ECHO OFFSHORE, LLC

Application for Letter of Authorization for the Non-Lethal Taking of Marine Mammals

Outer Continental Shelf, Gulf of Mexico

Echo Offshore
Letter of Authorization

January 05, 2023

Prepared by:

RPS Energy Operations

Stephanie Milne, Russell Dauksis

20 Park Plaza #322
Boston, MA 02116

T +1 206 334 0862
E Stephanie.Milne@rpsgroup.com

Prepared for:

Echo Offshore, LLC

Matt Keith

36499 Perkins Road
Prairieville, LA 70769

T +1 225-673-2163
E keithm@echo-offshore.net

Operations Contact:

Donald Spicer

T +1 225 673-2163
Marine T +1 985 218-8298
E spicerd@echo-offshore.net

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Table of Abbreviations

µPa	micropascal
2D	two-dimensional
3D	three-dimensional
AUV	Autonomous underwater vehicle
BOEM	Bureau of Ocean Energy Management
cm	centimeters
dB	decibels
ft	feet
GOM	Gulf of Mexico
Hz	Hertz
in	inches
ITR	Incidental take regulation
kg	kilogram
LOA	Letter of Authorization
m	meter
NMFS	National Marine Fisheries Service
OCS	Outer continental shelf
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment of the NE Atlantic
PAM	Passive acoustic monitoring
psi	pounds per square inch
PSO	Protected Species Observer
ROV	Remotely operated underwater vehicle
VSP	Vertical seismic profile

1 DESCRIPTION OF PROPOSED ACTIVITIES

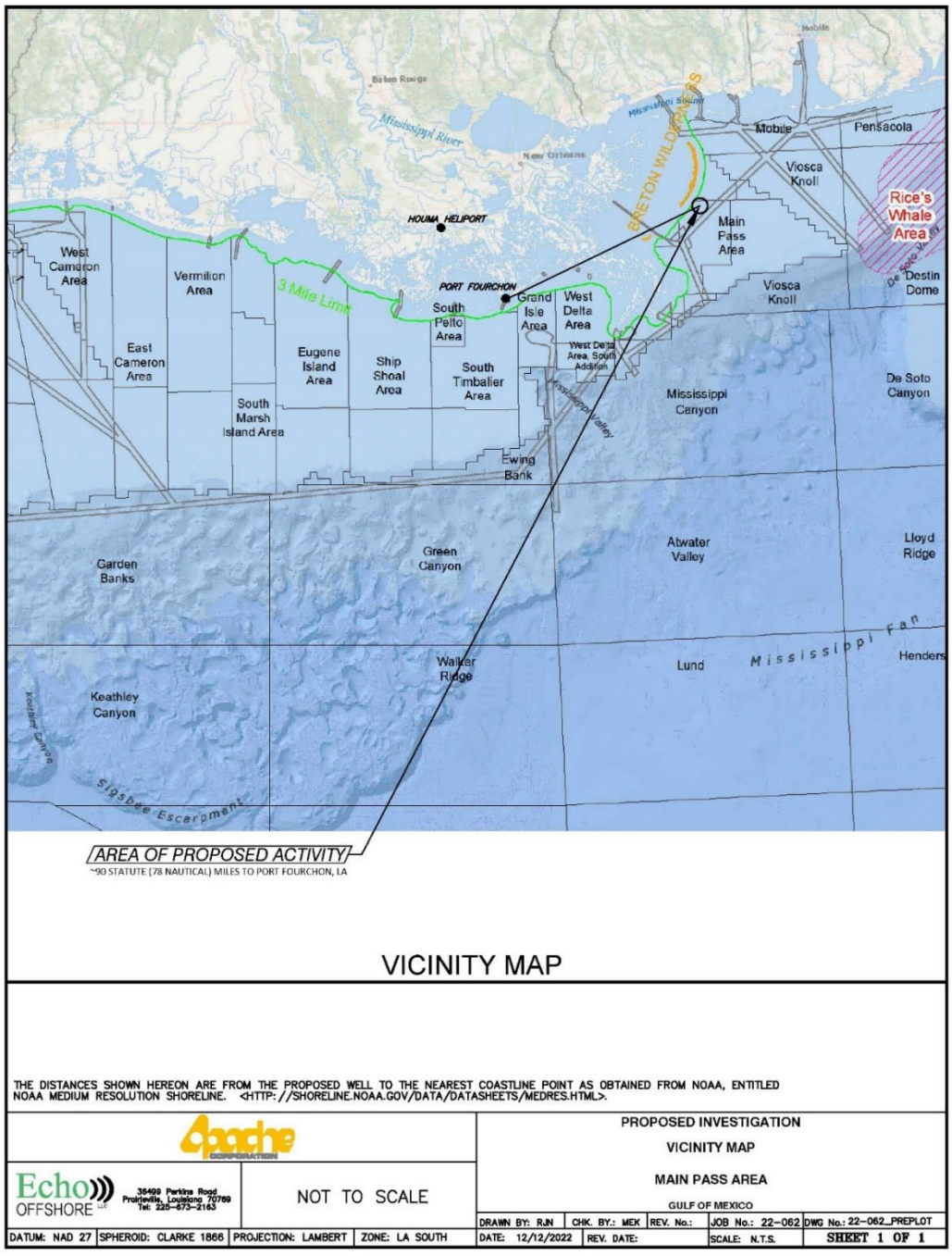
Following the most recent incidental take regulation (ITR) that took effect on April 19, 2021 (86 *Federal Register* 5322) and the requirements of 50 Code of Federal Regulations (CFR) § 216.104, Echo Offshore, LLC, referred to as the "Applicant", is submitting this request for a Letter of Authorization (LOA) for the unintentional, non-lethal taking of marine mammals from geophysical activities conducted in the Central Gulf of Mexico (GOM).

1.1 Project Description

The Applicant proposes to conduct a seismic investigation within the Bureau of Ocean Energy Management's (BOEM's) Central Planning Area of the Gulf of Mexico (GOM) that overlaps with ITR assessment zone 2 (Figure 1). Field operations will be conducted on behalf of Apache Corporation in a southern portion of Main Pass Area Block 91 and is expected to begin as soon as allowed but no later than June 2023 and take one day for seismic investigation and one more additional day for the HRG source investigation.

Table 1. Type of investigation.

Please indicate which type of investigation will be used in the proposed activity
___ **Deep Penetration Seismic (greater than 1,500 in^3 total airgun array volume)** • 2D Seismic-towed Streamer • 2D Seismic-Seafloor Cable or Nodes • 3D Seismic-towed Streamer • 3D Seismic-Seafloor Cable or Nodes • NAZ • WAZ • 4D (Time Lapse) • Vertical Cable • Borehole Seismic (VSP) _X_ **Shallow Penetration Seismic (less than 1,500 in^3 total airgun array volume)** • Surface Vessel • Surface Vessel and AUV/ROV • Borehole Seismic (VSP) ___ **HRG Investigations (no airguns used)** • Surface vessel • AUV/ROV • Both ___ **Other** Describe (if Other):



VICINITY MAP

THE DISTANCES SHOWN HEREON ARE FROM THE PROPOSED WELL TO THE NEAREST COASTLINE POINT AS OBTAINED FROM NOAA, ENTITLED NOAA MEDIUM RESOLUTION SHORELINE. <HTTP://SHORELINE.NOAA.GOV/DATA/DATASHEETS/MEDRES.HTML>.

Apache Corporation

Echo OFFSHORE LLC 35499 Perkins Road Prairieville, Louisiana 70769 Tel: 225-673-2163

NOT TO SCALE

PROPOSED INVESTIGATION
VICINITY MAP
MAIN PASS AREA
GULF OF MEXICO

DATUM: NAD 27	SPHEROID: CLARKE 1866	PROJECTION: LAMBERT	ZONE: LA SOUTH

DRAWN BY: RJN	CHK. BY.: MEK	REV. No.:	JOB No.: 22-062	DWG No.: 22-062_PREPLOT
DATE: 12/12/2022	REV. DATE:		SCALE: N.T.S.	SHEET 1 OF 1

Figure 1. Location of proposed seismic survey within Main Pass Block 91 and the 90-statute mile transit route to the south from Port Fourchon, LA. Approximately 5.5 nautical miles to nearest land, or sandbar in Breton Wilderness, and 35 nautical miles to Venice, LA.

1.2 Activities Considered in Application

A single day seismic investigation is planned to occur within the Main Pass Area Block 91 located in approximately 22 feet of water. All equipment will be towed in the water column, and then all equipment will be recovered back onto the vessel and no contact with the seafloor is expected during the proposed investigation. This investigation is expected to occur during one day between January of 2023 and June of 2023.

Table 2. Study area and operational plan.

Question:	Response:
Location: (Lease Block(s), Facility or Prospect Name, Lat/Lon, etc.)	Main Pass Area – Block 91 (29° 39' 16.28" N, 88° 50' 40.24" W)
Proposed Start Date:	No earlier than January 2023
Proposed End Date:	No later than June 2023
Overall Duration of the Activity (days):	1 day for seismic 1 additional day for non-seismic high resolution sources
Purpose of Activity:	Seismic exploration
Lease Number(s):	91
OCS Area(s):	Main Pass Area
OCS Lease Block(s):	1 lease block (Main Pass Area – Block 91)
Range of water depths (ft or m):	Between 20 and 25 feet
Average water depth (ft or m):	22 feet
Areal extent of the investigation area: (in OCS lease blocks or km^2) (Attach GIS file(s) of investigation lines and/or investigation area perimeter)	1 lease block (see Figure 3)
G&G ITR/PEIS Modeling Zone(s) in which the activity will occur (1-7):	2
Number of days during the overall activity period on which the sound source(s) listed in Section 1.3 will operate: (If the activity will occur in more than one Modeling Zone, provide the number of operating days within each modeling zone.)	2 days: 1 day for seismic survey and 1 additional day for HRG source operations

1.3 Sound Sources

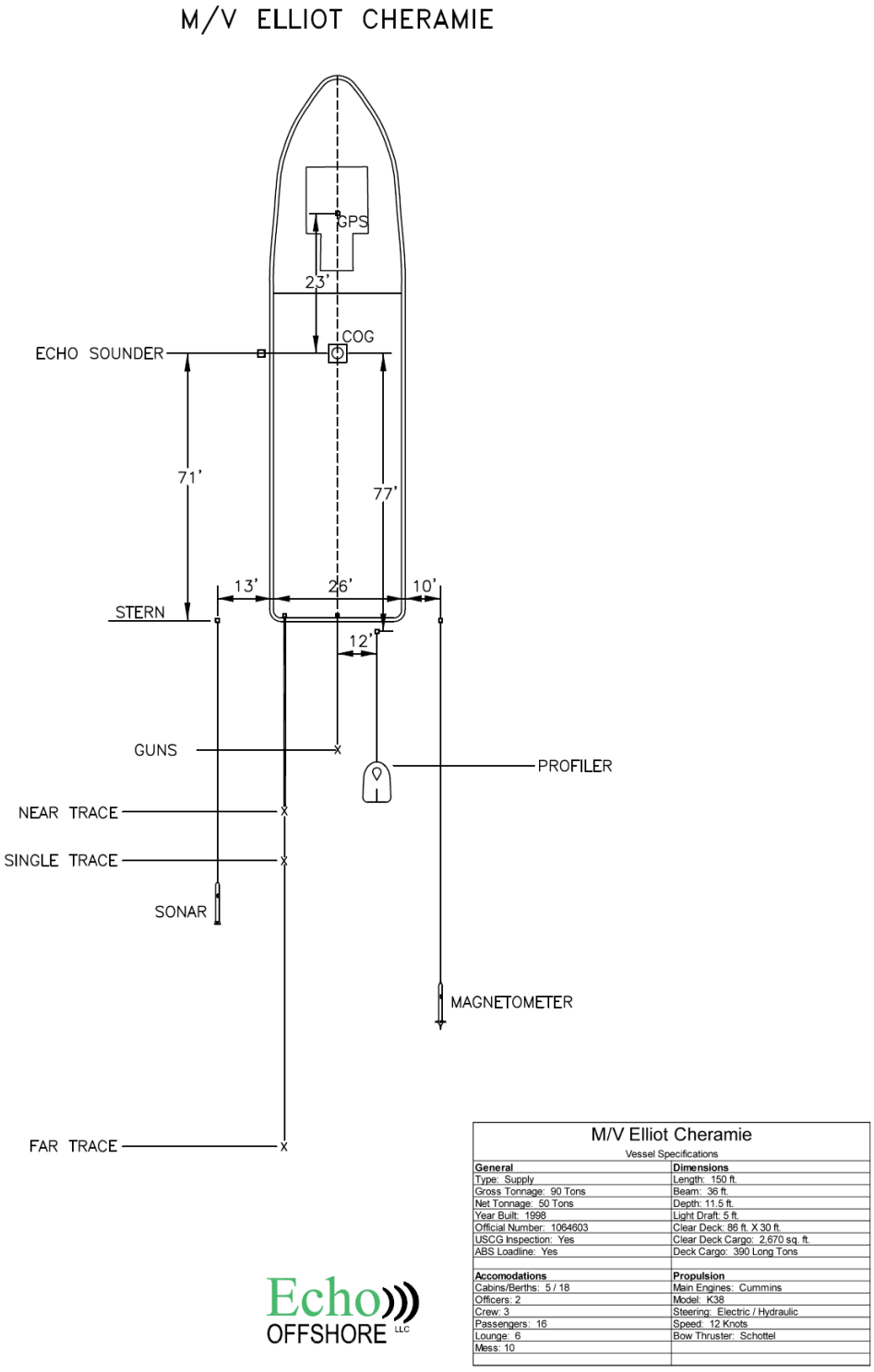
The Applicant intends to use three high resolution sources of an Edgetech sidescan sonar, an Edgetech sub-bottom profiler, and R2 Sonic mulitbeam echosounder. One ION Geophysical 2DHR air gun will be used with a maximum total volume of 20 in^3. The towing depth of this air gun will be 1 – 1.5 meters. This one day air gun investigation will cover 2 nautical miles over 6 transects covering a southern portion of one lease block (Figure 3). There will also be 29 non-seismic, north to south and east to west transects with the three high resolution sources over the two-day investigation covering 10 nautical miles.

Table 3. Sound sources to be used in the proposed investigation.

Energy Source	**Manufacturer**	**Model**	**Total Array Volume & Number of Elements** (cubic inches)	**Source Level (SL) in dB re 1µPa@1m in water** (RMS)	**Source Level (SL) in dB re 1µPa@1m in water** (Peak to Peak)	**Operating Frequency** (Hz, kHz, range)	**Pulse Duration** (seconds, milli-seconds)	**Pulse Rate (or Cycle)** (Pulses per second or minute)	**Towing Depth of the Source** (m)	**Towing Depth of the Receiver(s)** (ft or m)	**Duration of Use** (Number of Days or Percent of Active Sound Source Days)
Sidescan Sonar	Edgetech	4200-FS	N/A	163-169 dB rms	N/A	120 – 410 kHz	10 µ	2.6 Hz	1.5-2 m	N/A	2 days
SB Profiler	Edgetech	SB-216S	N/A	160 dB rms	N/A	2 – 10 kHz	125 µ	0.5 – 8/sec	1-1.5 m	N/A	2 days
Multibeam	R2 Sonic	2024	N/A	191-221 dB rms	N/A	200-400 kHz	15 µ-1ms	0-60 Hz	N/A	N/A	2 days
2DHR	ION Geophysical	SG II	20 in^3	~231 dB re 1µPa@1m	207 dB re 1µPa@1m	0 – 1,500 Hz	25 µ	6 sec	1-1.5 m	N/A	1 days

Table 4. Vessel Information.

Vessel Type	**Vessel Name**	**Registration Number**	**Registered Owner**	**Typical investigation speed** (knots)	**Highest Travelling Speed** (knots)	**Home Port**	**Vessel/Activity Support Base**	**Transit Route:**
Supply vessel (Sound source vessel)	M/V Elliot Cheramie	1064603	Cheramie Marine LLC	3 knots	12 knots	Port Fourchon, LA	Port Fourchon, LA	Direct route from Port Fourchon to Block 91 in Main Pass Area



M/V Elliot Cheramie

Vessel Specifications

General	Dimensions
Type: Supply	Length: 150 ft.
Gross Tonnage: 90 Tons	Beam: 36 ft.
Net Tonnage: 50 Tons	Depth: 11.5 ft.
Year Built: 1998	Light Draft: 5 ft.
Official Number: 1064603	Clear Deck: 86 ft. X 30 ft.
USCG Inspection: Yes	Clear Deck Cargo: 2,670 sq. ft.
ABS Loadline: Yes	Deck Cargo: 390 Long Tons
Accomodations	**Propulsion**
Cabins/Berths: 5 / 18	Main Engines: Cummins
Officers: 2	Model: K38
Crew: 3	Steering: Electric / Hydraulic
Passengers: 16	Speed: 12 Knots
Lounge: 6	Bow Thruster: Schottel
Mess: 10	

Figure 2. Schematic of high resolution sources and air gun towing location from vessel M/V *Elliot Cheramie*. The 2DHR air gun (20 in^3) will be towed approximately 1-1.5 meters below the surface.

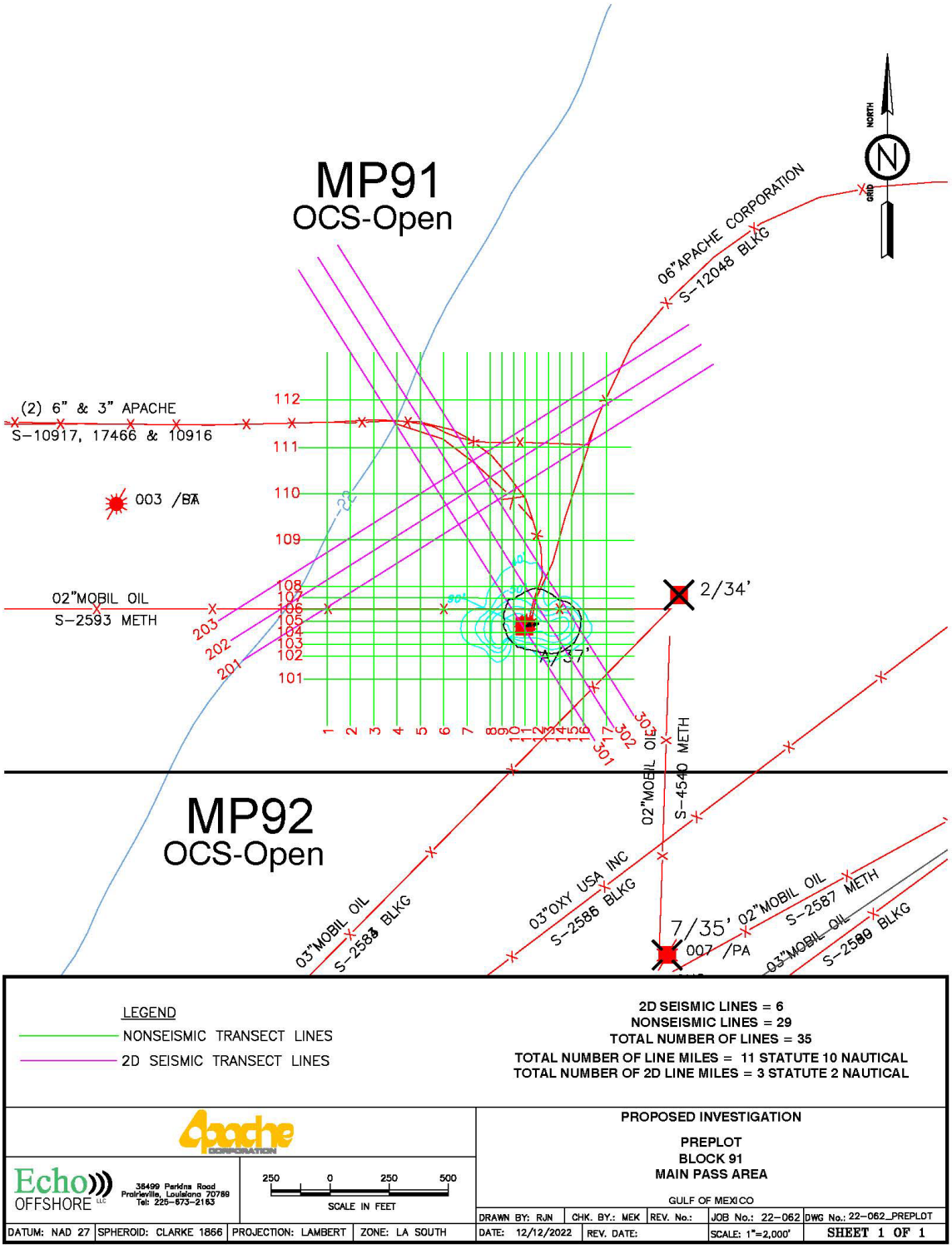


Figure 3. Proposed 2DHR air gun (20 in^3) investigation occurring during one day with magenta lines showing three transects running northeast to southwest and three transects running northwest to southeast for a total of 2 nautical miles of towing across Main Pass Area Block 91.

2 OPERATION DATES, DURATION, AND GEOGRAPHIC REGION

The Applicant proposes the investigation to occur in the months that the NOAA GOM exposure calculator classifies as winter if the survey occurs by March of 2023, or summer if the survey occurs during or after April 2023. The 2DHR seismic portion of the investigation will place during only one day, and other high-resolution sources will complete the survey over one additional day. The investigation will occur within Main Pass Area Block 91 within BOEM's Central Planning Area of the GOM. This location falls within ITR assessment zone 2, and this was used for the marine mammal exposure estimation. The investigation vessel M/V *Elliot Cheramie* will depart from Port Fourchon, LA and transit directly southward to Block 91, avoiding any transit or operation near the Bryde's Whale Core Distribution that is over 80 miles to the east of Port Fourchon, LA (Figure 1).

3 MARINE MAMMAL SPECIES AND ABUNDANCES

The published ITR (86 *Federal Register* 5322) provides information about marine mammal protection status, distribution, and predicted mean/maximum abundances for marine mammal species (Table 5).

Table 5. Summary information of species of marine mammals occurring in the northern Gulf of Mexico.

Common Name	Scientific Name	Stock	ESA Status[1]	Predicted Mean Abundance	Predicted Maximum Abundance
Rice's whale	*Balaenoptera edeni*	GOM	E/D	44	n/a
Sperm whale	*Physeter macrocephalus*	GOM	E/D	2,128	2,234
Pygmy sperm whale[2]	*Kogia breviceps*	GOM	N	2,234	6,117
Dwarf sperm whale[2]	*K. sima*	GOM	N	2,234	6,117
Cuvier's beaked whale[3]	*Ziphius cavirostris*	GOM	N	2,910	3,958
Gervais beaked whale[3]	*Mesoplodon europaeus*	GOM	N	2,910	3,958
Blainville's beaked whale[3]	*M. densirostris*	GOM	N	2,910	3,958
Rough-toothed dolphin	*Steno bredanensis*	GOM	N	4,853	n/a
Common bottlenose dolphin	*Tursiops truncatus truncatus*	GOM Oceanic, Coastal, and Continental Shelf	N	138,602	192,176
Clymene dolphin	*Stenella clymene*	GOM	N	11,000	12,115

Common Name	Scientific Name	Stock	ESA Status[1]	Predicted Mean Abundance	Predicted Maximum Abundance
Atlantic spotted dolphin	*S. frontalis*	GOM	N	47,488	85,108
Pantropical spotted dolphin	*S. attenuata attenuata*	GOM	N	84,014	108,764
Spinner dolphin	*S. longirostris longirostris*	GOM	N	13,485	31,341
Striped dolphin	*S. coeruleoalba*	GOM	N	4,914	5,323
Fraser's dolphin	*Lagenodelphis hosei*	GOM	N	1,665	n/a
Risso's dolphin	*Grampus griseus*	GOM	N	3,137	4,153
Melon-headed whale	*Peponocephala electra*	GOM	N	6,733	7,105
Pygmy killer whale	*Feresa attenuata*	GOM	N	2,126	n/a
False killer whale	*Pseudorca crassidens*	GOM	N	3,204	n/a
Killer whale	*Orcinus orca*	GOM	N	185	n/a
Short-finned pilot whale	*Globicephala macrorhynchus*	GOM	N	1,981	n/a

[1]ESA status: (E) – Endangered, (D) – Depleted, (N) – Not listed or designated as depleted under the Marine Mammal Protection Act.
[2]These species are too difficult to differentiate at sea and are grouped together in their abundance estimate.
[3]These species are too difficult to differentiate at sea and are grouped together in their abundance estimate.

4 TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED

The Applicant requests an LOA pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA) for incidental take of small numbers of marine mammals by Level B harassment in the specific ITR zone 2 (Figure 1). The sound source from the proposed investigation may exceed established acoustic thresholds for Level A or B marine mammal harassment (NMFS, 2018).

5 MARINE MAMMAL TAKE ESTIMATES

The GOM exposure estimation tool that was provided by the National Marine Fisheries Service (NMFS) was used to estimate exposures of each marine mammal species in the investigation area (NMFS, 2021b). The tool applies modeling by Zeddies et al. (2015) to estimate exposure. The smallest sized investigation option of the exposure calculator was a single air gun of a 90 in^3 volume, and it was deemed unsuitable to divide those estimated exposure metrics to equal the size of the air gun array used in this investigation. With the air gun to be used only 20 in^3, it must be noted that this is a conservative estimate of the exposure to marine mammals for the proposed investigation.

Acoustic thresholds are outlined by the NMFS to identify the received level of underwater sound at which marine mammals would be expected to have disrupted behavioral patterns or injury. Level B harassment

is considered a disruption in behavior, but it can be difficult to assess as individuals will react differently depending on their activity at the time of sound or previous exposure to sound. Different species will also react differently, but NMFS considers 160 dB as an acoustic threshold for impulsive sources (air guns) and 120 dB for continuous sources (NMFS, 2018). Level A harassment is defined as having the potential to injure a marine mammal or marine mammal stock in the wild.

Table 6. Representative species of marine mammal hearing groups from the NMFS exposure estimation tool (NMFS, 2020).

Marine Mammal Hearing Group	Species
Low-frequency cetaceans	Baleen whales
Mid-frequency cetaceans	Dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency cetaceans	True porpoises, *Kogia,* river dolphins, cephalorhynchid
Phocid pinnipeds	True seals
Otariid pinnipeds	Sea lions and fur seals

5.1 Level A Harassment of Marine Mammals

According to the Gulf of Mexico Seismic Survey Exposure Calculator (NOAA, 2021b) Level A harassment from this seismic investigation is not expected, with no zone 2 exposures to any of the GOM marine mammal populations (Table 7).

Table 7. Maximum annual Level A exposures for the one day proposed single airgun seismic survey estimated using the NMFS exposure estimation tool (NMFS, 2021b).

Common Name	Hearing Group	Predicted Mean Abundance	Zone 2 Exposures	Maximum Population Affected
Rice's (Bryde's) whale	Low-frequency	44	< 0.01	0%
Kogia sp. (Dwarf, pygmy sperm whale)	High-frequency	2,234	< 0.01	0%
Sperm whale	Mid-frequency	2,128	0	0%
Beaked whales (Cuvier's/Blainville's/Gervais)	Mid-frequency	2,910	0	0%
Rough-toothed dolphin	Mid-frequency	4,853	0	0%
Common bottlenose dolphin	Mid-frequency	138,602	0	0%
Clymene dolphin	Mid-frequency	11,000	0	0%
Atlantic spotted dolphin	Mid-frequency	47,488	0	0%

Common Name	Hearing Group	Predicted Mean Abundance	Zone 2 Exposures	Maximum Population Affected
Pantropical spotted dolphin	Mid-frequency	84,014	0	0%
Spinner dolphin	Mid-frequency	13,485	0	0%
Striped dolphin	Mid-frequency	4,914	0	0%
Fraser's dolphin	Mid-frequency	1,665	0	0%
Risso's dolphin	Mid-frequency	3,137	0	0%
Melon-headed whale	Mid-frequency	6,733	0	0%
Pygmy killer whale	Mid-frequency	2,126	0	0%
False killer whale	Mid-frequency	3,204	0	0%
Killer whale	Mid-frequency	185	0	0%
Short-finned pilot whale	Mid-frequency	1,981	0	0%

5.2 Level B Harassment of Marine Mammals

Level B exposures were calculated using the NMFS exposure estimation tool (NMFS, 2021b) using the sound source information (Tables 8 and 9) of and the investigation occurring in the ITR zone 2 of exposures. Exposure to level B harassment of marine mammals within the investigation area is expected to be low to non-existent, with common bottlenose dolphins potentially having the highest percentage of the population at 0.02% or only 27 individuals in summer or 31 individuals in winter (Tables 8 and 9). The only other populations with any expected Level B harassment are the rough-toothed dolphin (0.01%), Atlantic spotted dolphin (0.01%), and the false killer whale (< 0.01%). All other populations of marine mammals are estimated to have no exposure to Level B harassment.

Table 8. Maximum annual Level B exposures for the one day proposed single airgun seismic survey estimated using the NMFS exposure estimation tool during summer months (NMFS, 2021b).

Common Name	Hearing Group	Predicted Mean Abundance	Zone 2 Exposures	Maximum Population Affected
Rice's (Bryde's) whale	Low-frequency	44	< 0.01	0%
Kogia sp. (Dwarf, pygmy sperm whale)	High-frequency	2,234	< 0.01	0%
Sperm whale	Mid-frequency	2,128	< 0.01	0%
Beaked whales (Cuvier's/Blainville's/Gervais)	Mid-frequency	2,910	< 0.01	0%

Common Name	Hearing Group	Predicted Mean Abundance	Zone 2 Exposures	Maximum Population Affected
Rough-toothed dolphin	Mid-frequency	4,853	0.46	0.01%
Common bottlenose dolphin	Mid-frequency	138,602	27.17	0.02%
Clymene dolphin	Mid-frequency	11,000	< 0.01	0%
Atlantic spotted dolphin	Mid-frequency	47,488	5.90	0.01%
Pantropical spotted dolphin	Mid-frequency	84,014	< 0.01	0%
Spinner dolphin	Mid-frequency	13,485	< 0.01	0%
Striped dolphin	Mid-frequency	4,914	< 0.01	0%
Fraser's dolphin	Mid-frequency	1,665	< 0.01	0%
Risso's dolphin	Mid-frequency	3,137	< 0.01	0%
Melon-headed whale	Mid-frequency	6,733	< 0.01	0%
Pygmy killer whale	Mid-frequency	2,126	< 0.01	0%
False killer whale	Mid-frequency	3,204	0.03	< 0.01%
Killer whale	Mid-frequency	185	< 0.01	0%
Short-finned pilot whale	Mid-frequency	1,981	< 0.01	0%

Table 9. Maximum annual Level B exposures for the one day proposed single airgun seismic survey estimated using the NMFS exposure estimation tool during winter months (NMFS, 2021b).

Common Name	Hearing Group	Predicted Mean Abundance	Zone 2 Exposures	Maximum Population Affected
Rice's (Bryde's) whale	Low-frequency	44	< 0.01	0%
Kogia sp. (Dwarf, pygmy sperm whale)	High-frequency	2,234	< 0.01	0%
Sperm whale	Mid-frequency	2,128	< 0.01	0%
Beaked whales (Cuvier's/Blainville's/Gervais)	Mid-frequency	2,910	< 0.01	0%
Rough-toothed dolphin	Mid-frequency	4,853	0.52	0.01%
Common bottlenose dolphin	Mid-frequency	138,602	30.87	0.02%
Clymene dolphin	Mid-frequency	11,000	< 0.01	0%

Common Name	Hearing Group	Predicted Mean Abundance	Zone 2 Exposures	Maximum Population Affected
Atlantic spotted dolphin	Mid-frequency	47,488	6.68	0.01%
Pantropical spotted dolphin	Mid-frequency	84,014	< 0.01	0%
Spinner dolphin	Mid-frequency	13,485	< 0.01	0%
Striped dolphin	Mid-frequency	4,914	< 0.01	0%
Fraser's dolphin	Mid-frequency	1,665	< 0.01	0%
Risso's dolphin	Mid-frequency	3,137	< 0.01	0%
Melon-headed whale	Mid-frequency	6,733	< 0.01	0%
Pygmy killer whale	Mid-frequency	2,126	< 0.01	0%
False killer whale	Mid-frequency	3,204	0.04	< 0.01%
Killer whale	Mid-frequency	185	< 0.01	0%
Short-finned pilot whale	Mid-frequency	1,981	< 0.01	0%

6 EFFECTS ON MARINE MAMMALS OR STOCKS

The results of an analysis of 10 years of geophysical activities in the GOM following an expert working group (Southall et al. 2014) shows that the total take from all approved activities will have negligible impacts on all impacted marine mammal stocks within the GOM (86 *Federal Register* 5322). Level A harassment of marine mammal populations are expected to be non-existent during the proposed one-day investigation, with no individuals of any species estimated to be exposed. Only 0.02% of the common bottlenose dolphin population are estimated to be exposed to Level B harassment, with all other GOM species experiencing ≤ 0.01% of their populations exposed. The difference between whether this survey occurs during winter or summer months is so negligible that the percent of populations exposed to level B harassment does not change between the two seasons. Also, with the take estimates of this investigation conservatively estimated using a larger 90 in^3 single air gun as the closest available investigation type in the GOM exposure estimator tool instead of the proposed 20 in^3 air gun, no negative impacts to marine mammal populations are expected to occur.

The take estimates represent the entirety of the ITR zone 2, but this investigation will only occur within one lease block. The NMFS exposure estimation tool also does not factor mitigation efforts, which would be expected to negate any potential for Level A exposures and greatly reduce the risk of Level B

harassment. No negative effects to marine mammal stocks are anticipated from this proposed project by the Applicant.

7 MINIMIZATION OF ADVERSE EFFECTS TO SUBSISTENCE USES

NMFS requires any marine mammal stocks within the investigation area that are used for subsistence hunting to be identified and any adverse effects to be minimized. There are no subsistence hunting areas near the proposed investigation location, and no stocks of marine mammals that are used for subsistence uses will be impacted.

8 ANTICIPATED IMPACTS ON HABITAT

Disturbance of the benthic environment is expected to be non-existent, as no contact of any equipment with the seafloor is expected. No use of ROVs is required for this investigation, and no nodes or receivers are being placed on the seafloor.

9 ANTICIPATED EFFECTS OF HABITAT IMPACTS ON MARINE MAMMALS

The effects to marine mammals from loss or modification of habitat from the proposed investigation will be negligible and undetectable.

10 MITIGATION AND MONITORING EFFORTS

Following the final ITR (86 *Federal Register* 5322), the investigation will aim to have the “least practicable adverse impact” on the affected species or stocks and their habitat. There will be no adverse effects to marine life. The use of airgun sources will follow NTL 2016-BOEM-G02.

Noise from our source activities can create a disturbance to marine mammals. To mitigate the impact, we have real-time PSO (Protected Species Observers) aboard the source vessel during the one day of 2DHR air gun operation. This allows us to detect marine mammals 24/7 during operations and take avoiding action and/or vessel standby until the area is free for seismic data acquisition to recommence. Another control is our soft start procedures in line with JNCC requirements where the source airgun steadily increases over a period of 20 minutes to allow mammals to vacate the area. This requirement is monitored for compliance by the PSO.

Fluids are not dispersed into the environment from our normal subsea and source operations.

11 ARCTIC PLAN OF COOPERATION

This plan is not applicable for this application as this is only for activities that occur in Alaskan waters north of 60°N latitude, and the proposed investigation is in the Gulf of Mexico.

12 REFERENCES

50 Code of Federal Regulations (CFR) § 216.104. 2009. Submission of Requests.

86 Federal Register (FR) 5322. 2018. Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Geophysical Surveys Related to Oil and Gas Activities in the Gulf of Mexico. 19 January 2021.

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National Marine Fisheries Service (NMFS). 2021b. Gulf of Mexico exposure estimation tool.

Southall BL, Ellison WT, Clark CW, Tollit D. 2014. Analytical Framework for Assessment Potential Effects of Seismic Airgun Surveys on Marine Mammals in the Gulf of Mexico (GOMEX). Expert Working Group (EWG) Final Report. 55 pp.

Zeddies DG, Zykov M, Yurk H, Deveau T, Bailey L, Gaboury I, Racca R, Hannay D, Carr S. 2015. Acoustic Propagation and Marine Mammal Exposure Modeling of Geological and Geophysical Sources in the Gulf of Mexico: 2016-2025 Annual Acoustic Exposure Estimates for Marine Mammals. Technical Report by JASCO Applied Sciences for the U.S. Department of the Interior, Bureau of Ocean Energy Management. JASCO Document 00976, Version 3.0. 385 pp.