea bed by use of a trailing suction pipe. The material may be carried on board and discharged elsewhere through the bottom of the vessel, either by bottom doors or a split hull, or delivered to other vessels
16	Supply Platform, semi submersible	A semi submersible offshore supply platform
17	Water Tank Barge, non propelled	A non propelled tank barge for the carriage of water
19	Asphalt/Bitumen Tanker	A tanker for the bulk carriage of asphalt/bitumen at temperatures between 150 and 200 deg C
24	Cable Repair Ship	A vessel equipped for the retrieval and repair of underwater cables
25	Pipe Layer Crane Vessel	A pipe layer also equipped with a large crane or derrick

26	Bulk Cement Barge, non propelled	A non propelled barge for the carriage of bulk cement
33	FSO, Oil	A tanker purpose built or converted to store oil produced from a field prior to its transfer to another vessel for transportation. May be self or non propelled. This type does not include vessels which are temporarily being used for storage of oil
34	Jacket Launching Pontoon, semi submersible	A semi submersible pontoon designed for positioning and launching jackets for offshore use
37	Drilling Rig, jack up	A jack up offshore drilling rig
44	Combination Gas Tanker (LNG/LPG)	A tanker for the bulk carriage of Liquefied Natural Gas (primarily methane) and/or Liquefied Petroleum Gas in independent insulated tanks
52	Research Survey Vessel	A vessel equipped for research and/or survey (e.g. geophysical, hydrographic)
53	LNG Tanker	A tanker for the bulk carriage of Liquefied Natural Gas (primarily methane) in independent insulated tanks. Liquefaction is achieved at temperatures down to -163 deg C
54	Effluent carrier	A vessel equipped for the transportation of effluents. Discharge at sea is now illegal
55	Utility Vessel	A small multi functional response vessel not dedicated to a particular function
57	Anchor Handling Tug Supply	An offshore tug/supply ship equipped with a high bollard pull and a stern roller for anchor handling
58	Accommodation Platform, semi submersible	A semi submersible offshore accommodation platform
71	Cement Storage Barge, non propelled	A barge with pumping facilities for loading & discharging cement.
82	Support Platform, jack up	A non-propelled jack up vessel for offshore support
83	Pollution Control Vessel	A vessel equipped for the primary function of pollution control. Typical types include oil spill recovery vessel and a pollution and debris collector
86	Pusher Tug	A vessel equipped to push cargo-carrying barges and pontoons.
88	Bulk/Oil Carrier (OBO)	A bulk carrier arranged for the alternative (but not simultaneous) carriage of crude oil
91	Crane Platform, jack up	A jack up offshore crane platform
94	Crane Vessel, non propelled	A non self propelled vessel equipped with a large crane for lifting operations

96	Bulk Aggregates Barge, non propelled	A non propelled barge for the carriage of bulk aggregates
99	Jacket Launching Pontoon	A pontoon designed for positioning and launching jackets for offshore use
100	Crew Boat	A vessel equipped for the transportation of crew to ships and/or installations
102	Crude Oil Tanker	A tanker for the bulk carriage of crude oil
107	Hopper/Dredger (unspecified)	A vessel equipped to obtain material from the sea bed by an unspecified means. The material may be carried on board and discharged elsewhere through the bottom of the vessel, either by bottom doors or a split hull, or delivered to other vessels, pumped a
110	FSO, Gas	A tanker purpose built or converted to store gas produced from a field prior to its transfer to another vessel for transportation. May be self or non propelled. This type does not include vessels which are temporarily being used for storage of gas
112	Barge Carrier	A cargo vessel arranged for the carriage of purpose built barges (lighters) loaded with cargo. Typically loading is by way of a gantry crane. Also known as Lighter Aboard SHip vessels (LASH)
113	Grab Dredger	A vessel equipped to obtain material from the sea bed by use of a grab. The material may be carried on board, transferred to other vessels, pumped ashore or deposited elsewhere using a spray
118	Pipe Carrier	A platform supply ship equipped with increased scantlings & longer deck space for the transportation of pipes
123	Pipe layer Platform, semi submersible	A semi submersible offshore pipe layer platform
131	LPG Tanker	A tanker for the bulk carriage of Liquefied Petroleum Gas in insulated tanks, which may be independent or integral. The cargo is pressurised (smaller vessels), refrigerated (larger vessels) or both ('semi-pressurised') to achieve liquefaction.
132	Well Stimulation Vessel	A vessel primarily equipped to maximize oil production from a well
136	Grab Hopper Dredger	A vessel equipped to obtain material from the sea bed by use of a grab or backhoe. The material may be carried on board and discharged elsewhere through the bottom of the vessel, either by bottom doors or a split hull, or delivered to other vessels, pump

147	Ore/Oil Carrier	An ore carrier arranged for the alternative (but not simultaneous) carriage of crude oil
152	Maintenance Platform, semi Submersible	A semi submersible offshore maintenance platform
153	Tug	A vessel equipped with a towing winch to tow other vessels (either in harbour or in open sea) and with manoeuvring capabilities to assist vessels to berth/unberth in ports. May also be able to push barges and other vessels
155	Pipe Layer	A vessel primarily equipped to lay solid or flexible pipes on the sea bed
156	Pile Driving Vessel	A vessel equipped for pile driving operations
158	FPSO, Oil	A vessel with the capability to control production rates from an oilfield and to store oil produced prior to its transfer to another vessel for transportation. May be self or non propelled
162	Production Platform, jack up	A jack up offshore production platform
165	Offshore Tug/Supply Ship	A vessel for the transportation of stores and goods to offshore platforms on an open stern deck and equipped with a towing facility
166	CNG Tanker	A tanker for the bulk carriage of Compressed Natural Gas. Cargo remains in gaseous state but is highly compressed
167	Offshore Support Vessel	A single or multi functional offshore support vessel
168	Accommodation Platform, jack up	A jack up offshore accommodation platform
175	Water Tanker	A tanker for the bulk carriage of water
176	Trenching Support Vessel	A vessel primarily equipped to operate submersibles for digging trenches on the sea bed for pipes and cables
177	Crude Oil Tank Barge, non propelled	A non propelled tank barge for the carriage of crude oil
180	Cable Layer	A vessel equipped to lay and repair underwater cables
182	Sheerlegs Pontoon	A pontoon with sheerlegs for lifting
184	Production Platform, semi submersible	A semi submersible offshore production Platform
186	Drilling Ship	A vessel primarily equipped for offshore drilling operations. May also be able to obtain cores for research purposes
187	Anchor Handling Vessel	A vessel equipped to assist with the handling of anchors

188	Barge Carrier, semi submersible	A barge carrier which is semi submersible for the float on loading/unloading of the barges
194	Heavy Load Carrier, semi submersible	A heavy load carrier which is semi submersible for the float on loading/unloading of the cargoes
195	LPG/Chemical Tanker	An LPG tanker additionally capable of the carriage of chemical products as defined in the International Bulk Chemical Code
210	Drilling Rig, semi submersible	A semi submersible offshore drilling rig
214	Suction Dredger Pontoon	A non propelled dredger pontoon fitted with suction equipment
218	Passenger Ship	A vessel certificated to carry more than 12 passengers, some of whom may be accommodated in cabins
222	Crew/Supply Vessel	A typically high speed vessel primarily for the transportation of crew to offshore facilities; may also have limited stores carriage capability on an open deck
228	Work/Repair Vessel	A multi functional vessel for general work and repair operations
236	Floating Dock	A submersible unit constructed and fitted out to dry dock ships whilst afloat.
237	Cement Carrier	A single deck cargo vessel fitted with pumping arrangements for the carriage of cement in bulk. There are no weather deck hatches. May be self discharging
238	Salvage Ship	A vessel equipped for salvage operations
239	Diving Support Platform, semi submersible	A semi submersible diving support platform
243	Crane Platform, semi submersible	A semi submersible offshore crane platform
244	Deck Cargo Pontoon, semi submersible	A non propelled semi submersible pontoon for the carriage of general deck cargoes
248	LPG Tank Barge, non propelled	A non propelled tank barge for the carriage of LPG
251	Suction Hopper Dredger	A vessel equipped to obtain material from the sea bed by use of a suction pipe. The material may be carried on board and discharged elsewhere through the bottom of the vessel, either by bottom doors or a split hull, or delivered to other vessels
256	Supply Platform, jack up	A supply platform, jack up
258	Accommodation Ship	A vessel providing accommodation for those working on other vessels and installations

263	Standby Safety Vessel	A vessel primarily equipped to perform safety standby duties. Will be fitted with accommodation and facilities for the rescue, reception and initial care of survivors from offshore installations accidents
271	Pipe layer Platform, jack up	A jack up offshore pipe layer platform
277	Diving Support Vessel	A vessel primarily equipped with decompression chambers for air dive operation. Does not include vessels which can only operate submersibles
281	Platform Supply Ship	A vessel for the transportation of stores and goods to offshore platforms on an open deck, typically at the stern. May also be fitted with specialist under deck tanks for water, cement and/or drilling mud
286	Cutter Suction Dredger	A vessel equipped to obtain material from the sea bed by use of a cutter wheel, which loosens the material, and a suction pipe. The material may be carried on board, transferred to other vessels, pumped ashore or deposited elsewhere using a spray
297	Production Testing Vessel	A vessel primarily equipped for testing the quality and amount of oil produced by a well
298	Mechanical Lift Dock	A lifting dock facility using winches to lower and raise platform
301	Offshore Construction Vessel, jack up	A propelled vessel with a self-elevating facility to facilitate offshore maintenance, construction and/or installation
305	Grab Dredger Pontoon	A non propelled dredger pontoon fitted with a system of grabs
318	Suction Dredger	A vessel equipped to obtain material from the sea bed by use of a suction pipe. The material may be carried on board, transferred to other vessels, pumped ashore or deposited elsewhere using a spray

Appendix G. Extremely large spill assessment

Before we conducted our hazard assessment and exposure analysis for oil spills associated with the proposed action, we first assessed the available information used to determine the potential largest spill size volumes (refer to Table 114 in the Opinion), which one of these estimates of representative very large spill sizes was provided by BOEM (100,000 bbl per Ji et al. 2014).

Determination of the Upper Range of Spill Sizes

BOEM has defined very large spills as any spill volume greater than or equal to 10,000 bbl, and provided NMFS with information projecting that two oil spills greater than or equal to 10,000 bbl may occur over the duration of the proposed action. However, BOEM has not defined an upper volume for such a spill size. BOEM stated that it "does not consider an extremely large event as reasonably certain to occur" over the time frame of this opinion, although BOEM does acknowledge that impacts from the DWH blowout and resulting spill warrant inclusion in Gulf of Mexico consultation as part of the environmental baseline. For informational purposes for decision-makers, BOEM used current reservoir sizes to demonstrate the size and duration of extremely large releases in shallow water and deepwater areas. BOEM characterized an extremely large spill in shallow water as being uncontrolled flow for one to three months, resulting in an estimated range of 900,000-3,000,000 bbl released[1]. For deep water, BOEM provided information that if an extremely large event occurred and remained uncontrolled up to four months, potentially 2.7-7.2 million bbl could be released. Following our analysis of spill data and statistical assessments of the occurrence of very large spills that is explained in more detail below, we estimated the volume of the largest spill size based on the duration of a spill that could possibly occur over the timeframe of the opinion.

A fundamental challenge is to accurately describe this risk, especially since there have been relatively few large to very large oil spills that can serve as benchmarks. Prior to the DWH event, the three largest blowout spills on the U.S. OCS were 80,000 bbl, 65,000 bbl, and 53,000 bbl, and all occurred before 1971 (Anderson et al. 2012). At the present time, there is a not an ideal, standardized approach to characterizing the risk of spill occurrence and consequence. Historically, BOEM has characterized oil-spill risk using the Oil Spill Risk Analysis (OSRA) model to identify the risk of oil released from numerous locations on the OCS occurring and contacting environmental, social and economic resources. BOEM performs OSRA modeling in the evaluation of individual lease sales and certain exploration/development plans. BOEM or BSEE also consider risk during the review of an operator's Exploration Plan, Development and Production Plan (or Development Operations Coordination Document), and/or Application for Permit to Drill.

BOEM's probabilistic spill estimates use an oil spill risk method based on historical spill rates per volume of oil produced. The number of spills has been estimated for different spill sizes based on the anticipated volume of oil produced over this consultation period. One data point,

[1] BOEM 2014 Qualitative Review of Safety Measures to Minimize Frequency of Blowouts and Spills and Maximize Containment Capabilities

the DWH event, represents both the greater than or equal to 10,000 bbl and extremely large spill categories in BOEM's analyses. The lack of data for very large spills results in a high degree of statistical uncertainty. It is worth noting that BOEM's methodology would not have predicted that the DWH event would have occurred. Because of this high uncertainty to produce probabilistic estimates of the frequency of large oil spills resulting from protracted loss of well control, BOEM provided NMFS additional information to support their conclusions. BOEM provided NMFS a summary of recent peer reviewed literature regarding oil spills, information on new safety requirements, spill response preparedness, and new spill response and containment technology. Given the additional information we decided to defer to BOEM as the experts on the probability of occurrence of an extremely large spill.

To estimate a reasonable maximum possible spill size, we considered the following main factors:

- The pre-DWH spill risk considered in the 2007 biological opinion.
- The causes of blowout, loss of well control and other potential risks that cause spills.
- Information from our review of extremely large spill risk assessments provided by BOEM, federal reports, and independent studies on determining the risk and frequency of very large spills found in the peer-reviewed literature.
- Regulatory reforms and improvements in offshore drilling safety since DWH. Assuming some risk of a blowout and other risk factors, we will consider the likelihood of those risk factors that could actually result in a loss of well control and uncontrolled release of oil into the ocean.
- The volume of oil that could be spilled in the future using BOEM's estimated flow rates.
- The anticipated flow duration of an uncontrolled blowout based on our assessment of the ability of industry to rapidly respond to a blowout and bring a well under permanent control.
- The adequateness of OSRPs to prepare for extremely large spill responses, limit the duration of the spill, clean up the oil, and respond to ESA-listed species and critical habitat that may be affected.

Pre-Deepwater Horizon Risk

In the 2007 biological opinion, although BOEM did not predict a major, uncontrolled oil spill, we predicted that a single extremely large spill would occur approximately every 40 years. That estimate proved reasonably accurate, with the DWH spill's occurrence 31 years after Ixtoc I and is reflected in the 26-34 year pre-DWH extremely large spill frequency estimate found in the economic analysis prepared for BOEM's drilling safety rule (https://www.bsee.gov/sites/bsee.gov/files/research-guidance-manuals-or-best-practices/regulations-and-guidance/aa02-final-rule-8-10-12.pdf). Our 2007 opinion significantly underestimated the severity of a major uncontrolled release, as evidenced by the DWH event. The flow rate of oil from the well and the amount of time it took to bring the well under control were the primary reasons we underestimated the size of and impacts associated with the largest spill we predicted would occur. Our underestimate of impacts to listed species was the primary reason reinitiation of consultation was requested in 2010. During consultation, we emphasized

the necessity of additional information on the risk of future extremely large spills to complete this opinion.

Causes of Very Large Oil Spills and Risks

Blowouts and subsequent losses of well control are the primary concern for a very large release of oil in the Gulf of Mexico. Blowouts are generally associated with equipment failures, human error, hurricane-related failures, or a combination of these events. The DWH event has been the only disastrous blowout and loss of well control on the U.S. OCS in the Gulf of Mexico; therefore, in this section, we will review the past occurrences of blowouts, as well as some recent causes of other large, but non-disasterous oil spills.

There have been 21 blowouts associated with seven individual events that have resulted in loss of well control in the Gulf of Mexico (Table 1). Four of the spills were the result of hurricane-related failures, another four were the result of blowouts during drilling, and the remaining spills resulted from a single event where a platform shifted position and blew out all the wells connected to it. Four of these blowout-related spills, including DWH, were greater than 10,000 bbl. Until the occurrence of the DWH event, all blowout-related spills occurred between 1965 and 1970 (Table 1).

Table 1. Blowouts on the Federal OCS that have Resulted in Loss of Well Control and Oil Spills Greater than 1,000 bbl.

Year of Spill Event	Number of Blowouts	Duration (days)	Water Depth (ft)	Volume Spilled (bbl)	Details
1964	3	several days	48	5,180	Hurricane Hilda destroyed 3 platforms in Eugene Island, Block 208
1964	1	17	33	5,100	Hurricane Hilda destroyed a platform in Ship Shoal, Block 149
1965	1	8	190	1,688	Drilling Blowout in Ship Shoal, Block 29
1969	1	10	190	80,000	Drilling blowout in Santa Barbara Channel in lease area 6B 5165
1970	13	49	39	65,000	Rig shift and fire resulting in 13 blowouts in Main Pass, Block 41

Year of Spill Event	Number of Blowouts	Duration (days)	Water Depth (ft)	Volume Spilled (bbl)	Details
1970	1	138	60	53,000	Drilling blowout and fire in South Timbalier, Block 26
2010	1	86	4,992	4.9 million est.	Blowout and fire in Mississippi Canyon, Block 252

Source: BOEM BA supplemental information

Several other non-blowout-related spills were caused by Hurricane Rita in 2005 (six structures lost or damaged), Hurricane Jeanne in 1980 (one damaged structure), a sinking storage barge (one event), vessels colliding with platform (two events), and leaking storage structures (three events) (Table 2). However, all but one of these non-blowout-related spills were less than 10,000 bbl.

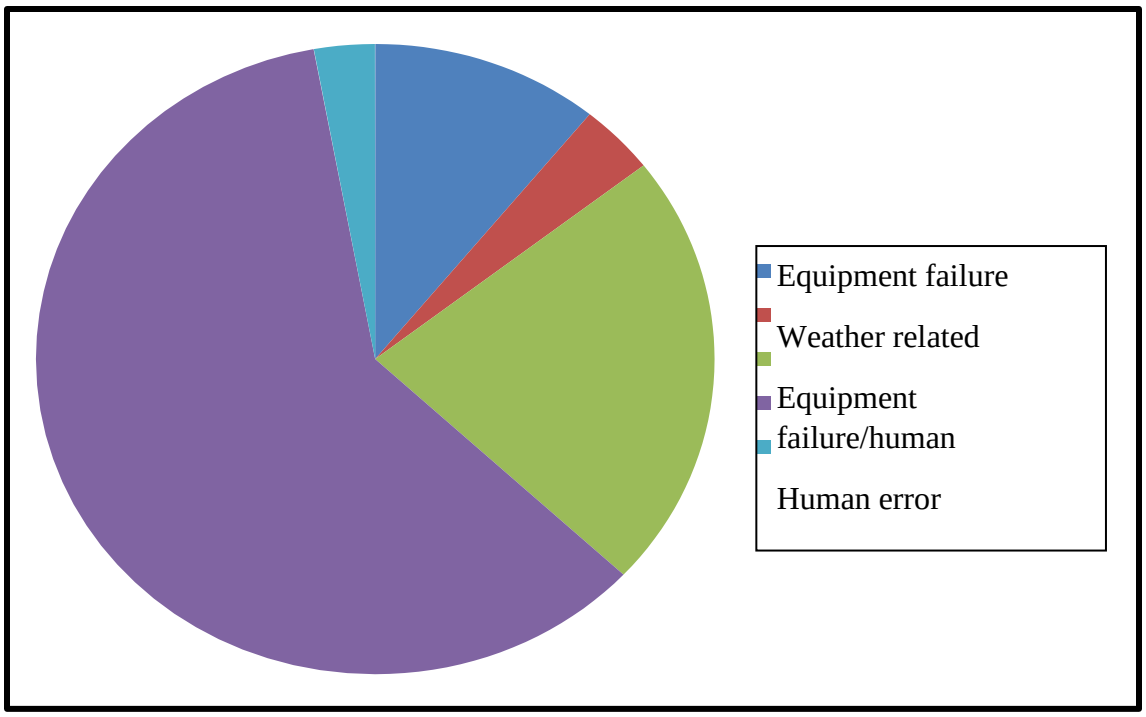
Table 2. Non-blowout Spills on the Outer Continental Shelf that Have Resulted in Spills Greater than 1,000 bbl.

Year of Spill Event	Number of Structures	Water Depth (ft)	Volume Spilled (bbl)	Details
1964	1	94	2,559	Freighter struck platform in Eugene Island, block 208.
1964	1	102	1,589	Storage tank lost during Hurricane Hilda in Ship Shoal, Block 149
1969	1	30	2,500	Supply vessel collided with a semisubmersible drilling rig in Ship Shoal, Block 72
1973	1	110	9,935	Storage tank failure in West Delta, Block 79
1973	1	61	7,000	Storage barge sank
1979	1	61	1,500	Workboat collided with a drilling rig putting a hole in a diesel tank, Main Pass, Block 151

Year of Spill Event	Number of Structures	Water Depth (ft)	Volume Spilled (bbl)	Details
1980	1	60	1,456	A storage tank overflowed during evacuation of platform during hurricane Jeanne, High Island, Block 206
2004	1		>1,000	Hurricane Ivan and underwater landslide toppled platforms and severed numerous wellheads. Low discharge, chronic oil seepage is still ongoing.
2005	3	182-238	5,066	Hurricane Rita destroyed 1 platform and 2 drilling rigs.
2013	1		1,531	Drilling rig lost station; lower marine riser emergency disconnect activated.
2015	1		2,200	Lower marine riser installation error.
2016	1		2,100	Subsea flowline.
2017	1		16,152	Subsea jumper (pipeline segment) damage.

Source: BOEM BA supplemental information

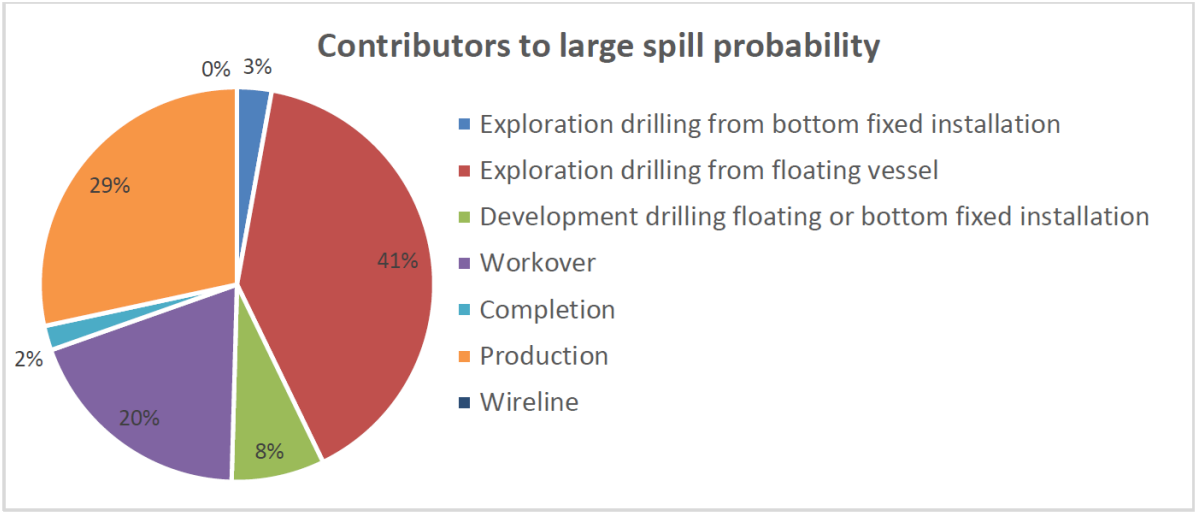
After the DWH incident, from 2011-2013 BSEE investigated 139 total accidents including 18 spill releases. One hundred and fifteen accidents (82.7 percent) were caused, at least in part, by human error and 73 (52.5 percent) were determined to have been entirely caused by human error (Figure 1). Eighteen of the accidents (12.9 percent) resulted in some type of pollution being released and those included spills of less than one gallon of gas/oil (only enough to produce a sheen), minor chemical or diesel spills associated with facility maintenance, drilling fluid releases and releases of synthetic oil based mud. Spills were mainly small volumes of oil caused by human error (misuse of equipment or failure to notice an over-pressurized vessel), sometimes leading to a series of events, and ultimately causing an unplanned release.



Source: BOEM BA supplemental information

Figure 1. Causes of oil and gas accidents reported on the Gulf of Mexico OCS from 2011-2013 as reported to BSEE.

BSEE (2017) examined loss of well control events and categorized contributors to the probability as shown in Figure 2, and Figure 3 displays BSEE's risk analysis for oil spills caused by loss of well control events. The highest risk events are the blowout (surface flow) accidents, which have potential for the more severe overall impacts (BSEE 2017). According to BSEE (2017), risk may be reduced by reducing the drilling kick frequency.



Source: BOEM BA supplemental information

Figure 2. Pie chart from BSEE (2017) displaying the categories of contributors to large spill probability.

Probability	LOWC consequence (Spill size)					
	No or insignificant spill	Minor spill (10 - 50 bbls)	Medium spill (50 -500 bbls)	Large spill (500 – 5,000 bbls)	Very large spill (5,000 - 50,000 bbls)	Gigantic spill (>50,000 bbls)
More frequent than once a year	X					
1 - 5 times in 5 year		X				
1 - 4 times in 20 year						
1- 4 times in 80 year			X			
1 - 2 times in 160 year				X	X	X
less than once in 160 year						

Source: BOEM BA supplemental information

Figure 3. Risk matrix from BSEE (2017) for oil spills caused by loss of well control events, with the X indicating BSEE's predicted loss of well control risk level. Red indicates high risk, yellow indicates moderate risk, green indicates low risk.

Based on our review of the historical spill data above, the cause of spills occurring in volumes greater than 10,000 bbl could likely be the result of a loss of well control resulting from a drilling-related blowout. Three of the four very large drilling-related blowouts that have occurred in the greater than or equal to 10,000 bbl category average a spill size of 66,000 bbl (53,000, 65,000 and 80,000 bbl) and one spill (DWH) has been extremely large (≥ three million bbl). BOEM has indicated that two spills greater than 10,000 bbl may result from the proposed action. Based on the historical data above and the estimate of the number of spills provided by BOEM, two very large (greater than 10,000 bbl) drilling-related releases of oil can be expected to occur during the next 50 years, for the reasons discussed in further detail below. The information above leads us to conclude that one of these spills can be expected as the result of a blowout resulting in a release of 100,000 bbl (per Ji et al. 2014; and Table 114, section 8.8 of the biological opinion). Since we have only a single extremely large release of oil (the DWH event) from which to estimate future impacts, we will next consider in more detail the frequency and likely largest size of such extremely large releases occurring on the OCS.

Best Available Information on the Largest Potential Spill

This section first provides a summary of some relevant peer-reviewed literature regarding statistical methods to predict the risk of extremely large spills occurring from significant uncontrolled blowouts. As discussed above, loss of well control and associated extremely large release of oil is more likely to occur in deep water due to the increased risks associated with higher well pressures and the technological challenges of drilling in deep water than are present in shallow water. Many regulatory changes have been made since the DWH event. NMFS agrees with BOEM that new regulatory and technological advances reduce the risk of another DWH-sized event. However, the effectiveness of the changes cannot be quantitatively measured. By their very nature, oil spill risk analyses rely on data from past accidents to project future spill occurrences. Consequently, analyses published since the DWH event do not consider the effectiveness of post-DWH risk-reducing measures that decrease the likelihood or magnitude of

spills which occur in the future. NMFS requested that BOEM provide a quantitative estimate of risk reduction from their new regulations, but this was not provided. Thus, we consider qualitative information on risk reducing measures that BOEM provided and we will take into account that oil and gas drilling is occurring in increasingly deeper waters thereby increasing risk. An ultra-deep lease at 2200 m can yield a predicted 374.9 thousand barrels per month-18 times a lease at 200m deep (Murawski et al. 2020). Murawski et al. (2020) also states: "The inherent risks of catastrophic well blowouts at extreme depths will increase as the productivity of oil facilities increases exponentially with water depth." The following summarizes some of the relevant oil spill risk literature since DWH.

Muehlenbachs et al. 2013 provides an empirical analysis of company-reported incidents (e.g. blowouts, injuries, spills) on oil and gas production platforms in the Gulf of Mexico between 1996 and 2010. This same time period was marked by a dramatic increase in the depths at which offshore oil and gas extraction occurred. Compared with platforms at water depths less than 1,000 ft, the average number of incidents increases more than threefold for depths greater than 1,000 ft. One of the key findings is that company-reported incidents (such as blowouts, fires, injuries, and pollution) increase with water depth. Controlling for platform characteristics such as age, quantity of oil and gas produced, and number of producing wells, for an average platform, each 100 ft of added depth increases the probability of a company-reported incident by 8.5 percent. The paper does not demonstrate that there is a causal link between water depth and incident or violations, but it demonstrates there are statistically significant relationships between the variables.

Rathnayaka et al. (2013) developed an accident modeling and risk assessment framework based on "early warning" accident precursors using system hazard identification, prediction and prevention methodology to model the event. The risk assessment methodology was demonstrated using the DWH event and modeled over a given time period a disasterous event occurrence probability of 1.52×10^{-5}. Results generated from this method of assessment can provide a comprehensive understanding of safety barrier performance, occurrence probabilities, risk values of severity levels, and safety performance of the deepwater drilling rig.

Xue et al. (2013) proposed a new barrier-based accident model for drilling-related blowouts based on the three-level well-control theory: primary and secondary well-control barriers and an extra well-monitoring barrier established between the reservoir and the blowout event. The DWH event was used as a case study to show how the model can be used to understand the development of events leading to an accident and can also be used as an aid to prevent future blowouts or to stop the escalation of events. In addition to primary and secondary barriers, well monitoring is included as an independent and special barrier between the other barriers. Well monitoring is considered crucial to remedy an incomplete primary well barrier or activate the secondary barrier in a timely manner. The authors state that "the simplest and safest way to prevent blowout accidents is certainly keeping all the safety barriers intact" and further noted that "these failures, especially the ones based on statistical data or accident reports, are still conceptual because the records or reports are not always sufficiently detailed."

In Eckle et al. (2012) accidental global oil spills in the energy sector larger than 200 tons between 1974 and 2010 were extracted from the global Energy-Related Severe Accident Database, resulting in a total of 1,213 accidents. This independent analysis with global data of marine exploration and production oil spills, including the DWH event, calculated an approximate return frequency (i.e., occurrence) of an event the size of DWH as of once every 17 years with an uncertainty of between eight and 91 years (five and 95 percent confidence). The high uncertainty is a direct result of the structure of the risk with few but very severe events. Importantly, given that this analysis relied on a global dataset, the calculated return period represents the occurance on a global scale.

Ji et al. (2014), an analysis conducted by BSEE oil spill experts, used new methods to predict rare events and apply extreme value methods to predict the return period specific to the OCS for extremely large spills. These methods have been used with good results for other events that are rare when considered individually for a smaller area or shorter time period, but become predictable or foreseeable when larger areas and longer times periods are considered. The authors used Federal OCS oil spill data from 1964-2012, which mainly consists of data from the Gulf of Mexico. This study predicted the return period for a worst-case spill (defined as a spill over 1 Mbbl) as 165 years with a 95 percent confidence interval between 41-500 years (Ji et al. 2014).

The peer-reviewed literature discussed above highlights some key points that are relevant for determining the largest spill size that is possible within the time frame covered in the scope of this opinion. The large range of predicted frequency, or return periods, of disasterous spills from a minimum of 17 years globally to more than 500 years in the Gulf of Mexico specifically demonstrates that different statistical methods and different data sets can yield very different results. Human error and hurricanes play a large role in the occurrence of large spill events and occurrence of blowouts resulting in loss of well control in the Gulf of Mexico. There is some evidence suggesting that there may be a relationship between increased accidents as the depth of oil and gas development increases (Muehlenbachs et al. 2013). Increased accident rates could lead to an increased risk of an oil spill occurring.

BOEM estimates that in an average year operators will drill 160 deepwater wells and 186 shallow wells on the federal OCS. In shallow water, well pressures are generally lower due to the fact that many reserves have been produced, resulting in lower well pressures and the general trend of no new large discoveries in shallow water. Although small to medium volumes of oil are sometimes released from blowouts, the blowout is most often controlled with safety equipment such as BOPs, and any release of oil is minimized.

BOEM believes that a blowout leading to a loss of well control and release of oil is most likely in water deeper than 3,000 ft, where the spill size and consequences from a blowout are estimated to be greater (BSEE 2012). Figure 2 displays the annual number of blowouts resulting in a loss of well control from 2007 through 2016. Although blowouts may still occur in shallow water, there is a high likelihood that well control will be maintained due to lower reservoir pressure, the greater prevalence of gas rather than oil, and the presence of more accessible surface BOPs with diverters (BSEE 2012). If a release were to occur, it most likely would not be

a large volume of oil. From 1990-2010, BSEE recorded six Gulf of Mexico shallow water well-control incidents resulting in a spill of hydrocarbons. The total volume spilled is estimated to be 132 bbl of condensate over these last two decades. Our review of the information for shallow water and deep water wells leads us to agree with BOEM's finding of a low risk of an extremely large release of oil in shallow water. However, based on the historical data we analyzed above, including Ji et al. (2014), we believe the very large release of 100,000 bbl of oil could occur either in shallow water or deep water.

Regulatory Reform and Drilling Safety Improvements

BOEM and BSEE have carried out many regulatory reforms in response to reviews of the DWH event to improve offshore safety and oversight. These reforms are expected to reduce the volume of oil spilled during accidental events by reducing risks and improving control and response measures. BOEM provided NMFS a qualitative analysis of oil spill literature, regulatory changes, and improvements in response since DWH. The key points of the 2014 *Qualitative Review of Safety Measures to Minimize Frequency of Blowouts and Spills and Maximize Containment Capabilities* appear in the proposed action section of this opinion. Pertinent to this section of the analysis, we looked at the improvements in the well-containment system and responses that are specifically designed to cap a well after a blowout in order to assess how long a drilling-related extremely large release might last. While the blowout preventer is designed to manage drilling operations and prevent a blowout, a capping stack is designed to be deployed after a subsea blowout has already occurred. At the time of the DWH, there were few capping stacks in existence, and capabilities to support subsea well containment were limited. Subsequent improvements have increased industry's capacity to respond to a subsea well blowout in the Gulf of Mexico. The new well-containment response capability includes multiple vessels for assessment of the well, clearance of debris from the well, and launch and installation of the capping stack. BSEE conducted field testing with installation and testing of capping stacks for Shell and the Marine Well Containment Corporation in July 2012 and Noble Energy and Helix Well Containment Group in April 2013 to assess compliance with their regulations for oil-spill-response/containment systems. In both of these actual field tests, the capping stacks were installed and tested in less than seven days. The total process would take about 21 days under ideal sea conditions. BOEM has indicated that a new capping system has the capacity to contain about 55,000 bbl for transfer to storage vessels and includes a 15,000 psi single or dual ram capping stack. New regulatory measures and improvements in the capping stack technology are effective to bringing a spill under control in shorter time periods than occurred for DWH.

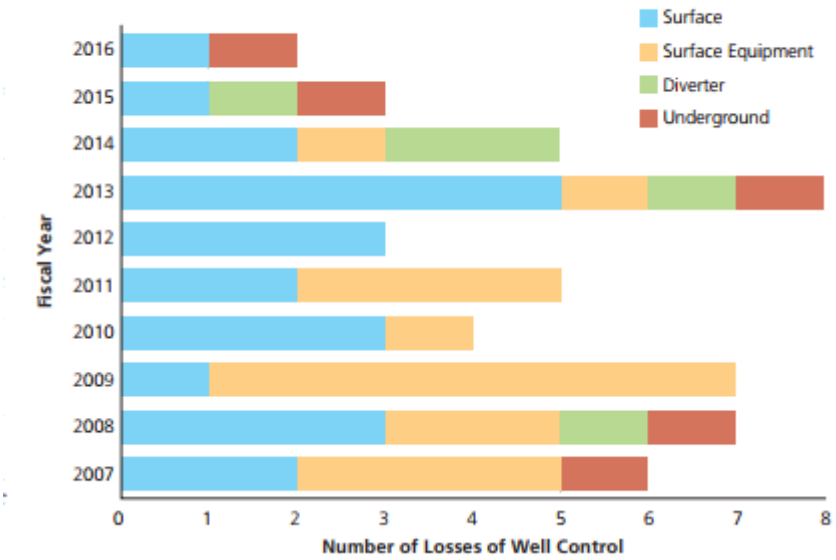


Figure 4. Annual losses of well control from 2007 to 2016 (BSEE 2016).

There were 4,123 deepwater wells drilled between 1973 and 2010. Active leases and associated oil and gas activities have been moving into increasingly deeper waters over the last two decades and are continuing to move into ultra deepwater. As drilling occurs at deeper depths, there can be an increased risk of loss of well control (Murawski et al. 2020). Pressures and temperatures in deeper waters provide extreme conditions where equipment, including safety-critical systems, could be more likely to fail and that are more difficult to reach quickly. Capping deepwater wells is not a regularly-occurring activity, so lack of experience also plays into the risk. Vessels are having to travel much farther to get out to those deeper sites, which could increase spill response times or have fewer available response vessels. Murawski et al. (2020) states, "…the next deep oil blowout and ensuing spill, wherever it may happen, will likely occur under fundamentally different conditions than have the two previous sub-surface mega-blowouts (DWH and Ixtoc)… While the previous 80+ years of oil exploration and production from the Gulf of Mexico have included responses to literally hundreds of oil spills (Ramseur 2010), a 3000 m blowout will be unlike any previous."

Muehlenbachs et al. (2013) reported that the probability of offshore oil and gas accidents increase by 8.5 percent for every 100 feet of increasing depth. BOEM indicated there have been 20 deepwater blowouts. In their 2016 annual report, BSEE calculated an average of five losses of well control per year over the last ten years. According to BSEE's loss of well control data (available at BSEE's website; www.bsee.gov), from 2006 to 2014 and including DWH, there have been eleven blowouts resulting in loss of well control in greater than 2,000 feet of water, eight of which were greater than 3,000 feet of water, and two of which resulted in spills. Since 1990, the frequency of deepwater blowouts is about one blowout for about every 275 deepwater wells. BOEM forecasts that an average of 160 wells will be drilled each year in deep water, or up

to 8,000 wells over the scope of this opinion. Using these estimates, we predict up to 29 blowouts [(1/275)*8000] will occur in deepwater over the next 50 years. Using BSEE loss of well control data to estimate for two spills for every eight loss of well control incidents, we would expect about eight (rounding up) of those blowouts occurring in depths at the greatest risk (i.e., depth greater than 3,000 ft) of an oil spill resulting from loss of well control (Table 3). Eight blowouts in deepwater over 50 years is equivalent to about one deepwater blowout every six years for the proposed action. Based on historical data provided by BOEM, most of these blowouts will result in non-disasterous loss of well control.

Table 3. Deepwater Wells Drilled Greater Than 3,000 ft and Blowout Risk as a Result of the Proposed Action.

Total Wells			
Annual Average Number of Deepwater Wells Drilled	Total Number of Deepwater Wells Drilled under the Proposed Action	Number of Deepwater Blowouts and Subsequent Oil Spill Predicted*	Number of Deepwater Disasterous Blowouts resulting in uncontrolled release of oil
160	8,000	8	1

*Number of drilled deepwater wells resulting in blowout over 38 years.

BOEM has concluded that an extremely large blowout and uncontrolled release of oil should not be considered an effect of the action because the probability is so low that it is not reasonably certain to occur within the time period covered by this opinion and so is not an anticipated result of the proposed action. The more recent analysis by Ji et al. (2014) used more applicable statistical methods to evaluate the risk of extremely large spill events on the U.S. OCS. As noted earlier, this study predicted the return period for a worst-case spill (defined as a spill over 1 Mbbl) as 165 years with a 95 percent confidence interval between 41-500 years. This still results in a wide range of years over which a disasterous uncontrolled blowout might occur. This wide range of years is due, in part, to the high uncertainty involved in predicting rare events. The lower end of this range (the year 2051 is 41 years after DWH) places us at the higher end of the scope of this consultation (2068). According to this statistical prediction, a disasterous blowout, subsequent protracted loss of well control and resulting oil spill would still be a statistically rare event, but it could possibly occur within the timeframe analyzed in this opinion. The majority of spills are less than one barrel, however the majority of volume spilled comes from larger spill events. DWH was 8.5 times the cumulative 570,000 bbl that were spilled in the previous 46 years in the U.S. (Ji et al. 2014). Figure 3, from Ji et al. (2014) shows the time series of annual largest oil spills derived from OCS data for 49 years from 1964 to 2012. The return level (or return frequency or value) of a random variable is the quantile value which is exceeded, on

average, once in a period of time (called the return period). For example, the return period (such as 100-year flood) based on extreme precipitation (i.e., certain return value) is commonly used to assess the capacity of drainage systems (Ji et al. 2014).

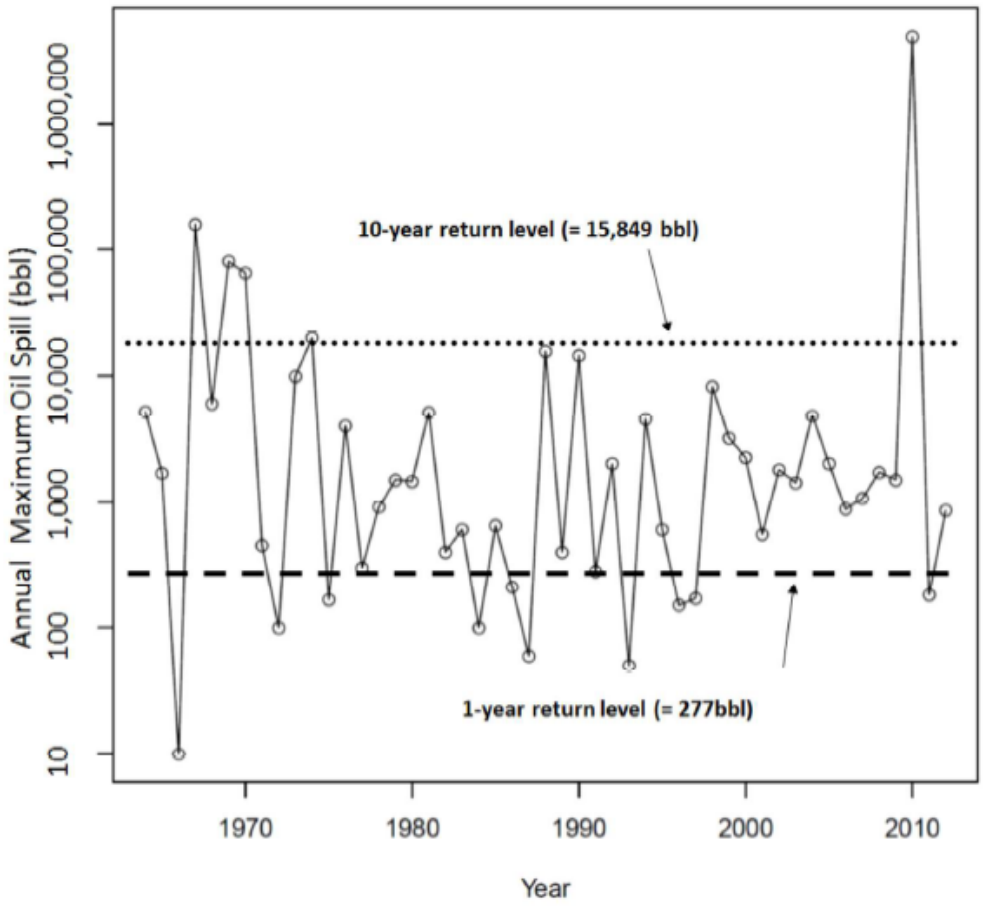


Figure 5. Annual largest oil spills derived from OCS data from 1964 to 2012. The dotted line is the 10-year return level and the dashed line is the 1-year return level. Figure from Ji et al. (2014).

The ranges in return frequencies of oil spills from protracted loss of well control provided in several studies and their strengths/limitations are provided in Table 4. The lower spill return value of 41 years from Ji et al. (2014) is within range of other estimates of possible spill

frequencies[2], and is still consistent with the predicted frequency of one extremely large spill every 40 years used in the 2007 biological opinion. Considering all the information above, while an extremely large spill is hypothetically possible, NMFS agrees with BOEM that new regulatory and technological advances reduce the risk of another DWH-sized event.

Table 4. Comparison from Different Studies of Recurrence Values for Very Large Spill Risk.

Study	Recurrence frequency (years)	95 percent confidence interval (years)	Limitations	Strengths
Rathnayaka et al. 2013	probability 1.52 X 10^{-5}	NA	Narrow focus on DWH and risk assessment methodology is reliant on available and precise precursory data	Used publicly available data to create a framework accident model and risk assessment algorithm based on DWH series of events
Eckle et al. 2012	17	8-91	Global data takes into account risk factors potentially not relevant to Gulf of Mexico	More data points on extreme spill events; 1213 accidents total. Data from 1974-2010. Bayesian model fitting.
Ji et al. 2014	165	41-500	Using all available data, which is mostly shallow water spill data, to analyze for ultra deepwater drilling risk	Uses multiple approaches and 49 years of spill data (rather than only one or a few data points). Data from 1964-2012. Maximum likelihood model fitting.

In summary, BOEM provided NMFS with information that two oil spills greater than or equal to 10,000 bbl may occur over the duration of the proposed action. Based on the historical

[2] Note also that, as shown in Table 4, Eckle et al 2012 estimated a 17 year recurrence frequency based on a larger number of large events with a confidence interval range from 8-91 years.

information on oil spills and advances in offshore drilling safety, we anticipate that one of these spills will be on the order of approximately 100,000 bbl (Ji et al. 2014). We define the largest spill size possible as a median spill volume of 1.1 million bbl (Mbbl) in the Gulf of Mexico (between 900,000-1.3 Mbbl). We determined this volume of oil by assessing how long a spill might last and how much oil could flow over that time. We also determined that a median volume would be a reasonable estimate of the largest spill size possible because of the safety measures that were implemented with the 2012 drilling rule and subsequent safety measures.

The volume of oil spilled during an uncontrolled blowout is highly dependent on the flow rate per day and the duration of the flow. BOEM estimates an uncontrolled flow rate of 30,000-60,000 bbl per day is possible if an uncontrolled blowout occurs. These flow rates are based on BOEM data from well tests, the maximum flow rate from the 1979 Ixtoc blowout in shallow water, and the maximum flow rate estimated for the 2010 DWH oil spill in deep water. Considering the time to deploy a capping stack and accounting for poor weather or other logistical delays that could arise, we conservatively consider the possibility of BOEM's position that an uncontrolled blowout release could last up to 30 days before containment, which we estimated could result in a release of up to 1.1 Mbbl of oil. BOEM and BSEE, predicted the return period for an extremely large event due to a well-control incident in the Gulf of Mexico (Ji et al. 2014) within the next 165 years with a 95 percent confidence interval between 41-500 years. NMFS will defer to the BOEM and BSEE analysis for this conclusion based on their expertise in this subject, and accordingly will not carry an extremely large event into our analysis of the effects of the action for the hypothetical occurrence of this low-probability extremely large (greater than 1 Mbbl) event.

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BSEE. 2016. Bureau of Safety and Environmental Enforcement 2016 Annual Report.

BSEE. 2017. Loss of well control occurrence and size estimators. USDOI Bureau of Safety and Environmental Enforcement.

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Ji, Z.-G., W. R. Johnson, and G. L. Wikel. 2014. Statistics of Extremes in Oil Spill Risk Analysis. Environmental Science & Technology 48(17):10505-10510.

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Ramseur, J. L. 2010. Deepwater Horizon Oil Spill: The Fate of the Oil. Congressional Research Service, Washington D.C.

Rathnayaka, S., F. Khan, and P. Amayotte. 2013. Accident modeling and risk assessment framework for safety critical decision-making: application to deepwater drilling operation. Proceedings of the Institution of Mechanical Engineers Part O: J Risk and Reliability 227(1):86-105.

Xue, L., J. Fan, M. Rausand, and L. Zhang. 2013. A safety barrier-based accident model for offshore drilling blowouts. Journal of Loss Prevention in the Process Industries 26(1):164-171.

Appendix H. Cetacean and Sea Turtle Wildlife Response Guidance for the Gulf of Mexico

I. Introduction

The protection of wildlife during the course of an oil release event is an essential element in every oil spill response operation. A Wildlife Response Plan (WRP) as part of an OSRP provides for coordinated, immediate, and effective protection, rescue or recovery, and rehabilitation of wildlife resources present in the oceanic, coastal, and inland waters of the Gulf of Mexico. WRPs typically focus on bird species and coastal terrestrial animals. This document provides a framework for Cetacean *and Sea Turtle Response Plans*, which should be included in the larger WRP covering all potential impacted wildlife based on the geographic area covered[1].

Under incident command, NOAA's National Marine Fisheries Service (NMFS) will lead marine mammal and sea turtle response efforts for spills that may impact any sea turtle species, cetaceans, and/or pinnipeds. Therefore, the Wildlife Response Plan for these species must ensure that NMFS is notified immediately if any sea turtle or cetacean species are suspected to be impacted, using the contact information provided in this document. If response is determined to be necessary, NMFS will lead the response and follow existing protocols found in approved agency Oil Spill Response Guidelines documents. The WRP and OSRP must ensure that NMFS is engaged and included in the response efforts, and that the responsible party is prepared to provide appropriate and reasonable resources for response efforts.

II. Marine Mammal and Sea Turtle Response Plans and Guidance Documents

Oil spill response planning and strategies should follow standard protocols, techniques, and best management practices for particular taxa, species and habitats, as available. NMFS developed Oil Spill Response Guideline documents for use during oil spills, and recommends that these Guidelines be incorporated by reference to WRPs, to avoid duplication and variability between

[1] Wildlife Response Plan considerations for birds are not included in this document, although that information is available in other documents and formats. Additionally, this document does not address response strategies to other ESA-listed species under NMFS jurisdiction, such as corals, smalltooth sawfish, and sturgeon. If an oil spill involves these species, please consult with NMFS representatives on response needs. Emergency consultation for responses which may affect ESA-listed species in the Gulf of Mexico can be accomplished by emailing nmfs.ser.emergency.consult@noaa.gov.

protocols. This will allow for consistent and coordinated response efforts regardless of the responsible party. NMFS recommends that all WRPs include the following information related to marine mammal and sea turtle species that are present in the specific geographic area covered: 1) the notification/contact information listed in Section III below, 2) reference to the following two documents, and 3) overview of response roles and anticipated response strategies including pre-planned facility and equipment availability during a spill. For response to marine mammals and sea turtles during a spill, response strategies will likely include initial reconnaissance efforts at a minimum. Based on initial reconnaissance, response strategies may also require continued reconnaissance/surveillance throughout the response, recovery of stranded and oiled animals, triage, and rehabilitation care. Further details on these activities including descriptions of procedures and safety considerations can be found in the following guidance documents.

Title: *Pinniped and Cetacean Oil Spill Response Guidelines*
Citation: Ziccard, M., Wilkin, S., Rowles, T.K. and S. Johnson. 2015. NOAA Technical Memorandum.
URL: https://www.fisheries.noaa.gov/resource/document/pinniped-and-cetacean-oil-spill-response-guidelines
These Guidelines provide a foundation for coordination and communication between local, state and federal oil spill response agencies and the marine mammal conservation, research and welfare communities (including marine mammal stranding networks and research scientists). More specifically, these Guidelines provide key information to, and standardize activities of, marine mammal responders to build and maintain oiled wildlife readiness at a national level.

Title: *Guidelines for Oil Spill Response and Natural Resource Damage Assessments: Sea Turtles*
(in review): Stacy, B.A., B.P. Wallace, T. Brosnan, S.M. Wissmann, B.A. Schroeder, A.M. Lauritsen, R.F. Hardy, J.L. Keene, S.A. Hargrove. 2018. Guidelines for Oil Spill Response and Natural Resource Damage Assessment: Sea Turtles. U.S. Department of Commerce, National Marine Fisheries Service and National Ocean Service, NOAA Technical Memorandum [Designated number], Washington, D.C.
URL: https://www.fisheries.noaa.gov/resource/document/guidelines-oil-spill-response-and-natural-resource-damage-assessment-sea-turtles
These guidelines provide a foundation for coordination and communication between local, state and federal oil spill response agencies for sea turtle response efforts. These guidelines specifically cover actions that may be undertaken during emergency response to oil spills or subsequent Natural Resource Damage Assessment (NRDA), and provide standardized protocols for responders. Since the circumstances of each oil spill vary significantly, the information in this document is not meant to be prescriptive, it is intended to supplement existing regulations, policy, and guidance.

III. Notification of Spills

NMFS Office of Protected Resources coordinates agency assessment of the need for response and leads response efforts for spills that may impact sea turtles, and cetaceans. If a spill may impact cetaceans, or sea turtles, NMFS Protected Resources Contacts should be notified and they will initiate notification of other relevant parties.

NMFS Protected Resources Contacts for the Gulf of Mexico:

- Marine mammals- Southeast emergency stranding hotline 1-877-433-8299
- Sea turtles- Dr. Brian Stacy at brian.stacy@noaa.gov and 352-283-3370$_{(cell);}$ or Stacy Hargrove at stacy.hargrove@noaa.gov and 305-781-7453$_{(cell)}$
- Other ESA-listed species- ESA section 7 consulting biologist: nmfs.ser.emergency.consult@noaa.gov

Appendix I. Explosive Removal of Structures Measures

I. *Sargassum* habitat monitoring

"*Sargassum* habitat" is defined as the presence of *Sargassum* in sufficient amounts that serve as developmental habitat in which small juvenile sea turtles are likely to be found. Small juvenile turtles are extremely difficult to detect and *Sargassum* habitat will be used as the primary indicator of their presence in an impact zone. Typically, the occasional presence of a few, small *Sargassum* "clumps" are not considered developmental habitat. *Sargassum* habitat for sea turtles is visually described as mats, continuous lines, broken windrows (short lines or non-linear clumps), or scattered patches (Table 135). NMFS PSOs will be required to monitor local conditions to determine if *Sargassum* habitat is present based on the hourly conditions at a decommissioning site and implement the appropriate measures.

Table I- 1. Description of Sea Turtle Sargassum Habitat Types {Witherington, 2012 #648}.

***Sargassum* Habitat Type**	**Description**
Mat	One or more consolidated areas of *Sargassum* forming a mat large enough to provide shelter and/or food for a small sea turtle.
Continuous Line	One or more contiguous meandering lines or scattered patches along a linear path. Lines may be narrow or wide. These lines are often associated with convergence zones.
Broken Windrows	Many parallel, short lines or clumps that may or may not be distributed linearly
Scattered patches	Numerous patches scattered over an area

II. Requirements for Establishing Impact Zones

A. Impact zones in both shallow and deep water are determined by the net explosive weights used during a decommissioning event. The impact distance(s) shall be based on the largest charge size proposed to be used during a removal event when multiple charges are used. The measures herein apply to any charge size up to 500 lb. The charge weight establishes the specific mitigation scenario that must be adhered to as a permit condition.

B. Impact zones for each scenario shall be calculated using the most recent version of the Underwater Calculator (UWC) that has been reviewed and approved by NMFS. The current required impact zones (Table 136) are based on UWC version 1.5.3 that is the latest approved version at the time of this opinion. Review and approval of UWC revisions will be completed according to the second tier consultation procedures detailed in section 4 of this opinion.

Table I- 2. Impact zones for net explosive weights based on underwater calculator version 1.5.3.

Net Explosive Weight (lb)	Impact Zone Distance	
	BLM	AML
1-10	261 m (856 ft)	293 m (961 ft)
>10-20	373 m (1,224 ft)	522 m (1,714 ft)
>20-80	631 m (2,069 ft)	829 m (2,721 ft)
>80-200	941 m (3,086 ft)	1,126 m (3,693 ft)
>200-500	1,500 m (4,916 ft)	1,528 m (5,012 ft)

C. NMFS understands all decisions on explosive composition, configuration, and usage need to be made by the qualified explosive contractors in accordance with the applicable explosive-related laws and regulations. BSEE or their permitee shall provide a written blasting plan to the PROP Program Manager prior to the anticipated blasting date. The blasting plan shall include the number of and type of structures, number of decommissioning events, type of explosives, and weight of explosives. Any changes to the net explosive weights detailed in the blasting plan shall be submitted in writing to the PROP program manager or lead PSO on site. The PROP Program Manager or lead PSO will determine the appropriate scenario measure (described below) and impact zone required based on the final net explosive weights used for the removal.

D. PSOs may use binoculars and the naked eye to monitor the exclusion zones. The sighting distance of all listed species and *Sargassum* habitat that result in delays must be recorded.

E. Buoys or some visible markers will be necessary for visual reference of the impact zone when only surface monitoring is required. The perimeter of impact zones should be demarcated (e.g., brightly colored buoys, vessels, or other markers) for visual reference.

F. If any ESA-listed species, or *Sargassum* habitat indicative of small juvenile sea turtles are present in the impact zone, a detonation must not proceed. Steps for tracking animals, inspecting *Sargassum* habitat, delay periods, and additional monitoring are detailed below.

III. Requirements for differing scenario mitigations

A. Permittees must fully comply with the relevant measures according to impact zones in Table 136 and the mitigation scenarios in Table 137. Table 136 provides the impact zone distances required based on the net explosive weight used. Table 137 summarizes the required mitigation and monitoring surveys, and duration of monitoring required. Sea turtles can remain submerged on a single dive for well over 30 minutes, hence the reason for increasing the pre-detonation aerial survey to 45 minutes (Byles, 1989; Renaud, 1995; Gitschlag, 1996).

Table I- 3. Mitigation overview for net explosive weights used in any configuration in shallow water (SW; less than 200 m) and deep water (DW; greater than 200 m).

Mitigation scenario Number	Net explosive weight (lb)	Pre-Det Surface Survey (min)	Pre-Det Aerial Survey (min)	Pre-Det PAM (min)	Animal Sightings Waiting Period (min)	*Sargassum* Habitat Waiting Period	Post-Det Surface Survey (min)	Post-Det Aerial Survey (min)	Post-Post-Det Aerial Survey within one Week
SHALLOW WATER									
SW-1	1-10	60	N/A	N/A	30	Until visually inspected or *Sargassum* floats out of Impact Zone	30	N/A	No
SW-2	>10-20	90	45	N/A	30		N/A	45	No
SW-3	>20-80	90	45	N/A	30		N/A	45	No
SW-4	>80-200	120	60	N/A	30		N/A	45	No
SW-5	>200-500	150	90	N/A	45		N/A	45	No
DEEPWATER									
DW-1	1-10	90	N/A	N/A	45	Until visually inspected or *Sargassum* floats out of Impact Zone	30	N/A	No
DW-2	>10-20	90	45	N/A	45		N/A	45	No
DW-3	>20-80	90	60	150	45		N/A	45	Yes
DW-4	>80-200	150	60	180	45		N/A	45	Yes
DW-5	>200-500	180	90	270	45		N/A	45	Yes

B. Permittees must stagger the detonation of multiple charges in a series by an interval of at least 0.9 sec (900 msec) between blasts. Otherwise, the combined charge sizes (or net explosive weight) will be used to determine the impact zone.

C. Detonations must only occur during daylight and during a time that would allow for post- detonation surveys. Monitoring will cease if the lead PSO determines that weather or marine conditions are not adequate for visual observations.

D. Scare charges shall not be used to clear impact zones of sea turtles or ESA-listed whales (i.e., sperm whale).

E. Images/pictures taken during any surveys are the property of the U.S. Government and should not be sold, duplicated or used in any way other than for which the project it was intended.

F. Unusual Circumstances: Occasionally, sea turtle(s) remain within the impact zone or are present in high numbers. On rare occasions, very small turtles may be seen in absence of *Sargassum* habitat near vessels from which monitoring is occurring. During these unusual circumstances, the on-site NMFS PSO shall exercise discretion in the implementation of measures or modification of the mitigation procedures that serve to avoid or minimize impacts to sea turtle(s). Typically, modifications of

mitigations include increasing the duration of monitoring periods, increasing the number of PSOs, delaying blasting, or a combination of measures. The lead PSO will coordinate with the PROP Manager, appropriate BSEE personnel, and NMFS ESA section 7 consulting biologist when circumstances necessitate additional monitoring.

IV. Requirements for Surface Monitoring Surveys

A. A surface monitoring survey is required for all blasting scenarios and must be conducted for the length of time indicated for the net explosive weights in Table 136 and Table 137.

B. Surface monitoring is generally conducted by at least two PSOs. Surface monitoring surveys are to be conducted from the highest vantage point(s) and/or other location(s) that provide the best, clear view of the entire impact zone. These vantage points may be on the structure being removed or proximal surface vessels such as crew boats and derrick barges. Additional PSOs will be positioned around the decommissioning site, as determined by the PROP manager/coordinator in consultation with the lead PSO for additional structures, large net explosive weights, or other circumstances as needed.

C. Surface monitoring must be conducted in adequate light during daylight hours (sunrise to sunset) and with an adequate line of sight including meteorological conditions free of rain or fog, and free of other visual obstructions such as other work vessels.

D. For mitigation scenarios requiring only surface monitoring and no aerial monitoring, surface monitoring must be conducted under good environmental conditions that are conducive for monitoring for sea turtles and marine mammals. Surface-only monitoring shall be delayed if: 1.) Sea conditions exceed Beaufort Wind Force Scale 4.5 (see Table 138), or 2.) inadequate line of sight including poor light conditions, meteorological conditions (e.g., rain or fog) and other visual obstructions such as other work vessels.

Table I- 4. Beaufort Sea State Scale.

Beaufort State	Wind mph	Wind Knots	Wave Height (ft)	Description
0 (calm)	0-1	0-1	0	Sea surface like a mirror
1 (light air)	1-3	1-3	0.33-0.65	Ripples with the appearance of scales, but no foam crests
2 (light breeze)	4-7	4-6	0.66-1.9	Small wavelets, more pronounced. Crests have glassy appearance, but do not break.
3 (gentle breeze)	8-12	7-10	2-3.2	Large wavelets. Crests begin to break. Foam of glassy appearance. Perhaps scattered white horses.

Beaufort State	Wind mph	Wind Knots	Wave Height (ft)	Description
4 (moderate breeze)	13-18	11-16	3.3-6.5	Small waves, becoming larger; fairly frequent white horses.
4.5 (moderate-fresh breeze)	≤15.5	≤13.5	≤4.9	Small waves, crests break, scattered but regular white horses
5 (fresh breeze)	19-24	17-21	6.6-9.8	Moderate waves, more pronounced long form, many white horses, some spray possible

E. For charge sizes between 0-10 lb, the detonation may proceed if ESA-listed species or *Sargassum* habitat is not sighted.

F. If a listed species is sighted, or sighted heading inbound toward the impact zone, a waiting period is required (see Waiting Periods in "F" below), or

G. If *Sargassum* habitat is sighted in the impact zone, , a waiting period is required until the *Sargassum* habitat drifts out of the impact zone (see Waiting Periods in "F" below). Alternatively, a vessel-based PSO could inspect the *Sargassum* for juvenile sea turtles. This must be done from a small vessel or inflatable boat so that an observer will be close to the water surface and can see small turtles. If no sea turtles are sighted, the waiting period ends and the survey can continue for the remaining period required under the mitigation. If a sea turtle(s) is sighted, the waiting period must continue until the *Sargassum* drifts out of the impact zone.

V. Requirements for Pre-Det Aerial Surveys

A. Aerial monitoring surveys are to be conducted from helicopters running standard low-altitude search patterns over the extent of the decommissioning area, including the impact zone that corresponds to the appropriate mitigation scenario.

B. Aerial surveys will be restricted to daylight hours only and cannot begin until the requisite surface monitoring survey has been completed.

C. Aerial surveys will cease if the lead PSO determines that weather or marine conditions are not adequate for visual observations, or when the pilot/removal supervisor determines that helicopter operations must be suspended.

D. When two or more PSOs are on site, NMFS may decide two PSOs conduct the aerial survey or have one or more PSOs continue surface monitoring while the other observer flies the survey. The helicopter will traverse the impact zone at low speed/altitude in the specified survey pattern.

E. Flight patterns during pre-detonation and post-detonation surveys shall follow the procedures listed in Table 139. At any time during the survey period, the flight path may be altered to investigate sightings and confirm their location in reference to the impact zone.

Table I- 5. Flight patterns during pre-detonation surveys. All surveys should begin at the center of the impact zone. At any time during the entire survey period it may be necessary to alter the flight path to investigate sightings and confirm their location in reference to the impact zone.

Flight Path	30-minute	45-minute	60-minute	90-minute
Follow a spiraling or corkscrewing flight path out from the center of the impact zone to the perimeter of the impact zone. This should be followed by a gradually contracting spiral flight path until the aircraft returns to the center of the impact zone. Repeat the pattern for the specified time period.	10 minutes	20 minutes	25 minutes	40 minutes
Unless higher priority targets (ex. turtles, dolphins, *Sargassum*) are present, the aircraft should survey outside of the impact zone to a distance approximately equal to the radius of the impact zone to determine if any protected species (sea turtles or marine mammals) might be moving into the area. Expanding and contracting spirals should again be used for the	5 minutes	5 minutes	5 minutes	5 minutes
The aircraft should survey inside the impact zone and follow the same procedures as during the first part of the survey. However, near the end of the survey period the flight path should usually be concentrated near the center of the impact zone since this is where animals will have the highest risk of [illegible]	15 minutes	20 minutes	30 minutes	45 minutes

F. For charge sizes greater than 10-500 lb, the detonation may proceed if listed species are not sighted.

G. If listed species are sighted, or sighted heading inbound toward the impact zone, a waiting period is required (see Waiting Periods below).

H. If *Sargassum* habitat is sighted, a waiting period is required until either a) a vessel-based PSO inspects the *Sargassum* from a small vessel or inflatable boat for juvenile sea turtles to determine if a *Sargassum* waiting period is required, or b) no vessel-based inspection occurs and a waiting period is triggered until the *Sargassum* has drifted out of the impact zone. If no sea turtles are sighted during a PSO inspection, the surface monitoring can continue for the remainder of the required monitoring period.

VI. Requirements for Passive Acoustic Monitoring (PAM)

A. BOEM and BSEE must require operators to provide for review a plan for the use of passive acoustic monitoring for marine mammal detection in the relevant deepwater mitigation scenarios (DW-3, DW-4, and DW-5). The plan must include on-site monitoring protocols, description of the passive acoustic system, software used, recording and storage of data, and other aspects of acoustic monitoring.

B. Persons conducting acoustic surveys will be required to comply with NMFS-approved passive acoustic monitoring protocols and use approved devices and technicians.

C. Acoustic surveys will be run concurrent with requisite pre-detonation surveys, beginning with the surface observations and concluding at the finish of the aerial surveys when the detonation(s) is allowed to proceed. Operators must also report on an assessment of the usefulness, effectiveness, and problems encountered with the use of the method. PAM operators shall notify NMFS PSOs immediately when any acoustic targets are detected.

D. For mitigation Scenarios DW-3, DW-4, and DW-5, the detonation may proceed if ESA-listed whales (i.e., sperm whale) are not detected with PAM and the other pre-det surveys do not detect listed species or Sargassum habitat. If ESA-listed whales are detected with PAM (or listed species or Sargassum habitat are otherwise sighted), a waiting period is required (see Waiting Periods below).

VII. Requirements for Waiting Periods for Surface, Aerial, and PAM Surveys

A. For pre-det surveys. If sea turtle, Sargassum habitat or ESA-listed whales (i.e., sperm whale) are observed within (or about to enter, heading inbound) the impact zone of any pre-detonation survey, detonations must be delayed until no protected species are inside the impact zone or the *Sargassum* has drifted out of the impact zone. The waiting period must be completed before the monitoring protocol for the requisite mitigation, and following measures can continue. The purpose of a waiting period is to allow any inbound animal(s) within the impact zone to exit the impact zone under their own volition. For small juvenile sea turtles, the purpose of the waiting period is to allow floating *Sargassum* habitat to drift out of the area or to confirm no turtles are present in the *Sargassum*.

B. For surface, aerial, PAM surveys. When listed species are inside the impact zone or inbound toward the impact zone during a surface, aerial or PAM survey:

i. Halt the detonation countdown and implement the waiting period,

ii. Continue opportunistic monitoring during the required waiting period after the last sighting.

iii. If additional sightings occur inside the impact zone or animals sighted heading inbound during the waiting period, then continue surface surveys and start a new waiting period after the occurrence of the last sighting.

iv. Except for waiting periods triggered by Sargassum habitat, anytime a waiting period for an aerial survey or for a surface survey for blast scenarios with surface only surveys (when no aerial survey is required) is triggered by a sea turtle or marine mammal sighting, the interrupted survey must be completed over in its entirety. For blast scenarios that include both survey types, only the aerial survey would need to be repeated.

v. Anytime a surface survey waiting period is due only for *Sargassum* habitat, a waiting period is required until either a) a vessel-based PSO inspects the *Sargassum* and determines no turtles are present, or b) no vessel-based inspection occurs and a waiting period is triggered until the *Sargassu*m has drifted out of the impact zone. If no sea turtles are sighted during a PSO inspection of Sargassum habitat, the surface monitoring can continue for the remainder of the required monitoring period.

vi. Anytime an aerial survey waiting period is triggered only due to Sargassum habitat (no marine mammals or large juvenile or adult sea turtles sighted), only the aerial survey needs to be repeated.

vii. Other than in the case of waiting periods described above, any interrupted surface or aerial surveys must be repeated in their entirety. Also, the post-detonation aerial survey must begin immediately following completion of the pre-detonation surface survey.

VIII. Requirements for Post-Detonation and Post-Post Detonation Monitoring Surveys

The primary purpose of post-det and post-post-det surveys is to detect any listed species that may have been impacted (stunned, injured or killed) by the detonation and monitor the effectiveness of the pre-det mitigation requirements. Post-det and post-post-det surveys must follow the following measures.

A. A 45-minute post-detonation aerial survey must be conducted by the PSO(s) for all explosive use greater than 10 lb. The aerial survey must be conducted immediately upon conclusion of the detonation.

B. For deepwater, mitigation scenarios DW-3, DW-4 and DW-5, post-post-detonation aerial monitoring surveys must be conducted within 2-7 days after detonation activities conclude, by either helicopter or fixed-wing aircraft. Any distressed, stunned, injured, or dead marine mammals will be noted in the survey report, and if possible, tracked and collected after notifying the National Marine Fisheries Service.

C. Detonations shall not occur if the post-detonation survey cannot be concluded prior to sunset.

D. For post-detonation surveys, follow a spiraling or corkscrewing flight path out from the center of the impact zone to the perimeter of the impact zone. This should be followed by gradually contracting spiral flight path until the aircraft returns to the center of the impact zone. If strong currents are present, the down current area should be surveyed outside the impact zone to an appropriate distance. Repeat the pattern for the specified time period.

E. For post-post-detonation surveys, survey a 7x7 nmi grid centered over the removal site. This grid includes eight, parallel transect lines each measuring 7 nmi long and spaced approximately 1 nmi apart. If strong currents are determined to be present, the the grid may be shifted in the down current direction to an appropriate distance. Any injured or dead sea turtle or marine mammal must be recorded in the survey report and reported to the appropriate stranding network. The stranding network may request that the carcass be tracked and collected if possible.

IX. Requirements for the Recovery of Sea Turtles

A. BOEM and BSEE shall allow an option for trained diver(s) to attempt capture of sea turtles known to be present around a structure slated for removal by explosive severance. NMFS SERO shall be notified prior to any capture attempts and the capture, handling, holding, and release of sea turtles shall be under the guidance and supervision of NMFS PSOs

B. Sea turtles that are observed to be stunned, injured, or killed during post-det surveys or follow-up aerial surveys must be recovered by PSOs when it is possible to do so. The company and offshore service contractors on site must make assets available, such as vessels, divers, so PSOs can capture or recover stunned, injured, or dead turtles and transport them to shore.

C. Impacted sea turtles that are recovered alive or dead must be immediately transported to shore in coordination with NMFS. Turtles must be transported to an authorized rehabilitation facility for veterinary treatment, or properly stored for necropsy to document the injuries and cause of death.

D. If a sperm whale is unintentionally exposed to a blast, the incident must immediately be reported to the Marine Mammal Stranding Network at 1-877-WHALE-HELP (1-877-942-5343).

X. PSO Requirements

A. NMFS PSOs are required to perform surface and aerial surveys. These PSOs are qualified NMFS employees or contractors delegated under the Platform Removal Observer Program (PROP) of NMFS' Galveston Laboratory. Explosive-severance contractors or operators enter into agreements with the NMFS Galveston Laboratory to provide PSO monitoring. Under the agreements, NMFS achieves full cost recovery for the goods and services provided. Generally, at least 2 or 3 NMFS PSOs are required to conduct surveys for the mitigation scenarios. When simultaneous surface, aerial, or PAM surveys are required, teams of PSOs may be required. The PROP Manager will determine the required number of teams and PSOs depending on the complexity of severance activities, structure configurations, adequacy of structures and vessels to conduct effective monitoring, and other environmental monitoring conditions.

B. PSOs must brief affected crew and severance contractors of the monitoring efforts and notify topsides personnel to report any sighted animals or Sargassum habitat to the lead PSO immediately;

C. PSOs must establish an active line of communication (such as 2-way radio) with company and blasting personnel;

D. PSOs must devote the entire, uninterrupted survey time to listed species monitoring.

E. For aerial surveys, a PSO should sit in one of the seats in the front of the cockpit. This is typically on the port side of the aircraft next to the pilot. Whenever possible, a second PSO should sit on the opposite side of the aircraft so that both sides of the aircraft are surveyed. If additional PSOs are available, seating should be adjacent to a window. Communications equipment should be provided which allows the pilot and PSOs to talk to each other and which provides clear communications.

XI. Requirements for Reporting

A. Any take of listed species should be reported to NMFS at takereport.nmfsser@noaa.gov and nmfs.psoreview@noaa.gov. If the taking involves a whale, the lead PSO shall also report it immediately to the Marine Mammal Stranding Network at 1-877-WHALE-HELP (1-877-942-5343).

B. Final monitoring reports (also referred to as the trip report) will be prepared for each removal. The monitoring report responsibilities will be assumed by NMFS's lead PSO and completed following completion of the severance activities.

C. In addition to basic operational data (e.g., area and block, water depth, company/platform information), the trip reports must contain all of the applicable information:

i. Target: Type/Composition (pile, caisson, concrete piling, nylon mooring, etc.) and Diameter and Thickness

ii. Charge: Type (bulk, configured-bulk, linear-shaped, etc.), Charge weight/material (RDX, C4, HMX, etc.), Configuration (internal/external, cut depth [below mud line], water depth [above mud line], etc.), Deployment method (diver, ROV, from surface, etc.)

iii. Monitoring: Survey Type: (pre-det and post-det; surface, aerial, etc.), Time(s) initiated/terminated, Marine Conditions

iv. Observed/Detected summary: Type/number (basic description or species identification, if possible, during all survey types- i.e., surface, aerial, and acoustic and both during pre- and post-detonation periods), Location/orientation – inside/outside impact zone, inbound/outbound, etc., Any "halted-detonation" details – i.e., waiting periods, re-surveys, etc., Any "Take-Event" details – actual MPS injury/mortality

D. BOEM shall provide an annual report to the NMFS consulting biologist describing the total annual structures removed, sea turtle and sperm whale sightings during pre-detonation surveys, sea turtle and sperm whale sightings during post- detonation surveys, visibility during the surveys, details of sea turtles (including loggerhead, green, Kemp's ridley, hawksbill and leatherback sea turtles) and ESA-listed whales (i.e., sperm whale) that were observed injured, killed or otherwise affected and the measures taken for each sea turtle and sperm whale. These annual reports should be combined with any MMPA reporting requirements, as appropriate.

E. The annual reports shall be sent electronically by email to nmfs.psoreview@noaa.gov with "Decommissioning Protected Species Annual Report" in the subject header.

References:

Byles, R.A., 1989. Satellite telemetry of Kemp's ridley sea turtle, Lepidochelys kempi, in the Gulf of Mexico. In, Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology, compiled by S.A. Eckert, K. L. Eckert and T. H. Richardson, NOAA Tech. Memo. NMFS-SEFC-232, pp. 25-26.

Renaud, M. L., 1995. Movements and submergence patterns of Kemp's ridley turtles (Lepidochelys kempii). J. Herpetology, Vol. 29, pp. 370-374.

Gitschlag, G. R. 1996. Migration and diving behavior of Kemp's ridley (Garman) sea turtles along the U.S. southeastern Atlantic coast. J. Experimental Marine Biology and Ecology, Vol. 205, pp. 115-135.

Appendix J. Sea Turtle Handling and Resuscitation Guidelines

Any sea turtles taken incidentally during the course of fishing or scientific research activities must be handled with due care to prevent injury to live specimens, observed for activity, and returned to the water according to the following procedures:

I. Sea turtles that are actively moving or determined to be dead (as described in paragraph (B)(4) below) must be released over the stern of the boat. In addition, they must be released only when fishing or scientific collection gear is not in use, when the engine gears are in neutral position, and in areas where they are unlikely to be recaptured or injured by vessels.

II. Resuscitation must be attempted on sea turtles that are comatose or inactive by:

   i. Placing the turtle on its bottom shell (plastron) so that the turtle is right side up and elevating its hindquarters at least 6 inches (15.2 cm) for a period of 4 to 24 hours. The amount of elevation depends on the size of the turtle; greater elevations are needed for larger turtles. Periodically, rock the turtle gently left to right and right to left by holding the outer edge of the shell (carapace) and lifting one side about 3 inches (7.6 cm) then alternate to the other side. Gently touch the eye and pinch the tail (reflex test) periodically to see if there is a response.
   ii. Sea turtles being resuscitated must be shaded and kept damp or moist but under no circumstance be placed into a container holding water. A water-soaked towel placed over the head, carapace, and flippers is the most effective method in keeping a turtle moist.
   iii. Sea turtles that revive and become active must be released over the stern of the boat only when fishing or scientific collection gear is not in use, when the engine gears are in neutral position, and in areas where they are unlikely to be recaptured or injured by vessels. Sea turtles that fail to respond to the reflex test or fail to move within 4 hours (up to 24, if possible) must be returned to the water in the same manner as that for actively moving turtles.
   iv. A turtle is determined to be dead if the muscles are stiff (rigor mortis) and/or the flesh has begun to rot; otherwise, the turtle is determined to be comatose or inactive and resuscitation attempts are necessary.

Any sea turtle so taken must not be consumed, sold, landed, offloaded, transshipped, or kept below deck.

These requirements are excerpted from 50 CFR 223.206(d)(1). Failure to follow these procedures is therefore a punishable offense under the Endangered Species Act.

United States Department of the Interior
BUREAU OF OCEAN ENERGY MANAGEMENT
Gulf of Mexico Regional Office
1201 Elmwood Park Blvd
New Orleans, Louisiana 70123-2394

March 03, 2021

ELECTRONIC MAIL – RETURN RECEIPT REQUESTED

Shell Offshore Inc.
Attention: Tracy Albert
701 Poydras St., Room 2418
New Orleans, LA 70139

Dear Ms. Albert:

Your application received November 10, 2020, requests a Federal permit to conduct geophysical operations in the area shown on the map accompanying the application. Magseis Fairfield will conduct exclusive operations for Shell Offshore Inc. The proposed program is a 3D-OBN ROV seismic survey.

A permit designated OCS Permit T20-004 is hereby granted to conduct geophysical operations on the OCS in the area and manner described in the application subject to the enclosed Permit for Geophysical Exploration for Mineral Resources on the OCS and Attachment A that follow. **Before starting acquisition, you are required to notify BOEM of your survey start date. BOEM must also be advised of the end date immediately upon survey completion.** Also note Mitigation 13 whereby the Permittee is required to submit bi-weekly reports on the 1st and 15th of the month. The report is required even if no activity took place during the 2-week period. In reference to Mitigation 12, BOEM is notifying you that the following permitted deep penetration seismic operations are currently active or issued in or adjacent to your survey area:

T20-001; Seabed Geosolutions (US), Inc.; Brent O'Brien; 713-609-1404
T20-002; CGG Services (US), Inc.; Michael Whitehead; 832-351-1603
T20-003; Shell E&P Co.; Tracy Albert; 504-425-7215

In accordance to the NRDC Lawsuit Stay Agreement, BOEM is required to provide each permittee with a copy of the Agreement when a Deep Penetration Seismic Survey permit is issued to the permittee during the Stay period. A copy of the agreement will be emailed to you and you must confirm via email that you have received the attachment.

Our National Environmental Policy Act (NEPA) review of the subject action is complete and results in a Finding of No Significant Impact (FONSI). This FONSI is conditioned on adherence to the conditions of approval that ensure environmental protection, consistent environmental policy, and safety as required by NEPA, as amended, and is valid only insofar as the conditions are met in Attachment A.

If you have any questions, please call Chad Vaughan at (504) 736-2900 (chad.vaughan@boem.gov) or the Office of Resource Evaluation, Data Acquisition and Special Projects Unit at (504) 736-3231 (GGPermitsGOMR@boem.gov).

Sincerely,

DONALD MACLAY Digitally signed by DONALD MACLAY Date: 2021.03.03 13:59:01 -06'00'

For Matthew G. Wilson
Regional Supervisor
Gulf of Mexico Office
Office of Resource Evaluation

Our National Environmental Policy Act (NEPA) review of the subject action is complete and results in a Finding of No Significant Impact (FONSI). This FONSI is conditioned on adherence to the following mitigation and monitoring measures that ensure environmental protection, consistent environmental policy, and safety as required by NEPA, as amended, and is valid only insofar as the following conditions are met:

Conditions of Approval

1. **COMPLIANCE WITH BIOLOGICAL OPINION TERMS AND CONDITIONS AND REASONABLE AND PRUDENT MEASURES:** This approval is conditioned upon compliance with the Reasonable and Prudent Measures and implementing Terms and Conditions of the Biological Opinion (BO) issued by the National Marine Fisheries Service on March 13, 2020. This includes mitigation, particularly any appendices to Terms and Conditions applicable to the plan, as well as record-keeping and reporting sufficient to allow BOEM and BSEE to comply with reporting and monitoring requirements under the BO; and any additional reporting required by BOEM or BSEE developed as a result of BO implementation. The NMFS BO may be found here:

   https://www.fisheries.noaa.gov/resource/document/biological-opinion-federally-regulated-oil-and-gas-program-activities-gulf-mexico.

   The Appendices and protocols may be found here:

   https://www.fisheries.noaa.gov/resource/document/appendices-biological-opinion-federally-regulated-oil-and-gas-program-gulf-mexico.

2. **SUPPORT BASES AND VESSEL TRANSIT ROUTES:** Approval of your application is conditioned upon your use of the support bases and vessel transit routes as described in your application. BOEM/BSEE must be notified at least 15 days prior to any vessel route changes that require transit of the Bryde's Whale area, and you must receive prior approval for that transit from BOEM/BSEE.

3. **SEISMIC SURVEY OPERATION, MONITORING, AND REPORTING GUIDELINES:** The applicant will follow the guidance provided under Appendix A. Seismic Survey Mitigation and Protected Species Observer Protocols found in the Biological Opinion issued by the National Marine Fisheries Service on March 13, 2020. The guidance can be accessed on NOAA Fisheries internet website at https://www.fisheries.noaa.gov/resource/document/appendices-biological-opinion-federally-regulated-oil-and-gas-program-gulf-mexico.

4. **MARINE TRASH AND DEBRIS AWARENESS AND ELIMINATION**: The applicant will follow the protocols provided in Appendix B. Gulf of Mexico Marine Trash and Debris Awareness and Elimination Survey Protocols found in the Biological Opinion issued by the National Marine Fisheries Service on March 13, 2020. The Appendix can be accessed on NOAA Fisheries internet website at https://www.fisheries.noaa.gov/resource/document/appendices-biological-opinion-federally-regulated-oil-and-gas-program-gulf-mexico.

5. **VESSEL-STRIKE AVOIDANCE/REPORTING:** The applicant will follow the guidance provided under Appendix C. Gulf of Mexico Vessel Strike Avoidance and Injured/Dead Aquatic Protected Species Reporting Protocols found in the Biological Opinion issued by the National Marine Fisheries Service on March 13, 2020. The Appendix can be accessed on the NOAA Fisheries internet site at https://www.fisheries.noaa.gov/resource/document/appendices-biological-opinion-federally-regulated-oil-and-gas-program-gulf-mexico.

6. **SEA TURTLE RESUSCITATION GUIDELINES:** The applicant will follow the guidance provided under Appendix J. Sea Turtle Handling and Resuscitation Guidelines found in the Biological Opinion issued by the National Marine Fisheries Service on March 13, 2020. The guidance can be accessed on the NOAA Fisheries internet site at https://www.fisheries.noaa.gov/resource/document/appendices-biological-opinion-federally-regulated-oil-and-gas-progr.am-gulf-mexico.

7. **MOON POOL MONITORING AND MEASURES:** A moon pool has been identified during review of your plan submission. If any ESA-listed species is detected, you are required to contact NMFS at nmfs.psoreview@noaa.gov and BSEE at protectedspecies@bsee.gov for additional guidance and incidental reporting information.

   General Requirements

   - Use of a moon pool requires regular monitoring while open to the water column and if a vessel is not underway. Regular monitoring means 24-hour video monitoring with hourly recurring checks for at least five minutes of the video feed, or hourly recurring visual checks of the moon pool for at least five minutes by a dedicated crew observer with no other tasks during that short visual check.
   - If water conditions are such that observers are unable to see within a meter of the surface, operations requiring the lowering or retrieval of equipment through the moon pool must be conducted at a rate that will minimize potential harm to protected species.
   - Moon pools with hull doors should attempt to keep doors closed when no activity is occurring within the moon pool, unless the safety of crew or vessel require otherwise. This will prevent protected species from entering the confined area during periods of non-activity.

   Movement of the Vessel (Without Closed Hull Door) and Equipment Deployment/Retrieval

   - Prior to movement of the vessel and/or deployment/retrieval of equipment, the moon pool must be monitored continuously for a minimum of 30 minutes, by a dedicated crew observer with no other tasks, to ensure no individual protected species is present in the moon pool area.
   - If a protected species is observed in the moon pool prior to movement of the vessel, the vessel must not be moved and equipment must not be deployed or retrieved, to the extent practicable. If the observed animal leaves the moon pool, the operator may commence activities. If the observed animal remains in the moon pool contact BSEE prior to planned movement of the vessel according to reporting requirements (see *below* under *Reporting of Observations of Protected Species within an Enclosed Moon Pool)*.
   - Should a protected species be observed in a moon pool prior to activity commencement (including lowering or retrieval of equipment), recovery of the animal or other actions specific to the scenario may be required to prevent interaction with the animal. Operators must not take such action except at the direction of, and after contact with, NMFS (see *Reporting Requirements* below).

   Closure of the Hull Door

   - Should the moon pool have a hull door that can be closed, then prior to and following closure, the moon pool must be monitored continuously by a dedicated crew observer with no other tasks to ensure that no individual protected species is present in the moon pool area. If visibility is not clear to the hull door from above (e.g., turbidity or low light), 30 minutes of monitoring is required prior to hull door closure.
   - If a protected species is observed in the moon pool prior to closure of the hull door, the hull door must not be closed, to the extent practicable. If the observed animal leaves the moon pool, the operator may commence closure. If the observed animal remains in the moon pool, contact BSEE prior to closure of the hull doors according to reporting requirements (see *below* under *Reporting of Observations of Protected Species within an Enclosed Moon Pool)*.

8. **NMFS SLACK-LINE PRECAUTIONS:** If operations require the use of flexible, small diameter (< 2 inch) lines to support operations (with or without divers), operators/contractors must reduce the slack in the lines, to the extent practicable, to prevent accidental entanglement of protected species (i.e.

species protected under the ESA and/or MMPA). This may include tether lines attached to remotely operated equipment. The requirements below must be followed for any activities entailing use of flexible, small diameter lines that will not remain continuously taut, except under circumstances when complying with these requirements would put the safety of divers, crew or the vessel at risk:

- Operators must utilize tensioning tools and/or other appropriate procedures to reduce unnecessary looseness in the lines and/or potential looping.
- The lines must remain taut, as long as additional safety risks are not created by this action.
- A line tender must be present at all times during dive operations and must monitor the line(s) the entire time a diver is in the water.
- Should the line tender and/or diver become aware of an entanglement of an individual protected species, the reporting requirements described below must be followed as soon as safety permits.

9. **NMFS REPORTING REQUIREMENTS:** Review of your proposed activities identified potential entanglement and/or entrapment risk(s) to protected species (i.e. species protected under the ESA and/or MMPA). Procedures and measures for reporting are dependent upon the situation and must be followed only in cases where they do not jeopardize human safety. These general requirements replace those specific to dead and injured species reporting in respective sections of Appendix A as they relate to geophysical surveys and Appendix C of the 2020 Biological Opinion on the Bureau of Ocean Energy Management's Oil and Gas Program Activities in the Gulf of Mexico.

Incidents Requiring Immediate Reporting

Should any of the following occur at any time, **immediate reporting** of the incident is required after personnel and/or diver safety is ensured:

- Entanglement or entrapment of a protected species (i.e., an animal is entangled in a line or cannot or does not leave a moon pool of its own volition).
- Injury of a protected species (e.g., the animal appears injured or lethargic).
- Interaction, or contact with equipment by a protected species.
- Any observation of a leatherback sea turtle within a moon pool (regardless of whether it appears injured, or an interaction with equipment or entanglement/entrapment is observed).

As soon as personnel and/or diver safety is ensured, report the incident to NMFS by contacting the appropriate expert for 24-hr response, until contact is made. Contact information for reporting is as follows:

- **Marine mammals**: contact Southeast Region's Marine Mammal Stranding Hotline at 1-877-433-8299.
- **Sea turtles**: contact Brian Stacy, Veterinary Medical Officer at 352-283-3370. If unable to reach Brian Stacy, contact Lyndsey Howell at (301) 301-3061. This includes the immediate reporting of any observation of a leatherback sea turtle within a moon pool.
- **Other protected species** (e.g., giant manta ray, oceanic whitetip shark, or Gulf sturgeon)**:** contact the ESA Section 7 biologist at 301-427-8413 (nmfs.psoreview@noaa.gov), and
- **Report all incidents** to takereport.nmfsser@noaa.gov.

Minimum reporting information is described below:

1. Time, date, water depth, and location (latitude/longitude) of the first discovery of the animal;
2. Name, type, and call sign of the vessel in which the event occurred;
3. Equipment being utilized at time of observation;
4. Species identification (if known) or description of the animal involved;
5. Approximate size of animal;

6. Condition of the animal during the event and any observed injury / behavior;
7. Photographs or video footage of the animal, only if able; and
8. General narrative and timeline describing the events that took place.

After the appropriate contact(s) have been made for guidance/assistance, you may call BSEE at 985-722-7902 (24 hours/day) for questions or additional guidance on recovery assistance needs (if still required) and continued monitoring requirements. You may also contact this number if you do not receive a timely response from the appropriate contact(s) listed above. Minimum post-incident reporting includes all information described above (1 through 8) in addition to the following:

1. NMFS liaison or stranding hotline that was contacted for assistance;
2. For moon pool observations or interactions:
3. Size and location of moon pool within vessel (e.g., hull door or no hull door);
4. Whether activities in the moon pool were halted or changed upon observation of the animal; and
5. Whether the animal remains in the pool at the time of the report, or if not, the time/date the animal was last observed.

Reporting of Observations of Protected Species within an Enclosed Moon Pool

If a protected species is observed within an enclosed moon pool and does not demonstrate any signs of distress or injury or an inability to leave the moon pool of its own volition, measures described in this section must be followed (only in cases where they do not jeopardize human safety). Although this particular situation may not require immediate assistance and reporting as described under *Incidents Requiring Immediate Reporting* (see above), a protected species could potentially become disoriented with their surroundings and may not be able to leave the enclosed moon pool of their own volition. In order for operations requiring use of a moon pool to continue, the following reporting measures must be followed:

Within 24 hours of any observation, and daily after that for as long as an individual protected species remains within a moon pool (i.e., in cases where an ESA listed species has entered a moon pool but entrapment or injury has not been observed), The following information must be reported to BSEE (protectedspecies@bsee.gov):

1. For an initial report, all information described above should be included.
2. For subsequent daily reports:
    - Describe the animal's status to include external body condition (e.g., note any injuries or noticeable features), behaviors (e.g., floating at surface, chasing fish, diving, lethargic, etc.), and movement (e.g., has the animal left the moon pool and returned on multiple occasions?);
    - Description of current moon pool activities, if the animal is in the moon pool (e.g., drilling, preparation for demobilization, etc.);
    - Description of planned activities in the immediate future related to vessel movement or deployment of equipment;
    - Any additional photographs or video footage of the animal, if possible;
    - Guidance received and followed from NMFS liaison or stranding hotline that was contacted for assistance;
    - Whether activities in the moon pool were halted or changed upon observation of the animal; and
    - Whether the animal remains in the pool at the time of the report, or if not, the time/date the animal was last observed.

10. **REQUIRED PASSIVE ACOUSTIC MONITORING (PAM):** BOEM requires that the applicant use passive acoustic monitoring (PAM) in water depths of 100 meters or greater at times of reduced

visibility (darkness, rain, fog, etc.) as part of their protected species observer program. PAM will be monitored at all times of reduced visibility. Applicants will be required to provide BSEE with a description of the passive acoustic system, the software used, and the monitoring plan prior to its use. Additionally, after survey completion, the applicant will provide an assessment of the usefulness, effectiveness, and problems encountered with the use of PAM for marine mammal detection to BSEE for review. The pre-survey information and post-survey assessment is to be submitted via email to protectedspecies@bsee.gov or via hardcopy to Bureau of Safety and Environmental Enforcement, Gulf of Mexico OCS Region, 1201 Elmwood Park Blvd, New Orleans, LA 70123-2394; Attention: Environmental Enforcement Branch (MS GE466).

11. **PRE-ACTIVITY SOUND-SOURCE AND ARRAY CALIBRATION VERIFICATION:** Prior to conducting survey activities, the applicant will verify in writing that the proposed airgun arrays to be used are of the lowest sound intensity level that still achieves the survey goals. The written verification must include confirmation that the airgun array has been calibrated/tuned to maximize subsurface illumination, and minimize, to the extent practicable, horizontal propagation of noise. The written verification is to be submitted via email to GGPermitsGOMR@boem.gov or via hardcopy to Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, 1201 Elmwood Park Blvd, New Orleans, LA 70123-2394; Attention: Data Acquisition and Special Projects Unit (MS GM 881A).

12. **MANDATORY SEPARATION BUFFER BETWEEN SURVEY OPERATIONS:** The applicant will be required to maintain, to the extent it can practicably and safely do so, a minimum separation distance of 30 km from any other vessels concurrently conducting deep-penetration seismic surveys and 40 km when operating within an Area of Concern. Details on the locations of these Areas of Concern can be found at http://www.boem.gov/BOEM-Lawsuit-Settlement-Agreement/. To assist in implementation of this measure, BOEM will provide the applicant with contact information for all deep-penetration seismic applicants concurrently permitted/authorized to operate within or near the proposed survey area.

13. **SUPPLEMENTAL REPORTING REQUIREMENTS:** In addition to the reporting requirements under NTL No. 2016-G02, the applicant is required to submit bi-weekly reports containing the information listed below. The reporting periods end on the 1st and 15th of each month. These bi-weekly reports are required for the *total* duration of the permit. When applicable, they must be submitted with survey navigation data for the two week reporting period. BOEM has a suggested format for the written report. If BOEM suggested written format is not used the following information must be submitted along with the navigation data:

    1. The dates, locations, and duration of any Deep-Penetration Seismic operations conducted during the reporting period (*The navigation data provides this information*).
    2. Any circumstances that caused the total energy output of the airgun source array to exceed that set forth in the permit application.
    3. Confirmation that the permittee maintained, to the extent they could practicably and safely do so, the minimum separation distance. If applicable, submit a written explanation of why the minimum separation distance was not maintained.
    4. Confirmation that the permittee complied with the other terms of Section V of the Settlement Agreement.

    The bi-weekly reports are to be submitted via email to: GGPermitsGOM@boem.gov or via hardcopy to Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, 1201 Elmwood Park Blvd, New Orleans, LA 70123-2394; Attention: Data Acquisition and Special Projects Unit (MS GM 881A).

14. **NON-RECURRING MITIGATION FOR THE PROTECTION OF POTENTIAL ARCHAEOLOGICAL RESOURCES:** There are significant portions of the project area within the OCS that have received either limited or no previous archaeological survey, and these areas are likely to contain additional archaeological materials that may be impacted by the proposed operations. If the applicant discovers man-made debris that appears to indicate the presence of a shipwreck (e.g., a sonar image or visual confirmation of an iron, steel, or wooden hull, wooden timbers, anchors, concentrations of man-made objects such as bottles or ceramics, piles of ballast rock) within or adjacent to the proposed action area during the proposed survey operations, they will be required to immediately halt operations, take steps to ensure that the site is not disturbed in any way, and contact the BOEM Regional Supervisor for Environment within 48-hours of its discovery. They must cease all operations within 1,000 feet (ft) (305 meters [m]) of the site until the Regional Director instructs you on what steps you must take to assess the site's potential historic significance and what steps you must take to protect it. If an OBN, ROV, PIES or other activity impacts any submerged object, then the applicant must also submit a report detailing each instance of this activity. This report should include the coordinates of the impact (to DGPS accuracy), a description of the submerged object, any damage that may have resulted from the OBN placement or retrieval operations, and any photographic or video imagery that is collected. The applicant must submit a copy of any data collected as a result of these investigations.

    Following completion of fieldwork, the applicant must submit as-placed plats, at a scale of 1 inch = 1,000 ft (305 m), of all OBNs relative to the listed target and the avoidance boundary. If remote-sensing survey data is collected for any reason during the course of this project (i.e., side-scan sonar, sector-scan sonar, multi-beam bathymetry, or magnetometer) then the applicant must submit copies of this data to BOEM.

    Please direct any questions or correspondence pertaining to these requirements to Scott Sorset (504) 736-2999 or Dr. Jack Irion (504) 736-1742.

15. **NON-RECURRING MITIGATION BENTHIC COMMUNITIES:** The method Shell Exploration & Production Company proposes for deployment and retrieval of ocean bottom nodes (OBN) and PEIS is summarized as follows:

    Each node will be deployed on the seafloor using two work-class ROVs guided by a USBL navigation system. The ROVs pause to visually inspect the seafloor prior to approaching the pre-plotted location. Nodes will be placed clear of standoff zones including chemosynthetic or other hard bottom deep water communities. The ROV will land on location, deploy/recover a node from/to a skid on the base of the ROV. The ROV then departs vertically and transits to the next location. The process is repeated until all nodes are deployed/recovered.

    A vessel crane will be used to deploy the Pressure Inverted Echo Sounder (PEIS). The crane line will be monitored by an ROV at 500 ft water depth. Once on the seabed, the ROV will unlatch the crane line from the PEIS. The PEIS will remain on the seabed for ~120 days.

    BOEM review of geophysical activities proposed in T20-004 identified confirmed and potential sensitive sessile benthic resources within the proposed node area. According to NTL 2009-G40, the minimum separation distance for bottom disturbing activities is 76 m (250 ft) from any sensitive sessile benthic community (e.g., deepwater coral, chemosynthetic tube worms). Based on the methods described in the application, BOEM authorizes the applicant to deploy nodes with less than 76 m (250 ft) avoidance of high-density deepwater benthic communities contingent upon the applicant adhering to the mitigations described below:

    1. All seafloor disturbances, including nodes, cables, and ROV, must remain a minimum of 5 m (16 ft) from all sensitive sessile benthic communities.
    2. The contractor must photograph the seabed within a 10 m (33 ft) radius of any node placed within 76 m (250 ft) of a BOEM anomaly (June 2019 dataset, see link below). Photographs of each such location shall be taken: Pre-node deployment, post-node deployment, and post-node retrieval. The photos shall clearly show the geographic location of each node.

3. If any sessile benthic communities are present at a proposed node location, a new site that allows compliance with the above requirements shall be selected.
4. The contractor must provide an as-placed GIS shapefile of actual OBN locations to demonstrate compliance. Submit the required photographs and shapefile to the BOEM Regional Supervisor, Office of Resource Evaluation, Data Acquisition and Special Projects Unit, within 90 calendar days after you complete the G&G activity.

Refer to the following BOEM site for GIS data layers of known 3D seismic water bottom anomalies:

https://www.boem.gov/Seismic-Water-Bottom-Anomalies-Map-Gallery/

The following feature classes have a high probability of supporting sensitive sessile benthic organisms and shall be avoided unless visual inspection and photographic data confirm an absence of high-density deepwater benthic communities:

1. Anomaly_patchreefs (Shallow Water)
2. Anomaly_confirmed_patchreefs (Shallow Water)
3. Seep_anomaly_positives
4. Seep_anomaly_positives_possible_oil
5. Seep_anomaly_positives_confirmed_oil
6. Seep_anomaly_positives_confirmed_gas
7. Seep_anomaly_confirmed_corals
8. Seep_anomaly_confirmed_organisms
9. Seep_anomaly_confirmed_hydrate
10. Seep_anomaly_confirmed_carbonate
11. Anomaly_Cretaceous
12. Anomaly_Cretaceous_talus

Shell Exploration & Production Company proposes to follow the below field methodology for deployment/recovery of OBNs to meet the above requirements:

To support node placement within the water bottom anomalous areas and in proximity to any identified communities, Shell propose photographing the seabed within a circular area of approximately 10m diameter, around the proposed node location. Three photographs shall be taken from a height of 15m per node location: Pre-node deployment; post-node deployment and post-node retrieval. In addition, a continuous video feed will be recorded during operations within the water bottom anomalous zones and stored.

It is understood from NTL No. 2009-G40, a minimum separation of 250 ft must be maintained between documented communities or features that could potentially support high-density deepwater benthic communities, and bottom disturbing activities. However, due to the small footprint of the nodes, the accuracy of their positioning and the ability of the ROV to fully document any disturbance caused, it is requested to place the nodes no closer than 5m from any high-density deepwater benthic communities. If any such communities are present at the proposed location of each node, a new location shall be selected. Shell will provide the photographs and video feeds as described above, for each proposed location within the water bottom anomalous zone. The photos and video shall clearly show the geographic location of each node.

15. **NON-RECURRING MITIGATION:** Our review indicates that there are pipelines in the vicinity of the planned activities that may pose a hazard to your proposed operations. Therefore, take

precautions in accordance with Notice to Lessees and Operators No. 2008-G05, Section VI.B, prior to performing operations.

16. **MILITARY WARNING AREA COORDINATION**: Our review indicates that the routes to be taken by boats in support of your proposed activities are within Military Warning Area W-602 (see BOEM Internet website for a map of the areas at):

    http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Gulf-of-Mexico-Region/MWA_boundaries-pdf.aspx.

    You shall contact the appropriate individual military command headquarters concerning the control of electromagnetic emissions and use of boats in each of the areas before commencing your operations. For a list of contacts, reference:

    http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Gulf-of-Mexico-Region/Military-Contacts-pdf.aspx.

Additional Conditions of Approval:

1. Man-made structure(s) such as pipeline(s) or other potential hazard(s) may be located in the permitted work area; therefore, prior to performing operations that involve seafloor disturbance (e.g., coring), take precautions in accordance with Notice to Lessees and Operators No. 2008-G05, Section VI.B, Shallow Hazards Program (see the BOEM website at: http://www.boem.gov/Regulations/Notices-To-Lessees/2008/08-g05.aspx).

2. If you conduct activities that could disturb the seafloor in an Ordnance Dumping Area (see the BOEM website at: https://www.boem.gov/Ordnance-Dumping- Areas/ for a map), exercise caution, since this area might contain old ordnance, including unexploded shells and depth charges, dumped before 1970. In addition, the U.S. Air Force has released an undeterminable amount of unexploded ordnance in Water Test Areas 1 through 5 (most of the Eastern Planning Area of the GOM).

3. If you discover any site, structure, or object of potential archaeological significance (i.e., cannot be definitively identified as modern debris or refuse) while conducting operations, the provisions of 30 CFR 250.194(c) and NTL 2005-G07, (Archaeological Resource Surveys and Reports) require you to immediately halt operations within 1,000 feet of the area of discovery and report this discovery to the Regional Supervisor (RS) of the Office of Environment (OE) within 48 hours. Every reasonable effort must be taken to preserve the archaeological resource from damage until the RS of OE has told you how to protect it.

4. Comply with the provisions of NTL 2009-G39, Biologically-Sensitive Underwater Features and Areas, effective January 27, 2010, (see the BOEM website at: https://www.boem.gov/Regulations/Notices-To-Lessees/2009/09-G39.aspx). If you conduct activities near an identified biologically sensitive topographic features (see the specific list at https://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Gulf-of-Mexico-Region/topoblocks-pdf.aspx), in the Live Bottom "Pinnacle Trend" Area, or Live Bottom "Low Relief" Area (see the BOEM website at https://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Gulf-of-

Mexico-Region/topomap-pdf.aspx for a map of all three features), the following measures apply:

a. Ensure you do not anchor or otherwise disturb the seafloor within 152 meters (500 feet) of a designated "No Activity Zone." Information on the activities that disturbed the seafloor within 305 meters (1,000 feet) of the "No Activity Zone" of a biologically sensitive topographic feature shall be submitted to BOEM (see "d" below.)

b. Do not anchor or otherwise disturb the seafloor within 30 meters (100 feet) of any identified pinnacles or other hard bottoms that have a vertical relief of eight feet or more. Information on the activities that disturbed the seafloor within 61 meters (200 feet) of pinnacles in the "Pinnacle Trend" Area shall be submitted to BOEM (see "d" below.)

c. Do not anchor or otherwise disturb the seafloor near any identified live bottom low relief features. Information on the activities that disturbed the seafloor within 30 meters (100 feet) of live bottom low relief features in the Live Bottom "Low Relief" Area shall be submitted to BOEM (see "d" below.)

d. Within 90 calendar days of completing activities, submit information regarding seafloor disturbances to BOEM New Orleans Office Data Acquisition and Special Project Unit (see page 5 of these "Protective Measures" for the address) a PDF map and the appropriate shape files to reproduce the map, showing the location of the seafloor disturbance relative to these features.

5. If you conduct activities in water depths 300 meters (984 feet) or greater, make sure that you do not anchor, use anchor chains, wire, ropes, or cables, or otherwise disturb the seafloor within 76 meters (250 feet) of any features or areas that could support deep water sessile benthic communities. Refer to NTL No. 2009-G40, Deepwater Chemosynthetic Communities, effective January 27, 2010 (see the BOEM website at: http://www.boem.gov/Regulations/Notices-To-Lessees/2009/09-G40.aspx). Also, refer to the BOEM website for GIS data layers of known 3D seismic water bottom anomalies at https://www.boem.gov/Seismic-Water-Bottom-Anomalies-Map-Gallery/.

   The following feature classes have a high probability of supporting sensitive sessile benthic organisms and shall be avoided unless visual inspection and photographic data confirm an absence of high-density deepwater benthic communities:

   1. Anomaly_patchreefs (Shallow Water)
   2. Anomaly_confirmed_patchreefs (Shallow Water)
   3. Seep_anomaly_positives
   4. Seep_anomaly_positives_possible_oil
   5. Seep_anomaly_positives_confirmed_oil
   6. Seep_anomaly_positives_confirmed_gas
   7. Seep_anomaly_confirmed_corals
   8. Seep_anomaly_confirmed_organisms
   9. Seep_anomaly_confirmed_hydrate
   10. Seep_anomaly_confirmed_carbonate
   11. Anomaly_Cretaceous

12. Anomaly_Cretaceous_talus

Within 90 calendar days after completing activities that disturbed the seafloor within 152 meters (500 feet) of features or areas that could support high-density chemosynthetic communities, submit to the BOEM New Orleans Office Data Acquisition and Special Project Unit (see page 5 of these "Protective Measures" for the address) a PDF map and the appropriate shape files to reproduce the map, showing the location of the seafloor disturbance relative to these features

6. Comply with the provisions of NTL 2009-G39, Biologically-Sensitive Underwater Features and Areas of the Gulf of Mexico, effective January 27, 2010, (see the BOEM website at: http://www.boem.gov/Regulations/Notices-To-Lessees/2009/09- G39.aspx). If you discover any high-relief topographic feature with a relief greater than eight (8) feet while conducting activities, report the discovery to the BOEM New Orleans Office Regional Director. Make sure you do not anchor on or otherwise disturb such a feature. Within 90 calendar days after completing an activity that disturbed the seafloor within 30 meters (100 feet) of such a feature, submit to the BOEM New Orleans Office Data Acquisition and Special Project Unit (see page 5 of these "Protective Measures" for the address) a map at a scale of 1 inch = 1,000 feet with DGPS accuracy, showing the location of the seafloor disturbance relative to the feature.

7. Before you conduct activities that could disturb the seafloor within 254 meters (1,000 feet) of a Texas artificial reef site or artificial reef permit area, within152 meters (500 feet) of a Louisiana artificial reef site or artificial reef permit area, or could disturb the seafloor within a General Permit Area established by the States of Texas, Alabama or Florida for the placement of artificial reef material, contact the appropriate State reef management agency. See the BOEM websites at: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Gulf-of- Mexico-Region/artreefmap.aspx for a map and http://www.boem.gov/Environmental- Stewardship/Environmental-Studies/Gulf-of-Mexico-Region/artreefcontacts-pdf.aspx for State contacts.

8. If you conduct activities within the boundaries of the Flower Gardens National Marine Sanctuary (Flower Gardens Banks and Stetson Bank), exercise caution to ensure that such activities do not endanger any other users of the Sanctuary. See the BOEM website at: http://www.boem.gov/Environmental-Stewardship/Environmental- Studies/Gulf-of-Mexico-Region/FGNMSmap-pdf.aspx for map. Additionally, activities involve moving the marker buoys at the Sanctuary, contact Mr. G. P. Schmahl, the current Sanctuary Manager, for instructions. See the BOEM website at: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Gulf-of- Mexico-Region/FGNMScontacts-pdf.aspx for Mr. Schmahl's contact information. See the BOEM website at: http://www.boem.gov/Environmental-Stewardship/Environmental- Studies/Gulf-of-Mexico-Region/FGNMSbuoys-pdf.aspx for the locations of the Flower Gardens' marker buoys.

9. If your proposed activities will involve using boats from a port located south of the Suwannee River mouth in Florida, make sure that you adhere to the following manatee protection plan:
   a. Advise your personnel of the possibility of the presence of manatees in the inland and coastal waters of Florida in the Eastern Gulf of Mexico.

b. Advise your personnel that there are civil and criminal penalties for harming, harassing, or killing manatees, which are protected under the Endangered Species Act, the Marine Mammal Protection Act, and the Florida Manatee Sanctuary Act of 1978.
c. Advise your vessel operators to (1) use the deeper ship channels to the maximum extent possible; (2) avoid collisions with manatees and to stay within the existing channels; and (3) obey all speed restrictions and travel at "no wake/idle" speeds at all times while operating in shallow water or in channels where the draft of the vessel provides less than four (4) feet of clearance. (Areas of manatee concentrations have been identified and speed limit signs have been erected in accordance with Federal, State, and local regulations.)
d. While vessels are berthed in port, advise your vessel operators to use fenders between the dock and the vessel and/or between adjacent vessels berthed side-by-side. Make sure that the fenders have a minimum clearance of three feet when compressed between the dock and the vessel
e. Ensure that your vessel operators keep logs detailing any sighting of, collision with, damage to, or death of manatees that occur while you conduct an ancillary activity. If a mishap involving a manatee should occur, make sure that the vessel operator immediately calls the "Manatee Hotline" ((888) 404-3922), and the U.S. Fish and Wildlife Service, Jacksonville Field Office ((904) 232-2580) for north Florida or the U.S. Fish and Wildlife Service, Vero Beach Ecosystem Office ((772) 562-3909) for South Florida.
f. Within 60 calendar days after completing the activity, submit a report summarizing all manatee incidents and sightings to the Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission, 100 Eighth Avenue SE, St. Petersburg, FL 33701-5095; and to the U.S. Fish and Wildlife Service, 6620 Southpoint Drive South, Suite 310, Jacksonville, FL 32216-0958, for north Florida, or to the U.S. Fish and Wildlife Service, 1339 20th Street, Vero Beach, Florida 32960-3559, for south Florida.

10. The Magnuson-Stevens Fisheries Conservation and Management Act (see 50 CFR 600.725) prohibits the use of explosives to take reef fish in the Exclusive Economic Zone. Therefore, if your activities involve the use of explosives, and the explosions result in stunned or killed fish, do not take such fish on board your vessels. If you do, you could be charged by the National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries Service) with a violation of the aforementioned Act. If you have any questions, contact NOAA Fisheries Service, Office for Law Enforcement, Southeast Division, at (727) 824-5344.

11. When operations extend south of approximately 26 degrees north latitude in the Western Gulf of Mexico or 24 degrees to 25 degrees north latitude in the Eastern Gulf of Mexico (the 200-nautical mile provisional maritime also called the Exclusive Economic Zone Conservation Zone Limit), notify the Department of State: Ms. Roberta Barnes, Room 2665, OES/OPA, Department of State, Director, Office of Ocean and Polar Affairs, Washington, D.C., 20520, at (202) 647-0240 or barnesrm@state.gov.

12. As part of the requirements of 30 CFR 551.6(a), if any operation under this Permit and Agreement is to be conducted in a leased area, the Permittee shall take all necessary

precautions to avoid interference with operations on the lease and damage of existing structures and facilities. The lessee (or operator) of the leased area will be notified, in writing, before the Permittee enters the leased area, or commences operations, and a copy of the notification will be sent to the Regional Supervisor executing this Permit Agreement.

13. (a) Solid or liquid explosives shall not be used, except pursuant to written authorization from the Regional Supervisor. Requests of the use of such explosives must be in writing, giving the size of charges to be used, the depth at which they are to be detonated, and the specific precautionary methods proposed for the protection of fish, oysters, shrimp, and other natural resources. The use of explosives represents a may affect situation under Section 7 of the Endangered Species Act of 1973, as amended.

    (b) The following provisions are made applicable when geophysical exploration on the Outer Continental Shelf using explosives is approved:

    i. Each explosive charge will be permanently identified by markings so that unexploded charges may be positively traced to the Permittee and to the specific field party of the Permittee responsible for the explosive charge
    ii. The placing of explosive charges on the seafloor is prohibited. No explosive charges shall be detonated nearer to the seafloor than five (5) feet (1.52 meters).
    iii. No explosive shall be discharged within 1,000 feet (304.8 meters) of any boat not involved in the survey.

14. Any serious accident, personal injury, or loss of property shall be immediately reported to the Regional Supervisor of Resource Evaluation.

15. All pipes, buoys, and other markers used in connection with seismic work shall be properly flagged and lighted according to the navigation rules of the U.S. Corps of Engineers and the U.S. Coast Guard.

Shell Offshore Inc.
One Shell Square
P. O. Box 61933
New Orleans, LA 70161-1933
United States of America
Tel +1 504 425 4652
Email Tracy.Albert@shell.com

Proprietary Copy

November 10, 2020

Regional Supervisor, Resource Evaluation
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Attn: Data Acquisition and Special Projects Unit
MS 5123

SUBJECT: Geophysical Permit for 2021 Leopard OBN Seismic Survey Alaminos Canyon 690 and Surrounding Area

Gentlemen:

Please find attached our OBN permit for above referenced area. Also attached is the cost recovery fee and the shape/source array files to assist in your review.

Please contact us if you have any questions or require additional information.

Sincerely,

Tracy Albert
Sr. Regulatory Specialist

Attachments

Alert Message:

Coronavirus (COVID-19) updates

Receipt - BOEM Geological and Geophysical Exploration or Prospecting

Receipt

Tracking Information

Pay.gov Tracking ID: 26QE4IRI

Agency Tracking ID: 76049195383

Form Name: BOEM Geological and Geophysical Exploration or Prospecting

Application Name: BOEM Geological and Geophysical Exploration or Prospecting - CG

Payment Information

Payment Type: Debit or credit card

Payment Amount: $2,012.00

Transaction Date: 11/10/2020 10:33:06 AM EST

Payment Date: 11/10/2020

Region: Gulf of Mexico

Contact: Tracy Albert 504-425-4652

Company Name: Shell Offshore Inc.

Area(s): Alaminos Canyon AC, , ,

Contractor Name: Magseis Fairfield

G&G Permit Form: Form MMS-327

Account Information

Cardholder Name: Vishram Rambaran

Card Type: Visa

Card Number: **********9512

Print Receipt

Need Help?

Contact:
Brenda Dickerson

Email:
Click to email

Phone:
(703) 787-1617

Shell Offshore Inc.
One Shell Square
P. O. Box 61933
New Orleans, LA 70161-1933
United States of America
Tel +1 504 425 7215
Fax +1 504 425 4652
Email tracy.albert@shell.com

November 10, 2020

Data Acquisition and Special Projects Unit
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

SUBJECT: Additional Information for Geophysical Permit for
3D OBN Seismic Survey Alaminos Canyon (Leopard)

Gentlemen:

Please be advised that the proposed 2021 Leopard OBN survey in the vicinity of OCS Alaminos Canyon 690 and surrounding blocks is non-duplicative as this is an OBN seismic 4D baseline survey designed to image reservoir structures over this field.

I hereby verify that the 5110 cu in air and 8000 cu in gun arrays will be utilized in the OBN survey in the vicinity of OCS Alaminos Canyon 690 and surrounding block are of the lowest practicable sound intensity level that still achieves the survey objectives. The air gun array will be operated in a manner to maximize subsurface illumination, and minimize, to the extent practicable, horizontal propagation of noise.

Please contact us if you have any questions or require additional information.

Sincerely,

Tracy Albert
Regulatory Specialist

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OCEAN ENERGY MANAGEMENT

Gulf of Mexico OCS Region

(Insert Appropriate Regional Office)

APPLICATION FOR PERMIT TO CONDUCT GEOLOGICAL OR GEOPHYSICAL EXPLORATION FOR MINERAL RESOURCES OR SCIENTIFIC RESEARCH ON THE OUTER CONTINENTAL SHELF

(Section 11, Outer Continental Shelf Lands Act of August 7, 1953, as amended on September 18, 1978, by Public Law 95-372, 92 Statute 629, 43 U.S.C. 1340; and 30 CFR Parts 551 and 251)

Shell Offshore Inc.
Name of Applicant

701 Poydras, Room 2418
Number and Street

New Orleans, LA 70139
City, State, and Zip Code

Application is made for the following activity: (check one)

- ☐ Geological exploration for mineral resources
- ☐ Geological scientific research
- ☒ Geophysical exploration for mineral resources
- ☐ Geophysical scientific research

Submit: Original plus three copies, totaling four copies, which include one copy of the original, one digital copy, and one public copy (all with original signatures).

==========

To be completed by BOEM

Permit Number: T20-004 **Date:** 10-Nov-2020

A. General Information

1. The activity will be conducted by:

Magseis Fairfield Service Company Name	For Shell E&P Co Purchaser(s) of the Data
9811 Katy Fwy Suite 1100 Address	701 Poydras Street, Room 2418 Address
Houston, Texas 77024 City, State, Zip	New Orleans, LA 70139 City, State, Zip
+1 281-275-7613 Telephone/FAX Numbers	+1 832-337-0481 Telephone/FAX Numbers
steve.mcintosh@magseisfairfield.com E-Mail Address	vishram.rambaran@shell.com E-Mail Address

2. The purpose of the activity is: ☒ Mineral exploration

☐ Scientific research

3. Describe your proposed survey activities (i.e., vessel use, benthic impacts, acoustic sources, etc.) and describe the environmental effects of the proposed activity, including potential adverse effects on marine life. Describe what steps are planned to minimize these adverse effects (mitigation measures). For example: 1) Potential Effect: Excessive sound level Mitigation; Soft Start, Protected Species Observers (PSO's), mammal exclusion zone or 2) Potential Effect: Bottom disturbance; Mitigation: ROV deployment/retrieval of bottom nodes) (use continuation sheets as necessary or provide a separate attachment. Label as **BOEM-0327 Section A General Information**.):

There will be no adverse effects on marine life. The use of airgun sources will follow NTL 2016-G02.

Additionally, the use of a Passive Acoustic Monitoring (PAM) should be implemented following NTL 2016-G02.

4. The expected commencement date is: March 1, 2021

The expected completion date is: July 1, 2021

5. The name of the individual(s) in charge of the field operation is:
Vishram Rambaran

May be contacted at:
150 North Dairy Ashford Road, Houston Tx, 77079

Telephone (Local) +1 713 307 2444 (Marine) +47 22 40 81 61 Iridium +881641411572 (Olympic Challenger

+47 56 99 74 Iridium: +88 16 777 54005 (Eagle Explorer)

Email Address: vishram.rambaran@shell.com

6. The vessel(s) to be used in the operation is (are):

Vessel Name (s)	Vessel Model	Registry Number(s)	Radio Call Sign(s)	Registered Owner(s)
M/V Eagle Explorer	Source Vessel	9381299(IMO)	5BCL5	SeaBird Exploration Vessels Ltd
M/V OLYMPIC CHALLENGER	ROV Vessel	9398292 (IMO)	C6ZZ7	Olympic Shipping

7. The port from which the vessel(s) will operate is: Galveston, TX
8. Briefly describe the navigation system (vessel navigation only):

DGPS

B. Complete for Geological Exploration for Mineral Resources or Geological Scientific Research

1. The type of operation(s) to be employed is: (check one)
   a. ☐ Deep stratigraphic test, or
   b. ☐ Shallow stratigraphic test with proposed total depth of _____, or
   c. ☐ Other _____
2. Attach a page-size plat showing: 1) The generalized proposed location for each test, where appropriate, a polygon enclosing the test sites may be used; 2) BOEM protraction areas, coastline, point of reference, OCS boundary/3-mile limit; 3) Distance and direction from a point of reference to area of Activity; and 4) Label as "**Public Information**".

C. Complete for Geophysical Exploration for Mineral Resources or Geophysical Scientific Research

1. The proposed operation: Seismic survey
   a. Acquisition method (OBN, OBC, Streamer): OBN
   b. Type of acquisition: (High Resolution Seismic, 2D Seismic, 3D Seismic, gravity, magnetic, CSEM, etc.)
   3D Seismic
2. Attach a page-size plat showing:
   a. The generalized proposed location of the activity with a representative polygon;
   b. BOEM protraction areas, coastline, point of reference, OCS boundary/3- mile limit;
   c. Distance and direction from a point of reference to area of activity;
   d. Label as "**Public Information**"; and
   e. Submit relevant shape files needed to recreate the map as part of the required digital copy.

3. List all energy source types to be used in the operation(s): (Air gun, air gun array(s), sub-bottom profiler, sparker, towed dipole, side scan sonar, etc.).

Airgun Source Array

4. Explosive charges will [ ] will not [X] be used. If applicable, indicate the type of Explosive and maximum charge size (in pounds) to be used: _____

Type _____ Pounds _____ Equivalent Pounds of TNT _____

D. Proprietary Information Attachments

Use the appropriate form on page 9 for a "geological" permit application or the form on page 11 for a "geophysical" permit application. You must submit a separate Form BOEM-0327 to apply for each geological or geophysical permit.

E. Certification

I hereby certify that foregoing and attached information are true and correct.

Print Name: Tracy W. Albert

SIGNED Tracy W. Albert **DATE** 11/10/2020

TITLE Sr. Regulatory Specialist

COMPANY NAME: Shell Offshore Inc.

==========

TO BE COMPLETED BY BOEM

Permit No. T20-004 **Assigned by** W. Chad Vaughan **of BOEM** **Date** 17-Nov-2020

This application is hereby:

a. X Accepted

b. _____ Returned for reasons in the attached

SIGNED MATTHEW WILSON Digitally signed by MATTHEW WILSON Date: 2020.11.19 10:08:08 -06'00' **TITLE** Regional Supervisor **DATE** 11/19/2020

Section D Proprietary Information Attachment
Required for an Application for Geophysical Permit

Please provide the information in an attached document labeled **BOEM-0327 Section D Proprietary Information Attachment**.

1. Attach detailed narrative and description of the energy source(s) and receiving array.

2. Attach a map view diagram/schematic that illustrates vessel(s) source and receiver(s) configuration. Label each vessel indicating its function and include the dimensions of streamer(s), tow fish, etc. Indicate the number of chase and alternate vessels to be used.

Please refer to the attached material

3. List each energy source to be used (e.g., airgun, airgun array(s), sparker, towed dipole, side scan sonar, sub bottom profiler, etc.). Indicate the source's manufacturer, model, Source Level (SL) in dB re 1µPa @1m in water (RMS) and if applicable, Source Level (SL) in dB re 1µPa @1m in water (Peak to Peak) and ping rate. If the manufacturer does not provide a peak to peak level (many side scan sonars, etc.), please enter N/A. Additionally, provide the operational frequency ranges.

Energy Source	Manufacturer	Model	Array or Airgun Size (cu. in.)	Source Level (SL) in dB re 1µPa@1m in water (RMS)	Source Level (SL) in dB re 1µPa@1m in water (Peak to Peak)	Frequency (Hz, kHz range)	Ping Duration/ Cycle	Ping Rate
Airgun arrary	Bolt	LLX	5110	~239dB	~264dB	0-200Hz	0.1 second	10.5 seconds
Enhance Energy frequency source	ION	EFL	8000	~220dB	~243dB	0-10HZ	NA	NA
PIES	Sonardyne	Type 8306	NA	188-200 dB	190-200 dB	14-19 kHz	NA	30 seconds

For air guns/air gun arrays (excludes multibeam bathymetry, high frequency subbottom profilers, and side scan sonar systems), provide the maximum distance from the sound source to the 190, 180, and 160 dB in RMS dB levels: (Required for Alaska region, GOM region only requires this information for surveys in the GOM that will use simsource during acquisition; Not required for Atlantic permits).

dB level	Maximum Distance from Source
190 dB	
180 dB	
160 dB	

4. State the shot frequency of the source array(s) as shots per minute or shots per linear mile (statute): 32 shots per mile for source lines, 64 shots per mile for sail lines (dual source c

5. List the towing depth (ft/m) of the source array(s):
8 to 10 meters

6. If applicable, list the towing depth (ft/m) of the receiver(s):
OBN receivers will be located on seabed.

7. CSEM, OBN, Magnetotelluric, and OBC surveys: Describe the receiver deployment and retrieval procedures. Indicate the number and spacing of anyocean bottom receivers, cables, and anchors. If anchors will not be retrieved, provide theirphysical composition and rate of decomposition.

Please refer to the attached material

8. List the navigation/positioning system or method used to position shotpoint locations and/or ocean bottom receivers:
Shot points: dGPS. OBN receivers: dGPS and USBL.

9. Proposed areal extent (in OCS blocks) for 3D surveys or total number of line miles for 2D surveys:
Alaminos canyon 690, 691 and surrounding 95 blocks.

10. Provide the company identification name of the proposed survey (e.g., Deep Six Survey) and list all proposed initial and final processed data sets that will result from survey acquisition..

Leopard OBN survey

11. State the estimated date (month and year) on which initial and final processing will be available for all proposed processed data sets:

Initial December 2021, Final: July 2022

12. Attach map(s), plat(s), and chart(s) (preferably at a scale of 1:250,000) and an electronic version of same showing latitude and longitude, scale, specific protraction areas, OCS boundary/3-mile limit, block numbers. The map, plat or chart should be submitted at a sufficient size and scale to make out all details of the activities shown. The map should be labeled "**Proprietary**." For 2D data acquisition provide specific track lines with line identifications with the total number of line miles proposed or a representative polygon and total number of blocks for 3D surveys. Along with the hardcopy map, submit on CD or flashdrive (subject to security screening), the necessary ArcGIS shape files to reproduce the map for 2D track lines including individual line names in the attribute table. For 3D surveys provide a representative polygon as an ArcGIS shape file. You must provide a shapefile data set of the latitude/longitude location for all track lines, shot lines, and node placements. This can be submitted at a later time but must be received before activities can take place.

G&G Permits Request for Information

The following information is requested to ensure BOEM has the details necessary to evaluate your proposed action and ensure it will protect the ESA-listed species covered by the 2020 Biological Opinion. If your activity includes any of the following, please provide additional details on the equipment / technology, procedures for ensuring ESA-listed species are not impacted, and/or results of modeling and analysis of sound associated with pile-driving or air guns.
This information must be included as part of your application.

1. Use of New or Unusual Technology (NUT). N/A
2. Use of a vessel with a moon pool.
   For OBN deployment and retrieval, Magseis Fairfield would follow the Shell Marine Note 1 – 2020, COMPLIANCE WITH MARINE MAMMAL & ENDANGERED SPECIES PROTECTION & REPORTING REQUIREMENTS as well as the BOEM permit for moonpool use item GoM as outlined in the link attached to the Shell clarification. As part of the Magseis Fairfield procedure and according to the excerpt from the Shell Marine Note 1- 2020 below, two additional dedicated PSOs will be included as moonpool observers as per the requirements stated above.

   Vessels with Moon-Pools
   - Operations that require use of the vessel moon pool(s), the contractor or company representative will be required to provide a dedicated crew member to survey the pool area for sea turtles and/or marine mammals after securing from operations and prior to closure of the hull door(s) and vessel transit. If a turtle/marine mammal is detected, you are required to cease hull door closure and immediately contact NMFS at nmfs.psoreview@noaa.gov and BSEE at protectedspecies@bsee.gov and 985-722-7902 for additional guidance and incidental report information. If no animals are detected, the dedicated crew member must continue observations while the door(s) is closing; keeping in communications with the door operator and/or bridge. Once the door(s) are closed, the observer can secure, and the vessel can continue with its transit.

   - Any vessels required to support operations and utilize a moon pool(s) to conduct various subsea, remotely-operated vehicle (ROV), and/or support activities. Your contractor or company representative will be required to provide a dedicated crew member to monitor and continually survey the moon pool area during the operations for sea turtles and marine mammals. If any sea turtle or marine mammal is detected in the moon pool, you are required to cease operations and contact NMFS at nmfs.psoreview@noaa.gov and BSEE at protectedspecies@bsee.gov and 985-722-7902 for additional guidance and incidental report information.

3. Equipment with an entanglement or entrapment risk (e.g., flexible lines/ropes). Towed seismic airguns will be used on this project along with two ROV tether/umbilical lines.

   ROV Tethers:
   MIL208:
   Manufacturer: Nexans Enable
   Length: Approximately 625 Meters
   Diameter: 40 mm

   MIL211:
   Manufacturer: Nexans Enable
   Length: Approximately 625 Meters
   Diameter: 30 mm

   Umbilical's:
   MIL208:
   Manufacturer: Rochester
   Length: Approximately 3,500 Meters
   Diameter: 41 mm

   MIL211:
   Manufacturer: Rochester
   Length: Approximately 3,500 Meters
   Diameter: 41 mm

4. Please indicate on a Vicinity Map all associated support bases / ports used and verify that no vessels, including supply and crew vessels, cross or enter the Bryde's whale area. If vessels will enter the Bryde's whale area, you must clearly state this, as additional restrictions will apply. Seismic vessel will not be entering Bryde's Whale area.

5. Review and update your application to verify the threatened or endangered species, critical habitat, and marine mammal information reflects the requirements found in the 2020 Biological Opinion. Reviewed

   The 2020 Biological Opinion may be found here:
   https://www.fisheries.noaa.gov/resource/document/biological-opinion-federally-regulated-oil-and-gas-program-activities-gulf-mexico. The Appendices may be found here: (https://www.fisheries.noaa.gov/resource/document/appendices-biological-opinion-federally-regulated-oil-and-gas-program-gulf-mexico).

Request for reduction to the minimum separation distance from water bottom anomalies

Shell respectfully requests a reduction to the minimum separation distance of 250ft, from Mageseis Fairfield node placement to water bottom anomalies, within the proposed Leopard area.

Review of the BOEM 3D seismic database of water bottom anomalies identified features that could potentially support communities with the proposed survey area.

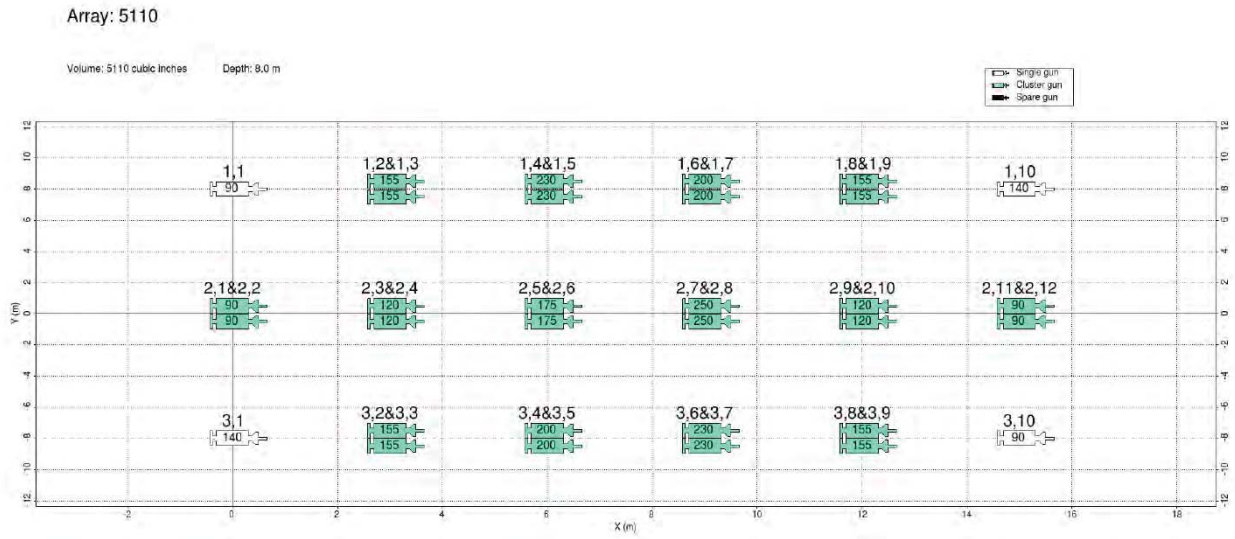
To support node placement within the water bottom anomalous areas and in proximity to any identified communities, Shell propose photographing the seabed within a circular area of approximately 10m diameter, around the proposed node location. Three photographs shall be taken from a height of 15m per node location: Pre-node deployment; post-node deployment and post-node retrieval. In addition a continuous video feed will be recorded during operations within the water bottom anomalous zones and stored.

It is understood from NTL No. 2009-G40, a minimum separation of 250ft must be maintained between documented communities, or features that could potentially support high-density deepwater benthic communities, and bottom disturbing activities. However, due to the small footprint of the nodes, the accuracy of their positioning and the ability of the ROV to fully document any disturbance caused, it is requested to place the nodes no closer than 5m from any high-density deepwater benthic communities. If any such communities are present at the proposed location of each node, a new location shall be selected. Shell will provide the photographs and video feeds as described above, for each proposed location within the water bottom anomalous zone. The photos and video shall clearly show the geographic location of each node.

Form 327 Section D, Number 1

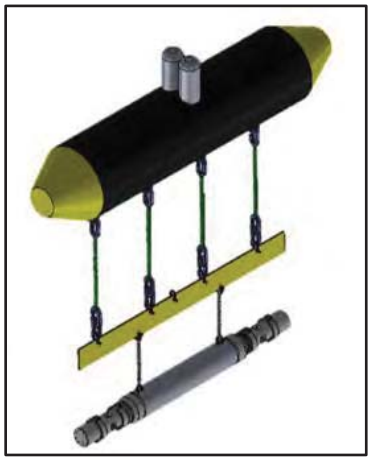
Seismic Conventional Source:

The energy source consists of dual air-gun arrays towed behind a single vessel. Each array is composed of 32 airguns divided between 3 subarrays and has a total output of 5110 cu in (as shown in figure below). The airguns' volumes vary between 90 cu in and 250 cu in. The airguns in each array are synchronized to discharge at the same time and generate a single seismic shot. The arrays alternate shooting resulting in a staggered 50 m x 50 m shot grid.



Seismic Enhance Energy Frequency Source:

The array is comprised of two individual EFL Airguns operating at 2000 psi. Each has a volume of 4000 cu in (as shown in figure below). Total output will be 8000 cu in. The arrays will shoot at on a 50 m x 50 m shot grid.



Form 327 Section D, Number 7

Node deployment and retrieval procedures:

Nodes are placed/recovered individually on the seafloor using two ROVs guided by a USBL navigation system. The ROVs pause to visually inspect the seafloor prior to approaching the preplot node location. Nodes are placed clear of standoff zones such as chemosynthetic, artifacts or subsurface infrastructure. The ROV lands on location and deploys/recovers a node from/to a skid on the base of the ROV. The ROV then departs vertically and transits to the next location.

Node Specification:

Nodes are passive, continuous recording, autonomous receivers with no external connections while on the seafloor with a ~ 100 + day battery life (MFFN ZXPLR). The MFFN ZXPLR nodes measure 38.6 cm diameter by 15.2 cm high and weigh 11.8 kg in water. Operating depth is up to 4000 m.

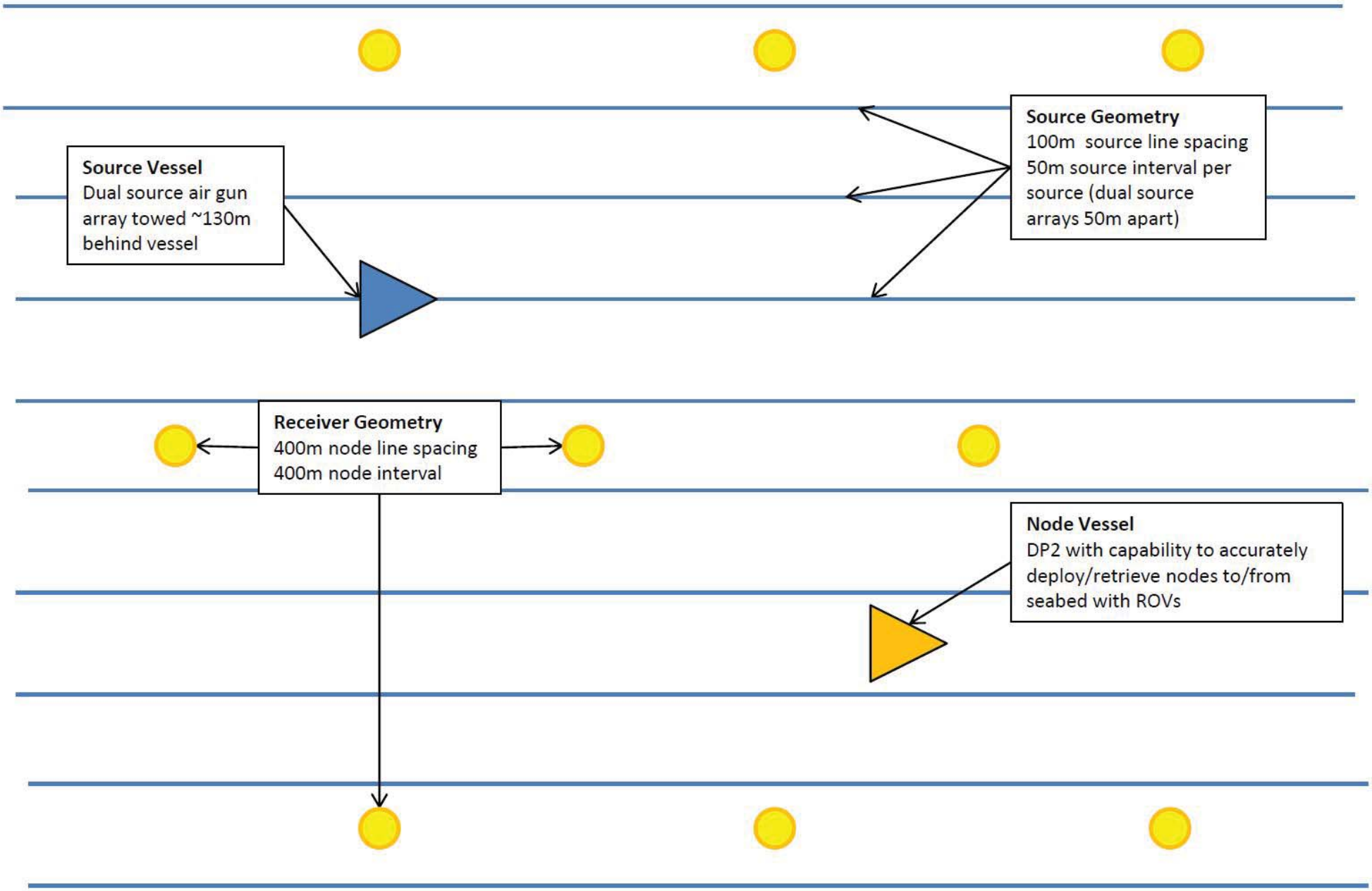
Node spacing: 400 m x 400 m

Number of nodes: approximately 3680

Receiving array:

The seismic receivers are ZXPLR ocean bottom nodes offered by Mageseis Fairfield. The nodes are placed on the seafloor by ROVs on a nominal 400 m x 400 m grid and have up to ~ 100 days of battery life. The nodes are passive, continuously recording, autonomous receivers with no external connections while on the seafloor. The nodes are recovered from the seafloor using ROVs following the completion of the survey shot grid.

Survey Configuration



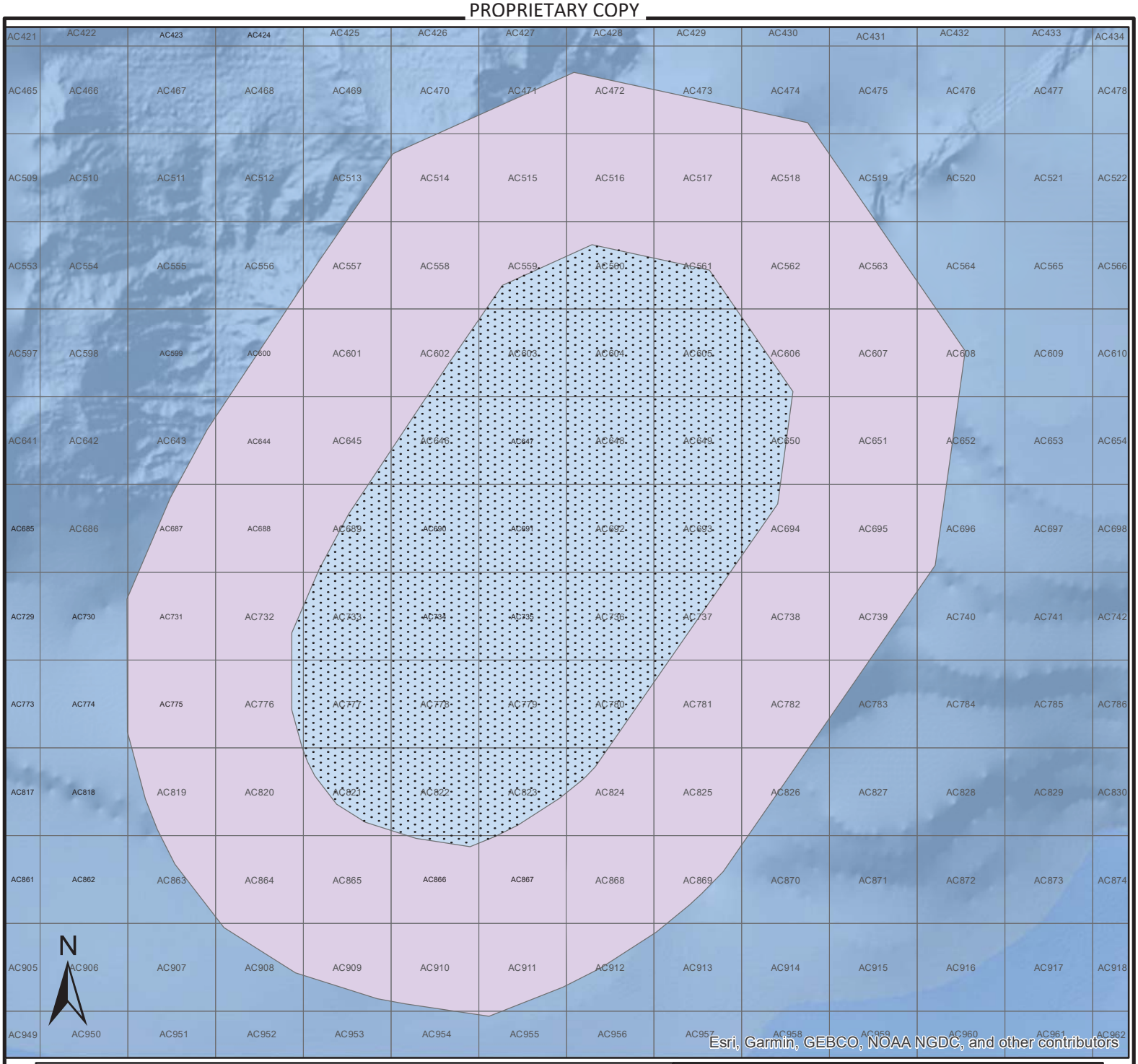
LEOPARD OBN Lease Block Details

Block Number	Operator	Node	Source
AC470	Open	No	Yes
AC471	Open	No	Yes
AC472	Open	No	Yes
AC473	Open	No	Yes
AC474	Open	No	Yes
AC513	Open	No	Yes
AC514	Open	No	Yes
AC515	Open	No	Yes
AC516	Open	No	Yes
AC517	Open	No	Yes
AC518	Open	No	Yes
AC519	Open	No	Yes
AC556	Open	No	Yes
AC557	Open	No	Yes
AC558	Open	No	Yes
AC559	Open	Yes	Yes
AC560	Open	Yes	Yes
AC561	Open	Yes	Yes
AC562	Open	No	Yes
AC563	Open	No	Yes
AC600	Chevron	No	Yes
AC601	Open	No	Yes
AC602	Open	Yes	Yes
AC603	Open	Yes	Yes
AC604	Open	Yes	Yes
AC605	Open	Yes	Yes
AC606	Open	Yes	Yes
AC607	Open	No	Yes
AC608	Open	No	Yes

Block Number	Operator	Node	Source
AC643	Open	No	Yes
AC644	LLOG	No	Yes
AC645	Open	Yes	Yes
AC646	Open	Yes	Yes
AC647	Shell	Yes	Yes
AC648	Open	Yes	Yes
AC649	Open	Yes	Yes
AC650	Open	Yes	Yes
AC651	Open	No	Yes
AC652	Open	No	Yes
AC687	LLOG	No	Yes
AC688	LLOG	No	Yes
AC689	Open	Yes	Yes
AC690	Shell	Yes	Yes
AC691	Shell	Yes	Yes
AC692	Open	Yes	Yes
AC693	Open	Yes	Yes
AC694	Open	Yes	Yes
AC695	Open	No	Yes
AC696	Open	No	Yes
AC731	LLOG	No	Yes
AC732	Open	Yes	Yes
AC733	Open	Yes	Yes
AC734	Shell	Yes	Yes
AC735	Shell	Yes	Yes
AC736	Open	Yes	Yes
AC737	Open	Yes	Yes
AC738	Open	No	Yes
AC739	Open	No	Yes

Block Number	Operator	Node	Source
AC863	Open	No	Yes
AC864	Open	No	Yes
AC865	Open	No	Yes
AC866	Shell	Yes	Yes
AC867	Shell	Yes	Yes
AC868	Open	No	Yes
AC869	Open	No	Yes
AC819	Open	No	Yes
AC820	Open	No	Yes
AC821	Open	Yes	Yes
AC822	Open	Yes	Yes
AC823	Open	Yes	Yes
AC824	Open	Yes	Yes
AC825	Open	No	Yes
AC826	Open	No	Yes
AC775	Shell	No	Yes
AC776	Open	Yes	Yes
AC777	Open	Yes	Yes
AC778	Open	Yes	Yes
AC779	Open	Yes	Yes
AC780	Open	Yes	Yes
AC781	Open	Yes	Yes
AC782	Open	No	Yes
AC783	Open	No	Yes
AC908	Open	No	Yes
AC909	Open	No	Yes
AC910	Open	No	Yes
AC911	Open	No	Yes
AC912	Open	No	Yes
AC913	Open	No	Yes

PROPRIETARY COPY



MAP INFORMATION

Legend

- Leopard 1st Design-Receivers-Location
- Active
- HBP
- Active
- HBP
- GoM OCS Block (open)
- Leopard_VR_100520-Leopard Node Polygon x1.5
- Leopard_VR_100520-Leopard Source Polygon x 1.5

MAP SCALE

0 1 2 4 6 8 10
Kilometers

1:300,325
Print size: 8.5"x11" (ANSI A)

SHELL EXPLORATION & PRODUCTION COMPANY

Leopard OBN

Aliminos Canyon Area

GEODETIC PARAMETERS

Horizontal Coordinate Reference System
CRS name (ESRI): NAD 1927 BLM Zone 15N
CRS name (Shell): NAD27 / UTM zone 16N (ftUS) [1241_32066]
CRS code (EPSG): [32066]
Geodetic datum: North American 1927
Projection name: Transverse Mercator
Horizontal units: Foot US

Author: Brad Nolan | Date: 06 Nov 2020

Name: Blacktip_OBS_Planning_Map_ArcGIS

EP Catalog No.: N/A

RESTRICTED

magseis fairfield

ZXPLR™

Typical Node Specifications

Seismic Data Channels:
4

ADC Resolution:
24 bits (23 + sign)

Sample Interval:
0.5, 1.0, 2.0, 4.0 ms

Preamplifier Gain
1, 2, 4, 8, 16, 32, 64
(0 dB to 36 dB in 6 dB steps)

Anti-Alias Filter
Digital Decimation Filter
206.5 Hz @ 2 ms (82.6% of Nyquist)
SINC/FIR Linear Phase

Low Cut Filter
1 Hz to 60 Hz, 6 dB/octave, or Out

Operating Temperature Range
- 10˚C to + 60˚C

Operating Life
100 days @ 2 ms acquisition

Battery
Charging Temperature Range
+ 3˚C to + 40˚C
Recharge Time: < 5 hours

Acquisition Channel
@ 2 ms sample interval, 25°C,
31.25 Hz, internal test

Total Harmonic Distortion
0.0003% @ 12 dB gain, - 3 dB Full Scale

Equivalent Input RMS Noise
0.8 µV @ 0 dB Gain

Maximum Peak Input Signal
2500 mV @ 0 dB Gain

Dynamic Range
127 dB @ 0 dB Gain

Gain Accuracy
0.50%

Timing Accuracy
± 1 ms – corrected post-acquisition

Self Test Features

Internal Noise (preamp input terminated)
Internal Total Harmonic Distortion
Internal Gain Accuracy
Internal CMRR
Internal Crossfeed
Internal Impulse
Sensor Impedance
Sensor Impulse

Sensors

Geophone
3 orthogonal, omni directional,
15 Hz @ - 3 dB, 70% damped
69.3 V/m/s

Hydrophone
3.0 Hz @ -3 dB, 8.4 V/Bar

Orientation
± 1.5° tilt indication
± 5° azimuth (at latitudes within ±50°
of the Equator)

Physical

Weight:
23.5 kg in air,
11.8 kg in water

Dimensions:
38.6 cm diameter by
15.2 cm high

Operating Depth: 4000 m

2020 NOAA Biological Opinion
G&G Permit (PIES Installation)
AC Block 690 and Surrounding Areas

1. **Deployment of PIES**:

A vessel crane will be used to deploy the Pressure Inverted Echo Sounder (PIES). The crane line with the PIES will be monitored by a Remote Operated Vehicle (ROV) at 500ft water depth, to confirm the rigging and acoustic functionality of an individual PIE is working prior to lowering an individual PIE unit to the seabed. Once the PIE unit lands on the seabed, the ROV will unlatch the crane line from the PIE unit. The ROV will verify that the crane line is clear of the PIE unit and returned to the surface. The ROV would not monitor the crane line back to the surface. There are human observers onboard the vessel monitoring the crane and ROV activities at all times.

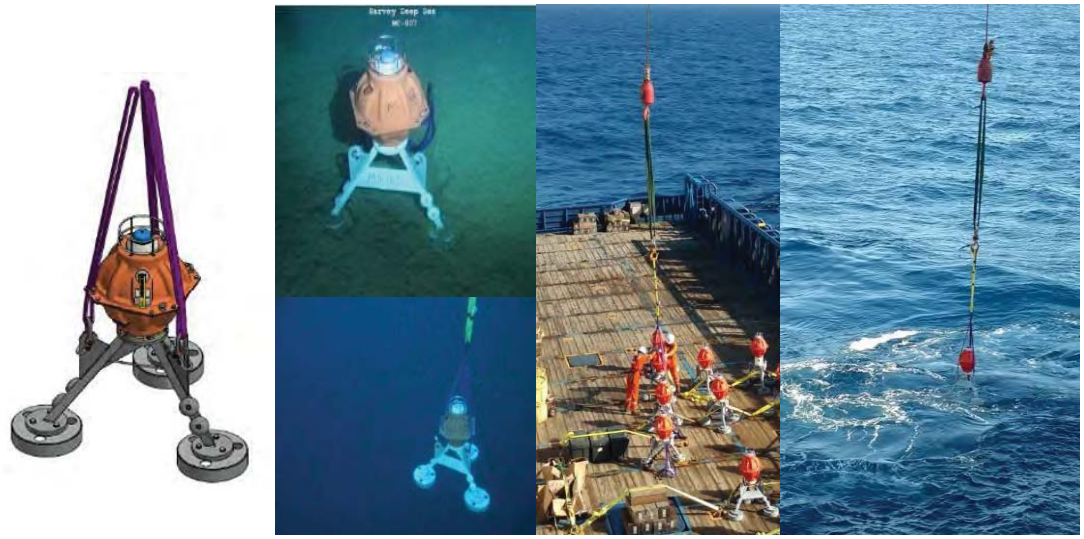
The crane cable will be in the water and is monitored by visual observers and the ROV. The cable line is generally greater than 1 inch in diameter and is a rigid, non-flexible line. The image below gives a representative view on the crane and cable used in these types of operations.

These PIES are not ocean bottom cables and will not have interconnecting cables. These are stand-alone nodes, meaning there are no cables or lines in the water associated with individual units.

The water depths of PIES at Leopard will be between 5740 ft and 9350ft. The installation of the PIES for Leopard will last approximately 3 days. The subsea duration for the PIES at these locations will be approximately 120 days.

In general, PIES routinely measure the two-way travel time of sound waves propagated through the water column from the seabed to the sea surface and back as well as the pressure (depth) at the seabed. These data are used to calculate a continuous time history of the average sound speed velocity and tidal variation throughout the entire water column. PIES are instruments also commonly used in ocean science research applications to gather oceanography data, in addition to being used during some marine seismic surveys. These are also used in various NOAA applications (NOAA Technical Report, OAR-AOML-51).

The images below show different steps for PMT (Pressure Monitoring Transponders) installation at Mars (performed in Jan 2017, permitted in 2016), but it is the same design and methodology for deployment for the PIES.



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Datasheet

Pressure Inverted Echo Sounder (PIES)

Description

The Pressure Inverted Echo Sounder (PIES) is a long-life sensor logging node that accurately measures the average sound velocity through a column of water from the seabed to the sea surface.

It works by transmitting a wideband acoustic pulse from its stable location on the seabed. This pulse is reflected off the sea surface and returns to the seabed where it is detected by PIES. The resulting data enables two-way travel-time to be calculated.

At the same time, an accurate measurement of depth (distance to the surface) is made using a highly accurate internal pressure sensor.

Average water column velocity can then be calculated directly from the depth and travel time data, noting that speed = distance / time.

The sampling interval of PIES can be configured serially before deployment and also via its internal acoustic telemetry link. This telemetry link also allows recorded data to be transmitted to surface at data rates ranging from 100 to 9,000 bits per second.

A high capacity primary lithium or alkaline battery pack enables deployment for months or even years depending on the transmission sampling interval configured.

PIES is compatible with Sonardyne's LMF Ultra-Short-Baseline (USBL) systems for positioning during deployment and recovery.

Key Features

- Autonomous sensor logging combined with high speed acoustic telemetry of recorded data
- LMF frequency band utilising Sonardyne Wideband®2 ranging and telemetry protocols
- Freefall deployment possible from surface vessel
- Integrated acoustic release for buoyant ascent to the surface with float
- Long life – with excellent corrosion resistance
- Primary lithium/alkaline battery pack option
- Integrated modem mode with data rates ranging from 100 to 9000 bits per second in multiple frequency bands
- Wireless configuration using surface software and acoustic dunker

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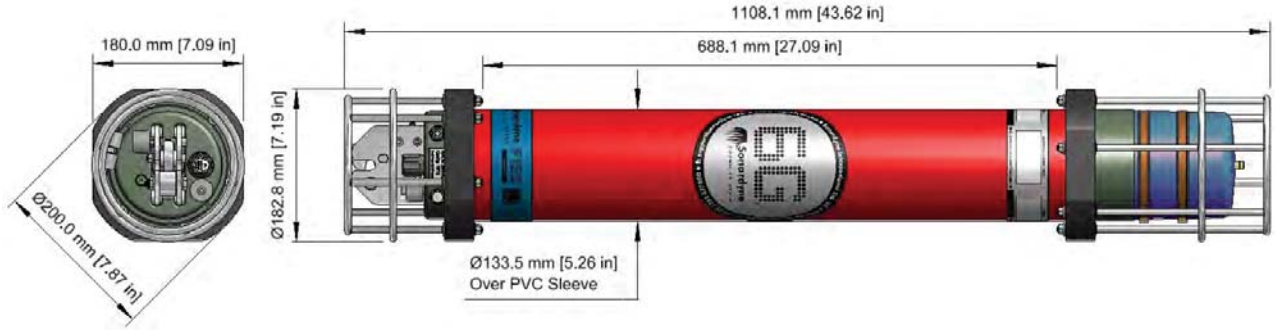
Specifications

Pressure Inverted Echo Sounder (PIES)



Feature	Type 8302-3116
Depth Rating	3,000 or 6,000 metres
Operating Frequency	LMF (14–19 kHz)
Transmit Source Level (dB re 1 µPa @ 1 m)	190-202 dB (4 Levels)
Receive Sensitivity (dB re 1µPa)	80-120 dB (7 levels)
Battery Life (Capacity)	Multi-years life, dependent on sensors and sampling interval (100 Ahr)
Mechanical Construction	Hard anodised aluminium housing, duplex stainless steel guards
Weight in Air/Water*	30.6/16.1 kg

End Cap Sensors and Options	
Temperature (±0.1°C)	Standard
Tilt Switch (±30-45°)	Standard
High Precision Strain Gauge (±0.01%) Keller or Presens	Optional
Paroscientific DigiQuartz Pressure Sensor (±0.01%) 1350 m, 2000 m, 4130 m, 6800 m	Standard
High Accuracy Inclinometer Range: ±90°, Accuracy: ±0.05° over 0 - ±15°; ±0.2° over 0 - ±45°	Optional
Sound Velocity Sensor ±0.02 m/s accuracy under calibration conditions	Optional
Release Mechanism (Screw-off)	Standard
Connector Type	Subconn MCIL8M

See Compatt 6 and AMT datasheets for more information.

*Estimated Weights.

2. *Will the up-chirp be focus-directional (i.e. pointed down towards the sediment?) or omnidirectional?*

A PIES produces a frequency modulated up-chirp signal to accurately measure the two-way travel-time through the water column. As the name implies, the PIES is very much like a single-beam echosounder on a vessel that measures water depth below the vessel by sending a focused directional signal (produced by an electromechanical transducer) downwards through the water column that bounces off the seafloor and then returns to the surface. The PIES use the same type of directional echosounder signal but sends it from the seabed upwards where it bounces off the surface and returns to the seabed. The PIES simultaneously measure pressure at the seabed. Pressure measurements are converted to depth to find the acoustic distance travelled from the seabed to the surface and back again. By combining the depth and travel time the average sound speed in the water column can be calculated.

Using the source level and operating frequency information on the PIES equipment specification sheet, and assuming a 7 degree beam width (borrowed from source measurements of a traditional single-beam echosounder in a reference source often cited by NMFS), the distance to the Marine Mammal Protection Act behavioral harassment threshold ("Level B" = 160 dB SPL) would be less than 10 m (range from 2 m to 8 m depending on use of the highest or lowest source level setting). Even if twice the beam width is conservatively assumed, the distance would still be less than 16 m.

The PIES sends a signal ("ping") once every 30 min.

3. *If using a rig or vessel that includes equipment with a potential for entanglement or entrapment (e.g., moon pool, flexible lines/ropes, or gear without turtle guards), your plan/application must describe in detail the equipment and procedures used. For example, if using a moon pool, procedures may include a dedicated contractor, crew member or company representative monitoring the moon pool area during the operations for sea turtles or other marine life. This information must be updated in the Environmental Monitoring and Environmental Mitigation Measures Sections. The Biological Opinion can be found here: https://www.fisheries.noaa.gov/resource/document/biological-opinion-federally-regulated-oil-and-gas-program-activities-gulf-mexico.*

Shell's activities do not require the use of a moon pool. All equipment deployment will be conducted using cranes and starboard and port hangers.

4. *Will your operations utilize pile-driving? If yes, describe.*

No

5. *Are any new pipelines expected to make landfall? If yes, describe.*

There are no pipeline installations associated to this permit

6. *Please provide a vicinity map, to support your application under 30CFR§250.1751(a) or §250.1752(a), to include all associated support bases proposed for your operations and provide a statement to note if any vessels supporting your proposed activities, including pipelay, supply, and crew vessels, will require crossing or entering the Bryde's whale area (see attached map).*

The primary port of call for the vessels supporting this work is Galveston, Texas. This port will serve for all mobilization and demobilization supporting operations. No vessels, in either the normal or extenuating circumstance case, will transit the Bryde's whale area.

7. Any additional information associated with your proposed operation s that can assist BOEM in the review of your application as it related to the protection of ESA-listed species and their critical habitat, as outlined in the 2020 Biological Opinion and the applicable Appendices (A, B, C, and J) referenced below. The Biological Opinion can be found here: https://www.fisheries.noaa.gov/resource/document/biological-opinion-federally-regulated-oil-and-gas-program-activities-gulf-mexico.

The Appendices may be found here: (https://www.fisheries.noaa.gov/resource/document/appendices-biological-opinion-federally-regulated-oil-and-gas-program-gulf-mexico).

Appendix A: No seismic survey activities will take place with these ancillary notifications and the vessels. The only operations will be the installation and retrieve of PIES units, which will take place before starting Whale OBN acquisition and after the completion of Whale OBN acquisition, respectively.

Appendix B: Shell will comply with GOM Marine and Trash Requirements in Appendix B 2020 NMFS BiOp and BOEM/BSEE Regulations.

Appendix C: Shell will comply with GOM Vessel Strike Avoidance and Protected Species Reporting Requirements in Appendix C and BOEM/BSEE Regulations.

Appendix J: There will be no explosive severance operations or trawling supporting decommissioning conducted from the vessel that may result in potential for entanglement or entrapment of endangered marine species requiring resuscitation measures.

NOAA (NMFS) is requesting additional information regarding the Diver Activities. Please provide specific information related to the following:

1. *Specific activity diver will be involved in.*

   There will be no diver activity associated with the PIE installations.

2. *How the line will be weighted, moored or attached.*

   Not applicable

3. *Whether there are separate descent lines that are also loose or if the divers free-descending/swimming to the activity area.*

   Not applicable

4. Whether divers and/or tenders would be able to monitor lines.

   Not applicable

5. How long lines are expected to be in the water.

   Not applicable

6. How many hours/days the activity will last.

   The field-time activity will last approximately 120 days.

Leopard 2021 OBN Survey

PIE Coordinates

PIES	X (ft)	Y (ft)	Water Depths (ft)
1	1189810	9579911	5740
2	1207138	9551545	6234
3	1161470	9542955	7053
4	1169243	9499678	9350

SeaBird Exploration

EAGLE EXPLORER

EAGLE EXPLORER

SeaBird Exploration

General

Name:	Eagle Explorer
IMO no:	9381299
Flag:	Cyprus
Call Sign:	5BCL5
Built:	2009
Owner:	SeaBird Exploration Vessels Ltd
Classification:	RINA C✠ Research ship ✠AUT-UMS, ✠AVM-DPS
LOA:	93.96m
Beam:	19m / 25.7m
Draft:	6.10m
Gross Tonnage:	7,969mt
Net Tonnage:	2,391mt

Machinery & propulsion

Main engines:	4 x 3,060kW
Aux engine:	1 x 1,950kW
Propulsion:	2 X 3,300kW steerable azimuth thrusters 1 X 800kW azimuth thruster
Bow Thruster:	1 x 590kW

Fuel & fresh water

Fuel capacity:	2,500 m3 MGO
Endurance:	Cruising: 90 days Production: 70 days
Fresh water capacity:	296m^3
Freshwater maker:	2 x ENWA MT 20TSRH abt 18m^3/day

Speed & consumption

Full speed:	12 kts - abt 26 m^3/24hrs
Transit:	10 kts – abt 14 m^3/24hrs
Production:	abt 12-15 m^3/24 hrs (subject to speed and source configuration)

Navigation

Radar:	1 JRC S-Band 1 JRC X Band SeaHawk High Res Radar
GMDSS:	A4
GPS Navigator:	2 x R4 Navigator DGPS

EAGLE EXPLORER

SeaBird Exploration

GPS positioning	Fugro Starfix G2 / Starfix XP2 GNSS with Starfix L1
Seismic Gyro Compass:	SG Brown TSS Meridian Surveyor
Bridge Gyro Compass:	SIMRAD Robertson RGSC 12
Autopilot:	Robertson AP9 MK3
RobTrack	Robertson STS 500
Magnetic compass	Cassens & Plath, Type II
Speed Log:	1x Furuno DS80
Echo sounder:	1 x Skipper GDS-101
Navtex/weather fax:	1 x Furuno NX 700
ADCP	Nortek VM AWAC 400kHZ current profiler

Communication

Inmarsat C:	1 x Furuno – FELCOM 15, number 437212412 1 x Sailor DT – H2095, number 437212411
VSAT:	VSAT GIS/MTN 320kbs
Internal telephone/PA:	Vingtor VMP 430 / Vingtor VMP 603
Video Monitoring system:	CCTV – Radio Holland

Accomodation

Total:	67 persons
Single cabins:	35
Double cabins:	16
Conference room:	1
Day rooms:	4
Gym:	1

Helideck

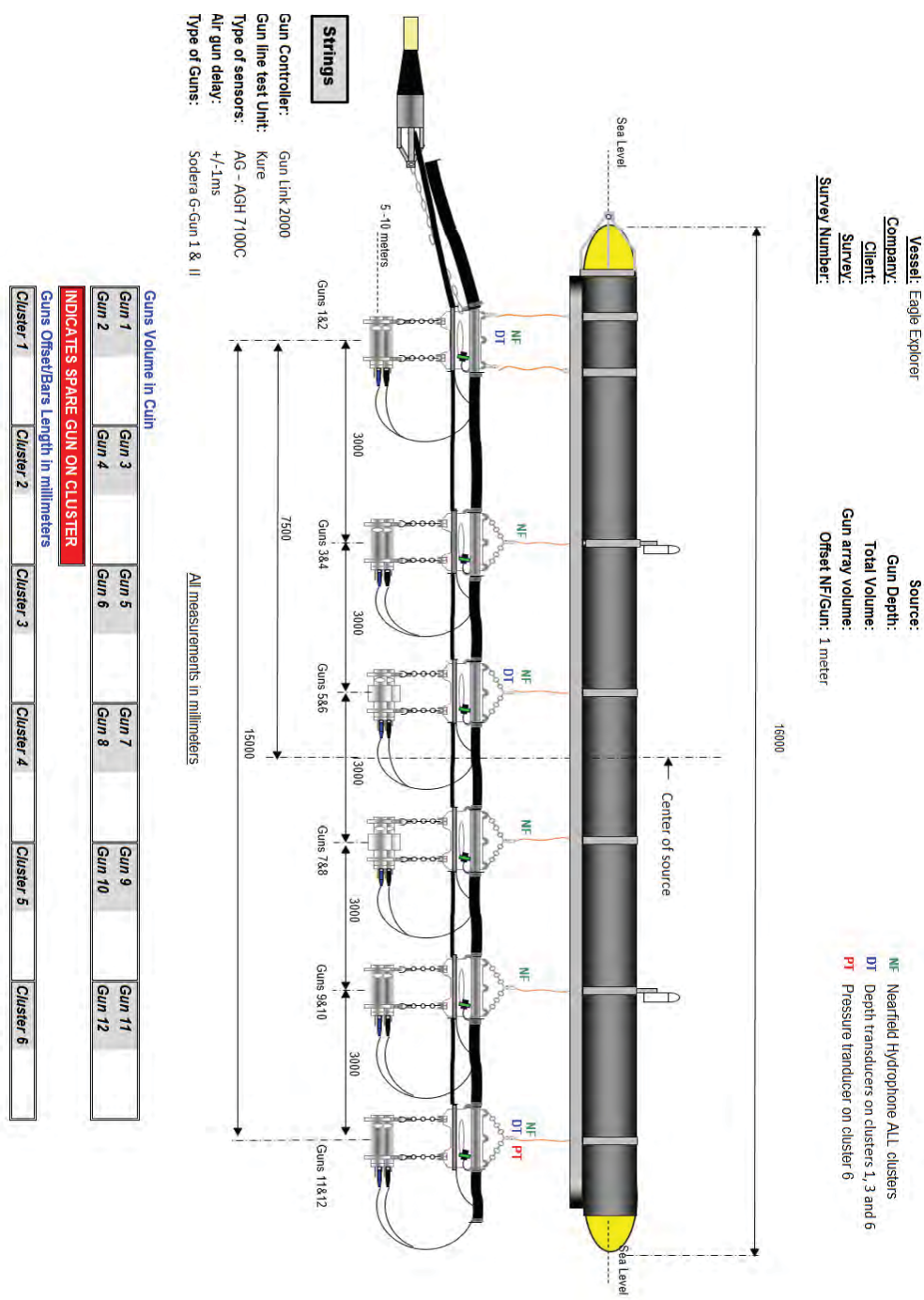
Diameter	22.2m
Max take off weight	12.8 tonnes

Seismic

Compressors:	3 x LMF 62/138-207-E (2,200cfm each)
Source arrays:	6 sub-arrays / gunstrings
Airguns:	Sercel G-Guns I & II
Nearfield hydrophones:	AGH 7100C
RGPS:	SeaMap / Buoylink EX
Gun controller:	SeaMap GunLink 2000
Navigation:	Sercel SeaPro Nav

EAGLE EXPLORER

SeaBird Exploration



Guns Volume in Cu/in

Gun 1	Gun 3	Gun 5	Gun 7	Gun 9	Gun 11
Gun 2	Gun 4	Gun 6	Gun 8	Gun 10	Gun 12

INDICATES SPARE GUN ON CLUSTER

Guns Offset/Bars Length in millimeters

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6

OLYMPIC CHALLENGER – AKER ROV 02 CD

BEST PERFORMING CHARTER VESSEL

OLYMPIC
OLYMPIC SHIPPING

"I am delighted to confirm the Best Performing Charter Vessel Norway Business Unit winner for the 2013 season, as announced at the T-MOS seminars held in February and March; **Olympic Challenger**"

"I am delighted to confirm the Best Performing Charter Vessel Norway Business Unit winner for the 2014 season, as announced at the T-MOS seminars held in February and March; **Olympic Challenger**"

David McGuire,
Vice President
Technip Marine Operations Services

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MAIN PARTICULARS

OLYMPIC
OLYMPIC SHIPPING

CALL SIGN:	C6ZZ7
IMO NUMBER:	9398292
VESSEL DESIGN:	ROV 02 CD
YEAR BUILT:	2008
VESSEL BUILT:	Aker Aukra
CLASSIFICATION:	DNV +1A1, E0, Dynpos-Autr (IMO III), DK(+), Helidk, Ice-C, Clean Design (as made valid January 2006), Naut-OSV (Letter of compliance), Comf-V(3)

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DIMENSIONS / CAPACITIES

OLYMPIC
OLYMPIC SHIPPING

DIMENSIONS

LENGTH O.A:	105,90 m
LENGTH P.P:	94,70 m
BREADTH P.P:	21,00 m
DEPTH TO MAIN DECK:	8,50 m

TONNAGE

GROSS TONNAGE:	6596 t
NET TONNAGE:	1979t

WORKING DECK

MAIN DECK:	1000 m^2
DECK CARGO CAPACITY:	2000 t
DEADWEIGHT:	3900 t

CARGO TANK CAPACITIES

FUEL OIL:	1350 m^3
FRESH WATER:	1060 m^3
WATER BALLAST:	3700 m^3

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DECK EQUIPMENT

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CRANES

STARBORD CRANE:	3 t at 15 m
PORT CRANE:	3 t at 15 m

WINCHES

ANCHOR WINDLASS:	2x 10 t electric com. anchor windlass/mooring winch
MOORING WINCHES:	2x 10 t electric

HANGAR

HANGAR:	x2

MOONPOOL

SIZE:	7,2 m x 7,2 m
SIZE:	4,8 m x 4,8 m

OFFSHORE CRANE

OLYMPIC
OLYMPIC SHIPPING

OFFSHORE CRANE 1

TYPE:	Mac Gregor HydraMarine 250 t AHC
SWL MAIN:	250 t at 10 m
MAIN WIRE LENGTH:	3000 m
LIFT CAPACITY:	200 t at 12 m
LIFT CAPACITY:	100 t at 20 m
LIFT RADIUS MAX:	40 t at 33,5 m
LIFT RADIUS MIN:	250 t at 10 m
MAIN RADIUS:	~10,0 - 33,5 m
AUX RADIUS:	~8,0 m – 34,5 m

ACCOMMODATION

OLYMPIC
OLYMPIC SHIPPING

ACCOMMODATION VESSEL

PERSONS:	100 persons
1 MAN CABINS:	x22
2 MEN CABINS:	x39

ACCOMMODATION MARINE CREW:

PERSONS:	25 persons
1 MAN CABINS:	x11
2 MEN CABINS:	x7

ACCOMMODATION ROV CREW:

PERSONS:	6 persons
2 MEN CABINS:	x3

ACCOMMODATION CHARTERER:

PERSONS:	69 persons
1 MAN CABINS:	x11
2 MEN CABINS:	x29

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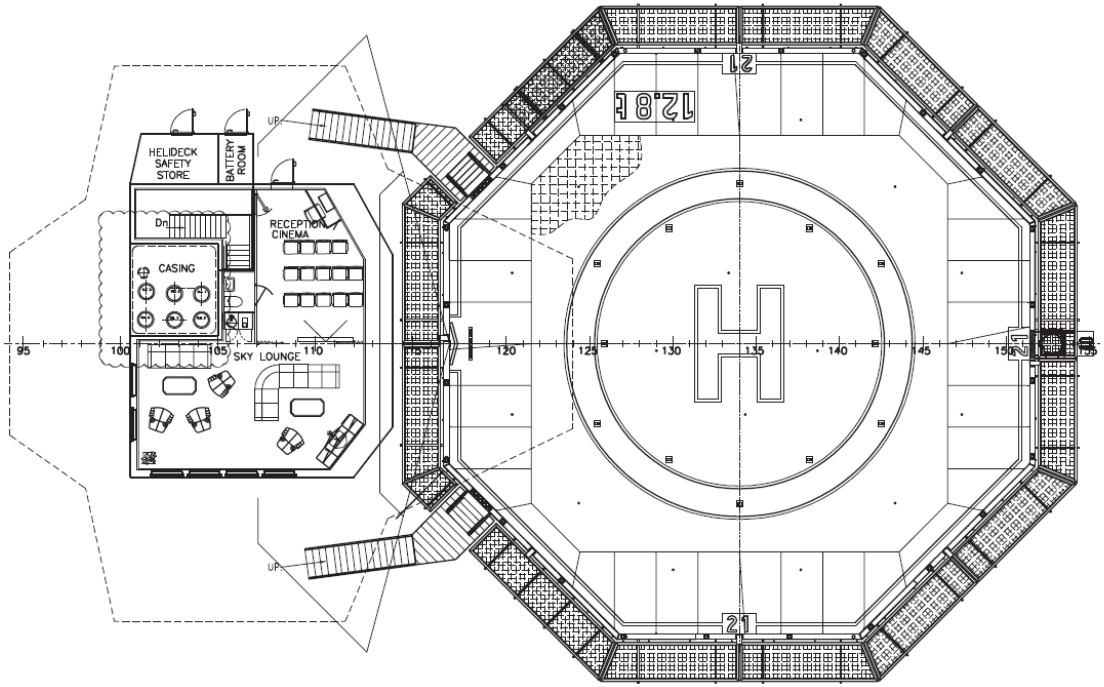
HELI DECK

OLYMPIC
OLYMPIC SHIPPING

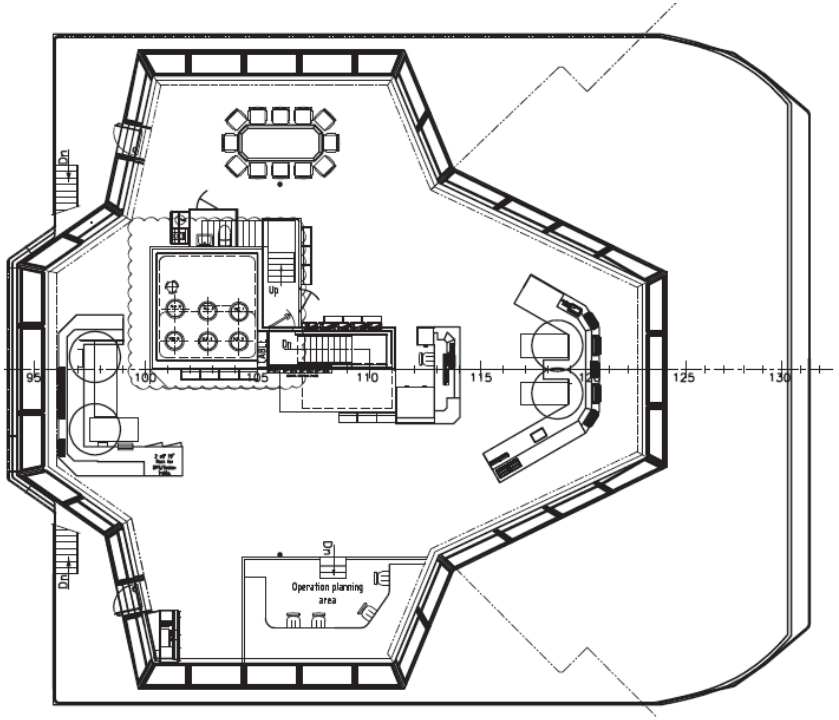


HELI RECEPTION

OLYMPIC
OLYMPIC SHIPPING

BRIDGE DECK

OLYMPIC
OLYMPIC SHIPPING



BRIDGE

OLYMPIC
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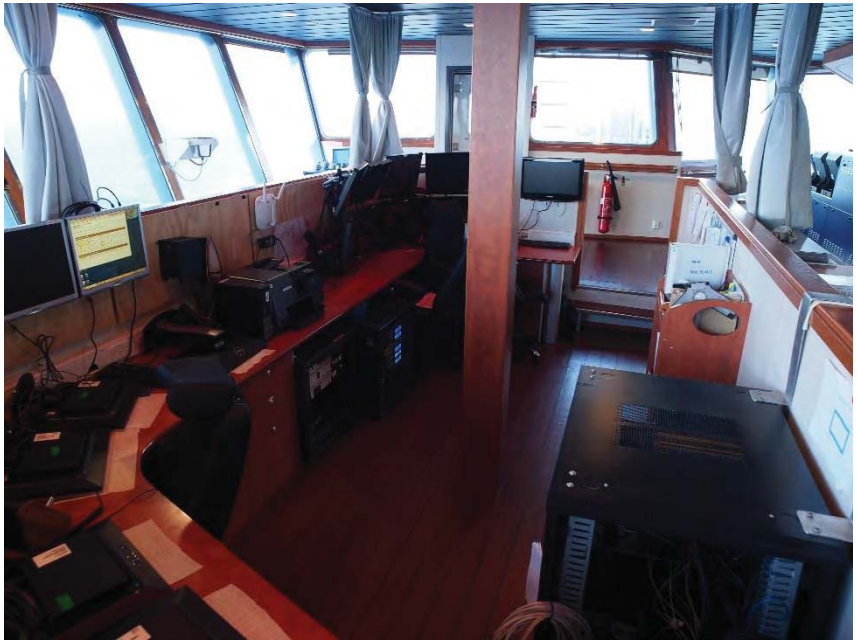

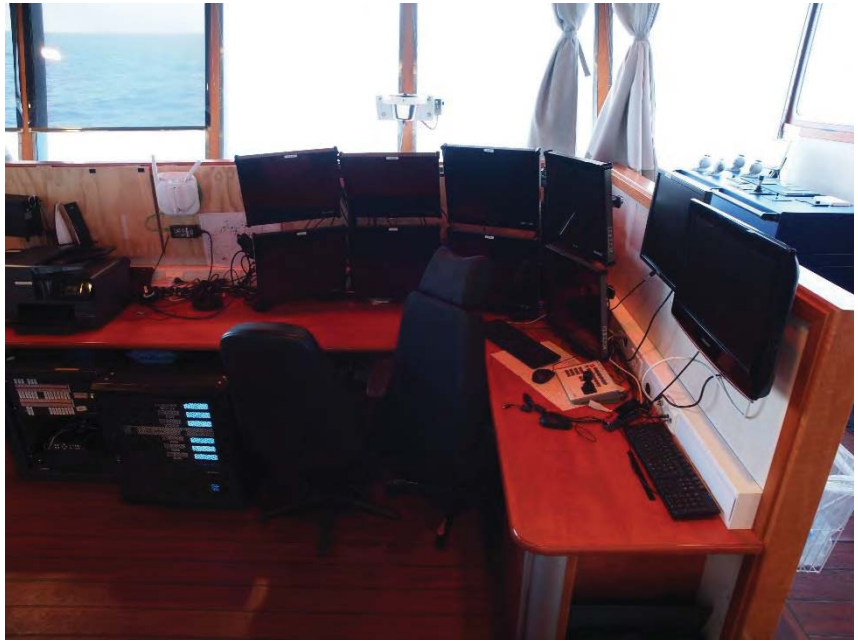

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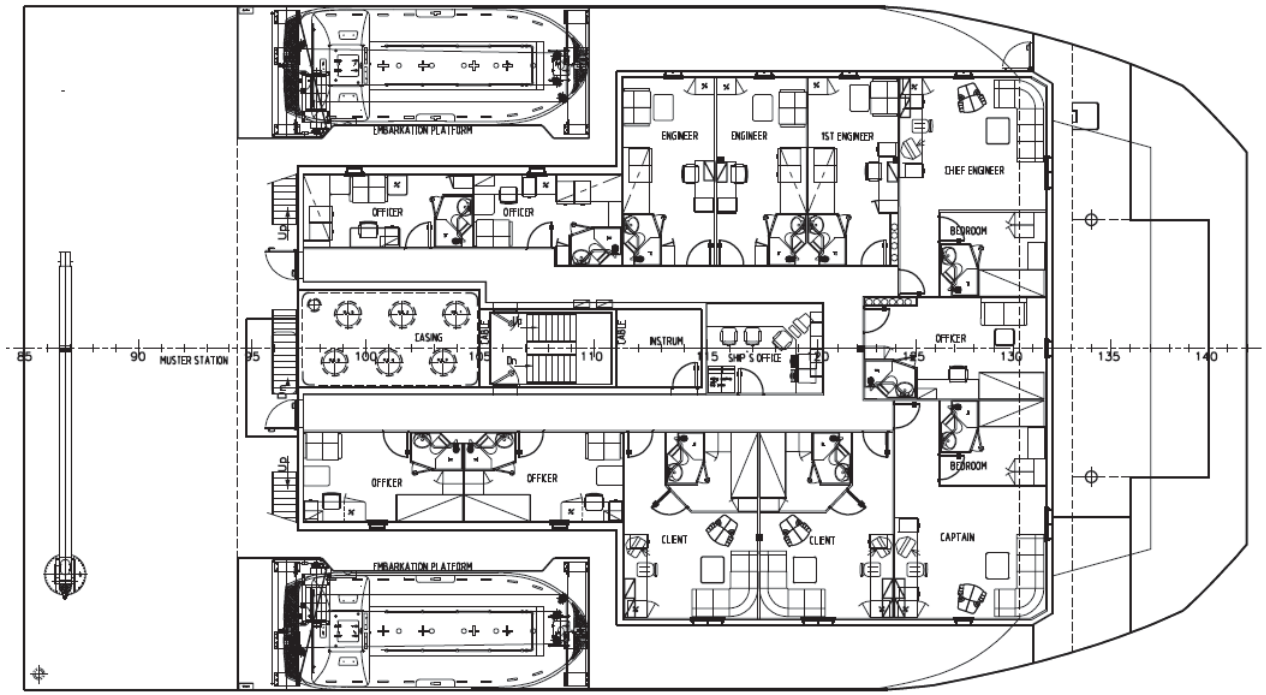
D-DECK

OLYMPIC
OLYMPIC SHIPPING



CABINS

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CLIENT CABINS

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OLYMPIC SHIPPING

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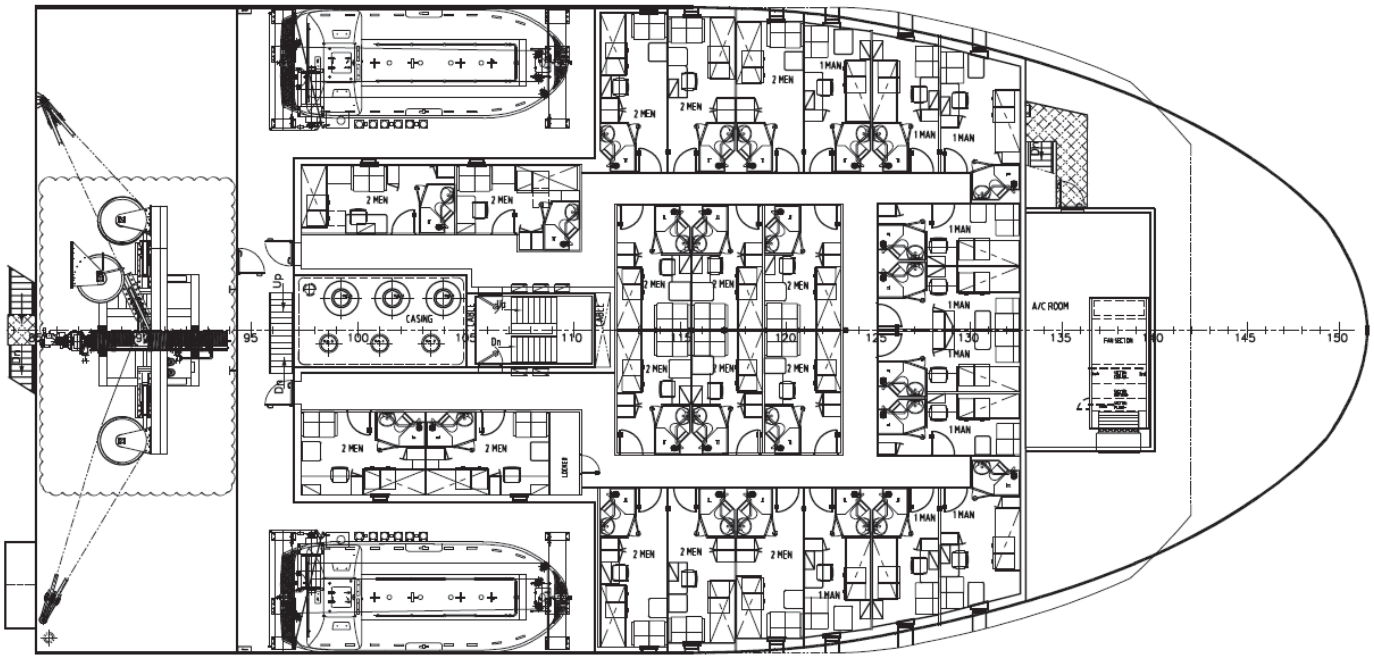
C-DECK

OLYMPIC
OLYMPIC SHIPPING



2 MEN CABINS

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1 MEN CABINS

OLYMPIC
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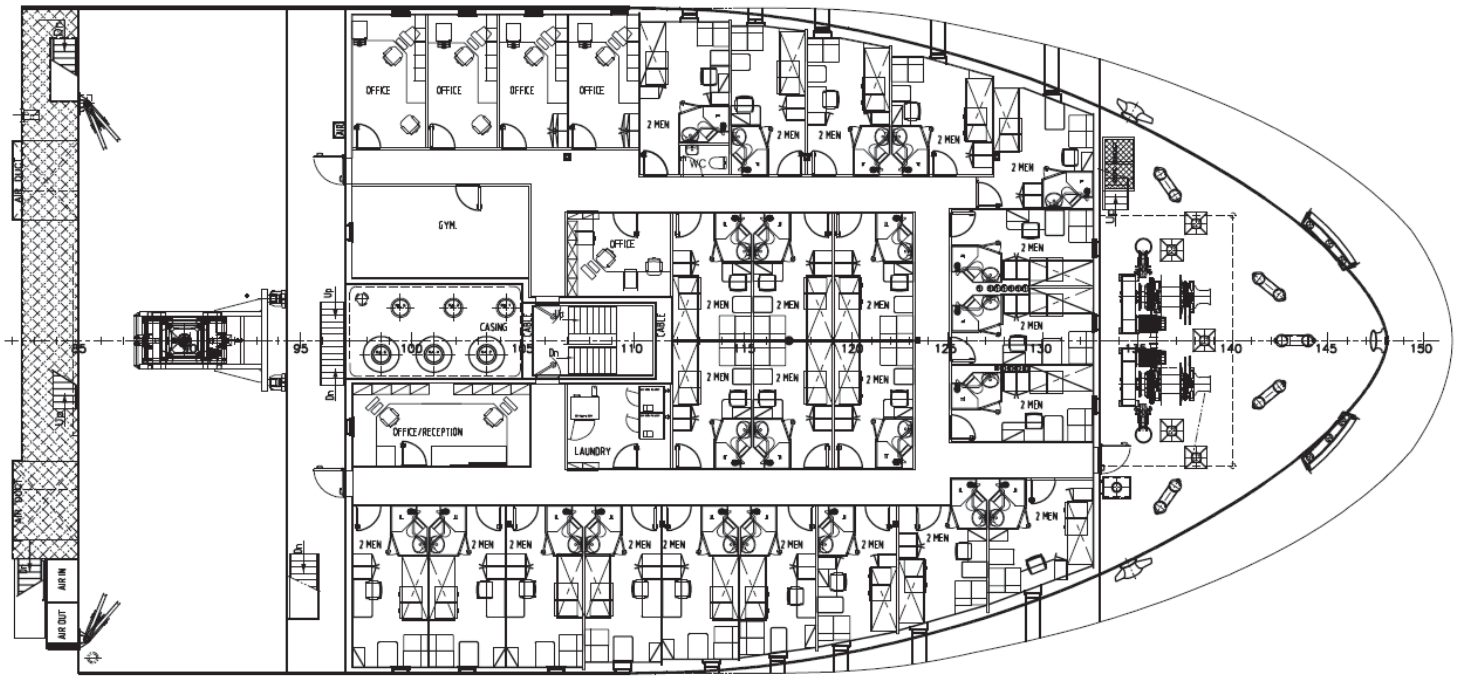
B-DECK

OLYMPIC
OLYMPIC SHIPPING



OFFICES

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GYMNASIUM

OLYMPIC
OLYMPIC SHIPPING

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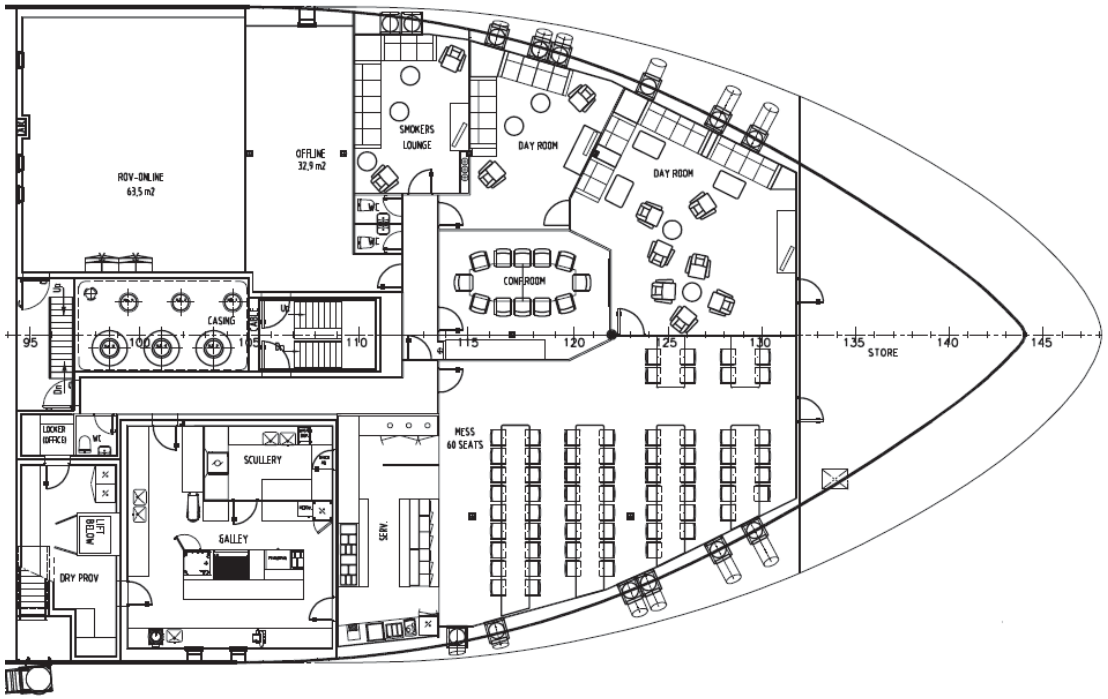
A-DECK

OLYMPIC
OLYMPIC SHIPPING



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MESS ROOM

OLYMPIC
OLYMPIC SHIPPING

DAYROOM

OLYMPIC
OLYMPIC SHIPPING

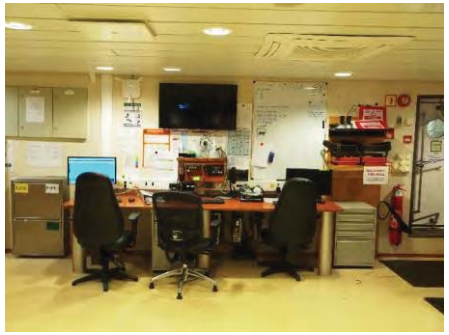


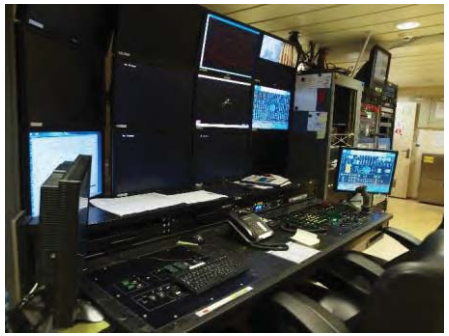


ROV ONLINE/OFFLINE

OLYMPIC
OLYMPIC SHIPPING





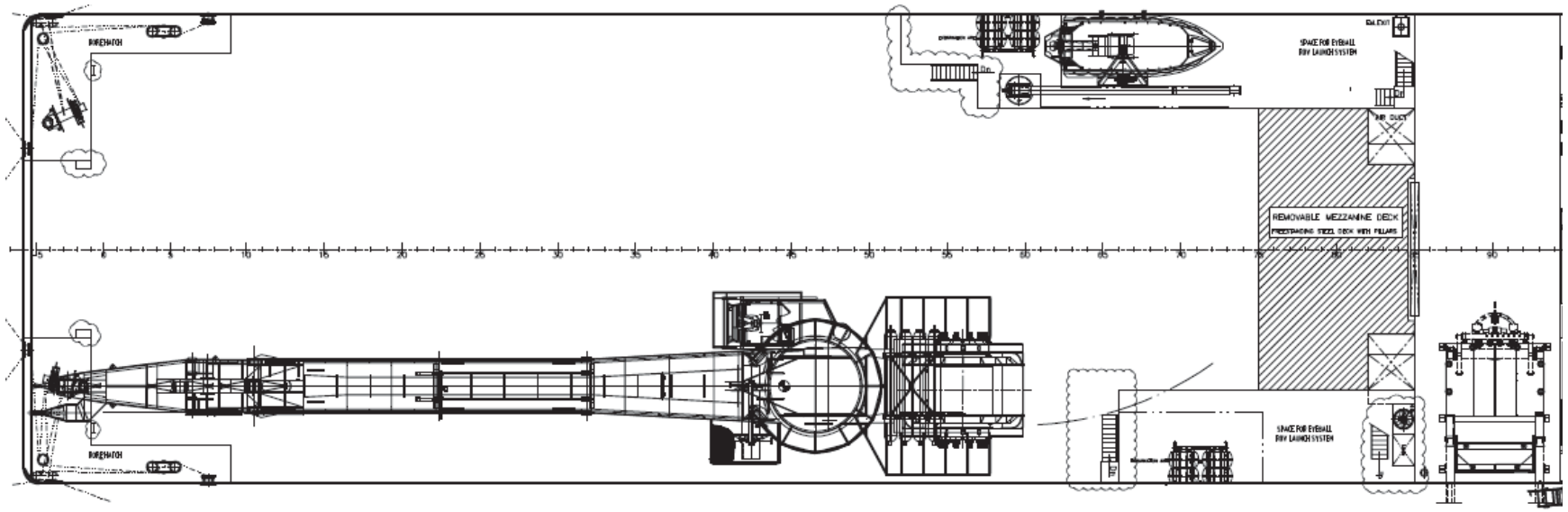



CONFERENCE ROOM

OLYMPIC
OLYMPIC SHIPPING

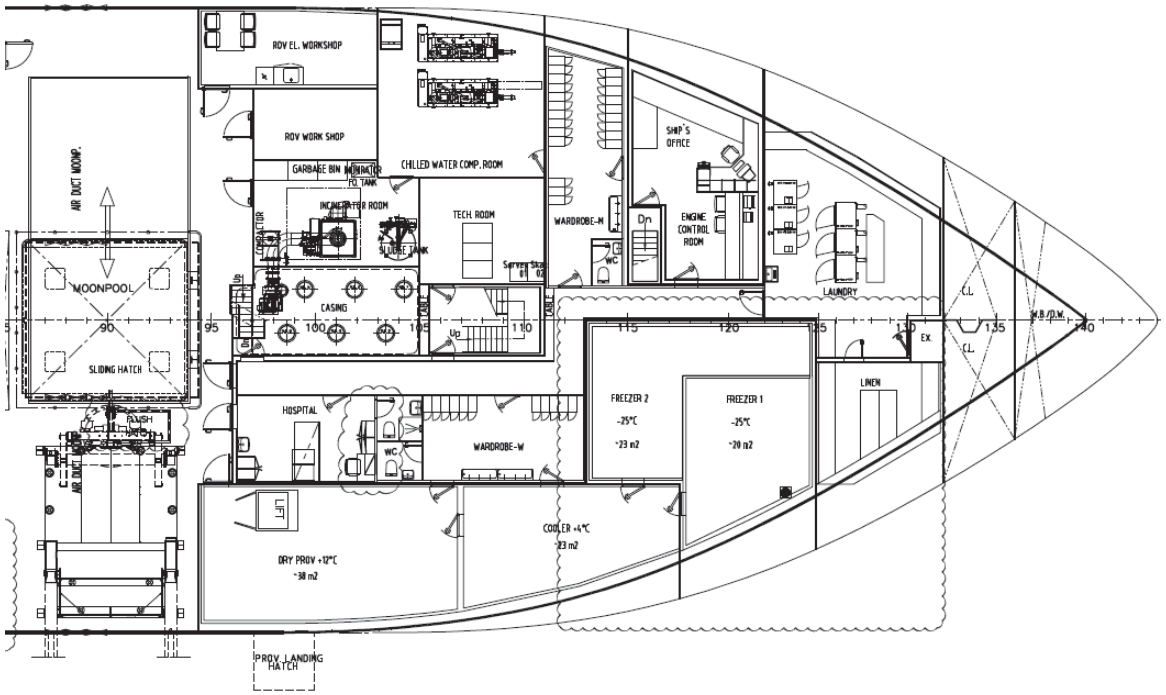
A-DECK

OLYMPIC
OLYMPIC SHIPPING



MAIN DECK

OLYMPIC
OLYMPIC SHIPPING



WARDROBE

OLYMPIC
OLYMPIC SHIPPING

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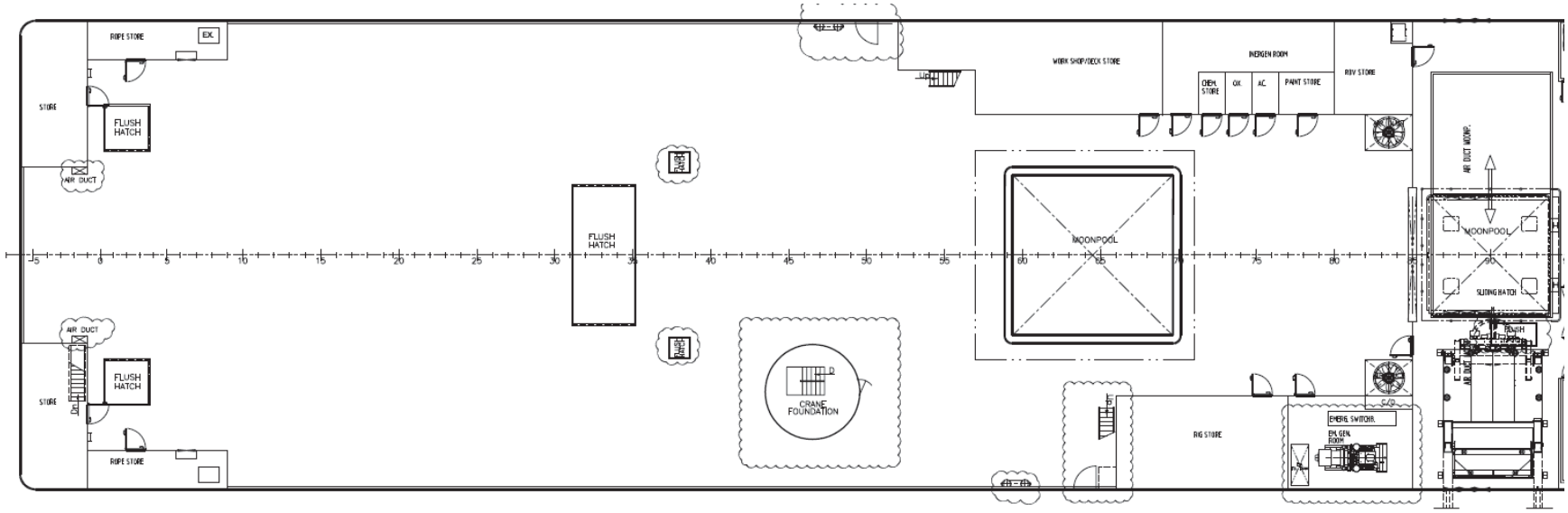
MAIN DECK

OLYMPIC
OLYMPIC SHIPPING



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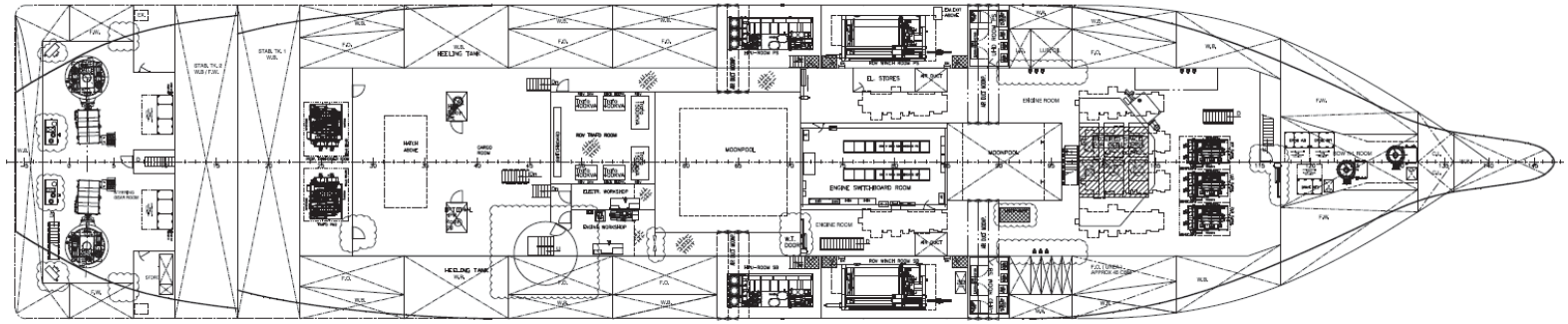
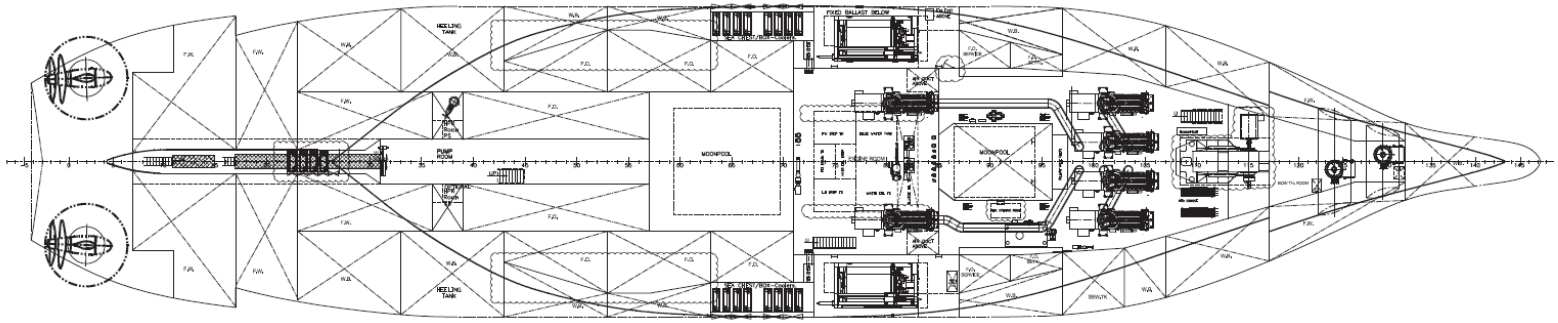
TWEEN DECK AND TANK TOP

OLYMPIC
OLYMPIC SHIPPING





OLYMPIC
OLYMPIC SHIPPING

NOTICE: *"This specification is the design standard vessel specification for the Vessel provided by Owners` yard. The information is provided in good faith, but may be subject to adjustments to accommodate for efficient use of the vessel, equipment, and Charterers` requirements. The information is offered for information only, without any guarantee whatsoever as to the correctness or completeness of the terms, details, requirements, performance information or conditions contained herein".*

Proprietary Data

JASCO APPLIED SCIENCES

Acoustic Modeling for a Novel Airgun Source

OCS Permit L19-036 Addendum—Sound Propagation Report for GoM Green Canyon 3-D OBN Seismic Survey

Submitted to:

Simon Stockwell
ION
Contract: *1035*

Authors:

Connor Grooms
Alexander MacGillivray
Jennifer Wladichuk
Cynthia Pyć

19 December 2019

P001522-001
Document 01943
Version 1.0

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8630 Fenton Street, Suite 218
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www.jasco.com

Suggested citation:

Grooms, C.H., A.O. MacGillivray, J.L. Wladichuk, and C.D. Pyć. 2019. *Acoustic Modeling for a Novel Airgun Source: OCS Permit L19-036 Addendum—Sound Propagation Report for GoM Green Canyon 3-D OBN Seismic Survey*. Document 01943, Version 1.0. Technical report by JASCO Applied Sciences for ION.

Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

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1. Introduction

GX Technology Corp. (GXT) was granted a permit by the Bureau of Ocean Energy Management (BOEM) to conduct Geophysical Exploration for Mineral Resources (OCS Permit L19-036) in the Gulf of Mexico (GoM). GXT plans to use a dual barbell airgun source with a total volume of 8000 in^3 to acquire geophysical data during the permitted GoM Green Canyon 3-D ocean bottom node (OBN) seismic survey (Figure 1). The information provided in this addendum is required for Sections A.3 and D of the BOEM Application for Permit to Conduct Geological or Geophysical Exploration, and addresses NTL 2016-G02 requirements with eNGO legal settlement amendments.

JASCO Applied Sciences (JASCO) performed an underwater sound level modeling study for the 8000 in^3 seismic source. The goal of this modeling study was to estimate the horizontal radial distances to regulatory-defined sound level exposure thresholds for marine mammals and sea turtles. Exposure levels are estimated using acoustic criteria for marine mammals and frequency weighting outlined in the National Marine Fisheries Service (NMFS) *Acoustic Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (NMFS 2018) and by the best available scientific approaches for assessing auditory injury and behavioral disturbance for sea turtles (McCauley et al. 2000, Popper et al. 2014). The High Energy Seismic Survey (HESS 1999) acoustic thresholds are also reported in the analysis. The results of the acoustic modeling may be used in assessing the potential acoustic impact of a large volume airgun source on marine mammals and sea turtles.

The survey will be acquired using two source vessels sailing at ~4.5 knots. Each vessel will tow an 8000 in^3 source at 8 m depth. The source vessels will travel along the survey lines spaced 250 m, releasing an acoustic impulse every 40 s. The survey will use OBNs deployed on the seabed nominally spaced at 1 × 1 km.

Far-field source levels for the proposed survey were predicted using JASCO's Airgun Array Source Model (AASM). The resultant sound fields were estimated using JASCO's Marine Operations Noise Model (MONM) to determine total sound propagation in the seismic survey area at two representative model sites using a conservative sound speed profile (January). Radial distances to various sound level isopleths were estimated for regulatory-defined threshold values—unweighted peak pressure (PK) and frequency-weighted sound exposure level (SEL) (NMFS 2018) for marine mammal auditory injury and unweighted sound pressure levels (SPL) associated with behavioral response thresholds (Wood et al. 2012). The distances to turtle injury (Popper et al. 2014) and behavioral response (McCauley et al. 2000) thresholds were also calculated.

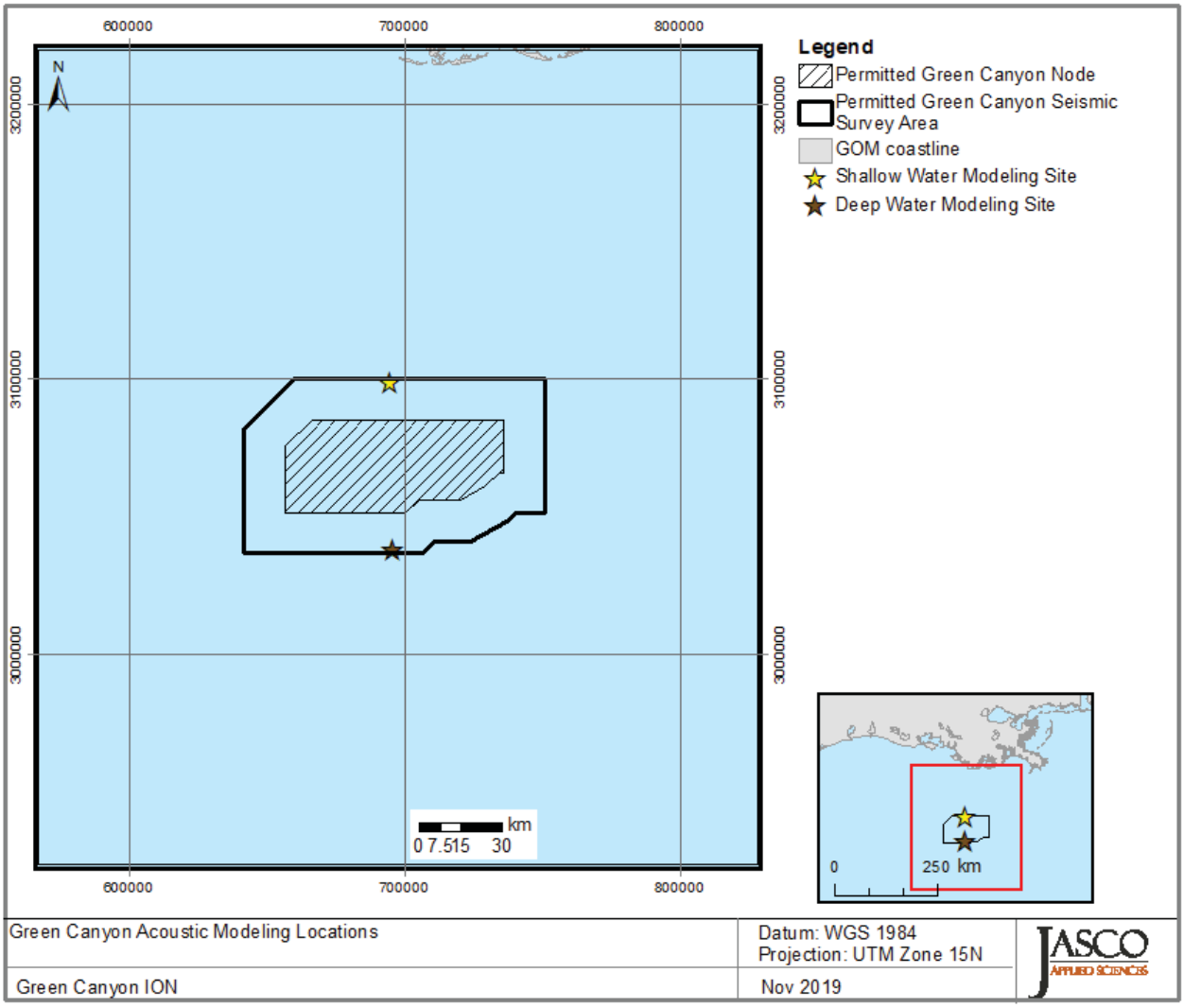

Figure 1. The acquisition area in the permitted GXT GoM Green Canyon 3-D OBN seismic survey (black boundary). Representative single-impulse modeled sites are shown (colored stars).

2. Sound Source Model

2.1. Source Characteristics

GXT proposes to deploy one towed large volume (8000 in^3) seismic array from each of two seismic source vessels. The array is comprised of two individual BOLT 1500LL airguns operating at 2000 psi, each with a volume of 4000 in^3 (Figure 2). Table 1 includes the array specifications. Array tow depth is ~26 feet (8 m).

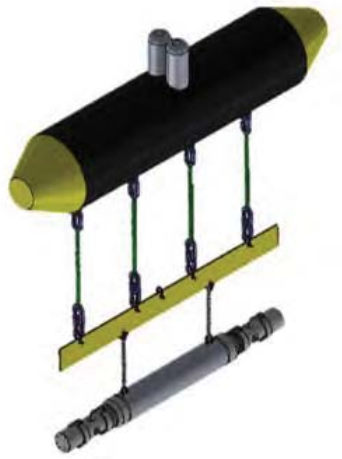

Figure 2. An 8000 in^3 dual “barbell” source array configuration.(Image: ION).

Table 1. Position of array elements relative to the center of the dual element proposed for the GXT GoM 3-D OBN seismic survey. The chamber volume is given for each element.

Element	x (m)	y (m)	z (m)	Volume (in^3)	Total volume (in^3)	Configuration
1	−1.0	0.0	8	4000	8000	Dual (barbell) seismic source
2	1.0	0.0	8	4000		

2.2. Source Modeling Methods

The source levels and directivity of the 8000 in^3 source array was predicted with JASCO’s Airgun Array Source Model (AASM; MacGillivray 2006, 2019). AASM includes both a low-frequency and a high-frequency module for predicting different components of an airgun array’s spectrum. The low-frequency module is based on the physics of oscillation and radiation of airgun bubbles, as originally described by Ziolkowski (1970), that solves the set of parallel differential equations that govern bubble oscillations. The high-frequency module of AASM uses a stochastic simulation to predict the sound emissions of individual airguns above 800 Hz, using a multivariate statistical model.

The current version of AASM (v1.3) has been tuned to fit a large library of high-quality seismic source signature data obtained from the Joint Industry Program (JIP) on Sound and Marine Life (Mattsson and Jenkerson 2008).The JIP dataset only includes measurements for airguns up to a maximum volume of 520 in^3, so additional tuning data was incorporated into AASM to represent the large volume seismic source modeled for the GXT survey. Measured source waveform data for a single 2000 in^3 source was

used to augment AASM's tuning parameters. This ensured that the source model output accurately represented the source levels of the proposed arrays. It should be noted, however, that maximum frequency of the 2000 in^3 airgun measurements was 500 Hz, and so they could only be used for tuning AASM's low-frequency module (<800 Hz). The high-frequency source level predictions (>800 Hz) were based on the largest available airgun size used to develop the statistical model (520 in^3), which represents the best available information at the present time. Source modeling methods are described in more detail in Appendix E.

2.3. Source Modeling Results

Figures 3 and 4 show the source waveforms and source spectra for the 8000 in^3 array in the endfire and broadside (horizontal) directions, respectively. Table 2 lists the source levels (PK and SEL) for the four seismic source arrays in the broadside and endfire directions. Figure 5 displays the maximum (horizontal) decidecade-band source levels over all directions for the arrays. The minimum acoustic model frequency was extended down to 3 Hz to accurately model the energy spectrum of these low-frequency sources.

Figure 6 shows the horizontal directivity plots of the selected 8000 in^3 seismic source for each corresponding sound levels in the decidecade band.

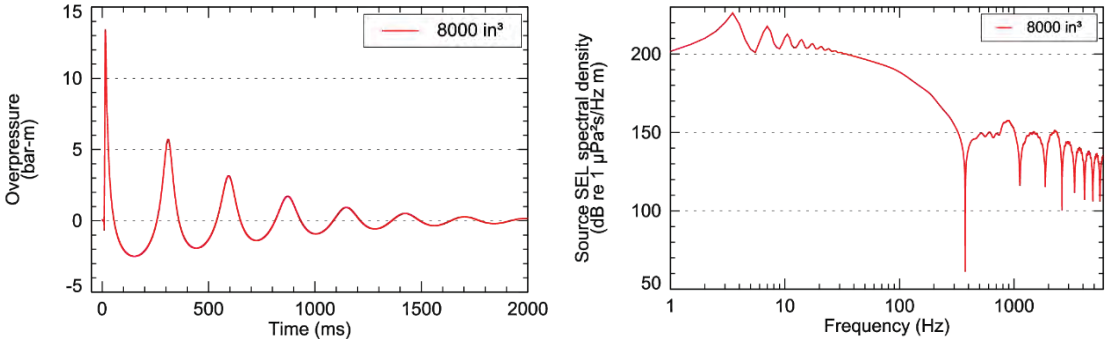

Figure 3. Endfire (left) overpressure signatures and (right) power spectrum for an 8000 in^3 seismic source. Surface ghosts (effects of the pulse reflection at the water surface) are not included in these signatures as they are accounted for by the MONM propagation model.

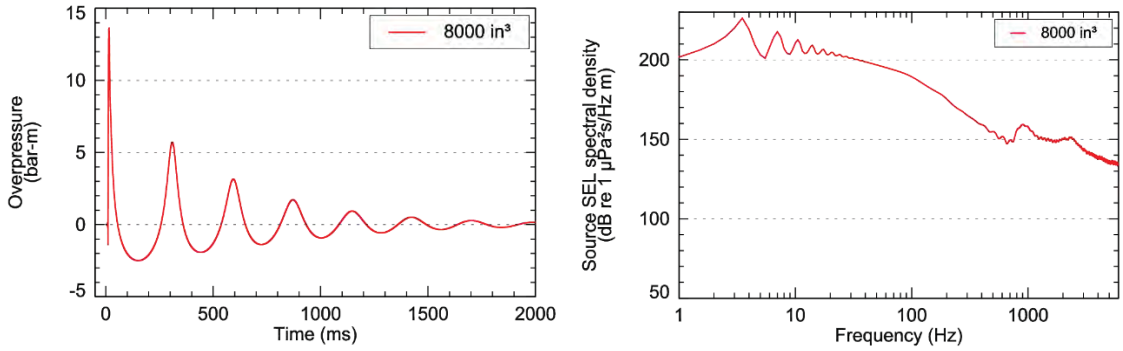

Figure 4. Broadside (left) overpressure signatures and (right) power spectrum for the 8000 in^3 seismic source. Surface ghosts (effects of the pulse reflection at the water surface) are not included in these signatures as they are accounted for by the MONM propagation model.

Table 2. Horizontal source level specifications for the 8000 in^3 seismic source. Computed with AASM in the broadside and endfire directions. SEL source levels for the source are for frequency range 0.003–25 kHz. Surface ghost effects are not included as they are accounted for by the MONM propagation model.

Source volume (in^3)	Broadside		Endfire	
	PK	SEL	PK	SEL
8000	242.7	220.1	242.6	220.0

PK = unweighted peak sound pressure (dB re 1 µPa); SEL = frequency-weighted sound exposure level (dB re 1 µPa^2·s)

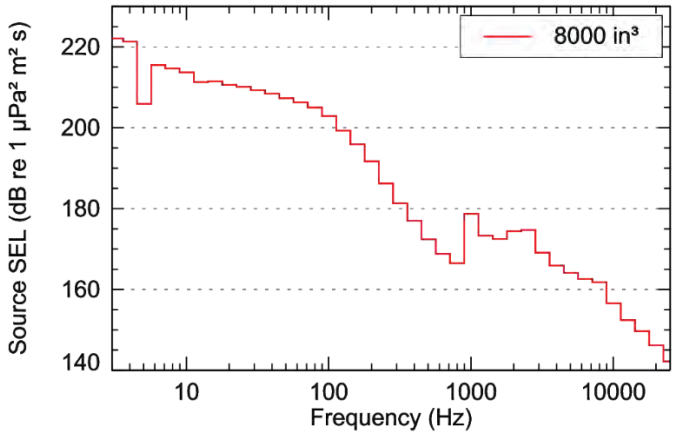

Figure 5. Maximum directional source level in the horizontal plane, in each decidecade band, for the 8000 in^3 seismic source (3–25,000 Hz).

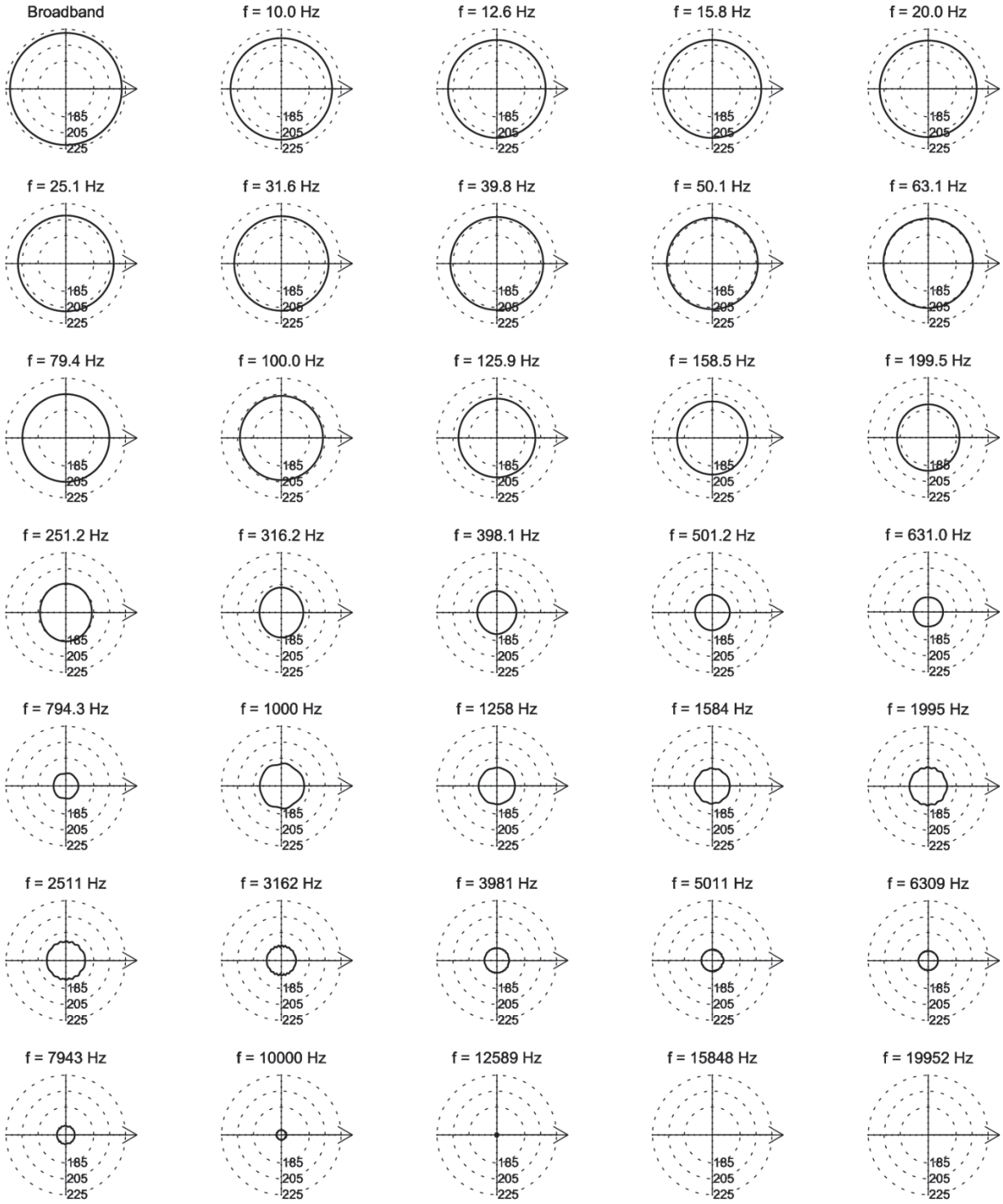

Figure 6. Horizontal directivity of the 8000 in^3 seismic source levels (dB re 1 $\mu Pa^2 \cdot s$) in decidecade bands. The decidecade-band center frequencies are indicated above each plot.

3. Acoustic Impact Assessment: Estimated Sound Fields

3.1. Sound Propagation Models

Two sound propagation models were used to estimate the sound field around the seismic source:

- Combined range-dependent parabolic equation and Gaussian beam acoustic ray-trace model (MONM-BELLHOP, 3 Hz to 25 kHz). MONM was used to model the low frequency domain (3–2000 Hz) and BELLHOP was used to model the high-frequency domain (2.5–25 kHz)
- Full Waveform Range-dependent Acoustic Model (FWRAM; 5–2048 Hz).

The models were used in combination to characterize the acoustic fields at short and long ranges in terms of SEL, SPL, PK, and PK-PK. Appendix E details each model. MONM-BELLHOP was used to calculate the SEL of a 360° area around each source location. FWRAM was used to model synthetic seismic pulses and to generate a generalized range dependent SEL to SPL conversion function for the considered modeled sites. The range-dependent conversion function was applied to predicted per-pulse SEL results from MONM-BELLHOP to estimate SPL values. FWRAM was also used to calculate water column PK and PK-PK levels.

Two model sites within the permitted survey area were selected for single impulse and accumulated SEL calculations. The sites are considered representative of the water depth range within the survey area (Figure 1, Table 3). The modeling assumes that during a 24 hour period, the two survey vessels will be operating in tandem traveling at a speed of ~4.5 knots. A single survey line is expected to take 7.7 hours with an assumed turning radius of 0.5 km. During acquisition, impulses will be released once every 250 m (every 40 seconds). Therefore, a single survey line involves 256 array impulses. Over 24 hours, assuming approximately six seismic lines are acquired, the total number of impulses would be 1548.

Table 3. Location detail for the single impulse modeled sites

Scenario	Site	Latitude	Longitude	UTM Zone 15	
				Easting (m)	Northing (m)
Shallow Water	1	27° 59' 50.2816" N	91° 00' 58.6374" W	695069.2	3098488.88
Deep Water	2	27° 27' 00.2908" N	91° 00' 58.6374" W	696046.38	3037843.33

3.2. Propagation Modeling Results

The modeling methodology considered source directivity and range-dependent environmental properties at each of the two sites assessed. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), zero-to-peak pressure levels (PK, L_{pk}), peak-to-peak pressure levels (PK-PK; $L_{pk\text{-}pk}$), and either single-impulse (i.e., per-pulse) or accumulated sound exposure levels (SEL, L_E) as appropriate for different acoustic threshold criteria. A conservative sound velocity profile (January) was defined and used in the modeling. The analysis estimated the horizontal radial distances away from the seismic source at which the regulatory-defined threshold criteria or relevant sound levels for marine mammals and sea turtles were reached. The threshold criteria used in this study include regulatory-defined thresholds, and thresholds used in the most recent best available science literature. These include:

1. Peak pressure levels and frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from the US National Oceanic and Atmospheric Administration (NOAA) Technical Guidance (NMFS 2018) for the onset of Permanent Threshold Shift (PTS) in marine mammals.
2. Turtle auditory injury and behavioral response thresholds (SPL; (L_p)) from (Popper et al. 2014).

The results are summarized below for the representative single-impulse sites and accumulated SEL scenarios for marine mammals (Table 4) and sea turtles (Table 6).

Table 4. Summary table of radial distances ($R_{95\%}$ in m) to auditory injury thresholds for marine mammal functional hearing groups (NMFS 2018).

Hearing group	Metric	Threshold (dB)	Shallow Site	Deep Site
LF	L_E	183	16	16
	L_{pk}	219	-	-
MF	L_E	185	-	-
	L_{pk}	230	-	-
HF	L_E	155	7	7
	L_{pk}	202	90	89

LF–low-frequency cetaceans, MF–mid-frequency cetaceans, HF–high-frequency cetaceans
A dash indicates that distances could not be calculated because thresholds were not reached

Ranges to thresholds listed in the Bureau of Ocean Energy Management (BOEM) G&G Permit Application include unweighted L_p 190, 180, and 160 dB re 1µPa (HESS 1999). These thresholds are used to define areas of exposure for injury to pinnipeds, which are not present in the GoM, and to injury and behavioral effects to marine mammals. The HESS (1999) criteria are no longer considered best available science. The unweighted 190 and 180 dB thresholds have been replaced by the NMFS (2018) criteria. Table 5 lists the maximum distance from source for these criteria.

Table 5. Ranges to thresholds required for BOEM G&G permit applications (HESS 1999).

Decibel level	Threshold category	Maximum distance (R_{max}) from source (m)	
		Shallow Site	Deep Site
190	Pinnipeds injury*	72	72
180	marine mammal injury	418	234
160	marine mammal behavior	4855	3435

* Note that there are no pinnipeds in the Gulf of Mexico

Table 6. Radial distance ($R_{95\%}$ in m) to auditory injury and behavioral thresholds for sea turtles.

Impact	Metric	Threshold (dB)	Shallow Site	Deep Site
Mortal injury*	L_E	>210	-	-
	L_{pk}	207	50	50
Behavioral disturbance‡	L_p	166	2226	1762

A dash indicates that distances could not be calculated because thresholds were not reached
L_{pk} = unweighted peak sound pressure (dB re 1 µPa)
L_E = frequency-weighted sound exposure level (dB re 1 µPa^2·s)
L_p = unweighted sound pressure level (dB re 1 µPa)
* Popper et al. 2014
‡ McCauley et al. 2000

3.2.1. SEL Isopleth Maps

Figure 7 shows the unweighted 24 hour SEL for the 8000 in^3 seismic source. Six full survey lines and two partial lines were modeled over the 24 hour period with 1548 impulses.

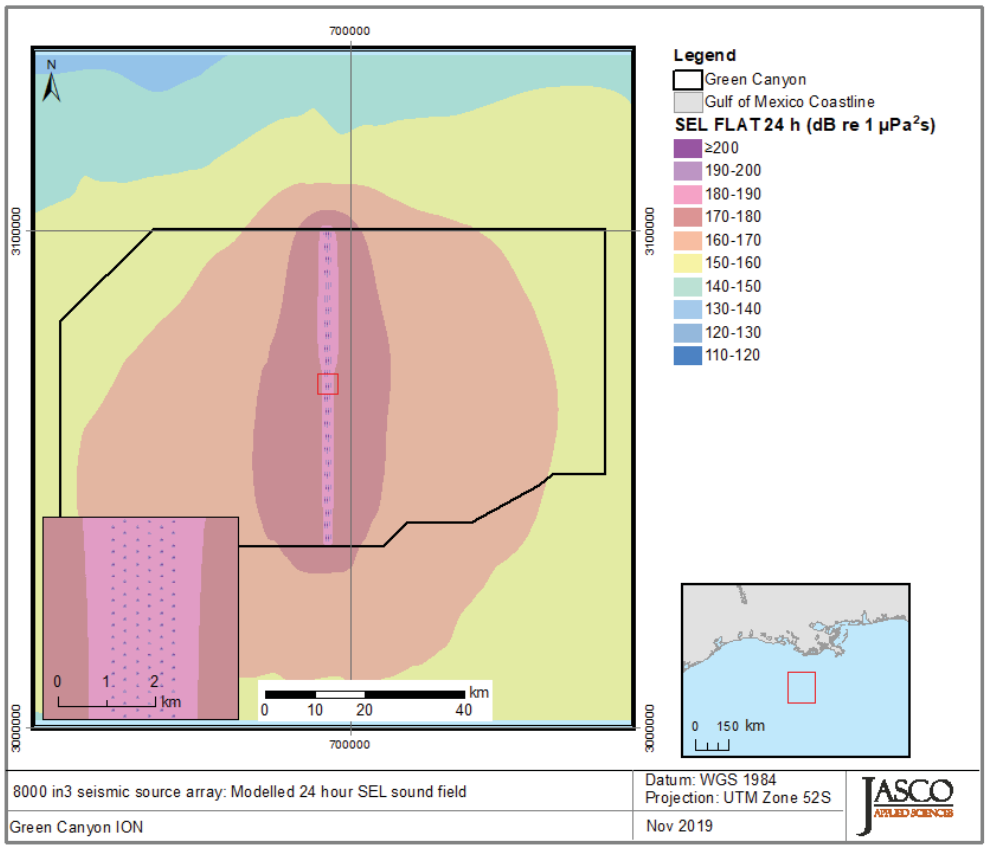

Figure 7. Cumulative unweighted SEL over a 24 hour period while operating the modeled 8000 in^3 seismic source array.

4. Discussion

The proposed 8000 in^3 seismic source is comprised of specially designed, large volume airguns that have a higher air capacity than conventional airguns. These large-volume airguns are designed to emit lower sound frequencies than conventional airguns, in order to produce higher-quality seismic images beneath salt domes. Because the same air volume is used to operate two very large guns, rather than many tens of smaller guns, the proposed array produces lower sound levels than a conventional array of equivalent total volume. The planned impulse spacing is also much larger than that in a conventional 3-D survey (250 m, versus 25–75 m for a typical survey). As a result, the cumulative sound exposure is also much lower than for a conventional survey. Taken together, these two features of the planned survey result in smaller radii than for a conventional 3-D seismic survey.

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Appendix A. Glossary

1/3-octave
One third of an octave. Note: A one-third octave is approximately equal to one decidecade (1/3 oct ≈ 1.003 ddec; ISO 2017).

1/3-octave-band
Frequency band whose bandwidth is one one-third octave. Note: The bandwidth of a one-third octave-band increases with increasing center frequency.

90%-energy time window
The time interval over which the cumulative energy rises from 5 to 95% of the total pulse energy. This interval contains 90% of the total pulse energy. Symbol: T_{90}.

azimuth
A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

broadband sound level
The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measured frequency range.

broadside direction
Perpendicular to the travel direction of a source. Compare with endfire direction.

cavitation
A rapid formation and collapse of vapor cavities (i.e., bubbles or voids) in water, most often caused by a rapid change in pressure. Fast-spinning vessel propellers typically cause cavitation, which creates a lot of noise.

cetacean
Any animal in the order Cetacea. These are aquatic, mostly marine mammals and include whales, dolphins, and porpoises.

compressional wave
A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called primary wave or P-wave.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

endfire direction
Parallel to the travel direction of a source. See also broadside direction.

ensonified
Exposed to sound.

far-field
The zone where, to an observer, sound originating from an array of sources (or a spatially distributed source) appears to radiate from a single point. The distance to the acoustic far-field increases with frequency.

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

hearing group
Groups of marine mammal species with similar hearing ranges. Commonly defined functional hearing groups include low-, mid-, and high-frequency cetaceans, pinnipeds in water, and pinnipeds in air.

geoacoustic
Relating to the acoustic properties of the seabed.

hertz (Hz)
A unit of frequency defined as one cycle per second.

high-frequency (HF) cetacean
The functional cetacean hearing group that represents those odontocetes (toothed whales) specialized for hearing high frequencies.

impulsive sound
Sound that is typically brief and intermittent with rapid (within a few seconds) rise time and decay back to ambient levels (NOAA 2013, ANSI S12.7-1986 R2006). For example, seismic airguns and impact pile driving.

low-frequency (LF) cetacean
The functional cetacean hearing group that represents mysticetes (baleen whales) specialized for hearing low frequencies.

mean-square sound pressure spectral density
Distribution as a function of frequency of the mean-square sound pressure per unit bandwidth (usually 1 Hz) of a sound having a continuous spectrum (ANSI S1.1-1994 R2004). Unit: $\mu Pa^2/Hz$.

mid-frequency (MF) cetacean
The functional cetacean hearing group that represents those odontocetes (toothed whales) specialized for mid-frequency hearing.

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

parabolic equation method
A computationally efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

particle acceleration
The rate of change of particle velocity. Unit: meters per second squared (m/s^2). Symbol: *a*.

peak pressure level (PK)
The maximum instantaneous sound pressure level, in a stated frequency band, within a stated period. Also called zero-to-peak pressure level. Unit: decibel (dB).

peak-to-peak pressure level (PK-PK)
The difference between the maximum and minimum instantaneous pressure levels. Unit: decibel (dB).

permanent threshold shift (PTS)
A permanent loss of hearing sensitivity caused by excessive noise exposure. PTS is considered auditory injury.

point source
A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: *p*.

received level (RL)
The sound level measured (or that would be measured) at a defined location.

rms
root-mean-square.

shear wave
A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

signature
Pressure signal generated by a source.

sound
A time-varying pressure disturbance generated by mechanical vibration waves traveling through a fluid medium such as air or water.

sound exposure
Time integral of squared, instantaneous frequency-weighted sound pressure over a stated time interval or event. Unit: pascal-squared second ($Pa^2 \cdot s$) (ANSI S1.1-1994 R2004).

sound exposure level (SEL)
A cumulative measure related to the sound energy in one or more pulses. Unit: dB re 1 $\mu Pa^2 \cdot s$. SEL is expressed over the summation period (e.g., per-pulse SEL [for airguns], single-strike SEL [for pile drivers], 24 hour SEL).

sound exposure spectral density
Distribution as a function of frequency of the time-integrated squared sound pressure per unit bandwidth of a sound having a continuous spectrum (ANSI S1.1-1994 R2004). Unit: $\mu Pa^2 \cdot s/Hz$.

sound field
Region containing sound waves (ANSI S1.1-1994 R2004).

sound intensity
Sound energy flowing through a unit area perpendicular to the direction of propagation per unit time.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound level measured in the far-field and scaled back to a standard reference distance of 1 meter from the acoustic center of the source. Unit: dB re 1 µPa m (pressure level) or dB re 1 $\mu Pa^2 \cdot s \cdot m^2$ (exposure level).

spectral density level
The decibel level ($10 \cdot \log_{10}$) of the spectral density of a given parameter such as SPL or SEL, for which the units are dB re 1 μPa^2/Hz and dB re 1 $\mu Pa^2 \cdot s$/Hz, respectively.

spectrum
An acoustic signal represented in terms of its power, energy, mean-square sound pressure, or sound exposure distribution with frequency.

surface duct
The upper portion of a water column within which the sound speed profile gradient causes sound to refract upward and therefore reflect off the surface resulting in relatively long-range sound propagation with little loss.

temporary threshold shift (TTS)
Temporary loss of hearing sensitivity caused by excessive noise exposure.

thermocline
The depth interval near the ocean surface that experiences temperature gradients due to warming or cooling by heat conduction from the atmosphere and by warming from solar heating.

transmission loss (TL)
The decibel reduction in sound level between two stated points that results from sound spreading away from an acoustic source subject to the influence of the surrounding environment. Also referred to as propagation loss.

wavelength
Distance over which a wave completes one cycle of oscillation. Unit: meter (m). Symbol: λ.

Appendix B. Propagation Modeling Details

Appendices B.1 to B.4 present tables of SEL and SPL radii threshold kilometers from the operating seismic source for the shallow and deep modeling sites. The low frequency (LF), mid frequency (MF), and high frequency (HF) weightings follow the weighting curves presented in Appendix D

B.1. Shallow Site Modeling Results

Table B-1. *Shallow site*: Ranges to per-pulse SEL isopleths for the 8000 in^3 array as maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (km) from the source to modeled broadband (3–25,000 Hz) maximum over depth sound levels, with frequency weighting (NMFS 2018) applied for low-frequency (LF), mid-frequency (MF), and high-frequency (HF) cetaceans.

SEL (dB re 1 µPa²s)	LF		MF		HF	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.01	0.01	-	-	-	-
180	0.02	0.02	-	-	-	-
170	0.07	0.07	-	-	-	-
160	0.44	0.42	0.01	0.01	-	-
150	1.55	1.24	0.01	0.01	0.01	0.01
140	5.22	4.50	0.02	0.02	0.01	0.01
130	14.02	12.15	0.06	0.06	0.04	0.03
120	52.46	43.83	0.22	0.21	0.11	0.11
110	70.68**	57.89	0.88	0.79	0.39	0.37

A dash indicates that distances could not be calculated because thresholds were not reached
** Radii extend beyond modeling boundary.

Table B-2.*Shallow Site*: Per-pulse SPL threshold distances for the 8000 in^3 array as maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (km) from the source to modeled broadband (3–25,000 Hz) maximum over depth sound level thresholds, unweighted and with frequency weighting (NMFS 2018) applied for low-frequency (LF), mid-frequency (MF), and high-frequency (HF) cetaceans.

SPL (dB re 1 µPa)	Unweighted		LF		MF		HF	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.07	0.07	0.02	0.02	-	-	-	-
180	0.42	0.40	0.06	0.06	-	-	-	-
170	1.55	1.36	0.39	0.21	0.01	0.01	-	-
166*	2.56	2.23	0.55	0.51	0.01	0.01	-	-
160	4.86	4.29	1.26	1.01	0.01	0.01	0.01	0.01
150	12.07	10.39	4.17	3.62	0.02	0.02	0.01	0.01
140	50.86	34.58	11.46	9.16	0.05	0.05	0.03	0.03
130	70.68**	58.41	50.46	27.89	0.18	0.17	0.09	0.09
120	70.68**	57.07	70.68**	58.47	0.76	0.73	0.34	0.33

A dash indicates that distances could not be calculated because thresholds were not reached
* Threshold for turtle behavioral response
** Radii extend beyond modeling boundary.

B.2. Shallow Site Single Shot Isopleth Maps

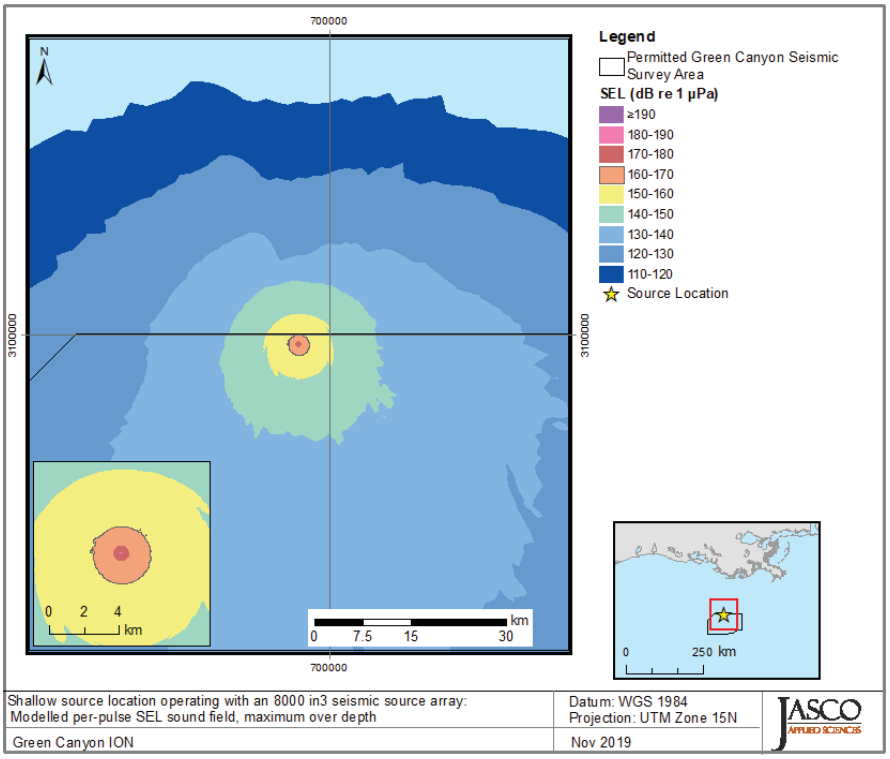


Figure B-1. Shallow site single impulse sound exposure level (SEL) for an 8000 in^3 array.

B.3. Deep Site Modeling Results

Table B-3. *Deep Site*: Ranges to per-pulse SEL isopleths for the 8000 in^3 array as maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (km) from the source to modeled broadband (3–25,000 Hz) maximum over depth sound levels, with frequency weighting (NMFS 2018) applied for low-frequency (LF), mid-frequency (MF), and high-frequency (HF) cetaceans.

SEL (dB re 1 µPa^{2}s)	LF		MF		HF	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.01	0.01	-	-	-	-
180	0.02	0.02	-	-	-	-
170	0.06	0.06	-	-	-	-
160	0.22	0.22	0.01	0.01	-	-
150	0.71	0.67	0.01	0.01	0.01	0.01
140	5.84	3.68	0.02	0.02	0.01	0.01
130	21.08	15.77	0.06	0.06	0.03	0.03
120	51.94	40.21	0.21	0.20	0.11	0.10
110	70.68**	59.64	0.70	0.66	0.38	0.36

A dash indicates that distances could not be calculated because thresholds were not reached
** Radii extend beyond modeling boundary.

Table B-4. *Deep Site*: Per-pulse SPL threshold distances for the 8000 in^3 array as maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (km) from the source to modeled broadband (3–25,000 Hz) maximum over depth sound level thresholds, unweighted and with frequency weighting (NMFS 2018) applied for low-frequency (LF), mid-frequency (MF), and high-frequency (HF) cetaceans.

SPL (dB re 1 µPa)	Unweighted		LF		MF		HF	
	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
190	0.07	0.07	0.02	0.02	-	-	-	-
180	0.23	0.23	0.06	0.06	-	-	-	-
170	0.76	0.72	0.20	0.19	0.01	0.01	-	-
166*	1.90	1.76	0.31	0.30	0.01	0.01	-	-
160	3.44	3.19	0.63	0.59	0.01	0.01	0.01	0.01
150	15.44	12.61	3.41	3.10	0.02	0.02	0.01	0.01
140	41.00	34.84	15.15	11.29	0.05	0.05	0.03	0.03
130	70.68**	59.29	40.98	31.52	0.18	0.17	0.09	0.09
120	70.68**	59.89	70.68**	59.21	0.62	0.58	0.34	0.32

A dash indicates that distances could not be calculated because thresholds were not reached
* Threshold for turtle behavioral response
** Radii extend beyond modeling boundary.

B.4. Deep Single Shot Isopleth Maps

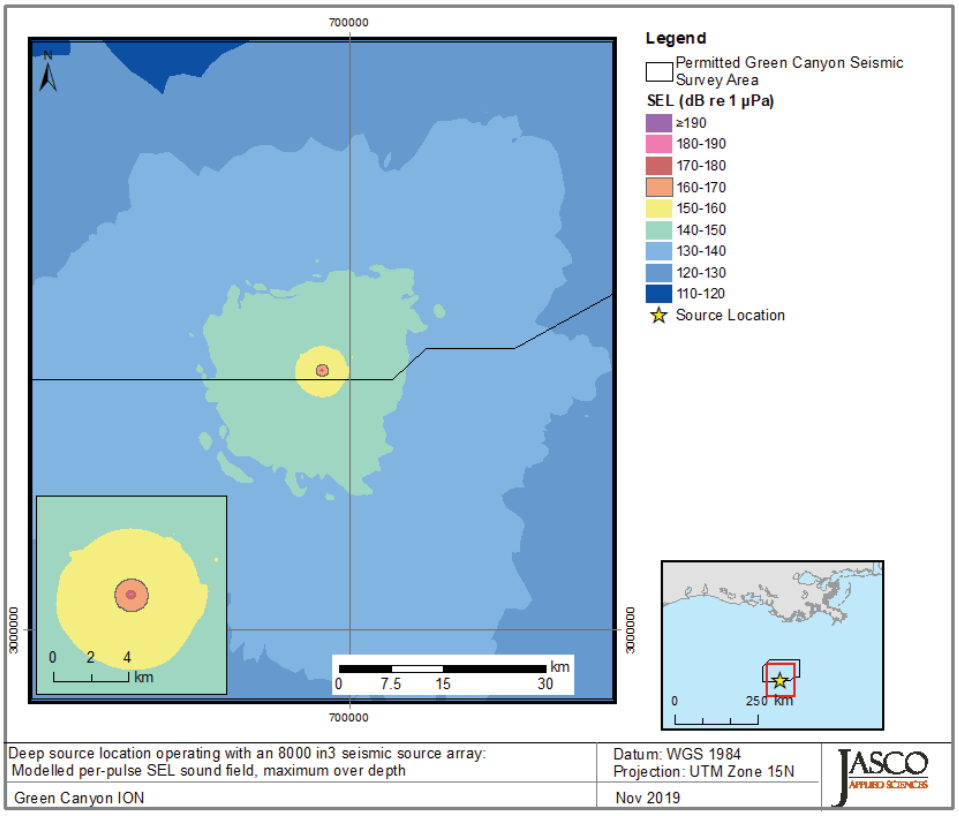


Figure B-2. Deep site single impulse sound exposure level (SEL) for an 8000 in^3 array

Appendix C. Underwater Acoustic Metrics and Modeling

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 µPa. Because the perceived loudness of sound, especially pulsed sound such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate sound and its effects on marine life. Here we provide specific definitions of relevant metrics used in the accompanying report. Where possible, we follow the American National Standard Institute and International Organization for Standardization definitions and symbols for sound metrics (e.g., ANSI 2013, ISO 2017), but these standards are not always consistent.

The zero-to-peak sound pressure, or peak sound pressure (PK or $L_{p,\text{pk}}$; dB re 1 µPa), is the decibel level of the maximum instantaneous acoustic pressure in a stated frequency band attained by an acoustic pressure signal, $p(t)$:

$$L_{p,\text{pk}} = 10 \log_{10} \frac{\max|p^2(t)|}{p_0^2} = 20 \log_{10} \frac{\max|p(t)|}{p_0} \tag{C-1}$$

PK is often included as a criterion for assessing whether a sound is potentially injurious; however, because it does not account for the duration of an acoustic event, it is generally a poor indicator of perceived loudness.

The peak-to-peak sound pressure (PK-PK or $L_{p,\text{pk-pk}}$; dB re 1 µPa) is the difference between the maximum and minimum instantaneous sound pressure, possibly filtered in a stated frequency band, attained by an impulsive sound, $p(t)$:

$$L_{p,\text{pk-pk}} = 10 \log_{10} \frac{[\max(p(t)) - \min(p(t))]^2}{p_0^2} \tag{C-2}$$

The sound pressure level (SPL or L_p; dB re 1 µPa) is the root-mean-square (rms) pressure level in a stated frequency band over a specified time window (T; s). It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$L_p = 10 \log_{10} \left(\frac{1}{T} \int_T g(t)\, p^2(t)\, dt \Big/ p_0^2 \right) \tag{C-3}$$

where $g(t)$ is an optional time weighting function. In many cases, the start time of the integration is marched forward in small time steps to produce a time-varying SPL function. For short acoustic events, such as sonar pulses and marine mammal vocalizations, it is important to choose an appropriate time window that matches the duration of the signal. For in-air studies, when evaluating the perceived loudness of sounds with rapid amplitude variations in time, the time weighting function $g(t)$ is often set to a decaying exponential function that emphasizes more recent pressure signals. This function mimics the leaky integration nature of mammalian hearing. For example, human-based fast time-weighted SPL ($L_{p,\text{fast}}$) applies an exponential function with time constant 125 ms. A related simpler approach used in underwater acoustics sets $g(t)$ to a boxcar (unity amplitude) function of width 125 ms; the results can be referred to as $L_{p,\text{boxcar 125ms}}$. Another approach, historically used to evaluate SPL of impulsive signals underwater, defines $g(t)$ as a boxcar function with edges set to the times corresponding to 5% and 95% of the cumulative square pressure function encompassing the duration of an impulsive acoustic event. This calculation is applied individually to each impulse signal, and the results have been referred to as 90% SPL ($L_{p,90\%}$).

The sound exposure level (SEL or L_E; dB re 1 µPa²·s) is the time-integral of the squared acoustic pressure over a duration (T):

$$L_E = 10 \log_{10} \left(\int_T p^2(t)\, dt \Big/ T_0 p_0^2 \right) \tag{C-4}$$

where T_0 is a reference time interval of 1 s. SEL continues to increase with time when non-zero pressure signals are present. It is a dose-type measurement, so the integration time applied must be carefully considered for its relevance to impact to the exposed recipients.

SEL can be calculated over a fixed duration, such as the time of a single event or a period with multiple acoustic events. When applied to pulsed sounds, SEL can be calculated by summing the SEL of the N individual pulses. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10 \log_{10} \sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}} \tag{C-5}$$

Because the SPL(T_{90}) and SEL are both computed from the integral of square pressure, these metrics are related numerically by the following expression, which depends only on the duration of the time window T:

$$L_p = L_E - 10\log_{10}(T) \tag{C-6}$$

$$L_{p90} = L_{\mathrm{E}} - 10\log_{10}(T_{90}) - 0.458 \tag{C-7}$$

where the 0.458 dB factor accounts for the 10% of pulse SEL missing from the SPL(T_{90}) integration time window.

Energy equivalent SPL (L_{eq}; dB re 1 µPa) denotes the SPL of a stationary (constant amplitude) sound that generates the same SEL as the signal being examined, $p(t)$, over the same time period, T:

$$L_{\mathrm{eq}} = 10 \log_{10} \left(\frac{1}{T} \int_T p^2(t)\, dt \Big/ p_0^2 \right) \tag{C-8}$$

The equations for SPL and the energy-equivalent SPL are numerically identical. Conceptually, the difference between the two metrics is that the SPL is typically computed over short periods (typically of one second or less) and tracks the fluctuations of a non-steady acoustic signal, whereas the L_{eq} reflects the average SPL of an acoustic signal over time periods typically of one minute to several hours.

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,\mathrm{LF24h}}$; see Appendix D) or auditory-weighted SPL ($L_{p,\mathrm{ht}}$). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should also be specified.

In the present report, audiogram-weighted, fast-averaged SPL ($L_{p,\mathrm{ht,F}}$) is defined by the exponential function from Plomp and Bouman (1959):

$$\begin{aligned} L_{p,\mathrm{ht}} &= L_{E,\mathrm{ht,per\text{-}pulse}} - 10 \log_{10}(d/0.9)\,, \\ L_{p,\mathrm{ht,F}} &= L_{p,\mathrm{ht}} + 10 \log_{10} \frac{1 - e^{-d/\tau}}{1 - e^{-T/\tau}} \end{aligned} \tag{C-9}$$

where d is the duration in seconds, τ is the time constant of 0.125 s representing marine mammal auditory integration time, $L_{p,\mathrm{ht}}$ is the audiogram-weighted SPL over pulse duration, and T is the pulse repetition period. This metric accounts for the hearing sensitivity of specific species through frequency weighting, and results in reduced perceived loudness (i.e., sensation level) for pulses shorter than auditory integration time (τ).

C.1. Decidecade Band

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Because animals perceive exponential increases in frequency rather than linear increases, analyzing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are approximately one-third of an octave (base 2) wide and often referred to as 1/3-octave-bands. Each octave represents a doubling in sound frequency. The center frequency of the ith band, $f_c(i)$, is defined as:

$$f_c(i) = 10^{\frac{i}{10}}, \tag{C-10}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith band are defined as:

$$f_{lo,i} = 10^{\frac{-1}{20}} f_c(i) \quad \text{and} \quad f_{hi,i} = 10^{\frac{1}{20}} f_c(i)\ . \tag{C-11}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure C-1).

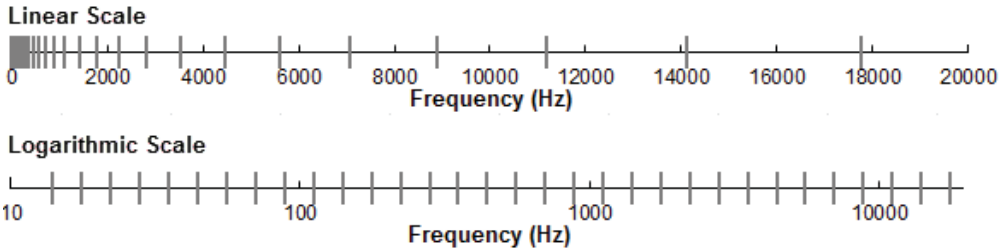


Figure C-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{lo,i}$ and $f_{hi,i}$:

$$L_{p,i} = 10 \log_{10} \int_{f_{lo,i}}^{f_{hi,i}} S(f)\, df \tag{C-12}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10 \log_{10} \sum_i 10^{\frac{L_{p,i}}{10}} \tag{C-13}$$

Figure C-2 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient noise signal. Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the spectral levels, especially at higher frequencies. Acoustic modeling of decidecade bands requires less computation time than 1 Hz bands and still resolves the frequency-dependence of the sound source and the propagation environment.

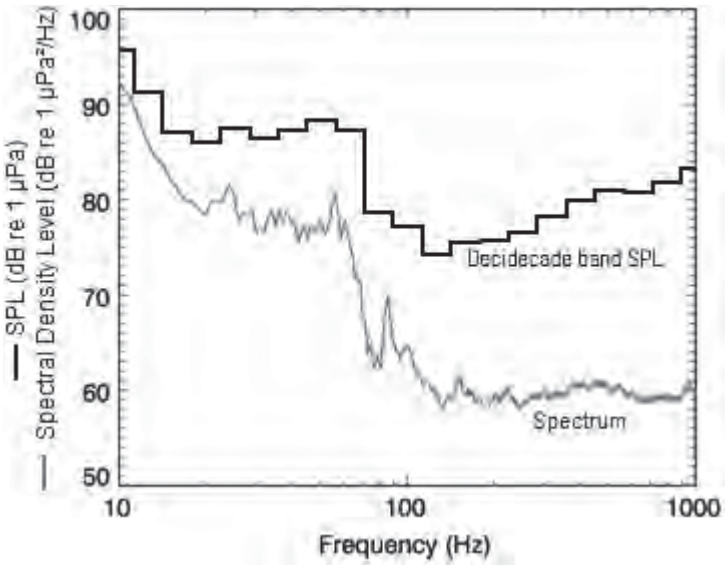


Figure C-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.

Appendix D. Auditory (Frequency) Weighting Functions

Weighting functions are applied to the sound spectra under consideration to weight the importance of received sound levels at particular frequencies in a manner reflective of an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007). Southall et al. (2007) were first to suggest weighting functions and functional hearing groups for marine mammals. The Technical Guidance issued by NOAA (NMFS, 2018) includes weighting functions and associated thresholds, and is used here for determining the ranges for potential Level A harassment to marine mammals.

D.1.1. Frequency Weighting Functions - Technical Guidance (NMFS 2018)

In 2015, a U.S. Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. This frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left\{\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^{2}\right]^{a}\left[1+(f/f_{hi})^{2}\right]^{b}}\right)\right\}, \quad \text{(D-1)}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses noise impacts on marine mammals (NMFS, 2018). Table D-1 lists the frequency-weighting parameters for each hearing group; Figure D-1 shows the resulting frequency-weighting curves.

Table D-1. Parameters for the auditory weighting functions recommended by NMFS (2018).

Hearing group	a	b	f_{lo} (Hz)	f_{hi} (kHz)	K (dB)
Low-frequency cetaceans	1.0	2	200	19,000	0.13
Mid-frequency cetaceans	1.6	2	8,800	110,000	1.20
High-frequency cetaceans	1.8	2	12,000	140,000	1.36
Phocid pinnipeds in water	1.0	2	1,900	30,000	0.75
Otariid pinnipeds in water	2.0	2	940	25,000	0.64

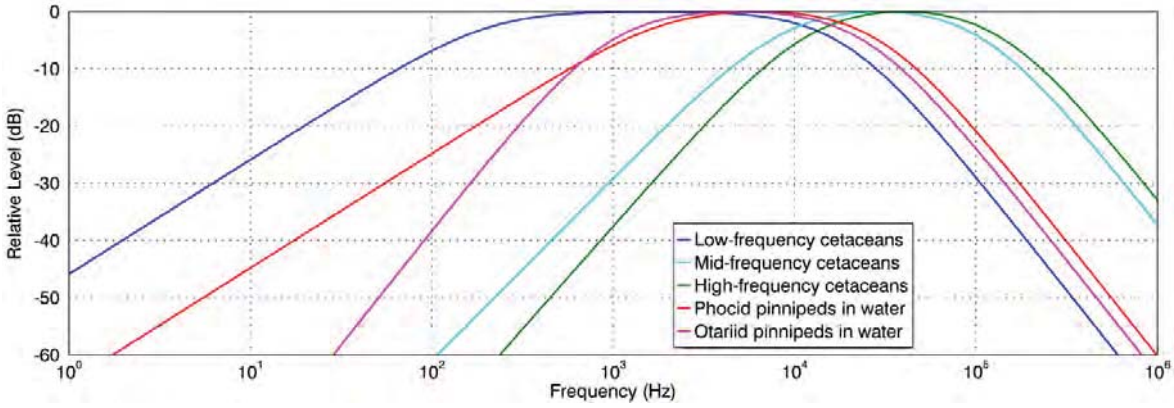


Figure D-1. Auditory weighting functions for functional marine mammal hearing groups as recommended by NMFS (2018).

Appendix E. Airgun Array Source Model

The source levels and directivity of the 8000 in^3 source array was predicted with JASCO's Airgun Array Source Model (AASM; MacGillivray 2006, 2019). AASM includes both a low-frequency and a high-frequency module for predicting different components of an airgun array's spectrum. The low-frequency module is based on the physics of oscillation and radiation of airgun bubbles, as originally described by Ziolkowski (1970), that solves the set of parallel differential equations that govern bubble oscillations. The high-frequency module of AASM uses a stochastic simulation to predict the sound emissions of individual airguns above 800 Hz, using a multivariate statistical model. The current version of AASM (v1.3) has been tuned to fit a large library of high-quality seismic source signature data obtained from the Joint Industry Program (JIP) on Sound and Marine Life (Mattsson and Jenkerson 2008).

The JIP dataset only includes measurements for airguns up to a maximum volume of 520 in^3 so additional tuning data was incorporated into AASM to represent the large volume seismic source modeled for the GXT survey. Measured source waveform data for a single 2000 in^3 source was used to augment AASM's tuning parameters. This ensured that the source model output accurately represented the source levels of the proposed arrays. It should be noted, however, that maximum frequency of the 2000 in^3 airgun measurements was 500 Hz, and so they could only be used for tuning AASM's low-frequency module (<800 Hz). The high-frequency source level predictions (>800 Hz) were based on the largest available airgun size used to develop the statistical model (520 in^3), which represents the best available information at the present time

AASM produces a set of notional signatures for each array element based on:

- Array layout
- Volume, tow depth, and firing pressure of each airgun
- Interactions between different airguns in the array

These notional signatures are the pressure waveforms of the individual airguns at a standard reference distance of 1 m; they account for the interactions with the other airguns in the array. The signatures are summed with the appropriate phase delays to obtain the far-field source signature of the entire array in all directions. This far-field array signature is filtered into 1/3-octave-bands to compute the source levels of the array as a function of frequency band and azimuthal angle in the horizontal plane (at the source depth), after which it is considered to be a directional point source in the far field.

A seismic array consists of many sources and the point-source assumption is invalid in the near field where the array elements add incoherently. The maximum extent of the near field of an array (R_{nf}) is:

$$R_{\mathrm{nf}} < \frac{l^2}{4\lambda}\,, \tag{E-1}$$

where λ is the sound wavelength and l is the longest dimension of the array (Lurton 2002, §5.2.4). For example, an airgun array length of l = 16 m yields a near-field range of 85 m at 2 kHz and 17 m at 100 Hz. Beyond this R_{nf} range, the array is assumed to radiate like a directional point source and is treated as such for propagation modelling.

The interactions between individual elements of the array create directionality in the overall acoustic emission. Generally, this directionality is prominent mainly at frequencies in the mid-range between tens of hertz to several hundred hertz. At lower frequencies, with acoustic wavelengths much larger than the inter-airgun separation distances, the directionality is small. At higher frequencies, the pattern of lobes is too finely spaced to be resolved and the effective directivity is less.

Appendix F. Sound Propagation Models

F.1. Marine Operations Noise Model (MONM) with BELLHOP

Underwater sound propagation (i.e., transmission loss) was predicted with JASCO's Marine Operations Noise Model (MONM). This model computes sound propagation from highly-directional, high-frequency acoustic sources via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994). This version of MONM accounts for sound attenuation due to energy absorption through ion relaxation and viscosity of water in addition to acoustic attenuation due to reflection at the medium boundaries and internal layers (Fisher and Simmons 1977). The former type of sound attenuation is important for frequencies higher than 5 kHz and cannot be neglected without noticeably affecting the model results.

MONM computes acoustic fields in three dimensions by modelling transmission loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding $N = 360°/\Delta\theta$ number of planes (Figure F-1). The angular step size of the radials is chosen to sufficiently sample the source beam pattern. MONM accounts for the variability of the sound level of the emitted pulse with both azimuth and depression angles according to the 3-D beam pattern of the source and estimates sound levels at various horizontal distances from the source as well as at various depths.

The received sound level at a sampling location is taken as the maximum value that occurs over all samples within the water column below, i.e., the maximum-over-depth received sound level. These maximum-over-depth levels are then presented as color contours around the source (e.g., Figure F-1).

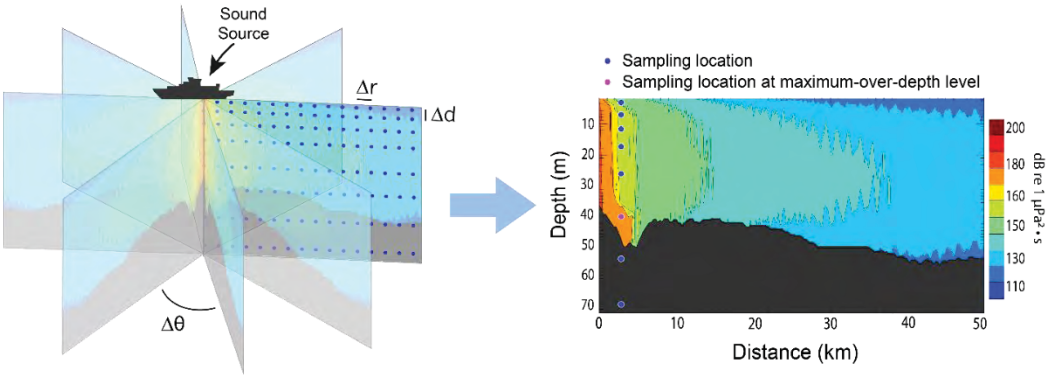


Figure F-1. The N×2-D and maximum-over-depth modeling approach used by MONM.

F.2. Full Waveform Range-dependent Acoustic Model: FWRAM

For impulsive sounds from the seismic source, time-domain representations of the pressure waves generated in the water are required for calculating SPL and PK. Furthermore, the seismic source must be represented as a distributed source to accurately characterize vertical directivity effects in the near-field zone. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic model based on the same wide-angle parabolic equation (PE) algorithm as MONM. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, and it takes the same environmental inputs as MONM (bathymetry, water sound speed profile, and seafloor geoacoustic profile). Unlike MONM, FWRAM computes pressure waveforms via Fourier synthesis of the modeled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012). Besides providing direct calculations of the PK and SPL, the synthetic waveforms from FWRAM can also be used to convert the SEL values from MONM to SPL.

F.3. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modeled depths above the sea floor for each location in the modeled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure F-2).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure F-2(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure F-2(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.

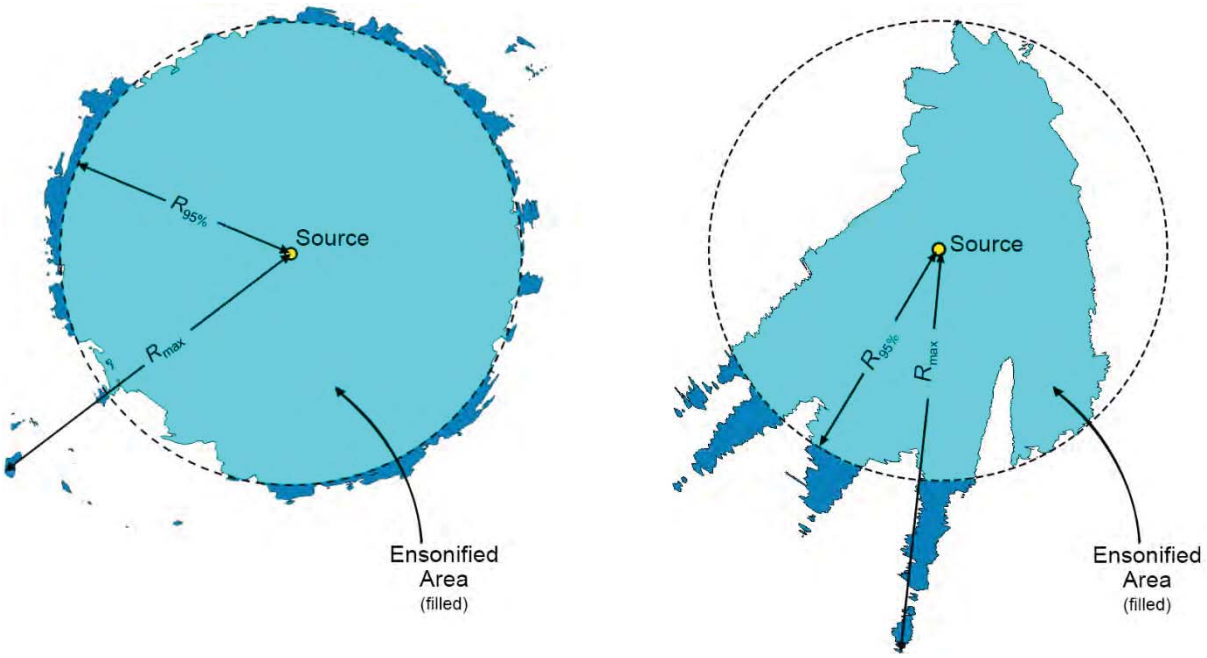


Figure F-2. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

F.4. Environmental Parameters

F.4.1. Bathymetry

Bathymetry data was selected from the STRM15+ database, contours were compared against local coastline to ensure consistency. Bathymetry data was gridded to a 250m x 250m resolution.

F.4.2. Sound Speed Profile

The sound speed profile chosen for this study was selected by determining each month's sound speed profile in the area and selecting the most down refracting profile as this profile would be most favorable to sound propagation. The selected SSP was for the month of January. The figure below shows the resulting profile used as input to the sound propagation modeling. The profile was confirmed by calculating a SSP given January's salinity and temperature data in the region.

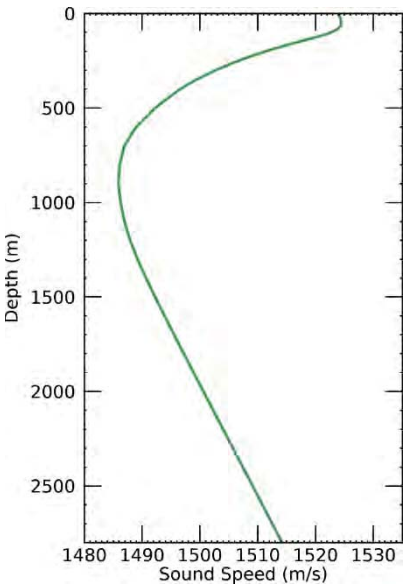


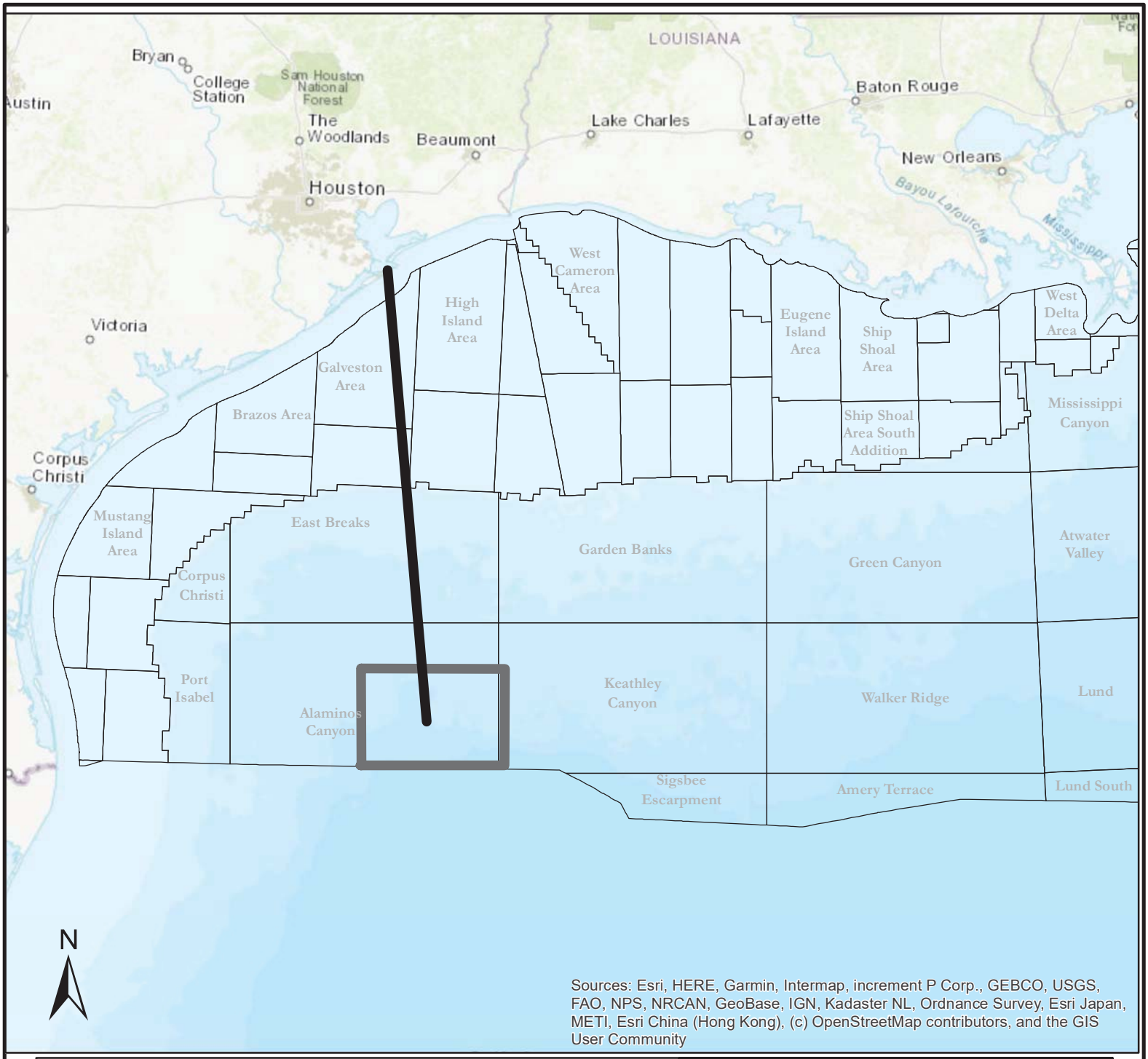
Figure F-3. The final sound speed profile, January, used for the modeling showing the entire water column.

F.4.3. Geoacoustics

The fluid porosity was found to be a constant value for material which was determined to be 2, and which corresponds to sand. All known porosity values were input into a geoacoustic model given specific depths and densities to confirm the reported geoacoustical properties (Table F-1). The known geoacoustics were taken from data collected on the shelf zone in the center and western regions of the GoM.

Table F-1. Depth dependent geoacoustic data from the shelf zone in the central and western region of the GoM.

Depth below seafloor (m)	Material	Density (g/cm³)	Compressional wave		Shear wave		Porosity (%)
			Speed (m/s)	Attenuation (dB/λ)	Speed (m/s)	Attenuation (dB/λ)	
0–20	Sand φ = 2	1.61	1610	0.62	200	0.76	65
20–50		1.70	1900	1.44			60
50–200		1.78	290	1.77			55
200–600		1.87	2500	2.31			50
>600		2.04	2500	2.67			40



MAP INFORMATION

Legend

Manuever Area

Protraction Areas

MAP SCALE

0 20 40 Kilometers

1:4,060,878

Print size: 8.5"x11" (ANSI A)

SHELL EXPLORATION & PRODUCTION COMPANY

Leopard Survey PUBLIC INFORMATION

210 Miles from Port Galveston

GEODETIC PARAMETERS

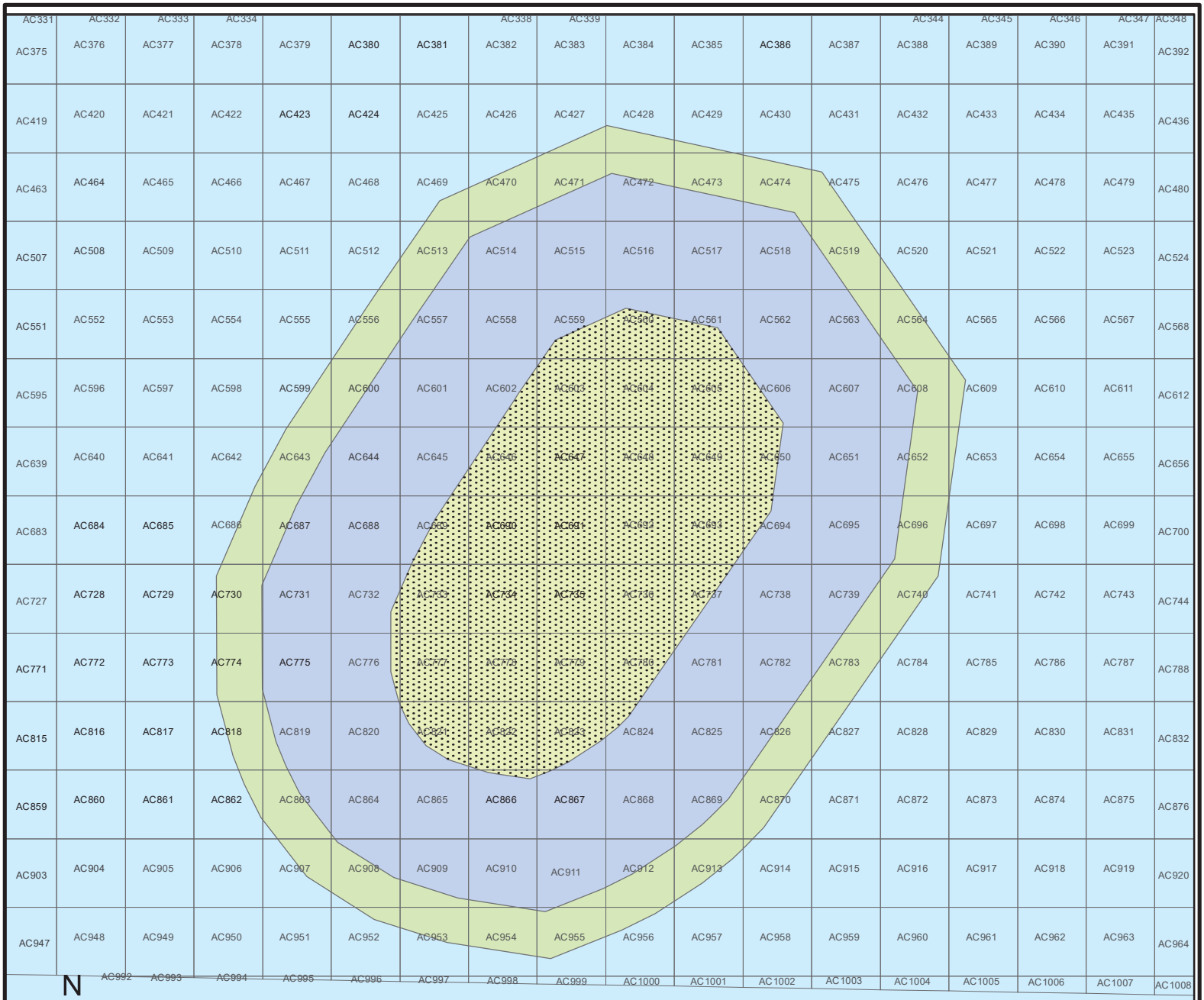
Horizontal Coordinate Reference System
CRS name (ESRI): NAD 1927 BLM Zone 15N
CRS name (Shell): NAD27 / UTM zone 16N (ftUS) [1241_32066]
CRS code (EPSG): [32066]
Geodetic datum: North American 1927
Projection name: Transverse Mercator
Horizontal units: Foot US

Author: Brad Nolan | Date: 14 Nov 2020

Name: Leopard_OBS_Planning_Map_ArcGIS

EP Catalog No.: N/A

RESTRICTED



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

MAP INFORMATION

Legend

- Active
- HBP
- Active
- HBP
- GoM OCS Block (open)
- Leopard 1st Design-Receivers-Location
- Leopard_VR_100520-Leopard Node Polygon x1.5
- Leopard_VR_100520-Leopard Source Polygon x 1.5
- Leopard Operating Area

MAP SCALE

0 1 2 4 6 8 10
Kilometers

1:406,088
Print size: 8.5"x11" (ANSI A)

SHELL EXPLORATION & PRODUCTION COMPANY

Leopard OBN Survey

Aliminos Canyon Area

GEODETIC PARAMETERS

Horizontal Coordinate Reference System
CRS name (ESRI): NAD 1927 BLM Zone 15N
CRS name (Shell): NAD27 / UTM zone 16N (ftUS) [1241_32066]
CRS code (EPSG): [32066]
Geodetic datum: North American 1927
Projection name: Transverse Mercator
Horizontal units: Foot US

Author: Brad Nolan | Date: 14 Nov 2020

Name: Leopard_OBS_Planning_Map_ArcGIS

EP Catalog No.: N/A

RESTRICTED

UNITED STATES

DEPARTMENT OF THE INTERIOR
BUREAU OF OCEAN ENERGY MANAGEMENT

Gulf of Mexico OCS Region

(Insert Appropriate Regional Office)

PERMIT FOR GEOPHYSICAL EXPLORATION FOR MINERAL RESOURCES OR SCIENTIFIC RESEARCH ON THE OUTER CONTINENTAL SHELF

In consideration of the terms and conditions contained herein and the authorization granted hereby, this permit is entered into by and between the United States of America (the Government), acting through the Bureau of Ocean Energy Management (BOEM) of the Department of the Interior, and

Shell Offshore Inc.

(Name of Permittee)

701 Poydras, Room 2418

(Number and Street)

New Orleans, LA 70139

(City, State, and Zip Code)

PERMIT NUMBER: T20-004 **DATE:** 10-Nov-2020

This permit is issued pursuant to the authority of the Outer Continental Shelf Lands Act, as amended (43 U.S.C. 1331 *et seq*.), hereinafter called the "Act," and Title 30 Code of Federal Regulations Parts 551 (Geological and Geophysical (G&G) Explorations of the Outer Continental Shelf). The permittee must conduct all activities in compliance with the terms and conditions of this permit, including the "Stipulations," "Environmental Protective Provisions," and the approved "Application for Permit," which are attached to and incorporated into this permit. The permittee must conduct all geophysical exploration or scientific research activities in compliance with the Act, the regulations in 30 CFR Parts 551 and 251, and other applicable statutes and regulations whether such statutes and regulations are enacted, promulgated, issued, or amended before or after this permit is issued. Some of the provisions of 30 CFR Parts 551 and 251 are restated in this permit for emphasis. However, all of the provisions of 30 CFR Parts 551 and 251 apply to this permit. The permittee should note particularly that G&G activities may cause incidental "taking" of animals under the Marine Mammal Protection Act (16 U.S.C. 1361 et seq.) or the Endangered Species Act (16 U.S.C. § 1531 et seq.). Any such incidental taking is not authorized by this permit, and it may only be authorized by the National Marine Fisheries Service or the U.S. Fish and Wildlife Service. The permittee should contact these two agencies to address any questions about these laws or requirements.

Paperwork Reduction Act of 1995 (PRA) Statement: This permit refers to information collection requirements contained in 30 CFR Parts 551 and 251 regulations. The Office of Management and Budget (OMB) has approved those reporting requirements under OMB Control Number 1010-0048.

Section I. Authorization

The Government authorizes the permittee to conduct:

[X] Geophysical exploration for mineral resources as defined in 30 CFR 551.1.

[ ] Geophysical scientific research as defined in 30 CFR 551.1. A permit is required for any geophysical investigation that involves the use of solid or liquid explosives or developing data and information for proprietary use or sale.

This permit authorizes the permittee to conduct the above geophysical activity during the period from 03-Mar-2021 to 03-Mar-2022 in the following area(s):

see attached map

The permittee shall not conduct any geophysical operation (i.e., active sound source(s)) outside of the permitted area specified herein even if no data is collected or obtained from such operations. Geophysical operations shall not be conducted "in-transit" to the permitted area and may only proceed once the survey vessel enters the permitted area. (This restriction does not apply to Alaska.)

Extensions of the time period specified above must be requested in writing. A permit plus extensions for activities will be limited to a period of not more than 1 year from the original issuance date of the permit. Inspection and reporting of geophysical exploration activities, suspension and cancellation of authority to conduct exploration or scientific research activities under permit, and penalties and appeals will be carried out in accordance with 30 CFR 551.8, 551.9, and 551.10.

The authority of the Regional Director may be delegated to the Regional Supervisor for Resource Evaluation for the purposes of this permit.

Section II. Type(s) of Operations and Technique(s)

The permittee will employ the following type(s) of operations:
OBN Seismic Surveys
; and

will utilize the following instruments and/or technique(s) in such operations:
Air gun source array, seafloor seismographs (nodes), seafloor deployed Pressure Inverted Echo Sounders (PIES) .

Section III. Reports on Operations

A. Status Reports

1. In the Gulf of Mexico and Atlantic OCS Regions:

The permittee must submit status reports every **two months** in a manner approved or prescribed by

the Regional Supervisor, Resource Evaluation (here after referred to as Supervisor). The report must include a map of appropriate scale showing traverse lines, protraction areas, blocks, and block numbers (if map scale permits). The map should be a cumulative update for each status report and clearly illustrate the planned traverse lines (one color) and the portion of those traverse lines in which data acquisition has been completed to date (a second color). Please indicate the cumulative total line miles (2D) or blocks (3D) of data acquired. The map should be submitted in digital format preferably as a GeoPDF.

2. In the Alaska and Pacific OCS Regions:

The permittee must submit status reports **weekly** in a manner approved or prescribed by the Regional Supervisor, Resource Evaluation (here after referred to as Supervisor). The report must include a map of appropriate scale showing the location and extent of acquired lines of 2D data or traverse lines for 3D data and the 3-mile limit when data collection is adjacent to the OCS boundary or other important boundaries as specified by BOEM. The map should be a cumulative update for each status report and clearly illustrate the planned lines (one color) and the portion of those lines in which data acquisition has been completed to date (a second color). The report must show the activity of the source vessel (i.e., no seismic activity, time and location when a mitigation gun is on, ramp-up, and full acquisition mode). Protected Species Observer (PSO) reports must also be included. Please indicate the cumulative total line miles (2D) or square miles (3D) of data acquired. The map should be submitted in digital format as a PDF and ESRI file – gdb-feature class(s) or shape files.

B. The permittee must submit to the Supervisor a Final Report within 30 days after the completion of operations. The final report must contain the following:

1. In the Gulf of Mexico and Atlantic OCS Regions:

i. The total number of 2D line miles or OCS blocks of geophysical data acquired as well as the "typical" or average sail miles per block for the survey;

ii. A *brief* daily log of operations. A suggested format for the daily log of operations would include, but is not limited to, a table that provides the name of the survey, a date column, a column for number of line miles or blocks collected each day, and an operations column. Preferably, the date column would commence on the date in which the vessel begins to transit to the permitted area and end on the date in which the vessel either transits away from the permitted area or when operations pertinent to the permitted activity are completed. The corresponding operations column would contain a *brief* description of the operations for each day listed in the date column noting activities such as the major work stoppages, no data acquired, and other pertinent activities. This may be submitted as a digital Word document or as an Excel spreadsheet;

iii. A PDF or, preferably, a GeoPDF or shape file indicating the areal extent of the data *actually acquired*;

iv. The start and finish dates on which the actual geophysical exploration or scientific research activities were performed;

v. A narrative summary of any: (a) hydrocarbon slicks or environmental hazards observed and (b) adverse effects of the geophysical exploration or scientific research activities on the environment, aquatic life, archaeological resources, or other uses of the area in which the activities were conducted;

vi. The estimated date on which the processed or interpreted data or information will be available for inspection by BOEM;

vii. A CD or DVD containing a *single*, final edited navigational data file. Shot point locations should be provided in both latitude/longitude degrees and in x, y coordinates. The single navigational file should be in either SEG-P1 or UKOOA P190 format for either two-dimensional or three-dimensional geophysical data. Two-dimensional data should be decimated to the first, last, and every tenth shot point. Three-dimensional data should be decimated at every line and first and last CDP. A single ESRI shape file containing navigational data and one shape file with post-plot locations of any geophysical equipment on the seafloor (i.e., ocean bottom nodes, CSEM, etc.) should also be submitted if applicable;

viii. Identification of geocentric ellipsoid (NAD 27 or NAD 83) used as a reference for the data or sample locations; and

ix. Such other descriptions of the activities conducted as may be specified by the Supervisor.

2. In the Alaska and Pacific OCS Regions:

i. The total number of 2D line miles or square miles for 3D surveys and the number of OCS blocks of geophysical data acquired, as well as total number of traverse miles for the survey;

ii. A *weekly report*.

iii. Chart(s), map(s), or plat(s) depicting the areas in which any exploration or scientific research activities were conducted. These graphics must clearly indicate the location of the activities so that the data produced from the activities can be accurately located and identified;

iv. The start and finish dates on which the actual geophysical exploration or scientific research activities were performed;

v. A narrative summary of any: (a) hydrocarbon slicks or environmental hazards observed, (b) adverse effects of the geophysical exploration or scientific research activities on the environment, aquatic life, archaeological resources, or other uses of the area in which the activities were conducted, and (c) safety incidents;

vi. The estimated date on which the processed or interpreted data or information will be available for inspection by BOEM;

vii. A final edited navigation file on suitable storage medium of all data or sample locations in latitude/longitude degrees including datum used. The navigation for 2D lines should include line name and location for the first, last, and every tenth SP. For 3D surveys, please submit a

navigation file for the acquired track lines that includes the location of the first and last SP and/or the corner locations for the area acquired. Contact the G&G permitting office for the specific navigation required for this permitted activity. The digital file is to be formatted in standard SEG-P1, UKOOA P1-90 or other current, standard industry format, coded in ASCII. A printed data listing and a format statement are to be included;

viii. Identification of geocentric ellipsoid (NAD 83) used as a reference for the data or sample locations; and

ix. Such other descriptions of the activities conducted as may be specified by the Supervisor.

C. The Final Report is a stand-alone document containing all the pertinent information regarding the permit.

Section IV. Submission, Inspection, and Selection of Geophysical Data and Information

A. The permittee must notify the Supervisor, in writing, when the permittee has completed the initial processing and interpretation of any geophysical data and information collected under an exploration permit or a scientific research permit that involves developing data and information for proprietary use or sale. If the Supervisor asks if the permittee has further processed or interpreted any geophysical data and information collected under a permit, the permittee must respond within 30 days. If further processing of the data and information is conducted, it is the responsibility of the permittee to keep the most current resulting products available in the event the Supervisor requests the current status of data processing. At any time within 10 years after receiving notification of the completion of the acquisition activities conducted under the permit, the Supervisor may request that the permittee submit for inspection and possible retention all or part of the geophysical data, processed geophysical information, and interpreted geophysical information.

B. The Supervisor will have the right to inspect and select the geophysical data, processed geophysical information, or interpreted geophysical information. This inspection will be performed on the permittee's premises unless the Supervisor requests that the permittee submit the data or information to the Supervisor for inspection. Such submission must be within 30 days following the receipt of the Supervisor's request unless the Supervisor authorizes a later delivery date. If the inspection is done on the permittee's premises, the permittee must submit the geophysical data or information selected within 30 days following receipt of the Supervisor's request, unless the Supervisor authorizes a longer period of time for delivery. The data or information requested for inspection or selected by the Supervisor must be submitted regardless of whether the permittee and the Government have or have not concluded an agreement for reimbursement. If the Supervisor decides to retain all or a portion of the geophysical data or information, the Supervisor will notify the permittee, in writing, of this decision.

C. In the event that a third party obtains geophysical data, processed geophysical information, or interpreted geophysical information from a permittee, or from another third party, by sale, trade, license agreement, or other means:

1. The third party recipient of the data and information assumes the obligations under this section except for notification of initial processing and interpretation of the data and information and is subject to the penalty provisions of 30 CFR Part 550, Subpart N; and

2. A permittee or third party that sells, trades, licenses, or otherwise provides the data and information to a third party must advise the recipient, in writing, that accepting these obligations is a condition precedent of the sale, trade, license, or other agreement; and

3. Except for license agreements, a permittee or third party that sells, trades, or otherwise provides data and information to a third party must advise the Supervisor in writing within 30 days of the sale, trade, or other agreement, including the identity of the recipient of the data and information; or

4. With regard to license agreements, a permittee or third party that licenses data and information to a third party, within 30 days of a request by the Supervisor, must advise the Supervisor, in writing, of the license agreement, including the identity of the recipient of the data and information.

D. Each submission of geophysical data, processed geophysical information, and interpreted geophysical information must contain, unless otherwise specified by the Supervisor, the following:

1. An accurate and complete record of each geophysical survey conducted under the permit, including digital navigational data and final location maps of all surveys;

2. All seismic data developed under a permit presented in a format and of a quality suitable for processing;

3. Processed geophysical information derived from seismic data with extraneous signals and interference removed, presented in a format and of a quality suitable for interpretive evaluation, reflecting state-of-the-art processing techniques; and

4. Other geophysical data, processed geophysical information, and interpreted geophysical information obtained from, but not limited to, shallow and deep subbottom profiles, bathymetry, side-scan sonar, gravity, magnetic, and electrical surveys, and special studies such as refraction, shear wave, and velocity surveys.

Section V. Reimbursement to Permittees

A. After the delivery of geophysical data, processed geophysical information, and interpreted geophysical information requested by the Supervisor in accordance with subsection IV of this permit, and upon receipt of a request for reimbursement and a determination by BOEM that the requested reimbursement is proper, BOEM will reimburse the permittee or third party for the reasonable costs of reproducing the submitted data and information at the permittee's or third party's lowest rate or at the lowest commercial rate established in the area, whichever is less.

B. If the processing was in a form and manner other than that used in the normal conduct of the permittee's business at BOEM's request, BOEM will reimburse the permittee or third party for the reasonable costs of processing or reprocessing such data. Requests for reimbursement must identify processing costs separate from acquisition costs.

C. The permittee or third party will not be reimbursed for the costs of acquiring or interpreting geophysical information.

D. Data and information required under section IV.D.1. of this permit are not considered to be geophysical data or processed geophysical information and must be provided by the permittee at no cost to the Government.

Section VI. Disclosure of Data and Information to the Public

A. BOEM will make data and information submitted by a permittee available in accordance with the requirements and subject to the limitations of the Freedom of Information Act (5 U.S.C. 552) and the implementing regulations (43 CFR Part 2), the requirements of the Act, and the regulations contained in 30 CFR Parts 550 and 250 (Oil and Gas and Sulphur Operations in the Outer Continental Shelf), 30 CFR Parts 551 and 251, and 30 CFR Parts 552 and 252 (Outer Continental Shelf (OCS) Oil and Gas Information Program).

B. Except as specified in this section, or Section VIII, or in 30 CFR Parts 550, 552, 250, and 252, no data or information determined by BOEM or the Bureau of Safety and Environmental Enforcement to be exempt from public disclosure under subsection A of this section will be provided to any affected State or be made available to the executive of any affected local government or to the public, unless the permittee or third party and all persons to whom such permittee has sold, traded, or licensed the data or information under promise of confidentiality agree to such an action.

C. Geophysical data and processed or interpreted geophysical information submitted under a permit, and retained by BOEM, will be disclosed as follows:

1. Except for deep stratigraphic tests, BOEM will make available to the public geophysical data 50 years after the date of issuance of the permit under which the data were collected (see 30 CFR 551.14).

2. Except for deep stratigraphic tests, BOEM will make available to the public processed geophysical information and interpreted geophysical information 25 years after the date of issuance of the permit under which the original data were collected (see 30 CFR 551.14).

3. BOEM will make available to the public all geophysical data and information and geophysical interpretations related to a deep stratigraphic test, at the earlier of the following times: (a) 25 years after the completion of the test, or (b) for a lease sale held after the test well is completed, 60 calendar days after the Department of the Interior executes the first lease for a block, any part of which is within 50 geographic miles (92.6 kilometers) of the site of the completed test.

D. All line-specific preplot or postplot plat(s), and navigation tapes, including but not limited to seismic survey traverses and shotpoint locations, submitted as a requirement of 30 CFR 551.7, 551.l2, or 251.7, will be considered as "PROPRIETARY INFORMATION." Such information will not be made available to the public without the consent of the permittee for a period of 25 years from the date of issuance of the permit, unless the Director, BOEM, determines that earlier release is necessary for the proper development of the area permitted.

E. All other information submitted as a requirement of 30 CFR 551.8 and determined by BOEM to be exempt from public disclosure will be considered as "PROPRIETARY." Such data and information will not be made available to the public without the consent of the permittee for a period of up to 25 years from the date of issuance of the permit as addressed in 30 CFR 551.14, unless the Director, BOEM, determines that earlier release is necessary for the proper development of the area permitted. The executed permit will be considered as "PROPRIETARY" except the public information copy, which will be available to the public upon request and on BOEM's website.

F. The identities of third party recipients of data and information collected under a permit will be kept confidential. The identities will not be released unless the permittee and the third parties agree to the disclosure.

Section VII. Disclosure to Independent Contractors

BOEM reserves the right to disclose any data or information acquired from a permittee to an independent contractor or agent for the purpose of reproducing, processing, reprocessing, or interpreting such data or information. When practicable, BOEM will advise the permittee who provided the data or information of intent to disclose the data or information to an independent contractor or agent. BOEM's notice of intent will afford the permittee a period of not less than 5 working days within which to comment on the intended action. When BOEM so advises a permittee of the intent to disclose data or information to an independent contractor or agent, all other owners of such data or information will be deemed to have been notified of BOEM's intent. Prior to any such disclosure, the contractor or agent will be required to execute a written commitment not to sell, trade, license, or disclose any data or information to anyone without the express consent of BOEM.

Section VIII. Sharing of Information with Affected States

A. At the time of soliciting nominations for the leasing of lands within 3 geographic miles of the seaward boundary of any coastal State, BOEM, pursuant to the provisions of 30 CFR Parts 552.7 252.7 and subsections 8(g) and 26(e) (43 U.S.C. 1337(g) and 1352(e)) of the Act, will provide the Governor of the State (or the Governor's designated representative) the following information that has been acquired by BOEM on such lands proposed to be offered for leasing:

1. All information on the geographical, geological, and ecological characteristics of the areas and regions proposed to be offered for leasing;

2. An estimate of the oil and gas reserves in the area proposed for leasing; and

3. An identification of any field, geological structure, or trap located within 3 miles of the seaward boundary of the State.

B. After the time of receipt of nominations for any area of the OCS within 3 geographic miles of the seaward boundary of any coastal State and Area Identification in accordance with the provisions of Subparts D and E of 30 CFR Part 556, BOEM, in consultation with the Governor of the State (or the Governor's designated representative), will determine whether any tracts being given further consideration for leasing may contain one or more oil or gas reservoirs underlying both the OCS and lands subject to the jurisdiction of the State.

C. At any time prior to a sale, information acquired by BOEM that pertains to the identification of potential and/or proven common hydrocarbon-bearing areas within 3 geographic miles of the seaward boundary of any such State will be shared, upon request by the Governor and pursuant to the provisions of 30 CFR Parts 552.7 and 252.7 and subsections 8(g) and 26(e) of the Act, with the Governor of such State (or the Governor's designated representative).

D. Knowledge obtained by a State official who receives information under subsections A, B, and C of this section will be subject to the requirements and limitations of the Act and the regulations contained in 30 CFR Parts 550, 551, 552, 250, 251, and 252.

Section IX. Permit Modifications

The Department will have the right at any time to modify or amend any provisions of this permit, except that the Department will not have such right with respect to the provisions of Sections VI, VII, and VIII hereof, unless required by an Act of Congress.

IN WITNESS WHEREOF the parties have executed this permit and it will be effective as of the date of signature by the Supervisor.

PERMITTEE:

Tracy W. Albert

(Signature of Permittee)

Tracy W. Albert

(Type or Print Name of Permittee)

Sr. Regulatory Specialist

(Title)

11/10/2020

(Date)

THE UNITED STATES OF AMERICA:

DONALD MACLAY Digitally signed by DONALD MACLAY Date: 2021.03.03 13:30:21 -06'00'

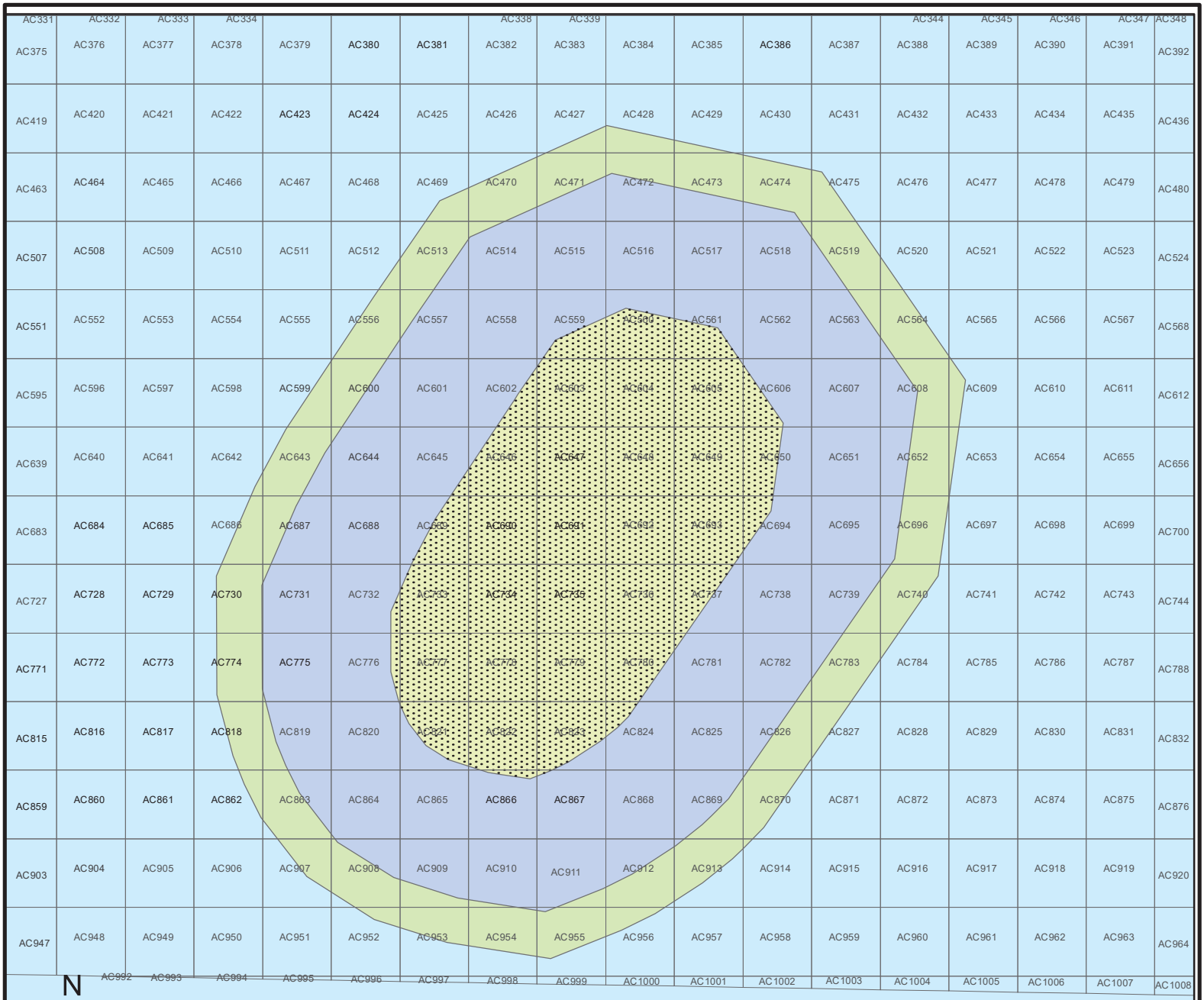
(Signature of Regional Supervisor)

For Matthew G. Wilson

(Type or Print Name of Regional Supervisor)

March 3, 2021

(Date)



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

MAP INFORMATION

Legend

- Active
- HBP
- Active
- HBP
- GoM OCS Block (open)
- Leopard 1st Design-Receivers-Location
- Leopard_VR_100520-Leopard Node Polygon x1.5
- Leopard_VR_100520-Leopard Source Polygon x 1.5
- Leopard Operating Area

MAP SCALE

0 1 2 4 6 8 10
Kilometers

1:406,088
Print size: 8.5"x11" (ANSI A)

SHELL EXPLORATION & PRODUCTION COMPANY

Leopard OBN Survey

Aliminos Canyon Area

GEODETIC PARAMETERS

Horizontal Coordinate Reference System
CRS name (ESRI): NAD 1927 BLM Zone 15N
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Geodetic datum: North American 1927
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RESTRICTED

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

LETTER OF AUTHORIZATION

Shell Offshore Inc. and its designees are hereby authorized under section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371(a)(5)(A)) to take marine mammals incidental to geophysical survey activities in the Gulf of Mexico, subject to the provisions of the MMPA and the Regulations Governing Taking Marine Mammals Incidental to Geophysical Survey Activities in the Gulf of Mexico (50 CFR Part 217, Subpart S) (Regulations).

1. This Letter of Authorization (LOA) is valid from July 15, 2021, to August 15, 2021.

2. This LOA authorizes take incidental to the specified geophysical survey activities (LISS-TPS survey of Lease Block AC 690 and surrounding lease blocks in the Leopard development area) described in the LOA request.

3. General Conditions

(a) A copy of this LOA must be in the possession of the Holder of the Authorization (Holder), vessel operator, other relevant personnel, the lead protected species observer (PSO), and any other relevant designees operating under the authority of the LOA.

(b) The species and/or stocks authorized for taking are listed in Table 1. Authorized take, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 1.

(c) The taking by serious injury or death of any of the species listed in Table 1 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized amounts listed in Table 1 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) The Holder must instruct relevant vessel personnel with regard to the authority of the protected species monitoring team (PSO team), and must ensure that relevant vessel personnel and PSO team participate in a joint onboard briefing, led by the vessel operator and lead PSO, prior to beginning work to ensure that responsibilities, communication procedures, protected species monitoring protocols, operational procedures, and LOA requirements are clearly understood. This briefing must be repeated when relevant new personnel join the survey operations before work involving those personnel commences.

(e) The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source must be avoided. Notified operational capacity (i.e., total array volume) (not including redundant backup airguns) must not be exceeded during the survey,

except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be communicated to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(f) PSO requirements:

i. LOA-holders must use independent, dedicated, qualified PSOs, meaning that the PSOs must be employed by a third-party observer provider, must have no tasks other than to conduct observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards), and must be qualified pursuant to section 5(a) of this LOA. Acoustic PSOs are required to complete specialized training for operating passive acoustic monitoring (PAM) systems and are encouraged to have familiarity with the vessel on which they will be working. PSOs may act as both acoustic and visual observers (but not simultaneously), so long as they demonstrate that their training and experience are sufficient to perform each task.

ii. The Holder must submit PSO resumes for NMFS review and approval prior to commencement of the survey. Resumes should include dates of training and any prior NMFS approval, as well as dates and description of last experience, and must be accompanied by information documenting successful completion of an acceptable training course. NMFS is allowed one week to approve PSOs from the time that the necessary information is received by NMFS, after which PSOs meeting the minimum requirements will automatically be considered approved.

iii. At least one visual PSO and two acoustic PSOs aboard each acoustic source vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, with no more than eighteen months elapsed since the conclusion of the at-sea experience. One visual PSO with such experience must be designated as the lead for the entire PSO team. The lead must coordinate duty schedules and roles for the PSO team and serve as the primary point of contact for the vessel operator. (Note that the responsibility of coordinating duty schedules and roles may instead be assigned to a shore-based, third-party monitoring coordinator.) To the maximum extent practicable, the lead PSO must devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

4. Mitigation Requirements

(a) Visual monitoring requirements:

i. During survey operations (i.e., any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset).

ii. Visual monitoring must begin not less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

iii. Visual PSOs must coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and must conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

iv. Visual PSOs must immediately communicate all observations of marine mammals to the on-duty acoustic PSO, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

v. Any observations of marine mammals by crew members aboard any vessel associated with the survey must be relayed to the PSO team.

vi. During good conditions (e.g., daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs must conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

vii. Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. NMFS may grant an exception for LOA applicants that demonstrate such a "two hours on/one hour off" duty cycle is not practicable, in which case visual PSOs will be subject to a maximum of four consecutive hours on watch followed by a break of at least two hours between watches. Combined observational duties (visual and acoustic but not at the same time) must not exceed 12 hours per 24-hour period for any individual PSO.

(b) Acoustic monitoring requirements:

i. All source vessels must use a towed PAM system at all times when operating in waters deeper than 100 m, which must be monitored by a minimum of one acoustic PSO beginning at least 30 minutes prior to ramp-up, at all times during use of the acoustic source, and until one hour

after use of the acoustic source ceases. "PAM system" refers to calibrated hydrophone arrays with full system redundancy to detect, identify, and estimate distance and bearing to vocalizing cetaceans, coupled with appropriate software to aid monitoring and listening by a PAM operator skilled in bioacoustics analysis and computer system specifications capable of running appropriate software. The PAM system must have at least one calibrated hydrophone (per each deployed hydrophone type and/or set) sufficient for determining whether background noise levels on the towed PAM system are sufficiently low to meet performance expectations. Applicants must provide a PAM plan including description of the hardware and software proposed for use prior to proceeding with any survey where PAM is required.

ii. Acoustic PSOs must immediately communicate all detections of marine mammals to visual PSOs (when visual PSOs are on duty), including any determination by the PSO regarding species identification, distance, and bearing, and the degree of confidence in the determination.

iii. Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches, and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic but not at the same time) must not exceed 12 hours per 24-hour period for any individual PSO.

iv. Survey activity may continue for 30 minutes when the PAM system malfunctions or is damaged, while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring during daylight hours only under the following conditions:

(A) Sea state is less than or equal to BSS 4;

(B) No marine mammals (excluding delphinids) detected solely by PAM in the applicable exclusion zone in the previous two hours;

(C) NMFS is notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system; and

(D) Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

(c) PSOs must establish and monitor applicable exclusion and buffer zones. These

zones must be based upon the radial distance from the edges of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source (i.e., anytime the acoustic source is active, including ramp-up), occurrence of marine mammals within the relevant buffer zone (but outside the exclusion zone) should be communicated to the operator to prepare for the potential shutdown of the acoustic source.

i. Two exclusion zones are defined, depending on the species and context. A standard exclusion zone encompassing the area at and below the sea surface out to a radius of 500 meters from the edges of the airgun array (0-500 m) is defined. For special circumstances (defined at 4(e)(v) of this LOA), the exclusion zone encompasses an extended distance of 1,500 meters (0-1,500 m).

ii. During pre-start clearance monitoring (i.e., before ramp-up begins), the buffer zone acts as an extension of the exclusion zone in that observations of marine mammals within the buffer zone would also preclude airgun operations from beginning (i.e., ramp-up). For all marine mammals (except where superseded by the extended 1,500-m exclusion zone), the buffer zone encompasses the area at and below the sea surface from the edge of the 0-500 meter exclusion zone out to a radius of 1,000 meters from the edges of the airgun array (500-1,000 m). The buffer zone is not applicable when the exclusion zone is greater than 500 meters, i.e., the observational focal zone is not increased beyond 1,500 meters.

(d) A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total active array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. A 30-minute pre-start clearance observation period must occur prior to the start of ramp-up. The Holder must adhere to the following pre-start clearance and ramp-up requirements:

i. The operator must notify a designated PSO of the planned start of ramp-up as agreed upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up.

ii. Ramp-ups must be scheduled so as to minimize the time spent with source activated prior to reaching the designated run-in.

iii. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed.

iv. Ramp-up must not be initiated if any marine mammal is within the applicable exclusion or buffer zone. If a marine mammal is observed within the exclusion zone or the buffer zone during the 30-minute pre-start

clearance period, ramp-up must not begin until the animal(s) has been observed exiting the zones or until an additional time period has elapsed with no further sightings (15 minutes for small delphinids and 30 minutes for all other species).

v. Ramp-up must begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Total duration must not be less than 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed.

vi. Ramp-up must cease and the source shut down upon observation of marine mammals within the applicable exclusion zone. Once ramp-up has begun, observations of marine mammals within the buffer zone do not require shutdown.

vii. Ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections of a marine mammal other than delphinids in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at night where operational planning cannot reasonably avoid such circumstances.

viii. If the acoustic source is shut down for brief periods (i.e., less than 30 minutes) for reasons other than implementation of prescribed mitigation (e.g., mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant visual and/or acoustic observation and no visual or acoustic detections of any marine mammal have occurred within the applicable exclusion zone. For any longer shutdown, pre-start clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (e.g., BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation maintained, pre-start clearance watch is not required.

ix. Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require the pre-start clearance observation period.

(e) Shutdown requirements:

i. Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source pursuant to the requirements of this subpart.

ii. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to

ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch.

iii. When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs.

iv. When the airgun array is active (i.e., anytime one or more airguns is active, including during ramp-up) and (1) a marine mammal appears within or enters the applicable exclusion zone and/or (2) a marine mammal (excluding delphinids) is detected acoustically and localized within the applicable exclusion zone, the acoustic source must be shut down. When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation.

v. The extended 1,500-m exclusion zone must be applied upon detection (visual or acoustic) of a baleen whale, sperm whale, beaked whale, or *Kogia* spp. within the zone.

vi. Shutdown requirements are waived for dolphins of the following genera: *Tursiops*, *Stenella*, *Steno*, and *Lagenodelphis*. If a delphinid is visually detected within the exclusion zone, no shutdown is required unless the PSO confirms the individual to be of a genus other than those listed above, in which case a shutdown is required. Acoustic detection of delphinids does not require shutdown.

vii. If there is uncertainty regarding identification or localization, PSOs may use best professional judgment in making the decision to call for a shutdown.

viii. Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable exclusion zone or following a 30-minute clearance period with no further detection of the marine mammal(s).

(f) *Entanglement avoidance*. To avoid the risk of entanglement, if conducting surveys using ocean-bottom nodes or similar gear the Holder must:

i. Use negatively buoyant coated wire-core tether cable;

ii. Retrieve all lines immediately following completion of the survey; and

iii. Attach acoustic pingers directly to the coated tether cable; acoustic releases should not be used.

(g) *Vessel strike avoidance*. The Holder must adhere to the following requirements:

i. Vessel operators and crews must maintain a vigilant watch for all marine mammals and must slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel, which shall be defined according to the parameters stated in this subsection. Visual observers monitoring the vessel strike avoidance zone may be third-party observers (i.e., PSOs) or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a baleen whale, sperm whale, or other marine mammal;

ii. Vessel speeds must be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of marine mammals are observed near a vessel;

iii. All vessels must maintain a minimum separation distance of 500 m from baleen whales;

iv. All vessels must maintain a minimum separation distance of 100 m from sperm whales;

v. All vessels must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel; and

vi. When marine mammals are sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distance, e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area. If marine mammals are sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This does not apply to any vessel towing gear or any vessel that is navigationally constrained.

vii. These requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply.

5. <u>Monitoring Requirements</u>

(a) PSO qualifications:

i. PSOs must successfully complete relevant, acceptable training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

ii. PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must be submitted to NMFS and shall include written justification. Requests will be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to:

(A) secondary education and/or experience comparable to PSO duties;

(B) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or

(C) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

(b) *Equipment*. The Holder is required to:

i. Provide PSOs with bigeye binoculars (e.g., 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality solely for PSO use. These must be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel.

ii. For each vessel required to use a PAM system, provide a PAM system that has been verified and tested by an experienced acoustic PSO who will be using it during the trip for which monitoring is required;

iii. Work with the selected third-party observer provider to ensure PSOs have all equipment (including backup equipment) needed to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals. (Equipment specified in A. through G. below may be provided by an individual PSO, the third-party observer provider, or the LOA-holder, but the LOA-holder is responsible for ensuring PSOs have the proper equipment required to perform the duties specified herein.) Such equipment, at a minimum, must include:

(A) Reticle binoculars (e.g., 7 x 50) of appropriate quality (at least one

per PSO, plus backups);

(B) Global Positioning Unit (GPS) (plus backup);

(C) Digital camera with a telephoto lens (the camera or lens should also have an image stabilization system) that is at least 300 mm or equivalent on a full-frame single lens reflex (SLR) (plus backup);

(D) Compass (plus backup);

(E) Radios for communication among vessel crew and PSOs (at least one per PSO, plus backups); and

(F) Any other tools necessary to adequately perform necessary PSO tasks.

(c) *Data collection*. PSOs must use standardized electronic data forms. PSOs must record detailed information about any implementation of mitigation requirements, including the distance of marine mammals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up or activation of the acoustic source. If required mitigation was not implemented, PSOs must record a description of the circumstances. At a minimum, the following information should be recorded:

i. Vessel names (source vessel and other vessels associated with survey), vessel size and type, maximum speed capability of vessel, port of origin, and call signs;

ii. PSO names and affiliations;

iii. Dates of departures and returns to port with port name;

iv. Dates of and participants in PSO briefings;

v. Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;

vi. Vessel location (latitude/longitude) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;

vii. Vessel location at 30-second intervals (if software capability allows) or 5-minute intervals (if location must be manually recorded);

viii. Vessel heading and speed at beginning and end of visual PSO duty shifts

and upon any line change;

ix. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly), including Beaufort sea state and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;

x. Vessel location when environmental conditions change significantly;

xi. Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions change (e.g., vessel traffic, equipment malfunctions);

xii. Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in an array, tow depth of an acoustic source, and any other notes of significance (i.e., pre-start clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.); and

xiii. Upon visual observation of a marine mammal, the following information:

(A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);

(B) PSO who sighted the animal and PSO location (including height above water) at time of sighting;

(C) Time of sighting;

(D) Vessel coordinates at time of sighting;

(E) Water depth;

(F) Direction of vessel's travel (compass direction);

(G) Speed of the vessel(s) from which the observation was made;

(H) Direction of animal's travel relative to the vessel;

(I) Pace of the animal;

(J) Estimated distance to the animal (and method of estimating distance) and its heading relative to vessel at initial sighting;

(K) Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified), PSO confidence in identification,

and the composition of the group if there is a mix of species;

(L) Estimated number of animals (high/low/best);

(M) Estimated number of animals by cohort (adults, juveniles, group composition, etc.);

(N) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);

(O) Detailed behavior observations (e.g., number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior), including an assessment of behavioral responses to survey activity;

(P) Animal's closest point of approach (CPA) and/or closest distance from any element of the acoustic source;

(Q) Platform activity at time of sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other); and

(R) Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up) and time and location of the action.

xiv. Upon acoustic detection of a marine mammal using a PAM system, the following information:

(A) An acoustic encounter identification number, and whether the detection was linked with a visual sighting;

(B) Date and time when first and last heard;

(C) Types and nature of sounds heard (e.g., clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal); and

(D) Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, and any other notable information.

6. Reporting Requirements

(a) Annual reporting:

i. The Holder must submit a summary report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the LOA, whichever comes sooner, and must include all information described above under section 5(c) of this LOA. If an issued LOA is valid for greater than one year, the summary report must be submitted on an annual basis.

ii. The report must describe activities conducted and sightings of marine mammals, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities, and information regarding locations where the acoustic source was used). In addition to the report, all raw observational data must be made available to NMFS.

iii. For operations requiring the use of PAM, the report must include a validation document concerning the use of PAM, which should include necessary noise validation diagrams and demonstrate whether background noise levels on the PAM deployment limited achievement of the planned detection goals. Copies of any vessel self-noise assessment reports must be included with the report.

iv. The Holder must provide geo-referenced time-stamped vessel tracklines for all time periods in which airguns (full array or single) were operating. Tracklines must include points recording any change in airgun status (e.g., when the airguns began operating, when they were turned off). GIS files must be provided in ESRI shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates must be referenced to the WGS84 geographic coordinate system.

v. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring.

vi. A final report must be submitted within 30 days following resolution of any comments on the draft report.

(b) *Comprehensive reporting*. The Holder must contribute to the compilation and analysis of data for inclusion in an annual synthesis report addressing all data collected and reported through annual reporting in each calendar year. The synthesis period shall include all annual reports deemed to be final by NMFS in a

given one-year reporting period. The report must be submitted to NMFS within 90 days following the end of a given one-year reporting period.

(c) Reporting of injured or dead marine mammals:

i. In the event that personnel involved in the survey activities discover an injured or dead marine mammal, the Holder must report the incident to the Office of Protected Resources (OPR), NMFS and to the Southeast Regional Stranding Network as soon as feasible. The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);

(B) Species identification (if known) or description of the animal(s) involved;

(C) Condition of the animal(s) (including carcass condition if the animal is dead);

(D) Observed behaviors of the animal(s), if alive;

(E) If available, photographs or video footage of the animal(s); and

(F) General circumstances under which the animal was discovered.

ii. In the event of a ship strike of a marine mammal by any vessel involved in the survey activities, the LOA-holder must report the incident to OPR, NMFS and to the Southeast Regional Stranding Network as soon as feasible. The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the incident;

(B) Species identification (if known) or description of the animal(s) involved;

(C) Vessel's speed during and leading up to the incident;

(D) Vessel's course/heading and what operations were being conducted (if applicable);

(E) Status of all sound sources in use;

(F) Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;

(G) Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;

(H) Estimated size and length of animal that was struck;

(I) Description of the behavior of the marine mammal immediately preceding and following the strike;

(J) If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;

(K) Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and

(L) To the extent practicable, photographs or video footage of the animal(s).

7. Actions to Minimize Additional Harm to Live-Stranded (or Milling) Marine Mammals

(a) In the event of a live stranding (or near-shore atypical milling) event within 50 km of the survey operations, where the NMFS stranding network is engaged in herding or other interventions to return animals to the water, the Director of OPR, NMFS (or designee) will advise the Holder of the need to implement shutdown procedures for all active acoustic sources operating within 50 km of the stranding. Shutdown procedures for live stranding or milling marine mammals include the following:

i. If at any time, the marine mammal(s) die or are euthanized, or if herding/intervention efforts are stopped, the Director of OPR, NMFS (or designee) will advise the LOA-holder that the shutdown around the animals' location is no longer needed.

ii. Otherwise, shutdown procedures will remain in effect until the Director of OPR, NMFS (or designee) determines and advises the LOA-holder that all live animals involved have left the area (either of their own volition or following an intervention).

iii. If further observations of the marine mammals indicate the potential for re-stranding, additional coordination with the LOA-holder will be required to determine what measures are necessary to minimize that likelihood (e.g., extending the shutdown or moving operations farther away) and to implement those measures as appropriate.

(b) If NMFS determines that the circumstances of any marine mammal stranding

found in the vicinity of the activity suggest investigation of the association with survey activities is warranted, and an investigation into the stranding is being pursued, NMFS will submit a written request to the LOA-holder indicating that the following initial available information must be provided as soon as possible, but no later than 7 business days after the request for information. In the event that the investigation is still inconclusive, the investigation of the association of the survey activities is still warranted, and the investigation is still being pursued, NMFS may provide additional information requests, in writing, regarding the nature and location of survey operations prior to the time period above.

i. Status of all sound source use in the 48 hours preceding the estimated time of stranding and within 50 km of the discovery/notification of the stranding by NMFS; and

ii. If available, description of the behavior of any marine mammal(s) observed preceding (i.e., within 48 hours and 50 km) and immediately after the discovery of the stranding.

8. This Authorization may be modified, suspended or revoked if the Holder fails to abide by the conditions prescribed herein (including, but not limited to, failure to comply with monitoring or reporting requirements), or if NMFS determines: (1) the authorized taking is likely to have or is having more than a negligible impact on the species or stocks of affected marine mammals, or (2) the prescribed measures are likely not or are not effecting the least practicable adverse impact on the affected species or stocks and their habitat.

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Catherine Marzin
Acting Director,
Office of Protected Resources,
National Marine Fisheries Service.

Table 1. Authorized Incidental Take.

Common name	Scientific name	Level A harassment	Level B harassment
Bryde's whale	*Balaenoptera edeni*	0	0
Sperm whale	*Physeter macrocephalus*	0	347
Pygmy/Dwarf sperm whale	*Kogia* spp.	4	103
Beaked whales	*Ziphius cavirostris*/ *Mesoplodon* spp.	0	1,990
Rough-toothed dolphin	*Steno bredanensis*	0	270
Bottlenose dolphin	*Tursiops truncatus*	0	511
Clymene dolphin	*Stenella clymene*	0	1,001
Atlantic spotted dolphin	*Stenella frontalis*	0	213
Pantropical spotted dolphin	*Stenella attenuata*	0	4,946
Spinner dolphin	*Stenella longirostris*	0	152
Striped dolphin	*Stenella coeruleoalba*	0	347
Fraser's dolphin	*Lagenodelphis hosei*	0	125
Risso's dolphin	*Grampus griseus*	0	180
Melon-headed whale	*Peponocephala electra*	0	552
Pygmy killer whale	*Feresa attenuata*	0	169
False killer whale	*Pseudorca crassidens*	0	222
Killer whale	*Orcinus orca*	0	7
Short-finned pilot whale	*Globicephala macrorhynchus*	0	216

MAGSEIS FAIRFIELD: SHELL LEOPARD OBN SURVEY

Environmental Management Plan: Marine Mammal and Sea Turtle Monitoring, Mitigation, and Reporting

Version 5
Version 5
July 16, 2021

rpsgroup.com

MAGSEIS FAIRFIELD LEOPARD OBN T20-004: TEXAS STATE WATER TESTING

Environmental Management Plan: Marine Mammal and Sea Turtle Monitoring, Mitigation, and Reporting

With reference to the Biological Opinion (BO) issued by the National Marine Fisheries Service on March 13, 2020 & BOEM T20-004.

Revision		
Date	**Version**	**Revision made**
4/23/2021	1	First Draft issued to MFF
5/24/2021	2	Update to Section 9.1.2 with new guidance from NMFS and NSEE
6/1/2021	3	Update to Section 5.2.2 and 9.1.2 with new guidance from NMFS and NSEE
7/11/2021	4	Update to Section 8.1 turtle pause changed from 12 shots to 6 shots
7/16/2021	5	Update to Section 8.3 Ramp-up for TPS source
7/17/2021	1_1	Updated with LOA requirements for TX state waters. 1500 m mitigation zones. No night time operations

Approval for issue
Stephanie Milne

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1 INTRODUCTION

Magseis Fairfield (MFF) has been contracted by Shell to conduct a 3D ocean bottom node (OBN) seismic survey within the Gulf of Mexico. The details of the survey activities are provided in the survey plan application.

In an effort to minimize the potential impacts of seismic operations on certain protected species, including marine mammals and sea turtles, the Bureau of Ocean Energy Management (BOEM), the National Marine Fisheries Service (NMFS), and the Bureau of Safety and Environmental Enforcement (BSEE), have outlined monitoring, mitigation, and reporting procedures that survey operators and permit holders are expected to implement during their seismic survey operations.

1.1 Applicable Regulatory Documents and Permits

Protected species monitoring, mitigation and reporting procedures that are applicable to the OBN survey are contained in the following regulatory documents:

1. The Biological Opinion (BO) issued by the NMFS on March 13, 2020, where Protected Species Observer (PSO) procedures are outlined in detail in Appendix A

2. The survey permit issued by BOEM, permit T20-004

This document, the Environmental Management Plan (EMP), prepared by RPS on behalf of MFF, describes how monitoring, mitigation, and reporting measures for protected species will be executed during the OBN program to maintain compliance with the regulatory requirements in the 2020 Gulf of Mexico Biological Opinion and its appendices and the BOEM survey permit T20-004.

2 MARINE PROTECTED SPECIES

Marine protected species or protected species refers to any marine species for which dedicated monitoring and mitigation procedures will be implemented, including:

- All marine mammals
- All sea turtles
- Gulf sturgeon, oceanic white-tipped shark, giant manta ray*

*Note that strike avoidance procedures apply to these ESA listed species but monitoring and sound source mitigation procedures do not need to be implemented.

3 PROTECTED SPECIES OBSERVERS AND PASSIVE ACOUSTIC MONITORING OPERATORS

3.1 Staffing Plan

A team of three Protected Species Observers (PSOs), supplied by RPS, will be onboard each source vessel to undertake day-time visual watches, implement mitigations, conduct data collection and reporting in accordance with the BO and the survey permit.

A team of four Passive Acoustic Monitoring (PAM) Operators will conduct 24-hour PAM monitoring, implement mitigations, and conduct data collection and reporting in accordance with the BO and the survey permit with three working remotely from shore and one onboard the vessel.

3.2 Roles and Responsibilities

Lead PSO / PAM Tech / Onboard Team Lead

- Coordinate and oversee PAM and PSO Operations and ensure compliance with monitoring requirements
- Oversee all deployments and retrievals of the hydrophone cable
- Maintain and troubleshoot the PAM system hardware and software
- Visually monitor, detect, and identify protected species, as well as determine distance from source.
- Acoustically monitor, detect, and identify protected species, as well as determine distance from source, as needed during remote PAM downtime.
- Record and report protected species sightings, survey activities, and environmental conditions, per regulations
- Monitor and advise on sound source and vessel operations for compliance with the environmental requirements for the survey
- Communicate with the crew to implement mitigation actions as required by environmental protocols
- Participate in daily operation meeting with crew when appropriate

PSO

- Visually monitor, detect, and identify protected species
- Record and report according to survey plan
- Monitor and advise on sound source and vessel operations for compliance with the environmental requirements for the survey plan
- Communicate with the crew to implement mitigation actions as required by environmental protocols
- Participate in daily operation meeting with crew when appropriate

Remote PAM Operator

- Acoustically monitor, detect, and identify marine mammals and determine distance to source
- Record and report marine mammal sightings, survey activities and environmental conditions, per regulations
- Monitor and advise on sound source and vessel operations for compliance with the environmental requirements for the survey
- Assist onboard PAM tech in maintaining and troubleshooting the PAM system hardware and software
- Communicate with the crew to implement mitigation actions as required by environmental protocols, including delays to initiation of survey equipment
- Participate in daily meetings and drills with crew when appropriate

3.3 PSO and PAM Operator Requirements

All Protected Species Observers (PSOs) and PAM Operators will have completed a protected species observer training program as described in the BO.

PAM Operators will have completed a PAM training course as described in the BO.

PSOs' and PAM Operators' CVs will be submitted to NMFS for approval prior to deployment on the project.

PSOs will have completed HUET / Sea Survival training

PSOs will be equipped with Personnel Protective Equipment (PPE), including hard hat, steel-toe boots, fire-retardant coveralls, work gloves, and safety glasses.

4 MONITORING EQUIPMENT

4.1 Visual Monitoring Equipment

The PSO on duty will monitor for marine protected species using the naked eye, hand-held reticle binoculars, and big-eye binoculars as described in BO.

Digital single-lens reflex camera equipment, including zoom lens, will be used to record sightings and verify species identification.

4.2 Acoustic Monitoring Equipment

4.2.1 Passive Acoustic Monitoring (PAM) System

Two complete PAM systems will be deployed to each source vessel. Only one will be deployed and actively monitored. The hydrophone cable will be deployed from a location that does not hinder operations, allows for changes in vessel heading and currents, and provides optimal acoustic coverage. A vessel and survey specific deployment and retrieval procedure will be developed between the Lead PSO/PAM Technician and vessel crew. A “Permit to Work” will be secured and a Task Based Risk Assessment (TBRA) will be completed prior to hydrophone deployment, as implemented by ship management.

A Seiche-designed remote monitoring PAM system, consisting of a deck cable, a hydrophone cable, a data processing unit with rack-mounted PC running a suite of acoustic monitoring software, monitors, and headphones for aural monitoring will be installed on each source vessel. The system consists of a 250-meter towed hydrophone cable that will be deployed from a winch on the back deck and relay data to the electronic processing unit through a 100-meter deck cable. The conventional array contains three broad-band hydrophone elements (H1 through H3, 2kHz to 200 kHz, -3 dB points) and one low-frequency element (H4, 10Hz to 24kHz, -3dB points) where H1 and H2 are spaced 0.25 meters apart, H2 and H3 and H3 and H4 are spaced 1.2 meters apart. The array also contains a depth gauge. Additional communications hardware will be installed to allow communication with the onshore remote systems through dedicated VSAT bandwidth.

Remote PAM operators will have access to an onshore remote monitoring station connected to the electronics installed on each vessel via satellite using the RPS dedicated VSAT with a bandwidth of 3000+ kb uplink, 400+ kb downlink, and 800- 850 millisecond response time. The onshore remote monitoring station PAM Operators will be able to fully manipulate software settings and stream audio from their location. Communications between PAM Operator and survey crew will be conducted by satellite phone.

The PAM system has been designed to monitor for most cetacean species found in the Gulf of Mexico, covering a broad range of frequencies up to 200kHz. The predominant vessel noise (propellers) will automatically be filtered out because the hydrophone will only begin to pick up frequencies at 2 kHz. Some propeller and engine noise will still dominate the lower frequencies, but the species of concern should all be detectable above the noise as their dominant frequencies are around the 8 to 20 kHz ranges.

Mid and high frequency marine mammal vocalizations are processed by the laptop internal sound card. Mid frequency vocalizations include sperm whale click trains and codas and delphinid whistles in the frequency range of approximately 2 kHz to 24 kHz. Kogia species, beaked whales, and delphinid echolocation clicks that are emitted at very high frequencies in excess of 80kHz are processed by a specialized sound card in the buffer unit, an external National Instruments sound card, capable of sampling audio at 500kHzPAM equipment specifications are provided in Appendix B.

4.2.2 PAM JSA and PAM deployment and retrieval procedure

A job safety analysis (JSA) will be completed prior to hydrophone deployment. The Lead PSO/PAM Operator will develop, in cooperation with the vessel crew, a vessel-specific deployment and retrieval procedure that considers both the minimization of entanglement risks with other towed equipment while maximizing the acoustic range of the system.

4.2.3 Distance estimation of acoustic detections

There are a variety of methods that can be used to estimate the distance to vocalizing marine mammals using the acoustic detection software, Pamguard. When the distance to a vocalizing animal cannot be determined by Pamguard, the experienced PAM Operator can make a distance estimation assisted by the noise or detection score system developed by Gannier et al. (2002). Gannier et al. monitored sperm whales in the Mediterranean both visually and acoustically. A scale was developed based upon the strength or intensity of the sperm whale clicks at various distances that were then measured when the sperm whales surfaced and were visually observed. Although the scale is subjective, and sounds produced in marine environments will vary according to local conditions, the scale provides a measure for approximating distances when using a single, linear hydrophone array.

5 VISUAL AND ACOUSTIC MONITORING PROCEDURES

5.1 Visual Monitoring Watches

There will be **at least two PSOs on visual watch** during:

- All seismic source activity in daylight hours, including testing
- During search periods prior to activating the seismic source
- **For the duration of any day when there is planned acoustic source activity, regardless of whether the source is deployed**

When the above conditions are not met, such as days when no source activity is planned, there will still be at least one PSO on watch at all times, whenever the monitoring conditions are defined as “good”, (good conditions are defined in the BO as Beaufort sea state of 3 or less).

Visual monitoring will begin 30 minutes before sunrise and continue until 30 minutes after sunset.

The following guidelines will apply to these watch periods:

- No additional duties may be assigned to the PSO during his/her visual observation watch
- No PSO will be allowed more than **two consecutive hours on watch** before being allocated a one-hour break from visual monitoring
- No PSO will be assigned a combined watch schedule of more than 12 hours in a 24-hour period

The PSOs will stand watch in a suitable location that will not interfere with the navigation or operation of the vessel and affords an optimal view of the sea surface. PSOs will maintain 360° coverage surrounding the vessel and the seismic source.

If a protected species is observed, the PSO should first take care of any necessary mitigation actions, or if no mitigation actions are required, they will note and monitor the position (including latitude/longitude of the vessel and relative bearing and estimated range to the animal) until the animal dives or moves out of visual range of the observer.

5.2 Passive Acoustic Monitoring Watches

The Lead PSO on the source vessel will also be a trained PAM Operator, whose responsibilities will include any technical onboard tasks with the PAM system. However, monitoring and data collection will be primarily conducted remotely by PAM Operators based on land.

Remote PAM Operators will conduct acoustic monitoring from monitoring stations set up in their homes. The monitoring station location will be selected to provide a quiet environment from which to monitor and the station will be configured to be ergonomically comfortable for the Operator.

Remote PAM monitoring will be conducted with the remote access software Team-viewer. The remote PAM Operators will monitor the acoustic software for indications of a failing or insufficient remote connection. The

Operator will monitor for marine mammals aurally using the headphones as well as visually monitoring the spectrogram and click detectors. Remote Operators will be able to monitor the same acoustic monitoring software modules at the same level of quality as they would from a vessel-based monitoring station.

Passive acoustic monitoring will be conducted, day and night, during all uses of the seismic sources AND during the search periods prior to activation of the seismic sources.

During acoustic monitoring watches, the following guidelines shall be followed:

- No additional duties may be assigned to the PAM Operator during their acoustic monitoring watch
- No PAM Operator will be allowed more than **four consecutive hours of acoustic monitoring** before they will be allocated a break of two hours
- No person on watch as a PSO or PAM Operator will be assigned a combined watch schedule of more than 12 hours in a 24-hour period

Acoustic monitoring must be consistent, diligent, and free of distractions for the duration of the watch.

5.2.1 Communications between Vessel and Remote PAM Operators

Each remote monitoring station will be equipped with multiple methods of communications with the vessel for which they are conducting acoustic monitoring:

1. A satellite phone linked through the dedicated satellite bandwidth for PAM monitoring.
2. A computer chat program connecting via the internet will be installed on each remote PAM computer and on the computer used by the personnel controlling the sound source.
3. In the event that the previous communications methods fail, a call to the ship's satellite phone system will be employed.

5.2.2 Procedures for PAM System Malfunction

In the event that a PAM system is not functional for the purposes of mitigation monitoring, whether because of malfunction with the cables, electronics, monitoring software or another issue, the PAM Operator is permitted **30 mins to diagnose the issue** without the need to shut down the source array.

During daylight when PSOs are also on watch, an additional 2 hours is permitted to conduct repairs, where seismic operations can continue during that time **if all of the following conditions are met:**

1. The sea state at the time of the malfunction is B4 or less. AND
2. There were no acoustic-ONLY detections of marine mammals other than delphinids inside the applicable EZ in the 2 hours preceding the malfunction.

Operations conducted without ongoing acoustic monitoring **may not exceed a total of 4 hours in a 24-hour period**.

NMFS and BSEE must be notified as soon as is practicable of any PAM system malfunctions exceeding 30 minutes in duration that occur while acoustic source operations are ongoing. Reporting procedures are outlined in the Reporting section of this EMP.

6 PROJECT BRIEFING

The vessel crew and PSO team should participate in a project briefing that includes communication procedures, monitoring requirements and operating protocols.

The briefing should be repeated every time relevant new personnel join the vessel before operations begins.

7 MITIGATION PROCEDURES: STRIKE AVOIDANCE

7.1 Strike Avoidance Monitoring and Vessel Maneuvering

Vessel operators must maintain a vigilant watch for all aquatic protected species.

Vessels must slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any protected species:

- All marine mammals
- All sea turtles
- Gulf sturgeon, oceanic white-tipped shark, giant manta ray

These procedures apply to physical interactions involving vessels and the towed equipment.

7.2 Vessel Speed Restrictions

Vessel speeds must be reduced to 10 knots or less **when mother/calf pairs, pods, or large assemblages (greater than three) of any marine mammal** are observed near a vessel.

7.3 Separation Distances

When protected species are sighted while a vessel is underway, the vessel should take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area).

If marine protected species are sighted within the relevant separation distance, the vessel should reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This does not apply to any vessel that is towing gear. **Vessels are not required to shift into neutral for animals that approach the vessel.**

500 m: All baleen whales including the Bryde's (pronounced ˈbrü-dəz) whale

100 m: Sperm whales

50 m: All other marine mammals (including manatees), and sea turtles, and the ESA-listed fish species referenced in 7.1

NOTE: Any large whale for which species can't be identified should be mitigated for as a baleen whale.

8 MITIGATION PROCEDURES: SOUND SOURCES

8.1 Day-time Source Operations Restriction

The source is only to be operated during the day time while the vessel is in Texas State waters.

No night time source operations will be conducted.

Source operations will start no sooner than 30 mins past sunrise, once visual PSOs have confirmed that they could search and clear the full mitigation zones as described below.

Source operations will cease at sunset.

8.2 Sound Source Exclusion Zones and Buffer Zones

Two types of zones will be established around the seismic sources, both radii that extend from the outer edge of the airgun array.

Buffer Zones (BZ): Applicable during the pre-clearance search periods conducted prior to initiating the sound source from silence, where detections of a protected species inside it's applicable BZ during the search will result in a delay to activating the source

Exclusion Zones (EZ): Applicable once the source has been activated, where detections of a protected species inside it's applicable EZ will result in a shutdown of the sound source.

A 1500 m Buffer Zone and Exclusion Zone will be applied to all marine mammal species and sea turtles while operations are conducted in Texas state waters.

To activate the sound source, a minimum of a 30-minute search period must be conducted.

During the daytime, the search will be conducted visually by the PSOs and acoustically by the PAM Operator.

PSO and PAM on watch should be notified of the intent to turn on the source from silence, either to conduct a ramp-up or for testing, at least 60 minutes prior to the planned start,

8.3 Delays to Initiation of the Seismic Source

If any marine mammal or sea turtle was detected inside the 1500 m Buffer Zone during the 30-minute search period, initiation of the seismic source must be delayed until:

- When all marine protected species that were observed inside the relevant Buffer Zone have been confirmed by the visual observer to have exited the relevant Buffer Zone.
- 15 minutes from last detection for small odontocetes if not observed exiting the BZ
- 30 minutes from last detection for all other protected species, including sea turtles, if not observed exiting the BZ
- 30 minutes from last detection for acoustic-only detections

NOTE: Both the 30-minute pre-clearance search period and the mandatory delay for animals not seen exiting the buffer zone must be completed before source initiation, but the pre-clearance search and delays can be implemented concurrently (they overlap). For a delay period that ends BEFORE the clearance search period is completed, the BZ will be cleared when the clearance search is completed. For a delay period that ends AFTER the standard clearance search period is completed, the source can be turned on when the delay period is completed.

8.4 Ramp Up Procedure and Testing

The intent of ramp-up is to warn marine mammals and sea turtles of pending seismic operations and to allow sufficient time for those animals to leave the immediate vicinity.

For all acoustic source activity, including source testing involving more than one airgun element, ramp-up procedures must be conducted to allow marine mammals and sea turtles to depart the exclusion zone before surveying begins.

Ramp-up is not required for testing of single elements or strings.

Ramp-up should be planned in an effort to minimize time that the source is active on the run in to the start of the survey line.

Ramp-up procedures for Air Gun are as follows:

- Visually and acoustically (day) monitor the buffer zone and adjacent waters for the absence of marine mammals and sea turtles for at least 30 minutes before initiating ramp-up procedures.
- If no protected species are visually or acoustically detected inside their respective BZs, ramp-up procedures may begin. If animals are detected, refer to Section 7.4 for Procedures to clear the BZs prior to start of source operations
- Seismic personnel confirm with PSOs on watch (daytime) that the BZs are clear of protected species.
- Ramp-up begins by activating a single airgun of the smallest volume in the array
- Continue ramp-up in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration.
- Total duration of the ramp-up should not be less than 20 minutes.

The TPS source is one single element so ramp-up is not possible. When the search period is complete and the PSOs and PAM Operator have confirmed it is cleared to begin, the TPS source will be turned on at the full operating level.

8.5 Protected Species Shutdown Procedures

If any **marine mammal** is detected visually or acoustically within its EZ, an immediate shutdown of the source is required.

Shut down is required for all marine mammals detected inside the 1500 meter exclusion zone. There are no exceptions to the shut down requirement while the vessel is operating in Texas state waters.

NOTE: All resumptions of source activity following a protected species shutdown must begin with a ramp-up

8.6 Short Breaks in Source Operations

In recognition of occasional short periods of silence for a variety of reasons other than for mitigation, the seismic source may be silenced for periods of time not exceeding 30 minutes in duration and may be restarted at the same volume for operations without a ramp-up if:

1. Visual and acoustic monitoring (daytime) and acoustic monitoring (nighttime) is continued diligently through the silent period

   AND

2. No marine protected species are visually observed in their respective EZ during the silent period, and no acoustic detections made **at any distance**

NOTE: Procedures for returning to full volume without ramp up after silent periods also apply to returning to full volume from reduced volume.

For example, if two of three strings were silenced from full volume for the purpose of testing single strings, and testing was completed in less than 30 minutes, the array could return to full volume without a ramp-up provided that the conditions described above were met.

However, if the source were operating at that reduced volume for more than 30 minutes, **a ramp up would be required to return to full volume.**

8.7 Non-acquisition and Non-Testing Source Activity

The acoustic source should be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided.

9 REPORTING

9.1 Incident Reporting

9.1.1 Potential Non-Compliance Incidents

The Lead PSO or Lead PAM Operator verbally informs MFF Party Manager and on-board Shell Client Representative of any potential compliance related issues immediately. The Lead PSO/PAM Operator also informs the RPS Project Manager immediately of all potential non-compliance events.

If the issue can be resolved between the Lead PSO/PAM Operator, Client Representative and Party Manager, the lead PSO/PAM Operator will document in writing the compliance issue and the agreed-upon practices for minimizing future non-compliance incidents of the same nature. The party manager and QC Representative review and approve, and the statement is submitted to the following distribution list:

Katie Dekis (Katie.Dekis@rpsgroup.com)
Asif Ali (asif.ali@magseisfairfield.com)
BJ Thompson (bj.thompson@magseisfairfield.com)
Shawn Gilliam (shawn.gilliam@magseisfairfield.com)
Vishram Rambaran (Vishram.Rambaran@shell.com)
Bradley Nolan (Bradley.Nolan@shell.com)

The representatives listed above will distribute any pertinent information resulting from the incident to their respective crews as deemed necessary and appropriate.

If the issue cannot be resolved at the vessel level, MFF and RPS will discuss and determine the appropriate future actions to be taken. When a common position is reached, notification of the agreed procedures will be distributed by MFF to vessel crew and by RPS to the PSOs and PAM Operators.

If an agreement cannot be reached at the office level, a MFF representative will contact BOEM/NMFS/BSEE for clarification. Results from the clarification will be distributed by MFF.

9.1.2 Reporting A Non-functioning PAM System During Seismic Operations

The PAM Operator on duty will notify by email, NMFS (nmfs.psoreview@noaa.gov) and BSEE (protectedspecies@bsee.gov) as soon as is practicable of any PAM system malfunctions exceeding 30 minutes in duration that occur while acoustic source operations are ongoing

The PAM Operator will copy the RPS PM.

The notification will include the vessel name, the time and location (GIS position) in which the PAM system ceased function where seismic operations continued. The template for this email will be provided by the RPS PM.

The PAM Operator will also notify by email:

- The vessel Party Chief
- The Client Representative

9.1.3 Injured or Dead Protected Species Reporting

1. The PSO on watch will report the sightings of a dead and/or injured marine species to the Lead PSO, the RPS project manager, on board client representative and vessel Party Chief as soon as possible after the sighting.
2. A PSO, either the Lead or the PSO that observed the dead/injured animal, will report the sighting to the NMFS stranding hotline. This will occur as soon as practicably possible but no more than 24 hours of the detection. The shore-based RPS Project Manager may collect the data and assist with the initial phone report.
3. A written report will be prepared including any photos taken of the animal and sent to RPS as soon as possible.
4. The RPS office will submit the written report to the following distribution list within 12 hours of the detection for review:

   On-board:
   - Onboard Party Chief
   - Client Representative

   On-shore:
   - Magseis Fairfield Project Manager

RPS will provide the written report, once the draft has been reviewed and approved per above, to NOAA, NMFS, and BOEM with MFF and Shell included in copy.

Unless otherwise directed by BOEM, NOAA Fisheries, or NOAA, the dead or injured marine mammal or sea turtle SHOULD NOT be touched! Dead and injured marine mammals and sea turtles are still protected by the ESA and the MMPA and touching the animals in any manner is considered harassment and is punishable by law.

9.2 Daily Progress, Interim and Final Reporting

9.2.1 Daily Progress Reports

A daily report will be completed and submitted to the Party chief, onboard client representative and RPS project manager. The template will be provided by RPS and MFF and Shell will be provided opportunity to review and provide comments.

9.2.2 Interim Reports

RPS will submit interim reports in the format of an excel spreadsheet for each vessel containing the required information listed in the BO.

RPS will submit interim reports (a dataset in a format approved by NMFS and BSEE) on the 1st of each month to BSEE (protectedspecies@bsee.gov).

9.2.3 Final Report

RPS will develop a final report summarizing the survey activities and all PAM / PSO observations. The report will contain all the data required to meet the requirements of the BO.

The RPS Project Manager will provide the draft final report to the MFF Project Manager within 45 days of project completion.

Appendix C

SURVEY VESSELS

REM SALTIRE

Node Vessel	
Name:	REM Saltire
Size	111 meters
Type:	Offshore supply
Max speed capabilities: Recovery	1 knot
Port of Origin:	Galveston, Tx
Call signs:	**5BYV4**

ARTEMIS ARCTIC

Source Vessel	
Name:	Artemis Arctic
Size	74 meters
Type:	Survey vessel
Max speed capabilities:	12 knots
Port of Origin:	Galveston, Tx
Call signs:	**LJZK3**

VICTORY G

Chase vessel	
Name:	Victory G
Size	54
Type:	Survey vessel
Max speed capabilities:	14 knots
Port of Origin:	Galveston, Tx
Call signs:	**3ECY4**

Appendix D

PSO AND PAM OPERATORS FOR ARTEMIS ARCTIC

PSO	Affiliations
Jill Nace	RPS Associate
Monica Arancibia	RPS Associate
Sam Dorado	RPS Associate
Yessica Vincencio	RPS Associate
Cesar Coronel	RPS Associate
Pauls Castro	RPS Associate
Juliette Saux	RPS Associate

Appendix E

RETICLE BINOCULAR CALIBRATION TABLE FOR ARTEMIS ARCTIC

Week #	Date	Observer Name	Reticle Binocular Estimated Distance (m)	True Distance from Radar (m)	Sea State (Beaufort)	Wind Force (knots)	Swell (m)	Comments
1	7/21/2021	Juliette Saux	2280	6290	2	7	<2	The distances of the reticles were adjust. However, it was clear that the further the objective is from the observers, the reticle's distance had bigger errors.
1	7/21/2021	Paulo Castro	2600	2963	2	7	<2	
1	7/21/2021	Yessica Vicencio	3067	4083	2	7	<2	
2	7/25/2021	Juliette Saux	2800	4630	1	6	<2	
2	7/29/2021	Yessica Vicencio	3066	2600	2	6	<2	
2	7/29/2021	Cesar Coronel	3083	2600	2	6	<2	
3	7/31/2021	Yessica Vicencio	2299	2037	2	7	<2	
3	7/31/2021	Paulo Castro	2642	2037	2	7	<2	
3	7/31/2021	Juliette Saux	2130	2037	2	7	<2	

Exhibit C

SAILOR® 100 GX

Your 1m Ka-band system for Inmarsat Global Xpress®

Product Sheet

Now with Universal ACU, GNSS, module and new software features

The SAILOR 100 GX is an advanced 3-axis stabilized Ka-band antenna system designed for the Inmarsat Global Xpress® satellite network. It is built to the same high quality and high performance that has made SAILOR the leading name in professional maritime communication equipment over decades.

SAILOR 100 GX is a direct development from the immensely successful SAILOR 900 VSAT antenna system, which has created a new industry standard through innovative design for ease-of-use, quick deployment and reliable operation.

The top performing GX system

SAILOR 100 GX features advanced Tracking Receiver technology that enables it to verify the right satellite in less than a second. This unique feature, tried and tested in the benchmark SAILOR FleetBroadband systems, ensures quick satellite acquisition at start-up and re-acquisition of the satellite in case of temporary blockage, after bad weather or poor signal strength.

Quick & Easy to deploy

As with all SAILOR VSAT antenna systems, SAILOR 100 GX is light and compact. It uses a single cable between antenna and below deck equipment for RF, power and data, while advanced features such as Automatic Azimuth Calibration (home flag) and Automatic Cable Calibration significantly reduce installation time further. The unique Global Xpress One Touch Commissioning feature completes the package, making SAILOR 100 GX incredibly easy to deploy.

Re-defining maritime broadband

With SAILOR 100 GX you have reliable access to the full range of Inmarsat Global Xpress global high throughput satellite services so you can enjoy the power of broadband for business applications, vessel operations and crew welfare.

Remote access and diagnostics

In order to offer the best support to system integrators, in line with our world-class customer care, SAILOR 100 GX offers a number of features for remote access and remote diagnostic including monthly statistics logging, SNMP traps and Syslog functionality. These remote maintenance features are supported by Cobham SATCOM's worldwide network of On-board Service Centers.

Compatibility and testing

SAILOR 100 GX ships with the original SAILOR GX Modem Unit (GMU), which works directly with SAILOR 500/250 FleetBroadband to form the cornerstone of the Inmarsat Fleet Xpress service. The system is designed and tested to the highest maritime shock and vibration requirements, IEC EN 60721 to ensure reliable service and the longest possible life at sea.

SAILOR® 100 GX

Your 1m Ka-band system for Inmarsat Global Xpress®

COBHAM

SYSTEM SPECIFICATIONS

Frequency band	Ka-Band (Inmarsat GX)
Reflector size	103 cm / 40.6"
Type approvals	Inmarsat
Certification	Compliant with CE (Maritime), ETSI, FCC
System power supply range	100-240 VAC, 50-60 Hz
Total system power consumption	200W typical, 410W peak
Vibration, operational	Sine: EN60945 (8.7.2), DNV A, MIL-STD-167-1 (5.1.3.3.5). Random: Maritime
Vibration, survival	Sine: EN60945 (8.7.2) dwell, MIL-STD-167-1 (5.1.3.3.5) dwell. EN60721-3-6 6M3
Shock	MIL-STD-810F 516.5 (Proc. II)
Temperature (ambient)	Operational: -25°C to 55°C Storage: -40°C to 85°C

FREQUENCY BAND

Rx	19.2 to 20.2 GHz
Tx	29.0 to 30.0 GHz

ANTENNA CABLE

ACU to ADU cable	Single 50 Ω coax for Rx, Tx and power

ANTENNA CONNECTORS

ADU	Female N-Connector (50 Ω)
ACU	Female N-Connector (50 Ω)

ABOVE DECK UNIT (ADU)

Antenna type, pedestal	3-axis stabilised tracking antenna with integrated GNSS (GPS, GLONASS, Beidou)
Antenna type, reflector system	Reflector/sub-reflector, ring focus
Transmit Gain	47.5 dBi typ. @ 29.5 GHz (excl. radome)
Receive Gain	44.0 dBi typ. @ 19.7 GHz (excl. radome)
System G/T	20.1 dB/K typ. @ 19.7 GHz, at ≥10° elevation and clear sky (incl. radome)
BUC output power	5W GX BUC
EIRP	≥53.5 dBW (incl. radome) MAX. 36.0 dBW/40KHz
LNB	GX Ka single band LNB
Tracking Receiver	Internal "all band/modulation type" including e.g. power, DVB-S2, GSC and modem RSSI
Polarisation	Circular Cross-Pol (Inmarsat GX, TX: RHCP, RX: LHCP)
Elevation Range	-25° to +125°
Cross Elevation	+/-42°
Azimuth Range	Unlimited (Rotary Joint)
Ship motion, angular	Roll +/-30°, Pitch +/-15°, Yaw +/-10°
Ship, turning rate and acceleration	15°/S and 15°/S²
ADU motion, linear	Linear accelerations +/-2.5 g max any direction
Satellite acquisition	Automatic - with or without Gyro/GPS Compass input
Humidity	100%, condensing
Rain / IP class	EN60945 Exposed / IPX6
Wind	80 kt. operational 110 kt. survival
Ice, survival	25 mm / 1"
Solar radiation	1120 W/m2 to MIL-STD-810F 505.4
Compass safe distance	1 m / 40" to EN60945
Maintenance, scheduled	None
Maintenance, unscheduled	All electronic, electromechanical modules and belts are replaceable through service hatch
Built In Test	Power On Self Test, Person Activated Self Test and Continuous Monitoring w. error log
Power OFF	Automatic safe mode
Dimensions (overall)	Height: H 150 cm / 58.9" Diameter: Ø 130 cm / 51.3"
Weight	126 Kgs. / 276 lbs.

ANTENNA CONTROL UNIT (ACU)

Dimensions, Rack Mount	1U 19" ACU HxWxD: 4.4 x 48 x 33 cm HxWxD: 1.75" x 19" x 13"
Weight, Rack Mount	4.5 kgs. / 10 lbs.
Humidity	EN60945 Protected, 95% (non-consending)
IP class	IP30
Compass safe distance	1.4 m / 55.1" to IEC 60945
Interfaces	1 x N-Connector for antenna RF Cable (50 Ω) w. automatic cable loss compensation 2 x F-Connectors (75 Ω) for Rx / Tx to Modem 1 x Ethernet (Modem Control) 1 x RS-422 (Modem Control) 1 x RS-232 (Modem Control) 1 x NMEA 0183 (RS-422 or RS-232) for Gyro/GPS Compass input (future NMEA2000) 2 x Ethernet (User) 1 x Ethernet (ThraneLink, service, set-up etc.) 1 x AC Power Input 1 x Grounding bolt
Input power	100 - 240 VAC, 175W typical, 370W peak
Modem interface (control)	Generic, OpenAMIP, Custom protocol
Display	Web MMI, OLED (red) display, 5 pushbuttons, 3 discrete indicator LEDs and ON/OFF switch
No transmit zones	Programmable, 8 zones with azimuth and elevation

GX MODEM UNIT (GMU)

GMU Dimensions	1U 19" Rack Mount HxWxD: 4.4 x 48 x 33 cm HxWxD: 1.75" x 19" x 13"
Weight, Rack Mount	3.5 kgs. / 7.7 lbs.
Humidity	EN60945 Protected, 95% (non-consending)
IP class	IP30
Compass safe distance	0.4m / 16" to EN60945
Modem type	SAILOR Global Xpress Modem / iDirect X7
Interfaces	2 x F-Connectors (75 Ω) for Rx / Tx to ACU 1 x LAN connector for control and user data - Routes through ACU 1 x RS-422 Data (Modem Control) 1 x RS-232 Data (Modem Control) 1 x RS-232 Modem console 1 x Universal AC input 1 x Grounding bolt
Input power	100-240 VAC, 50-60 Hz
Modem interface (control)	OpenAMIP, RS422 & RS232
Display	Web MMI, ON/OFF switch and Power LED
Temperature control	Built-in fan and heater

For further information please contact:

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Exhibit C

SAILOR® 500 FLEETBROADBAND

The ultimate global broadband connectivity and voice solution

2013 Product Sheet

The most important thing we build is trust

The SAILOR 500 FleetBroadband is designed for vessels and platforms with demanding requirements for connectivity. It meets the critical needs for voice and data communication of maritime and offshore professionals globally but despite its power, is a compact, lightweight solution. It provides extensive functionality including full access to bandwidth-hungry IP applications, broadband internet/intranet, e-mail, secure VPN and nine simultaneous voice lines.

High-end connectivity

With high-speed internet connectivity, running efficiency enhancing custom IP solutions in parallel with email, VPN and voice calling is all in a day's work for SAILOR 500 FleetBroadband. It enables tracking and telemetry functionality, so colleagues on shore have all the information they need; real-time engine data for maintenance, drilling data for improving production or position data for fleet tracking and management. With SAILOR 500 FleetBroadband, you can also provide communication and internet access for crew, which is vital for ensuring an efficient workforce.

Professional & proven performance

SAILOR 500 FleetBroadband uses a fully stabilized 3-axis antenna with rate sensors for improved performance and fast, intelligent satellite tracking. It's built to the world-renowned SAILOR standards, so you benefit from reliable, always available connectivity at all times, regardless of location and conditions.

Simple and secure installation

SAILOR 500 FleetBroadband is easy to deploy and getting connected is a straightforward, cost-effective process. The system is delivered with everything you need to get started in the box and because it is based on standard IP services and features a clear user interface, connecting your computer, corporate network, external sensors or phone system is simple and secure.

Multiple voice lines

With up to nine simultaneous voice lines possible using Inmarsat Multi-voice, an important part of the SAILOR 500 FleetBroadband solution is the Thrane IP Handset. This advanced plug-and-play handset provides an intuitive user interface through a 2.2" TFT colour screen and features cutting-edge technology, such as a state-of-the-art echo cancellation and noise suppression software, for excellent audio clarity.

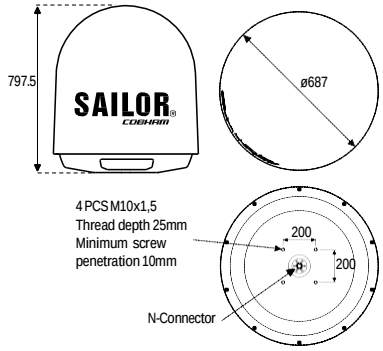
Communicate with confidence

SAILOR products are highly regarded by maritime professionals for their design and build quality, which results in excellent reliability. To support this, we guarantee fast and dependable service through our established network of On Board Service Centers (OSC). With OSC locations all around the world, service and support is always available, whenever and wherever it is needed.

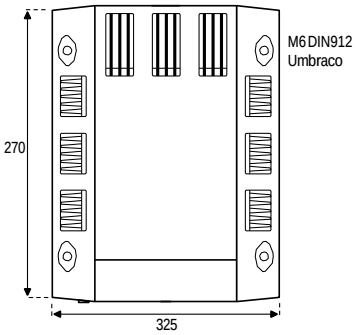
SAILOR® 500 FLEETBROADBAND

The ultimate global broadband connectivity and voice solution

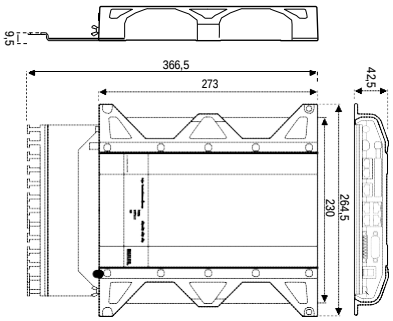
SAILOR 500 FleetBroadband
Above Deck Unit



SAILOR 6080 AC/DC Power Supply



SAILOR 500 FleetBroadband
Below Deck Unit



SPecIFIcATIONS

Inmarsat FleetBroadband approved. Compliant to RTTE, CE Marked. Testet to FCC part 25

FRequeNcy BANd

Rx	1525.0 - 1559.0 MHz
Tx	1626.5 - 1660.5 MHz
Ch. spacing	10.5 - 189 kHz, Rx
	21 - 189 kHz, Tx

RecOmmeNded ANTeNNA cABLe

Cable loss max/min	20 dB at 1,62 GHz and 1.0 Ω DC loop resistance
	3 dB at 36 MHz -4 dB at 54 MHz

POweR SuPPLy ANd cONSumPTION

DC input range (isolated)	10 to 32V DC
Power (max), incl. antenna & PoE output	150 W @ 10 - 32V

eNVIRONmeNTAL cONdITIONS

Ambient Temperature	-25 to +55°C
ADU Storage	-40 to +85°C
Survival (power on, non functional)	-40 to +80°C
Automatic thermal surveillance shuts down terminal gradually at +85˚C PCB temperature	
ADU enclosure	IPX6
ADU operating humidity	"Exposed" according to EN60 945
BDU enclosure	IP31
BDU operating humidity	95% non-condensing at +40˚C
Icing (survival)	Max 25 mm

VIBRATION (Adu)

Vibration, operational	Random spectrum 1.05 g rms x 3 axes: 5 to 20 Hz: 0.02 g2/Hz 20 to 150 Hz: -3 dB/octave
Vibration, non-operational (survival)	Random spectrum 1.7 g rms 2 h x 3 axes (6 h total): 5 to 20 Hz: 0.05 g2/Hz, 20 to 150 Hz: -3 dB/octave

ShIP mOTION

Roll	+/- 30 deg. per. 4 s, max. 0.7 g tan.
Pitch	+/- 15 deg. per. 3 s, max. 0.6 g tan.
Yaw	+/- 10 deg. per. 5 s, max. 0.3 g tan.
Surge	+/- 0.5g
Sway	+/- 0.5g
Heave	+/- 0.7g
Turning rate	+/- 36˚/s; Acc. 12˚/s²
Headway speed	22 m/s (42 knots)
Wind	100 knots

mechANIcAL ShOck

20g/11 half-sine

ANTeNNA cONNecTOR

ADU	50 Ω N, female
BDU	TNC-socket, female

cOmPARISON chART

	SAILOR 500 FleetBroadband	SAILOR 250 FleetBroadband	SAILOR 150 FleetBroadband
Standard IP	Up to 432 kbps	Up to 284 kbps	Up to 150 kbps
Streaming IP	8, 16, 32, 64, 128, 256 kbps	8, 16, 32, 64, 128 kbps	-
ISDN Data	64 kbps	-	-
Fax	G4 via UDI, G3 fax via 3.1 kHz Audio	G3 fax via 3.1 kHz Audio	G3 fax via 3.1 kHz Audio
SMS (standard 3G)	160 characters	160 characters	160 characters
Standard Voice	4 kbps	4 kbps	4 kbps
Premium Voice	3.1 kHz Audio, 64 kbps	3.1 kHz Audio, 64 kbps	3.1 kHz Audio, 64 kbps
Multi-voice	9 voice lines simultaneously	6 voice lines simultaneously	4 voice lines simultaneously
Ethernet/PoE	4 ports	4 ports	2 ports
Phone/Fax (2-wire)	2 ports	2 ports	1 port
ISDN	1 port (data/3.1 kHz Audio)	1 port (3.1 kHz Audio)	-
I/O Connector	1 connector with 5 configurable inputs/outputs	1 connector with 5 configurable inputs/outputs	1 connector with 5 configurable inputs/outputs
L-Band Output	1 port for L-Band Broadcast service	1 port for L-Band Broadcast service	1 port for L-Band Broadcast service
Status LED	Full status LED panel	Full status LED panel	Full status LED panel
SIM Card Slot	1 SIM Card slot for BGAN SIM card	1 SIM Card slot for BGAN SIM card	1 SIM Card slot for BGAN SIM card
Router	Integral DHCP/NAT router	Integral DHCP/NAT router	Integral DHCP/NAT router
PBX	Built-in PBX	Built-in PBX	Built-in PBX

For further information please contact:

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Appendix G

PAM HYDROPHONE DEPLOYMENT / RECOVERY

1 ARTEMIS ARCTIC

1.1 Hydrophone deployment

A chain, weighing a total of ~10kg, is securely attached onto the tow cable at approximately 1m from the tow cable connection point with the hydrophone array section (Figure 1). The weight was added to aid in proper towing depth and decrease the likelihood of entanglement.

Figure 1: Chain secured to tow/hydrophone cable.

The main hydrophone cable was set up on the starboard winch, slightly offset to either side of the ship's centreline. The main hydrophone cable is deployed from the starboard side winch (Figure 2).

Prior to any full recovery or deployment operation, the DPU's buffer unit must be powered off, and the deck cable must be disconnected from the tow cable.

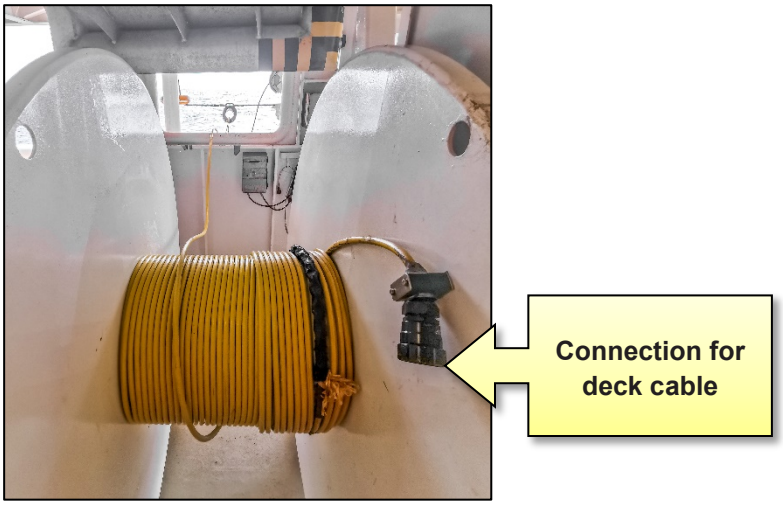

Figure 2. Main tow/array cable spooled onto the starboard winch.

The main 250-meter tow/array cable is spooled onto the starboard winch at the aft of the streamer deck, from there it is guided through the centered fairlead block and the first 25 meters of the cable are fed manually over the stern to the sea (Figure 9). Afterwards, the mechanic opens the local hydraulic valves to activate and run the winch to deploy the cable to the desired tow length. There are two Chinese fingers at different distances, one of them at 50 meters and the other at 120 meters from the depth gauge. Once deployed, the cable is secured to an anchor rope by a C-link connected to the Chinese finger on the cable at

50 meters or 120 meters. To avoid tangling problems, before each turn the PAM cable is manually retrieved up to 50 meters and deployed up to 120 meters when the vessel is straight again.

Figure 3: Figure 10. PAM cable placed through the fairlead block

Figure 4. Chinese finger secured to the anchoring rope. (A) Chinese finger at 50m (B) Chinese finger at 120m

The local hydraulic valve can then be closed to deactivate the winch levers and the deck cable must be connected to the tow cable on the winch before switching on the DPU's buffer unit. At full deployment the trailing end of the PAM cable tows 120 meters astern the vessel, and the hydrophone elements are

approximately 50 meters from the acoustic source. Tow depths register between 8 and 20 meters, while the vessel is at survey speed, depending on sea state and deployment distance.

1.2 Deployment and Recovery

For recover the cable, once the system was turned off and the deck cable disconnected; the Chinese finger must be released from the hook c-clip, then secure the c-clip with tape and spool the cable into the winch. Once the hydrophone section reach the deck, the cable can be spooling in the deck if there is an intention to deploy de cable in the next hours. If not, spool the rest of the cable slowly onto the winch.

Appendix I

Figure 1: AD#01 19 July 2021 – Green sea turtle- Artemis Arctic 3
Figure 2: AD#03 19 July 2021 – Unidentified whale- Artemis Arctic.....4
Figure 3: AD#05 30 July 2021 – Sperm whale- Artemis Arctic 4
Figure 4: AD#06 30 July 2021 – Sperm whale- Artemis Arctic 5
Figure 5: AD#07 01 August 2021 – Sperm whale- Artemis Arctic.....5
Figure 6: AD#08 01 August 2021 – Unidentified whale- Artemis Arctic 6
Figure 7: AD#09 02 August 2021 – Sperm whale- Artemis Arctic.....6

VISUAL DETECTIONS FOR ARTEMIS ARTIC

VD01 – Green Sea Turtle

Figure 1: VD#01 19 July 2021 – Green sea turtle- Artemis Arctic

VD03 – Unidentified whale

Figure 2: VD#03 19 July 2021 – Unidentified whale- Artemis Arctic

VD05 – Sperm whale

Figure 3: VD#05 30 July 2021 – Sperm whale- Artemis Arctic

VD06 – Sperm whale

Figure 4: VD#06 30 July 2021 – Sperm whale- Artemis Arctic

VD07 – Sperm whale

Figure 5: VD#07 01 August 2021 – Sperm whale- Artemis Arctic

VD08 – Unidentified whale

Figure 6: VD#08 01 August 2021 – Unidentified whale- Artemis Arctic

VD09 – Sperm whale

Figure 7: VD#09 02 August 2021 – Sperm whale- Artemis Arctic