Bay State Wind LLC

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Request for the Taking of Marine Mammals Incidental to the Site Characterization of the Bay State Wind Offshore Wind Farm

Submitted to National Oceanic and Atmospheric Administration
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Acronyms and Abbreviations

ASV	autonomous surface vehicle
BOEM	Bureau of Ocean Energy Management
CeTAP	Cetacean and Turtles Assessment Program
CFR	Code of Federal Regulations
dB	decibel
DMA	Dynamic Management Area
DoN	U.S. Department of the Navy
ECM	Environmental Compliance Monitor
ESA	Endangered Species Act
ft	foot
GAPS	global acoustic positioning system
GPS	global positioning system
HF	high-frequency
HRG	high-resolution geophysical
Hz	hertz
IHA	Incidental Harassment Authorization
IUCN	World Conservation Union
IWC	International Whaling Commission
kHz	kilohertz
km	kilometer
knot	nautical mile per hour
LF	low-frequency
m	meter
MF	mid-frequency
mi	mile
MMPA	Marine Mammal Protection Act
nm	nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
OPAREA	Operations Area
OSS	offshore substation
PAM	Passive Acoustic Monitoring
PSO	Protected Species Observer
PTS	permanent threshold shift
RMS	root mean square
SEL	sound exposure level
SELcum	cumulative SEL
SL	sound level
SMA	Seasonal Management Area
The Applicant	Bay State Wind LLC
The Lease Area	OCS-A 0500
TTS	temporary threshold shift
USBL	Ultra-Short Base Line
WTG	wind turbine generator

ZOI	Zone of Influence
μPa	microPascal

1. Description of Specified Activity

Bay State Wind LLC (the Applicant) is proposing to conduct marine site characterization surveys off the coast of Massachusetts in the area of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0500) (the Lease Area; Figure 1-1). The Applicant submits this request for Incidental Harassment Authorization (IHA) pursuant to Section 101(a)(5) of the Marine Mammal Protection Act (MMPA) and 50 Code of Federal Regulations (CFR) § 216 Subpart I to allow for the incidental harassment of small numbers of marine mammals resulting from the execution of marine site characterization surveys in the Lease Area specifically associated with the operation of high-resolution geophysical (HRG) and geotechnical survey equipment during upcoming field activities. The objective of this survey is to acquire geophysical data within the proposed construction and operational footprints of the Project (i.e., export and inter array cable construction corridors, wind turbine generator [WTG] foundation and installation areas, the offshore substation [OSS] foundation and installation area) in accordance with Bureau of Ocean Energy Management (BOEM) Archaeological guidelines and geophysical and geotechnical guidelines:

1. Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR Part 585 (March 2017)
2. Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585 (July 2015)

Both the National Oceanic and Atmospheric Administration (NOAA) and BOEM have advised that sound-producing survey equipment operating below 200 kilohertz (kHz) (e.g., sub-bottom profilers) has the potential to cause acoustic harassment to marine species, in particular marine mammals. This request is being submitted to specifically address survey sound-producing data acquisition equipment that operate below 200 kHz.

The regulations set forth in Section 101(a) (5) of the MMPA and 50 CFR § 216 Subpart I allow for the incidental taking of marine mammals by a specific activity if the activity is found to have a negligible impact on the species or stock(s) of marine mammals and will not result in immitigable adverse impact on the availability of the marine mammal species or stock(s) for certain subsistence uses. In order for the NOAA National Marine Fisheries Service (NMFS) to consider authorizing the taking by U.S. citizens of small numbers of marine mammals incidental to a specified activity (other than commercial fishing), or to make a finding that incidental take is unlikely to occur, a written request must be submitted to the Assistant Administrator. Such a request is detailed in the following sections.

1.1 Survey Activities

The Applicant will conduct marine site characterization surveys in the marine environment within the Phase I Development Area located approximately 14 miles (mi, 22.5 kilometers [km]) south of Martha’s Vineyard, Massachusetts, at its closest point and associated Export Cable construction corridor to shore (Figure 1-1). Marine site characterization surveys will consist of HRG survey activities. The purpose of the marine site characterization surveys are to:

- Support the final siting, design, and installation of offshore project facilities, turbines and subsea cables within the project area; and
- Collect the data necessary to support the Project review requirements associated with Section 106 of the National Historic Preservation Act of 1966, as amended.

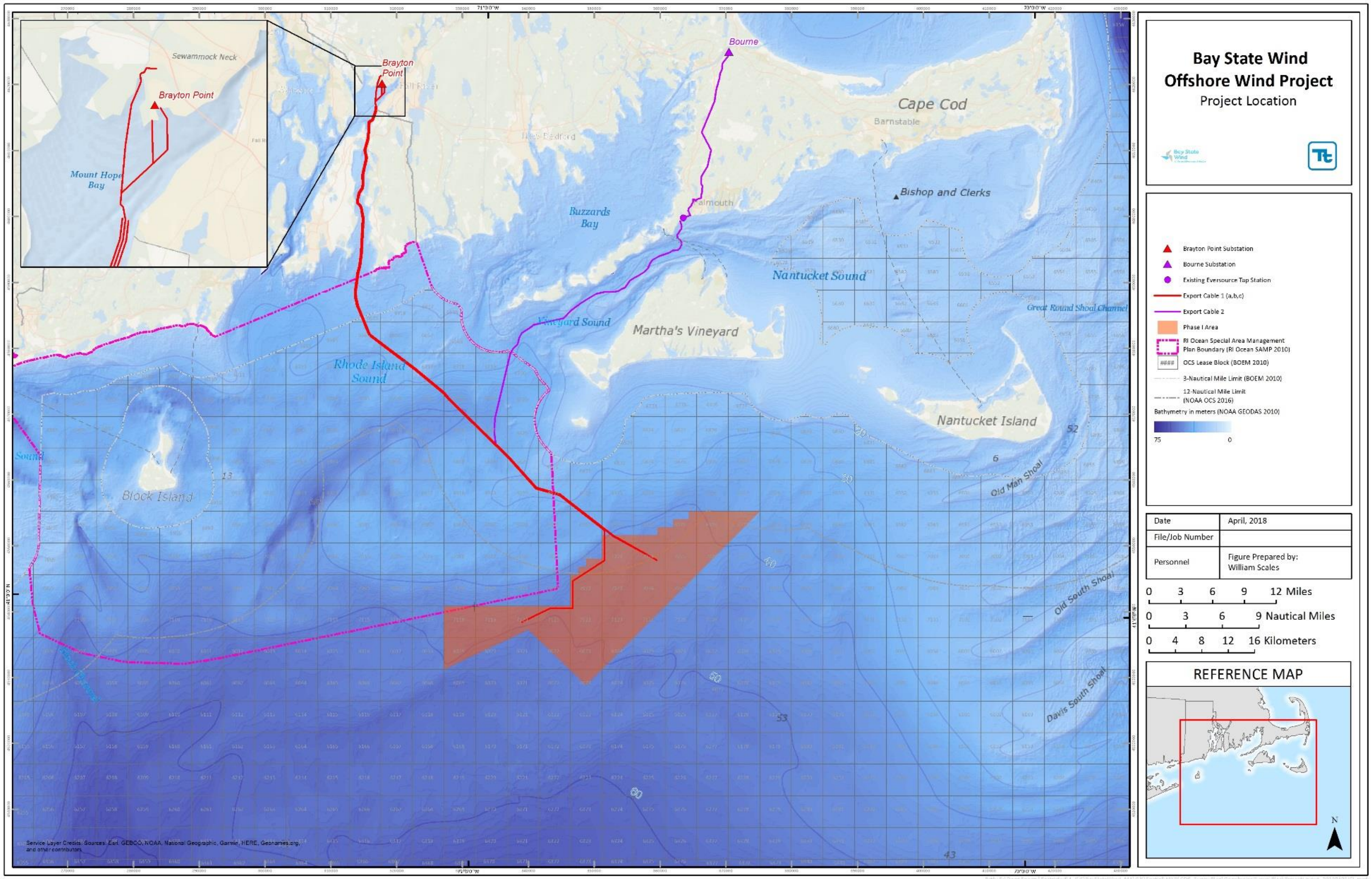

Figure 1-1 Project Location

The HRG survey activities will include the following:

- Depth sounding (multibeam depth sounder) to determine water depths and general bottom topography (currently estimated to range from approximately 3 to 180 feet [ft, 1 to 55 meters [m][, in depth below mean lower low water);
- Magnetic intensity measurements for detecting local variations in regional magnetic field from geological strata and potential ferrous objects on and below the bottom;
- Seafloor imaging (sidescan sonar survey) for seabed sediment classification purposes, to identify natural and man-made acoustic targets resting on the bottom as well as any anomalous features;
- Shallow penetration sub-bottom profiler (pinger/chirp) to map the near surface stratigraphy (top 0 to 5 m soils below seabed); and
- Medium penetration sub-bottom profiler (sparker) to map deeper subsurface stratigraphy as needed (soils down to 75-100 m below seabed).

The HRG surveys are scheduled to begin no earlier than May 1, 2018. The survey equipment to be employed will be equivalent to the equipment utilized during the previous 2016 and 2017 Bay State Wind HRG surveys. Table 1-1 identifies the representative survey equipment and relevant acoustic parameters that is being considered in support the HRG survey activities. The make and model of the listed HRG equipment have been finalized as part of the survey preparations and contract negotiations with the survey contractor. None of the proposed HRG survey activities will result in the disturbance of bottom habitat in the survey area.

Assuming a maximum survey track line to fully cover the Phase I Development Area, the survey activities will be supported by up to three vessels sufficient in size to accomplish the survey goals in specific survey areas and capable of maintaining both the required course and a survey speed of approximately 4.0 nautical miles per hour (knots) while transiting survey lines. Recent survey requirements have necessitated an expansion of potential survey activities to include an additional cable route and landfall locations. While the exact location for this expansion remains unknown, a general survey area has been provided in Figure 1-1. While survey tracks could shorten, the maximum survey track scenario has been selected to provide operational flexibility. These vessels will be assigned their respective survey segments (see Figure 1-1). Survey segment distances represent a maximum extent, and distances may vary depending on contractor used. To the extent possible, the survey activities within each segment will build from and infill the HRG data collected in 2016 and 2017.

- **Export Cable Route to Somerset, MA** – The Export Cable Route to Somerset will be split into two Lots. The separation between the Lots reflects the boundary between state and federal waters; this boundary coincides with the 3-nm maritime boundary:
  - **Lot 1** – 1,640-ft (500-m) wide survey corridor from the 3-nm maritime boundary near coastal shallow water region at which point the corridor splits into three extensions towards the proposed landfall locations (Extension 1a, 1b, and 1c). Each extension is 820 ft (250 m) wide. The total estimated trackline miles are estimated to be approximately 350 miles (mi) (563 km); and
  - **Lot 2** – 3,281-ft (1,000-m) wide survey corridor in the offshore region. The total estimated trackline miles are estimated to be approximately 678 mi (1,091 km);

- **Phase I Development Area** – The Phase 1 Development Area will comprise Lot 3. Lot 3 will consist of the following survey areas resulting in approximately 1,768 mi (2,845 km) survey trackline miles:
  - 656-ft (200-m) radius around the planned locations for OSS;
  - 492-ft (150-m) radius around the planned locations for WTGs; and
  - 246-ft (75-m) radius around planned location for inter-array cable segments; and
- **Export Cable Route to Falmouth, MA** – The Export Cable Route to Falmouth, MA will be split into two Lots. The separation between the Lots reflects the boundary between state and federal waters; this boundary coincides with the 3-nm maritime boundary:
  - **Lot 4** – 3,281-ft (1,000-m) wide survey corridor in the offshore region. The total estimated trackline miles are estimated to be approximately 1,400 mi (2,253 km); and
  - **Lot 5** – 1,640-ft (500-m) wide survey corridor in the near coastal shallow water region. The total estimated trackline miles are estimated to be approximately 67 mi (108 km).

Table 1-1 Summary of Proposed HRG Survey Data Acquisition Equipment

Representative HRG Survey Equipment	Operating Frequencies	Source Level Reported by Manufacturer	Beamwidth (degree)	Pulse Duration (millisec)	Pulse Repetition Rate (Hz)
USBL & GAPS Transceiver					
Sonardyne Ranger 2 USBL HPT 5/7000	19 – 34 kHz	206 dBPeak 200 dBRMS	180	8 to 16	1
Sonardyne Ranger 2 USBL HPT 3000	19 – 34 kHz	194 dBPeak 188 dBRMS	180	8 to 16	3
Easytrak Nexus 2 USBL	18 to 32 kHz	198 dBPeak 192 dBRMS	180	10	1
IxSea GAPS System	20 to 30 kHz	191 dBPeak 188 dBRMS	200	10	10
Sidescan Sonar					
EdgeTech 4200 dual frequency Side Scan Sonar	300 or 600 kHz	208 to 213 dB_{Peak} 205 to 210 dB_{RMS}	0.5 to 0.26 x50	2.8 to 12	5 to 55
Multibeam Sonar					
R2 Sonic 2024 Multibeam Echosounder	200 or 400 kHz	229 dB_{Peak} 162 dB_{RMS}	0.5 X 1 256 beams	0.15 to 0.5	60
Kongsberg EM2040C Dual Head	200 to 400 kHz	210 dB_{Peak} 204.5 dB_{RMS}	1 x 1	3 or 12	Up to 50
Shallow Sub-Bottom Profiler					
Edgetech 3200 XS 216	2 – 16 kHz	208 to 213 dB_{Peak} 205 to 210 dB_{RMS}	17	20	10
Innomar					
Innomar SES-2000 Medium Sub-bottom Profiler	85 – 115 kHz	250 dB_{peak} 243 dB_{RMS}	1	0.07 to 2	40

Table 1-1 Summary of Proposed HRG Survey Data Acquisition Equipment

Representative HRG Survey Equipment	Operating Frequencies	Source Level Reported by Manufacturer	Beamwidth (degree)	Pulse Duration (millisec)	Pulse Repetition Rate (Hz)
Innomar SES-2000 Standard Sub-bottom Profiler	85 – 115 kHz	243 dB_{peak} 236 dB_{RMS}	1	0.07 to 2	60
Sparkers					
GeoMarine Geo-Source 400tip	0.2 – 5 kHz	220 dB_{Peak} 205 dB_{RMS}	30	3.8	2
Boomers					
Applied Acoustics S-Boom Triple Plate Boomer	0.250 – 8 kHz	222 dB_{Peak} 216 dB_{RMS}	25 to 35	0.3 to 0.5	3
Applied Acoustics S-Boom Boomer	0.1 to 5 kHz	209 dB_{Peak} 203 dB_{RMS}	30	0.3 to 0.5	3

To minimize cost, the duration of survey activities, and the period of potential impact on marine species, the Applicant has proposed conducting continuous HRG survey operations 24 hours per day for the Phase I Development Area (Lot 3) and the offshore regions of the two Export Cable Routes (Somerset and Falmouth, Lots 2 and 4, respectively), as listed above. Near coastal shallow water regions of the Export Cable Routes (Lots 1 and 5) will require daylight-only operations. Based on 24-hour operations, the estimated duration of the survey activities for Lot 3 would be approximately 60 days. To complete Lots 2 and 4 (24-hour operations), and Lots 1 and 5 (daylight-only operations), an estimated 40 days would be required. The estimated durations to complete survey activities includes weather downtime.

To complete the proposed survey quickly and efficiently, the Applicant proposes to use multiple vessels of varying size depending on survey area location. To reduce the total survey duration, simultaneous survey activities will occur across multiple vessels in respective survey lot locations, where appropriate. For the near coastal shallow water regions of the Export Cable Routes (Lots 1 and 5), small vessels with a draft sufficient to survey shallow waters (up to 72 ft [22 m]) will be needed. Approximately 2 small vessels are planned for the shallow water regions. For the Phase I Development Area (Lot 3) and the offshore regions of the two Export Cable Routes (Somerset and Falmouth, Lots 2 and 4, respectively), up to 3 large vessels (approximately 170 ft [52 m] in length) will conduct survey operations. Out of these, a vessel surveying Lots 3 and 4 will serve as the mother vessel to a 41 ft (12.5 m) autonomous surface vehicle (ASV) that may be used to ‘force multiply’ survey production. This will allow the survey team to double the coverage through the use of the ASV. Additionally, the ASV will also capture data in water depths shallower than 26 ft (8 m), increasing the shallow end reach of the larger vessel. The ASV can also be used for nearshore operations and shallow work, approximately 20 ft (6 m) and less, in a “manned” configuration.

The ASV and mother vessel will acquire survey data in tandem and the ASV will be kept within sight of the mother vessel at all times. The ASV will operate autonomously along a parallel track to, and slightly ahead of, the mother vessel at a distance set to prevent crossed signaling of survey equipment (within 2,625 ft [800 m]). During data acquisition surveyors have full control of the data being acquired and have the ability to make changes to settings such as power, gain, range scale etc. in real time. Surveyors will also be able to monitor the data as it is acquired by the ASV utilizing a real time IP radio link. For each 12 hour shift, an ASV technician will be assigned to manage the vessel during his or her shift to ensure the vehicle is operating properly and to take over control of the vehicle should the need arise. The ASV is outfitted with an array of cameras, radars, thermal equipment and AIS, all of which is monitored in real time by the ASV technician. This includes a forward-facing dual thermal/HD camera installed on the mother vessel to provide a field of view ahead of the vessel and around the ASV, forward-facing thermal camera on the ASV itself with a real-time monitor display installed on the mother vessel bridge, and use of night-vision goggles with thermal clip-ons for monitoring around the mother vessel and ASV. Additionally, there will be 2 survey technicians per shift assigned to acquire the ASV survey data.

All data-acquiring survey vessels will utilize an assemblage of HRG survey equipment from those represented in Table 1-1, and will be in operation simultaneously in their respective survey lots. As noted previously, both NOAA and BOEM have advised that the deployment of HRG survey equipment including the use of sound-producing equipment operating below 200 kHz (e.g., sub-bottom profilers) has the potential to cause acoustic harassment to marine species, in particular marine mammals. Based on the frequency ranges of the potential equipment to be used in support of the HRG survey activities (Table 1-1) and the hearing ranges of the marine mammals that have the potential to occur in the Survey Area during survey activities (Table 6-1), only the Ultra-Short Base Line (USBL) positioning system, sub-bottom profilers (GeoPulse Sub-bottom Profiler and Geo-Source sparker), the Innomar SES-2000 Sub-bottom Profiler, and Applied Acoustics S-Boom boomer fall within the established marine mammal hearing ranges and have the potential to result in Level B Harassment of marine mammals.

1.2 Survey Activities Resulting in the Potential Incidental Taking of Marine Mammals

The potential effects of underwater noise resulting in takes on marine mammals are federally managed by NOAA under the MMPA to minimize the potential for both harm and harassment. Under the MMPA, Level A harassment is statutorily defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild; however, the actionable sound pressure level is not identified in the statute. Level B harassment is defined as any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

In July of 2016, NMFS finalized the *Technical Guidance for Assessing the Effect of Anthropogenic Sound on Marine Mammals.* Under this new NMFS guidance, Level A harassment is said to occur as a result of exposure to high noise levels and the onset of permanent hearing sensitivity loss, known as a permanent threshold shift (PTS). This revision to earlier NMFS guidelines is based on findings published by the Noise Criteria Group (Southall et al., 2007). For transient and continuous sounds, it was concluded that the potential for injury is not just related to the level of the underwater sound and the hearing bandwidth of the animal, but is also influenced by the duration of exposure. The evaluation of the onset of PTS and temporary threshold shift (TTS) provides additional species-specific insight on the potential for affect that is not captured by evaluations completed using the previous NMFS thresholds for Level A and Level B harassment alone.

Frequency weighting provides a sound level referenced to an animal's hearing ability either for individual species or classes of species, and therefore a measure of the potential of the sound to cause an effect. The measure that is obtained represents the perceived level of the sound for that animal. This is an important consideration because even apparently loud underwater sound may not effect an animal if it is at frequencies outside the animal's hearing range. In the NMFS final Guidance document, there are five hearing groups: Low-frequency (LF) cetaceans (baleen whales), Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales), High-frequency (HF) cetaceans (true porpoises, Kogia, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*), Phocid pinnipeds (true seals), and Otariid pinnipeds (sea lions and fur seals). It should be noted that Otariid pinnipeds do not occur within the Lease Area.

There are specific hearing criteria thresholds provided by NMFS for each of group. These criteria apply hearing adjustment curves for each animal group known as M-weighting (see Table 1-2).

Table 1-2 M-Weighted PTS and TTS Criteria and Functional Hearing Range for Maine Mammals (NMFS, 2016)

Functional Hearing Group	PTS Onset Impulsive	PTS Onset Non-Impulsive	Functional Hearing Range
LF cetaceans	219 dB_{peak} & 183 dB SEL_{cum}	199 dB SEL_{cum}	7 Hz to 35 kHz
MF cetaceans	230 dB_{peak} & 185 dB SEL_{cum}	198 dB SEL_{cum}	150 Hz to 160 kHz
HF cetaceans	202 dB_{peak} & 155 dB SEL_{cum}	173 dB SEL_{cum}	275 Hz to 160 kHz
Phocid pinnipeds	218 dB_{peak} & 185 dB SEL_{cum}	201 dB SEL_{cum}	50 Hz to 86 kHz
Otariid pinnipeds	232 dB_{peak} & 203 dB SEL_{cum}	219 dB SEL_{cum}	60 Hz to 39 kHz

NOAA has defined the threshold level for Level B harassment at 120 dB_{RMS} re 1 μPa for continuous noise and 160 $dB_{RMS90\%}$ re 1 μPa for impulse noise. Within this zone, the sound produced by the proposed HRG survey equipment may approach or exceed ambient sound levels (i.e., threshold of perception or zone of audibility); however, actual perceptibility will be dependent on the hearing thresholds of the species under consideration and the inherent masking effects of ambient sound levels. The Level B harassment threshold was not updated with the July 2016 technical guidance.

As discussed further in Section 5.0, evaluation of potential take of marine mammals resulting from the generation of underwater noise from operation of the USBL positioning system, sub-bottom profilers (GeoPulse Sub-bottom Profiler and Geo-Source sparker), Innomar SES-2000 Sub-bottom Profiler, and Applied Acoustics S-Boom boomer during the proposed HRG Surveys have been evaluated under the criteria for PTS onset for impulsive noise as prescribed in the Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals (NMFS 2016; Table1-2) and NOAA's threshold level for Level B harassment of 160 $dB_{RMS90\%}$ re 1 μPa.

2. Dates, Duration, and Specific Geographic Region

2.1 Dates and Duration

The Phase I Development Area HRG surveys are anticipated to commence no earlier than May 1, 2018 and will last for approximately 60 days (including estimated weather down time). Likewise, the two Export Cable Routes (Somerset and Falmouth) are anticipated to commence no earlier than May 1, 2018 and will last for approximately 40 days (including estimated weather down time). Offshore and near coastal shallow water regions of the HRG survey will occur within the same 40-day timeframe.

2.2 Specific Geographic Region

The Applicant's survey activities will occur within both federal waters as well as state waters of Rhode Island and Massachusetts as depicted in Figure 1-1.

3. Species and Numbers of Marine Mammals

The BOEM Environmental Assessment (2014) reports 38 species of marine mammals (whales, dolphins, porpoise, and seals) in the Northwest Atlantic Outer Continental Shelf (OCS) region of the Mid-Atlantic that are protected by the MMPA, 5 of which are listed under the Endangered Species Act (ESA) and are known to be present, at least seasonally, in the Lease Area (see Table 3-1). A description of the status and distribution of these species are discussed in detail in Section 4.0.

Table 3-1 Marine Mammals Known to Occur in the Marine Waters of Southern New England

Common Name	Scientific Name	NMFS Status	Estimated Population	Stock
Toothed Whales (Odontoceti)				
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	N/A	48,819	W. North Atlantic
Atlantic spotted dolphin	*Stenella frontalis*	N/A	44,715	W. North Atlantic
Bottlenose dolphin	*Tursiops truncates*	Northern coastal stock: Strategic [a/]	11,548	W. North Atlantic, Northern Migratory Coastal
Clymene Dolphin	*Stenella clymene*	N/A	Unknown	W. North Atlantic
Fraser's Dolphin	*Lagenodelphis hosei*	N/A	Unknown	W. North Atlantic
Pan-Tropical Spotted Dolphin	*Stenella attenuata*	N/A	3,333	W. North Atlantic
Risso's dolphin	*Grampus griseus*	N/A	18,250	W. North Atlantic
Rough-Toothed Dolphin	*Steno bredanensis*	N/A	271	W. North Atlantic
Common dolphin	*Delphinus delphis*	N/A	70,184	W. North Atlantic
Striped dolphin	*Stenella coeruleoalba*	N/A	54,807	W. North Atlantic
Spinner Dolphin	*Stenella longirostris*	N/A	Unknown	W. North Atlantic
White-beaked dolphin	*Lagenorhynchus albirostris*	N/A	2,003	W. North Atlantic
Harbor porpoise	*Phocoena*	N/A	79,833	Gulf of Maine/Bay of Fundy
Killer whale	*Orcinus orca*	N/A	Unknown	W. North Atlantic
Pygmy Killer Whale	*Feresa attenuata*	N/A	Unknown	W. North Atlantic
False killer whale	*Pseudorca crassidens*	Strategic	442	W. North Atlantic
Long-finned pilot whale	*Globicephala malaena*	N/A	5,636	W. North Atlantic
Short-finned pilot whale	*Globicephala macrorhynchus*	N/A	21,515	W. North Atlantic
Sperm whale	*Physeter macrocephalus*	Endangered	2,288	North Atlantic
Pigmy sperm whale	*Kogia breviceps*	N/A	3,785 [b/]	W. North Atlantic
Dwarf sperm whale	*Kogia sima*	N/A	3,785 [b/]	W. North Atlantic
Cuvier's beaked whale	*Ziphius cavirostris*	N/A	6,532	W. North Atlantic
Blainville's beaked whale	*Mesoplodon densirostris*	N/A	7,092 [c/]	W. North Atlantic
Gervais' beaked whale	*Mesoplodon europaeus*	N/A	7,092 [c/]	W. North Atlantic
True's beaked whale	*Mesoplodon mirus*	N/A	7,092 [c/]	W. North Atlantic
Sowerby's Beaked Whale	*Mesoplodon bidens*	N/A	7,092 [c/]	W. North Atlantic

Table 3-1 Marine Mammals Known to Occur in the Marine Waters of Southern New England

Common Name	Scientific Name	NMFS Status	Estimated Population	Stock
Northern bottlenose whale	*Hyperoodon ampullatus*	N/A	Unknown	W. North Atlantic
Melon-headed whale	*Peponocephala electra*	N/A	Unknown	W. North Atlantic
Baleen Whales (Mysticeti)				
Minke whale	*Balaenoptera acutorostrata*	N/A	2,591	Canadian East Coast
Blue whale	*Balaenoptera musculus*	Endangered	Unknown	W. North Atlantic
Fin whale	*Balaenoptera physalus*	Endangered	1,618	W. North Atlantic
Humpback whale	*Megaptera novaeangliae*	N/A	823	North Atlantic
North Atlantic right whale	*Eubalaena glacialis*	Endangered	440	W. North Atlantic
Sei whale	*Balaenoptera borealis*	Endangered	357	Nova Scotia
Earless Seals (Phocidae)				
Gray seals	*Halichoerus grypus*	N/A	348,900	W. North Atlantic
Harbor seals	*Phoca vitulina*	N/A	75,834	W. North Atlantic
Hooded seals	*Cystophora cristata*	N/A	Unknown	W. North Atlantic
Harp seal	*Phoca groenlandica*	N/A	8,300,000	W. North Atlantic

Notes:
a/ A strategic stock is defined as any marine mammal stock: 1) for which the level of direct human-caused mortality exceeds the potential biological removal level; 2) which is declining and likely to be listed as threatened under the ESA; or 3) which is listed as threatened or endangered under the ESA or as depleted under the MMPA (http://www.ncseonline. org/nle/crsreports/biodiversity/biodv-11.cfm).

b/ This estimate may include both the dwarf and pygmy sperm whales.

c/ This estimate includes Gervais' and Blainville's beaked whales and undifferentiated Mesoplodon spp. beaked whales.

Sources: Hayes et al. 2017; Waring et al. 2015; Waring et al 2013; Waring et al 2011; Warring et al 2010; RI SAMP 2011; Kenney and Vigness-Raposa 2009; NMFS 2012

4. Affected Species Status and Distribution

As described in Section 3.0, there are up to 38 marine mammal species (whales, dolphins, porpoise, and seals) which are known to be present (some year–round, and some seasonally) in the Northwest Atlantic OCS region. The marine mammal species with the greatest likelihood of occurring in the Survey Area are listed in Table 3-1. All 38 marine mammal species identified in Table 3-1 are protected by the MMPA and some are also listed under the ESA. The 5 ESA-listed marine mammal species known to be present year round or seasonally in the waters of Southern New England are the sperm whale, right whale, fin whale, blue whale, and sei whale. The humpback whale, which may occur year-round, was recently delisted as an endangered species. These large whale species are generally migratory and typically do not spend extended periods of time in a localized area. The waters of Southern New England (including the Survey Area) are primarily used as areas where animals occur seasonally to feed, or as habitat during seasonal movements between the more northward feeding areas and southern hemisphere breeding grounds typically used by some of the large whale species (though some winter breeding areas exist further offshore vs. in the southerly latitudes). The mid-sized whale species (minke) and large baleen whales, and the sperm whale are present year-round in the continental shelf and slope waters and may occur in the waters of the Survey Area though movements will vary with prey availability and other habitat factors. The fin and right whales have the greater potential to occur within the offshore portions of the Survey Area however, the sperm, blue, sei and humpback whales can also occur. In particular, while sperm whales are known to occur occasionally in the region, their sightings are considered rare and thus their presence in the Survey Area at the time of the proposed activities is considered unlikely. However, based on a recent increase in sightings, they are included in the discussion below. Because the potential for the blue whale and sei whale to occur within the Survey Area during the marine survey period is the least likely, these species will not be described further in this analysis.

The following subsections provide additional information on the biology, habitat use, abundance, distribution, and the existing threats to the non-endangered or threatened and endangered marine mammals that are both common in the waters of the OCS of Southern New England and have the likelihood of occurring, at least seasonally, in the Survey Area. These species include the humpback and minke whales, bottlenose and short-beaked common dolphins, harbor porpoise, and gray and harbor seals (BOEM 2014). White-beaked dolphins are likely to occur in the nearby waters surrounding the Survey Area (i.e., within 40 nautical miles [nm, 74 km]), but not in the Survey Area, and beaked whales are likely to occur in the region to the south of the Survey Area, but not within 40 nm (74 km) (Right Whale Consortium 2014). In general, the remaining non-ESA mammal species listed in Table 3-1 range outside the Survey Area, usually in more pelagic waters, or are so rarely sighted that their presence in the Survey Area is unlikely.

4.1 Toothed Whales (Odontonceti)

4.1.1 Sperm Whale (*Physeter macrocephalus*) – Endangered

Currently, there is no reliable estimate for the total number of sperm whales worldwide. The best estimate is that there are between 300,000 and 450,000 sperm whales, based on extrapolations from only a few areas that have useful estimates (NMFS 2015). Estimates show about 1,665 in the northern Gulf of Mexico, 14,000 in the North Atlantic, 80,000 in the North Pacific, and 9,500 in the Antarctic (NMFS 2006; Waring et al. 2009). For the North Atlantic, the minimum population size has been estimated at 1,815 individuals (Hayes et al. 2017).

Sperm whales are highly social, with a basic social unit consisting of 20 to 40 adult females, calves, and some juveniles (Rice 1989; Whitehead 2008). During their prime breeding period and old age, male sperm whales are essentially solitary. Males rejoin or find nursery groups during prime breeding season. While foraging, the whales typically gather in small clusters. Between diving bouts, sperm whales are known to raft together at the surface. Adult males often forage alone. Groups of females may spread out over distances greater than 0.5 nm when foraging. When socializing, they generally gather into larger surface-active groups (Jefferson et al. 2008; Whitehead 2003). In the Northern Hemisphere, the peak breeding season for sperm whales occurs between March and June, and in the Southern Hemisphere, the peak breeding season occurs between October and December (NMFS 2009).

This species primarily preys on squid and octopus and are also known to prey on fish, such as lumpsuckers and redfish. Although sperm whales are generalists in terms of prey, specialization does appear to occur in a few places. The main sperm whale feeding grounds are correlated with increased primary productivity caused by upwelling.

The sperm whale is thought to have a more extensive distribution than any other marine mammal, except possibly the killer whale. This species is found in polar to tropical waters in all oceans, from approximately 70° N to 70° S (Rice 1989; Whitehead 2003). It ranges throughout all deep oceans of the world, essentially from equatorial zones to the edges of the polar pack ice. In the Atlantic, sperm whales are found throughout the Gulf Stream and North Central Atlantic Gyre. The current abundance estimate for this species in the North Atlantic is 2,288 individuals. The species is listed as Endangered (Hayes et al. 2017).

Sperm whales show a strong preference for deep waters (Rice 1989; Whitehead 2003). Their distribution is typically associated with waters over the continental shelf break and the continental slope and into deeper waters (Jefferson et al. 2008; Whitehead et al. 1992). Sperm whale concentrations near drop-offs and areas with strong currents and steep topography are correlated with high productivity. These whales occur almost exclusively found at the shelf break, regardless of season (NYDOS 2013). Sperm whales are somewhat migratory; however, their migrations are not as specific as seen in most of the baleen whale species. In the North Atlantic, there appears to be a general shift northward during the summer, but there is no clear migration in some temperate areas (Rice 1989; Whitehead 2003).

4.1.2 Harbor Porpoise (*Phocoena phocoena*) – Non-Strategic

The harbor porpoise inhabits shallow, coastal waters, often found in bays, estuaries, and harbors. In the western Atlantic, they are found from Cape Hatteras north to Greenland. They are likely to occur frequently in southern New England waters within all seasons, but are most likely to reach their highest densities in spring when migration brings them toward the Gulf of Maine feeding grounds from their wintering areas offshore and in the mid-Atlantic (Kenney and Vigness-Raposa 2009). After April, they migrate north towards the Gulf of Maine and Bay of Fundy. Kenney and Vigness-Raposa (2009) report that harbor porpoises are among the most abundant cetaceans in southern New England coastal waters. Harbor porpoises are the smallest North Atlantic cetacean, measuring at only 1.4 to 1.9 m, and feed primarily on fish, but also prey on squid and crustaceans (Reeves and Read 2003; Kenney and Vigness-Raposa 2009). Sighting records from the 1978 to 1981 Cetacean and Turtle Assessment Program (CeTAP) surveys showed porpoises in spring exhibited highest densities in the southwestern Gulf of Maine in proximity to the Nantucket Shoals and western Georges Bank, with presence throughout the southern New England shelf and Gulf of Maine (CeTAP 1982). While strandings have occurred throughout the south shore of Long Island and coastal Rhode Island, many sightings have occurred offshore in the OCS area (Kenney and Vigness-Raposa 2009). The North Atlantic harbor porpoise population is likely to be over 500,000 (Kenney and Vigness-Raposa 2009). The current population estimate for harbor porpoise in the Gulf of Maine/Bay of Fundy is 79,833 (Hayes et al. 2017).

The most common threat to the harbor porpoise is from incidental mortality from fishing activities, especially from bottom-set gillnets. It has been demonstrated that the porpoise echolocation system is capable of detecting net fibers, but they either must not have the “system activated” or else they fail to recognize the nets (Reeves et al. 2002). Roughly 437 harbor porpoises are killed by human-related activities in U.S. and Canadian waters each year (Hayes et al. 2017). In 1999, a Take Reduction Plan to reduce harbor porpoise bycatch in U.S. Atlantic gillnets was implemented. The plan that pertains to the Gulf of Maine focuses on sink gillnets and other gillnets that can catch groundfish in New England waters. The ruling implements time and area closures, some of which are complete closures, as well as requiring pingers on multispecies gillnets. In 2001, the harbor porpoise was removed from the candidate species list for the ESA; a review of the biological status of the stock indicated that a classification of “Threatened” was not warranted (Waring et al. 2009). This species has been listed as “non-strategic” because average annual human-related mortality and injury does not exceed the potential biological removal (Waring et al. 2015).

4.1.3 Bottlenose Dolphin (Tursiops truncatus) – Non-Strategic

The bottlenose dolphin is a light- to slate-gray dolphin, roughly 8 to 12 ft (2.4 to 3.7 m) long with a short, stubby beak. Because this species occupies a wide variety of habitats, it is regarded as possibly the most adaptable cetacean (Reeves et al. 2002). It occurs in oceans and peripheral seas at both tropical and temperate latitudes. In North America, bottlenose dolphins are found in surface waters with temperatures ranging from 10 to 32°C (50 to 90°F). Its hearing is in the mid-frequency range (Southall et al. 2007).

There are two distinct bottlenose dolphin morphotypes: migratory coastal and offshore. The migratory coastal morphotype resides in waters typically less than 65.6 ft (20 m) deep, along the inner continental shelf (within 7.5 km (4.6 miles) of shore), around islands, and is continuously distributed south of Long Island, New York into the Gulf of Mexico. This migratory coastal population is subdivided into 7 stocks based largely upon spatial distribution (Waring et al. 2016). Of these 7 coastal stocks, the Western North Atlantic migratory coastal stock is common in the coastal continental shelf waters off the coast of New Jersey (Waring et al. 2016). These animals often move into or reside in bays, estuaries, the lower reaches of rivers, and coastal waters within the approximate 25 m depth isobath north of Cape Hatteras (Reeves et al. 2002; Waring et al. 2016).

Generally, the offshore migratory morphotype is found exclusively seaward of 34 km (21 miles) and in waters deeper than 34 m (111.5 feet). This morphotype is most expected in waters north of Long Island, New York (Waring et al. 2016; Hayes et al. 2017). The offshore population extends along the entire continental shelf-break from Georges Bank to Florida during the spring and summer months, and has been observed in the Gulf of Maine during the late summer and fall. However, the range of the offshore morphotype south of Cape Hatteras has recently been found to overlap with that of the migratory coastal morphotype, sampled as close as 7.3 km (4.5 miles) from the shore in water depths of 13 m (42.7 feet) (Waring et al. 2016; Hayes et al. 2017). While bottlenose dolphins have the potential to occur in the waters off southern New England, most sightings have been during summer months and in waters deeper than 40 to 50 m (131 to 164 ft; Kenney 2013). NMFS species stock assessment report estimates the population of Western North Atlantic offshore bottlenose dolphin stock at approximately 77,532 individuals and the Western North Atlantic migratory coastal stock at approximately 11,548 individuals (Waring et al. 2016; Hayes et al. 2017).

Bottlenose dolphins feed on a large variety of organisms, depending on their habitat. The coastal, shallow population tends to feed on benthic fish and invertebrates, while deepwater populations consume pelagic or mesopelagic fish such as croakers, sea trout, mackerel, mullet, and squid (Reeves et al. 2002). Bottlenose dolphins appear to be active both during the day and night. Their activities are influenced by the seasons, time of day, tidal state, and physiological factors such as reproductive seasonality (Wells and Scott 2002).

The biggest threat to the population is bycatch because they are frequently caught in fishing gear, gillnets, purse seines, and shrimp trawls (Waring et al. 2016). They have also been adversely impacted by pollution, habitat alteration, boat collisions, human disturbance, and are subject to bioaccumulation of toxins. Scientists have found a strong correlation between dolphins with elevated levels of PCBs and illness, indicating certain pollutants may weaken their immune system (ACSonline 2004). Total U.S. fishery related mortality and serious injury for this stock is less than 10 percent of the calculated potential biological removal and, therefore, can be considered to be insignificant and approaching the zero mortality and serious injury rate. NMFS considers this species as “non-strategic” (Hayes et al. 2017).

4.1.4 Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*) – Non-Strategic

The Atlantic white-sided dolphin is typically found at a depth of 330 ft (100 m) in the cool temperate and subpolar waters of the North Atlantic, generally along the continental shelf between the Gulf Stream and the Labrador current to as far south as North Carolina (Bulloch 1993; Reeves et al. 2002; Jefferson et al. 2008). They are the most abundant dolphin in the Gulf of Maine and the Gulf of St. Lawrence, but seem relatively rare along the North Atlantic coast of Nova Scotia (Kenney and Vigness-Raposa 2009).

Atlantic white-sided dolphins range between 8 and 9 ft (2.5 and 2.8 m) in length, with females being approximately 20 centimeters shorter than males (Kenney and Vigness-Raposa 2009). This species is highly social and is commonly seen feeding with fin whales (NOAA 1993). White-sided dolphins feed on a variety of small species, such as herring, hake, smelt, capelin, cod, and squid, with regional and seasonal changes in the species consumed (Kenney and Vigness-Raposa 2009). Sand lance is an important prey species for these dolphins in the Gulf of Maine during the spring. Other fish prey include mackerel, silver hake, herring, smelt, and several other varieties of gadoids (Kenney and Vigness-Raposa 2009). There are seasonal shifts in the distribution of Atlantic white-sided dolphins off the northeastern U.S. coast, with low abundance in winter between Georges Basin and Jeffrey's Ledge and very high abundance in the Gulf of Maine during spring. During the summer, Atlantic white-sided dolphins are most abundant between Cape Cod and the lower Bay of Fundy. During the fall, the distribution of Atlantic white-sided dolphins is similar to that in the summer, although they are less abundant (DoN 2005). Recent population estimates for Atlantic white-sided dolphins in the Western North Atlantic Ocean places this species at 48,819 individuals (Hayes et al. 2017). This species can be found off the coast of southern New England during all seasons of the year, but is usually most numerous in areas farther offshore at depth range of 330 ft (100 m) (Kenney and Vigness-Raposa 2009; Bulloch 1993; Reeves et al. 2002).

The biggest human-induced threat to the Atlantic white-sided dolphin is bycatch, because they are occasionally caught in fishing gillnets and trawling equipment. An estimated average of 328 dolphins each year were killed by fishery-related activities during 2003 to 2007 (Waring et al. 2010). From 2008 through 2012, an estimated annual average of 116 dolphins per year were killed (Waring et al. 2015), and from 2010 through 2014, the estimate decreased to 74 individuals annually (Hayes et al. 2017). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as "non-strategic" (Waring et al. 2011; 2015).

4.1.5 Short-Beaked Common Dolphin (*Delphinus delphis*) – Non-Strategic

The short-beaked dolphin is one of the most widely distributed cetaceans and occurs in temperate, tropical, and subtropical regions (Jefferson et al. 2008). Short-beaked dolphins feed on squids and small fish, including species that school in proximity to surface waters as well as mesopelagic species found near the surface at night (World Conservation Union [IUCN] 2010; NatureServe 2010). They have been known to feed on fish escaping from fishermen's nets or fish that are discarded from boats (NOAA 1993). This species is found between Cape Hatteras and Georges Bank from mid-January to May, although they migrate onto Georges Bank and the Scotian Shelf between mid-summer and fall, where large aggregations occur on Georges Bank in fall (Waring et al. 2007). These dolphins can gather in schools of hundreds or thousands, although the schools generally consist of smaller groups of 30 or fewer. They are eager bow riders and are active at the surface (Reeves et al. 2002). The short-beaked common dolphin feeds on small schooling fish and squid. While this dolphin species can occupy a variety of habitats, short-beaked common dolphins occur in greatest abundance within a broad band of the northeast edge of Georges Bank in the fall (Kenney and Vigness-Raposa 2009). According to the species stock report, the best population estimate for the western North Atlantic common dolphin is approximately 70,184 individuals (Hayes et al. 2017).

Short-beaked common dolphins can be found either along the 650- to 6,500-ft (200- to 2,000-m) isobaths over the continental shelf and in pelagic waters of the Atlantic and Pacific Oceans. They are present in the western Atlantic from Newfoundland to Florida. The short-beaked common dolphin is especially common along shelf edges and in areas with sharp bottom relief such as seamounts and escarpments (Reeves et al. 2002). They show a strong affinity for areas with warm, saline surface waters. Off the coast of the eastern United States, they are particularly abundant in continental slope waters from Georges Bank southward to about 35 degrees north (Reeves et al. 2002) and usually inhabit tropical, subtropical, and warm-temperate waters (Waring et al. 2009).

The short-beaked common dolphin is also subject to bycatch. It has been caught in gillnets, pelagic trawls, and during longline fishery activities. During 2008 to 2012, it was estimated that on average approximately 289 dolphins were killed each year by human activities (Waring et al. 2015). This number increased to 409 dolphins during 2010 to 2014 (Hayes et al. 2017). This species is also the most common dolphin species to be stranded along the southern New England Coast (Kenney and Vigness-Raposa 2009). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2009; 2010; 2015).

4.2 Baleen Whales (Mysticeti)

4.2.1 North Atlantic Right Whale (*Eubalaena glacialis*) – Endangered

The North Atlantic right whale was listed as a federal endangered species in 1970. The North Atlantic right whale has seen a nominal 2 percent recovery rate since it was listed as a protected species (NOAA 2015). This is a drastic difference from the stock found in the Southern Hemisphere, which has increased at a rate of 7 to 8 percent (Knowlton and Kraus 2001). Right whales are considered grazers as they swim slowly with their mouths open. They are the slowest swimming whales and can only reach speeds up to 10 miles (mi) (16 km) per hour. They can dive at least 1,000 ft (300 m) and stay submerged for typically 10 to 15 minutes, feeding on their prey below the surface (ACSonline 2004). Right whales’ hearing is in the low-frequency range (Southall et al. 2007).

The right whale is a strongly migratory species that moves annually between high-latitude feeding grounds and low-latitude calving and breeding grounds. The present range of the western North Atlantic right whale population extends from the southeastern United States, which is utilized for wintering and calving, to summer feeding and nursery grounds between New England and the Bay of Fundy and the Gulf of St. Lawrence (Kenney 2002; Waring et al. 2011). The winter distribution of North Atlantic right whales is largely unknown, although offshore surveys have reported 1 to 13 detections annually in northeastern Florida and southeastern Georgia (Waring et al. 2013). A few events of right whale calving have been documented from shallow coastal areas and bays (Kenney 2002). Some evidence provided through acoustic monitoring suggests that not all individuals of the population participate in annual migrations, with a continuous presence of right whales occupying their entire habitat range throughout the year, particularly north of Cape Hatteras (Davis et al. 2017). These data also recognize changes in population distribution throughout the right whale habitat range that could be due to environmental or anthropogenic effects, a response to short-term changes in the environment, or a longer-term shift in the right whale distribution cycle (Davis et al. 2017).

Observations in December 2008 noted congregations of more than 40 individual right whales in the Jordan Basin area of the Gulf of Maine, leading researchers to believe this may be a wintering ground (NOAA 2008). A right whale satellite tracking study within the northeast Atlantic (Baumgartner and Mate 2005) reported that this species often visited waters exhibiting low bottom water temperatures, high surface salinity, and high surface stratification, most likely for higher food densities. The winter distribution of North Atlantic right whales is largely unknown, although offshore surveys have reported between one and 13 detections annually in northeastern Florida and southeastern Georgia (Waring et al. 2007). A few documented events of right whale calving have been from shallow coastal areas and bays (Kenney 2002). North Atlantic right whales may be found in feeding grounds within New England waters between February and May, with peak abundance in late March (NOAA 2005). While in New England, right whales feed mostly on copepods belonging to the *Calanus* and *Pseudocalanus* genus (Waring et al. 2015).

The North Atlantic right whale was the first species targeted during commercial whaling operations and was the first species to be greatly depleted as a result of whaling operations (Kenney 2002). North Atlantic right whales were hunted in southern New England until the early twentieth century. Shore-based whaling in Long Island involved catches of right whales year-round, with peak catches in spring during the northbound migration from calving grounds off the southeastern United States to feeding grounds in the Gulf of Maine (Kenney and Vigness-Raposa 2009). Abundance estimates for the North Atlantic right whale population vary. From the 2003 United States Atlantic and Gulf of Mexico Marine Mammal Stock Assessments, there were only 291 North Atlantic right whales in existence, which is less than what was reported in the Northern Right Whale Recovery Plan written in 1991 (NMFS 1991a; Waring et al. 2004). This is a tremendous difference from pre-exploitation numbers, which are thought to be more than 1,000 individuals. When the right whale was finally protected in the 1930s, it is believed that the North Atlantic right whale population was roughly 100 individuals (Waring et al. 2004). In 2015, the Western North Atlantic population size was estimated to be at least 476 individuals (Waring et al. 2016). That population size estimate decreased to 440 individuals in 2017 (Hayes et al. 2017). Additional information provided by Pace et al. (2017), confirms that the probability that the North Atlantic right whale population has declined since 2010 is 99.99 percent. Data indicates that the number of adult females dropped from 200 in 2010 down to 186 in 2015 while males dropped from 283 to 272 in the same timeframe. Also cause for concern is the confirmed mortality of 17 individuals so far in 2017 alone (NOAA 2017; Pace et al. 2017).

Contemporary anthropogenic threats to right whale populations include fishery entanglements and vessel strikes, although habitat loss, pollution, anthropogenic noise, and intense commercial fishing may also negatively impact their populations (Kenney 2002). Entanglements can represent a significant energy expenditure for large whales, leading to injury or death if disentanglement efforts are not successful within a critical time period (van der Hoop et al. 2017; van der Hoop et al. 2016). Such energy expenditures can have significant sub-lethal impacts to right whales, particularly reproductive females where time for reproduction could be delayed for months or years (van der Hoop et al. 2016). Recovery from entanglements and subsequent energy losses resulting in physiological stress could limit reproductive success and contribute to fluctuations in population growth (van der Hoop et al. 2016). Unfortunately, evidence suggests that recent efforts to reduce entanglement through fishing gear modification have not resulted in decline of frequencies of entanglement or serious injury due to entanglement (Pace et al. 2014). Between 2002 and 2006, a study of marine mammal stranding and human-induced interactions reported that right whales in the western Atlantic were subject to the highest proportion of entanglements (25 of 145 confirmed events) and ship strikes (16 of 43 confirmed occurrences) of any marine mammal studied (Glass et al. 2008). Bycatch of North Atlantic right whale has also been reported in pelagic drift gillnet operations by the Northeast Fisheries Observer Program, however, no mortalities have been reported (Glass et al. 2008). From 2010 through 2014, the minimum rate of annual human-caused mortality and serious injury to this species from fishing entanglements averaged 5.66 per year, while ship strikes averaged 1.01 whales per year (Hayes et al. 2017). Environmental fluctuations and anthropogenic disturbance may be contributing to a decline in overall health of individual North Atlantic right whales that has been occurring for the last 3 decades (Rolland et al. 2016). The NOAA marine mammal stock assessment for 2014 reports that the low annual reproductive rate of right whales, coupled with small population size, suggests anthropogenic mortality may have a greater impact on population growth rates for the species than for other whales (Waring et al. 2016).

Ship strikes of individuals can impact northern right whales on a population level due to the intrinsically small remnant population that persists in the North Atlantic (Laist et al. 2001). Most ship strikes are fatal to the North Atlantic right whales (Jensen and Silber 2004). Right whales have difficulty maneuvering around boats and spend most of their time at the surface, feeding, resting, mating, and nursing, increasing their vulnerability to collisions. Mariners should assume that North Atlantic right whales will not move out of their way nor will they be easy to detect from the bow of a ship for they are dark in color and maintain a low profile while swimming (World Wildlife Fund 2005). To address potential for ship strike, NMFS designated the nearshore waters of the Mid-Atlantic Bight as the Mid-Atlantic U.S. Seasonal Management Area (SMA) for right whales. NMFS requires that all vessels 65 ft (19.8 m) or longer must travel at 10 knots or less within the right whale SMA from November 1 through April 30 when right whales are most likely to pass through these waters (NOAA 2010). The most recent stock assessment report noted that studies by van der Hoop et al. (2015) have concluded large whale vessel strike mortalities decreased inside active SMAs but have increased outside inactive SMAs. The proposed survey area has components located both within and outside of the right whale Block Island SMA located in the waters between Long Island, New York, and Martha’s Vineyard, Massachusetts.

Right whales have been observed in or near southern New England during all four seasons; however, they are most common in the spring when they are migrating north and in the fall during their southbound migration (Kenney and Vigness-Raposa 2009).

4.2.2 Humpback Whale (*Megaptera novaeangliae*) – Non-Strategic

The humpback whale was listed as endangered in 1970 due to population decrease resulting from overharvesting; however, this species was delisted as threatened or endangered as of September 8, 2016 (81 FR 62259). Humpback whales feed on small prey that is often found in large concentrations, including krill and fish such as herring and sand lance (Waring et al. 2007; Kenney and Vigness-Raposa 2009). Humpback whales are thought to feed mainly while migrating and in summer feeding areas; little feeding is known to occur in their wintering grounds. Humpbacks feed over the continental shelf in the North Atlantic between New Jersey and Greenland, consuming roughly 95 percent small schooling fish and 5 percent zooplankton (i.e., krill), and they will migrate throughout their summer habitat to locate prey (Kenney and Winn 1986). They swim below the thermocline to pursue their prey, so even though the surface temperatures might be warm, they are frequently swimming in cold water (NMFS 1991b). Humpback whales from all of the North Atlantic migrate to the Caribbean in winter, where calves are born between January and March (Blaylock et al. 1995).

Humpback whales exhibit consistent fidelity to feeding areas within the northern hemisphere (Stevick et al. 2006). There are six subpopulations of humpback whales that feed in six different areas during spring, summer, and fall. These feeding populations can be found in the Gulf of Maine, the Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway (Waring et al. 2015). The highest abundance for humpback whales is distributed primarily along a relatively narrow corridor following the 328-ft (100-m) isobath across the southern Gulf of Maine from the northwestern slope of Georges Bank, south to the Great South Channel, and northward alongside Cape Cod to Stellwagen Bank and Jeffreys Ledge. In winter, whales from waters off New England, Canada, Greenland, Iceland, and Norway migrate to mate and calve primarily in the West Indies (including the Antilles, the Dominican Republic, the Virgin Islands and Puerto Rico), where spatial and genetic mixing among these groups occurs (Waring et al. 2015). While migrating, humpback whales utilize the mid-Atlantic as a migration pathway between calving/mating grounds to the south and feeding grounds in the north (Waring et al. 2007). Since 1989, observations of juvenile humpbacks in the Mid-Atlantic have been increasing during the winter months, peaking January through March (Swingle et al. 1993). Biologists theorize that non-reproductive animals may be establishing a winter feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. Swingle et al. (1993) identified a shift in distribution of juvenile humpback whales in the nearshore waters of Virginia, primarily in winter months.

Humpback whales were hunted as early as the seventeenth century, with most whaling operations having occurred in the nineteenth century (Kenney and Vigness-Raposa 2009). Before whaling activities, it was thought that the abundance of whales in the North Atlantic stock was in excess of 15,000 (Nowak 2002). By 1932, commercial hunting within the North Atlantic may have reduced the humpback whale population to as little as 700 individuals (Breiwick et al. 1983). Humpback whales were commercially exploited by whalers throughout their whole range until they were protected in the North Atlantic in 1955 by the International Whaling Commission (IWC) ban. Humpback whaling ended worldwide in 1966 (NatureServe 2010). Contemporary anthropogenic threats to humpback whales include fishery entanglements and vessel strikes. Glass et al. (2008) reported that between 2002 and 2006, humpback whales belonging to the Gulf of Maine population were involved in 77 confirmed entanglements with fishery equipment and nine confirmed ship strikes. Humpback whales that were entangled exhibited the highest number of serious injury events of the six species of whale studied by Glass et al. (2008). A whale mortality and serious injury study conducted by Nelson et al. (2007) reported that the minimum annual rate of anthropogenic mortality and serious injury to humpback whales occupying the Gulf of Maine was 4.2 individuals per year. During this study period, humpback whales were involved in 70 reported entanglements and 12 vessel strikes, and were the most common dead species reported. This number has increased to 9.05 animals per year between 2010 and 2014 (Hayes et al. 2017). Entanglements can represent a significant energy expenditure for large whales, leading to injury or death if disentanglement efforts are not successful within a critical time period (van der Hoop et al. 2017; van der Hoop et al. 2016). Such energy expenditures can have significant sub-lethal impacts, particularly to reproductive females where time for reproduction could be delayed for months or years (van der Hoop et al. 2016). Recovery from entanglements and subsequent energy losses resulting in physiological stress could limit reproductive success and contribute to fluctuations in population growth (van der Hoop et al. 2016). Unfortunately, evidence suggests that recent efforts to reduce large whale entanglement through fishing gear modification have not resulted in decline of frequencies of entanglement or serious injury due to entanglement (Pace et al. 2014). The humpback whale population within the North Atlantic has been estimated to include approximately 11,570 individuals (Waring et al. 2015). Through photographic population estimates, humpback whales within the Gulf of Maine (the only region where these whales summer in the United States) have been estimated to consist of 600 individuals in 1979 (NMFS 1991b). According to the species stock assessment report, the best estimate of abundance for the Gulf of Maine stock of humpback whales is, at a minimum, 823 individuals (Hayes et al. 2017).

Humpbacks occur off southern New England in all four seasons, with peak abundance in spring and summer.

4.2.3 Fin Whale (*Balaenoptera physalus*) – Endangered

The fin whale was listed as federally endangered in 1970. Fin whales' range in the North Atlantic extends from the Gulf of Mexico, Caribbean Sea, and Mediterranean Sea in the south to Greenland, Iceland, and Norway in the north (Jonsgård 1966; Gambell 1985a). They are the most commonly sighted large whales in continental shelf waters from the Mid-Atlantic coast of the United States to Nova Scotia (Sergeant 1977; Sutcliffe and Brodie 1977; CETAP 1982; Hain et al. 1992; Waring et al. 2008). Fin whales, much like humpback whales, seem to exhibit habitat fidelity (Waring et al. 2007; Kenney and Vigness-Raposa 2009). However, fin whales habitat use has shifted in the southern Gulf of Maine, most likely due to changes in the abundance of sand lance and herring, both of which are major prey species along with squid, krill, and copepods (Kenney and Vigness-Raposa 2009). While fin whales typically feed in the Gulf of Maine and the waters surrounding New England, mating and calving (and general wintering) areas are largely unknown (Waring et al. 2007). The overall pattern of fin whale movement is complex, consisting of a less obvious north-south pattern of migration than that of right and humpback whales. Based on acoustic recordings from hydrophone arrays, Clark (1995) reported a general southward flow pattern of fin whales in the fall from the Labrador/Newfoundland region, past Bermuda, and into the West Indies. The overall distribution may be based on prey availability, as this species preys opportunistically on both invertebrates and fish (Watkins et al. 1984). Fin whale abundance off the coast of the northeastern United States is highest between spring and fall, with some individuals remaining during the winter (Hain et al. 1992). A recent estimate of fin whale abundance conducted between Georges Bank and the Gulf of St. Lawrence during the feeding season in August 2006 places the western North Atlantic fin whale populations at 2,269 individuals (Waring et al. 2007). Fin whales are the second largest living whale species on the planet (Kenney and Vigness-Raposa 2009). The gestation period for fin whales is approximately 11 months and calve births occur between late fall and winter. Females can give birth every two to three years.

Present threats to fin whales are similar to other whale species, namely fishery entanglements and vessel strikes. Fin whales seem less likely to become entangled than other whale species. Glass et al. (2008) reported that between 2002 and 2006, fin whales belonging to the Gulf of Maine population were involved in only eight confirmed entanglements with fishery equipment. Furthermore, Nelson et al. (2007) reported that fin whales exhibited a low proportion of entanglements (eight reported events) during their 2001 to 2005 study along the western Atlantic. On the other hand, vessel strikes may be a more serious threat to fin whales. Eight and 10 confirmed vessel strikes with fin whales were reported by Glass et al. (2008) and Nelson et al. (2007), respectively. This level of incidence was similar to that exhibited by the other whales studied. Conversely, a study compiling whale/vessel strike reports from historical accounts, recent whale strandings, and anecdotal records by Laist et al. (2001) reported that of the 11 great whale species studied, fin whales were involved in collisions most frequently (31 in the United States and 16 in France). From 2008 to 2012, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 3.35 per year (Waring et al. 2015) while from 2010 to 2014, this number has increased to 3.8 per year (Hayes et al. 2017). Increase in ambient noise has also impacted fin whales, for whales in the Mediterranean have demonstrated at least two different avoidance strategies after being disturbed by tracking vessels (Jahoda et al. 2003). The best abundance estimate available for the western North Atlantic fin whale stock is 1,618 (Hayes et al. 2017).

Fin whales are present in southern New England waters during all four seasons. In spring, summer, and fall, the main center of their distribution is in the Great South Channel area to the east of Cape Cod, which is a well-known feeding ground (Kenney and Winn 1986). Winter is the season of lowest overall abundance, but they do not depart the area entirely. Fin whales are the most common large whale encountered in continental shelf waters south of New England and into the Gulf of Maine. They are the whales most often encountered by local whale-watching operations in most years and are likely to occur in the Lease Area. The species is listed as Endangered due to the depletion of its population from whaling (Reeves et al. 1998). A recovery plan has been written and is available from the NMFS for review (Waring et al. 2010; 2011).

4.2.4 Minke Whale (*Balaenoptera acutorostrata*) – Non-Strategic

Minke whales are among the most widely distributed of all the baleen whales. They occur in the North Atlantic and North Pacific, from tropical to polar waters. Common minke whales range between 20 and 30 ft (6 and 9 m, with maximum lengths of 30 to 33 ft [9 to 10 m]) and are the smallest of the North Atlantic baleen whales (Jefferson et al. 1993; Wynne and Schwartz 1999; Kenney and Vigness-Raposa 2009). The primary prey species for minke whales are most likely sand lance, clupeids, gadoids, and mackerel (Kenney and Vigness-Raposa 2009). These whales basically feed below the surface of the water, and calves are usually not seen in adult feeding areas. Minke whales are almost absent from OCS waters off the western Atlantic in winter; however, they are common in the fall and abundant in spring and summer (CeTAP 1982; Kenney and Vigness-Raposa 2009). In the 2015 stock assessment, the estimate for minke whales in the Canadian East Coast stock was 20,741 (Waring et al. 2015). This population estimate substantially decreased to 2,591 individuals in the most recent stock assessment because estimates older than eight years were excluded from the newest estimate (Hayes et al., 2017). This new estimate should not be interpreted as a decline in abundance of this stock, as previous estimates are not directly comparable (Hayes et al., 2017). Minke whales have been observed in southern New England waters during all four seasons.

As is typical of the baleen whales, minke whales are usually seen either alone or in small groups, although large aggregations sometimes occur in feeding areas (Reeves et al. 2002). Minke populations are often segregated by sex, age, or reproductive condition. Known for their curiosity, minke whales often approach boats.

Minke whales are impacted by ship strikes and bycatch from bottom trawls, lobster trap/pot, gillnet, and purse seine fisheries. From 2008 to 2012, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 9.9 per year (Waring et al. 2015), while from 2010 to 2014 this decreased to 8.25 per year (Hayes et al. 2017). In addition, hunting for Minke whales continues today, by Norway in the northeastern North Atlantic and by Japan in the North Pacific and Antarctic (Reeves et al. 2002). International trade in the species is currently banned. The best recent abundance estimate for this stock is 8,987 (Waring et al. 2011). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2010; 2011; 2015).

4.3 Earless Seals (Phocidae)

4.3.1 Harbor Seal (*Phoca vitulina*) – Non-Strategic

Harbor seals are the most abundant seals in eastern United States waters and are commonly found in all nearshore waters of the Atlantic Ocean and adjoining seas above northern Florida; however, their “normal” range is probably only south to New Jersey. While harbor seals occur year-round north of Cape Cod, they only occur during winter migration, typically September through May, south of Cape Cod (Southern New England to New Jersey) (Waring et al. 2015; Kenney and Vigness-Raposa 2009). During the summer, most harbor seals can be found north of New York, within the coastal waters of central and northern Maine, as well as the Bay of Fundy (DoN 2005). Harbor seals are relatively small pinnipeds, with adults ranging between 5.6 and 6.2 ft (1.7 and 1.9 m) in length, with females being slightly smaller than males (Jefferson et al. 1993; Wynne and Schwartz 1999; Kenney and Vigness-Raposa 2009).

Harbor seals prey upon small to medium-sized fish, followed by octopus and squid, and lastly by shrimp and crabs (Kenney and Vigness-Raposa 2009). Fish eaten by harbor seals include commercially important species such as mackerel, herring, cod, hake, smelt, shad, sardines, anchovy, capelin, salmon, rockfish, sculpins, sand lance, trout, and flounders (Kenney and Vigness-Raposa 2009). They spend about 85 percent of the day diving, and much of the diving is presumed to be active foraging in the water column or on the seabed. They dive to depths of about 30 to 500 feet (10 to 150 meters), depending on location. Harbor seals forage in a variety of marine habitats, including deep fjords, coastal lagoons and estuaries, and high-energy, rocky coastal areas. They may also forage at the mouths of freshwater rivers and streams, occasionally traveling several hundred miles upstream (Reeves et al. 2002). They haul out on sandy and pebble beaches, intertidal rocks and ledges, and sandbars, and occasionally on ice floes in bays near calving glaciers.

Except for a strong bond between mothers and pups, harbor seals are generally intolerant of close contact with other seals. Nonetheless, they are gregarious, especially during the molting season, which occurs between spring and autumn, depending on geographic location. They may haul out to molt at a tide bar, sandy or cobble beach, or exposed intertidal reef. During this haulout period, they spend most of their time sleeping, scratching, yawning, and scanning for potential predators such as humans, foxes, coyotes, bears, and raptors (Reeves et al. 2002). In late autumn and winter, harbor seals may be at sea continuously for several weeks or more, presumably feeding to recover body mass lost during the reproductive and molting seasons and to fatten up for the next breeding season (Reeves et al. 2002).

Historically, these seals have been hunted for several hundred to several thousand years. Harbor seals are still killed legally in Canada, Norway, and the United Kingdom to protect fish farms or local fisheries (Reeves et al. 2002). From 2010 to 2014, the average rate of mortality for the Western North Atlantic harbor seal stock from anthropogenic causes was approximately 389 per year (Hayes et al. 2017). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2013).

4.3.2 Gray Seal (*Halichoerus grypus*) – Non-Strategic

The gray seal occurs in cold temperate to sub-arctic waters in the North Atlantic, and is partitioned into three major populations occurring in eastern Canada, northwestern Europe, and the Baltic Sea (Jefferson et al. 2008; Kenney and Vigness-Raposa 2009). The western North Atlantic stock is considered to be the same population as the one found in eastern Canada, and ranges between New England and Labrador

(Waring et al. 2007). As exhibited in harbor seal populations, gray seals occur most often in the waters off of Maine during winter and spring, and spend summer and fall off northern Maine and in Canadian waters (DoN 2005). Gray seals exhibit sexual dimorphism, with adult males reaching 7.5 ft (2.3 m) long and females reaching 6.6 ft (2.0 m) (Jefferson et al. 1993; Wynne and Schwartz 1999; Kenney and Vigness-Raposa 2009). The gray seal is primarily found in coastal waters and forages in OCS regions (Lesage and Hammill 2001).

Gray seals are gregarious, gathering to breed, molt, and rest in groups of several hundred or more at island coasts and beaches or on land-fast ice and pack-ice floes. They are thought to be solitary when feeding and telemetry data indicates that some seals may forage seasonally in waters close to colonies, while others may migrate long distances from their breeding areas to feed in pelagic waters between the breeding and molting seasons (Reeves et al. 2002). Gray seals molt in late spring or early summer and may spend several weeks ashore during this time. When feeding, most seals remain within 45 mi (72 km) of their haulout sites. Gray seals feed on numerous fish species and cephalopods (Kenney and Vigness-Raposa 2009). Gray seal scat samples from Muskeget Island, Massachusetts, included species such as sand lance, skates, flounder, silver hake, and gadids (Kenney and Vigness-Raposa 2009).

Gray seals form colonies on rocky island or mainland beaches, though some seals give birth in sea caves or on sea ice, especially in the Baltic Sea. Gray seals prefer haulout and breeding sites that are surrounded by rough seas and riptides where boating is hazardous. Pupping colonies have been identified at Muskeget Island (Nantucket Sound), Monomoy National Wildlife Refuge, and in eastern Maine (Rough 1995). Total western Atlantic gray seal population estimates are not currently available (Hayes et al. 2017). However, the gray seal colony of Massachusetts has more than 5,600 seals total and there are more than 1,700 individuals in Maine (Waring et al. 2007). This species has been reported with greater frequency in waters south of Cape Cod in recent years, likely due to a population rebound in southern New England and the mid-Atlantic (Kenney and Vigness-Raposa 2009); however, most gray seals present are juveniles dispersing in the spring. The only consistent haul-out locations within the vicinity of the Lease Area are along the sandy shoals around Monomoy and Nantucket in Massachusetts (Kenney and Vigness-Raposa 2009).

The biggest threats to gray seals are entanglements in gillnets or plastic debris (Waring et al. 2004). From 2006 to 2010, the total estimated human-caused mortality to gray seals was approximately 5,253 per year, which includes the removal of nuisance animals in Canada (Waring et al. 2015). For the period 2010 through 2014, the average annual mortality estimate decreased to 4,937 gray seals per year (Hayes et al. 2017). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2015).

5. Type of Incidental Taking Requested

The Applicant is requesting the authorization for potential non-lethal “taking” of small numbers of marine mammals to allow for incidental harassment resulting from the HRG surveys. The request is based upon projected HRG survey activities during the anticipated survey schedule as stated in Sections 2.1.

The underwater noise impacts of HRG survey equipment were evaluated under the criteria prescribed for PTS Onset in the Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals (NMFS 2016) to determine the potential for take by Level A harassment. To determine the potential for Level B harassment, the take criteria for impulsive noise (160 $dB_{RMS90\%}$ re 1 μPa) was applied.

5.1 HRG Survey Equipment Field Verification Results

Gardline completed an underwater noise monitoring program for the field verification at the Bay State Wind project site prior to the commencement of the HRG survey which took place between 14 August and 06 October, 2016 (Gardline 2016, 2017). As required by the Project permits, one of the main objectives of the field verification program was to determine the apparent sound source levels of HRG activities. Far field measurement data were analyzed by linear regression. A key assumption of the linear regression method is that the acoustic propagation environment does not substantially change between measurement positions. The environment is characterized by the water depth, geoacoustic seabed properties, and sound speed profile in the water column. This method may also be used to extrapolate received sound levels at ranges closer to the sound source.

In addition to identifying the apparent source levels associated with the HRG activities, the Gardline hydroacoustic monitoring program was also designed to support the field verification of the regulatory thresholds for injury/mortality and behavior disturbance of marine mammals that were established during the permitting process. Of particular importance was confirming the adequacy of the exclusion and monitoring zones used to support the active protection of marine mammals during HRG activities. All impact ranges measured for marine fauna during this field verification were within the thresholds as approved by BOEM.

Apparent source levels and differential between the averaged measured apparent source levels versus manufacturers' levels for each HRG equipment type are summarized in Table 5-1. The results of the Gardline field verification show the variability in source levels based on the extrapolated values from linear regression. These values were used to further calibrate calculations for the current suite of HRG equipment of similar type, as the differential accounts for both the site specific environmental conditions and directional beam width patterns for similar HRG equipment proposed (e.g. USBL, SBP, and UHRS Sparker systems). The differential was applied for the current survey HRG source terms provided in Table 1-1.

Table 5-1 Summary of Field Verified HRG Survey Equipment Results

Representative HRG Survey Equipment	Operating Frequencies	Source Level Reported by Manufacturer (dB re 1 µPa)	Source Level Measured During 2016 Bay State Wind FV Survey [a/] (dB re 1 µPa)	Differential (dB re 1 µPa)
USBL & GAPS Transceiver				
Sonardyne Ranger 2	19 – 34 kHz	200 dB_{Peak} 194 dB_{RMS}	194 dB_{Peak} 166 dB_{RMS}	-6 -28
Shallow Sub-Bottom Profilers				
GeoPulse Sub-bottom Profiler	1.5 – 18 kHz	223.5 dB_{Peak} 208 dB_{RMS}	203 dB_{Peak} 172 dB_{RMS}	-21 -36
Sparkers				
Geo-Source 600 J	0.05 – 5 kHz	221 dB_{Peak} 205 dB_{RMS}	206 dB_{Peak} 182 dB_{RMS}	-15 -23
Geo-Source 800 J	0.05 – 5 kHz	223 dB_{Peak} 207 dB_{RMS}	212 dB_{Peak} 188 dB_{RMS}	-11 -19

Source:
a/ Gardline 2016a, 2017 as measured in the acoustic farfield

5.2 Calculation of Disturbance ZOIs

The ZOIs for Level A harassment were calculated following the NOAA Fisheries 2016 guidance and the accompanying Optional User Spreadsheet for previously field verified equipment (see Appendix A). The Optional User Spreadsheet requires estimates of the sound produced by the source (RMS SPL) and the manufacturer source level which were adjusted per Table 5-1. This adjustment is necessary as the Optional User Spreadsheet does not consider the beamwidth or directivity of HRG sound sources, or the variable characteristics of the ocean environment. The use of previous field verification results with the same type of HRG equipment as a comparison helps reduce this level of uncertainty while allowing continued use of the Optional User Spreadsheet approach.

While the several HRG types of equipment in Table 5-1 were previously field verified, Table 1-1 includes additional equipment that has not. The additional pieces of equipment include the Innomar SES-2000 subbottom profiler and Applied Acoustics S-Boom boomer.

As no field verified data currently exists for these two specialized HRG equipment types, the acoustic modeling was completed based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM) and BELLHOP Gaussian beam ray-trace propagation model (Porter and Liu 1994). RAM is based on the parabolic equation (Collins 1993) method using the split-step Padé algorithm for improved numerical accuracy and efficiency in solving range dependent acoustic problems and has been extensively benchmarked (Collins et al. 1996). Commonly used for acoustic analysis of industrial sources in the offshore underwater environment, RAM was used primarily for reviewing site specific transmission loss associated with the Applied Acoustics Boomer. The Bellhop algorithm is based on a beam-tracing methodology and provides better accuracy by accounting for increased sound attenuation due to volume absorption at higher frequencies (Porter 1987) and allowing for source directivity components and was used to determine propagation distances for the Innomar SES-2000 shallow subbottom profiler. In contrast to RAM, the geoacoustic input for consists of only one interface, namely the sea bottom. This is an acceptable limitation because the influence of the sub-bottom layers on the propagation of acoustic waves with frequencies above 1 kHz is negligible. Both the BELLHOP and RAM models are widely used by noise engineers and marine biologists due to adaptabilities to describe complex acoustic propagation in the underwater environment.

For different HRG transducers, the beamwidth varies from 180° (almost omnidirectional) to a few degrees. The source directivity, is specified as a function of both azimuthal angle and depression angle. Directionality is generally measured in decibels relative to the maximum radiation level along the central axis perpendicular to the transducer surface. In the case of the Innomar Medium-100 and Standard sub bottom profiler exhibits a very narrow beamwidth of 1 to 2^0 while comparatively, the Applied Acoustics boomers have a wider beamwidth pattern ranging from 25 to 35^0 depending on model type. Both HRG systems were described numerically from technical specifications including the beam width, and main beam axis direction. The modeled directional sound levels (SLs) were then used as the input for the acoustic propagation models.

It is important to note that the Innomar SES-2000 sub-bottom profilers use the principle of "parametric" or "nonlinear" acoustics to generate short narrow-beam sound pulses. Additionally, due to the short sound pulses and the highly directional sound pulse transmission of parametric sub-bottom profilers, the volume of area affected is much lower than using conventional (linear) acoustics like boomer, sparker, and chirp systems. The modeling analysis showed the water volume ensonified by the Innomar sub-bottom profiler is rather small due to the narrow sound beams produced. Also, the maximum duty cycle was provided, which accounts for the pulse shape and duration, and used for the cumulative exposure calculations. The resulting distance to thresholds for the Innomar SES-2000 were confirmed as appropriate during direct consultation with the equipment manufacturer (personal communication January 23, 2018)[1].

Table 5-2 shows maximum distances to the level A regulatory thresholds for each major HRG equipment category proposed. For equipment categories with multiple devices (see Table 1-1), only the device with maximum distances to regulatory thresholds .is provided in Table 5-2. All results for NOAA Fisheries 2016 guidance and the accompanying Optional User Spreadsheets for survey equipment is provided in Appendix A. All The distances to Level B disturbance thresholds are summarized in Table 5-3.

Table 5-2 Maximum Distances to Regulatory Thresholds by Equipment Category – Level A

Representative HRG Survey Equipment	Marine Mammal Group	PTS Onset	Lateral Distance (m)
USBL/GAPS Positioning Systems [a/]			
Sonardyne Ranger 2 USBL HPT 5/7000	LF cetaceans	219 dBpeak 183 dB SEL_{cum}	--- ---
	MF cetaceans	230 dBpeak 185 dB SEL_{cum}	--- ---
	HF cetaceans	202 dBpeak 155 dB SEL_{cum}	--- ---
	Phocid pinnipeds	218 dBpeak 185 dB SEL_{cum}	--- ---
Subbottom Profiler [a/]			
Edgetech 3200 XS 216	LF cetaceans	219 dBpeak 183 dB SEL_{cum}	--- ---
	MF cetaceans	230 dBpeak 185 dB SEL_{cum}	--- ---
	HF cetaceans	202 dBpeak 155 dB SEL_{cum}	--- < 6
	Phocid pinnipeds	218 dBpeak 185 dB SEL_{cum}	--- ---
Innomar [b/]			
Innomar SES-2000 Medium Sub-bottom Profiler	LF cetaceans	219 dBpeak 183 dB SEL_{cum}	< 1 N/A
	MF cetaceans	230 dBpeak 185 dB SEL_{cum}	< 1 ---
	HF cetaceans	202 dBpeak 155 dB SEL_{cum}	< 5 < 75
	Phocid pinnipeds	218 dBpeak 185 dB SEL_{cum}	< 1 N/A

[1] Personal communication with Dr.-Ing. Jens Wunderlich, Manager of Research and Development, Innomar Technologie GmbH

Representative HRG Survey Equipment	Marine Mammal Group	PTS Onset	Lateral Distance (m)
Sparker [a/]			
GeoMarine Geo-Source 400tip	LF cetaceans	219 dBpeak 183 dB SEL_{cum}	--- ---
	MF cetaceans	230 dBpeak 185 dB SEL_{cum}	--- ---
	HF cetaceans	202 dBpeak 155 dB SEL_{cum}	< 3 ---
	Phocid pinnipeds	218 dBpeak 185 dB SEL_{cum}	--- ---
Boomer [c/]			
Applied Acoustics S-Boom Triple Plate Boomer	LF cetaceans	219 dBpeak 183 dB SEL_{cum}	< 2 < 15
	MF cetaceans	230 dBpeak 185 dB SEL_{cum}	--- ---
	HF cetaceans	202 dBpeak 155 dB SEL_{cum}	< 10 < 1
	Phocid pinnipeds	218 dBpeak 185 dB SEL_{cum}	< 2 < 1

Notes:

The peak SPL criterion is un-weighted (i.e., flat weighted), whereas the cumulative SEL criterion is M-weighted for the given marine mammal functional hearing group.

The calculated sound levels and results are based on NMFS Technical Guidance's companion User Spreadsheet except as indicated in this IHA application.

a/ indicates that distances for this equipment type have been field verified.

b/ distance to thresholds calculated distances estimated using ray tracing modeling methodologies

c/ distance to thresholds calculated using PE modeling methodologies

--- indicates not expected to be measurable to stated regulatory threshold at any appreciable distance.

N/A indicates not applicable as the HRG sound source operates outside the effective marine mammal hearing range.

Table 5-3 Distances to Regulatory Level B 160 dB$_{RMS90\%}$ Thresholds

HRG Survey Equipment	Lateral Distance (m)
USBL & GAPS Transceiver [a/]	
Sonardyne Ranger 2 USBL HPT 5/7000	6
Sonardyne Ranger 2 USBL HPT 3000	1
Easytrak Nexus 2 USBL	2
IxSea GAPS System	1
Sidescan Sonar	
EdgeTech 4200 dual frequency Side Scan Sonar	N/A
Multibeam Sonar	
R2 Sonic 2024 Multibeam Echosounder	N/A
Kongsberg EM2040C Dual Head	N/A
Shallow Sub-Bottom Profiler [a/]	
Edgetech 3200 XS 216	9
Innomar [b/]	
Innomar SES-2000 Sub-bottom Profiler	135[a/]
Sparker [a/]	
GeoMarine Geo-Source 400tip	54
Boomer [c/]	
Applied Acoustics S-Boom Triple Plate Boomer	400[a/]

Notes:

The calculated sound levels and results are based on NMFS Technical Guidance's companion User Spreadsheet except as indicated in this IHA application.

a/ indicates that distances for this equipment type have been field verified.

b/ distance to thresholds calculated distances estimated using ray tracing modeling methodologies

c/ distance to thresholds calculated using PE modeling methodologies

The Level B criterion is un-weighted (i.e., flat weighted).
N/A indicates the operating frequencies are above all relevant marine mammal hearing thresholds and therefore these HRG systems were not directly assessed within this IHA .

The Applicant is requesting the authorization for the incidental take by Level A harassment of small numbers of harbor porpoise, as well as Level B harassment of small numbers of marine mammals in the waters of the Bay State Wind Lease Area pursuant to Section 101 (a) (5) of the MMPA and in accordance with 50 CFR § 216 Subpart I, in support of the Applicant's survey activities as further detailed in Section 6.

6. Take Estimates for Marine Mammals

The Applicant seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of NMFS in the proposed region of activity. Anticipated impacts to marine mammals from the proposed survey activities will be associated with noise propagation from the use of specific HRG survey equipment. It should be noted that the estimates of exposure for marine mammals as presented in this section are conservative.

6.1 Basis for Estimating Numbers of Marine Mammals that Might be "Taken by Harassment"

Most marine animals can perceive underwater sounds over a broad range of frequencies from about 7 hertz (Hz) to more than 160,000 Hz (160 kHz) (Table 6-1). Many of the dolphins and porpoises use even higher frequency sound for echolocation and perceive these high frequency sounds with high acuity. Marine mammals respond to low-frequency sounds with broadband intensities of more than about 120 dB re 1 μPa, or about 10 to 20 dB above natural ambient noise at the same frequencies (Richardson et al. 1991).

Table 6-1 Functional Hearing Range of Marine Mammals

Species	Estimated Auditory Bandwidth
LF cetaceans (baleen whales)	7 Hz to 35 kHz
MF cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
HF cetaceans (true porpoises, Kogia, river dolphins, cephalorhynchid, Lagenorhynchus cruciger & L. australis)	275 Hz to 160 kHz
Phocid pinnipeds (underwater) (true seals)	50 Hz to 86 kHz
Otariid pinnipeds (underwater) (sea lions and fur seals)	60 Hz to 39 kHz
Source: NMFS (2016)	

Sound is important to marine mammals for communication, individual recognition, predator avoidance, prey capture, orientation, navigation, mate selection, and mother-offspring bonding. Potential effects of anthropogenic sounds to marine mammals can include physical injury (e.g., temporary or permanent loss of hearing sensitivity), behavioral modification (e.g., changes in foraging or habitat-use patterns), and masking (the prevention of marine mammals from hearing important sounds).

The survey activities that have the potential to cause harassment as defined by the MMPA include the noise produced by the 800 kJ Geo-Source (160 dB_{rms} re 1 μPa), GeoPulse Sub-bottom Profiler, the Innomar SES-2000 sub-bottom profiler, and the Applied Acoustics S-Boom triple plate boomer. Based on the results of this assessment (see Table 5-3), the furthest distance to the Level B harassment criteria is 1,312.3 ft (400 m) from the use of the boomer. The Applicant has applied the evaluated distance of 1,312.3 ft (400 m) to the 160 dB_{RMS} re 1 μPa Level B harassment criteria as the basis for determining potential take.

The basis for the take estimate is the number of marine mammals that would be exposed to sound levels in excess of Level B harassment criteria (160 dB_{RMS} re 1 μPa). Typically this is determined by multiplying the zone of influence (ZOI) out to the Level B harassment criteria isopleth by local marine mammal density estimates, and then correcting for seasonal use by marine mammals, seasonal duration of project-specific noise-generating activities, and estimated duration of individual activities when the maximum noise-generating activities are intermittent or occasional. In the absence of any part of this information, it becomes prudent to take a conservative approach to ensure the potential number of takes is not greatly underestimated.

The estimated distance of the daily vessel trackline was determined using the estimated average speed of the vessel and the 24-hour or daylight-only operational period within each of the corresponding survey segments. All noise producing survey equipment are assumed to be operated concurrently. Using the distance of 1,312.3 ft (400 m) to the 160 dBRMS re 1 μPa Level B isopleth, Level A harassment criteria (155 dB SEL_{cum}) criteria distance of 246.1 ft (75 m) for harbor porpoise, and the estimated daily vessel track of approximately 110.5 mi (177.8 km) for 24-hour operations and 26.7 mi (43.0 km) for daylight-only operations, estimates of incidental take by HRG survey equipment has been based on the ensonified area around the survey equipment as depicted in Table 6-2.

Table 6-2 Survey Segment Distances and ZOIs

Survey Segment	Total Track Line (km)	Number of Active Survey Days	Estimated distances per day (km)	Calculated ZOI per day (km^2)	
				Level A Harbor Porpoise	Level B
Phase I Development Area					
Lot 3 (Phase I Development Area)	2,845	60	177.8	26.69	142.74
Export Cable Route, Somerset					
Lot 1 (Near Coastal Shallow Water Region)	1,091	18	177.8	6.46	34.88
Lot 2 (Offhshore Region)	563	15	43.0	26.69	142.74
Export Cable Route, Falmouth					
Lot 4 (Offhshore Region)	2,253	37	177.8	26.69	142.74
Lot 5 (Near Coastal Shallow Water Region)	108	5	43.0	6.46	34.88

6.2 Estimate of Numbers of Marine Mammals that Might be "Taken by Harassment"

Estimates of take are computed according to the following formula as provided by NOAA (Personal Communication, November 24, 2015):

Estimated Take = D x ZOI x (d)

Where:

D = average highest species density (number per m^2)

ZOI = maximum ensonified area to MMPA threshold for impulsive noise (160 $dB_{RMS90\%}$ re 1 μPa)

d = number of days

Per new NOAA guidance for mobile sound sources, the ZOI was calculated according to the following formula (Personal Communication, November 24, 2015):

ZOI = maximum ensonified area around the sound source x the line miles travelled over a 24-hr period.

Refer to Table 6-2 for the calculated ZOI for each of the proposed HRG survey segments.

The data used as the basis for estimating species density for the Lease Area are derived from data provided by Duke Universities' Marine Geospatial Ecology Lab and the Marine-life Data and Analysis Team. This data set is a compilation of the best available marine mammal data (1994-2014) and was prepared in a collaboration between Duke University, Northeast Regional Planning Body, University of Carolina, the Virginia Aquarium and Marine Science Center, and NOAA (Roberts et al. 2016; MDAT 2016).

The Northeast Navy Operations Area (OPAREA) Density Estimates (DoN 2007) were also used in support for estimating take for seals, which represents the only available comprehensive data for seal abundance. However, abundance estimates for the Southern New England area includes breeding populations on Cape Cod, and therefore using this dataset alone will result in a substantial over-estimate of take in the Project

Area. However, based on reports conducted by Kenney and Vigness-Raposa (2009), Schroeder (2000), and Ronald and Gots (2003), harbor seal abundance off the Southern New England coast in the vicinity of the survey is likely to be less than the total abundance. In addition, because the seasonality of, and habitat use by, gray seals roughly overlaps with harbor seals, the same overestimated abundance assumption of the southern New England population of gray seals can be applied.

Due to the spatial distribution and transient nature of marine mammal species identified and the implementation of the mitigation measures as described in Section 11.0, these activities are not likely result in serious injury or death.

6.2.1 Estimate of Potential Project HRG Survey Takes by Harassment

The parameters in Table 6-2 were used to estimate Level A take for harbor porpoise and Level B for marine mammals along each segment of the HRG survey. Density data from Roberts et al. (2016) were mapped within the boundary of the Survey Area for each segment (Figure 1-1) using geographic information systems. For all Survey Area locations, the highest average seasonal density (between spring and summer for Lot 3 and Lot 4; spring for remaining survey Lots), as reported by Roberts et al. (2016), was used based on the proposed HRG survey schedule and individual segment durations (starting May 1). Georges Bank West OPAREA Density Estimates (DoN 2007) as reported for the summer season were used to estimate pinniped densities. Given that Roberts et al. (2016) data were absent within the upper reaches of Narragansett Bay and the shallow conditions within the survey area, density data from the mouth of Narragansett Bay were used to approximate likely densities for small cetaceans.

All noise producing survey equipment are assumed to be operated concurrently. Distances to NMFS noise criteria include 1,312.3 ft (400 m) to the 160 dBRMS re 1 μPa level B isopleth for the boomer and the level A harassment criteria (155 dB SEL_{cum}) distance of 246.1 ft (75 m) for harbor porpoise from the Innomar SES-2000 sub-bottom profiler. As a protective measure for harbor porpoise, the Applicant has proposed establishing a 246.1 ft (75 m) level A exclusion zone for harbor porpoise to prevent incidental take of this species. However, level A take has been estimated as a precaution in the event that harbor porpoise surface within the established exclusion zone before mitigation can be employed. The remaining ensonified area specific to level B, as well as the projected duration of each respective survey segment were then used to produce the results of take calculations provided in Table 6-3. It should be noted that were necessary, calculated take has been modified to account for actual sighting data in the Survey Area to date (Smultea Environmental Sciences 2016; Gardline 2016b) and proposed mitigations. In the instance of the North Atlantic right whale, the Applicant has proposed a 1,640.4-ft (500-m) exclusion zone which exceeds the distance to the level B harassment isopleth. Given that the proposed mitigation effectively prevents level B harassment, take has been adjusted to 0 individuals. In addition, the Applicant proposes a 328-ft (100 m) exclusion zone to be implemented for all non-delphinoid large cetaceans.

Table 6-3 Marine Mammal Density and Estimated Level A and B Harassment Take Numbers

Species	Phase I Development Lot 3		Somerset Export Lot 2		Somerset Export Lot 1		Falmouth Export Lot 4		Falmouth Export Lot 5		Totals	
	Highest Seasonal Average Density a/ (No./100 km²)	Calculated Take (No.)	Average Spring Density a/ (No./100 km²)	Calculated Take (No.)	Average Spring Density a/ (No./100 km²)	Calculated Take (No.)	Highest Seasonal Average Density a/ (No./100 km²)	Calculated Take (No.)	Average Spring Density a/ (No./100 km²)	Calculated Take (No.)	Adjusted Take Authorization (No.)	Percent of Population
Level A												
Harbor porpoise	6.67	106.75	4.89	19.56	-	-	1.11	10.95	-	-	137	0.17
Level B												
North Atlantic right whale	0.96	0.00	1.25	0.00	-	-	0.79	0.00	-	-	0 b/	0.00
Humpback whale	0.15	12.44	0.12	2.46	-	-	0.04	2.30	-	-	18	2.15
Fin whale	0.27	23.24	0.19	4.15	-	-	0.07	3.64	-	-	32	1.97
Sperm whale	0.01	0.71	0.01	0.15	-	-	0.00	0.22	-	-	5 d/	0.22
Minke whale	0.08	7.00	0.05	1.14	-	-	0.03	1.82	-	-	20 e/	0.77
Bottlenose dolphin	1.72	147.34	0.46	9.85	-	-	9.00	475.06	-	-	1000 d/	8.66
Short beaked common dolphin	6.26	535.71	2.74	58.67	-	-	0.46	24.34	-	-	2000 e/	2.85
Atlantic white-sided dolphin	1.90	162.75	1.07	22.98	-	-	0.21	10.85	-	-	500 d/	1.02
Harbor porpoise	6.67	570.94	4.89	104.61	-	-	1.11	58.57	-	-	755	0.95
Harbor seal c/	9.74	834.41	9.74	208.60	9.74	50.97	9.74	514.55	9.74	16.99	1667	2.20
Gray Seal c/	14.12	1209.26	14.12	302.32	14.12	73.87	14.12	745.71	14.12	24.62	2416	0.69

Notes:
a/ Density values from Duke University (Roberts et al. 2016)
b/ Exclusion zone for selected species exceeds Level B isopleth. Take adjusted to 0 given that mitigation will prevent harassment.
c/ Density values were derived using the number estimated from DoN (2007).
d/ Value increased to reflect typical pod size.
e/ Calculated take has been modified to account for actual sighting data in the Survey Area to date (Smultea Environmental Sciences 2016; Gardline 2016b)

7. Anticipated Impacts of the Activity

Consideration of negligible impact is required for NMFS to authorize the incidental take of marine mammals. In 50 CFR § 216.103, NMFS defines negligible impact to be "an impact resulting from a specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stocks [of marine mammals] through effects on annual rates of recruitment or survival." Based upon best available data regarding the marine mammal species (including density, status, and distribution) that are likely to occur in the Lease Area, the Applicant concludes that exposure to marine mammal species and stocks during marine site characterization surveys would result in short-term minimal effects and would not affect the overall annual recruitment or survival for the following reasons:

- As detailed in Section 1.2 and submitted field verification reports (Gardline 2016a), potential acoustic exposures from survey activities are within the non-injurious behavioral effects zone (Level B harassment);
- The potential for take as estimated in Sections 6.2.1 and 6.2.2 represents a highly conservative estimate of harassment based upon typical HRG survey scenarios utilizing an overly conservative ZOI and without taking into consideration the effects of standard mitigation and monitoring measures; and
- The protective measures as described in Section 11.0 are designed to avoid and/or minimize the potential for interactions with and exposure to marine mammals.

Marine mammals are mobile free-ranging animals and have the capacity to exit an area when noise-producing survey activities are initiated. Based on the conservative take estimations, survey activities may disturb more than one individual for some species (mainly dolphins), but in conjunction with other aforementioned factors we conclude the proposed HRG survey activities are not expected to result in population-level effects and that individuals will return to normal behavioral patterns after activities have ceased or after the animal has left the area under survey.

8. Anticipated Impacts on Subsistence Uses

There are no traditional subsistence hunting areas in the Lease Area.

9. Anticipated Impacts on Habitat

Bottom disturbance associated with the HRG activities may include grab sampling to validate the seabed classification obtained from the multibeam echosounder/sidescan sonar data. This will typically be accomplished using a Mini-Harmon Grab with 0.1 m^2 sample area or the slightly larger Harmon Grab with a 0.2 m^2 sample area. The temporary and localized impact of the ZOI in relation to the comparatively vast area of surrounding open ocean, would render any potential impacts to prey availability or potential avoidance by marine mammals would be insignificant and not likely to affect marine mammal species. The HRG survey equipment will not contact the seafloor and would not be a source of air or water pollution. Impact to prey species is expected to be limited to avoidance of the area around the HRG survey activities and short-term changes in behavior. Such impacts are not expected to result in population-level effects on prey species (BOEM 2012). Individuals disturbed by a survey would likely return to normal behavioral patterns after the survey has ceased or after the animal has left the survey area. Because of the limited immediate area of ensonification and duration of individual HRG surveys, few fish may be expected in most cases to be present within the Survey Area (BOEM 2012).

Impact on marine mammal habitat from these activities will be negligible.

10. Anticipated Effects of Habitat Impacts on Marine Mammals

As stated in Section 9.0, the effects to marine mammals from loss or modification of habitat from the proposed survey activities will be insignificant and discountable.

11. Mitigation Measures

The Applicant commits to engaging in ongoing consultations with NMFS. The Applicant is committed the following comprehensive set of mitigation measures during marine site characterization surveys. The mitigation procedures outlined in this section are based on protocols and procedures that have been successfully implemented for similar offshore projects and previously approved by NMFS (DONG Energy 2016 and 2017, ESS 2013; Dominion 2013 and 2014). Unless otherwise specified, the following mitigation measures apply to HRG survey activities.

Bay State Wind LLC will develop a training program that will be provided to all crew prior to the start of survey and during any changes in crew such that all survey personnel are fully aware and understand the mitigation, monitoring and reporting requirements. The training program will be provided to NMFS for review and approval prior to the start of surveys. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet. Signing the log sheet will certify that the crew members understand and will comply with the necessary requirements throughout the survey event.

11.1 Vessel Strike Avoidance Procedures

The Applicant will ensure that vessel operators and crew maintain a vigilant watch for cetaceans, pinnipeds, and sea turtles and slow down or stop their vessels to avoid striking these protected species. Survey vessel crew members responsible for navigation duties will receive site-specific training on marine mammal and sea turtle sighting/reporting and vessel strike avoidance measures. Vessel strike avoidance measures will include, but are not limited to, the following, except under extraordinary circumstances when complying with these requirements would put the safety of the vessel or crew at risk:

- All vessel operators and crew will maintain vigilant watch for cetaceans, pinnipeds and sea turtles and slow down or stop their vessel to avoid striking these protected species;
- All vessel operators will comply with 10 knot (<18.5 km per hour [km/h]) speed restrictions in any Dynamic Management Area (DMA). In addition, all vessels 65 ft (19.8 m) or greater operating from November 1 through July 31 will operate at speeds of 10 knots (<18.5 km/h) or less;
- All vessel operators will reduce vessel speed to 10 knots or less when mother/calf pairs, pods, or larger assemblages of non-delphinoid cetaceans are observed near an underway vessel;
- All survey vessels will maintain a separation distance of 1640 ft (500 m) or greater from any sighted North Atlantic right whale;
- If underway, vessels must steer a course away from any sited North Atlantic right whale at 10

knots (<18.5 km/h) or less until the 1640-ft (500-m) minimum separation distance has been established. If a North Atlantic right whale is sited in a vessel's path, or within 330 ft (100 m) to an underway vessel, the underway vessel must reduce speed and shift the engine to neutral. Engines will not be engaged until the North Atlantic right whale has moved outside of the vessel's path and beyond 330 ft (100 m). If stationary, the vessel must not engage engines until the North Atlantic right whale has moved beyond 330 ft (100 m);

- All vessels will maintain a separation distance of 330 ft (100 m) or greater from any sighted non-delphinoid cetacean. If sighted, the vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the non-delphinoid cetacean has moved outside of the vessel's path and beyond 330 ft (100 m). If a survey vessel is stationary, the vessel will not engage engines until the non-delphinoid cetacean has moved out of the vessel's path and beyond 330 ft (100 m);
- All vessels will maintain a separation distance of 164 ft (50 m) or greater from any sighted delphinoid cetacean. Any vessel underway remain parallel to a sighted delphinoid cetacean's course whenever possible, and avoid excessive speed or abrupt changes in direction. Any vessel underway reduces vessel speed to 10 knots or less when pods (including mother/calf pairs) or large assemblages of delphinoid cetaceans are observed. Vessels may not adjust course and speed until the delphinoid cetaceans have moved beyond 164 ft (50 m) and/or the abeam of the underway vessel;
- All vessels underway will not diver to approach any delphinoid cetacean or pinniped. Any vessel underway will avoid excessive speed or abrupt changes in direction to avoid injury to the sighted delphinoid cetacean or pinniped; and
- All vessels will maintain a separation distance of 164 ft (50 m) or greater from any sighted pinniped.

11.2 Seasonal Operating Requirements

Between watch shifts members of the monitoring team will consult NMFS North Atlantic right whale reporting systems for the presence of North Atlantic right whales throughout survey operations. Project vessel my transit the SMA located off the coast of Rhode Island (Block Island Sound SMA). The proposed survey activities for the WTG and OSS segments, as well as the Export Cable Route Segments, are anticipated to start April 1, which is within the seasonal mandatory speed restriction period for this SMA (November 1 through April 30). However, the proposed survey activities for the Nearshore/Landfall segment will occur outside of the SMA.

Throughout all survey operations, the Applicant will monitor NMFS North Atlantic right whale reporting systems for the establishment of a DMA. If NMFS should establish a DMA in the Lease Area under survey, the vessels will abide by speed restrictions in the DMA per the lease condition.

11.3 Exclusion and Monitoring Zone Implementation

The Applicant proposes to employ the following exclusion and monitoring zones during all HRG survey activities:

- 1,640-ft (500-m) North Atlantic right whale exclusion zone;
- 328-ft (100-m) non-delphinoid large cetacean and ESA-listed marine mammal exclusion zone;

- 246-ft (75-m) Level A exclusion zone for harbor porpoise;
- 16.4-ft (5-m) Level A exclusion zone for all marine mammals not otherwise excluded; and
- 1,312.3-ft (400-m) Level B monitoring zone for all marine mammals except for the North Atlantic right whale.

These proposed mitigation zones have been based on distances to NMFS harassment criteria and have also been submitted to BOEM for review. These zones will be monitored as described in Sections 11.4 through 11.8.

11.4 Visual Monitoring Program

Visual monitoring of the established exclusion zones and monitoring zone will be performed by qualified and NMFS-approved Protected Species Observers (PSOs). In the case of the Nearshore/Landfall segment, where the likelihood of encountering marine mammals is low and the size of the vessels limits the number of allowable personnel on board, a vessel crew member will be designated as an Environmental Compliance Monitor (ECM) to monitor for the presence of marine mammals and ensure compliance with mitigation, monitoring and reporting requirements.

PSO qualifications will include direct field experience on a marine mammal/sea turtle observation vessel and/or aerial surveys in the Atlantic Ocean/Gulf of Mexico. For the offshore segments of the HRG survey (Lots 2, 3 and 4), an observer team comprising a minimum of four NMFS-approved PSOs and two certified Passive Acoustic Monitoring (PAM) operators, operating in shifts, will be stationed aboard respective survey vessels. To monitor the ASV, PSOs will be stationed aboard the mother vessel which will offer clear, unobstructed view of the ASV's exclusion and monitoring zones. The ASV will be within 2,625 ft (800 m) of the mothership while conducting survey operations. PSOs will adjust their positions appropriately to ensure adequate coverage of the entire exclusion and monitoring zones around the mothership and the ASV. PSOs and PAM operators will work in shifts such that no one monitor will work more than 4 consecutive hours without a 2-hour break or longer than 12 hours during any 24-hour period. During daylight hours the PSOs will rotate in shifts of 1 on and 3 off, and while during nighttime operations PSOs will work in pairs. The PAM operators will also be on call as necessary during daytime operations should visual observations become impaired. Each PSO will monitor 360 degrees of the field of vision. The Applicant will provide resumes of all proposed PSOs and PAM operators (including alternates) to BOEM for review and approval by NMFS at least 45 days prior to the start of survey operations.

The PSOs and/or ECM will begin observation of the exclusion zones and monitoring zone during all HRG survey operations. Observations of the zones will continue throughout the survey activity and/or while equipment operating below 200 kHz are in use. The PSOs/ECM will be responsible for visually monitoring and identifying marine mammals approaching or entering the established zones during survey activities. It will be the responsibility of the Lead PSO/ECM on duty to communicate the presence of marine mammals as well as to communicate and enforce the action(s) that are necessary to ensure mitigation and monitoring requirements are implemented as appropriate. In the offshore portions of the Survey Area (Lots 2, 3, and 4) while surveys are being conducted either at night or during periods of low visibility, PAM operators will communicate detected vocalizations to the Lead PSO on duty, who will then be responsible for implementing the necessary mitigation procedures. A copy of the PSO/ECM mitigation and monitoring communications flow diagram has been included in Appendix B.

PSOs/ECM will be equipped with binoculars and have the ability to estimate distances to marine mammals located in proximity to their respective exclusion zones and monitoring zone using range finders. Reticulated binoculars will also be available to PSOs/ECMs for use as appropriate based on conditions and visibility to support the siting and monitoring of marine species. Digital single-lens reflex camera equipment will be used to record sightings and verify species identification. During night operations in the offshore portions of the Survey Area (Lots 2, 3, and 4), PAM, night-vision equipment (night-vision goggles with thermal clip-ons), and infrared technology will be used. Position data will be recorded using hand-held or vessel global positioning system (GPS) units for each sighting. Recent studies have concluded that the use of IR (thermal) imaging technology may allow for the detection of marine mammals at night as well as improve the detection during all periods with automated detection algorithms (Weissenberger 2011). Studies have indicated that IR performance is independent of daylight and exhibits an almost uniform, omnidirectional detection probability within a radius of 3.1 miles (5 km). Results of studies demonstrate that thermal imaging can be used for reliable and continuous marine mammal protection (Zitterbart 2013). For this reason, Bay State Wind LLC finds that use of IR systems for mitigation purposes warrants additional application in the field as both a standalone tool and in conjunction with other alternative monitoring methods (e.g., PAM and night vision binoculars). In addition, results from the ongoing Phase I Development Area HRG reconnaissance surveys have indicated that the night vision binoculars were most effective at detecting animals at a close distance of 328 ft (100 m); however, the greatest distance at which animals were detected was 2,461 ft (750 m), demonstrating that the equipment could still be effective at greater distances. Specifications for representative night-vision and infrared equipment are included in Appendix C and Appendix D, respectively. These equipment specifications are provided as examples of equipment most likely. Specific night-vision and infrared equipment models will be subject to availability.

Observations will take place from the highest available vantage point on all the survey vessels. General 360-degree scanning will occur during the monitoring periods, and target scanning by the PSO/ECM will occur when alerted of a marine mammal presence.

For monitoring around the ASV, a dual thermal/HD camera will be installed on the mother vessel, facing forward, angled in a direction so as to provide a field of view ahead of the vessel and around the ASV. PSOs will be able to monitor the real time out-put of the camera on hand-held iPads. Images from the cameras can be captured for review and to assist it verifying species identification. A monitor will also be installed on the bridge displaying the real-time picture from the thermal/HD camera installed on the front of the ASV itself, providing a further forward field of view of the craft. In addition, night-vision goggles with thermal clip-ons, as mentioned above, and a hand-held spotlight will be provided such that PSOs can focus observations in any direction, around the mother vessel and/or the ASV.

Data on all PAM/PSO/ECM observations will be recorded based on standard PSO collection requirements. This will include dates and locations of construction operations; time of observation, location and weather; details of the sightings (e.g., species, age classification [if known], numbers, behavior); and details of any observed behavioral disturbances or injury/mortality. The data sheet will be provided to both NMFS and BOEM for review and approval prior to the start of survey activities. In addition, prior to initiation of survey work, all crew members will undergo environmental training, a component of which will focus on the procedures for sighting and protection of marine mammals and sea turtles. A briefing will also be conducted between the survey supervisors and crews, the PSOs/ECMs, and the Applicant. The purpose of the briefing will be to establish responsibilities of each party, define the chains of command, discuss communication procedures, provide an overview of monitoring purposes, and review operational procedures.

11.5 Passive Acoustic Monitoring Program

To support 24-hour survey operations, the Applicant will include PAM as part of the project monitoring during the geophysical survey program during periods of low visibility and nighttime operations to provide for optimal acquisition of species detections at night and during low visibility conditions. Specifications for the PAM equipment will be provided to both NOAA and BOEM for review and acceptance prior to the start of surveys.

Given the range of species that could occur in the Lease Area, the PAM system will consist of an array of hydrophones with both broadband (sampling mid-range frequencies of 2 kHz to 200 kHz) and at least one low-frequency hydrophone (sampling range frequencies of 75 Hz to 30 kHz).

The PAM operator(s) will monitor the hydrophone signals in real time both aurally (using headphones) and visually (via the monitor screen displays). PAM operators will communicate detections to the Lead PSO on duty who will ensure the implementation of the appropriate mitigation measure.

In the event that distances to vocalizing animals cannot be determined through PAM system software, experienced PAM operators can make a distance estimation assisted by the noise or detection score system developed by Gannier et al. (2002). Although the scale is subjective, and sounds produced in marine environments will vary according to species and local conditions, the scale provides a measure for approximating distances when using a single, linear hydrophone array. Based on the PAM operator's estimations in such situations, the Lead PSO will be notified and shutdown procedures will be followed in accordance to established exclusion zones.

No PAM will be used for the Nearshore/Landfall segment, as survey activities will only be conducted during daylight hours (defined as 30 minutes after dawn to 30 minutes before dusk). In addition, PAM will not be used on the ASV, but will covered by PAM operators stationed onboard the mother vessel.

11.6 Pre-Clearance of the Exclusion Zones

The Applicant will implement a 30-minute clearance period of the exclusion zones prior to the initiation of ramp-up (Section 11.7). During this period the exclusion zones will be monitored by the PSOs/ECM, using the appropriate visual technology and/or PAM for a 30-minute period. No PAM, night vision, or thermal equipment will be used for the Nearshore/Landfall segment, as survey activities will only be conducted during daylight hours (defined as 30 minutes after dawn to 30 minutes before dusk). Ramp up may not be initiated if any marine mammal(s) is within its respective exclusion zone. If a marine mammal is observed within an exclusion zone during the pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting its respective exclusion zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

11.7 Ramp-Up Procedures

Where technically feasible, a ramp-up procedure will be used for HRG survey equipment capable of adjusting energy levels at the start or re-start of HRG survey activities. A ramp-up procedure will be used at the beginning of HRG survey activities in order to provide additional protection to marine mammals near the Survey Area by allowing them to vacate the area prior to the commencement of survey equipment use. The ramp-up procedure will not be initiated during periods of inclement conditions or if the exclusion zones cannot be adequately monitored by the PSOs/ECM, using the appropriate visual technology and/or PAM for a 30-minute period. No PAM, night vision, or thermal equipment will be used for the Nearshore/Landfall segment, as survey activities will only be conducted during daylight hours (defined as 30 minutes after dawn to 30 minutes before dusk).

A ramp-up would begin with the powering up of the smallest acoustic HRG equipment at its lowest practical power output appropriate for the survey. When technically feasible the power would then be gradually turned up and other acoustic sources added in a way such that the source level would increase in steps not exceeding 6 dB per 5-minute period.

Ramp-up activities will be delayed if a marine mammal(s) enters its respective exclusion zone. Ramp-up will continue if the animal has been observed exiting its respective exclusion zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

11.8 Shut-Down Procedures

An immediate shut-down of the HRG survey equipment will be required if a marine mammal is sighted at or within its respective exclusion zone. The vessel operator must comply immediately with any call for shut-down by the Lead PSO/ECM. Any disagreement between the Lead PSO/ECM and vessel operator should be discussed only after shut-down has occurred. Subsequent restart of the survey equipment can be initiated if the animal has been observed exiting its respective exclusion zone with 30 minutes of the shut-down or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for small odontocetes and 30 minutes for all other species).

If the acoustic source is shut down for reasons other than mitigation (e.g., mechanical difficulty) for brief periods (i.e., less than 30 minutes), it may be activated again without ramp-up, if PSOs/ECM have maintained constant observation and no detections of any marine mammal have occurred within the respective exclusion zones.

If the acoustic source is shut down for a period longer than 30 minutes and PSOs/ECM have maintained constant observation then ramp-up procedures will be initiated as described in Section 11.7.

12. Arctic Plan of Cooperation

Potential impacts to species or stocks of marine mammals will be limited to individuals of marine mammal species located in the northeast region of the United States, and will not affect Arctic marine mammals. Given that the Project is not located in Arctic waters, the activities associated with the Applicant’s marine characterization surveys will not have an adverse effect on the availability of marine mammals for subsistence uses allowable under the MMPA.

13. Monitoring and Reporting

13.1 Monitoring

Visual and passive acoustic monitoring protocols are described in Section 11.

13.2 Reporting

The Applicant will provide the following reports as necessary during construction activities:

- The Applicant will contact BOEM and NMFS within 24 hours of the commencement of survey activities and again within 24 hours of the completion of the activity;

- The Applicant will report any observed injury or mortality in accordance with NMFS' standard reporting guidelines; and
- Within 90 days after completion survey activities, a draft technical report will be provided to BOEM, and NMFS that fully documents the methods and monitoring protocols, summarizes the data recorded during monitoring, estimates the number of listed marine mammals that may have been taken during survey activities, and provides an interpretation of the results and effectiveness of all monitoring tasks. Any recommendations made by NMFS shall be addressed in the final report prior to acceptance by NMFS.

14. Suggested Means of Coordination Research

All marine mammal data collected by the Applicant during marine characterization survey activities will be provided to NMFS, BOEM, and other interested government agencies, and be made available upon request to educational institutions and environmental groups. These organizations could use the data collected during this period to study ways to reduce incidental taking and evaluate its effects.

All hydroacoustic data and resulting transmission loss rates collected during field verification of the monitoring and/or exclusion zones by the Applicant during HRG surveys will be provided to NMFS, BOEM, and other interested government agencies, and be made available upon request to educational institutions and environmental groups. These organizations could use the data collected during this period to study ways to reduce incidental taking from survey activities and evaluate its effects.

15. List of Preparers

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Appendix A
National Marine Fisheries Service Screening Level Methodology Calculation Spreadsheets for the Determination for Onset of Permanent and Temporary Threshold Shifts

(Version 1.1 August 2016)

F: MOBILE SOURCE: Impulsive, Intermittent (SAFE DISTANCE METHODOLOGY‡)

VERSION: 1.1 (Aug-16)

KEY

(gray)	Action Proponent Provided Information
(peach)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Bay State Wind
PROJECT/SOURCE INFORMATION Please include any assumptions	Sonardyne Ranger 2 USBL HPT 5/7000
PROJECT CONTACT	Tetra Tech, Inc

STEP 2: WEIGHTING FACTOR ADJUSTMENT Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	2.65

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 62), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either F1 OR F2 method to calculate isopleths (not required to fill in sage boxes for both)

F1: METHOD USING RMS SPL SOURCE LEVEL

FV Source Level (RMS SPL)	172
Mnfr Source Level (RMS SPL)	200
Source Velocity (meters/second)	2.045
Pulse Duration∆ (seconds)	0.016
1/Repetition rate^ (seconds)	1
Duty Cycle	0.0160
Source Factor	2.53583E+15

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

∆Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

^Time between onset of successive pulses.

RESULTANT ISOPLETHS*

* Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	0.0	0.0	0.0	0.0	0.0

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.06	-16.09	-22.63	-1.12	-0.49

F: MOBILE SOURCE: Impulsive, Intermittent (SAFE DISTANCE METHODOLOGY[‡])

VERSION: 1.1 (Aug-16)

KEY

(gray)	**Action Proponent Provided Information**
(peach)	**NMFS Provided Information (Acoustic Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Bay State Wind
PROJECT/SOURCE INFORMATION Please include any assumptions	Sonardyne Ranger 2 USBL HPT 3000
PROJECT CONTACT	Tetra Tech, Inc

STEP 2: WEIGHTING FACTOR ADJUSTMENT — Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2.65

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 62), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either F1 OR F2 method to calculate isopleths (not required to fill in sage boxes for both)

F1: METHOD USING RMS SPL SOURCE LEVEL

FV Source Level (RMS SPL)	160
Mnfr Source Level (RMS SPL)	188
Source Velocity (meters/second)	2.045
Pulse Duration[∆] (seconds)	0.016
1/Repetition rate^ (seconds)	0.333333333
Duty Cycle	0.0480
Source Factor	4.8E+14

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

[∆]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[^]Time between onset of successive pulses.

RESULTANT ISOPLETHS*

* Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.06**	**-16.09**	**-22.63**	**-1.12**	**-0.49**

F: MOBILE SOURCE: Impulsive, Intermittent (SAFE DISTANCE METHODOLOGY‡)

VERSION: 1.1 (Aug-16)

KEY

(gray)	**Action Proponent Provided Information**
(peach)	**NMFS Provided Information (Acoustic Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Bay State Wind
PROJECT/SOURCE INFORMATION Please include any assumptions	Easytrak Nexus 2 USBL
PROJECT CONTACT	Tetra Tech, Inc

STEP 2: WEIGHTING FACTOR ADJUSTMENT — Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	2.5

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 62), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either F1 OR F2 method to calculate isopleths (not required to fill in sage boxes for both)

F1: METHOD USING RMS SPL SOURCE LEVEL

FV Source Level (RMS SPL)	164
Mnfr Source Level (RMS SPL)	192
Source Velocity (meters/second)	2.045
Pulse Duration∆ (seconds)	0.01
1/Repetition rate^ (seconds)	0.1
Duty Cycle	0.1000
Source Factor	2.51189E+15

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

∆Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

^Time between onset of successive pulses.

RESULTANT ISOPLETHS*

* Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

F: MOBILE SOURCE: Impulsive, Intermittent (SAFE DISTANCE METHODOLOGY‡)

VERSION: 1.1 (Aug-16)

KEY

(gray)	Action Proponent Provided Information
(peach)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Bay State Wind
PROJECT/SOURCE INFORMATION Please include any assumptions	IxSea GAPS System
PROJECT CONTACT	Tetra Tech, Inc

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	2.6

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 62), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either F1 OR F2 method to calculate isopleths (not required to fill in sage boxes for both)

F1: METHOD USING RMS SPL SOURCE LEVEL

FV Source Level (RMS SPL)	160
Mnfr Source Level (RMS SPL)	188
Source Velocity (meters/second)	2.045
Pulse Duration∆ (seconds)	0.01
1/Repetition rate^ (seconds)	0.1
Duty Cycle	0.1000
Source Factor	1E+15

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

∆Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

^Time between onset of successive pulses.

RESULTANT ISOPLETHS*

* Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	0.0	0.0	0.0	0.0	0.0

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.06	-16.33	-22.91	-1.17	-0.52

F: MOBILE SOURCE: Impulsive, Intermittent (SAFE DISTANCE METHODOLOGY‡)

VERSION: 1.1 (Aug-16)

KEY

(gray)	**Action Proponent Provided Information**
(tan)	**NMFS Provided Information (Acoustic Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Bay State Wind
PROJECT/SOURCE INFORMATION Please include any assumptions	EdgeTech Subbottom Profiler 3200 XS 216
PROJECT CONTACT	Tetra Tech, Inc

STEP 2: WEIGHTING FACTOR ADJUSTMENT Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	9

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 62), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either F1 OR F2 method to calculate isopleths (not required to fill in sage boxes for both)

F1: METHOD USING RMS SPL SOURCE LEVEL

FV Source Level (RMS SPL)	174
Mnfr Source Level (RMS SPL)	210
Source Velocity (meters/second)	2.045
Pulse Duration∆ (seconds)	0.02
1/Repetition rate^ (seconds)	0.1000
Duty Cycle	0.2000
Source Factor	5.02377E+16

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

∆Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

^Time between onset of successive pulses.

RESULTANT ISOPLETHS*

* Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	0.0	0.0	5.3	0.0	0.0

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-1.63	-3.52	-6.66	-0.19	-0.51

F: MOBILE SOURCE: Impulsive, Intermittent (SAFE DISTANCE METHODOLOGY‡)

VERSION: 1.1 (Aug-16)

KEY

(gray)	**Action Proponent Provided Information**
(peach)	**NMFS Provided Information (Acoustic Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Bay State Wind
PROJECT/SOURCE INFORMATION Please include any assumptions	GeoMarine Geo-Source 400tip Sparker
PROJECT CONTACT	Tetra Tech, Inc

STEP 2: WEIGHTING FACTOR ADJUSTMENT Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	2

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 62), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either F1 OR F2 method to calculate isopleths (not required to fill in sage boxes for both)

F1: METHOD USING RMS SPL SOURCE LEVEL

FV Source Level (RMS SPL)	186
Mnfr Source Level (RMS SPL)	205
Source Velocity (meters/second)	2.045
Pulse Duration∆ (seconds)	0.0038
1/Repetition rate^ (seconds)	0.5
Duty Cycle	0.0076
Source Factor	3.02561E+16

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

∆Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

^Time between onset of successive pulses.

RESULTANT ISOPLETHS*

* Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.01**	**-19.74**	**-26.87**	**-2.08**	**-1.15**

F: MOBILE SOURCE: Impulsive, Intermittent (SAFE DISTANCE METHODOLOGY‡)

VERSION: 1.1 (Aug-16)

KEY

(gray)	**Action Proponent Provided Information**
(peach)	**NMFS Provided Information (Acoustic Guidance)**
(blue)	**Resultant Isopleth**

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Bay State Wind
PROJECT/SOURCE INFORMATION Please include any assumptions	Applied Acoustics S-Boom Triple Plate Boomer
PROJECT CONTACT	Tetra Tech, Inc

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	0.6

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 62), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either F1 OR F2 method to calculate isopleths (not required to fill in sage boxes for both)

F1: METHOD USING RMS SPL SOURCE LEVEL

Mnfr Source Level (RMS SPL)	216
Source Velocity (meters/second)	2.045
Pulse Duration∆ (seconds)	0.0005
1/Repetition rate^ (seconds)	0.1111
Duty Cycle	0.0045
Source Factor	1.79148E+19

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

∆Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

^Time between onset of successive pulses.

RESULTANT ISOPLETHS*

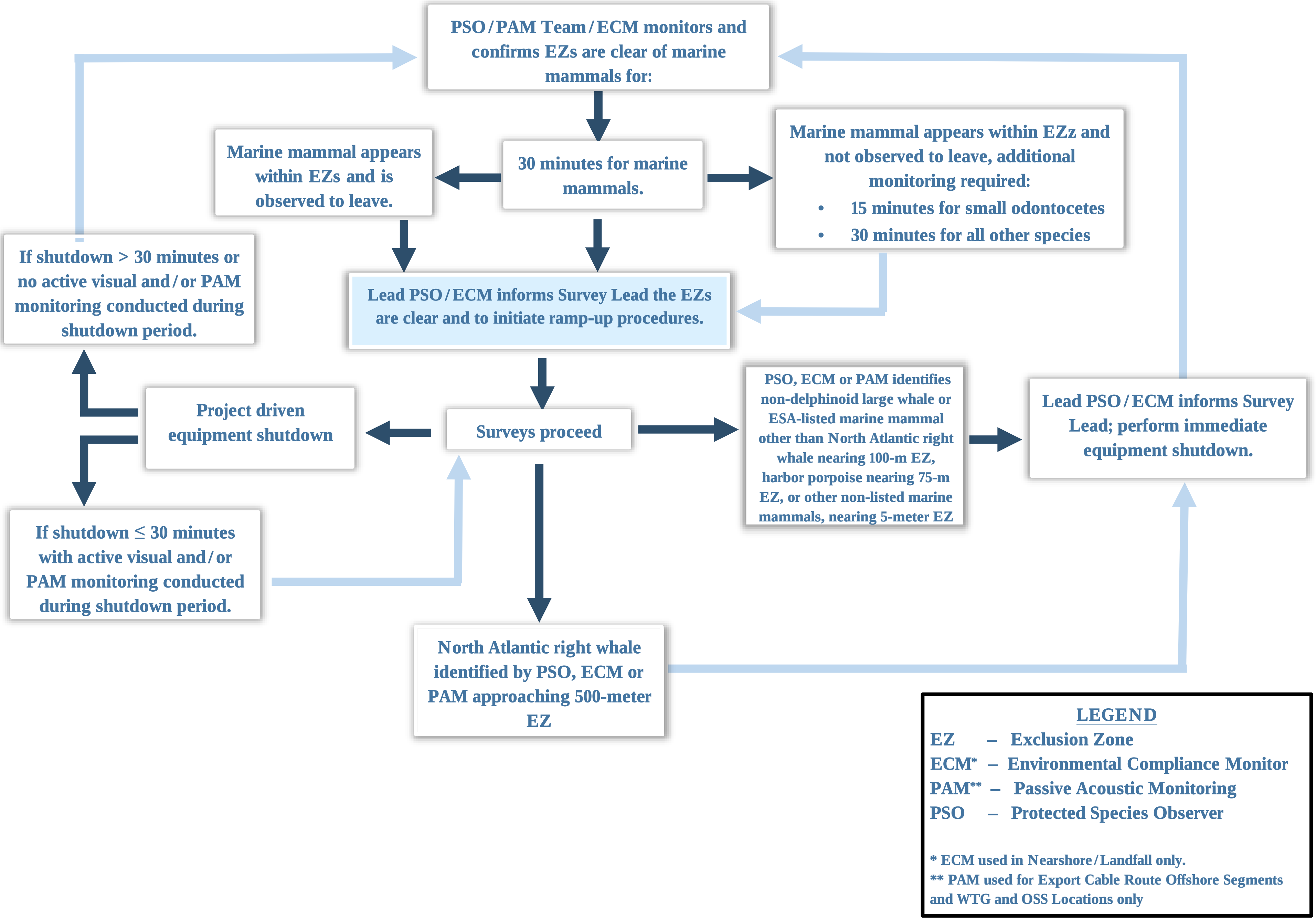
* Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**12.8**	**0.0**	**0.2**	**0.9**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.34**	**-36.16**	**-45.50**	**-9.68**	**-10.13**

Appendix B
Mitigation and Monitoring Communications Flow Diagram


PSO/PAM Team/ECM monitors and confirms EZs are clear of marine mammals for:
30 minutes for marine mammals.
Marine mammal appears within EZs and is observed to leave.
Marine mammal appears within EZz and not observed to leave, additional monitoring required:
• 15 minutes for small odontocetes
• 30 minutes for all other species
Lead PSO/ECM informs Survey Lead the EZs are clear and to initiate ramp-up procedures.
If shutdown > 30 minutes or no active visual and/or PAM monitoring conducted during shutdown period.
Project driven equipment shutdown
Surveys proceed
PSO, ECM or PAM identifies non-delphinoid large whale or ESA-listed marine mammal other than North Atlantic right whale nearing 100-m EZ, harbor porpoise nearing 75-m EZ, or other non-listed marine mammals, nearing 5-meter EZ
Lead PSO/ECM informs Survey Lead; perform immediate equipment shutdown.
If shutdown ≤ 30 minutes with active visual and/or PAM monitoring conducted during shutdown period.
North Atlantic right whale identified by PSO, ECM or PAM approaching 500-meter EZ
LEGEND
EZ – Exclusion Zone
ECM* – Environmental Compliance Monitor
PAM** – Passive Acoustic Monitoring
PSO – Protected Species Observer
* ECM used in Nearshore/Landfall only.
** PAM used for Export Cable Route Offshore Segments and WTG and OSS Locations only

Appendix C
Night Vision Binocular Specifications

THERMAL IMAGING BI-OCULAR

ARMASIGHT by FLIR COMMAND®

336 SERIES

COMMAND 336 3-12X50

COMMAND 336 5-20x75

COMMAND 336 8-32x100

The Command's design is better suited for sustained viewing periods and improved depth perception. The Command is a solid state, uncooled, long-wave infrared, magnified, dedicated handheld thermal imager intended for day and nighttime missions. Thermal imaging technology also allows you to detect targets by cutting through snow, dust, smoke, fog, haze, and other atmospheric obscurants.

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EXCEPTIONAL VISION

Advanced image processing eliminates the guesswork

- Completely digital for better detection, classification and recovery, day or night
- Built using the FLIR Tau 2 thermal core
- Bright, high definition OLED display for absolute clarity

HIGH PERFORMANCE

For sustained viewing periods

- Powerful hardware is protected by a robust body
- Featuring a 17 µm pixel pitch and on-chip image processing
- Outstanding thermal image quality in the darkness or through smoke, haze, fog, rain

SUPERIOR VALUE

Packed with features for a versatile and customizable viewing experience

- Its simple, intuitive 3-button controls give you rapid access to digital zoom and easy to navigate drop-down menus
- Multiple color palettes
- 4x digital zoom for extra reach

SPECIFICATIONS

General	Command 336 3-12×50	Command 336 5-20×75	Command 336 8-32×100
Detector Type	336 x 256 VOx Microbolometer		
Video Refresh Rate	30 Hz or 60 Hz		
Start Up	3 seconds		
Lens system	50 mm; F/1.0	75 mm; F/1.1	100 mm; F/1.3
Optical magnification	3×	5×	8×
Field of View (H x V)	7.8° x 5.9°	4.3° × 3.2°	3.3° × 2.5°
Digital Zoom	2×, 4×		
Diopter Adjustment Range	-5 to +5 dpt		
Focusing Range	5 m to infinity		
Display	800 x 600 OLED		
Video Output	PAL (768 x 574 pixels)/ NTSC (640 x 480 pixels)		
Temperature Imaging Modes (Image Palettes)	White Hot, Black Hot, Fusion, Rainbow, Globow, Ironbow1, Ironbow2, Sepia, Color1, Color2, Ice-Fire, Rain, and OEM		
User Interface			
Operation Switch	On/ Off/ Standby Mode		
Control Panel Buttons	Configures Operational Settings: • Display Brightness Control • Image Palette Control • Digital Zoom Control • On-Screen Menu Navigation		
Focus Ring	Adjusts the Objective Lens Focus		
Diopter Adjustment Ring	Adjusts the Eyepiece Diopter		
Interfacing			
Connector	Power In, analog video In/Out, digital video recorder, laser range finder connections		
Power			
Battery Type	Two CR123A 3V Lithium batteries or CR123 type rechargeable batteries with voltage from 3.0V to 3.7V (2)		
Battery Life (Operating)	Up to 4 hours at 20°C		
Environmental			
Operating Temperature Range	-40°C to +50°C (-40°F to +122°F)		
Storage Temperature Range	-50°C to +70°C (-58°F to +158°F)		
Physical			
Weight	0.8 kg (1.8 lbs)	1.08 kg (2.4 lbs)	1.3 kg (2.9 lbs)
Size	238 × 122 × 62 mm (9.4 × 4.8 × 2.2 in)	272 × 122 × 89 mm (10.7 × 4.8 × 3.5 in)	290 ×122 × 116 mm (11.4 × 4.8 × 4.5 in)

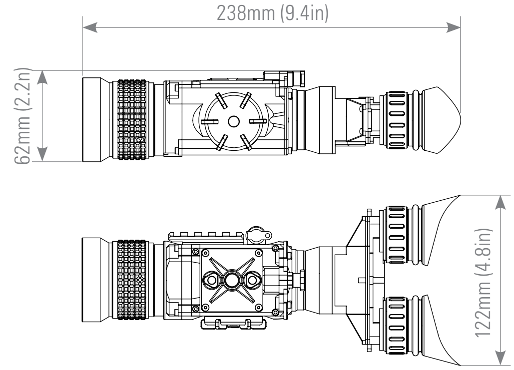
Package Includes

Thermal Bi-Ocular, Battery Cassette, Soft Carrying Case, Lens Cloth

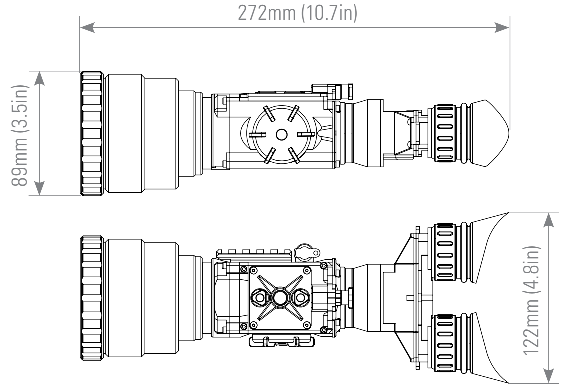
Optional Accessories

ATVR000002 – Wireless Head Mounted Display
IATAM000005 – HD DVR - High-Definition Digital Recorder
ATAM000008 – Extended Battery Pack - Extended Battery Pack with Rechargeable Batteries
ANAMTM0003 – Tripod with a Grip
ANHC000001 – Hard Shipping/Storage Case #101

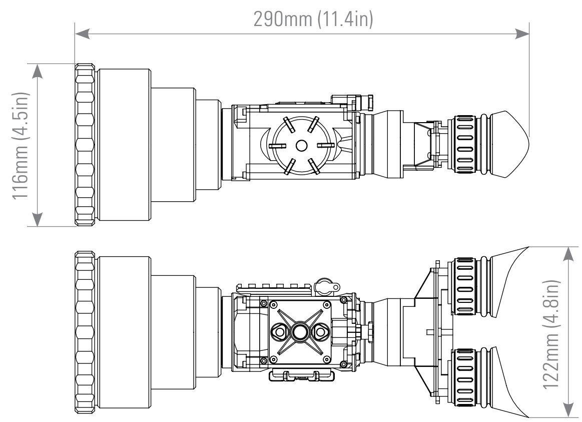
Specifications are subject to change without notice.
For the most up-to-date specs, go to www.flir.com



Command 336 3-12×50



Command 336 5-20×75



Command 336 8-32×100

FLIR OUTDOOR & TACTICAL SYSTEMS

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Appendix I Night Vision Binocular Specifications

ARMASIGHT by FLIR PVS-7

Night Vision Goggles

The Armasight by FLIR PVS-7 is the most widely recognized and dependable United States Military night vision goggle system available. The AN/PVS-7B/D system has proven itself in combat due to its rugged, ergonomic design.

The PVS-7 is equipped with Automatic Brightness Control (ABC), which automatically adjusts the brightness of the image tube to achieve the highest quality image resolution under varying light conditions, as well as a built-in infrared illuminator that allows the user to operate in total darkness. The PVS-7 also has an excessive-light cut-off feature that protects the image tube from bright light sources, and a flip-up shut-off feature when used with the optional helmet mount assembly. The PVS-7 is equipped with two LED indicators: yellow for a low battery, and red to alert the operator that the IR illuminator is on. Both are displayed on the eyepiece screen. Lightweight, rugged, and versatile, the PVS-7 can be handheld, head-mounted, and helmet-mounted. The dismounted goggle can also be used as an excellent long-range viewer with optional afocal magnifier lenses.

FEATURES

- Compact, rugged design
- Waterproof
- Head or helmet-mountable for hands-free usage
- Ergonomic, simple, easy to operate controls
- Built-in Infrared illuminator and focal lens
- Limited two-year warranty

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www.armasight.com

ARMASIGHT BY FLIR

Specifications

Overview	
Image intensifier tube	IDMG – Gen 2+, "Improved Definition" HDMG – Gen 2+, "High-Definition" 3Bravo – Gen 3+ 3Alpha – Gen 3+, High-Performance 3P – Gen 3, High-Performance Thin-Filmed Auto-Gated IIT
Magnification	1x standard, (3x, 5x optional)
Lens system	27mm, F/1.2
FOV	40°
Focus range	0.20 m to infinity
Exit pupil	15 mm
User Interface	
Function switch	On/ Off unit and built-in IR illuminator
Focus ring	Focuses the objective lens
Diopter adjustment rings	Focuses the eyepieces
System Specifications	
Bright light cut-off	Yes
Automatic shut-off system	Yes
IR indicator	Yes
Low battery indicator	Yes
Infrared illuminator	Yes (built-in with focal lens)
Power	
Battery type	Two AA batteries
Battery life (operating)	Up to 30hrs
Environmental	
Operating temperature range	-40° C to +50° C (-40° F to +122° F)
Storage temperature range	-50° C to +70° C (-58° F to +158° F)
Physical	
Weight (without mount)	0.68 kg (1.4 lbs)
Size (with mount)	162 × 152 × 76 mm (6.4 × 6 × 3 in)
Color (housing)	Black
Package Includes	
Night Vision Goggles, Lens Cap, Eyecup, Head Mount Assembly, Sacrificial Window, Demist Shields, Shoulder Strap, Neck Cord, AA Batteries, Operation and Maintenance Manual, Soft Carrying Case	
Optional Accessories	
ANHM000005 – Norotos MICH Helmet Mount Assembly USA #107 ANHM000006 – Norotos PASGT Helmet Mount Assembly USA #108 ANAF3X0003 – 3x A-Focal Mil-Spec Lens #99 ANAF3X000P – 3x A-Focal Lens #22 with Adapter #24/#25 ANAF5X000P – 5x A-Focal Lens with Adapter #24/#25 ANAMRF0003 – ARFS3 - Advanced Range-Finding Stadia for 3x A-Focal Lens ANAMRF0005 – ARFS5 - Advanced Range-Finding Stadia for 5x A-Focal Lens ANKXLR017 – IR850-XLR Detachable X-Long-Range Infrared Illuminator w/Dovetail to Weaver Transfer Piece #21, Rechargeable Battery, and Charger ANHC000001 – Hard Shipping/ Storage Case #101	

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Fax: 1-888-959-2260
International Phone/Fax: (650) 492-7755

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www.armasight.com

PVS-7 Goggle Generation 3 PINNACLE®

The PVS-7 (PVS-7B/D) is the standard issue goggle type supplied to the U.S. Military and its allies. Equipped with a factory new, high-performance, ITT Generation 3 **PINNACLE®** image intensifier tube, the PVS-7 Gen 3 **PINNACLE®** night vision goggle is designed for the most demanding of night time applications. Battle-proven technology includes Automatic Brightness Control (ABC) which automatically adjusts the brightness of the image tube to achieve the highest quality image resolution under varying light conditions as well as a built-in infra-red illuminator which allows the user to operate under zero light conditions. Lightweight and versatile, the PVS-7 Gen 3 **PINNACLE®** night vision goggle can be hand-held, head-mounted, and helmet-mounted. Standard accessories and System Data Sheet included.

PART #: MVP-MVPVS7-3P

Standard Accessories Included:

- **Head Mount Assembly** – Allows for hands free operation. Accommodates user's head size and eye positioning.
- **Medium & Thick Brow Pads** – Changeable pads. **Eye Cups** - Prevents the emission of stray light or facial reflections.
- **Lens Cap**
- **Soft Carrying Case** – Provides convenient storage.
- **Shoulder Strap** – Attaches to the PVS-7 carrying case for easy portability.
- **Lens Paper** – Used to lightly clean the objective and eyepiece glass surfaces.
- **Sacrificial Window**– Shields the optics from sand, air particles or anything that may scratch the lens.
- **Demist Shields** – Snaps onto the eyepiece to prevent condensation from forming on the optics.
- **Operators Manual -** Instructional users guide.
- **Batteries –** Two (2) AA
- **Data Sheet –** System Test Data Sheet

Features and Benefits:

- High resolution 64 lp/mm (Min) **PINNACLE®**, high gain and high photoresponse in visible and near infrared
- Multifunctional: Hand-held, head-mounted or helme mounted.
- Lightweight only 24 oz w/ batteries
- Equipped with momentary or continuous IR switch
- Automatic high-light cutoff
- Comprehensive two-year warranty

Optional Accessories (not included):

- 3x Mil-Spec Magnifier Lens
- 5x Mil-Spec Magnifier Lens
- Helmet Mount Assembly (PASGT/MICH)
- Sacrificial Window
- Magnetic Compass
- SKB Mil-Standard Hard Case
- And more… (see website)

MOROVISION NIGHT VISION, INC.
23382 Mill Creek Drive, Suite D-115
Laguna Hills, CA 92653

By Phone: Toll Free 1-800-424-8222 or 949-581-9988
By Fax: 949-581-1133
Email: info@morovision.com
Website: http://www.morovision.com

MOROVISION NIGHT VISION

LIGHT THE NIGHT™

SPECIFICATIONS: PVS-7 Goggle Generation 3 PINNACLE®

Intensifier Tube	Generation	3 U.S. (ITT PINNACLE®)
	Resolution	64 lp/mm (Min)
	Film	Thin
	Gate	Auto-Gated
Optics	Magnification	1x
	Field of View	40 ± 2º
	Objective Lens	F/1.2
	Eyepiece Lens	EFL 26mm
	Diopter Adjustment	+2 to -6 diopters
	Interpupillary Adjustment	55 to 71mm
	Range of Focus	20cm to infinity ∞
Power	Power Source	Two (2) AA size batteries
	Operating Time	Approx. 30 hrs at room temp.
Environmental Characteristics	Operating Temperature	-51º C to +52º C
	Storage Temperature	-51º C to +85º C
Physical Characteristics	Size:	
	Length	6 3/8”
	Height	3”
	Width	6”
	Weight:	
	w/batteries	24 oz (680 grams)
Warranty	System	Two (2) years

MOROVISION NIGHT VISION, INC.
23382 Mill Creek Drive, Suite D-115
Laguna Hills, CA 92653

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EXPORT NOTICE:
Export of this product is regulated by the U.S. Department of State in accordance with guidelines of “International Traffic in Arms Regulations (ITAR)” per Title 22, Code of Federal Regulations, Parts 120-130.

NIVISYS™ LLC

NIGHT VISION SYSTEMS

TACS-M™

Rev. 21 Jan 2013

Thermal Acquisition Clip-On System, Miniature

TACS-M shown here on a MUM-14.

Manufactured by OPTICS 1

SPECIFICATIONS*

Field of View	**Boresight Accuracy**	**Magnification**	**F Number**
20° circular (centered)	3 MOA	1X, optical unity	1.2
Sensor	**Spectral Response**	**Pitch**	**NEΔT**
320 x 240 VOx uncooled LWIR microbolometer	8-12µm	25µm	50mK
Display Brightness	**Polarity**	**Calibration**	**Display**
Adjustable	White hot/black hot	Manual	Kopin (RED)
Range (Clear)	**Range (Obscured)**	**Compatibility**	**Interface**
Detection: 300m Recognition: 260m	Detection: 250m Recognition: 210m	PVS-7, PVS-14, PVS-15, PVS-18, PVS-23, MUM-14	Standard quick connect
Battery Type	**Battery Life**	**Dimensions**	**Weight**
CR123, 3V Lithium, 1ea.	>3.0 hrs (23°C) 2.5 hrs (0°C)	(W x H x L) 38 x 64 x 89mm	166g with battery

*Specifications are subject to change without notice.

Export of the commodities described herein is strictly prohibited without a valid export license issued by the U.S. Department of State, Directorate of Defense Trade Controls as proscribed in the International Traffic in Arms Regulations (ITAR), Title 22 Code of Federal Regulation, Parts 120-130.

DESCRIPTION

The Miniature Thermal Acquisition Clip-On System (TACS-M) provides the soldier with ultimate performance in technology. Low power consumption, optimal sensor technology, and high-performance optics all seamlessly integrate to provide state of the art long wave infrared (LWIR) technology.

When added to a standard image intensified system, TACS-M provides a second channel with LWIR capability, extending engagement capabilities through obscurants. The TACS-M unit along with Nivisys experience and expertise provides the best value solution for adding low light and no light performance to currently fielded night vision systems.

The unit's waterproof and rugged construction stands up to the harshest environments and features a red display for visual security. This multi-purpose surveillance tool uses the latest in miniature thermal sensor technology and a high resolution display to provide superior imagery in the smallest package available.

For more information on the TACS-M or other Nivisys products call (480) 970-3222 or visit us on the web at www.nivisys.com.

Made in USA

Nivisys, LLC • 400 S. Clark Drive, Suite 105 • Tempe, Arizona USA • 480.970.3222 • 480.970.3555(fax) • email: info@nivisys.com

Appendix D
Infrared Equipment Specifications

Hardware – Thermal Imaging Monitoring System (Seiche)

Overview

The camera system consists of two modules: a High Definition (HD) camera and a thermal imaging camera. Each unit is robustly housed for maritime use with pan and tilt functionality. The system uses Seiche proprietary software RADES to stabilize image and enable accurate distance estimation. Various configuration options are available to ensure optimal visual coverage of up to 360 degrees (adjustable field of view, panning scope and speed etc). Three Cameras would be installed for full 360 degrees coverage.

Applications include:

- Consistent 24-hour monitoring
- Hazard detection, small fish boat detection and vessel security and safety
- Accurate distance and ranging with image stabilization
- Mitigation Zone Overlay

Technical Description

The camera system consists of two modules: a High Definition (HD) camera and a thermal imaging camera. Each unit is robustly housed for maritime use with pan and tilt functionality. The system uses Seiche proprietary software RADES to stabilize image and enable accurate distance estimation. Various configuration options are available to ensure optimal visual coverage of up to 360 degrees (adjustable field of view, panning scope and speed etc). Three Cameras would be installed for full 360 degrees coverage.

HD and Thermal Imaging Cameras

Each pan and tilt module makes up a wholly separable Remote High-definition Visual Monitoring (RHVM) system consisting the following:

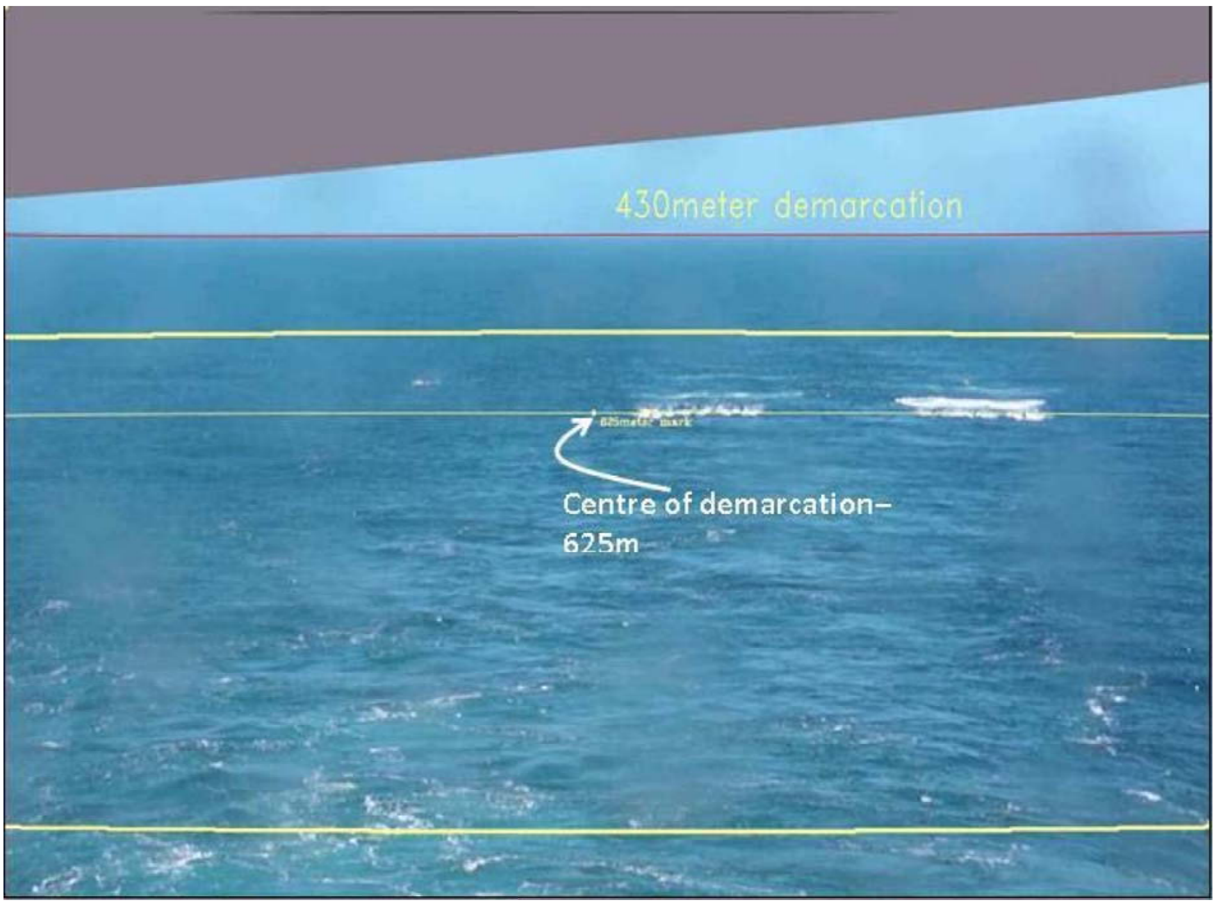
1. Pan and tilt head with two cameras
2. Cat7 link to display system
3. Display system consisting of one screen per RHMV system
4. Overlay of mitigation zone circle/ellipse on both images
5. Image stabilization in software such that all images are real time with the horizon horizontal in the displayed image

6. Option to stop scan and control pan and tilt manually.
7. Computer system and software control panel
8. Data storage unit

Image Display

The system uses one screen per RHMV system to display images from both thermal and visual cameras. Depending on individual preference, a user can choose to view only thermal or visual images at a time to get higher resolution. Images displayed simultaneously will be at smaller resolution.

The images are stabilized in software using horizon detection and an inertial measurement unit. Graphics are drawn on the images to demarcate the mitigation zone on the sea surface. In addition, a mouse pointer system enables distance determination to any point on the image.



Horizon detection and demarcation zone around a sound source

Sperm whale fluke on HD and Thermal Imaging Camera

Appendix K Infrared Equipment Specifications

ARMASIGHT by FLIR COMMAND PRO®

Thermal Imaging Bi-Ocular

The Command Pro is a high performance handheld thermal bi-ocular. The bi-ocular design is better for sustained viewing periods and improved depth perception. The Command Pro can withstand even the most brutal environmental shocks. The Command Pro features most advanced system on the market today including options like an electronic compass and inclinometer.

Utilizing advanced FLIR technology, the Command Pro is offered in 336x256 or 640x512 resolutions and with professional, military-grade lens. These options create a choice between two Optical magnifications and range performance capabilities. Command Pro also has a unique dual battery option that consists of either four 3.0VDC 123A batteries or four 1.5VDC AA batteries pre-loaded in a cartridge.

FEATURES

- Operation in presence of environmental obscurants (smoke, dust, haze, fog)
- Operates on 123A or AA batteries
- FLIR TAU-2 17µm pitch thermal sensor
- Multiple lens options
- OLED display
- Digital compass
- Digital inclinometer
- Battery status indicator
- Selectable palettes
- User-adjustable image enhancement tools
- Tracking digital e-zoom
- Still picture and video recording capability (mounted DVR option)
- Limited 3-year warranty
- 10-year warranty on FLIR detector
- Made in the USA

www.flir.com/ots
www.armasight.com

ARMASIGHT by FLIR

Specifications

	COMMAND PRO 336 4-16x50	COMMAND PRO 640 2-16x50	COMMAND PRO 336 8-32x100	COMMAND PRO 640 4-32x100
Sensor Specifications				
Detector type	336 x 256 VOx Microbolometer	640 x 512 VOx Microbolometer	336 x 256 VOx Microbolometer	640 x 512 VOx Microbolometer
Video refresh rate	30 Hz or 60 Hz			
Start up	<3 seconds			
Image processing	User adjustable image enhancement tools			
System Specifications				
Lens system	50mm, F1.4		100 mm, F1.4	
Optical magnification (NTSC PAL)	3.3x / 4x	1.8x / 2.1x	6.7x / 8x	3.5x / 4.2x
Field of view (HxV)	6.5° × 5°	12.5° x 10°	3.3° × 2.5°	6.2° x 5°
Digital zoom	1x, 2x, 4x	1x, 2x, 4x, 8x	1x, 2x, 4x	1x, 2x, 4x, 8x
Diopter adjustment range	-5 to +5 dpt			
Focusing range	5m to infinity			
Interocular Distance	66±7 mm (2.6±.3 in)			
Display	800x600 AMOLED SVGA 060			
Video output	PAL (768×574 pixels) / NTSC (640×480 pixels)			
Temperature imaging modes (image palettes)	White Hot, Black Hot, Sepia, Fusion, Rainbow, and Rain			
User Interface				
Control panel buttons	Configures operational settings: • Unit On/ Off • Display brightness control • Image palette control • Digital zoom control • On-screen menu navigation			
Focus ring	Adjusts the objective lens focus			
Diopter adjustment ring	Adjusts the eyepiece diopter			
Remote control	Wireless 5-button			
Interfacing				
Connector	Power In, analog video In/Out, digital video recorder, laser rangefinder connections			
Power				
Battery type	Four CR123A 3V lithium batteries or four AA 1.5V			
Battery life (operating)	Up to 7 hr (optional up to 14 hrs)			
Environmental				
Operating temperature range	-20 to +50° C (-4 to +122°F)			
Storage temperature range	-40 to +60°C (-40 to +140°F)			
Physical				
Weight	1.05kg (2.3 lbs)		1.4 kg (3.1 lbs)	
Size	241×102×60 mm (9.5×4.0×2.4 in)		309×102×90 mm (12.1×4.0×3.5 in)	
Color (housing)	Black			
Country Of Origin	USA			
Packages Include				
	Thermal Bi-Ocular, Set of Batteries (4), Battery Cartridge for AA Batteries, Battery Box Extender Ring, Wireless Remote control, Quick Start Guide, Soft Carrying Case			

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Equipment described herein may require US Government authorization for export purposes. Diversion contrary to US law is prohibited.

Infrared LED Pistol Grip Spotlight - 15 Hour Runtime - Rechargeable Lithium Ion - 3 Watt

Part #: RL-85-3W1-IR

Buy American Compliant

The Larson Electronics RL-85-3W1-IR Infrared LED Pistol Grip Spotlight is an extremely rugged and effective IR spotlight designed to give users in operations requiring infrared illumination a powerful, durable and easy to use source of IR light. This IR spotlight produces an infrared light beam approximately 1,800' long by 175' wide in the 850 to 940 Nm range depending upon configuration, requires no tools for servicing and runs for 15 hours on a single charge.

This light weight, infrared LED spotlight is ergonomically designed to produce a well balanced and easily managed handheld infrared light source that can withstand abuse under tactical conditions and operate for 15 hours on a single charge of its integrated lithium ion battery pack. This light contains a single infrared LED which is paired with a patent pending reflector design to produce an infrared light beam that reaches 1,800 feet in length and 175 feet in width. This beam is strong enough to allow operators to read signs, license plates, addresses and other similar markings at the far end of its total range. This pistol grip spotlight is designed for durability with a handle constructed of high impact nylon and an LED fully potted within a lamp assembly constructed of machined aluminum. The LED lamp assembly is protected by a thick Lexan lens and the integral lithium ion battery pack provides long battery life rated at 1,000's of charge cycles.

This IR spotlight and the materials it is constructed from are water, UV ray, impact and vibration resistant and designed to be easily field serviceable. This unit requires no tools to remove any components and th ctors are accessed through a snap in base at the bottom of the handle.

The Larson Electronics RL-85-3W1-IR handheld infrared spotlight from Larson Electronics was chosen as an Editor's Choice product by Military Embedded Systems Magazine and is featured in the Editors Choice Products column of their July/August 2011 edition.

Lithium Ion Reliability: This pistol grip IR spotlight contains an integral lithium ion battery pack for the highest reliability and durability possible. This unit charges in 2.5 hours and provides 15 hours of runtime when fully charged. The lithium ion batteries used in this unit do not require special charging practices to preserve their effectiveness or longevity and can be recharged when only halfway depleted or only charged to a fraction of their full capacity and will not suffer from degradation or battery memory issues. This means you do not need to wait until the batteries are fully depleted before recharging them, nor do you need to allow them to fully recharge before using the unit. This unit can be partially recharged, used, then the recharging process can be finished later as time allows without any loss of battery life as would happen with NiCad batteries if they were used in this manner. This allows users to use this unit at any time without having to follow complex or highly inconvenient battery charging procedures. Finally, these batteries hold their charge for up to 12 months, allowing users to avoid the need for constant maintenance charging.

Durability-Convenience: The RL-85-3W1-IR Infrared LED Pistol Grip Spotlight contains a single infrared LED that is fully potted within a machined aluminum lamp housing and protected by a thick Lexan lens. This LED has an expected life span of 50,000+ hours and the entire LED lamp housing can be removed and replaced. This light is constructed of UV, water and impact resistant materials including a handle constructed of high impact nylon for extreme durability and resistance to damage from vibrations, shocks and impacts. The machined aluminum lamp housing is finished with an anodized coating for corrosion resistance. 16 gauge wiring is used to connect the internal components and an integral lithium ion battery pack provides 16 hours of runtime and requires 2.5 hours for a full charge. The included universal smart charging unit is compatible with any voltages both domestic and international and plugs into any standard wall outlet. The smart charger that ships with this light operates automatically and will top off the battery and quit once the battery is fully charged, even if the light is left connected to the charger once fully charged.

Versatility: The entire unit weighs only 14 ounces. This light can be ordered in either 850Nm light output configuration for use with older and more common night vision devices or 940Nm light output configuration for use with the latest 4th generation night vision equipment. This light has a 3/8-16 inch brass nut fastener imbedded in the base of the handle to allow mounting this light to a tripod or magnetic base like our MM-2 or MM-5. We also offer permanent mount bases, which can be screwed into the base as well. This unit is fully field serviceable and requires no tools to disassemble or reassemble. This unit is ideal for military, security and law enforcement as well as hunting and any application that requires an extremely durable and effective source of infrared illumination.

Specifications / Additional Information

RL-85-3W1-IR Spotlight

Lamp Type: Infrared LED

Dimensions: 4.5"-L 1.5"-Depth 5/8" W

Weight: 14.Oz

Watts: 3 watts

Voltage: Rechargeable- Universal Smart Charger

Materials: Aluminum - High Impact Nylon

Lamp Life Expectancy: 50,000 Hours

Battery: Lithium Ion

Charge Time: 2.5 Hours

Wavelength: 850 or 940 Nm

Beam Type: Spot

Special Orders- Requirements

Contact us for special requirements

Toll Free: 1-800-369-6671

Intl: 1-903-498-3363

E-mail: sales@larsonelectronics.com

Scroll Down to Purchase-

Part #: RL-85-3W1-IR (48406)

Options:

RL-85-3W1-IR- IR WAVELENGTH

Example: RL-85-3W1-IR-850

IR WAVELENGTH	
IR850nm	-850
IR940nm	-940
IR750nm	-750

9419 E US HWY 175, Kemp, TX 75143 Phone: 903.498.3363 Fax: 903.498.3364 Email: sales@LarsonElectronics.com

Links (Click on the below items to view):

- SpecSheet French
- SpecSheet Arabic
- SpecSheet Spanish
- Dimensional Drawing
- Manual
- SpectrumChart
- STEP
- MSDS
- DXF
- Hi-Res Image 1 - Infrared LED Pistol Grip Spotlight
- Hi-Res Image 2 - Infrared LED Pistol Grip Spotlight
- Hi-Res Image 3 - Infrared LED Pistol Grip Spotlight
- Hi-Res Image 4 - Infrared LED Pistol Grip Spotlight
- Hi-Res Image 5 - Infrared LED Pistol Grip Spotlight
- Hi-Res Image 6 - Infrared LED Pistol Grip Spotlight
- Hi-Res Image 7 - Infrared LED Pistol Grip Spotlight
- Hi-Res Image 8 - Infrared LED Pistol Grip Spotlight

Seiche
Marine Acoustic Solutions

PRODUCT DATASHEET

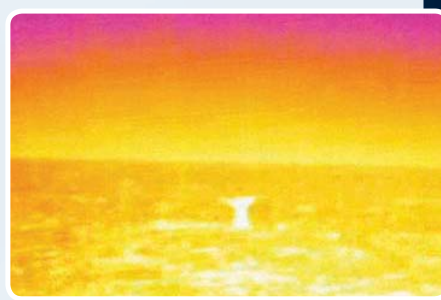
CAMERA MONITORING TECHNOLOGY SYSTEM

DESCRIPTION

This system enables real-time monitoring of marine mammals, small vessels, debris, ice and obstacles around a vessel. It consists of a dual visual/infrared system with HD and thermal imaging cameras, enabling both day and night monitoring up to 360˚ coverage.

Real-time Automated Distances Estimation at Sea (RADES) is our bespoke software for this camera system which gives objective and recordable distance estimation on the sea surface and provides an overlay of the mitigation zone. Software algorithms are utilised to enable automatic image stabilisation.

We are continually trialling new platforms and applications for its use. The ability to automatically detect marine mammals is also in development. The complete system comprises cameras, computer and suitable monitors, designed per bespoke requirement.



SPECIFICATIONS
Visual Camera • Field of view: 3.10–56.56° (12° default) • Zoom: 20x • Focal length of lens: 4.45–89mm • Resolution: HD1280x720
Thermal Camera • Field of view: 12° • Focal length of lens: 50mm • Sensitivity: 0.05°K • Resolution: 640x480
Pan and Tilt Unit • Control: automatic and software remote controls • Material: anodized (marine safe) aluminium – IP67 unit • Peripherals: wiper and washer module – also remotely controlled • Pan range: 0–360° (0.0075° resolution) • Max pan speed: 120 deg/sec • Commands: 50/seconds
• Height 1.8m including mounting pedestal • Weight camera unit 18kg, pedestal 17kg

APPLICATIONS

- Mitigation for seismic surveys
- Marine Mammal surveys
- Mitigation for civil engineering

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