Leading Light Wind

Application for Incidental Harassment Authorization

Non-Lethal Taking of Marine Mammals during a Site Characterization Survey in New York Bight

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Acronyms and Abbreviations

Acronym/abbreviation	Definition
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
dB	Decibel
dB_{peak}	Peak Decibel Level
DPS	Distinct Population Segment
ESA	Endangered Species Act
HFC	High Frequency Cetacean
HRG	High-resolution geophysical
Hz	Hertz
IHA	Incidental Harassment Authorization
J	Joules
kHz	Kilohertz
LFC	Low Frequency Cetacean
m	meters
km	kilometers
MA	Mean annual
MFC	Mid Frequency Cetacean
MM	Monthly mean
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
PPW	Phocid Pinnipeds in Water
PTS	Permanent Threshold Shift
SEL	Sound Exposure Level
SM	Seasonal maximum
SPL	Sound Pressure Level
TTS	Temporary Threshold Shift

Acronym/abbreviation	Definition
µPa	MicroPascal
USC	United States Code

1.
Description of Specified Activity

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

Invenergy Wind Offshore, LLC (Invenergy) is proposing to conduct marine surveys with high resolution geophysical (HRG) equipment and geotechnical sampling[1] within the Bureau of Ocean Energy Management (BOEM) Outer Continental Shelf (OCS) offshore wind Lease Area OCS-A 0542 and potential Export Cable Route (ECR), which is off the coasts of New York and New Jersey in the New York Bight in the Atlantic Ocean (Figure 1-1) in support of the Leading Light Wind project. Invenergy 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 (CFR 2000), to allow for the Level B incidental harassment of small numbers of marine mammals resulting from the operation of survey equipment during upcoming field activities. Level A incidental harassment of marine mammals is not anticipated and is therefore not included in this request; the rationale for excluding Level A from this request is further described in Section 1.4.

The completion of HRG and geotechnical surveys will support development of offshore wind facilities associated with Lease Area OCS-A 0542 and ECR Area (Survey Area). The purpose of the HRG and geotechnical surveys is to:

- Support site characterization, siting, and engineering design of offshore wind in the Survey Area including wind turbine generators, offshore substations, and submarine cables; and
- Collect the data necessary to support project review requirements associated with 30 CFR § 585 (CFR 2015) and the National Environmental Policy Act (42 United States Code [USC] § 4332; USC 1969).

[1] Recent NMFS assessments of types of equipment that will are used in geotechnical survey have indicated that thresholds for marine mammal received sound levels for harassment are not likely to be reached by such equipment (83 Federal Register 7655), so geotechnical survey is not included in this application.

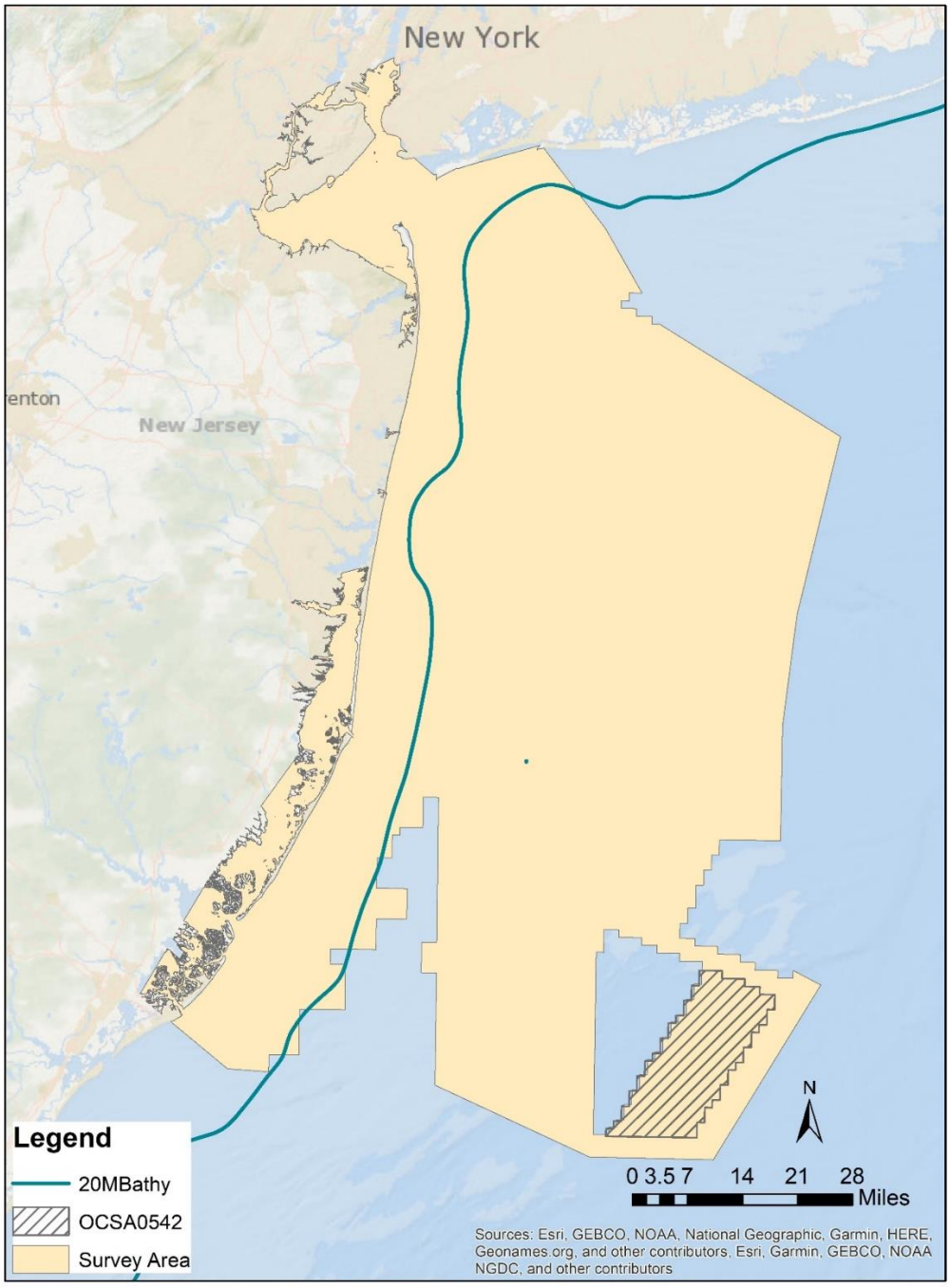

Figure 1-1 Proposed Survey Area – New York Bight

Note: Proposed Survey Area includes both the Lease Area (hatched) and ECR Area (beige). The 20-meter depth contour is shown in green.

1.1. Survey Requirements and Methods

Both the National Marine Fisheries Service (NMFS) and BOEM have advised that sound producing survey equipment operating below 180 kilohertz (kHz) has the potential to cause acoustic harassment to marine mammals. 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. 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. The actionable sound pressure levels are not identified in the statute. NMFS (2018) guidance indicates that Level A harassment is considered to potentially 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). NMFS has defined PTS for five distinct marine mammal hearing groups: Low-frequency cetaceans (LFC; baleen whales), Mid-frequency cetaceans (MFC; dolphins, toothed whales, beaked whales, bottlenose whales), High-frequency cetaceans (HFC; true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger,* and *L. australis*), Phocid pinnipeds in water (PPW) (true seals), and Otariid pinnipeds in water (sea lions and fur seals, not discussed further as there are no Otariid pinnipeds in the Survey Area). PTS levels for each of these hearing groups for both impulsive and non-impulsive noise, as defined by NMFS (2018), are shown in Table 1-1.

Table 1-1 M-Weighted PTS Criteria and Functional Hearing Range for Marine Mammals likely to occur in the Survey Area

Functional Hearing Group	PTS Onset Impulsive	PTS Onset Non-Impulsive	Functional Hearing Range
LFC (Baleen Whales)	$L_{p,0\text{-}pk,flat}$: 219 dB $L_{E,p,\ LF,24h}$: 183 dB	$L_{E,p,\ LF,24h}$: 199 dB	7 Hz to 35 kHz
MFC (Dolphins, Toothed Whales, Beaked Whales)	$L_{p,0\text{-}pk,flat}$: 230 $L_{E,p,\ MF,24h}$:185 dB	$L_{E,p,\ MF,24h}$: 198 dB	150 Hz to 160 kHz
HFC (Harbor Porpoise)	$L_{p,0\text{-}pk,flat}$:202 dB $L_{E,p,\ HF,24h}$: 155 dB	$L_{E,p,\ HF,24h}$: 173 dB	275 Hz to 160 kHz
PPW (Harbor and Gray Seals)	$L_{p,0\text{-}pk,flat}$: 218 dB $L_{E,p,\ PW,24h}$: 85 dB	$L_{E,p,\ PW,24h}$: 201 dB	50 Hz to 86 kHz

Sources: (NMFS 2016, 2018)

Key:

PTS – Permanent Threshold Shift

dB – decibel

Hz – hertz

kHz – kilohertz

LFC – Low frequency cetaceans

HFC – High frequency cetaceans

24h – Accumulation period of 24 hours

PPW – Phocid pinnipeds in water

$L_{p,0\text{-}pk}$ – Peak sound pressure level with reference value of 1 µPa

$L_{E,p}$ – Weighted cumulative sound exposure level with reference value of 1µPa^{2}s

MFC – Mid frequency cetaceans

Flat – peak sound pressures flat weighted or unweighted within generalized hearing range

NMFS has defined the threshold level for Level B harassment at 160 dB re 1 µPa (sound pressure level [SPL]) for non-impulsive intermittent sources (e.g., sonar, CHIRPs) and impulsive sources (e.g., sparkers, boomers). The Harassment

Zone is the area that is ensonified to those levels and constitutes the area in which take of marine mammals may occur for estimation purposes. The following sections provide specific information regarding the HRG survey activities proposed for the Survey Area. Each section includes information on the types of activities and associated equipment to be deployed, how the equipment will interact with the surrounding physical and biological environment, and which activities may or may not result in the taking of marine mammals per National Oceanic and Atmospheric Administration's (NOAA's) established thresholds for Level B harassment.

1.2. HRG Surveys

Per BOEM (2020), geophysical data are required over all areas where there is potential for seafloor-disturbing activities, such as foundation installation, inter-array and export cable installation, and other associated construction activities. HRG surveys within the Survey Area (Figure 1-1) will be conducted in a manner that meets criteria for engineering, habitat delineation, and identification of archaeological resources and geohazards.

The HRG survey activities that have been proposed will include:

- Depth sounding to determine water depth, site bathymetry, and general bottom topography (multibeam echosounder);
- Magnetic intensity measurements (gradiometer) 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 human-made acoustic targets resting on the bottom as well as any anomalous features;
- Shallow-bottom penetration sub-bottom profiler (SBP) to map the near surface stratigraphy (top 0 to 10 m [33 feet] below seabed in sand and 0 to 15 m [49 feet] in mixed sediments); and
- Medium penetration SBP (sparker) to map deeper subsurface stratigraphy as needed (soils down to at least 100 m [328 feet] below seabed in sand and at least 125 m [410 feet] below seabed in mixed sediments).

The HRG survey equipment (as described in Section 1.3) to be used in the identified Survey Area will be similar to the HRG survey equipment used to support other offshore wind development projects along the Atlantic Coast.

1.3. Equipment

HRG surveys will be conducted for the Survey Area with instrumentation consisting of multibeam echosounder, side scan sonar, gradiometer, shallow SBP, and medium SBP (Table 1-2; Attachment 1).

Multibeam echosounder and side scan sonar systems can be thought of as providing top-down plan-view coverage of the seabed. For the multibeam echosounder data, 100% coverage of the seafloor will be obtained. Side scan sonar data will have at least 100% overlap from line to line resulting in at least 200% coverage. The data processors aboard the vessel will track coverage for the multibeam echosounder and side scan sonar systems. If the coverage targets are not met, specific areas with data gaps will be 'infilled' to obtain the proper coverage.

The gradiometer, shallow SBP, and medium SBP systems will provide a representative sampling of the Survey Area. The gradiometer measures total field and magnetic gradient at the sensor while the SBPs show vertical profiles below the seabed.

Table 1-2 Proposed Acoustic Equipment for HRG Surveys for the Project

Equipment Type	Equipment Make/Model	Operating Frequency (kHz)	Source Level (dB SPL re 1 µPa @1m)	Source Level (Peak dB re 1 µPa @1m)	Sound Exposure Level (dB re 1µPa2·s	Reference for Source Level	Pulse Duration (milliseconds)	Repetition Rate (Hz)	Beam Width (degrees)
Mobile, Non-impulsive, Intermittent									
Side-Scan Sonar	EdgeTech 4205	230/540/850	205	210	176	Crocker and Fratantonio 2016*/ Manufacturer	1.3	NR	50
Multi-beam Echosounder	Konsberg EM 2040	200-400	NR	NR	NR	Manufacturer	NR	50	120
Gradiometer / Altimeter[a]	Geometrics G882	500	NR	NR	NR	Manufacturer	NR	20	NR
Shallow SBP (Chirp)	Edgetech 216	2-16	173	179	167	Crocker and Fratantonio 2016†/ Manufacturer	6.1	40	13.2
Shallow SBP (Parametric)	Innomar SES-2000 (standard model)	85-115	241	247	NR	Manufacturer	2	40	2
Shallow SBP (Parametric)	Innomar Deep 36	36	240	246	NR	Manufacturer	1.5	40	1.5
Mobile, Impulsive									
Medium SBP (Sparker)	GeoMarine Sparker Model Geo-Source 200-400 (400 J)	0.3–1.2	203	211	174	Crocker and Fratantonio 2016‡	1.1	4	180
Medium SBP (Sparker)	AA Dura-spark UHD Sparker 400x400	0.3-1.2	203	211	174	Crocker and Fratantonio 2016‡	1.1	4	180
Medium SBP (Sparker)	AA Dura-spark Sparker 240/400 (500J)	0.3-1.2	203	211	174	Crocker and Fratantonio 2016§	1.1	4.6	180

Proposed equipment or equivalents will be used.

a Acoustic specification applies to the optional altimeter on the gradiometer

* Edgetech 4200/400 kHz/100% Power Proxy

† Edgetech 424/4 to 20 kHz/100% Power Proxy

‡ Applied Acoustics Dura-spark 240/400 400 tip/500 J Proxy

§This system was tested and measured by Crocker and Frantantonio (2016) and we use the specifications for 400 tips and 500J

Key:
NR – Not Reported
SBP – Sub-bottom profiler
Hz – Hertz
kHz – Kilohertz
µPa – microPascal
SPL – sound pressure level
dB – Decibel
re – referenced at
m – meters
s- seconds
J - Joules

1.4. Distances to Regulatory Acoustic Thresholds

Survey equipment operating below 180 kilohertz (kHz) is considered to have the potential to cause Level A and/or Level B acoustic harassment to marine mammals. Therefore, for the survey equipment listed in Table 1-2, only the SBPs and sparkers are treated as having the potential to cause injury or harassment to marine mammals. The sound propagation modeling recommendations of NMFS (2020a) were used to calculate the distance to the Level B threshold of 160 dB SPL:

$$TL = 20log_{10}(\mathrm{r}) + {}^{a \cdot r}/_{1000}\,(dB)$$

$$a = 0.000339f^2 + 48.5\frac{f^2}{f^2 + 5715.36}\left({}^{dB}/_{km}\right)$$

where TL is transmission loss, r is the distance to threshold, a is the frequency-dependent absorption coefficient, and f is frequency (Hz). NMFS (2020a) further recommends accounting for beam angle using the following relationships (Figure 1-2):

$$h = r\,cos\left(\frac{\theta}{2}\right)$$

$$R = \frac{d\ or\ h\ (smaller\ value)}{tan\left(\varphi - \frac{\theta}{2}\right)}$$

where d is depth in meters and h is the vertical component of the slant distance in meters, the smaller of the two values is used in the calculation (Figure 1-2). θ is the beamwidth in radians, φ is the beam angle from the surface (i.e., it will be 90° for sources pointing straight down), and R is the horizontal distance to the Level B threshold. Water depth in the Survey Area does not exceed 55 meters, and Invenergy used 55 meters in the calculations. Table 1-3 shows the resulting r and R values for the SBP specifications in Table 1-2.

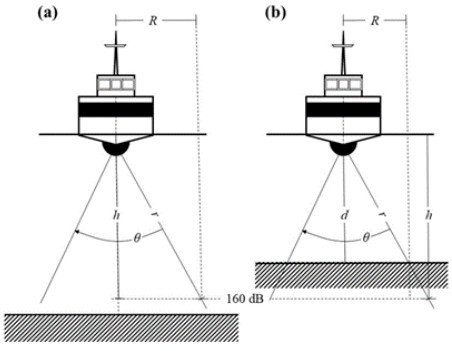

Figure 1-2. SBP Schematic diagrams

Showing horizontal impact distance R in relation to beamwidth θ when the beam is pointed downward. (a) shows the case where depth d is greater than the vertical component of slant distance h. (b) shows the case where depth d is less than the vertical component of the slant distance h.

The estimated distances to Level A thresholds are included in Attachment 2 and were derived using the NMFS User Spreadsheet (NMFS 2020b) and gear specifications (Table 1-2). Sound exposure level (SEL) values were calculated as SPLRMS+10log10(T/1 second) dB, where T is the pulse duration.

NMFS recommends using the source levels reported in Crocker and Fratantonio (2016) where feasible. There is no equipment comparable to the Innomar SES-2000 or Innomar Deep 36 SBP reported in Crocker and Fratantonio (2016); therefore, use specifications, including source level and operating frequency, provided by the manufacturer (Attachment 1) were used.

For the proposed sparker systems, the Applied Acoustics Dura-Spark 240/400 was assessed in Crocker and Fratantonio (2016) with the results presented in Table 10 of Crocker and Fratantonio (2016). Invenergy is proposing to use this sparker system with 400 tips at a source setting of 500 J, and we use the values from Table 10 of Crocker and Fratantonio (2016) that match these specifications.

Of the other two proposed sparker systems, the Applied Acoustics Dura-Spark UHD 400x400 is comprised of two Applied Acoustics Dura-Spark 204/400 stacked together to create two decks to the sparker system. The decks will not be discharged simultaneously but will be fired in a flip flop mode, and we expect the sound output to be consistent with the Applied Acoustics Dura-Spark 240/400 operated with 400 tip at 500 J as specified in Table 10 of Crocker and Fratantonio (2016). We note that this sparker may be used at a power setting of up to 800 J, however Crocker and Fratantonio (2016) only measured source levels for the Dura-Spark 240/400 at 500, 2,000, and 2,400 J power settings and given the logarithmic nature of sound source levels measured in decibels, the 2,000J measurements would vastly overestimate the anticipated sound output of the Dura-Spark UHD 400x400 operated at a maximum of 800 J. Crocker and Fratantonio (2016) measured another sparker system, the SIG ECL 820 at a power setting of 750 J with the result of the same RMS source level of 203 dB as the Dura-Spark 240/400 operated at 500J (see Table 9 in Crocker and Fratantonio 2016). Given that the Dura-Spark UHD 400x400 is comprised of two Dura-Spark 240/400, we consider the Dura-Spark 240/400 as the best proxy for the Dura-Spark UHD 400x400 and use the values in Table 10 of Crocker and Fratantonio (2016) for 400 tips and 500 J as the anticipated source levels.

The final sparker system being proposed by Invenergy is the GeoMarine Sparker Geo-Source 200-400 which was also not directly assessed by Crocker and Fratantonio (2016). Crocker and Fratantonio (2016) assessed three sparker systems, the Applied Acoustics Dura-Spark 204/400, the SIG ECL 820, and the Applied Acoustics Delta Sparker. The proposed GeoMarine Sparker Geo-Source 200-400 sparker would be operated with 400 tips and a power setting of 400 to 500 J and therefore has similar operational characteristics to the Applied Acoustics Dura-Spark 240/400 where Crocker and Fratantonio (2016) specify source levels for the Dura-Spark 240/400 with 400 tips and 500 J. The other two systems assessed in Crocker and Fratantonio (2016) did not specify the number of tips and the measured source levels were only differentiated by power (J) and depth. At 500 J, the Applied Acoustics Delta Sparker has an RMS source level of 192 dB (see Table 11 of Crocker and Fratantonio 2016) while the SIG ECL 820 at 500J and high setting has an RMS source level of between 200 and 201 dB, depending on depth (see Table 9 of Crocker and Fratantonio 2016). We therefore consider the RMS source level of 203 dB as estimated for the Applied Acoustics Dura-Spark 240/400 with 400 tips and 500 J to be reasonably conservative given the lack of an exact match of sparker systems and we consider this the best proxy for the Geo-Source 200-400 (Appendix B and Section 3.1.2.2 of Crocker and Fratantonio 2016).

Table 1-3 Level A and Level B threshold distances for the proposed SBPs.

Equipment Make/Model	Horizontal Distance to 160 dB SPL (m)	Distance to Level A Isopleth (m)				Distance to Level B Isopleth (m)
		Low Frequency	Mid Frequency	High Frequency	Pinnipeds	All
Edgetech 216	0.46	<1	<1	9.1	<1	0.46

Innomar SES-2000 (standard model)	0.96	<1	<1	135.9	<1	1.96
Innomar Deep 36	0.72	<1	<1	192.0	<1	0.72
Sparker Systems	141	<1	<1	2.8**	<1	141

*Potential sparker systems (see Table 1-2) have the same estimated distance to 160 dB SPL received sound level.
Level A distances are based on the cumulative sound threshold unless denoted with **, in which case it is based on the peak sound threshold (higher of the two values is shown).
Key:
m – meters
J - Joules
dB – Decibels
SPL – sound pressure level

The Innomar Medium SES-2000 and Innomar Deep 36 are parametric SBPs used for providing high data density in sub-bottom profiles that are typically required for cable routes, very shallow water, and archaeological surveys. There are no relevant information sources or measurement data within the Crocker and Fratantonio (2016) reference for parametric SBP. Source information is available from the manufacturer; however, no field measurements or propagation characteristics are provided with the manufacturer specifications (Attachment A). Due to the highly specialized nature of these sonars (high frequencies and narrow beamwidths) the source information alone is not sufficient to fully evaluate the expected propagation. The Innomar SES-2000 uses the principle of “parametric” or “nonlinear” acoustics to generate short, very narrow-beam sound pulses at very high frequencies (ranging from 85 to 115 kHz). The transducer projects a beamwidth of approximately 1° to 3.5°. The narrow beamwidth significantly reduces the impact range of the source while the high frequencies of the source are rapidly attenuated in seawater. Neither high frequency sonar nor narrow beamwidth sources are well-captured in the NMFS User Spreadsheets used to calculate Level A isopleths. Vineyard Wind and JASCO (2020) assessed the out-of-beam source levels for the Innomar SES 2000 and produced corrected SEL. This SEL value (178 dB re 1µPa2·s) was used to estimate the distance to Level A thresholds for both Innomar systems as the manufacturer source levels are similar for both systems. The resulting distance is less than 1 m for most marine mammals but is 135.9 m for high frequency cetaceans for the Innomar SES-2000 and 192.0 for the Innomar Deep 36. However, if horizontal distance is considered as recommended by NMFS (2020a), the horizontal threshold would be less than 1 m for both systems given the narrow beam focused directly under the vessel. Consistent with previous determinations by NMFS, because of the high frequency of the source and narrow bandwidth, parametric SBPs are not expected to result in Level A takes. Similarly, the horizontal distance for Level B exposures is also less than 1 m and the Innomar parametric SBPs are not expected to result in Level B takes. For the Edgetech 216, Invenergy used values for the Edgetech 424 from Table 14 in Crocker and Fratantonio (2016). As the Edgetech 424 is a more powerful source than the 216, this should result in appropriately conservative estimates. We found a distance to Level B, accounting for the narrow beam width, of 0.46 m. Similar to the Innomars, the distance to Level A was less than 1 m for all hearing groups except low-frequency cetaceans where it was 9.1 m. When adjusted for horizontal distance, the distance is 0.2 m. No Level A or Level B exposures can be reasonably expected from the operation of these SBPs (Innomar SES-2000, Innomar Deep 36, Edgetech 216); therefore, they were not carried forward in the analysis and the focus is on the impulsive SBPs (sparkers).

Due to the implementation of mitigation and monitoring measures, as detailed in Section 11, in combination with the behavior of marine mammal species (i.e., their transient nature and their ability to move away from the source of potential harassment), it is unlikely the proposed equipment (or equivalent) will result in the Level A harassment of marine mammals. Therefore, Level A take has not been requested for any marine mammal species. Invenergy is requesting authorization for the incidental take of small numbers of marine mammals within the Survey Area by Level B harassment. Estimates of Level B take are further detailed in Section 6.

2.
Dates, Duration, and Specific Geographic Region

The date(s) and duration of such activity and the specified geographical region where it will occur.

2.1.
Dates and Durations of Survey Activities

Invenergy is proposing to conduct HRG surveys in the Survey Area with a start date of June 9, 2023 for the IHA and a permit period through June 8, 2024. The time period of the survey is within the one-year IHA authorization term inclusive of active geophysical survey days as well as deployment, transit between survey area and port, crew changes, weather delays, and mechanical issues. Based on data from past surveys, we expect that the 24-hour vessels will each cover a distance of approximately 80 km/day, and the 12-hour vessel will cover a distance of approximately 25-30 km/day (considering line-turns, infills, etc. but not downtime for weather, equipment issues, etc.). Estimated total vessel days of survey (including downtime) is 136 days in the Lease Area and 138 days in the ECR Area spread across up to three vessels (two deepwater vessels, one on-lease and one in the ECR [24-hr operations] and one shallow water vessel in the ECR [~12-hr operations depending on hours of available daylight generally in < 20m]). These estimates include down time due to weather, maintenance, and other non-survey time on the water. Three vessels may operate simultaneously, and simultaneously operating vessels will adhere to BOEM and NMFS Letter of Concurrence requirements that vessels maintain sufficient separation distance to avoid overlap of sound from sound sources. This will be achieved through planning and vessel communications. Estimated operations with sparkers are as follows, though a full year permit is requested to allow for flexibility in case of weather, supply chain issues, or other delays that may extend estimated survey periods:

- Lease Area: July 28, 2023 – December 14, 2023
- ECR Area: June 9, 2023 – November 2, 2023

It is understood the IHA authorization may be eligible for a one-time, one-year renewal for qualified activities subject to the authorization of a IHA renewal request prepared in accordance with renewal conditions and processes. An Alternative Monitoring Plan (AMP) will be submitted by Invenergy to BOEM as a part of the Geophysical and Geotechnical Survey Plan as required for night and low-visibility operations (see Section 11 for more information). As noted, some shallow areas may be surveyed by a vessel that only operates during daylight hours, but larger vessels will operate 24-hours. The total survey area depicted in Figure 1-1 is 9,470 km^2, with 569 km^2 in the lease area and 8,901 km^2 in the ECR. Within these areas, an estimated 7,460 km of survey is planned for the Lease Area and 5,358 km of survey is planned for the ECR Area outside of the lease area for a total of 12,818 km of survey. All survey days are assumed to include the use of the sparker system, which produces the largest acoustic impact.

2.2.
Specified Geographic Region

HRG survey activities are planned to occur in the Survey Area (Lease Area and ECR Area), which is in Federal and State offshore waters. The proposed survey will be conducted within the Survey Area illustrated in Figure 2-1. The Survey Area is between 1 and 55 meters water depth; the lease area is between 40 and 50 meters water depth; and the ECR is between 1 and 55 meters water depth (Figure 2-1).

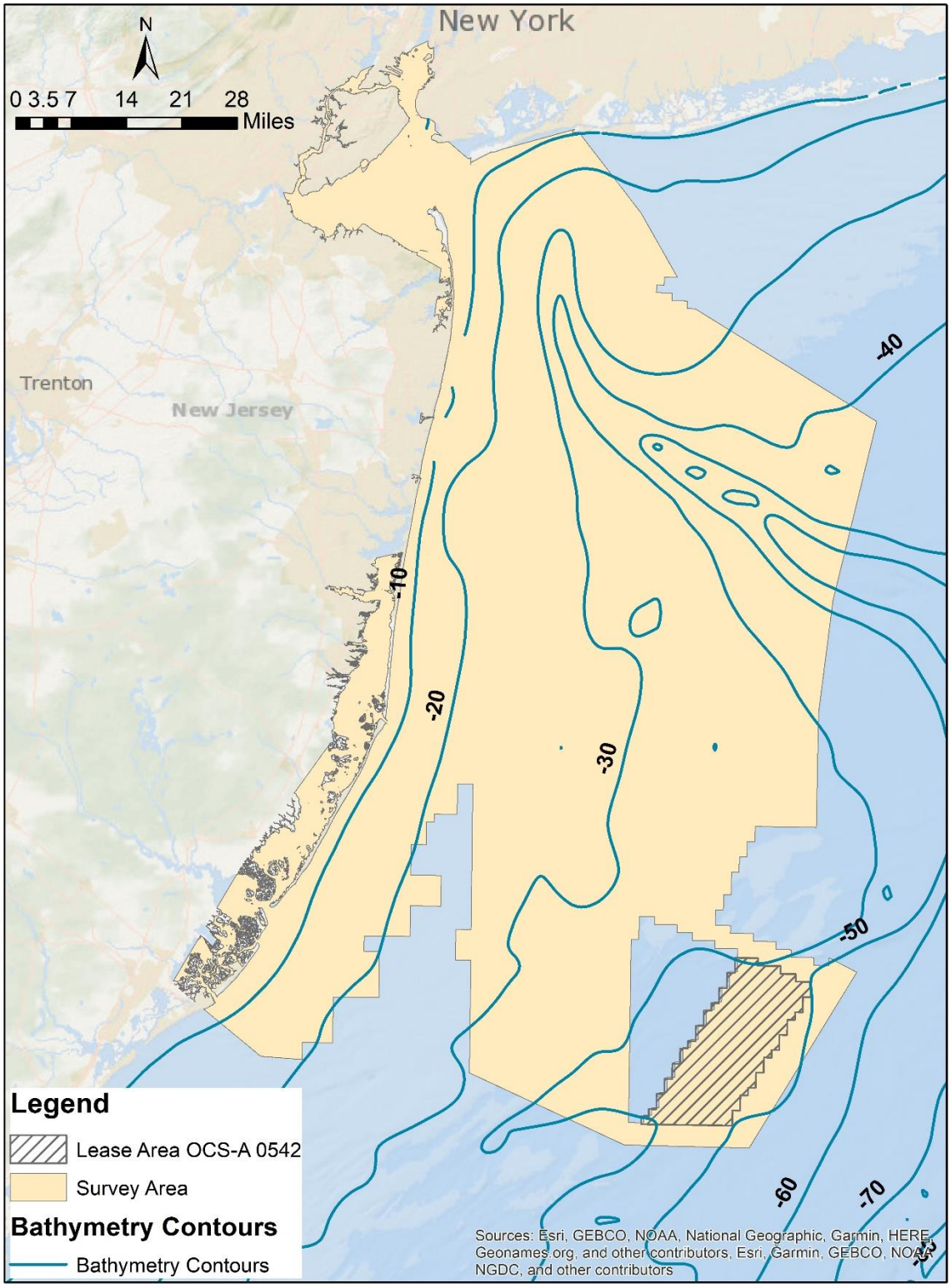

Figure 2-1. Invenergy's proposed Survey Area with bathymetric contours showing water depth.

3.
Species and Numbers of Marine Mammals

The species and numbers of marine mammals likely to be found within the activity area.

Marine mammals are protected under the MMPA. BOEM (2016, 2021) and Hayes et al. (2022) report 28 species/guilds of marine mammals (whales, dolphins, porpoises, and seals including four species of Mesoplodon Beaked Whales) in the Northwest Atlantic OCS region of the mid-Atlantic that are protected by the MMPA. The relative likelihood of the 28 species of marine mammals to occur in or transit near the Lease Area are defined as follows.

- Common – occurring consistently in moderate to large numbers
- Regular – occurring regularly, inhabitants at least seasonally and have been documented within and around the Lease Area
- Uncommon – occurring in low numbers or on an irregular basis
- Rare – records for some years but limited
- Not expected – range includes the Lease Area but due to habitat preferences and distribution information, species are not expected to occur in the Lease Area although records may exist for adjacent waters

Status, stock identification, abundance, and occurrence of these species are listed in Table 3-1 and each species/stock that is considered common, regular, or uncommon is discussed in detail in Section 4.

Five whale species of the 28 species protected under MMPA are listed as endangered under the Endangered Species Act (ESA) and are known to be present, at least seasonally, in tLease Area OCS-A 0542 (Table 3-1). These include:

- Fin whale (Balaenoptera physalus);
- Sei whale (Balaenoptera borealis);
- Blue whale (Balaenoptera musculus);
- North Atlantic right whale (Eubalaena glacialis); and
- Sperm whale (Physeter macrocephalus).

Table 3-1 Marine mammals known to occur in or near Lease Area OCS-A 0542.

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the Region	Abundance (Stock Assessment Report)	Abundance (Roberts et al., 2022)*
Fin Whale	*Balaenoptera physalus*	Western North Atlantic	ESA Endangered/ MMPA Depleted and Strategic	Common	6,802	4,387 (MM)
Sei Whale	*Balaenoptera borealis*	Nova Scotia	ESA Endangered/ MMPA Depleted and Strategic	Regular	6,292	2,010 (SM)
Minke Whale	*Balaenoptera acutorostrata*	Canadian East Coast	MMPA Non-Strategic	Common	21,968	5,154 (MA)
Blue Whale	*Balaenoptera musculus*	Western North Atlantic	ESA Endangered/ MMPA Depleted and Strategic	Rare	402 (minimum abundance)	33 (MA)
Humpback Whale	*Megaptera novaeangliae*	Gulf of Maine	MMPA Non-Strategic	Common	1,396 (ESA West Indies DPS estimate 11,570 1992/1993 [Bettridge et al 2015; Stevick et al. 2003])	366 (MM)
North Atlantic Right Whale	*Eubalaena glacialis*	Western North Atlantic	ESA Endangered/ MMPA Depleted and Strategic	Common	368[a]	418 (MM)
Sperm Whale	*Physeter macrocephalus*	North Atlantic	ESA Endangered/ MMPA Depleted and Strategic	Common	4,349 (North Atlantic estimate 11,185 based on 2001 surveys [Gunnlaugsson et al. 2009])	6,856 (MM)
Dwarf Sperm Whale	*Kogia sima*	Western North Atlantic	MMPA Non-Strategic	Rare	7,750†	7,980† (MA)
Pygmy Sperm Whale	*Kogia breviceps*	Western North Atlantic	MMPA Non-Strategic	Rare		

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the Region	Abundance (Stock Assessment Report)	Abundance (Roberts et al., 2022)*
Killer Whale	*Orcinus orca*	Western North Atlantic	MMPA Non-Strategic	Rare	Unknown	73 (MA)
False Killer Whale	*Pseudorca crassidens*	Western North Atlantic	MMPA Strategic	Rare	1,791	139 (MA)
Cuvier's Beaked Whale	*Ziphius cavirostris*	Western North Atlantic	MMPA Non-Strategic	Rare	5,744	5,588 (MA)
Mesoplodont Beaked Whale	*Mesoplodon spp.*	Western North Atlantic	MMPA Depleted	Rare	10,107	6,526 (MA)
Risso's Dolphin	*Grampus griseus*	Western North Atlantic	MMPA Non-Strategic	Common	35,215	32,529 (MM)
Long-finned Pilot Whale	*Globicephala melas*	Western North Atlantic	MMPA Non-Strategic	Common	39,215	23,905‡ (MM)
Short-finned Pilot Whale	*Globicephala macrorhynchus*	Western North Atlantic	MMPA Non-Strategic	Rare	28,924	
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	Western North Atlantic	MMPA Non-Strategic	Common	93,233	79,149 (MM)
White-beaked Dolphin	*Lagenorhynchus albirostris*	Western North Atlantic	MMPA Non-Strategic	Rare	536,016	129 (MA)
Common Dolphin	*Delphinus delphis*	Western North Atlantic	MMPA Non-Strategic	Common	172,974	177,543 (MM)
Atlantic Spotted Dolphin	*Stenella frontalis*	Western North Atlantic	MMPA Non-Strategic	Uncommon	39,921	42,495 (MM)
Pantropical Spotted Dolphin	*Stenella attenuata*	Western North Atlantic	MMPA Non-Strategic	Rare	6,593	1,403 (MA)
Striped Dolphin	*Stenella coeruleoalba*	Western North Atlantic	MMPA Non-Strategic	Rare	67,036	54,707 (MA)

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the Region	Abundance (Stock Assessment Report)	Abundance (Roberts et al., 2022)*
Common Bottlenose Dolphin	*Tursiops truncatus*	Western North Atlantic, Offshore	MMPA Non-Strategic	Common	62,851	78,974 (MM)[§]
		Western North Atlantic, Northern Migratory Coastal	MMPA Strategic	Common	6,639	
Harbor Porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	MMPA Non-Strategic	Common	95,543	75,951 (MM)
Harbor Seal	*Phoca vitulina*	Western North Atlantic	MMPA Non-Strategic	Regular	61,336 (additional ~20,000-30,000 in Canada [DFO 2019])	59,998 (MM)[‖]
Gray Seal	*Halichoerus grypus*	Western North Atlantic	MMPA Non-Strategic	Regular	27,300 (additional 424,300 in Canada [DFO 2019])	
Harp Seal	*Pagophilus groenlandica*	Western North Atlantic	MMPA Non-Strategic	Rare	7.6 million	
Hooded Seal	*Cystophora cristata*	Western North Atlantic	MMPA Non-Strategic	Rare	593,500[£]	

Notes:
Stock Assessment Report abundance estimates are the Nest numbers from Hayes et al. (2022) unless otherwise noted. Abundance estimates are also reported from the Duke University Habitat-based Marine Mammal Density Models (https://seamap.env.duke.edu/models/Duke/EC/; Roberts et al. [2016, 2017, 2018, and 2021]). Where available, the highest monthly mean (MM) value from the most recent model version for each species is provided. If monthly abundance estimates were not available, the seasonal maximum (SM) or mean annual abundance (MA is provided). DPS = Distinct Population Segment. DFO=Department of Fisheries and Oceans
[a]The draft stock assessment report for North Atlantic right whales that is available for public comment at the time of submission of this application indicates a proposed change to 338 as the best estimate for North Atlantic right whales (see https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports)
*Roberts et al. densities (updated in July 2022) are used for assessing density of stocks for take estimates in Section 6, so maximum abundances associated with those models are included here.
†The Stock Assessment Report and Roberts et al.'s models each combine *Kogia* spp. into a single estimated abundance.
‡Roberts et al. does not distinguish between short-finned and long-finned pilot whales in their density models. Long-finned pilot whales are the most likely species to be present in the region of the proposed survey.
§Roberts et al. does not distinguish between the Western North Atlantic Migratory Coastal and Western North Atlantic Offshore bottlenose dolphin stocks density models.

‖Roberts et al. does not distinguish between seal species in their density models. Harbor seals and gray seals are the most likely species to be present in the region and their density and abundance estimates primarily represent these species.
£Hooded seal population abundance is indicated as “unknown” in Hayes et al. 2022 and the most recent draft SAR available on NMFS’ website. The last numerical abundance was published in the 2018 SAR and was based on pup production surveys from 1984-2005.

4.
Affected Species Status and Distribution

A description of the status and distribution, including seasonal distribution (when applicable), of the affected species or stocks of marine mammals likely to be affected by such activities.

Of the 28 marine mammal species described in Section 3, (Table 3-1), 15 species/guilds (16 stocks) can be reasonably expected to reside, traverse, or occasionally visit the Survey Area and may be potentially affected. Recent IHA applications (Equinor 2020; Orsted 2020, Attentive Energy 2022) were submitted to NMFS to conduct similar HRG surveys for offshore wind development in the New York Bight. These applications include the same type of project (offshore wind facilities) within a similar geographic location as the Survey Area. Therefore, this IHA incorporates by reference species-specific information on the status and distribution of the potentially affected species from the Equinor (2020), Orsted (2020), and Attentive Energy (2022) IHA applications (Section 4, Affected Species Status and Distribution, of both IHA applications).

Potentially affected species are those that have a common, uncommon, or regular relative occurrence in the Survey Area (Table 3-1) or have a very wide distribution with limited distribution or abundance details. Species that are rare or not expected are not carried forward in this application. Short-finned pilot whales are not anticipated in the proposed Survey Area. Therefore, Invenergy requests an IHA for Level B disturbance for 15 species (16 stocks) listed below and described in the following sections:

- North Atlantic right whale (*Eubalaena glacialis*)
- Humpback whale (*Megaptera novaeangliae*)
- Fin whale (*Balaenoptera physalus*)
- Sei whale (*Balaenoptera borealis*)
- Minke whale (*Balaenoptera acutorostrata*)
- Sperm whale (*Physeter macrocephalus*)
- Risso's dolphin (*Grampus griseus*)
- Long-finned pilot whale (*Globicephala melas*)
- Atlantic white-sided dolphin (*Lagenorhynchus acutus*)
- Common dolphin (*Delphinus delphis*)
- Atlantic spotted dolphin (*Stenella frontalis*)
- Common bottlenose dolphin (*Tursiops truncatus*), Western North Atlantic offshore stock
- Common bottlenose dolphin (*Tursiops truncatus*), Western North Atlantic coastal stock
- Harbor porpoise (*Phocoena phocoena*)
- Harbor seal (*Phoca vitulina*)
- Gray seal (*Halichoerus grypus*)

Below, brief summaries of the information in Equinor (2020), Orsted (2020), and Attentive Energy (2022) are presented and supplemented with new information as appropriate. There is new information specific to the distribution and densities of large whales (North Atlantic right whales, humpback whales, fin whales, sei whales, and sperm whales) in the New York Bight (Normandeau Associates and APEM 2020, Zoidis et al. 2021). Local densities (not corrected for probability of detection) have been assessed by Normandeau Associates and APEM (2020), without differentiation within the lease

area. The corrected local densities estimated by Zoidis et al (2021) have been incorporated into the current version of the Roberts et al. (2022[2]) density models which were applied to Invenergy's current application.

4.1. Mysticetes

4.1.1. North Atlantic Right Whale (*Eubalaena glacialis*) - Endangered

Status and distribution for the North Atlantic right whale is based on information included in Equinor (2020) (Section 4.1.1; pg. 21, Orsted (2020; pg. 21; Section 4.1.1), and Attentive Energy (2022; Section 4.1.1; pg. 28) which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced. North Atlantic right whale status was also last reviewed under ESA in 2022 (NMFS 2022). So far, researchers have identified 11 live calves this calving season (NMFS 2023).

Status: North Atlantic right whales are listed as endangered under the ESA and are considered a depleted and strategic stock under the MMPA (Hayes et al. 2022). This species is considered one of the most endangered large whale species in the world (Jefferson et al. 2011). The latest North Atlantic right whale Annual Report Card was developed by the North Atlantic Right Whale Consortium based on data from 1990-2020 (Pettis 2022). The final report card was released in early 2022. In past reports multiple methods were used to generate estimates, but as of the 2021 report card, only one method will be used: the Pace et al. model (Pace et al. 2017). The Pace et al. (2017) model has been determined to be the most accurate method, and the 2020 estimate is 336 whales, which represents an 8% decline from the 2019 estimate. The population has been considered in decline with 40 calves born since 2017 and an unusual mortality event affecting whales (known death and known serious injuries since 2017), though more recently, as noted above 11 live calves were identified in the 2023 calving season. Major threats to the species include incidental fishery entanglement and ship strikes.

Distribution: North Atlantic right whales are observed year around in the Mid-Atlantic Bight, but some whales are also observed migrating seasonally between the waters off New England in the spring/summer to feed on copepods and zooplankton and in the fall, some whales are observed traveling south to their breeding and calving grounds off South Carolina, Georgia and northeastern Florida. Two Critical Habitats important for feeding, nursery, and calving habitat have been designated for this species in the Gulf of Maine/Georges Bank (feeding) and from North Carolina to Florida (migration and calving). Additionally, to reduce ship strikes, Seasonal Management Areas (SMAs) have been designated both in the U.S. and Canada where vessels greater than 19.8 meters (65 feet) in length are required to operate at speeds below 10 knots within these areas from November 1 to April 30.

New Information: As described in Attentive Energy (2022), recent work on cryptic mortality in this species has indicated that the total mortality would likely be 2.8 times the number of detected carcasses (based on 1990-2017 data) and that cryptic (or not documented) deaths were almost twice as likely to be due to entanglement than estimations derived from carcasses (Pace et al. 2021). Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-1), and North Atlantic right whales were observed both in winter and spring. Whales preferred deeper waters near the shelf break, but North Atlantic right whales were observed throughout the New York Offshore planning area. Similarly, in the New York Bight, an array of passive acoustic monitoring stations from 2018 to 2020 detected North Atlantic right whales throughout the year (Estabrook et al. 2021). Seasonally, North Atlantic right whale presence was highest in the fall, followed by spring, summer, and winter in that order. Zoidis et al. (2021) conducted aerial whale surveys in the New York Bight from 2017 to 2020. During this time, 15 North Atlantic right whale groups (24 individuals) were observed in depths ranging from 33 to 1,041 m (Figure 4-2). The uncorrected

[2] Retrieved from https://seamap.env.duke.edu/models/Duke/EC/ which states models were updated June 20, 2022

sightings rate was 0.17 whales per 1,000 km of effort. Within the New York Bight, Cornell University has been conducting passive acoustic recording to identify spatial and temporal trends in occupancy of large whales (Estabrook et al. 2020). Figure 4 1 shows the results of two years of this study for the six focal species (see Figure 13 of Estabrook et al. 2020). Right whales can be anticipated to occur in the Survey Area year-round but with lower levels from July to September. Figure 4-2shows the spatial and temporal acoustic detections of North Atlantic right whales in the New York Bight (see Figure 16 in Estabrook et al. 2020).

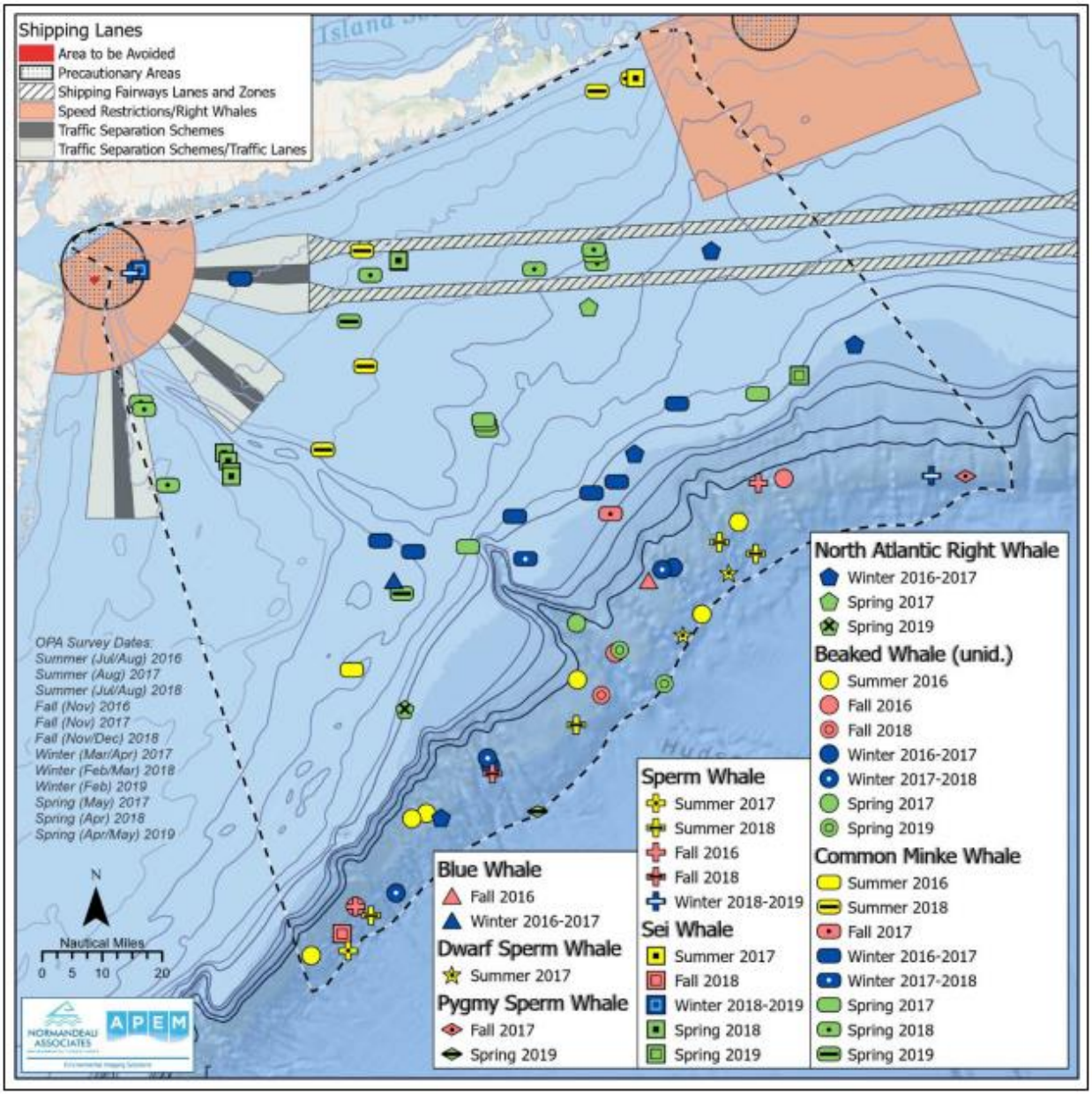

Figure 4-1 Distribution of North Atlantic Right Whale, Beaked Whale, Minke Whale, Sperm Whale, Sei Whale, Blue Whale, Dwarf Sperm Whale, and Pygmy Sperm

Whale sightings during the Summer 2016 to Spring 2019 Digital Aerial Surveys of Normandeau Associates and APEM (2020).
Source: Figure 78 in Normandeau Associates and APEM (2020)

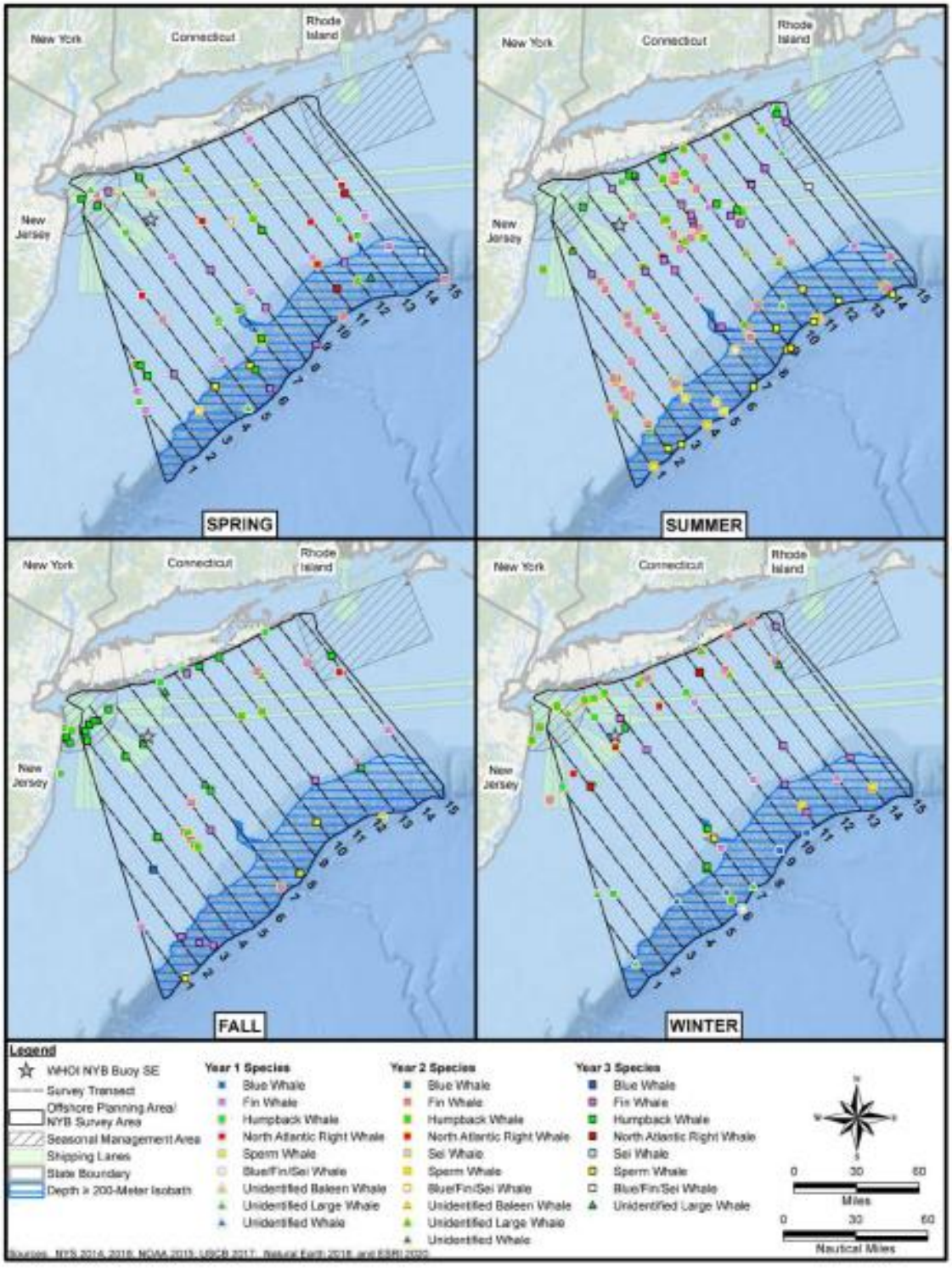

Figure 4-2 Location of Large Whale Sightings in the New York Bight

Sightings were recorded in surveys conducted from March 2017 to February 2020 by Zoidis et al. (2021)
Source: Figure 3 in Zoidis et al. (2021)

4.1.2. Humpback Whale (*Megaptera novaeangliae*) – Non-strategic

Status and distribution for the humpback whale is based on information included in Equinor (2020; Section 4.1.2; pg. 25), Orsted (2020; Section 4.1.2; pg. 23), and Attentive Energy (2022; Section 4.1.2, pg. 32), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: Humpback whales in this area are associated with the Gulf of Maine stock which is a primary feeding ground for the West Indies Distinct Population Segment (DPS) under ESA (not listed) of this migratory species. The majority of these whales migrate to their breeding and calving grounds in the Caribbean and West Indies in the winter. This stock is currently not listed as endangered under the ESA and is considered non-strategic under the MMPA. The most recent abundance estimate (Hayes et al. 2022) was about 1,396 individuals (Table 3-1 Marine mammals known to occur in or near Lease Area OCS-A 0542.) in this feeding stock. Another feeding stock in Newfoundland/Labrador was estimated at 8,439, and one in Bay of Fundy/Scotian Shelf/Gulf of St. Lawrence was estimated at 1,854 in 2016 based on Canadian surveys (Lawson and Gosselin 2018). These whales are all part of the breeding population of humpbacks in the West Indies DPS, which was estimated to be 11,570 in 1992-1993 (Stevick et al. 2003, Bettridge et al. 2015).

Distribution: Generally, the distribution of this species in the Survey Area is primarily driven by prey availability such as herring, sand lance, and other small fishes (NMFS, 2020). Humpback whales in this region also follow a diel pattern in foraging behavior that correlates with the diel patterns in sand lance behavior whereby sandlance move to the surface at night and migrate to deeper waters during the day (Friedlaender et al, 2009).

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-3) and humpback whales were observed primarily in the spring and in winter, but sightings year-round have been reported to occur in that area. Whales preferred deeper waters near the shelf break, but humpbacks were observed throughout the New York Offshore planning area. Similarly, in the New York Bight, an array of passive acoustic monitoring stations from 2018 to 2020 detected humpback whales throughout the year (Estabrook et al. 2021). Seasonally, Humpback Whale presence was highest during fall and summer months. Zoidis et al. (2021) conducted aerial whale surveys in the New York Bight from 2017 to 2020. During this time, 111 humpback whale groups (279 individuals) were observed in depths ranging from 11 to 1,542 m (Figure 4 2). The uncorrected sightings rate was 1.99 whales per 1,000 km of effort.

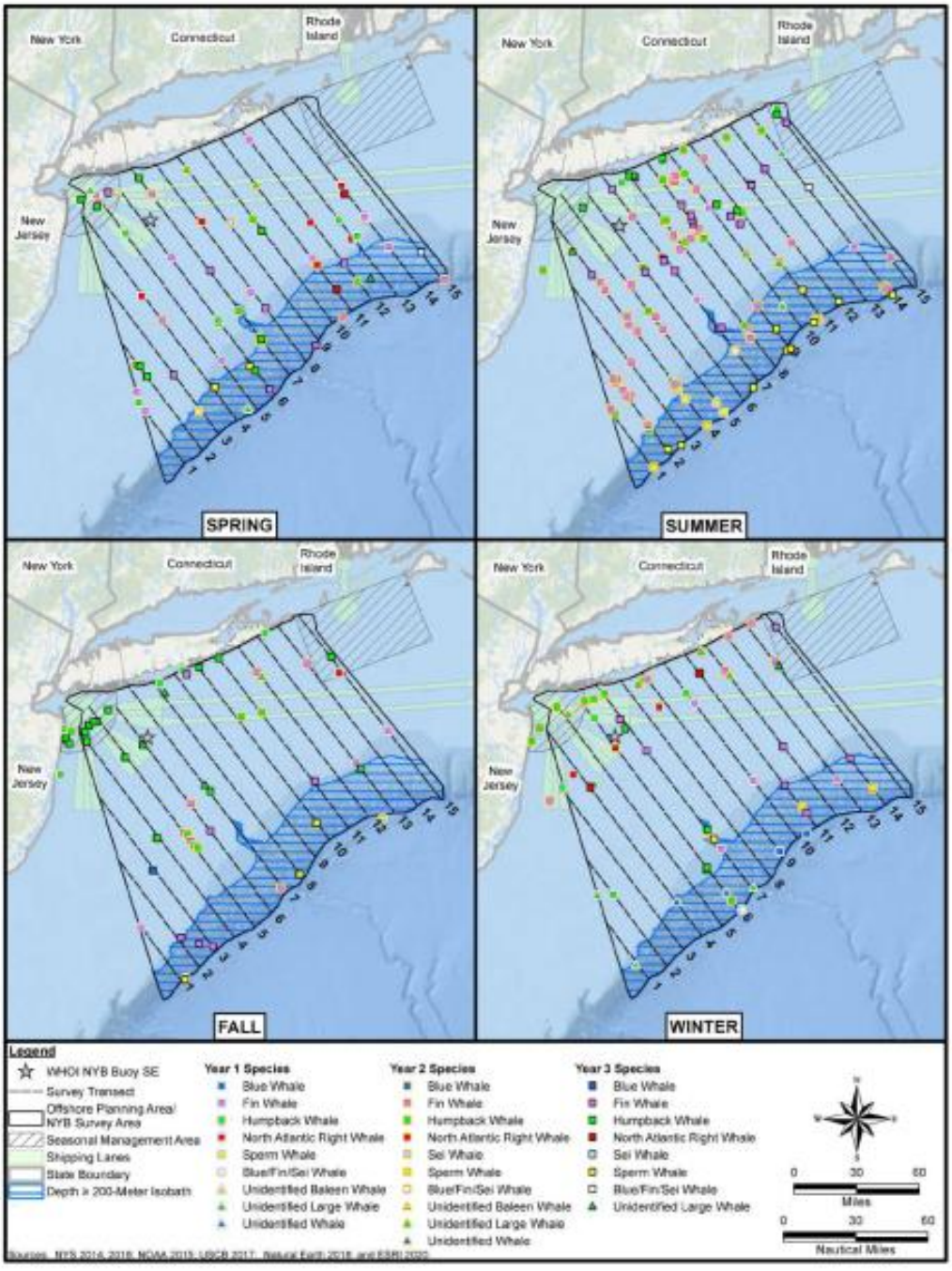

Figure 4-3 Distribution of Fin Whale and Humpback Whale in the New York Bight

Sightings during the Summer 2016 to Spring 2019 Digital Aerial Surveys of Normandeau Associates and APEM (2020)
Source: Figure 77 in Normandeau Associates and APEM (2020)

4.1.3. Fin Whale (*Balaenoptera physalus*) - Endangered

Status and distribution for the fin whale is based on information included in Equinor (2020; Section 4.1.3; pg. 26), Orsted (2020; Section 4.1.3; pg. 24), and Attentive Energy (2022; Section 4.1.3; pg.34), which are incorporated herein by

reference. Status and distribution information also incorporates more recent studies and surveys, as referenced. Status and distribution information also incorporates more recent studies and surveys, as referenced. Fin whale status was also last reviewed under ESA in 2019 (NMFS 2019).

Status: Fin whales are listed as endangered under the ESA and are considered a depleted and strategic stock under the MMPA (Hayes et al. 2022). The most recent abundance estimate (Hayes et al. 2022) for the Western North Atlantic stock was about 6,802 individuals (Table 3-1), which includes the area from Central Virginia to Newfoundland/Labrador Canada. This region is primarily a feeding ground for this migratory species that tends to calve and breed in lower latitudes or offshore. Acoustic data have indicated that a portion of the population might remain in feeding areas year around.

Distribution: There is currently no critical habitat listed for this species. Fin whale distribution tends to follow prey distribution and whales can be observed both on the continental shelf and in deeper waters. Fin whales feed primarily on sand lance, capelin, herring, copepods, euphausiids (krill) and cephalopods (e.g., squid) along the edge of the continental shelf.

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area (Figure 4-3) for wind development and fin whales were observed year-round. This species was the most frequently observed mysticete species in the region across seasons, with 43 sightings over four years of surveys (next greatest number for baleen whales was 30 minke whales). Whales preferred deeper waters near the shelf break, but fin whales were observed throughout the New York Offshore planning area. Similarly, in the New York Bight, an array of passive acoustic monitoring stations from 2018 to 2020 detected fin whales throughout the year (Estabrook et al. 2021) and this was the species the most regularly detected. Seasonally, fin whales were detected more from November to January and in August/September. Zoidis et al. (2021) conducted aerial whale surveys in the New York Bight from 2017 to 2020. During this time, 124 Fin whale groups (207 individuals) were observed in depths ranging from 17 to 2,162 m (Figure 4-2). The uncorrected sightings rate was 1.47 whales per 1,000 km of effort.

4.1.4. Sei Whale (Balaenoptera borealis) - Endangered

Status and distribution for the Sei whale is based on information included in Equinor (2020; Section 4.1.4; pg. 27), Orsted (2020; Section 4.1.4; pg. 25), and Attentive Energy (2022; Section 4.1.4; pg. 34), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced. Sei whale status was also last reviewed under ESA in 2021 (NMFS 2021a).

Status: Sei whales are listed as endangered under the ESA and are considered a depleted and strategic stock under the MMPA (Hayes et al. 2022). The most recent abundance estimate for the Nova Scotia stock was about 6,292 individuals (Table 3-1), which includes the area from Nova Scotia Canada to Florida. Occurrence and abundance of this species in this region, which is primarily a feeding ground, varies greatly and depends on prey availability.

Distribution: There is currently no critical habitat listed for this species. Sei whale distribution in the New York Bight area tends to follow prey distribution and whales can be observed along the shelf edge continental shelf. Sei whales feed primarily on copepods, euphausiids, and occasionally fish species.

New Information: As described in Attentive Energy (2022), Normandeau Associates (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4 1), and Sei whales were observed both in winter and spring in that area. Whales preferred deeper waters near the shelf break. In the New York Bight, an array of passive acoustic monitoring stations from 2018 to 2020 detected sei whales throughout the year except in January and July (Estabrook et al. 2021). The highest number of detections occurred in March and April while the fewest detections occurred in the fall. Zoidis et al. (2021) conducted aerial whale surveys in the New York Bight from 2017 to 2020. During

this time, two Sei whale groups (7 individuals) were observed in depths ranging from 60 to 381 m (Figure 4-2). The uncorrected sightings rate was 0.05 whales per 1,000 km of effort.

4.1.5. Common Minke Whale (*Balaenoptera acutorostrata*) – Non-strategic

Status and distribution for the common minke whale is based on information included in Equinor (2020; Section 4.1.5; pg. 28), Orsted (2020; Section 4.1.5; pg. 26), and Attentive Energy (2022; Section 4.1.5; pg. 35), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: Minke whales in this area are associated with the Canadian East Coast stock. This stock is currently not listed as endangered under the ESA and is considered non-strategic under the MMPA. The most recently published abundance estimate (Hayes et al. 2022) for this minke whale stock was about 21,968 individuals (Table 3-1), which includes the area from Central Virginia to Labrador Canada.

Distribution: This migratory species seems to return to its summer feeding grounds and follow the warm waters of the Gulf stream along the continental shelf. In the New York Bight, minke whales are regularly observed from April to October in coastal or continental shelf habitats where they feed on sand lance and herring.

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-1) and found that minke whales were the second most commonly observed species across surveys, with the highest numbers sighted in spring months. Minke whales preferred deeper waters near the shelf break but were observed throughout the New York Offshore planning area. Zoidis et al. (2021) did not include minke whales in their study. Estabrook et al. (2021) also did not report on minke whales in their study.

4.2. Odontocetes

4.2.1. Sperm Whale (*Physeter macrocephalus*) - Endangered

Status and distribution for the sperm whale is based on information included in Equinor (2020; Section 4.2.1; pg. 29), Orsted (2020; Section 4.2.1; pg. 27), and Attentive Energy (2022; Section 4.2.1; pg. 36, which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced. Sperm whale status was also last reviewed under ESA in 2015 (NMFS 2015).

Status: Sperm whales are listed as endangered under the ESA and are considered a strategic stock under the MMPA (Hayes et al. 2022). There are insufficient data to assess trends and abundance estimates are based on a fraction of the stock range (Table 3-1). An estimate for the North Atlantic based on 2001 surveys was 11,185 (Gunnlaugsson et al. 2009). This represents an estimate of the likely breeding population at that time; however, the stock of sperm whales that is present in the US EEZ at any given time is represented by the Stock Assessment Report (Table 3-1).

Distribution: Sperm whales are found throughout the world’s oceans; the North Atlantic stock is primarily found along the continental shelf edge, continental slope, and mid-ocean region; they are rarely found in waters less than 300 meters deep. In winter, North Atlantic stock sperm whales concentrate east and northeast of Cape Hatteras, moving northward in the spring and becoming widespread throughout the central Mid-Atlantic Bight and the southern Georges Bank.

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-1) and sperm whales were

observed in summer, fall, and winter surveys, with highest number of observations in summer. Sperm whales showed a preference for the shelf break. In the New York Bight, an array of passive acoustic monitoring stations from 2018 to 2019 detected sperm whales throughout the year; however, no sperm whales were detected in 2020 (Estabrook et al. 2021). Seasonally, sperm whales were detected more during spring and summer and least during the fall (Estabrook et al. 2021). Zoidis et al. (2021) conducted aerial whale surveys in the New York Bight from 2017 to 2020. During this time, 32 sperm whale groups (72 individuals) were observed in depths ranging from 258 to 2,265 m (Figure 4-2). The uncorrected sightings rate was 0.51 whales per 1,000 km of effort.

4.2.2. Risso's Dolphin (*Grampus griseus*) – Non-strategic

Status and distribution for the Risso's dolphin is based on information included in Equinor (2020; Section 4.2.2; pg. 30), Orsted (2020; Section 4.2.2; pg. 28), and Attentive Energy (2022; Section 4.2.2, pg. 36), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: Risso's dolphins are not listed under the ESA and are not considered a strategic stock under the MMPA (Table 3-1). The status of the Western North Atlantic stock is not well understood, and the abundance estimate was generated from shipboard surveys between Florida and Newfoundland. The current Stock Assessment Report estimated the stock to be 35,215 individuals (Hayes et al. 2022).

Distribution: Risso's dolphins are broadly distributed in tropical and temperate latitudes throughout the world's oceans. The Western North Atlantic stock occurs from Florida to eastern Newfoundland. They are common on the northwest Atlantic continental shelf in summer and fall with lower abundances in winter and spring.

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-4). Risso's dolphin was the second-most common dolphin species sighted during these surveys, with the highest numbers sighted in spring and summer months. Risso's dolphins showed a preference for deeper water at the shelf break throughout the year.

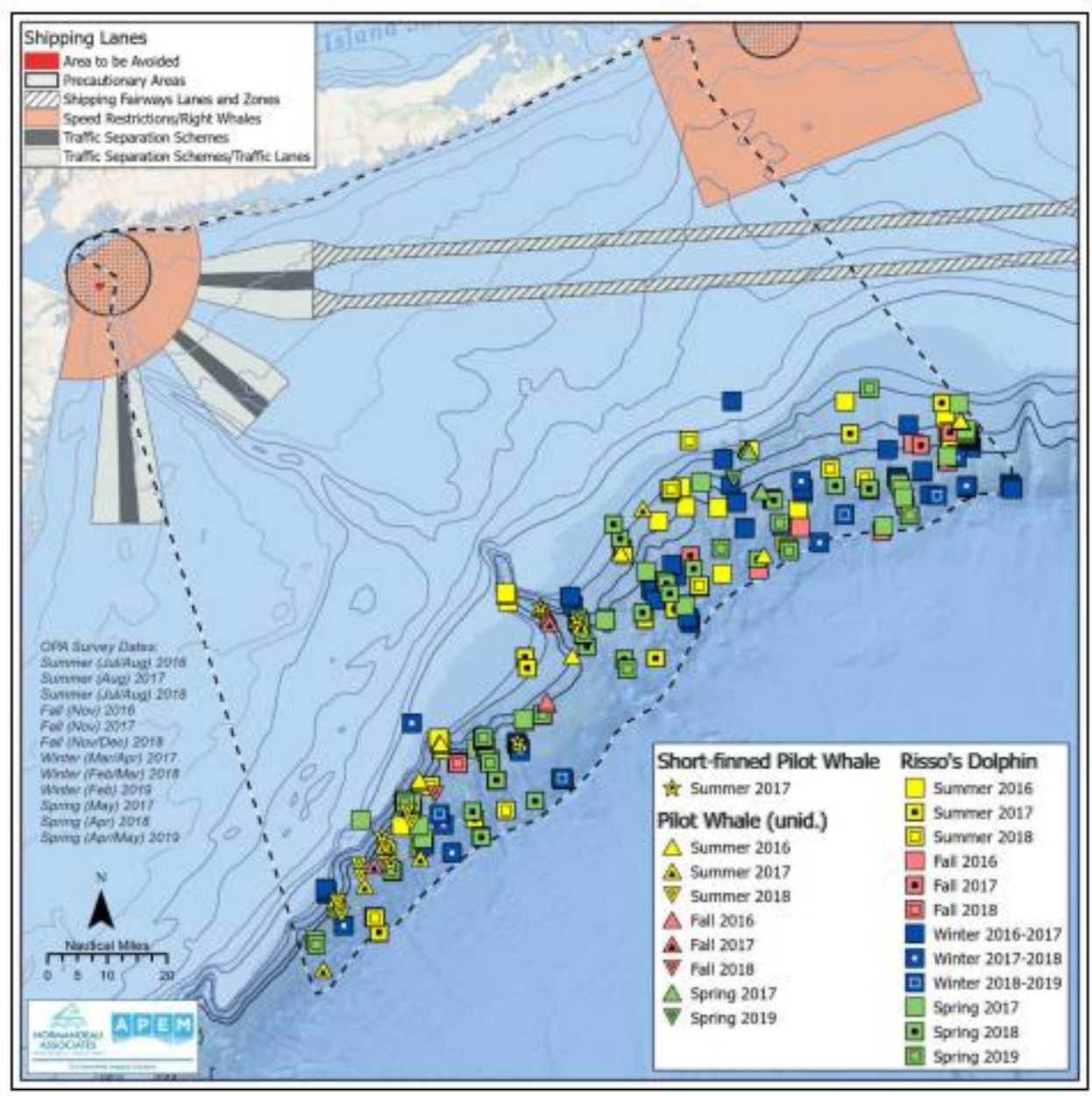

Figure 4-4 Distribution of Short-finned Pilot Whale, Unidentified Pilot Whale, and Risso's Dolphin in the New York Bight

Sightings during the Summer 2016 to Spring 2019 Digital Aerial Surveys of Normandeau Associates and APEM (2020).
Source: Figure 81 in Normandeau Associates and APEM (2020)

4.2.3. Long-Finned Pilot Whale (*Globicephala melas*) – Non-strategic

Status and distribution for the long-finned pilot whale is based on information included in Equinor (2020; Section 4.2.3; pg. 30), Orsted (2020; Sections 4.2.3; pg. 28), and Attentive Energy (2022; Section 4.2.3, pg. 39), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: There are two species of pilot whales that may found in the New York Bight; however, short-finned pilot whales are the much less common at this latitude than long-finned pilot whales (Waring et al. 2015), so short-finned pilot whales

are not considered likely to be taken in the proposed survey. The Western North Atlantic stock of the long-finned pilot whale (*Globicephala melas*) is not listed under ESA but is considered a strategic stock under the MMPA (Table 3 1). The most current abundance estimate for this stock is about 39,215 individuals (Hayes et al. 2022).

Distribution: Long-finned pilot whales tend to be observed along the continental slope in winter and spring and move closer to shore within the continental shelf during the summer and fall to follow prey movement and seasonality (mackerel, cephalopods).

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-4). Short-finned pilot whales were observed in Summer 2017. Unidentified Pilot whales were primarily observed in the summer and fall, to a lesser extent in the spring, and there were no sightings in the winter season across years. Pilot whales showed a preference for deeper water at the shelf break throughout the year.

4.2.4. Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*) – Non-strategic

Status and distribution for the Atlantic white-sided dolphin is based on information included in Equinor (2020; Section 4.2.4; pg. 31), Orsted (2020; Section 4.2.5; pg. 30), and Attentive Energy (2022; Section 4.2.4; pg. 39), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: The Western North Atlantic stock of Atlantic white-sided dolphins is currently not listed under the ESA and is not considered strategic under the MMPA. The most recent abundance for this stock was estimated to be 93,233 individuals (Hayes et al. 2022) and there is currently no information on the population trend.

Distribution: Atlantic white-sided dolphins are primarily observed offshore on the continental shelf edge and occasionally traveling inshore where they feed on herring, smelt, and other schooling fish, particularly during fall and spring months.

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-5). Atlantic white-sided dolphins were observed in the fall and winter. Atlantic white-sided dolphins showed a preference for deeper water at the shelf break throughout the year.

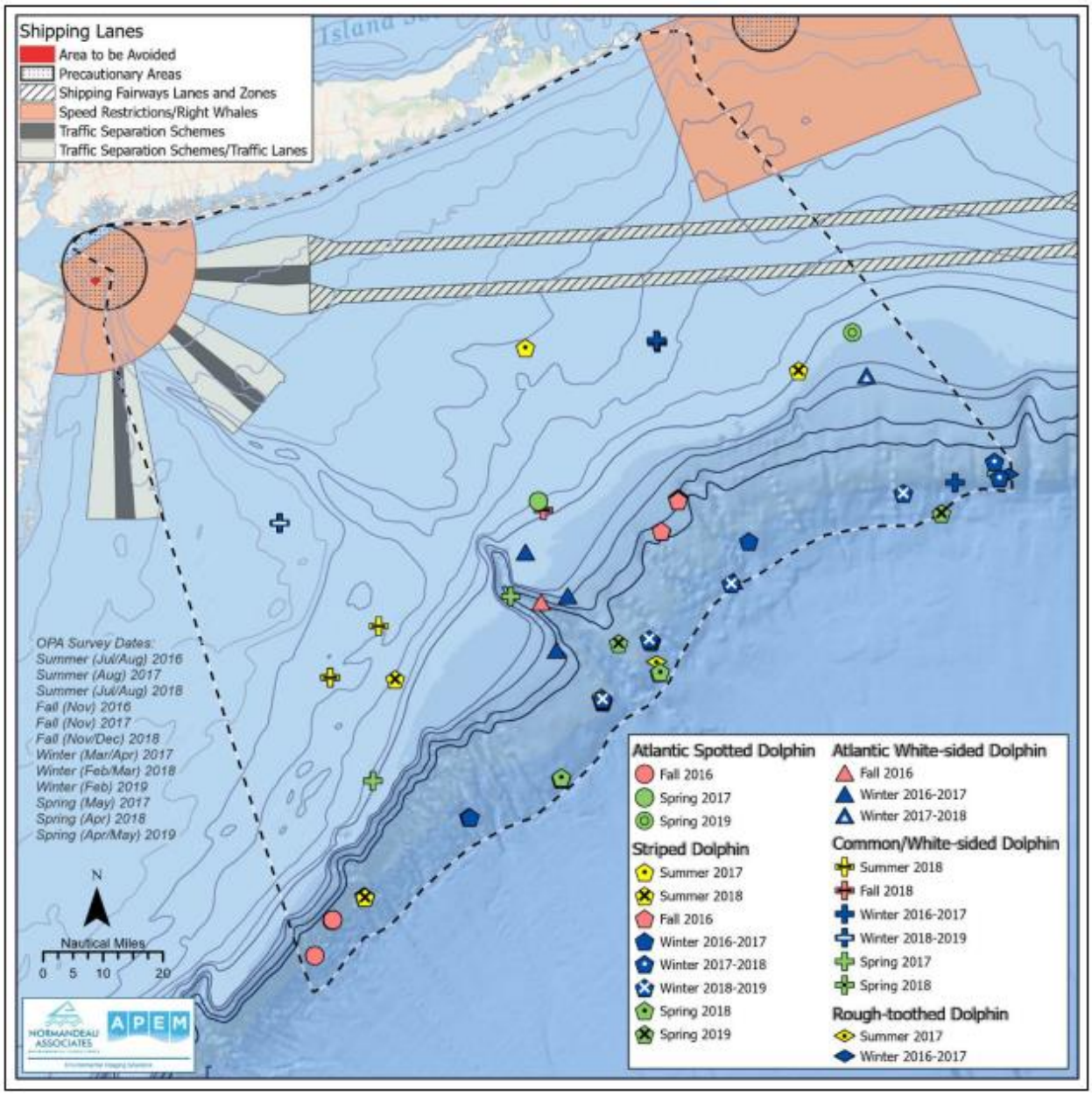

Figure 4-5 Distribution of Atlantic Spotted Dolphin, Atlantic White-sided Dolphin, Striped Dolphin, Common White-sided Dolphin, and Rough-toothed Dolphin in the New York Bight

Sightings during the Summer 2016 to Spring 2019 Digital Aerial Surveys of Normandeau Associates and APEM (2020)
Source: Figure 80 in Normandeau Associates and APEM (2020)

4.2.5. Short-Beaked Common Dolphin (*Delphinus delphis*) – Non-strategic

Status and distribution for the short-beaked common dolphin is based on information included in Equinor (2020; Section 4.2.5; pg. 31), Orsted (2020; Section 4.2.6; pg. 31), and Attentive Energy (2022; Section 4.2.5; pg. 41), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: The Western North Atlantic stock of short-beaked common dolphins is currently not listed under the ESA and is not considered strategic under the MMPA. The most recent abundance for this stock was estimated to be 172,974 individuals (Hayes et al., 2022).

Distribution: Common dolphins can be observed in large groups and tend to occupy the shelf and shelf break along the Gulf Stream, but they have also been observed in coastal habitats as well as offshore waters. This species feeds primarily on small schooling fish and squid. Common dolphins are also observed migrating to mid-Atlantic waters during winter months.

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-6). Common dolphins were the most frequently encountered species across seasons and years except for Summer 2016.

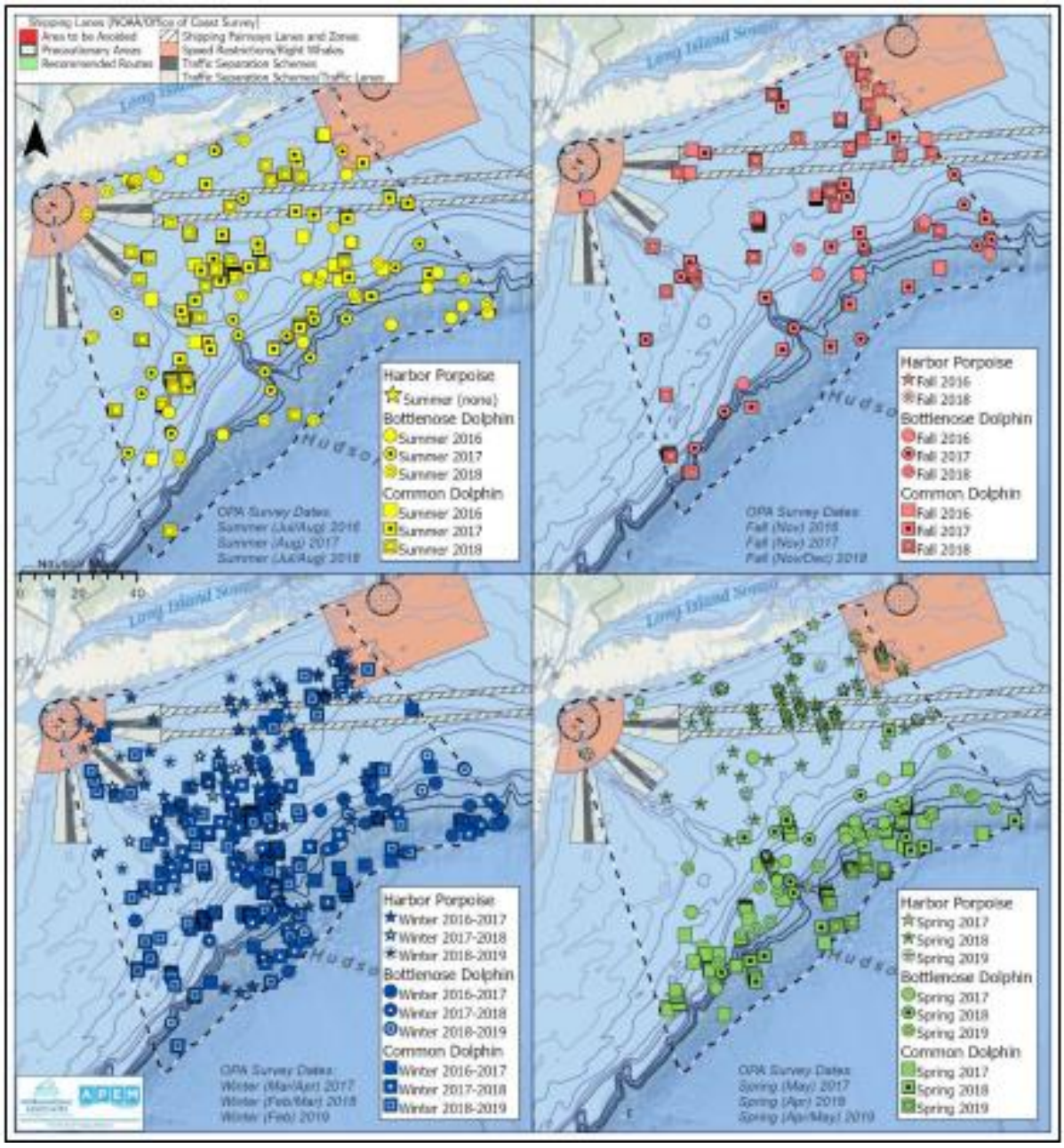

Figure 4-6 Distribution of Harbor Porpoise, Common Bottlenose Dolphin, and Short-Beaked Common Dolphin in the New York Bight

Sightings during the Summer 2016 to Spring 2019 Digital Aerial Surveys of Normandeau Associates and APEM (2020).
Source: Figure 79 in Normandeau Associates and APEM (2020)

4.2.6. Common Bottlenose Dolphin (*Tursiops truncatus*) – Strategic and Non-Strategic Stocks

Status and distribution for the common bottlenose dolphin is based on information included in Equinor (2020; Section 4.2.6; pg. 32), Orsted (2020; Section 4.2.8; pg. 32), and Attentive Energy (2022; Section 4.2.6, pg. 43), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: Two stocks of bottlenose dolphins, the Western North Atlantic Northern Migratory Coastal Stock and the Western North Atlantic Offshore Stock, are likely to occur in the proposed Survey Area. These two stocks are generally considered to be geographically separated for management by the 20 m depth contour, with the Coastal Stock in <20 m and the Offshore Stock in >20 m of water. The two stocks are genetically and morphologically distinct. (Hayes et al. 2022).

The Coastal Stock is considered strategic and depleted under the MMPA but is not listed under the ESA. The most recent abundance estimate for this stock was 6,639 individuals (Hayes et al. 2022). The Offshore Stock is considered non-strategic under the MMPA and is not listed under the ESA. This stock is relatively common in the Survey Area and the most recent abundance estimate for this population was 62,851 individuals (Hayes et al. 2022). Based on the monthly abundance maps of Roberts et al. (2022), which do not differentiate the two stocks, the maximum monthly abundance of bottlenose dolphins occurs in November and is 87,249. There are not enough data to determine population trends.

Distribution: The Offshore Stock is generally observed along the outer continental shelf and slope in waters deeper than 34 m and over 34 km offshore (Torres et al. 2003). In contrast, the Coastal Stock is typically within the 34 m depth profile and 34 km range from shore. The Coastal Stock migrates south during the late summer and fall and migrates north in the colder months. The offshore boundary of the Coastal Stock is defined as the 20 m isobath in summer north of Cape Hatteras and the 200 m isobath in winter between Cape Hatteras and Cape Lookout (Hayes et al. 2022).

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-6). Bottlenose dolphins were a frequently encountered species across seasons and years. Bottlenose dolphin stock affiliation cannot be distinguished visually in surveys, so these studies do not differentiate between Coastal and Offshore Stocks.

4.2.7. Atlantic Spotted Dolphin (*Stenella frontalis*) – Non-strategic

Status and distribution for the Atlantic spotted dolphin is based on information included in Equinor (2020; Section 4.2.7; pg. 33), Orsted (2020; Section 4.2.7; pg. 32), and Attentive Energy (2022; Section 4.2.7; pg. 43), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: Atlantic spotted dolphins are relatively uncommon in the Survey Area. The Western North Atlantic stock of Atlantic spotted dolphins is currently not listed under ESA and is not considered strategic or depleted under MMPA. Current stock population trends are unknown. The most recent population abundance for this stock was estimated at 39,921 individuals (Hayes et al. 2022).

Distribution: Spotted dolphins are usually observed along the continental shelf edge and the continental slope. This species has been associated with the Gulf stream and warm-core rings (Waring et al. 2015).

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-5). Atlantic spotted dolphins were mainly observed in Fall 2016, with three additional sightings in Spring 2017. They showed a preference for deeper water at the shelf break.

4.2.8. Harbor Porpoise (*Phocoena phocoena*) – Non-strategic

Status and distribution for the harbor porpoise is based on information included in Equinor (2020; Section 4.2.8; pg. 33), Orsted (2020; Section 4.2.9; pg. 34), and Attentive Energy (2022; Section 4.2.8; pg. 44), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: The Gulf of Maine/Bay of Fundy stock is not considered strategic or depleted under the MMPA and is not listed under the ESA. Current population trends are unknown, but the most recent abundance estimate for this stock was

95,543 individuals which includes the area from Central Virginia to Gulf of St. Lawrence/Bay of Fundy/Scotian Shelf Canada (Hayes et al. 2022).

Distribution: Harbor porpoise feed on cod, herring, and mackerel, as well as sand eels and cephalopods. This species is present in the Survey Area during fall and winter seasons (Whitt et al. 2015). They tend to occupy shallow waters in the Canada and the Gulf of Maine in summer.

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development (Figure 4-6). Harbor porpoises were observed mainly in winter, followed by spring, with seven additional sightings in fall over the three-year study and no observations of harbor porpoises in summer.

4.3. Pinnipeds

4.3.1. Gray Seal (*Halichoerus grypus*) – Non-strategic

Status and distribution for the gray seal is based on information included in Equinor (2020; Section 4.3.1; pg. 34), Orsted (2020; Section 4.3.2; pg. 35), and Attentive Energy (2022; Section 4.3.1; pg. 44), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: Gray seals in the Survey Area are part of the Western North Atlantic stock which is currently not listed under the ESA and is not considered strategic or depleted under the MMPA. This species is regularly observed in the Survey Area and the most current population abundance in US waters was estimated at 27,300 individuals (Hayes et al. 2022) (Table 3-1). Fisheries and Oceans Canada (DFO) estimates the part of this population to be 424,300 in Canadian waters (DFO 2017).

Distribution: Gray seals can be observed year around from Canada to Massachusetts. Some seals migrate to the waters off New York and New Jersey between the fall and spring months, with haul-outs documented in the Long Island area, (and) with a possible rookery on Little Gull Island.

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development. Gray seals were only randomly encountered in the fall, winter, and spring seasons. For the majority of the years and seasons, this species was not encountered. Seals were difficult to identify to species in this study.

4.3.2. Harbor Seal (*Phoca vitulina*) – Non-strategic

Status and distribution for the harbor seal is based on information included in Equinor (2020; Section 4.3.2; pg. 35), Orsted (2020; Section 4.3.1; pg. 35), and Attentive Energy (2022; Section 4.3.2; pg. 45), which are incorporated herein by reference. Status and distribution information also incorporates more recent studies and surveys, as referenced.

Status: This species is the most abundant seal in the Eastern U.S. The animals observed in Survey Area are part of the Western North Atlantic stock which is currently not listed under the ESA and is not considered strategic or depleted under the MMPA. The most recent population abundance estimated 61,336 individuals in the US (Hayes et al. 2022), and DFO estimates approximately 20,000-30,000 harbor seals in the Canadian Atlantic (DFO 2019).

Distribution: Harbor seals feed on a variety of prey and can be observed in coastal shallow environments as well as offshore. Harbor seals undergo a seasonal migration from Eastern Canada/Maine down to the mid-Atlantic from the fall to

spring months. Their numbers may be increasing in areas further south than New York, with consistent observations as far south as Eastern Shore, Virginia from November to April during surveys 2016-2018 (Jones et al. 2018). Harbor seals are the most common seal species observed by the Coastal Research and Education Society (CRESLI) in the Long Island area. The CRESLI website states that there are about 30 seal haul-out sites known on Long Island, and the organization has been collecting data on harbor seals using Cupsogue Beach for 16 years (Kopelman 2022). Harbor seals would be expected to occur offshore, nearshore, and in bays and inland waters mainly in winter.

New Information: As described in Attentive Energy (2022), Normandeau Associates and APEM (2020) conducted aerial surveys of the New York Bight offshore planning area for wind development. Harbor seals were only randomly encountered in the fall, winter, and spring seasons. For the majority of the years and seasons, this species was not encountered. Seals were difficult to identify to species in this study.

5. Type of Incidental Taking Authorization Requested

The type of incidental taking authorization that is being requested (i.e., takes by harassment only; takes by harassment, injury, and/or death) and the method of incidental taking.

The exposure assessment in this IHA application quantifies potential sound exposures of marine mammals resulting from proposed HRG surveys in the marine environment (Section 6). Exposure to Level A harassment thresholds is not anticipated and thus this application is not requesting take authorization for Level A harassment. Sound levels associated with operation of certain types of HRG survey equipment may result in Level B harassment as defined under the MMPA. The most likely and anticipated impact is Level B harassment resulting from avoidance or temporary displacement of some individuals or groups of marine mammals near the proposed activities. These are considered minor behavioral reactions.

For the Survey Area, Invenergy requests an IHA pursuant to Section 101 (a)(5)(D) of the MMPA for incidental take of small numbers of marine mammals by Level B harassment. Mitigation and impact reduction measures to protect marine mammals are described in Section 11 and are expected to decrease the likelihood that marine mammals will be exposed to extended or loud sound levels associated with survey activities. See Table 1-3 for distances to Level B acoustic thresholds.

6.
Take Estimates for Marine Mammals

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in Section 0, and the number of times such takings by each type of taking are likely to occur.

Invenergy is seeking authorization for potential takes by Level B harassment of small numbers of marine mammals under the jurisdiction of NMFS in the Survey Area as described in Section 2. There are 15 species/guilds (16 stocks) of marine mammals that have potential to be taken by Level B harassment during the HRG surveys. One of these species, the common bottlenose dolphin, is comprised of two stocks; the surveys are anticipated to potentially take individuals by Level B harassment from both the Offshore and Coastal Stocks since the proposed survey will occur in waters both shallower and deeper than 20 m. The 15 species (16 stocks) are listed below and detailed in Section 4.

Mysticetes	**Odontocetes**	**Pinnipeds**
North Atlantic Right Whale	Sperm Whale	Gray Seal
Humpback Whale	Risso's Dolphin	Harbor Seal
Fin Whale	Long-finned Pilot Whale	
Sei Whale	Atlantic White-sided Dolphin	
Common Minke Whale	Short-beaked Common Dolphin	
	Atlantic Spotted Dolphin	
	Harbor Porpoise	
	Common Bottlenose Dolphin Western North Atlantic Offshore Stock	
	Common Bottlenose Dolphin Western North Atlantic Northern Migratory Coastal	

The only anticipated potential exposures to Level B harassment for marine mammals is associated with sound and is limited to the use of a sparker system during HRG surveys. The proposed activities are not expected to take more than a small number of marine mammals by Level B harassment or have more than a negligible effect on their populations based on their seasonal density and distribution and known reactions to underwater sound exposure. The sound sources are described in Section 1.2, survey equipment is listed in Section 1.4, and species status and distributions are described in Section 4.

6.1.
Approach to Estimating Numbers of Marine Mammals that Might Be Taken by Harassment

Estimating exposures of marine mammal species in water assumes that exposure of an animal to a specified sound level within a region of ensonification will result in a take of that animal. Potential take by Level B harassment is estimated within the ensonified area as a sound pressure level (SPL) exceeding 160 dB SPL re 1 µPa for non-impulsive intermittent sources (e.g., sonar, CHIRPs) and intermittent sources (e.g., sparkers, boomers) during the course of surveys. For this application, the impulsive sparker is anticipated to cause potential Level B harassment in-water only, so the underwater Level B harassment acoustic thresholds are applicable. Potential take by Level B harassment was estimated assuming all trackline described in Section 2 would be surveyed with one of the sparker systems listed in Table 1-2 (or an equivalent) as the maximum case scenario (all of these systems have the same modeled 141 m Level B Harassment Zone). The

potential number of exposed animals is estimated from the maximum mean seasonal densities (animals per km^2) of a given species expected within the Survey Area based on the density models of Roberts et al. (2022). These calculations result in unmitigated take estimates by Level B harassment for each affected species over the survey period.

6.1.1. Level B Harassment Zone Calculation

As noted in Section 1.1, the Level B Harassment Zone (Harassment Zone) is the area that is ensonified to the Level B threshold level specific for the operating characteristics of the gear. In this case, as the sparker is an impulsive sound source, the threshold is 160 dB SPL, and the Harassment Zone is the area of water ensonifed to levels that meet or exceed 160 dB SPL. To estimate the area of the Harassment Zone, the total length of the survey trackline (L) was used and buffered with the horizontal distance to the Level B threshold (R; Table 3-1) to determine the total area ensonified to 160 dB SPL (Harassment Zone):

$$Harassment\ Zone = (L \times 2R) + \pi R^2$$

The πR^2 term is the area of a circle and accounts for semi-circles at the beginning and end of the trackline (Figure 6-1).

Source Name: **GeoMarine Geo-Spark/AA Dura-Spark UHD/AA Dura-Spark 240/400**

INPUT VALUES (LEVEL B)	
Threshold Level	160
Source Level (dBrms)	203
Frequency (kH)	1
Beamwidth (degree)	180
Water depth (m)	55

COMPUTED VALUES (LEVEL B)	DO NOT CHANGE
alpha (dB/km)	0.00882342
TL coefficient	20
Slant distance of threshold (m)	**141**
Vertical depth of threshold (m)	8.6373E-15
Horizontal threshold range (m)	**141**

Figure 6-1 Snapshot of Inputs and Outputs from NMFS' Level B HRG Impact Distance Calculator

As noted in Section 2, the total survey trackline for the Survey Area is 12,818 km, with 7,460 km in the Lease Area and 5,358 km in the ECR Area. Of the ECR survey trackline, 1,600 km are in waters less than 20 m depth. The distance to the Level B threshold for any of the sparkers) is 0.141 km (Table 1-3). Applying the equation above, the total Harassment Zone is 3,615 km^2, with 452 km^2 in waters less than 20 m depth. The Harassment Zone within the lease area is 2,104 km^2 and 1,511 km^2 within the ECR. The precise number of survey days cannot be accurately predicted, so Invenergy used the Harassment Zone of the full survey distance of 12,818 km of trackline to estimate potential takes by Level B Harassment.

6.1.2. Marine Mammal Density Estimations

The density calculations for marine mammals to be used for estimating take are derived from the habitat-based density models of Roberts et al. (2016) and subsequent unpublished reports updating the earlier models (Roberts et al. 2022). The most recent model version available for each species, updated in July 2022, was utilized for this analysis . The data provided by Roberts et al. (2022) are raster files binned into 5 km x 5 km grids, and each grid square has a monthly or annual density. For all species considered in the current application, except pilot whales, there is a raster file for each month; for pilot whales there is an annual raster file.

ArcGIS (Environmental Systems Research Institute 2018) software was used to identify the grid cells from most recent model versions of Roberts et al. (2022) that overlapped the Survey Area for each monthly raster. Figure 6-2 shows an example of the January density grids for seals. The grid cells that would be included in the example figure are highlighted

in yellow. Densities represented by the overlapping grids were averaged to estimate the monthly density within the Survey Area for each species.

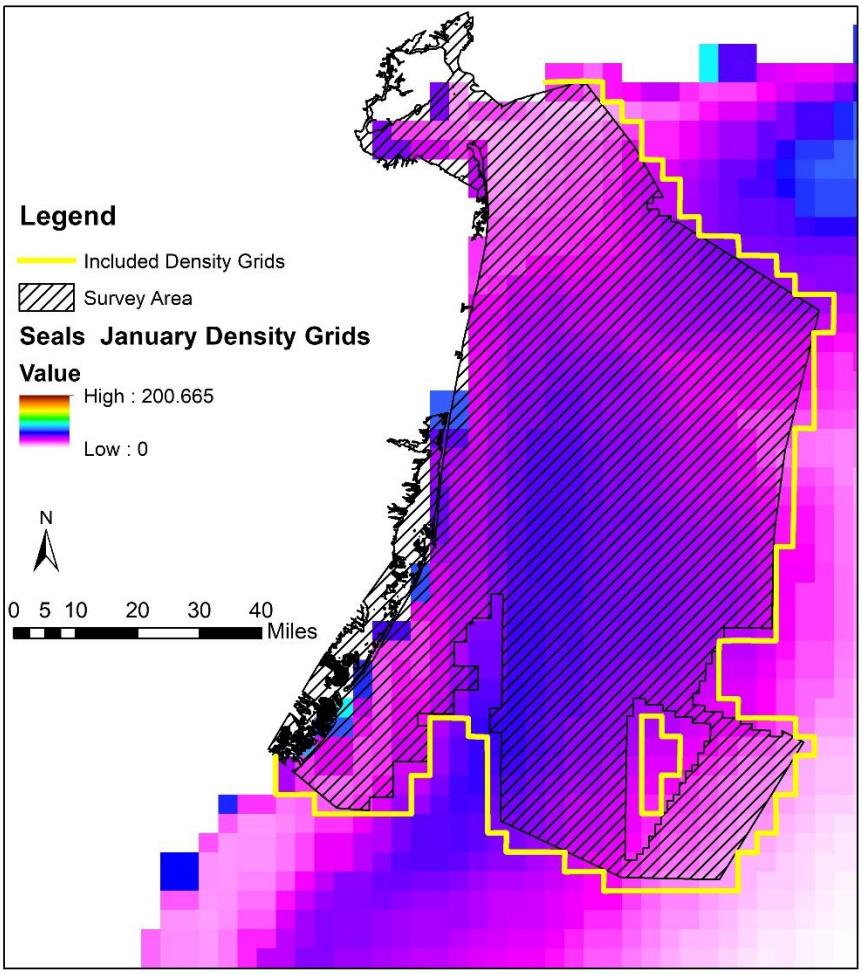

Figure 6-2 Survey Area with 5 km by 5 km Seal Density Grids

All density grids within the survey area (black hatch) are included in the calculation of mean density. In addition, the yellow outline highlights the density grids around the perimeter of the study area that were also included in the calculation for January seal densities.

It is anticipated the surveys will be completed with up to three vessels. Invenergy estimates 136 vessel-days in the Lease Area and 138 vessel-days in the ECR Area (with downtime) that would be spread across the three vessels; however, the exact timing of the surveys during the year is not yet certain (though estimated dates are provided in Section 2). Therefore, the monthly densities were averaged across seasons (Winter [December, January, February]; Spring [March, April, May], Summer [June, July, August] and Fall [September, October, November]), and Invenergy used the season with the highest density for each species for exposure calculations to account for the uncertainty in the timing of the surveys.

Recent IHAs for similar survey work off New York and New Jersey have observed more common dolphins than anticipated based on the Roberts et al. (2016, 2017, 2018, 2021, 2022) densities and other IHA's have used the maximum monthly density to adjust estimated take levels. However, the latest models from Roberts et al. (2022) represent substantial additional data, improved statistical methods, and increased spatial resolution for species, including common dolphins. For most species, the new models result in higher densities than the previous versions. For other species, such

as harbor porpoise, where new data were not available, the new models have removed sightings at high Beaufort sea state levels, acknowledging that marine mammal sightings are reduced in these conditions and are likely biasing density estimates low, again resulting in higher densities. Given the new models and revised (i.e., higher) densities for common dolphins, the same approach has been taken as with the other species and the highest seasonal mean density was used to estimate takes of common dolphins. Another substantial change in the Roberts et al. (2022) models is that the density grids are now 5 km by 5 km for all species compared to the 10 km by 10 km of the previous models for all species except North Atlantic Right Whales.

Exceptions to the above procedure for estimating densities are for bottlenose dolphins, pilot whales, and seals. There are two stocks of bottlenose dolphins that may be impacted by the surveys, the Coastal Stock found in waters less than 20 m and the Offshore Stock found in waters deeper than 20 m. For bottlenose dolphins, separate mean seasonal densities were calculated for the area less than 20 m and for the area greater than 20 m (Table 1-1) to use for estimating take of the Coastal and Offshore Stocks of bottlenose dolphins, respectively.

As noted above, for long-finned pilot whales, data from Roberts et al. (2022) only provide a single raster grid containing annual density estimate for *Globicephala* species (i.e., short-finned and long-finned pilot whales combined). The annual density raster grid was used to estimate densities in the Survey Area and assumed densities apply only to long-finned pilot whales, as short-finned pilot whales are not anticipated to occur as far north as the Survey Area.

For seals, given their size and behavior when in the water, they are difficult to identify during shipboard visual surveys; therefore, there is limited information available on species-specific distribution. Density estimates of Roberts et al. (2022) included all seal species that may occur in the Western North Atlantic combined (i.e., harbor, gray, hooded, and harp). Only the harbor seals and gray seals are reasonably expected to occur commonly in the Survey Area; therefore, densities of seals were split evenly between these two species.

Table 6-1 Estimated marine mammal densities (animals per km^2) for the Survey Area.

Species	Spring	Summer	Fall	Winter	Annual Mean	Monthly Maximum
Mysticetes						
North Atlantic Right Whale	0.00139	6.87E-05	0.00017	**0.001748**	0.000844	0.002278
Humpback Whale	**0.003657**	0.001622	0.002649	0.003332	0.002815	0.004196
Fin Whale	0.004387	0.003632	0.001521	**0.004856**	0.003599	0.005583
Sei Whale	**0.001813**	0.000172	0.000566	0.000952	0.000876	0.002576
Common Minke Whale	**0.025476**	0.007988	0.002114	0.00161	0.009297	0.04128
Odontocetes						
Sperm Whale	0.000162	**0.000371**	0.000154	0.000196	0.000221	0.000402
Risso's Dolphins	0.001394	0.00066	0.001237	**0.002841**	0.001533	0.00591
Long-finned Pilot Whale	N/A	N/A	N/A	N/A	N/A	**0.002365**
Atlantic White-sided Dolphin	**0.027836**	0.013441	0.018628	0.020565	0.020118	0.040584
Short-beaked Common Dolphin	0.125896	0.109562	0.154527	**0.245719**	0.158926	0.370446
Atlantic Spotted Dolphin	0.00074	0.005041	**0.011683**	0.000321	0.004446	0.015867
Harbor Porpoise	**0.262904**	0.043348	0.089274	0.255551	0.162769	0.304018

Species	Spring	Summer	Fall	Winter	Annual Mean	Monthly Maximum
Common Bottlenose Dolphin Western North Atlantic Offshore Stock	0.070379	**0.193127**	0.183589	0.078173	0.131317	0.20763
Common Bottlenose Dolphin Western North Atlantic Northern Migratory Coastal	0.591713	1.608153	**1.758553**	0.377374	1.083948	1.834576
			Pinnipeds			
Gray Seal	**0.262904**	0.043348	0.089274	0.255551	0.162769	0.304018
Harbor Seal	**0.262904**	0.043348	0.089274	0.255551	0.162769	0.304018

Numbers in bold are highest seasonal densities

6.1.3. Marine Mammal Take Estimations

To estimate the number of potential takes by Level B harassment, the Harassment Zone (km^2) was multiplied by the density of each species/stock (animals/km^2) to estimate total potential takes by Level B harassment (animals; Table 6-2). In the case where estimated takes by Level B harassment were less than a typical group size, the estimate was rounded up to a mean group size (Table 6-2) based on Palka et al. (2017, 2021) and Cetacean and Turtle Assessment Program (CETAP 1982; see Attachment 3 for data).

Importantly takes by Level B harassment per day were not calculated but rather takes anticipated over the duration of the survey were calculated. Multiplying the ensonified area times density gives the total expected exposures for the duration of the survey, regardless of how many days the survey requires. There is not an attempt to differentiate between individuals taken vs total exposures, so this approach conservatively assumes all exposures are different individuals. This approach will yield the same takes by Level B harassment as estimating takes per day based on the amount of trackline that could be surveyed in a 24-hour day.

As an example (not reflective of actual survey distance per day for the proposed survey), using a value of an average of 170 km of trackline surveyed per day, this would yield a Harassment Zone of 49 km^2 per day and suggest that 76 (12,818/170) 24-hr survey days are needed to complete the survey. If the maximum seasonal density for Fin Whales is in winter and is 0.004856 whales/ km^2, the daily take by Level B harassment of Fin Whales would then be 0.83 whales per day (49*0.004856 = 0.24). Multiplying this value by 76 active survey days results in 18 Fin Whale takes by Level B harassment. Using the method of multiplying maximum mean seasonal density by the entire survey Harassment Zone, Invenergy estimated 18 Fin Whale takes (3,615*0.004856 = 18). The amount of trackline needed to be surveyed is known, whereas survey days may vary due to weather or mechanical issues and therefore buffering the entire trackline with the distance to the Level B threshold to assess the Harassment Zone and overlaying this on animal density provides the best estimates of take by Level B harassment with the fewest assumptions regarding daily effort.

To understand the proportional impact on marine mammal species, the estimated take by Level B harassment was compared to abundance (Table 6-2). The best abundance estimates would be across the full range of the population, such as some of the abundance estimates from the Stock Assessment Reports that are inclusive of animals in Canadian waters. However, lacking such estimates, abundances are best represented relative to take by Level B harassment based on Roberts et al. (2022) densities by the maximum estimated abundance. Although mean densities from this source were used for estimating exposures, the fact that some individuals are not available for take during some months is realistic and does not mean that abundance of the population itself should be limited to the mean or minimum abundance estimates from Roberts et al (2022). Overall population abundance does not appreciably vary throughout the year even though

density in individual grid cells (and thus individual availability to be exposed to Level B harassment) does vary. Therefore, the highest abundance estimates for each species (from either Hayes et al. 2022 or the maximum monthly abundance from Roberts et al. 2022; Table 3-1) were used to estimate the percent of abundance that could be taken by Level B harassment for each species. Differences between individuals exposed and total exposures were not assessed

Table 6-2 Requested Marine Mammal Takes by Level B Harassment for HRG Survey

Species	Abundance*	Maximum Mean Seasonal Density	Harassment Zone (Total Ensonified Area km^2)	Estimated Level B Takes	Requested Level B Takes	Percent of Abundance
Mysticetes						
North Atlantic Right Whale**	418[a]	0.001748	3,615	6	6	1.44%
Humpback Whale	11,570[b]	0.003657	3,615	13	13	0.11%
Fin Whale	6,802[c]	0.004856	3,615	18	18	0.26%
Sei Whale	6,292[c]	0.001813	3,615	7	7	0.11%
Common Minke Whale	21,968[c]	0.025476	3,615	92	92	0.42%
Odontocetes						
Sperm Whale	11,185[d]	0.000371	3,615	1	2[†]	0.02%
Risso's Dolphins	35,215[c]	0.002841	3,615	10	10	0.03%
Long-finned Pilot Whale	39,215[c]	0.003363	3,615	12	15[†]	0.04%
Atlantic White-sided Dolphin	93,233[c]	0.027836	3,615	101	101	0.10%
Short-beaked Common Dolphin	172,974[c]	0.245719	3,615	888	888	0.51%
Atlantic Spotted Dolphin	39,921[c]	0.011683	3,615	42	42	0.11%
Harbor Porpoise	95,543[c]	0.262904	3,615	950	950	0.99%
Common Bottlenose Dolphin Western North Atlantic Offshore Stock	62,851[c]	0.193127	3,164	611	611	0.97%
Common Bottlenose Dolphin Western North Atlantic Northern Migratory Coastal	6,639[c]	1.758553	452	795	795	11.97%
Pinnipeds						
Gray Seal	451,600[e]	0.262904	3,615	950	950	0.21%
Harbor Seal	91,336 [e]	0.262904	3,615	950	950	1.04%

NOTES:

Estimated Level B Takes calculated as Ensonified Area * Density and rounded to the nearest integer.

* The abundances in this column are the best available abundances of the total population size, inclusive of areas outside of the U.S. Exclusive Economic Zone. Letters specify the sources of the estimates.

** Invenergy has not used the North Atlantic right whale abundance in the SAR or draft SAR because the abundance of North Atlantic right whales in the model is the abundance in the Roberts et al. (2022) density map, which was not scaled down to the current or draft SAR abundance for purposes of take modeling.

† Take request based on average group size using sightings data from Palka et al. (2017, 2021) and CETAP (1982). See Appendix C for data.

a Maximum monthly abundance from the most recent model version from the Duke University Habitat-based Marine Mammal Density Models (Roberts et al. 2022)

b Estimate of the abundance of the West Indies breeding population that includes the Gulf of Maine feeding stock (Bettridge et al 2015; Stevick et al. 2003)

c NMFS Stock Assessment Reports (Hayes et al. 2022)

d Abundance estimate for the North Atlantic population based on 2001 surveys (Gunnlaugsson et al. 2009)

e Sum of abundance from the NMFS Stock Assessment Report (Hayes et al. 2022) which are abundances in U.S. waters, and estimates of abundance from the Atlantic coast in Canada (DFO 2019)

7.
Anticipated Impact of the Activity

The anticipated impact of the activity to the species or stock of marine mammal.

This section addresses NMFS' requirements to consider the negligible impact of an activity to authorize the incidental take of marine mammals. Negligible impact is defined as "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" per 50 CFR § 216.103 (CFR 2003).

Based on the best available science regarding the current status of marine mammal populations occurring in the Survey Area (including distribution, density, and population status), combined with the project activities, a finding that these activities would only result in short-term and minimal effects and would therefore not affect the overall annual recruitment or survival of marine mammal species is supported.

Section 1 details the potential acoustic exposures from the activities that are within the non-injury behavioral effect zones (i.e., Level B harassment). The take estimate in Section 6 is considered highly conservative and does not incorporate the effects associated with mitigation and monitoring measures. Finally, the protective measures presented in Section 11 are designed to minimize and potentially avoid marine mammal exposures and interactions.

Marine mammals are mobile free-ranging animals and have the capacity to leave an area when sound-producing activities are initiated. Based on the conservative take estimates (Section 6), Project activities may disturb individual marine mammals. However, based on the factors listed above (type of activities, sound propagation, conservative approach to take estimates, and mitigation/protection measures), the activities will not be expected to result in population-level effects that could be detrimental to the annual recruitment or survival of these species. Additionally, it is expected that animals will resume normal behavioral patterns after the cessation of activities or after the animals have left the area of ensonification.

For references supporting these assertions, Orsted (2020) Section 7 is incorporated by reference. Overall, this Section of Orsted (2020) describes that mitigation, multiple exposures and seasonality, the nature of HRG sound sources, minimal effects to prey (see Section 9 below), and the temporary and localized nature of disturbance result in negligible effects, as defined in 50 CFR § 216.103 (CFR 2003), with no long-term or population level effects expected from behavioral reactions of marine mammals.

8.
Anticipated Impacts on Subsistence Uses

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses

There are no traditional subsistence hunting areas in the Survey Area; therefore, no impacts on the availability of species or stocks for subsistence use are anticipated.

9.
Anticipated Impacts on Habitat

The anticipated impact of the activity upon the habitat of the marine mammal populations and the likelihood of restoration of the affected habitat

This section addresses the short- and long-term impacts of the proposed activity on marine mammals associated with the predicted loss or modification of habitat. This section also addresses the available methods and likelihood of restoration of modified or lost habitat. The anticipated impacts to marine mammal habitats are described below and discussed in further detail in Section 10.

9.1.
Short-term Impacts

Short-term impacts have been identified as potential impacts to marine mammal habitat. Increased ambient sound levels from vessels and equipment might have localized and transient effects during the actual activities and would only temporarily affect potential marine mammal prey availability.

9.2.
Long-term Impacts

The minimal acoustic disturbance and the short duration of the activities are not expected to generate any long-term impact associated with habitat loss or modification. Habitat restoration is therefore not discussed any further.

10.
Anticipated Effects of Habitat Impacts on Marine Mammals

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

This section addresses the short- and long-term impacts of the proposed activity on marine mammals resulting from the predicted loss or modification of habitat described in Section 9.

10.1.
Short-term Impacts

Marine mammals rely extensively on sound to communicate, navigate and forage. Their acoustic habitat is therefore important to consider when looking at the impact of anthropogenic activities. Changes in their soundscape or acoustic habitat could determine access to resources. In that sense, a sound source could represent a temporary habitat loss as the anthropogenic source could occupy the frequency range generally utilized by marine mammals (Rice et al, 2014). The acoustic habitat generally represents the frequency range of a species' calls (echolocation and communication). Assessing how the HRG sources overlap with these frequencies is important to assess the potential temporary habitat loss associated with acoustic sources. Therefore, the frequency content, source levels, and sound propagation profile of the proposed activities will determine the extent of the acoustic habitat loss and will be species or hearing-group dependent. Generally, because of the short durations of the activities, marine mammals might experience a short-term loss of acoustic habitat during HRG surveys, but the extent and duration of this loss is not expected to represent a significant or long-term loss of habitat.

Marine mammals' prey might also be impacted by the HRG sound sources and thus indirectly affect prey availability to marine mammals. HRG sources are generally above the hearing range of most fish species. Small decline in catch rates following seismic activities has been reported for several fish species (Whitlock and Schluter, 2009; Engas et al. 1996). Fish distribution has been reported to return to baseline levels rapidly following the exposure to seismic activities, indicating that the acoustic habitat is only temporarily modified (Hassel et al, 2004). Given the low levels of sound energy generated by HRG sources compared to seismic surveys in these studies, no short-term impacts to prey distribution are anticipated.

In summary, marine mammals might experience temporary loss of acoustic habitat, but this is not expected to represent a substantive loss of habitat. Similarly, the impact of the activities on the prey fields are anticipated to be temporary and unlikely to generate any substantive impacts on marine mammals.

10.2.
Long-term Impacts

No long-term impacts to marine mammals associated with potential loss or modification of habitat is expected as the proposed activities are short in duration and likely to cause minimal disturbance.

11.
Mitigation Measures to Protect Marine Mammals and Their Habitat

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Invenergy is proposing a comprehensive set of mitigation measures during its site characterization surveys to minimize impacts to marine mammal species. These mitigation measures will provide protection to marine mammals by minimizing exposure to sound during surveys and by reducing the likelihood of vessel collisions with marine mammals. Invenergy will operate under the requirements of NMFS for conducting its survey; however, Invenergy provides proposed mitigation and monitoring measures below for NMFS consideration in developing its measures. Leading Light Wind proposes to operate its survey equipment 24-hours, during nighttime and low-visibility, and provides measures below that allow for implementation of mitigation during these times in compliance with MMPA and the ESA letter of concurrence (LOC; NMFS 2021b) associated with BOEM's Environmental Assessment (BOEM 2021) for authorizing site characterization surveys under Outer Continental Shelf Lands Act (OCSLA). Invenergy will also prepare an Alternative Monitoring Plan[3] as required by BOEM and NMFS for purposes of OCSLA and ESA compliance.

Invenergy's proposed mitigation measures for non-ESA-listed species follows the mitigation in the draft IHA for Bluepoint Wind[4]. All ESA requirements determined under the LOC noted above are included in proposed mitigation, monitoring, and reporting measures and described specifically in Section 11.1.1,13.1.1, and 13.1.2.

[3] An AMP is required for night and low-visibility operations per NMFS (2021b) Project Design Criterion 4, Best Management Practice 6.
[4] Available at NMFS website at https://www.fisheries.noaa.gov/s3/2023-01/BluepointWind_2023IHA_Proposed_OPR1.pdf.pdf.

Table 11-1 summarizes proposed clearance, shutdown, and vessel separation zones: and is based on NMFS' proposed mitigation measures for the draft IHA for Bluepoint Wind HRG surveys in the New York Bight.

Table 11-1 Distances for Clearance, Vessel Separation, and Shutdown Zones

Species	ESA Listed?	Clearance Zone		Vessel Separation Zone	Shutdown Zone	
		Distance (m)	Duration (minutes)	Distance (m)	Distance (m)	Duration (minutes)
North Atlantic Right Whale	Yes	500	30	500	500	30
Fin Whale				100	100	
Sei whale						
Sperm Whale						
Humpback Whale	No	100				
Minke Whale						
Long-finned Pilot Whale			15	50 (as feasible)		15
Risso's Dolphin						
Harbor Porpoise			15			15
Gray Seal		Not required			Not required	
Harbor Seal						
Atlantic White-sided Dolphin						
Atlantic Spotted Dolphin						
Common Bottlenose Dolphin						
Common Dolphin						

Notes:
Measures are the same as those in the Bluepoint Wind draft IHA published by NMFS January 13, 2023 (88 FR 2325).

Periods of 15 min (rather than 30 min) before ramp-up after last observation of Risso's dolphins or pilot whales in clearance and shutdown zones is supported by the following:

- Sound sources are not sufficiently loud to injure animals – the Level A zone is >0.1 m for mid-frequency cetaceans and > 0.2 m for seals.
- The vessel is moving. Travelling at 3.8 kts (7 km/hour), the vessel will be >1.75 km away from the location of observed animals in 15 minutes – very far from the 100 m clearance and shutdown zones and the potential Level B Harassment Zone.

- The Level B harassment radius is 141 m, so the vessel reaches the end of the zone where harassment is most likely to occur within 1.4 minutes and moves beyond the 100 m Clearance and Shutdown Zones in less than 1 minute. As described for clearance, delays due to shutdown can result in the vessel spending more time on the water to re-run trackline areas that are missed, increasing vessel collision risks, potential impacts to ESA-listed species, and human safety risks – shutdown should reduce impacts but when applied to species and at distances for which there is little impact, it can increase potential to harass or incur collision with species with more sensitivity through prolonging surveys.

11.1. Mitigation Measures

11.1.1. General

a) Invenergy will employ independent, qualified, NMFS-approved Protected Species Observers (PSOs; as described in Section 13.1 Monitoring) to conduct visual monitoring. When the impulsive sparker system (see Table 1-2 and Table 1-3) is operating, a minimum of one (1) PSO will be on duty during daylight hours and two (2) PSOs will be on duty during nighttime hours. During night and low-visibility, night-vision and thermal equipment will be used by PSOs to observe animals.

b) Visual monitoring will begin no less than 30 minutes prior to initiation of the sparker and will continue until 30 minutes after use of this acoustic source ceases.

c) Operational Shutdown Zones – PSOs will establish and monitor marine mammal Shutdown Zones. Distances to Shutdown Zones will be from the acoustic sources, not the distance from the vessel. Shutdown Zones will be as follows:

   i. 500-m Shutdown Zone for North Atlantic right whales for use of the sparker; and

   ii. 100-m Shutdown Zone for all other marine mammals for use of the sparker except for as noted in g(vii) below.

d) Harassment Zones – PSOs will establish and monitor Level B harassment zones specific to the sparker during the survey. Harassment Zones will be as follows:

   i. 141-m Harassment Zone for all marine mammals during survey operations employing sparker as the predominant acoustic source.

e) Pre-start clearance observation – PSOs will conduct 30 minutes of pre-start clearance observation prior to initiation of survey operations (except as described in g(ix) below). If a marine mammal is observed entering or within the pre-start clearance zones (described below) during the pre-start clearance period, the sparker use will not be initiated until the marine mammal(s) is confirmed by visual observation to have exited the relevant zone, or, until an additional time period has elapsed with no further sighting of the animal (15 minutes for odontocetes (except sperm whales) and 30 minutes for sperm whales and baleen whales). The pre-start clearance requirement does not include small delphinids (genera *Stenella*, *Lagenorhynchus*, *Delphinus*, or *Tursiops*) or seals. HRG surveys using the sparker will not be initiated if:

   i. North Atlantic right whale or other ESA-listed whale is observed within a 500-m radius of the sparker during the pre-start clearance period; or

   ii. Any non-listed ESA marine mammals, except small delphinids or seals, are observed within a 100 m radius of the sparker during the pre-start clearance period.

f) Ramp-up – when technically feasible the sparker will be ramped up at the start or restart of survey activities. Ramp-up will begin with the power of the smallest acoustic source at its lowest practical power output. When

technically feasible the power will then be gradually turned up and other acoustic sources added in a way that the source level would increase gradually.

i. Ramp-up activities will be delayed if a marine mammal(s) enters its respective Shutdown Zone. Ramp-up will continue if the animal has been observed exiting its respective Shutdown Zone or until an additional time period has elapsed with no further sighting (i.e., 15 minutes for odontocetes, except sperm whales, and 30 minutes for sperm whales and baleen whales).

g) Shutdown requirements:

i. If a marine mammal is observed within or entering the relevant Shutdown Zones as described under (c) while the sparker is operational, the sparker will be immediately shut down (except as described in (g)(vii)).

ii. Any PSO on duty will have the authority to call for shutdown of acoustic sources. When there is certainty regarding the need for mitigation action on the basis of visual detection, the relevant PSO(s) will call for such action immediately.

iii. When a shutdown is called for by a PSO, the shutdown will occur, and any dispute resolved only following shutdown.

iv. The vessel operator will establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the sparker to ensure that shutdown commands are conveyed swiftly, while allowing PSOs to maintain watch.

v. Upon implementation of a shutdown, survey equipment may be reactivated when all marine mammals that triggered the shutdown have been confirmed by visual observation to have exited the relevant Shutdown Zone or an additional time period has elapsed with no further sighting of the animal that triggered the shutdown (15 minutes for odontocetes except sperm whales and 30 minutes for sperm whales and baleen whales).

vi. If the sparker is shut down for less than 30 minutes for reasons other than marine mammal mitigation (e.g., due to mechanical or electronic failure) the sparker may be re-activated as soon as is practicable at full operational level if PSOs have maintained constant visual observation during the shutdown and no visual detections of marine mammals occurred within the applicable Shutdown Zone during that time. For a shutdown of 30 minutes or longer, or if visual observation was not continued diligently during the pause, pre-start clearance observation will be undertaken as described in (e).

vii. If delphinids from the genera *Delphinus*, *Lagenorhynchus*, *Stenella* (*frontalis* only), or *Tursiops* or seals (Table 3-1) are visually detected, shutdown will not be implemented. If there is uncertainty regarding identification of a marine mammal species (i.e., whether the observed marine mammal(s) belongs to one of the delphinid genera or is a seal for which shutdown is waived), PSOs will use best professional judgment in making the decision to call for a shutdown.

viii. Shutdown of acoustic sources will occur upon observation of either a species for which incidental take is not authorized or a species for which incidental take has been authorized but the authorized number of takes has been met, entering or within the Level B harassment zone.

ix. Shutdown, pre-start clearance, and ramp-up procedures will not be implemented during HRG survey operations using only non-impulsive sources.

h) Vessel Strike Avoidance – Vessel operators and crews will maintain a vigilant watch for all marine mammals and slow down, stop the vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammals. Survey vessel crew members responsible for navigation duties will receive site-specific training on marine mammal sightings/reporting and vessel strike avoidance measures. Vessel strike avoidance measures will include the following, except under circumstances when compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply:

i. A visual observer aboard the vessel will monitor a vessel strike avoidance zone based on the appropriate separation distance around the vessel (distances stated below).

ii. Visual observers monitoring the vessel strike avoidance zone may be third-party observers (i.e., PSOs) or crew members. Crew members responsible for these duties will be provided sufficient training to 1) distinguish protected species from other phenomena and 2) broadly identify a marine mammal as a right whale, other whale (defined in this context as sperm whales or baleen whales other than right whales), or other marine mammal.

iii. All survey vessels, regardless of size, will observe a 10-knot speed restriction in specific areas designated by NMFS for the protection of North Atlantic right whales from vessel strikes including seasonal management areas (SMAs) and dynamic management areas (DMAs) when in effect.

iv. All vessels greater than or equal to 19.8 m in overall length operating from November 1 through April 30 will operate at speeds of 10 knots or less while transiting to and from Survey Area.

v. All vessels will reduce their speed to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel.

vi. All vessels will maintain a minimum separation distance of 500 m from right whales. If a whale is observed but cannot be confirmed as a species other than a right whale, the vessel operator will assume that it is a right whale and take appropriate action.

vii. All vessels will maintain a minimum separation distance of 100 m from sperm whales and all other baleen whales.

viii. All vessels will, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an understanding that at times this may not be possible (e.g., for animals that approach the vessel).

ix. When marine mammals are sighted while a vessel is underway, the vessel will take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If marine mammals are sighted within the relevant separation distance, the vessel will reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This will not apply to any vessel towing gear or any vessel that is navigationally constrained.

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

11.1.2. Endangered Species Act Specific Measures

NMFS provides an Appendix (Appendix B) to its LOC that outlines the Project Design Criteria (PDC) and Best Management Practices (BMPs) for site characterization and site assessment activities to support offshore wind projects (NMFS 2021b). Invenergy proposes to be compliant with measures provided by NMFS to BOEM in the LOC (NMFS 2021b) and will therefore implement the measures applicable to the project, as described below.

Some measures described by NMFS (2021b) are not applicable to the project and this IHA request. These measures include:

- Measures that do not pertain at all to marine mammals, including sea turtle, coral, and fish mitigation;
- Measures associated with autonomous underwater vehicles (none of these vehicles have been proposed for use);
- Measures for Cape Cod or the right whale calving critical habitat (these are outside the proposed Survey Area);
- Marine debris measures are not described; and
- Measures for mooring systems and buoys (no mooring systems or buoys are proposed).

All lease stipulations and LOC requirements as required will be implemented regardless of whether they are explicitly listed in this application.

11.1.2.1. Avoid Live Bottom Features

All vessel anchoring and any seafloor-sampling activities (i.e., drilling or boring for geotechnical surveys) will avoid seafloor areas with consolidated seabed features (pavement, scarp walls, and deep/cold-water coral reefs and shallow/mesophotic reefs as defined in the CMECS Geologic Substrate Classifications). All sensitive live bottom habitats (eelgrass, cold-water corals, etc.) will be avoided as practicable. All vessels in coastal waters will operate in a manner to minimize propeller wash and seafloor disturbance and transiting vessels will follow deep-water routes (e.g., marked channels), as practicable, to reduce disturbance to habitat.

11.1.2.2. Minimize Interactions with Listed Species during Geophysical Survey Operations

For all vessels operating survey equipment that emits sound at frequency ranges <180 kHz[5] (within the functional hearing range of marine mammals), the following measures will be implemented: The Clearance Zone is defined as the area around the sound source that needs to be visually cleared of listed species for 30 minutes before the sound source is turned on. The Clearance Zone is equivalent to a minimum visibility zone for survey operations to begin. The Shutdown Zone is defined as the area around the sound source that must be monitored for possible shutdown upon detection of listed species within or entering that zone. For both the Clearance and Shutdown Zones, these are minimum visibility distances and for situational awareness PSOs will observe beyond this area when possible.

(a) For situational awareness a Clearance Zone extending at least 500 m (in all directions) will be established around all vessels operating sources <180 kHz.

(i) The Clearance Zone will be monitored by approved third-party PSOs at all times and any observed listed species will be recorded.

(b) To minimize exposure to sound that could be disturbing, Shutdown Zone(s) (500 m for North Atlantic right whales and 100 m for other ESA-listed whales visible at the surface) will be established around the sources operating at <180 kHz being towed from the vessel.

(i) The Shutdown Zone(s) will be monitored by third-party PSOs at all times when sound-producing equipment (<180 kHz) is being operated and all observed listed species will be recorded.

(ii) If an ESA-listed species is detected within or entering its respective Shutdown Zone, any sound-producing equipment operating below 180 kHz will be shut off until the minimum separation distance from the source is re-established (500 m for North Atlantic right whales and 100 m for other ESA-listed marine mammals) and the measures in 'e' are carried out.

(A) A PSO will notify the survey crew that a shutdown of all active boomer, sparker, and bubble gun acoustic sources[6] below 180 kHz is immediately required. The vessel operator and crew will comply immediately with any call for a shutdown by the PSO. Any disagreement or discussion will occur only after shutdown.

[5] This requirement does not apply to parametric SBP, ultra short baseline, echosounders, or side scale sonar, per NMFS' Letter of Concurrence. Thus, these measures do not apply to the Innomar shallow SBP.
[6] Although the ESA Letter of Concurrence includes boomers and bubble guns, only sparkers are proposed for the current IHA application.

(iii) If the Shutdown Zone(s) cannot be adequately monitored for ESA-listed species presence (i.e., a PSO determines conditions, including at night or other low-visibility conditions, are such that listed species cannot be reliably sighted within the Shutdown Zone[s]), no equipment operating at <180 kHz will be deployed until such time that the Shutdown Zone(s) can be reliably monitored.

(c) Before any sound-producing survey equipment (operating at <180 kHz) is deployed, the Clearance Zone (500 m for all listed species) will be monitored for 30 minutes of pre-clearance observation.

(i) If any ESA-listed species is observed within the Clearance Zone during the 30-minute pre-clearance period, the 30-minute clock will be paused. If the PSO confirms the animal has exited the zone and is headed away from the survey vessel, the 30-minute clock that was paused will resume. The pre-clearance clock will reset to 30 minutes if the animal dives or visual contact is otherwise lost.

(d) When technically feasible, a “ramp up” of the electromechanical survey equipment will occur at the start or re-start of geophysical survey activities. A ramp up will begin with the power of the smallest acoustic equipment for the geophysical survey at its lowest power output. When technically feasible the power will then be gradually turned up and other acoustic sources added in a way such that the source level would increase gradually.

(e) Following a shutdown for any reason, ramp up of the equipment will begin immediately only if: (a) the shutdown is less than 30 minutes, (b) visual monitoring of the Shutdown Zone(s) continued throughout the shutdown, (c) the animal(s) causing the shutdown was visually followed and confirmed by PSOs to be outside of the Shutdown Zone(s) (500 m for North Atlantic right whales and 100 m for other ESA- listed marine mammals) and heading away from the vessel, and (d) the Shutdown Zone(s) remains clear of all listed species. If all (a, b, c, and d) the conditions are not met, the Clearance Zone (500 m for all listed species) will be monitored for 30 minutes of pre-clearance observation before sound-producing equipment will be turned back on.

(f) In order for geophysical surveys to be conducted at night or during low-visibility conditions, PSOs will need to be able to effectively monitor the Clearance and Shutdown Zone(s). No survey may occur if the Clearance and Shutdown Zone(s) cannot be reliably monitored for the presence of ESA-listed species to ensure avoidance of injury to those species.

(i) An Alternative Monitoring Plan (AMP) will be submitted to BOEM detailing the monitoring methodology that will be used during nighttime and low-visibility conditions and an explanation of how it will be effective at ensuring that the Shutdown Zone(s) can be maintained during nighttime and low-visibility survey operations. The plan will be submitted to BOEM at least 60 days before survey operations are set to begin.

(ii) Two PSOs will be on watch during nighttime hours.

(iii) The two PSOs actively on watch will alternate the use of infrared and night vision device equipment throughout the course of each 4-hour shift.

(iv) The plan will include technologies that have the technical feasibility (Verfuss et al. 2018, Smultea et al. 2021) to detect all ESA-listed whales out to 500 m (and sea turtles to 100 m), such as, night-vision devices (Generation 3 or higher) with infrared light-emitting diodes spotlights, in combination with thermal imaging devices

(v) PSOs will be trained and experienced with the proposed alternative monitoring technology.

(vi) The AMP will describe how calibration will be performed, for example, by including observations of known objects at set distances and under various lighting conditions. This calibration will be performed during mobilization and periodically throughout the survey operation.

(vii) PSOs will make nighttime observations from the most effective location on the deck of the vessel that is not impacted by direct lighting with no visual barriers, due to the potential for the reflectivity from bridge windows or other structures to interfere with the use of the night vision optics.

(g) At times when multiple survey vessels are operating within a lease area, adjacent lease areas, or exploratory cable routes, a minimum separation distance (to be determined on a survey specific basis, dependent on equipment being used) must be maintained between survey vessels to ensure that sound sources do not overlap.

(h) Any visual observations of listed species by crew or Project personnel will be communicated to PSOs on-duty.

(i) During good conditions (e.g., daylight hours; Beaufort scale 3 or less) when survey equipment is not operating, to the maximum extent practicable, PSOs will conduct observations for protected species for comparison of sighting rates and behavior with and without use of active geophysical survey equipment. Any observed listed species will be recorded regardless of any mitigation actions required.

11.1.2.3. Minimize Vessel Interactions with Listed Species

All vessels associated with survey activities (transiting [i.e., travelling between a port and the survey site] or actively surveying) will comply with the vessel strike avoidance measures specified below. The only exception will be when the safety of the vessel or crew necessitates deviation from these requirements. If any such incidents occur, they will be reported as outlined in Section 13.1.2. The Vessel Strike Avoidance Zone is defined as 500 m or greater from any sighted ESA-listed species or other unidentified large marine mammal.

(a) Vessel captain and crew will maintain a vigilant watch for all protected species and slow down, stop the vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any listed species. The presence of a single individual at the surface may indicate the presence of submerged animals in the vicinity; therefore, precautionary measures will be exercised.

(b) Anytime a survey vessel is underway (transiting or surveying), the vessel will maintain a 500 m minimum separation distance and a PSO will monitor a Vessel Strike Avoidance Zone (500 m or greater from any sighted ESA-listed species or other unidentified large marine mammal visible at the surface) to ensure detection of that animal in time to take necessary measures to avoid striking the animal.

(i) Survey plans will include identification of vessel strike avoidance measures, including procedures for equipment shut down and retrieval, communication between PSOs/crew lookouts, equipment operators, and the captain, and other measures necessary to avoid vessel strike while maintaining vessel and crew safety. If any circumstances are anticipated that may preclude the implementation of this PDC, they must be clearly identified in the survey plan and alternative procedures outlined in the plan to ensure minimum distances are maintained and vessel strikes can be avoided.

(ii) All vessel crew members will be briefed in the identification of protected species that may occur in the Survey Area and in regulations and best practices for avoiding vessel collisions. Reference materials must be available aboard all Project vessels for identification of listed species. The expectation and process for reporting of protected species sighted during surveys must be clearly communicated and posted in highly visible locations aboard all Project vessels, so that there is an expectation for reporting to the designated vessel contact (such as the lookout or the vessel captain), as well as a communication channel and process for crew members to do so.

(iii) The Vessel Strike Avoidance Zone(s) are a minimum and will be maintained around all surface vessels at all times.

(iv) If a large whale is identified within 500 m of the forward path of any vessel, the vessel operator must steer a course away from the whale at 10 knots (18.5 km/hr) or less until the 500 m minimum separation distance has been established. Vessels may also shift to idle if feasible.

(v) If a large whale is sighted within 200 m of the forward path of a vessel, the vessel operator will reduce speed and shift the engine to neutral. Engines will not be engaged until the whale has moved outside of the vessel's path and beyond 500 m. If stationary, the vessel will not engage engines until the large whale has moved beyond 500 m.

(c) To monitor the Vessel Strike Avoidance Zone, a PSO (or crew lookout if PSOs are not required) will be posted during all times a vessel is underway (transiting or surveying) to monitor for listed species within a 180-degree direction of the forward path of the vessel (90 degrees port to 90 degrees starboard).

(i) Visual observers monitoring the vessel strike avoidance zone can be either PSOs or crew members (if PSOs are not required). If the trained lookout is a vessel crew member, this will be their designated role and primary responsibility while the vessel is transiting. Any designated crew lookouts will receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. All observations will be recorded per reporting requirements.

(ii) Regardless of monitoring duties, all crew members responsible for navigation duties will receive site-specific training on ESA-listed species sighting/reporting and vessel strike avoidance measures.

(d) Vessel operators will reduce vessel speed to 10 knots (18.5 mph) or less while operating in any Seasonal Management Area (SMA) and Dynamic Management Area (DMA) and Slow Zones. The only exception to this requirement is for vessels operating in areas within a DMA or Slow Zone where it is not reasonable to expect the presence of North Atlantic right whales (e.g., Long Island Sound, shallow harbors).

(e) Vessels underway will not divert their course to approach any listed species.

(f) All vessel operators will check for information regarding mandatory or voluntary ship strike avoidance (SMAs, DMAs, Slow Zones) and daily information regarding North Atlantic right whale sighting locations. These media may include, but are not limited to: NOAA weather radio, U.S. Coast Guard NAVTEX and channel 16 broadcasts, Notices to Mariners, the Whale Alert app, or WhaleMap website.

(i) North Atlantic right whale Sighting Advisory System info will be accessed at: https://apps-nefsc.fisheries.noaa.gov/psb/surveys/MapperiframeWithText.html

(ii) Information about active SMAs, DMAs, and Slow Zones will be accessed at: https://www.fisheries.noaa.gov/national/endangered-species- conservation/reducing-vessel-strikes-north-atlantic-right-whales

12.
Mitigation Measures to Protect Subsistence Uses

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, you must submit either a plan of cooperation (POC) or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses.

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 U.S. and will not affect Arctic marine mammals. Given that the Survey Area is not located in Arctic waters, the activities associated with Project'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

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding.

13.1.
Monitoring

13.1.1. General

Invenergy will conduct marine mammal visual monitoring during HRG survey activity using the impulsive sparker system. Monitoring will be conducted in accordance with the following:

(a) Visual monitoring will be performed by qualified, NMFS-approved PSOs. PSO resumes will be provided to NMFS for review and approval prior to the start of survey activities.

(b) In order to be considered qualified, PSOs will have successfully completed an acceptable PSO training course and/or have demonstrated experience in the role of independent PSO during an HRG survey. In the event it is relevant, on a case-by-case basis, non-independent observers may be proposed to NMFS for limited, specific duties in support of approved, independent PSOs on smaller vessels with limited crew capacity operating in nearshore waters.

(c) PSOs will be employed by a third-party observer provider and will not have tasks other than to conduct observational effort, collect data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards). At least one PSO aboard the vessel with acoustic sources will have a minimum of 90 days at-sea experience working as a PSO during a geophysical survey, with no more than 18 months elapsed since the conclusion of the at-sea experience. This lead PSO will coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. (Note that the responsibility of coordinating duty schedules and roles may instead be assigned to a shore-based, third-party monitoring coordinator). To the maximum extent practicable, the lead PSO will devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.

(d) PSOs will coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts.

(e) PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches and may conduct a maximum of 12 hours of observation per 24-hour period.

(f) PSOs will be equipped with binoculars and have the ability to estimate distances to marine mammals located in proximity to the vessel and/or Shutdown Zones. Reticulated binoculars will be available to PSOs for use as appropriate based on conditions and visibility to support the sighting and monitoring of marine species.

(g) Position data will be recorded using hand-held or vessel global positioning system (GPS) units for each sighting.

(h) Invenergy will consult NMFS North Atlantic right whale reporting system and Whale Alert, as able, for the presence of right whales throughout survey operations, and for the establishment of any DMAs. If NMFS should establish a DMA in the Lease Areas during the survey, the vessels will abide by speed restrictions in the DMA.

(i) Visual PSOs will conduct observations in the following circumstances (in addition to those described in Section 11 Mitigation Measures, 11.1.1 General, Sub-section (b):

(i) During good conditions (e.g., daylight hours; Beaufort sea state 3 or less) and no acoustic source is operating, for comparison of sighting rates and behavior with and without use of the specified acoustic sources and between acquisition periods (to the maximum extent practicable)

(ii) During all daylight hours, when any acoustic sources are active (in addition to the sparker).

(j) Night-vision equipment (i.e., night-vision goggles with thermal clip-ons and infrared/thermal imaging technology) will be available for use during nighttime monitoring.

(k) Any observations of marine mammals by crew members aboard any vessel associated with the survey will be relayed to the PSO team.

(l) In cases when pre-start clearance has begun in conditions with good visibility, including via the use of night-vision equipment, and the lead PSO has determined that the pre-start clearance zones (as described in Section 11 Mitigation Measures, 11.1.1 General, Sub-section (e) are clear of relevant marine mammals, survey operations may commence (i.e., no delay will be implemented) despite brief periods of inclement weather and/or loss of daylight. In cases where Shutdown Zones (as described in Section 11 Mitigation Measures Sub-section (c) become obscured for brief periods due to inclement weather, survey operations may continue (i.e., no shutdown will be implemented).

(m) Data on all PSO observations will be recorded based on standard PSO collection requirements. PSOs will use standardized data forms, whether hard copy or electronic. The following information will be reported:

(i) PSO names and affiliations

(ii) Dates of departures and returns to port with port name

(iii) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort

(iv) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts

(v) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change

(vi) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon

(vii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (e.g., vessel traffic, equipment malfunctions)

(viii) Survey activity information, such as type of survey equipment in operation, acoustic source power output while in operation, and any other notes of significance (i.e., pre-start clearance survey, ramp-up, shutdown, end of operations, etc.)

(ix) If a marine mammal is sighted, the following information should be recorded:

(A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform)

(B) PSO who sighted the animal

(C) Time of sighting

(D) Vessel location at time of sighting

(E) Water depth

(F) Direction of vessel's travel (compass direction)

(G) Direction of animal's travel relative to the vessel

(H) Pace of the animal

(I) Estimated distance to the animal and its heading relative to vessel

(J) Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species

(K) Estimated number of animals (high/low/best)

(L) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.)

(M) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics)

(N) Detailed behavior observations (e.g., number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior)

(O) Animal's closest point of approach and/or closest distance from the center point of the acoustic source

(P) Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up, speed or course alteration, etc.)

13.1.2. Endangered Species Act Specific Monitoring

Invenergy proposes to be compliant with measures provided by NMFS to BOEM in the LOC (NMFS 2021b). Below Invenergy clearly states the monitoring that will be implemented to achieve full compliance with the reasonable and prudent measures, as determined by NMFS. NMFS provides an Appendix (Appendix B) to its LOC that outlines the PDC and BMPs for threatened and endangered species for site characterization and site assessment activities to support offshore wind projects. There may be some redundancy with monitoring described above, but to be clear that the Project will be in compliance with the LOC that redundancy is maintained in the measures below.

Qualified third-party PSOs to observe Clearance and Shutdown Zones as required will be used as outlined in the conditions above and below.

(a) All PSOs will have completed an approved PSO training program and must receive NMFS approval to act as a PSO for geophysical surveys. Documentation of NMFS approval for geophysical survey activities in the Atlantic and copies of the most recent training certificates of individual PSOs' successful completion of a commercial PSO training course with an overall examination score of 80% or greater will be provided upon request. Instructions and application requirements to become a NMFS-approved PSO can be found at: www.fisheries.noaa.gov/national/endangered-species-conservation/protected-species-observers.

(b) In situations in which third-party party PSOs are not required, crew members serving as lookouts will receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements.

(c) PSOs deployed for geophysical survey activities will be employed by a third-party observer provider. While the vessel is underway, they will have no other tasks than to conduct observational effort, record data, and communicate with and instruct relevant vessel crew to the presence of listed species and associated mitigation requirements. PSOs on duty will be clearly listed on daily data logs for each shift.

(i) Non-third-party observers may be approved by NMFS on a case-by-case basis for limited, specific duties in support of approved, third-party PSOs.

(d) A minimum of one PSO (assuming condition 5 is met) must be on duty observing for listed species at all times that sound-producing equipment <180 kHz is operating, or the survey vessel is actively transiting during daylight hours (i.e., from 30 minutes prior to sunrise and through 30 minutes following sunset). Two PSOs will be on duty during nighttime operations. A PSO schedule showing that the number of PSOs used is sufficient to effectively monitor the affected area for the Project (e.g., surveys) and record the required data will be included. PSOs will not be on watch for more than 4 consecutive hours, with at least a 2-hour break after a 4-hour watch. PSOs must not be on active duty observing for more than 12 hours in any 24-hour period.

(e) Visual monitoring must occur from the most appropriate vantage point on the associated operational platform that allows for 360-degree visual coverage around the vessel. If 360-degree visual coverage is not possible from a single vantage point, multiple PSOs will be on watch to ensure such coverage.

(f) Suitable equipment will be available to each PSO to adequately observe the full extent of the Clearance and Shutdown Zones during all vessel operations and meet all reporting requirements.

(i) Visual observations will be conducted using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner

(ii) Rangefinders (at least one per PSO, plus backups) or reticle binoculars (e.g., 7 x 50) of appropriate quality (at least one per PSO, plus backups) to estimate distances to listed species located in proximity to the vessel and Clearance and Shutdown Zone(s)

(iii) Digital full frame cameras with a telephoto lens that is at least 300 mm or equivalent; the camera or lens will also have an image stabilization system. Used to record sightings and verify species identification whenever possible

(iv) A laptop or tablet to collect and record data electronically

(v) Global Positioning Units (GPS) if data collection/reporting software does not have built-in positioning functionality

(vi) PSO data must be collected in accordance with standard data reporting, software tools, and electronic data submission standards approved by BOEM and NMFS for the particular activity

(vii) Any other tools deemed necessary to adequately perform PSO tasks

13.2. Reporting

13.2.1. General

(a) A final technical monitoring report will be provided to NMFS within 90 days after completion of survey activities or expiration of the IHA, whichever comes sooner. The report will fully document the methods and monitoring protocols, summarize the data recorded during monitoring, describe, assess, and compare the effectiveness of monitoring and mitigation measures. Any recommendations made by NMFS will be addressed in the final report prior to acceptance by NMFS. PSO datasheets or raw sightings data will also be provided with the draft and final monitoring report.

(b) Reporting sightings of North Atlantic right whales:

(i) If a North Atlantic right whale is observed at any time by PSOs or personnel on any Project vessels, during surveys or during vessel transit, Invenergy will immediately report sighting information to the NMFS North Atlantic Right Whale Sighting Advisory System: (866) 755-6622. North Atlantic right whale sightings in any location will also be reported to the U.S. Coast Guard via channel 16.

(c) Reporting injured or dead marine mammals:

(i) In the event that personnel involved in the survey activities covered by the authorization discover an injured or dead marine mammal, Invenergy will report to the NMFS New England/Mid-Atlantic Regional Stranding Coordinator by phone (866-755-6622) or by email (nmfs.gar.stranding@noaa.gov and PR.ITP.MonitoringReports@noaa.gov) as soon as feasible. The report will include the following information:

(A) Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable)

(B) Species identification (if known) or description of the animal(s) involved

(C) Condition of the animal(s) (including carcass condition if the animal is dead)

(D) Observed behaviors of the animal(s), if alive

(E) If available, photographs or video footage of the animal(s)

(F) General circumstances under which the animal was discovered

(ii) In the event of a vessel strike of a marine mammal by any vessel involved in the activities covered by the authorization, Invenergy will report the incident to the NMFS New England/Mid-Atlantic Regional Stranding

Coordinator (866-755-6622) and NMFS Office of Protected Resources (nmfs.gar.stranding@noaa.gov and PR.ITP.MonitoringReports@noaa.gov) as soon as feasible. The report will include the following information:

(A) Time, date, and location (latitude/longitude) of the incident

(B) Species identification (if known) or description of the animal(s) involved

(C) Vessel's speed during and leading up to the incident

(D) Vessel's course/heading and what operations were being conducted (if applicable)

(E) Status of all sound sources in use

(F) Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike

(G) Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike

(H) Estimated size and length of animal that was struck

(I) Description of the behavior of the marine mammal immediately preceding and following the strike

(J) If available, description of the presence and behavior of any other marine mammals immediately preceding the strike

(K) Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared)

(L) To the extent practicable, photographs or video footage of the animal(s)

13.2.2. Endangered Species Act Specific Reporting

Invenergy proposes to be compliant with measures provided by NMFS to BOEM in the LOC (NMFS 2021b). Below Invenergy clearly states the reporting that will be implemented to achieve full compliance with the reasonable and prudent measures, as determined by NMFS. NMFS provides an Appendix (Appendix B) to its LOC that outlines the PDC and BMPs for threatened and endangered species for site characterization and site assessment activities to support offshore wind projects. There may be some redundancy with reporting measures described above, but to be clear that Invenergy will be in compliance with the Letter of Concurrence that redundancy is maintained in the measures below.

(a) Data from all PSO observations will be recorded based on standard PSO collection and reporting requirements. PSOs must use standardized electronic data forms to record data. The following information will be reported electronically in a format approved by BOEM and NMFS:

(i) Visual Effort:

(A) Vessel name

(B) Dates of departures and returns to port with port name

(C) Lease number

(D) PSO names and affiliations

(E) PSO ID (if applicable)

(F) PSO location on vessel

(G) Height of observation deck above water surface (in meters)

(H) Visual monitoring equipment used

(I) Dates and times (Greenwich Mean Time) of survey on/off effort and times corresponding with PSO on/off effort

(J) Vessel location (latitude/longitude, decimal degrees) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts; recorded at 30 second intervals if obtainable from data collection software, otherwise at practical regular interval

(K) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any change

(L) Water depth (if obtainable from data collection software) (in meters)

(M) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort scale, Beaufort wind force, swell height (in meters), swell angle, precipitation, cloud cover, sun glare, and overall visibility to the horizon

(N) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (e.g., vessel traffic, equipment malfunctions)

(M) Survey activity information, such as type of survey equipment in operation, acoustic source power output while in operation, and any other notes of significance (i.e., pre-clearance survey, ramp-up, shutdown, end of operations, etc.)

(ii) Visual Sighting (all Visual Effort fields plus)

(A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform)

(B) Vessel/survey activity at time of sighting

(C) PSO/PSO ID who sighted the animal

(D) Time of sighting

(E) Initial detection method

(F) Sightings cue

(G) Vessel location at time of sighting (decimal degrees)

(H) Direction of vessel's travel (compass direction)

(I) Direction of animal's travel relative to the vessel

(J) Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species

(K) Species reliability

(L) Radial distance

(M) Distance method

(N) Group size; Estimated number of animals (high/low/best)

(O) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.)

(P) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics)

(Q) Detailed behavior observations (e.g., number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior)

(R) Mitigation Action; Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up, speed or course alteration, etc.) and time and location of the action

(S) Behavioral observation to mitigation

(T) Equipment operating during sighting

(U) Source depth (in meters)

(V) Source frequency

(W) Animal's closest point of approach and/or closest distance from the center point of the acoustic source

(X) Time entered shutdown zone

(Y) Time exited shutdown zone

(Z) Time in shutdown zone

(AA) Photos/Video

(b) Invenergy will submit a final monitoring report to BOEM and NMFS (to: renewable_reporting@boem.gov and nmfs.gar.esa.section7@noaa.gov) within 90 days after completion of survey activities. The report will fully document the methods and monitoring protocols, summarize the survey activities and the data recorded during monitoring, estimate the number of listed species that may have been taken during survey activities, describe, assess and compare the effectiveness of monitoring and mitigation measures. PSO sightings and effort data and trackline data in Excel spreadsheet format must also be provided with the final monitoring report.

(c) Reporting sightings of North Atlantic right whales:

(i) If a North Atlantic right whale is observed at any time by a PSO or Project personnel during surveys or vessel transit, sightings will be reported within two hours of occurrence when practicable and no later than 24 hours after occurrence. In the event of a sighting of a right whale that is dead, injured, or entangled, efforts will be made to make such reports as quickly as possible to the appropriate regional NOAA stranding hotline (from Maine-Virginia report sightings to 866-755-6622). Right whale sightings in any location may also be reported to the U.S. Coast Guard via channel 16 and through the WhaleAlert App (http://www.whalealert.org/).

(ii) Further information on reporting a right whale sighting will be accessed at: https://apps-nefsc.fisheries.noaa.gov/psb/surveys/documents/20120919_Report_a_Right_Whale.pdf

(d) In the event of a vessel strike of an ESA-listed species by any survey vessel, Invenergy will immediately report the incident to BOEM (renewable_reporting@boem.gov) and NMFS (nmfs.gar.incidental-take@noaa.gov) and the NOAA stranding hotline: from Maine-Virginia, report to 866- 755-6622). The report will include the following information:

(i) Name, telephone, and email or the person providing the report

(ii) The vessel name

(iii) The Lease Number

(iv) Time, date, and location (latitude/longitude) of the incident

(v) Species identification (if known) or description of the animal(s) involved

(vi) Vessel's speed during and leading up to the incident

(vii) Vessel's course/heading and what operations were being conducted (if applicable)

(viii) Status of all sound sources in use

(ix) Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike

(x) Environmental conditions (wave height, wind speed, light, cloud cover, weather, water depth)

(xi) Estimated size and length of animal that was struck

(xii) Description of the behavior of the species immediately preceding and following the strike

(xiii) If available, description of the presence and behavior of any other protected species immediately preceding the strike

(xiv) Disposition of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, last sighted direction of travel, status unknown, disappeared)

(xv) To the extent practicable, photographs or video footage of the animal(s)

(e) Sightings of any injured or dead listed species will be immediately reported, regardless of whether the injury or death is related to survey operations, to BOEM (renewable_reporting@boem.gov), NMFS (nmfs.gar.incidental-take@noaa.gov), and the appropriate regional NOAA stranding hotline (from Maine-Virginia report sightings to 866-755-6622). If Invenergy's activity is responsible for the injury or death, Invenergy will ensure that the vessel assist in any salvage effort

as requested by NMFS. When reporting sightings of injured or dead listed species, the following information will be included:

(i) Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable)

(ii) Species identification (if known) or description of the animal(s) involved

(iii) Condition of the animal(s) (including carcass condition if the animal is dead)

(iv) Observed behaviors of the animal(s), if alive

(v) If available, photographs or video footage of the animal(s)

(vi) General circumstances under which the animal was discovered

14.
Suggested Means of Coordination

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

No direct research on marine mammals is planned as part of the proposed surveys, but information gathered by PSOs during observation for implementing mitigation and monitoring requirements will provide useful data. This information can inform a more refined understanding of marine mammal use in the Lease Area and ECR Area.

Overall, Invenergy's reports required as part of this permitting process will help inform marine mammal management and potential impacts of offshore wind survey activities. Invenergy will also share North Atlantic right whale sightings with NMFS as quickly as practicable and data will be shared with educational institutions and organizations as appropriate.

15. Literature Cited

Attentive Energy. 2022. Application for Incidental Harassment Authorization for the Non-Lethal Taking of Marine Mammals during a Site Characterization Survey. Submitted by Attentive Energy LLC; Prepared by Advisian, part of the Worley Group. June 2022. 110 pp.

Bettridge, S., C.S. Baker, J. Barlow, P.J. Clapham, M. Ford, D. Gouveia, D.K. Mattila, R.M. Pace III, P.E. Rosel, G.K. Silver, and P.R. Wade. 2015. Status review of the humpback whale (*Megaptera novaeangliae*) under the Endangered Species Act. NOAA-TM-NMFS-SWFSC-540.

Bureau of Ocean Energy Management [BOEM]. 2016. Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New York. Revised Environmental Assessment. OCS EIS/EA BOEM 2016-070. October 2016.

BOEM. 2020. Guidelines for Providing Geophysical, Geotechnical, and Geohazard Information Pursuant to 30 CFR Part 585. Retrieved from: https://www.boem.gov/sites/default/files/documents/about-boem/GG-Guidelines.pdf

BOEM. 2021. Commercial and Research Wind Lease and Grant Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf of the New York Bight. Final Environmental Assessment. OCS EIS/EA BOEM 2021-073. December 2021.

Cetacean and Turtle Assessment Program [CETAP]. 1982. A Characterization of Marine Mammals and Turtles in the Mid- and North Atlantic Areas of the U.S. Outer Continental Shelf. Kingston, Rhode Island: University of Rhode Island, Sponsored by the U.S. Department of the Interior, Bureau of Land Management. Contract #AA552-CT8-48. 576 pp.

Code of Federal Regulations [CFR]. 2015. Title 30 – Mineral Resources, Chapter V – BOEM, Part 585 – Renewable Energy and Alternative uses of Existing Facilities on the Outer Continental Shelf. Retrieved from: https://www.govinfo.gov/content/pkg/CFR-2015-title30-vol2/pdf/CFR-2015-title30-vol2-part585.pdf

CFR. 2000. Title 50 – Wildlife and Fisheries, Chapter II – NMFS/NOAA, Part 216 – Regulations Governing the Taking and Importing of Marine Mammals, Subpart I – General Regulations Governing Small Takes of Marine Mammals Indicidental to Specific Acitivies. Retrieved from: https://www.govinfo.gov/content/pkg/CFR-2000-title50-vol2/pdf/CFR-2000-title50-vol2-part216.pdf

CFR. 2003. Title 50 – Wildlife and Fisheries, Chapter II – NMFS/NOAA, Part 216 – Regulations Governing the Taking and Importing of Marine Mammals, Subpart I – General Regulations Governing Small Takes of Marine Mammals Incidental to Specific Activities, Section 216.103 Definitions. Retrieved from: https://www.govinfo.gov/app/details/CFR-2003-title50-vol6/CFR-2003-title50-vol6-sec216-103

Crocker, S.T. and F.D. Fratantonio. 2016. Characteristics of Sounds Emitted During High-Resolution Marine Geophysical Surveys. Naval Undersea Warfare Center Division Newport, Rhode Island.

Department of Fisheries and Oceans [DFO]. 2017. Stock assessment of Canadian Northwest Atlantic grey seals (Halichoerus grypus). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2017/045. 13pp.

DFO. 2019. Harbour Seal. Retrieved from https://www.dfo-mpo.gc.ca/species-especes/profiles-profils/harbour-seal-phoque-commun-eng.html on November 1, 2021.

Engås A., S. Løkkeborg, E, Ona and A.V. Soldal. 1996. Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (*Melanogrammus aeglefinus*). Canadian Journal of Fisheries and Aquatic Sciences 53(:2238-2249.

Environmental Systems Research Institute. 2018. ArcGIS Desktop: Release 10.7. Redlands, CA.

Equinor. 2020 Application for Marine Mammal Protection Act Incidental Harassment Authorization: Site Characterization Studies off the Coast of New England and New York Bight, Submitted by Equinor Wind U.S., LLC; Prepared by AECOM Technical Services, Inc and HDR Inc. March 2020. 81 pp.

Estabrook, B. J., K. B. Hodge, D. P. Salisbury, D. Ponirakis, D. V. Harris, J. M. Zeh, S. E. Parks, A. N. Rice. 2020. Year-2 Annual Survey Report for New York Bight Whale Monitoring Passive Acoustic Surveys October 2018- October 2019. Contract C009925. New York State Department of Environmental Conservation. East Setauket, NY.

Estabrook, B. J., K. B. Hodge, D. P. Salisbury, A. Rahaman, D. Ponirakis, D. V. Harris, J. M. Zeh, S. E. Parks and A. N. Rice. 2021. Final Report for New York Bight Whale Monitoring Passive Acoustic Surveys October 2017- October 2020. Contract C009925. New York State Department of Environmental Conservation. East Setauket, NY.

Friedlaender, A., E. Hazen, D. Nowacek, P. Halpin, C. Ware, M. Weinrich, T. Hurst and D. Wiley. 2009. Diel changes in humpback whale Megaptera novaeangliae feeding behavior in response to sand lance Ammodytes spp. behavior and distribution. Marine Ecology Progress Series 395:91–100.

Gunnlaugsson, T., G.A. Vikingsson, and D.G. Pike. 2009. Combined line-transect and cuecount estimate of sperm whale abundance in the North Atlantic, from Icelandic NASS2001 shipboard survey. NAMMCO Scientific Publications 7:73-80.

Hassel, A., T. Knutsen, J. Dalen, K. Skaar, S. Løkkeborg, O.A. Misund, Ø. Østensen, M. Fonn, E.K. Haugland. 2004. Influence of seismic shooting on the lesser sandeel (Ammodytes marinus). ICES Journal of Marine Science 61:1165-1173.

Hayes, S.A., E. Josephson, K. Maze-Foley, P.E. Rosel, B. Byrd, S. Chavez-Rosales, T.V.N. Cole, L. Engleby, L.P. Garrison, J. Hatch, A. Henry, S.C. Horstman, J. Turek (Editors). 2022. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2021. NOAA Tech Memo NMFS NE-271, Northeast Fisheries Science Center, Woods Hole, Massachusetts.

Jefferson T.As, M.A. Webber, and R.L. Pitman RL. 2011. Marine mammals of the world: A comprehensive guide to their identification. London, UK: Elsevier. 576 pp.

Jones D.V., D.R. Rees, and B.A. Bartlett. 2018. Haul-out Counts and Photo-Identification of Pinnipeds in Chesapeake Bay and Eastern Shore, Virginia: 2017/2018 Annual Progress Report. Final Report. Prepared for U.S. Fleet Forces Command, Norfolk, Virginia. 21 December 2018.

Lawson, J. and J-F. Gosselin. 2018. Estimates of cetacean abundance from the 2016 NAISS aerial surveys of eastern Canadian waters, with a comparison to estimates from the 2007 TNASS NAAMCO SC/25/AE/09. 40pp.

National Marine Fisheries Service [NMFS]. 2015. Sperm Whale (Physeter macrocephalus) 5-Year Review: Summary and Evaluation June 2015. Available at https://repository.library.noaa.gov/view/noaa/17032.

NMFS. 2015. Sperm whale (*Physeter macrocephalus*) 5-Year Review: Summary and Evaluation. Available at https://repository.library.noaa.gov/view/noaa/17032.

NMFS. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. NOAA Technical Memorandum NMFS-OPR-59, 167 pp.

NMFS. 2019. Fin Whale (*Balaenoptera physalus*) 5-Year Review: Summary and Evaluation. Available at https://media.fisheries.noaa.gov/dam-migration/508_compliant_final_feb_2019_finwhale_5-year_review.pdf.

NMFS. 2020a. Interim recommendation for sound source level and propagation analysis for high resolution geophysical sources. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Protected Resources. April 2020. 5 pp.

NMFS. 2020b. Optional User Spreadsheet Tool for: 2018 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. Retrieved from: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance

NMFS. 2021a. Sei whale (*Balaenoptera borealis*) 5-Year Review: Summary and Evaluation. Available at https://repository.library.noaa.gov/view/noaa/32073.

NMFS. 2021b. Letter of Concurrence for Programmatic Consultation under Section 7 of the ESA for BOEM Geophysical and Geotechnical Surveys and Meteorological Buoy Installations for OCS Lease Areas in Three Atlantic Renewable Energy Regions. NMFS/Greater Atlantic Regional Fisheries Office, June 29, 2021.

NMFS 2022. North Atlantic Right Whale (*Eubalaena glacialis*) 5-Year Review: Summary and Evaluation. Available at https://media.fisheries.noaa.gov/2022-12/Sign2_NARW20225YearReview_508-GARFO.pdf.

NMFS. 2023. North Atlantic right whale calving season 2023. Accessed at https://www.fisheries.noaa.gov/national/endangered-species-conservation/north-atlantic-right-whale-calving-season-2023 on January 23, 2023.

Normandeau Associates, Inc. and APEM LTD. 2020. Digital Aerial Baseline Survey of Marine Wildlife in Support of Offshore Wind Energy, Third Annual Report. Accessed at https://remote.normandeau.com/nys_overview.php on October 19, 2021.

Orsted. 2020. Orsted Wind Power North America, LLC Application for Incidental Harassment Authorization for the Non-Lethal Taking of Marine Mammals: Site Characterization Surveys, Lease OCS-A 0486, 0517, 0487, 0500 and Associated Export Cable Routes. Prepared by CSA Ocean Sciences Inc. July 2020. 89 pp.

Pace, R.M., P.J. Corkeron, and S.D. Kraus. 2017. State–space mark–recapture estimates reveal a recent decline in abundance of North Atlantic right whales. Ecology and Evolution 7:8730-8741.

Pace III, R.M., R. Williams, S.D. Kraus, A.R. Knowlton, and H.M. Pettis. 2021. Cryptic mortality of North Atlantic right whales. Conservation Science and Practice, 3:e346.

Palka, D.L., S. Chavez-Rosales, E. Josephson, D. Cholewiak, H.L. Haas, L. Garrison, M. Jones, D. Sigourney, G. Waring (retired), M. Jech, E. Broughton, M. Soldevilla, G. Davis, A. DeAngelis, C.R. Sasso, M.V.Winton, R.J. Smolowitz, G. Fay, E. LaBrecque, J.B. Leiness, Dettloff, M. Warden, K. Murray, and C. Orphanides. 2017. Atlantic Marine Assessment Program for Protected Species: 2010-2014. US Dept. of the Interior, Bureau of Ocean Energy Management, Atlantic OCS Region, Washington, DC. OCS Study BOEM 2017-071. 211 pp.

Palka, D., L. Aichinger Dias, E. Broughton, S. Chavez-Rosales, D. Cholewiak, G. Davis, A. DeAngelis, L. Garrison, H. Haas, J. Hatch, K. Hyde, M. Jech, E. Josephson, L. Mueller-Brennan, C. Orphanides, N. Pegg, C. Sasso, D. Sigourney, M. Soldevilla, H. Walsh. 2021. Atlantic Marine Assessment Program for Protected Species: FY15 – FY19. Washington DC: US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-051. 330 p.

Pettis, H.M., R.M. Pace III, P.K. Hamilton. 2022. North Atlantic Right Whale Consortium 2021 Annual Report Card. Report to the North Atlantic Right Whale Consortium. Retrieved from: https://www.narwc.org/uploads/1/1/6/6/116623219/2021report_cardfinal.pdf

Rice A.N., J.T. Tielens, B.J. Estabrook, C.A. Muirhead, A. Rahaman, M. Guerra, C.W. Clark. 2014. Variation of ocean acoustic environments along the western north Atlantic coast: a case study in context of the right whale migration route. Ecological Informatics 21:89-99.

Roberts, J.J., B.D. Best, L. Mannocci, E. Fujioka, P.N. Halpin, D.L. Palka, L.P. Garrison, K.D. Mullin, T.V.N. Cole, C.B. Khan, W.M. McLellan, D.A. Pabst, G.G. Lockhart. 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6: 22615. doi: 10.1038/srep22615

Roberts, J,J., L. Mannocci, P.N. Halpin. 2017. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2016-2017 (Opt. Year 1). Document version 1.4. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC

Roberts, J.J., L. Mannocci, R.S. Schick, P.N. Halpin. 2018. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2017-2018 (Opt. Year 2). Document version 1.2. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC

Roberts, J.J., R.S. Schick, P.N. Halpin. 2021. Final Project Report: Marine Species Density Data Gap Assessments and Update for the AFTT Study Area, 2020 (Option Year 4). Document version 2.2. Report prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Roberts, J.J., R.S. Schick, P.N. Halpin. 2022. Habitat-based Marine Mammal Density Models for U.S. Atlantic. Online Mapper prepared for Naval Facilities Engineering Command, Atlantic by the Duke University Marine Geospatial Ecology Lab, Durham, NC.

Smultea Sciences (Smultea Environmental Sciences). 2021. Review of Night Vision Technologies for Detecting Cetaceans from a Vessel at Sea, Produced for South Fork Wind. Prepared by Smultea Sciences. Prepared for Ørsted, Boston, Massachusetts.

Stevick, P. T., J. Allen, P. J. Clapham, N. Friday, S. K. Katona, F. Larsen, J. Lien, D. K. Mattila, P. J. Palsboll, J. Sigurjonsson, T. D. Smith, N. Oien, and P. S. Hammond. 2003. North Atlantic humpback whale abundance and rate of increase four decades after protection from whaling. Marine Ecology Progress Series. 258:263-273.

Torres, L.G., P.E. Rosel, C. D'Agrosa, A.J. Read. 2003. Improving management of overlapping bottlenose dolphin ecotypes through spatial analysis and genetics. Marine Mammal Science. 19(3): 502-514.

United States Code. 1969. Title 42 – The Public Health and Welfare, Chapter 55 – National Environmental Policy Act. Retrieved from: https://www.govinfo.gov/content/pkg/USCODE-2017-title42/html/USCODE-2017-title42-chap55.htm

Verfuss, U. K., D. Gillespie, J. Gordon, T.A. Marques, B. Miller, R. Plunkett, J.A. Theriault, D.J. Tollit, D.P. Zitterbart, P. Hubert, and L. Thomas. 2018. Comparing methods suitable for monitoring marine mammals in low visibility conditions during seismic surveys. Marine Pollution Bulletin 126(1):1-18. https://doi.org/10.1016/j.marpolbul.2017.10.034

Vineyard Wind and JASCO Applied Sciences. 2020. Draft Request for an Incidental Harassment Authorization to Allow the Non-Lethal Take of Marine Mammals Incidental to High-resolution Geophysical Surveys. Document 01923, Version 2.0. Technical report by JASCO Applied Sciences for Vineyard Wind, L.L.C.

Waring. G.T., E. Josephson, K. Maze-Foley, P.E. Rosel, (eds.). 2015. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2014. U.S. Department of Commerce, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA. NOAA Technical Memorandum NMFS-NE-231. 370 pp.

Whitlock, M.C. and D. Schluter. 2009. The analysis of biological data. Greenwood Village, Colorado: Roberts and Company Publishers. 704 pp

Whitt A.D., J.A. Powell, A.G. Richardson, J.R. Bosyk. 2015. Abundance and distribution of Marine mammals in nearshore waters off New Jersey, USA. Journal of Cetacean Research and Management 15:45-59.

Zoidis, A.M., K.S. Lomac-McNair, D.S. Ireland, M.E. Reckard, K.A. McKown, M. D. Schlesinger. 2021. Distribution and density of six large whale species in the New York Bight from monthly aerial surveys 2017 to 2020. Continental Shelf Research 230:104572.

Attachment 1
Manufacturer Specifications for Survey Equipment

applied acoustics
underwater technology

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Marine House, Marine Park,
Gapton Hall Road, Great Yarmouth
NR31 0NB, United Kingdom

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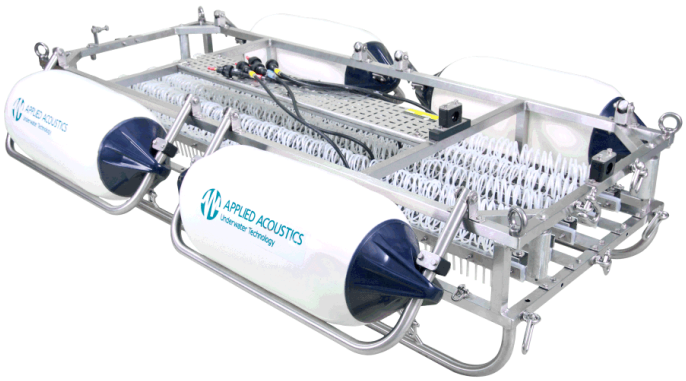
E general@appliedacoustics.com
W appliedacoustics.com

Dura-Spark UHD Seismic Sound Source



Key features

- Long life, durable electrodes
- Pulse stability
- High resolution sub-bottom data, up to 25cms
- Adjustable tow depth
- Tip array selection from onboard junction box
- Inter array: Flip-Flop capability
- Inter array: Fire-Delay capability
- GNSS receiver option (101G MiniPod)
- 240 tip and 400 tip versions

Applications

- High and Ultra-High Resolution geophysical surveys
- Single and multi-channel acquisition
- Water depths of 5 to >1000m

Dura-Spark UHD Overview

The Dura-Spark UHD has been designed to provide a stable, repeatable sound source for sub-bottom geophysical surveys. The long life, durable electrodes produce a consistent pulse signature and keep operational maintenance to a minimum. This provides increased survey efficiency and equipment reliability as the sparker tips rarely need replacement.

The Dura-Spark UHD consists of either 5 or 3 arrays of 80 tips that allow the operator to tune the source from the vessel to its application. This flexibility, together with selectable source depth, allows the sound source to be used in both shallow and deep waters.

The typical operational bandwidth of the Dura-Spark UHD is 300Hz to 1.2kHz. When coupled with the CSP-Nv Seismic Power Supply the system offers 2000J/s peak discharge rate, as well as industry leading design and safety standards.

Technical Specification

PHYSICAL

Dimensions	Length 1854mm Height 400mm frame, 555mm including floatation Width 650mm frame, 1465mm including floatation
Weight	130kg (max)
Connector	RMK 1/0 complete with locking collar

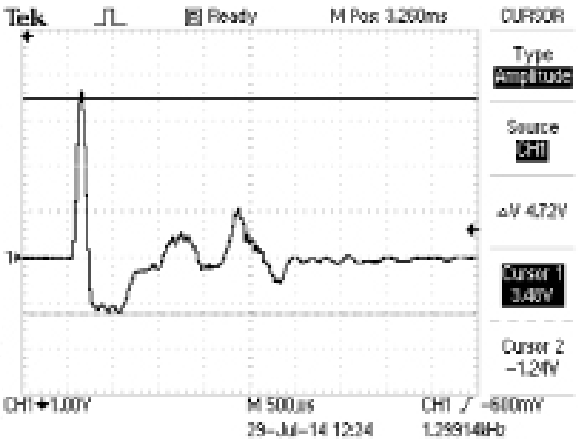
ELECTRICAL

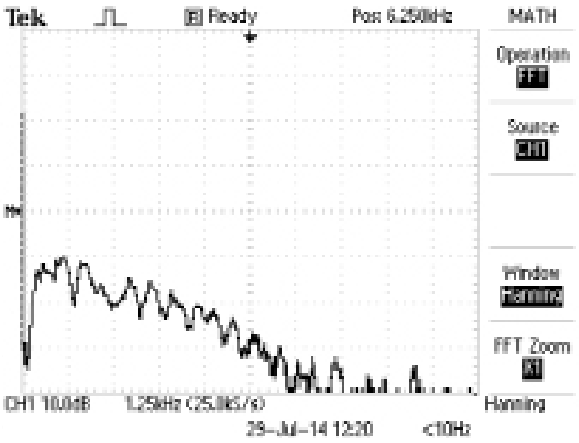
Typical operating energy (400 tip)	2000J, 5J per tip to minimise bubble collapse component, 2400J maximum
Typical operating energy (240 tip)	1000J, 5J per tip to minimise bubble collapse component, 1250J Maximum
Operating voltage	3000-4000V
Maximum number of tips	400 (5 x 80), 240 (3 x 80)
Power Supply	CSP-Nv 1200, CSP-Nv 2400, CSP-SNv 1250
HV Supply Cable	HVC-3502
Junction Box	HVJ-3004

SOUND OUTPUT

Source level	226dB re 1µPa at 1m (typical)
Pulse length	0.5 to 1.5ms Dependent on power applied

TYPICAL PULSE SIGNATURES AT 800J





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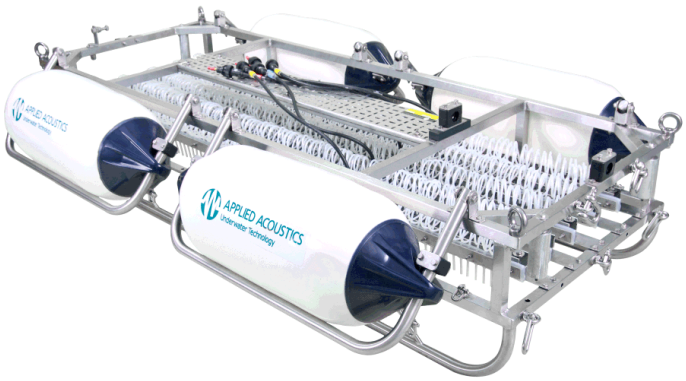
E general@appliedacoustics.com
W appliedacoustics.com

Dura-Spark UHD Seismic Sound Source



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Junction Box	HVJ-3004

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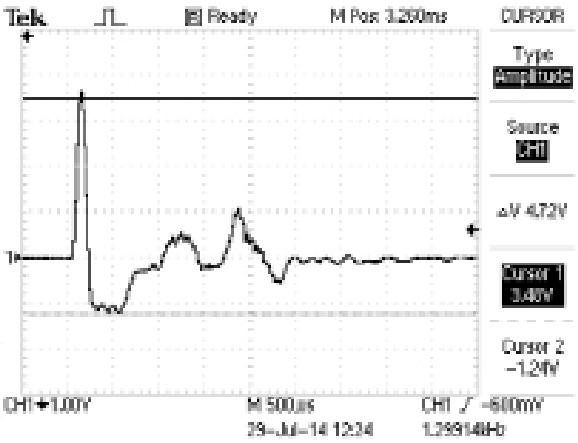
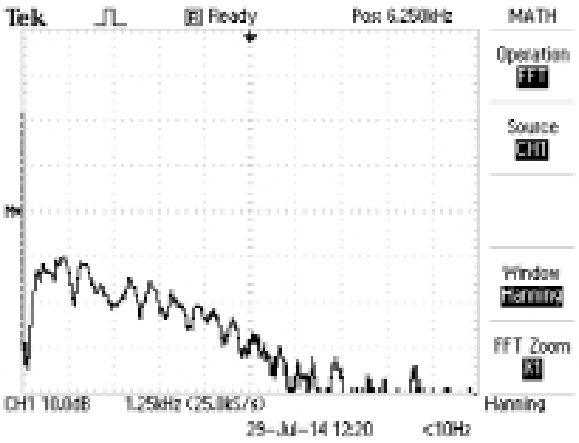




applied acoustics
underwater technology

Geo-Source 200 - 400

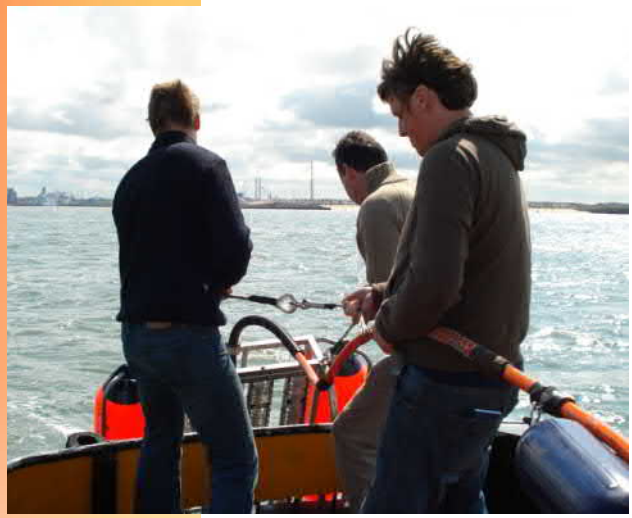
Marine Multi-Tip Sparker System

Operational Features

- Powerful hi-resolution seismic source
- Primary pulse < 1ms, no ringing
- Proven operation in 1000 m water depth
- Penetration to 400 ms below seabed, depending on geology and survey conditions
- Vertical resolution < 30 cm

Ideal seismic profiling system for small and large vessels

- Site & route surveys
- Offshore engineering
- Mineral exploration
- Oceanographic research



INNOVATIVE Preserving Electrode Mode

The innovative Geo-Source 200 has been designed for operation with the Geo-Spark 1000 pulsed power supply (PPS) using the patented **Preserving Electrode Mode.** This mode uses a NEGATIVE electric discharge pulse instead of a positive pulse.

(Please note that this negative pulse is NOT the same as the simple reversal of the positive polarity of a 'standard' power supply.)

Maintenance free electrodes 5 year guarantee

The Preserving Electrode Mode **reduces the tip wear to practically zero**. You can shoot day after day, week after week, month after month with practically **NO tip maintenance.**

Always a stable acoustic pulse

Zero tip wear is essential for the **acoustic repeatability** of the pulse, which depends largely on a constant, unaltered electrode surface and tip insulation.

Efficient & Cost Effective

With the Geo-Spark HV power supplies you will save a lot of time and money, since the electrodes do NOT burn off like in all other systems.

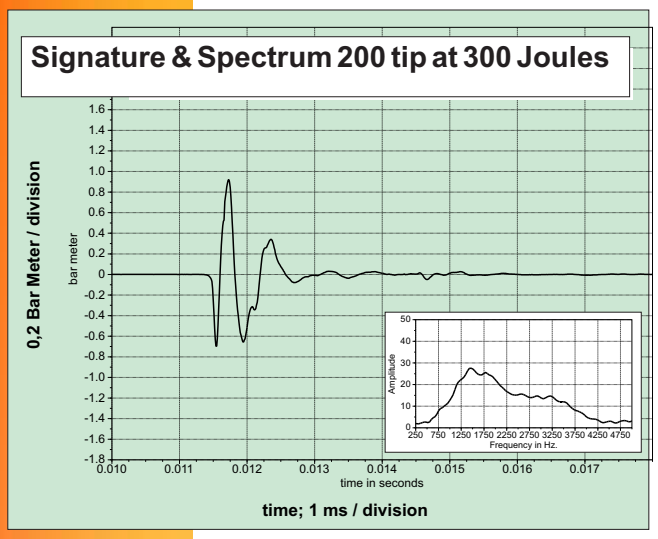
You don't need to trim tips during the survey. There is no need to have any stock of consumables.

Examples of Records

To see examples of our sparker records, please visit the 'Downloads' page on our website: ***www.geo-spark.com***

Geo-Source 200-400

Technical Specifications



Electrodes Geometry

The electrode modules are evenly spaced in a planar array of 0.75 m x 1.00 m. This geometry not only enhances the downward projection of the acoustic energy, it also reduces the primary pulse length, since all tips are perfectly in phase.

Control of Source Parameters 200 - 400 tips

The advanced Geo-Source 200-400 design gives you total control of the source depth and the energy (Joules) per tip

Source depth

Two floats provide a stable towing configuration and insure the proper depth of the electrode tips. This is critical to achieve constructive interference between the primary pulse and its own sea-surface reflection (surface ghost)

Number of tips in use and Energy per tip

Four individually powered electrode modules of 50 or 100 tips each allow you to distribute the energy from the Geo-Spark power supply over 50, 100....., up to 400 tips. (Each tip has an exposed surface area of 1.4 mm^2.)

200 tips, the classic 200 tip configuration is normally used with the Geo-Spark 1000 PPS and consists of four 50-tip electrode modules. This configuration gives an excellent hi-res pulse over the 100 to 500 J power range.

400 tips, for higher energies above 1000 J, and in particular with the Geo-Spark 2000X, we recommend a 400 tip configuration with 4 x 100-tip electrode modules

Coaxial High Voltage (HV) Power/Tow Cable

The Geo-Source 200 is towed by a very high quality, Kevlar-reinforced, coaxial power/tow cable with stainless steel kellum grip. This dedicated high voltage (HV) cable contains **4 x 10 mm^2** inner cores (negative) plus a **40 mm^2** braiding (ground-referenced). It is designed to have a very low self-inductance to preserve the high dI/dt pulse output of the Geo-Spark 1000 PPS.

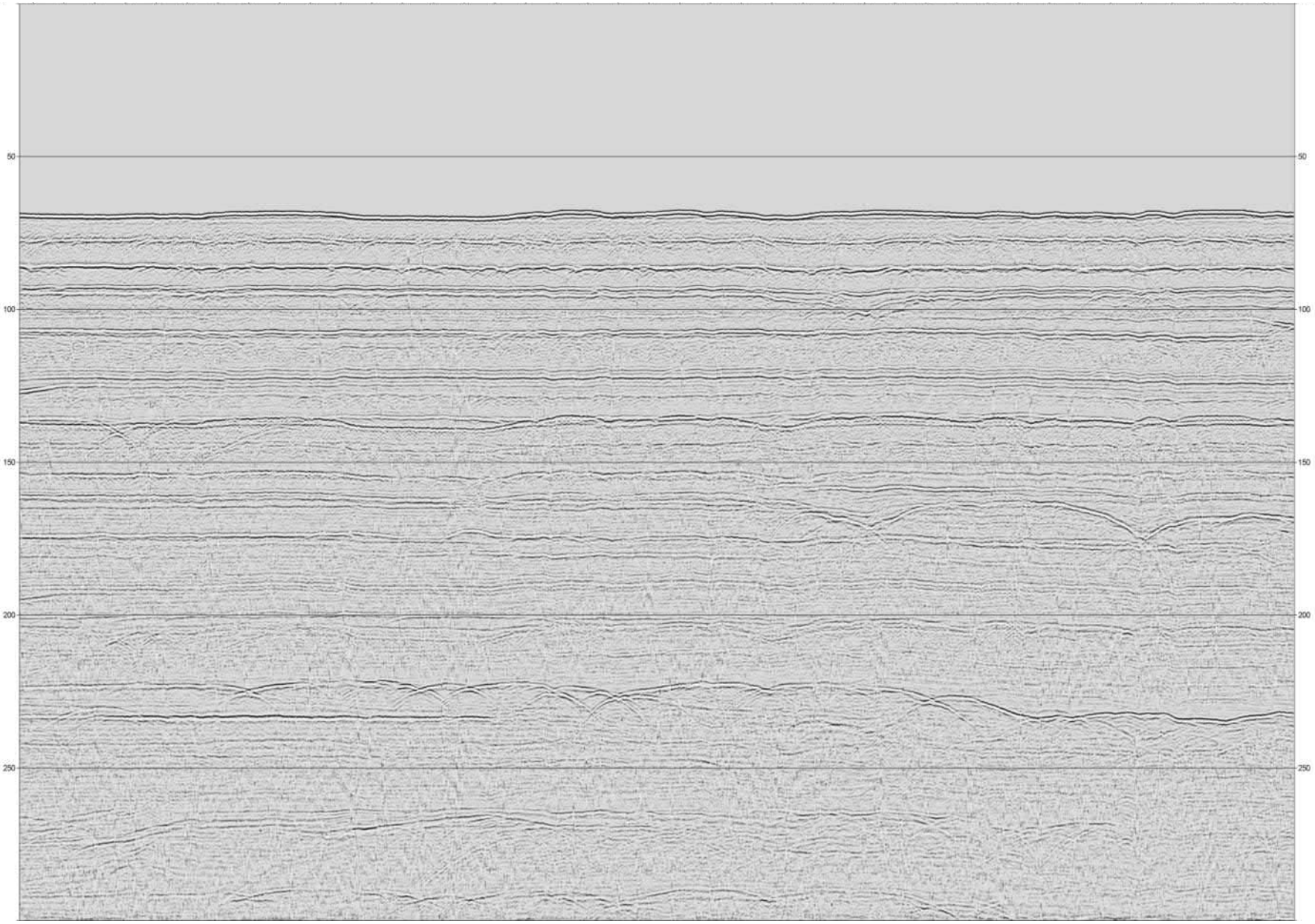
The coaxial structure of the HV cable reduces the electromagnetic interference to the absolute minimum.

The wet end of the cable is terminated with four special HV connectors to the electrode modules and a ground connector to the frame. Connecting or disconnecting the cable to the Geo-Source 200 takes only 10 minutes; so you can handle the sparker sled and the HV cable as independent units.

The dry end of the cable is terminated at the Geo-Source 200 patch panel, which allows you to select the number of electrode arrays in use

Maintenance free electrodes, no trimming, stable signature

GEO Marine Survey Systems b.v.
Sheffieldstraat 8, 3047 AP Rotterdam
The Netherlands
Phone: + 31 10 41 55 755
Fax: +31 10 41 55 351
info@geomarinesurveysystems.com
Website: www.geo-spark.com



RESOURCES

Location: Thailand

Date: August 2008

Client: MVM Surveys

Water Depth: 50 - 300 m

Acquisition

Source: Geo-Spark 200
Power Supply: Geo-Spark 1 kJ
Power: 300 J
Streamer: Geo sense
Recording System: Geo-Trace 2
Shot interval: 0.5 s
Record length: 300 ms
Sample Rate: 8000 Hz

Processing

Frequency filtering
Gain
Swell filter
Muting

Display

Horizontal scale 1:4000
Vertical scale 1 cm = 8 ms
One timeline every 50 ms

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Geo-Spark 200 Thailand- August 2008

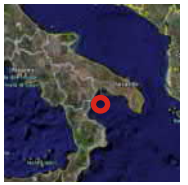
0.600
0.650
0.700
0.750
0.800
0.850
0.900
0.950
1.000
1.050

TWT in sec

Alternating sand and clay layers.
Strong reflector at the base of layer turbiditic sequence represents the top of Messinian evaporites.

Taranto Italy - May 2005

RESOURCES



Location: Taranto Italy

Date: May 2005

Client: Nautilus

Water Depth: 450 - 650 m

Acquisition

Source: Geo-Spark 200
Power Supply: Geo-Spark 1 kJ
Power: 700 J
Streamer: Geo-sense 8 elements
Recording System: Geo-Trace 2
Shot interval: 3 s
Record length: 1500 ms
Sample Rate: 8000 Hz

Processing

Frequency filtering
Gain
Swell filter
Muting

Display

Horizontal scale 1:12000
Vertical scale 1 cm = 15 ms
One timeline every 50 ms

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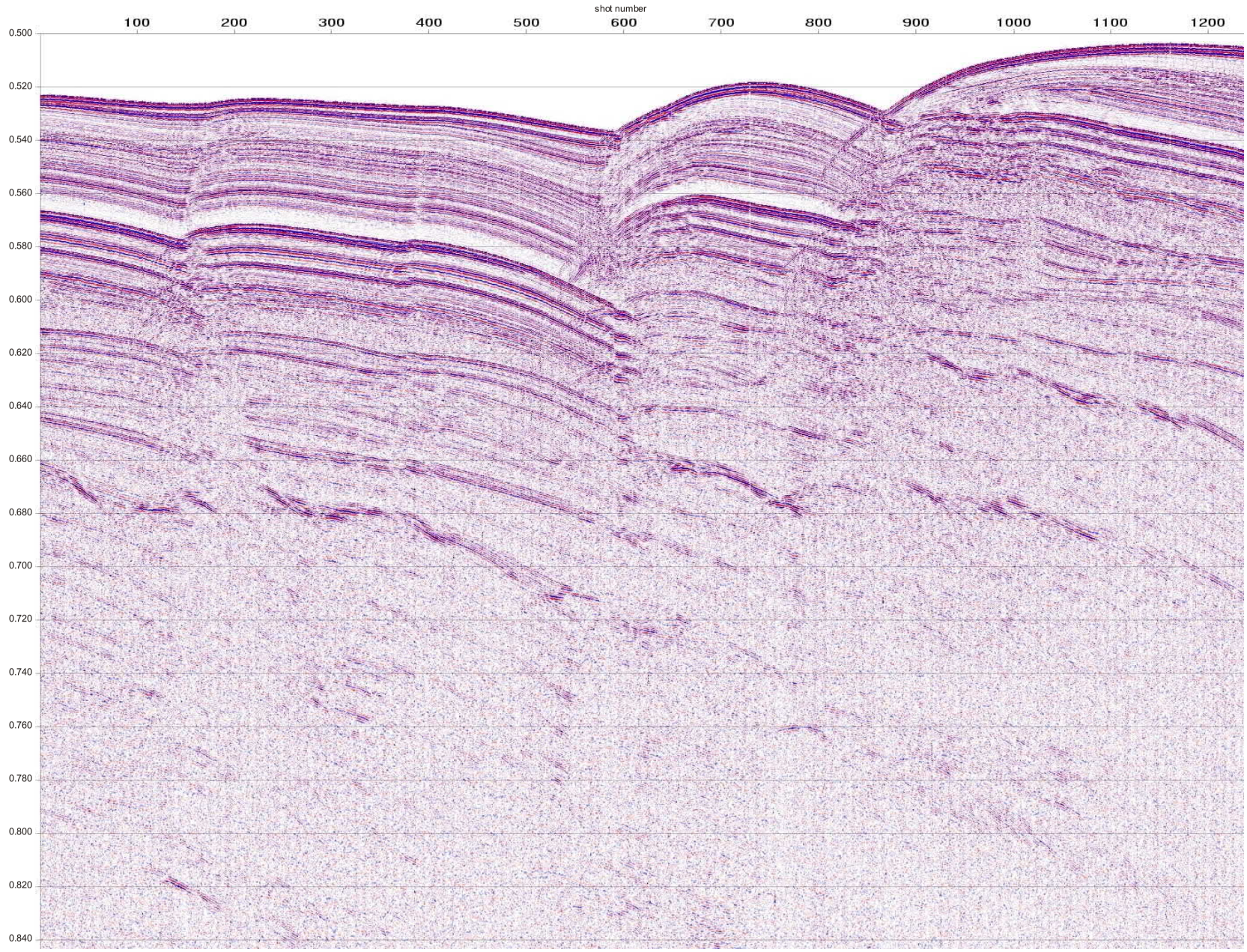
Approximately 500m



Mediterranean Sea Egypt , October 2005

RESOURCES

Location: Mediterranean Sea, Egypte

Date: October 2005

Client : Impresub

Water Depth: 350 - 400 m

Acquisition

Source: Geo-Spark 200
Power Supply: Geo-Spark 1 KJ
Streamer: Geo sense 8 elements
Recording System: Geo-Trace 2
Shot interval: 2 s
Record length: 1000 ms
Sample Rate: 10000 Hz

Display

Horizontal scale 1:9000
Vertical scale 1 cm = 10 ms
One timeline every 20 ms

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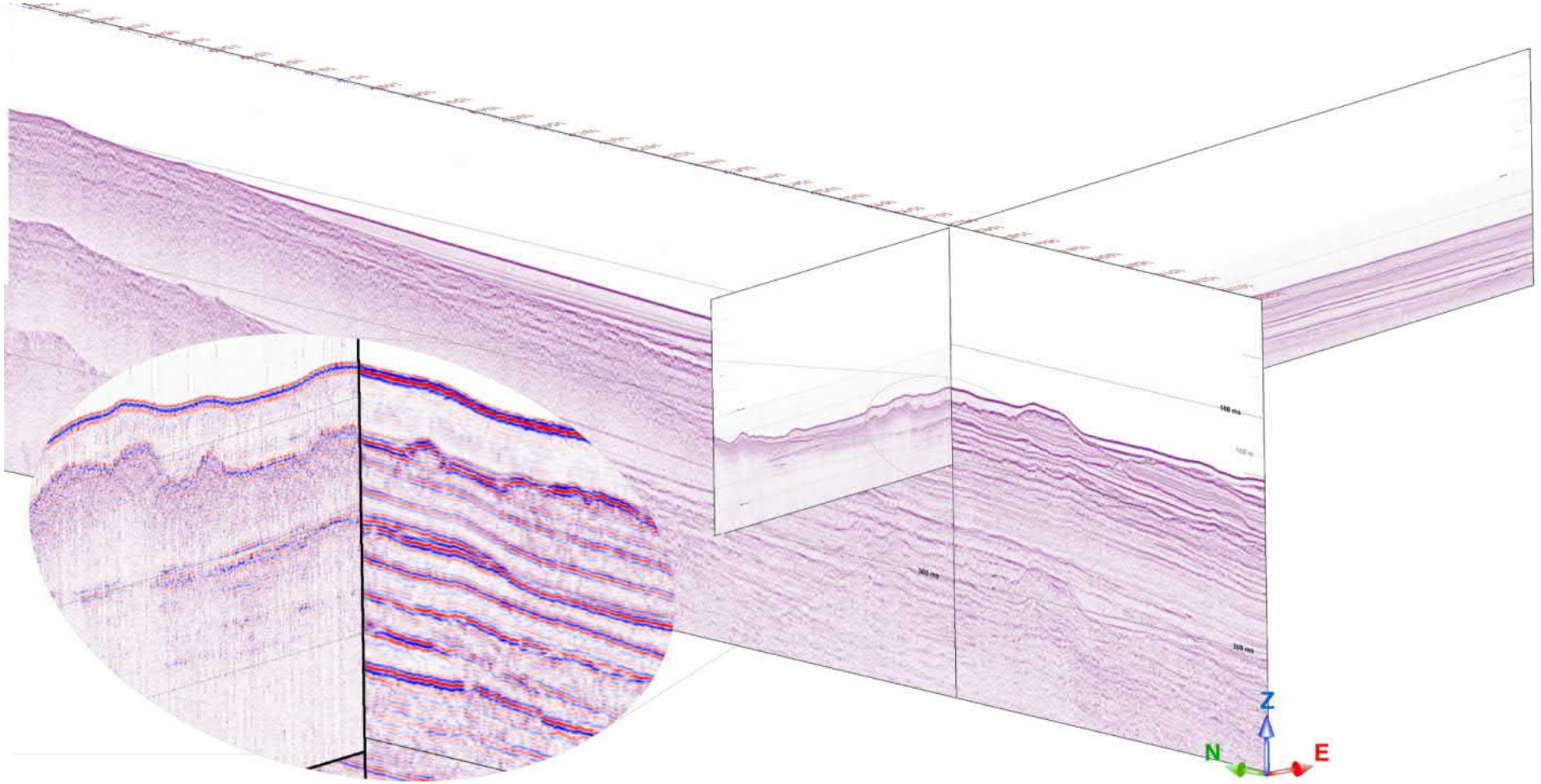
Approximately 500m

Comparison between the Sparker Geo-Spark 800 and a Chirp system.

Appreciate the difference of resolution and penetration.



Location: Elba Italy

Date: November 2004

Water Depth: 75 - 115 m

Courtesy of Danillo Morelli, Trieste University

Acquisition

Source: Geo-Spark 800
Power Supply: Geo-Spark 6 kJ
Recording System: Geo-Trace 2
Shot interval: 2 s
Record length: 1000 ms
Sample Rate: 6000 Hz

Sparker Processing

Frequency filtering
Gain
Swell filter
Muting

Display

Horizontal scale 1:5000
Vertical scale 1 cm = 25 ms
One scale line every 100 ms
Data displayed in 3D with OpendTect

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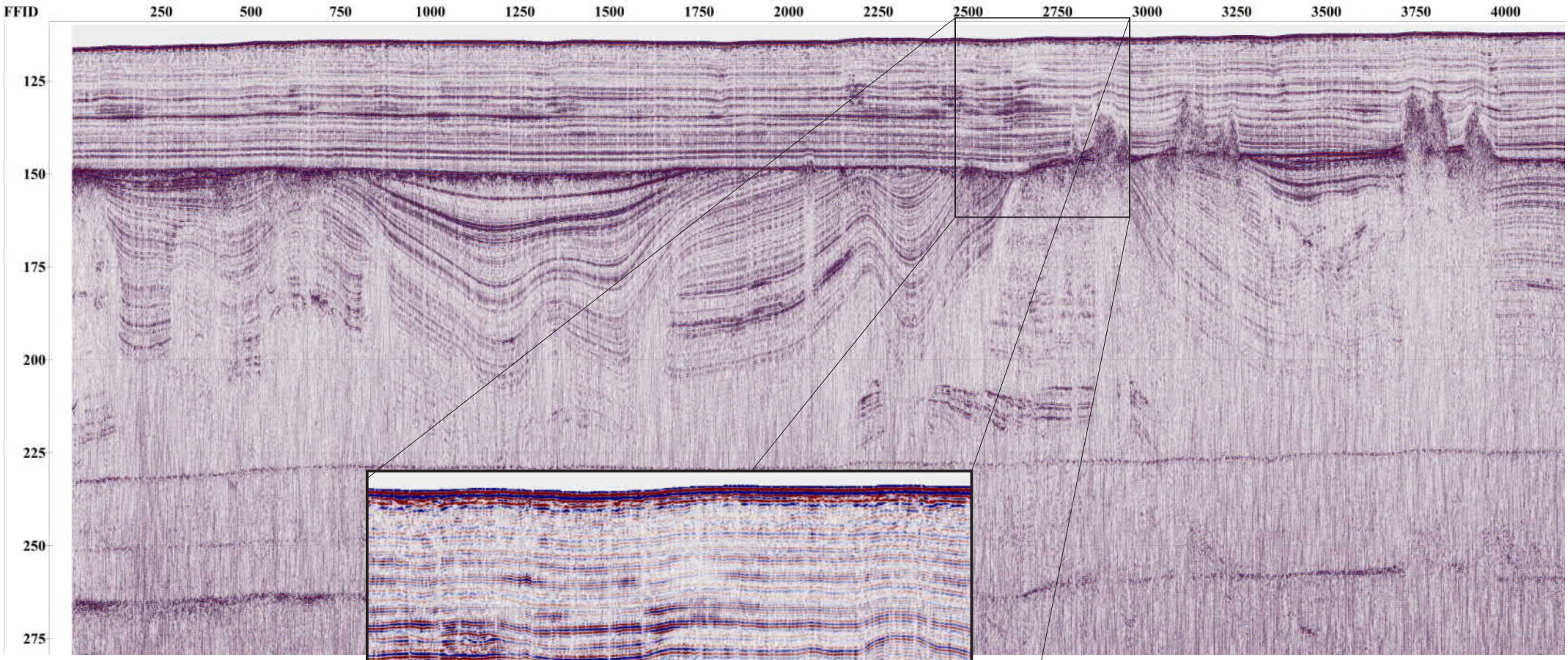
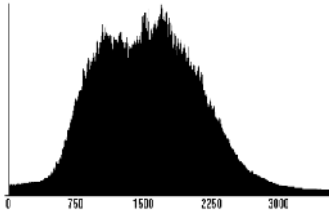
Elba Italy - November 2004

Approximately 200m





Appreciate the frequency content up to 3000 Hz and the decimeter scale resolution

Sparker profile shot with the Geo-Source 200 LW using the Geo-Spark 1000 pulsed power supply

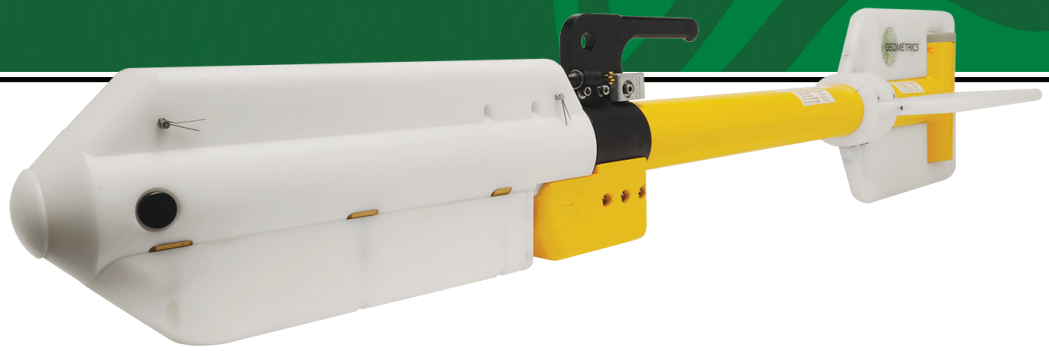
Energy: 300 J, Negative Discharge Technology

Vertical Scale in meters, Aspect ratio 1 :20

Location: Sicily, Gellasabbia
Date: May 2012
Geophysicist: Dr. Henrique Duarte

G-882
Cesium Marine Magnetometer

GEOMETRICS
Innovation • Experience • Results



Geometrics' G-882 Marine Magnetometer is the leading marine system in the industry with over 1,000 systems sold! The G-882 is the only system that meets the standards for UXO clearance in the North Sea.

This very high-resolution Cesium vapor marine magnetometer is low in cost, small in size, and offers flexibility for professional surveys in shallow or deep water. Use your personal computer with our MagLog™ software to log, display and print GPS position and magnetic field data.

The system directly interfaces to all major side-scan manufacturers for tandem tow configurations. Being small and lightweight, it is easily deployed and operated by one person. But add several streamlined weight collars and the system can quickly weigh more than 100 lbs for deep-tow applications.

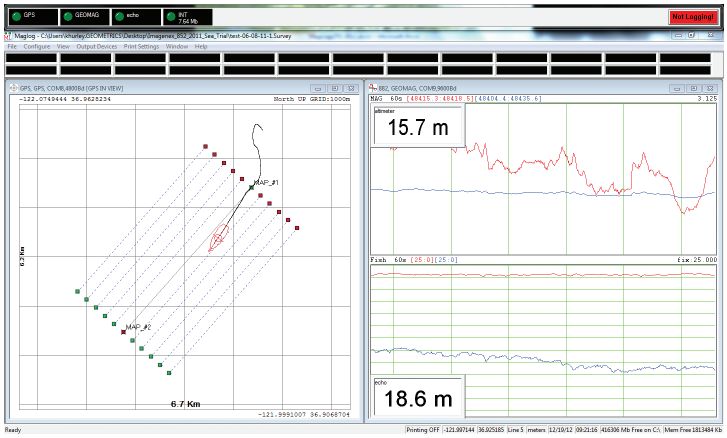
This marine magnetometer system is particularly well-suited for the detection and mapping of all sizes of ferrous objects. This includes anchors, chains, cables, pipelines, ballast stones and other scattered shipwreck debris, munitions of all sizes (UXO), aircraft, engines and any other object with a magnetic expression. The G-882 is also perfect for geological studies. Its high sensitivity and high sample rates are maintained for all applications.

Objects as small as a 5-inch screwdriver are readily detected provided that the sensor is close to the seafloor and within practical detection range (refer to table on back).

FEATURES & BENEFITS

- **Cesium Vapor High Performance** – Highest detection range and high probability of detecting all sized ferrous targets.
- **Streamlined Design for Tow Safety** – Low probability of fouling in fishing lines or rocks. Rugged fiber-wound fiberglass housing.
- **Sample at up to 20Hz** – Unparalleled data density while also covering larger areas per day.
- **Sensor can be Rotated for Optimal Signal** – Can be used worldwide.
- **Easy Portability and Handling** – No winch required. Built-in easy-carry handle. Operable by a single man; only 44 lb with 200 ft cable.
- **Combine Multiple Systems for Increased Coverage** – Internal CM-221 Mini-counter provides multi-sensor sync and data concatenation, allowing side-by-side coverage which maximizes detection of small targets and reduces noise.
- **Export Version Available** – Use anywhere in the world without need for an export license (except embargoed countries). See specifications.

SPECIFICATIONS | G-882 Cesium Marine Magnetometer



MagLogLite™ Data Logging software is included with each magnetometer and allows recording and display of data and position with automatic anomaly detection. Additional software options include: MagLog Pro™, advanced logging software; MagMap™, a plotting and contouring package; and MagPick™ post-acquisition processing software.

MAGNETOMETER / ELECTRONICS

Operating Principle: Self-oscillating split-beam Cesium vapor (non-radioactive).

Operating Range: 20,000 to 100,000 nT.

Operating Zones: The earth's field vector should be at an angle greater than 10° from the sensor's equator and greater than 6° away from the sensor's long axis. Automatic hemisphere switching.

Noise: <0.004 nT/$\sqrt{\text{Hz}}_{\text{rms}}$. (SX (export) version: <0.02 nT/$\sqrt{\text{Hz}}_{\text{rms}}$).

Max Sample Rate: 20 Hz.

Heading Error: < 1 nT (over entire 360° spin).

Output: RS-232 at 1,200 to 19,200 Baud.

Power: 24 to 32 VDC, 0.75 A at power-on and 0.5 A thereafter.

MECHANICAL

Sensor Fish

DIA: 7 cm; L: 137 cm (2.75x54 in) (with fin assembly).
Weight: 18 kg (40 lb).

Includes sensor and electronics and 1 main weight. Additional collar weights are 6.4 kg (14 lb) each; total of 5 capable.

Tow Cable

DIA: 12 mm; L: 800 m (0.47 in x 2,625 ft).
Weight: 7.7 kg (17 lb) with terminations.
Break strength: 1,630 kg (3,600 lb)
Bend diameter: 30 cm (12 in).

Typical Detection Range for Common Objects

1.	Ship: 1000 tons	0.5 to 1 nT at 800 ft (244 m)
2.	Anchor: 20 tons	0.8 to 1.25 nT at 400 ft (120 m)
3.	Automobile	1 to 2 nT at 100 ft (30 m)
4.	Light Aircraft	0.5 to 2 nT at 40 ft (12 m)
5.	Pipeline (12 inch)	1 to 2 nT at 200 ft (60 m)
6.	Pipeline (6 inch)	1 to 2 nT at 100 ft (30 m)
7.	Iron: 100 kg	1 to 2 nT at 50 ft (15 m)
8.	Iron: 100 lb	0.5 to 1 nT at 30 ft (9 m)
9.	Iron: 10 lb	0.5 to 1 nT at 20 ft (6 m)
10.	Iron: 1 lb	0.5 to 1 nT at 10 ft (3 m)
11.	Screwdriver: 5-inch	0.5 to 2 nT at 12 ft (4 m)
12.	Bomb: 1000 lb	1 to 5 nT at 100 ft (30 m)
13.	Bomb: 500 lb	0.5 to 5 nT at 50 ft (16 m)
14.	Grenade	0.5 to 2 nT at 10 ft (3 m)
15.	Shell: 20 mm	0.5 to 2 nT at 5 ft (1.8 m)

ENVIRONMENTAL

Operating Temperature: -35°C to +50°C (-30°F to +122°F).

Storage Temperature: -45°C to +70°C (-48°F to +158°F).

Altitude: 9,000 m (30,000 ft).

Depth: 4,000 psi (2,730 m; 8956 ft).

Water Tight: O-Ring sealed for up to 4,000 psi depth operation.

ACCESSORIES

Standard: Operation manual, shipping/storage container, ship kit with tools and hardware, power supply, MagLogLite™, MagMap™ and MagPick™ processing software, depth transducer, altimeter.

Optional: Steel tow cable to 6,000 m (19,600 ft) with telemetry, longitudinal or transverse gradiometer, plastic Pelican® case, MagLogPro™, collar weights.

GEOMETRICS
Innovation • Experience • Results

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3100-P PORTABLE SUB-BOTTOM

USER HARDWARE MANUAL

0004802_REV_F

7/2/2018

EdgeTech
4 Little Brook Road
West Wareham, MA 02576

Tel: (508) 291-0057
Fax: (508) 291-2491
www.EdgeTech.com

ATTENTION – READ THIS FIRST!

All personnel involved with the installation, operation, or maintenance of the equipment described in this manual should read and understand the warnings and cautions provided below.

CAUTION! This equipment contains devices that are extremely sensitive to static electricity. Therefore, extreme care should be taken when handling them. Normal handling precautions involve the use of anti-static protection materials and grounding straps for personnel.

WARNING! High Voltage may be present in all parts of the system. Therefore, use caution when the electronics are removed from their containers for servicing.

CAUTION! Operation with improper line voltage may cause serious damage to the equipment. Always ensure that the proper line voltage is used.

Warnings, Cautions, and Notes

Where applicable, warnings, cautions, and notes are provided in this manual as follows:

WARNING!

Identifies a potential hazard that could cause injury or death.

CAUTION!

Identifies a potential hazard that could damage equipment or data.

NOTE: Recommendations or general information that is particular to the material being presented.

HARDWARE VARIATIONS AND COMPATIBILITY

The 3100-P PORTABLE SUB-BOTTOM contains both standard and proprietary hardware. At times, EdgeTech may change the standard components due to their availability or performance improvements. Although the component manufacturers—along with their models and styles—may change from unit to unit, replacement parts will generally be interchangeable.

EdgeTech will make every effort to see that replacement components are interchangeable and use the same software drivers (if applicable). At times, however, direct replacements may not exist. When this happens, EdgeTech will provide the necessary drivers with the replacement part, if applicable.

EdgeTech may also change certain hardware per customer requirements. Therefore, portions of this manual, such as parts lists and test features, are subject to change. These sections should be used for reference only. When changes are made that affect system operation, they will be explicitly noted. Also, some options and features may not be active in the customer's unit at time of delivery. Upgrades will be made available when these features are implemented.

Contact **EDGETECH CUSTOMER SERVICE** with any questions relating to compatibility.

ABOUT THIS DOCUMENT

We, the employees at EdgeTech, would like to thank you for purchasing 3100-P. At EdgeTech, it is our policy to provide high-quality, cost-effective products and support services that meet or exceed your requirements. We also strive to deliver them on-time, and to continuously look for ways to improve them. We take pride in the products we manufacture, and want you to be entirely satisfied with your equipment.

Purpose of this Manual

The purpose of this manual is to provide the user with information on the setup and use of EdgeTech's 3100-P. Although this manual encompasses the latest operational features of the 3100-P, some features may be periodically upgraded. Therefore, the information in this manual is subject to change and should be used for reference only.

Liability

EdgeTech has made every effort to document the 3100-P in this manual accurately and completely. However, EdgeTech assumes no liability for errors or for any damages that result from the use of this manual or the equipment it documents. EdgeTech reserves the right to upgrade features of this equipment, and to make changes to this manual, without notice at any time.

Revision History

REVISION	DESCRIPTION	DATE	APPROVAL
A	Release to Production	N/A	RM
B	N/A	N/A	RM
C	N/A	01/2014	TS
D	Updates	02/05/2015	TS
E	Updated Images, content, and diagrams	10/04/2017	TS
F	Updates to Drawings	07/02/2018	TS

WARRANTY STATEMENT

All equipment manufactured by EdgeTech is warranted against defective components and workmanship for a period of one year after shipment. Warranty repair will be done by EdgeTech free of charge.

Shipping costs are to be borne by the customer. Malfunction due to improper use is not covered in the warranty, and EdgeTech disclaims any liability for consequential damage resulting from defects in the performance of the equipment. No product is warranted as being fit for a particular purpose, and there is no warranty of merchantability. This warranty applies only if:

i. The items are used solely under the operating conditions and in the manner recommended in Seller's instruction manual, specifications, or other literature.

ii. The items have not been misused or abused in any manner, nor have repairs been attempted thereon without the approval of EdgeTech Customer Service.

iii. Written notice of the failure within the warranty period is forwarded to Seller and the directions received for properly identifying items returned under warranty are followed.

iv. The return notice authorizes Seller to examine and disassemble returned products to the extent Seller deems necessary to ascertain the cause for failure.

The warranties expressed herein are exclusive. There are no other warranties, either expressed or implied, beyond those set forth herein, and Seller does not assume any other obligation or liability in connection with the sale or use of said products. Any product or service repaired under this warranty shall be warranted for the remaining portion of the original warranty period only.

Equipment not manufactured by EdgeTech is supported only to the extent of the original manufacturer's warranties.

SOFTWARE SERVICE OVERVIEW

EdgeTech provides software services free of charge. This software agreement does not address customer-specified modifications or enhancements. These services may be ordered separately. Furthermore, EdgeTech software upgrades are meant for the sole use of EdgeTech customers. Any reproduction of EdgeTech-supplied software or file sharing is strictly prohibited.

Software Updates and Enhancements

EdgeTech customers can download new software releases with all modifications and enhancements from the EdgeTech ftp site. Major software issues, should they occur, will be reported directly to the customer. New software releases consist of the following:

- Software enhancements that are not on the price list
- Software fixes and changes
- Product integration
- Documentation updates to on-line help
- Tests for compatibility with other modules

Software patches consist of software that has undergone the following:

- Minor software enhancements
- Software fixes and changes
- Software Telephone, Facsimile, and E-mail Support

EdgeTech customers are entitled to contact **EDGETECH CUSTOMER SERVICE** by telephone, facsimile, or e-mail to report a difficulty, to discuss a problem or to receive advice on the best way to perform a task. When contacted, EdgeTech Customer Service will do the following:

- Respond within 24 hours
- Immediately attend to serious problems affecting operations
- Attempt to find an immediate work-around

RETURNED MATERIAL AUTHORIZATION

Prior to returning any equipment to EdgeTech, a Returned Material Authorization (RMA) Number must be obtained from **CUSTOMER SERVICE**.

RMA Purpose

The RMA Number identifies returned equipment when it arrives at our receiving dock and enables tracking while at our facility. Refer to RMA number on all documentation and correspondences.

All returned materials must be shipped prepaid. Freight collect shipments will not be accepted. All equipment should be adequately insured for shipping, but equipment belonging to EdgeTech must be insured for full value.

If there is more than one item per consignment, include a packing with the shipment. An invoice can double as a packing slip only when the contents are clearly numbered and identified on the invoice.

CAUTION!

Never attempt to ship a Portable Topside in its Storm Case™ alone. Although rugged, these cases are not intended to be used as shipping containers and the delicate internal components could be damaged. Shipping in this manner will void any warranties.

NOTE: All shipping charges shall be the responsibility of the customer, unless under warranty, as EdgeTech will pay for return shipping.

NOTE: For International Shipments valued over $1000, the following Shipper's oath must be sent with the invoice.

Shipper's Oath:

"I, _____, declare that the articles herein specified are the growth, produce, or manufacture of the United States; that they were exported from the United States from the port of _____, on or about _____; that they are returned without having been advanced in value or improved in condition by any process of manufacture or any other means; and that no drawback, or allowance has been paid or admitted hereof."

Signed _____

CUSTOMER SERVICE

Customer service personnel at EdgeTech are always eager to hear from users of our products. Your feedback is welcome, and is a valuable source of information which we use to continually improve these products. Therefore, we encourage you to contact EdgeTech Customer Service to offer any suggestions or to request technical support:

E-mail:	service@edgetech.com
Mail:	4 Little Brook Road West Wareham, MA 02576
Telephone:	(508) 291-0057
Facsimile:	(508) 291-2491
24-Hour Emergency Technical Support Line:	(508) 942-8043

> **NOTE:** *Please have your system Serial Number available when contacting Customer Service.*

For more information please go to www.EdgeTech.com.

COMPANY BACKGROUND

EdgeTech (formerly EG&G Marine Instruments) traces its history in underwater data acquisition and processing back to 1966. EdgeTech has designed, developed, and manufactured products, instruments, and systems—for the acquisition of underwater data, including marine, estuarine, and coastal applications—for over 50 years.

The company has responded to the needs of the scientific, Naval, and offshore communities by providing equipment—such as sub-bottom profilers, side scan sonar, acoustic releases, USBL positioning systems, and bathymetric systems—that have become standards in the industry.

EdgeTech has also consistently anticipated and responded to future needs through an active research and development program. Current efforts are focused on the application of cutting-edge CHIRP and acoustic technology.

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SECTION 1: OVERVIEW

The 3100-P Sub-Bottom Profiling System is a lightweight, portable, high resolution wideband frequency modulated (FM) sub-bottom profiler that uses EdgeTech's proprietary Full Spectrum chirp technology to generate cross-sectional images of the seabed and collect digital normal incidence reflection data over many frequency ranges. The 3100-P transmits an FM pulse (also called a "chirp pulse") that is linearly swept over a full spectrum frequency range.

The reflections measured by the system are displayed as shades of gray or color on a computer monitor and may be printed on a continuous feed thermal printer. Data are stored in real time onto a large capacity hard drive and can be archived to a DVD.

1.1 Advantages of Full Spectrum Chirp Technology

EdgeTech's Full Spectrum chirp technology has several distinct advantages over conventional sub-bottom profiling systems: The use of separate acoustic projectors and receivers enable:

- Simultaneous transmission and reception of acoustic signals
- High repeatability of the transmitted signals to enable sediment classification,
- High signal-to-noise ratio (SNR) for improved acoustic imagery
- High resolution for measurement of fine sediment layering
- Additional processing gain for energy efficiency
- Gaussian shaped amplitude spectrum of the outgoing pulse to preserve resolution with sediment penetration
- Reduction of side lobes for minimal destructive signal scattering caused by the sediment when profiling near the bottom.

1.1.1 Separate Acoustic Projectors and Receivers

The 3100-P Sub-Bottom Profiling System uses acoustic projectors and receivers mounted in a towed vehicle to transmit and receive acoustic FM pulse signals. The projectors are wide band piston type transducers, and the receivers are hydrophone arrays composed of lead zirconate titanate (PZT) crystals. The transducers are mounted in the forward section of the tow vehicle, and the hydrophone arrays, which are designed for profiling at ship speeds up to seven knots, are mounted aft.

The use of separate transmitting transducers and receiving hydrophone arrays preserves linearity, and allows the simultaneous transmission and reception of the acoustic signals. The transducers and hydrophone arrays are mounted beneath acoustic baffles, which minimize direct path, tow vehicle, and surface reflections. A preamplifier in the tow vehicle amplifies and drives the received signals through a tow cable to the surface.

1.1.2 High Repeatability

The FM pulses are generated by a digital-to-analog (D/A) converter with a wide dynamic range and a transmitter with linear components. This allows the energy, amplitude, and phase characteristics of the acoustic pulses to be precisely controlled. This precision produces high repeatability and signal definition required for sediment classification.

The frequency range of operation is determined by the acoustic characteristics of the transmitter transducers and receiving hydrophone arrays mounted on the tow vehicle. Each tow vehicle can transmit acoustic pulses with different center frequencies and bandwidths.

The selection of this frequency is made by the operator while profiling to achieve the best imagery, and the tow vehicle is selected based on the sub-bottom conditions at the survey site, along with the type of sub-bottom features that need to be imaged. EdgeTech technical support can provide assistance in selecting the best tow vehicle for your application.

1.1.3 High Signal-to-Noise Ratio

Full Spectrum chirp technology does not use a conventional matched filter (the correlation filter that is widely used to compress FM signals) to process wide band signals. Rather it uses proprietary amplitude and phase weighting functions for the transmitted pulse and a pulse compression filter that maximizes the SNR of the acoustic images over a wide band of operating frequencies. These functions provide a significant SNR improvement in the acoustic image over other pulse and chirp sonars with band limited components that are limited in dynamic range.

1.1.4 High Resolution

Signals received at the surface from the hydrophone arrays in the tow vehicle pass through a software-controlled, programmable, gain amplifier before being digitized with a 16-bit analog-to-digital (A/D) converter at a sampling rate of 20, 25, 40, or 50 kHz The FM pulse is then compressed using a digital compression filter. This correlation process is implemented in real time with forward and inverse Fast Fourier Transforms.

The compressed pulse has a time duration approximately equal to the inverse of the bandwidth of the FM pulse which results in a high temporal resolution. This high resolution enables the measurement of fine layering in the sediment, an important factor in sediment classification, as it provides a more realistic picture of the true geologic variability of the sea floor and an accurate determination of the depositional processes.

1.1.5 Additional Processing Gain

In addition to the resolution improvement, correlation processing achieves a signal processing gain over the background noise. This gain is approximately ten times the log of the time-bandwidth product.

This improvement is due to the signal having a time duration longer than the inverse of the bandwidth, thus increasing signal energy without increasing the power of the outgoing pulse. To equal the typical performance of the full spectrum sonar pulse, conventional pulse sonar would have to operate at a peak pulse power of 100 times greater than a full spectrum pulse with a time-bandwidth product of 100.

1.1.6 Gaussian Shaped Amplitude Spectrum Outgoing Pulse

Another important feature of Full Spectrum chirp technology is that the signal processing optimizes the performance of the system. The sonar contains many components, each with a unique dynamic range and linearity characteristic, which are frequency dependent.

In addition to this characteristic, the amplitude spectrum of the outgoing pulse is chosen to be approximately Gaussian in shape to limit the side lobe level and temporal resolution losses due to attenuation. As a wavelet with a Gaussian shaped spectrum is attenuated by the sediment, energy is lost but its bandwidth is nearly preserved. Therefore, even after being attenuated by sand, the acoustic pulse has approximately the same resolution as an unattenuated pulse.

1.1.7 Reduction of Side Lobes

Use of Full Spectrum chirp technology reduces the side lobes in the effective transducer aperture. The wide bandwidth of the sweep frequency has the effect of smearing the side lobes of the transducer and thus achieving a beam pattern with virtually no side lobes. The effective spatial beam width obtained after processing a full spectrum 2–10 kHz signal, for example is 20 degrees measured at the -3db points.

1.2 Full Spectrum Chirp Technology Applications

Applications of the Full Spectrum Chirp Technology used in the 3100-P Sub-Bottom Profiling System include:

- EEZ resource development
- Imaging fluidized mud to a resolution of 8 cm
- Sediment classification
- Buried pipeline and cable location and routing
- Dredging studies for inlets
- Scour/erosion surveys in rivers and streams
- Marine geotechnical surveys
- Bridge erosion surveys
- Hazardous waste target location
- Geological surveys
- Archeological surveys

- Hazard surveys
- Mining and dredging surveys
- Bridge and shoreline scour surveys
- Imaging biologics in water column
- Mapping clam populations
- Beach re-nourishment
- Military and offshore oil applications
- Full ocean depth sub-bottom imaging (hull mount systems)
- Environmental site investigations

1.2.1 3100-P Portable Topside

The 3100-P Portable Topside has its electronics housed in a heavy-duty case that is watertight when closed. The case also holds a provided laptop computer that runs the DISCOVER acquisition software

CAUTION!

Never attempt to ship portable topside units in their Storm Case alone. Although rugged, these cases are not intended to be used as shipping containers, and the delicate internal components could be damaged if used in this manner.

FIGURE 1-1 and FIGURE 1-2 display the portable topside and its internal components.

Figure 1-1: 3100-P Portable Topside Open with Laptop

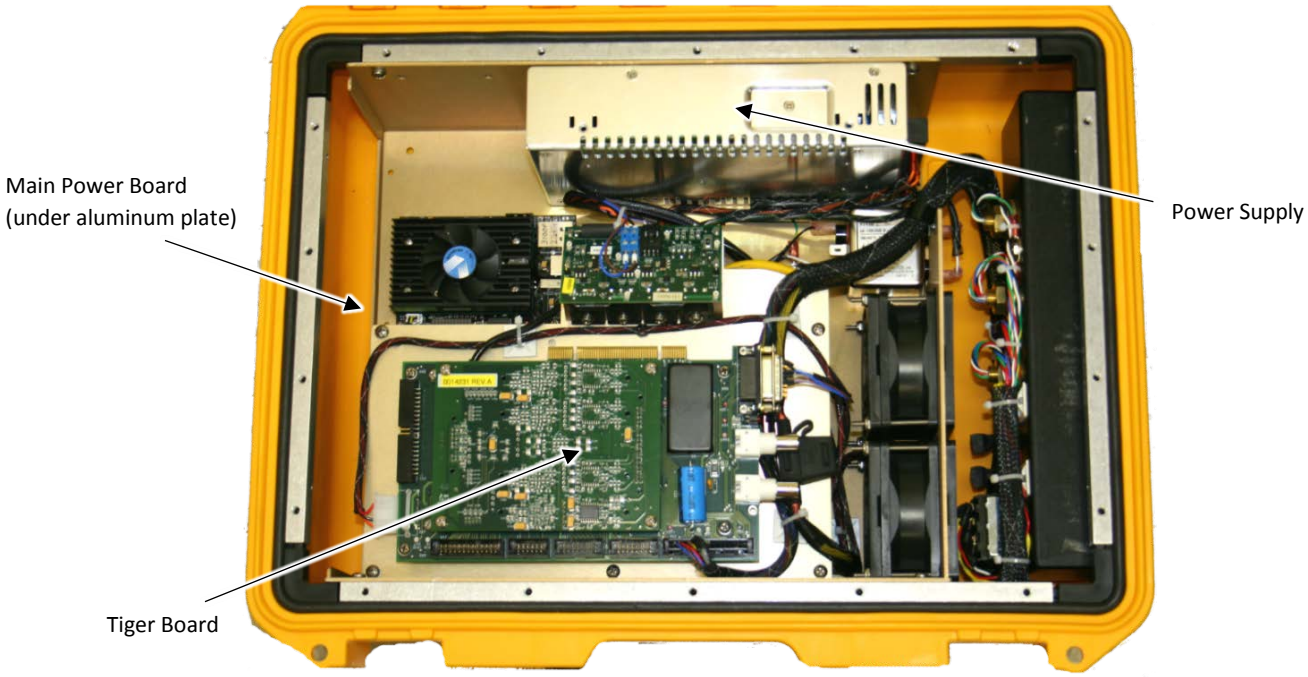


Figure 1-2: 3100-P Portable Topside Internal Components

1.2.2 SB-424 and SB-216S Tow Vehicles

The SB-424 and SB-512i Tow Vehicles are each designed to operate over a specific frequency range, and as lower operating frequencies generally require longer hydrophone arrays and larger transducers, the vehicles differ primarily in size and weight.

The SB-424 Tow Vehicle, which is the smaller of the two, operates over a frequency range of 4–24 kHz, while the SB-216S operates at 2–16 kHz. Both vehicles are displayed in **FIGURE 1-3**. The two vehicles are hydrodynamically stable, with the transducers and hydrophone arrays mounted under an acoustic baffle to reject downward traveling multiple echoes. These components, along with "spider" cable harnesses and a preamplifier, are enclosed in a two-piece fiberglass shell that is fitted with stabilizing fins and lead ballast.

A hinged U-framed tow bridle is used for towing, and the tow point location can be adjusted to accommodate different towing speeds and depths. The tow vehicles are each shipped in a wooden crate.

SB-424 Tow Vehicle

SB-216S Tow Vehicle

Figure 1-3: SB-424 and SB-216S Tow Vehicles

1.2.3 35-Meter Kevlar Reinforced Tow Cable

The 3100-P system comes standard with a 35 Meter Tow Cable, shown in **FIGURE 1-4**. The cable is Kevlar Reinforced, and includes three twisted shielded wire pairs. This cable is used to connect to and tow the SB-424 and SB-216S Tow Vehicles.

A steel cable can be attached to the tow cable to increase the life of the tow cable, which has a tensile strength of 650 pounds

The tow cable includes a cable grip for attaching to the tow bridle of the tow vehicle and is shipped in a wooden crate with the tow vehicle.

The system can handle a maximum length of 100 meters of tow cable. For more information on additional tow cable options, contact **EDGETECH CUSTOMER SERVICE**.

Figure 1-4: 35-Meter Kevlar Reinforced Tow Cable

SECTION 2: SPECIFICATIONS

The specifications for the 3100-P Sub-Bottom Profiling System include electrical, mechanical, and environmental characteristics for the Portable Topside Processor, Laptop, SB-424 and SB-216S Tow Vehicles, and the 35-Meter Kevlar Reinforced Tow Cable.

> **NOTE:** All specifications are subject to change without notice.

2.1.1 3100-P Portable Topside

Specifications for the 3100-P Portable Topside are as follows:

2.1.1.1 General Specifications

The general specifications for the 3100-P Portable Topside processor are shown in **TABLE 2-1**.

SPECIFICATION	VALUE
Size	390 D x 490 W x 190 H (mm), 15.2 D x 19.2 W x 7.3 H (inches)
Weight	13 kg (30 lbs) with jetBook Computer, 10 kg (22 lbs) without jetBook Computer
Construction	High-impact structural polypropylene
Color	Yellow
Sealing	Watertight cover O-ring seal with purge valve
Open Cover Operating Temperature	0°C to 40°C (32°F to 104°F) (shade conditions)
Storage Temperature	-20°C to 60°C (-4°F to 140°F)
Relative Humidity	Operating 0 to 80% (non-condensing), Non-operating 0 to 100%

Table 2-1: General Specs for 3100-P Portable Topside

2.1.1.2 3100-P Power Requirements

The 3100-P Power Requirements are listed in **TABLE 2-2**.

SPECIFICATION	VALUE
DC Input	12 to 15 VDC
AC Input	120/240 VAC (Auto-Ranging)
Peak Power (on start-up)	300 Watts 20 Amps at 12 VDC / 2 Amps at 120 VAC
Average Operating Power	48 Watts 4 Amps at 12 VDC 0.4 Amps at 120 VAC

Table 2-2: Power Requirements

2.1.1.3 3100-P Laptop Specifications

The 3100-P Laptop specifications are in **TABLE 2-3**.

SPECIFICATION	VALUE
Notebook Computer	Jetta SR JetBook, or equivalent
Operating System	Windows 7, 64 Bit
Processor	I7, 2.8GHZ Quad Core
Memory	4 GB, 1333 MHZ
Hard Drive	500 Gigabytes
Screen Size	15.6" – 1280 x 800 typical
Wireless	Windows 7 64 BIT CENTRINO 802.11 BGN 2x2 or Comparable

Table 2-3: Laptop Specifications

2.1.1.4 Interface between 3100-P and Laptop Computer

The specifications for the interface between the 3100-P / Notebook computer are in **TABLE 2-4**.

SPECIFICATION	VALUE
Ethernet LAN	100BaseT, TCP/IP Wireless
Wireless LAN	802.11 b/g

Table 2-4: 3100-P / Notebook Computer Interface

2.1.2 Tiger Board Description

The Sonar Interface board (Tiger board) is the real-time controller for sonar processing. It includes transmit waveform tables and multiple channels of 10-bit high speed digital-to-analog (D/A) converters, support for external and internal triggers, and support for multiple sonar analog-to-digital (A/D) converters.

The Tiger board was designed to support a combined sonar system (with both sub-bottom as well as multi-frequency side-scan capability), or to be used single channel as a basic sub-bottom controller. At periodic intervals the board generates the transmit waveform(s), and it continuously buffers ADC data.

The Tiger board represents a new generation of re-engineered and optimized sonar electronics. It is designed to address a broad spectrum of sonar applications from a common and well tested base of components. Among the features of this generation are lower power consumption, higher speeds, smaller form factors, and high analog sensitivity-to-minimum noise electronics for improved operating ranges.

The Tiger board is actually composed of a set of three boards as shown in **FIGURE 2-1**: a Carrier board, an Acquisition board, and a Sonar/IDE board. All three boards are connected electrically and mechanically as a single assembly that plugs into the Mother board PCI slot.

2.1.2.1 Carrier Board

This board has the same physical size as an industry standard full slot PCI card. There are two BNC connectors, TRIGGER IN and TRIGGER OUT, and female connectors on either side for mating with the

other two boards in the board set. An onboard DC/DC converter provides +12 VDC to the preamplifier in the tow vehicle.

2.1.2.2 Acquisition Board

The Acquisition board contains band pass filtering and up to eight 24-bit A/D converters, where only two channels are used. The first channel is for the received acoustic data from the preamplifier, and the second channel is used for power-up diagnostics.

2.1.2.3 Sonar/IDE Board

The sonar/IDE board is composed of two RAM memories, an acquisition memory and a chirp memory, and six 10-bit D/A converters for generating transmit waveforms. The transmit ping rate and sampling clock are generated from this board. The IDE portion of the board provides the interfacing circuitry required to communicate between the Mother board and the Tiger board.

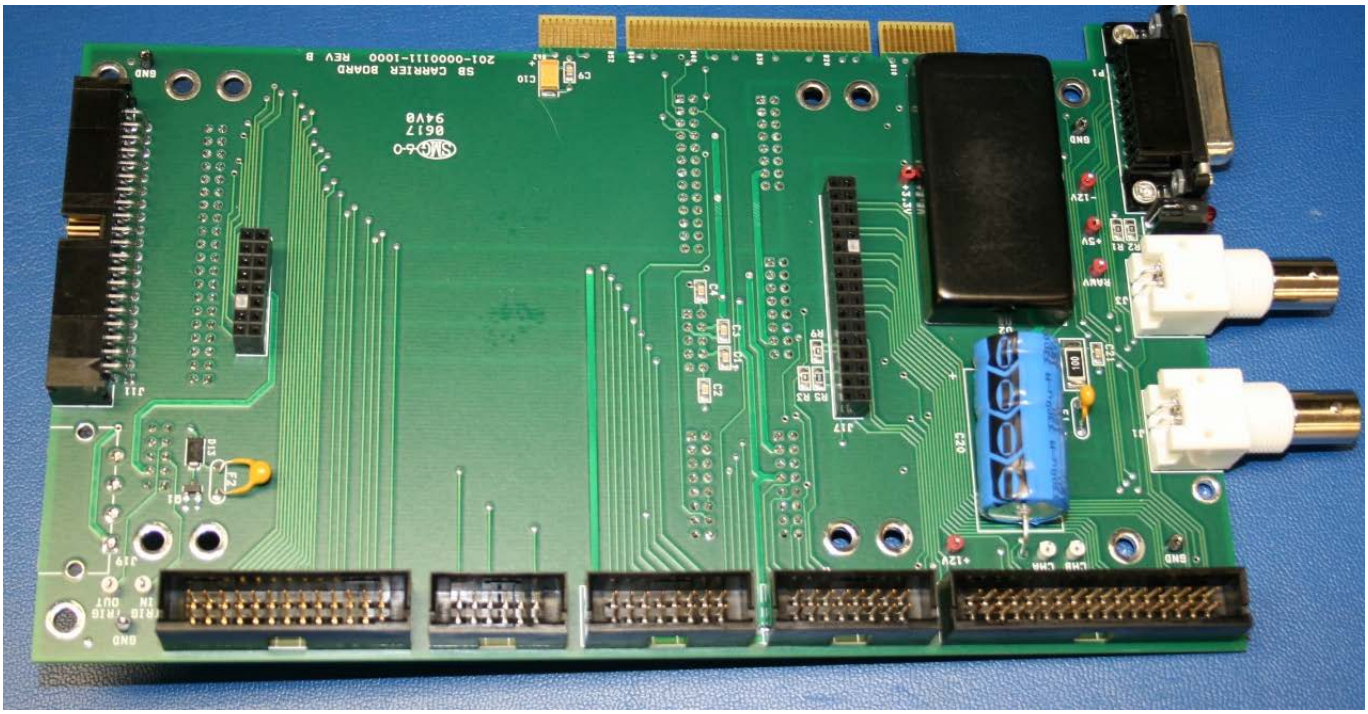


Figure 2-1: Tiger Board Set: Carrier (Front view) – 0006013

Figure 2-2: Tiger Board Set: Carrier (Rear View) – 0006013

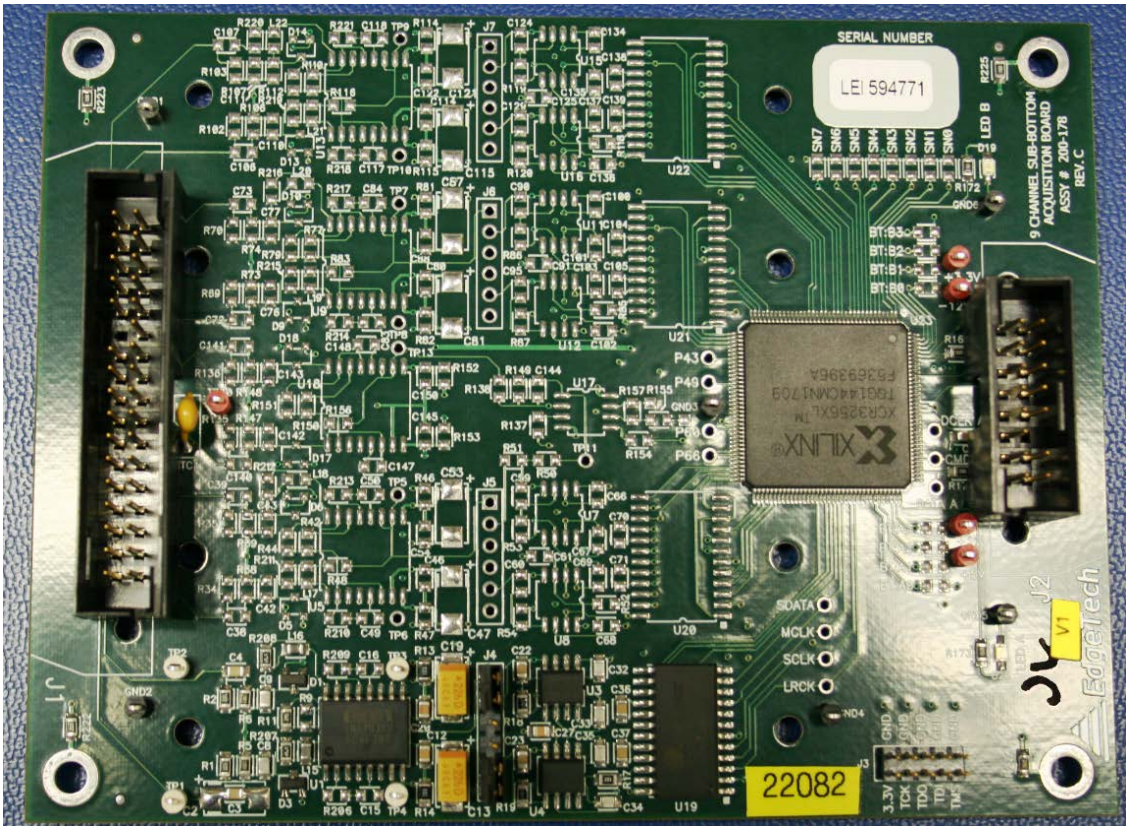


Figure 2-3: Tiger Board Set: Acquisition PCB - 0014231

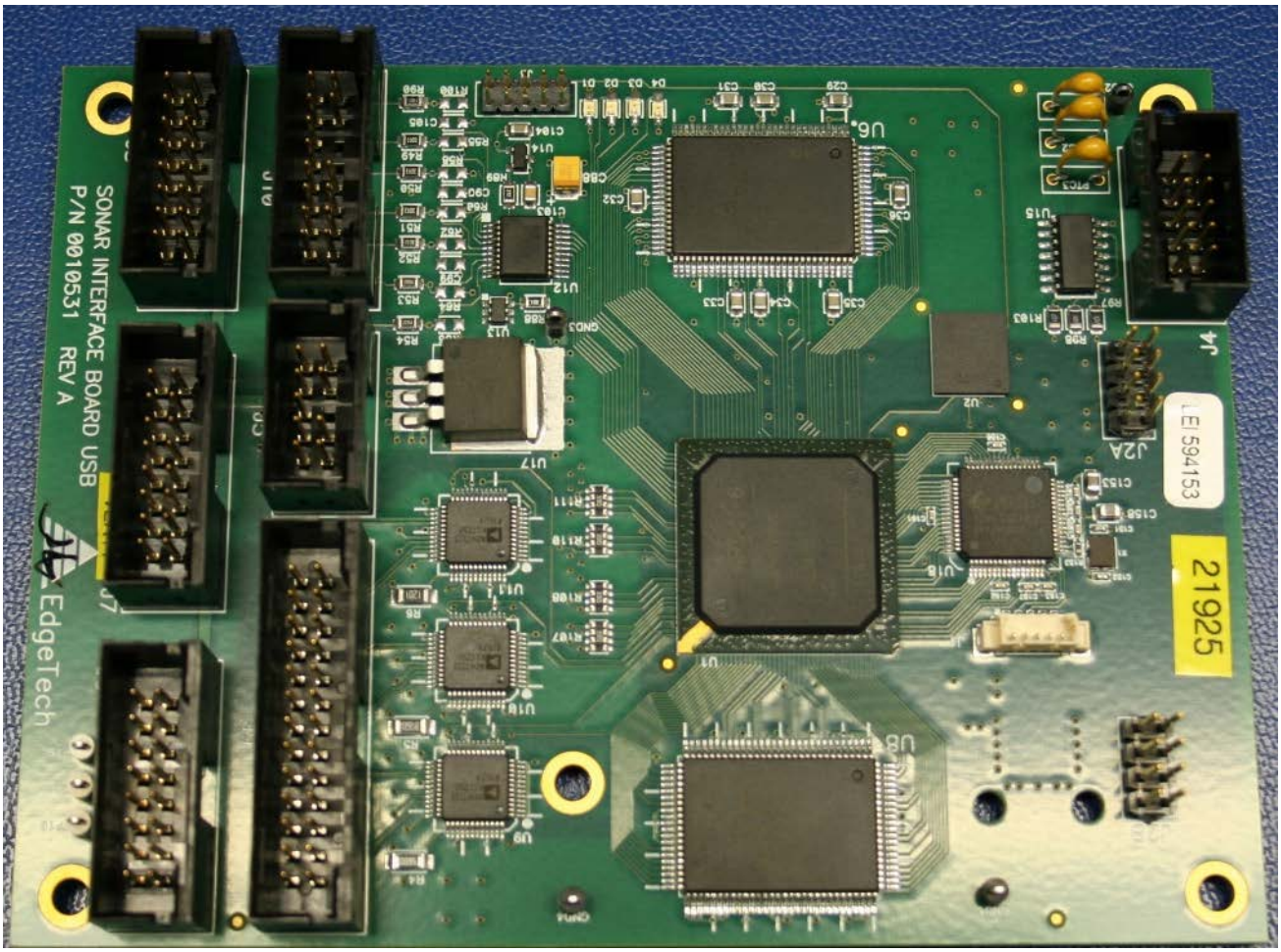


Figure 2-4: Tiger Board Set: SIBU aka Sonar Interface Board – 0011637

2.1.3 SB-424 and SB-216S

The general specifications for the SB-424 and SB-216S Tow Vehicles are show in TABLE 2-5.

SPECIFICATION	SB-424 VALUE	SB-216S VALUE
Frequency range	4-24 kHz	2-16 kHz
Pulse type	FM	FM
Pulse bandwidth/pulse length	4-24 kHz/10 ms 4-20 kHz/10 ms 4-16 kHz/10 ms	2-15 kHz/20 ms 2-12 kHz/20 ms 2-10 kHz/20 ms
Calibration	Gaussian-shaped pulse spectrum	Gaussian-shaped pulse spectrum
Vertical resolution[a]	4 cm (4–24 kHz) 6 cm (4–20 kHz) 8 cm (4–16 kHz)	6 cm (2–15 kHz) 8 cm (2–12 kHz) 10 cm (2–10 kHz)
Penetration in course and calcareous sand[b]	2 m (typ)	6 m (typ)
Penetration in soft clay[b]	40 m	80 m
Beam width	16°, 4–24 kHz 19°, 4–20 kHz 23°, 4–16 kHz	17°, 2–15 kHz 20°, 2–12 kHz 24°, 2–10 kHz
Optimum tow vehicle pitch/roll[c]	<7°, 4–24 kHz <8°, 4–20 kHz <10°, 4–16 kHz	<7°, 2–15 kHz <8°, 2–12 kHz <10°, 2–10 kHz
Optimum tow height	3-5m above sea floor	3-5 m above sea floor
Transmitters	1	1
Receive arrays	2	2
Output power	2000 W	2000W
Tow vehicle size	77 cm (30 in.) L 50 cm (20 in.) W 34 cm (13 in.) H	105 cm (41 in.) 67 cm (26 in.) W 46 cm (18 in.) H
Shipping container size	91 cm (36 in.) L 66 cm (26 in.) W 64 cm (25 in.) H	117 cm (46 in.) L 79 cm (31 in.) W 61 cm (24 in.) H
Weight in air	35 kg (78 lb)	72 kg (160 lb)
Shipping weight	110 kg (243 lb)	162 kg (357 lb)
Tow cable requirements	3 shield-twisted wire pairs	3 shield-twisted wire pairs
Depth rating	300 m (984 ft) max	300 m (984 ft) max

Table 2-5: Tow Vehicle Specifications

a. Vertical resolution is the smallest distinguishable distance between the peaks of two reflections that can be displayed on the screen as separate reflectors. Sound energy is reflected back to the sonar system when the transmitted pulse encounters a change in density. The resolution of a sonar system is measured by its ability to distinguish between two adjacent targets. The vertical resolution is dependent on the transmitted chirp pulse bandwidth. It is theoretically calculated by the product of the transmitted pulse length (inverse of the bandwidth) and half the speed of sound in water (approximately 750 m/s). For example, a full bandwidth pulse from an SB-424 Tow Vehicle has a vertical resolution of 3.75 cm (1/20,000 x 750).

b. The value for sub-bottom penetration is the maximum distance beneath the sea floor that a step change of 10% in density can be seen on the sub-bottom display. This assumes that the sediment is gas free (no organic materials), that the lowest frequency of the pulse spectrum is transmitted and that the vehicle is within 5 meters of the seabed (range for maximum penetration). Lower frequencies reduce attenuation (absorption of sound). Towing the vehicle close to the sea floor reduces the acoustic footprint thereby reducing scattering (interfering reflections) from the sea floor and within the sediments.

c. At the -3 dB points, depending on the center frequency.

2.2 Mechanical Drawings

The following pages contains Drawings for the SB-216 and SB-424.

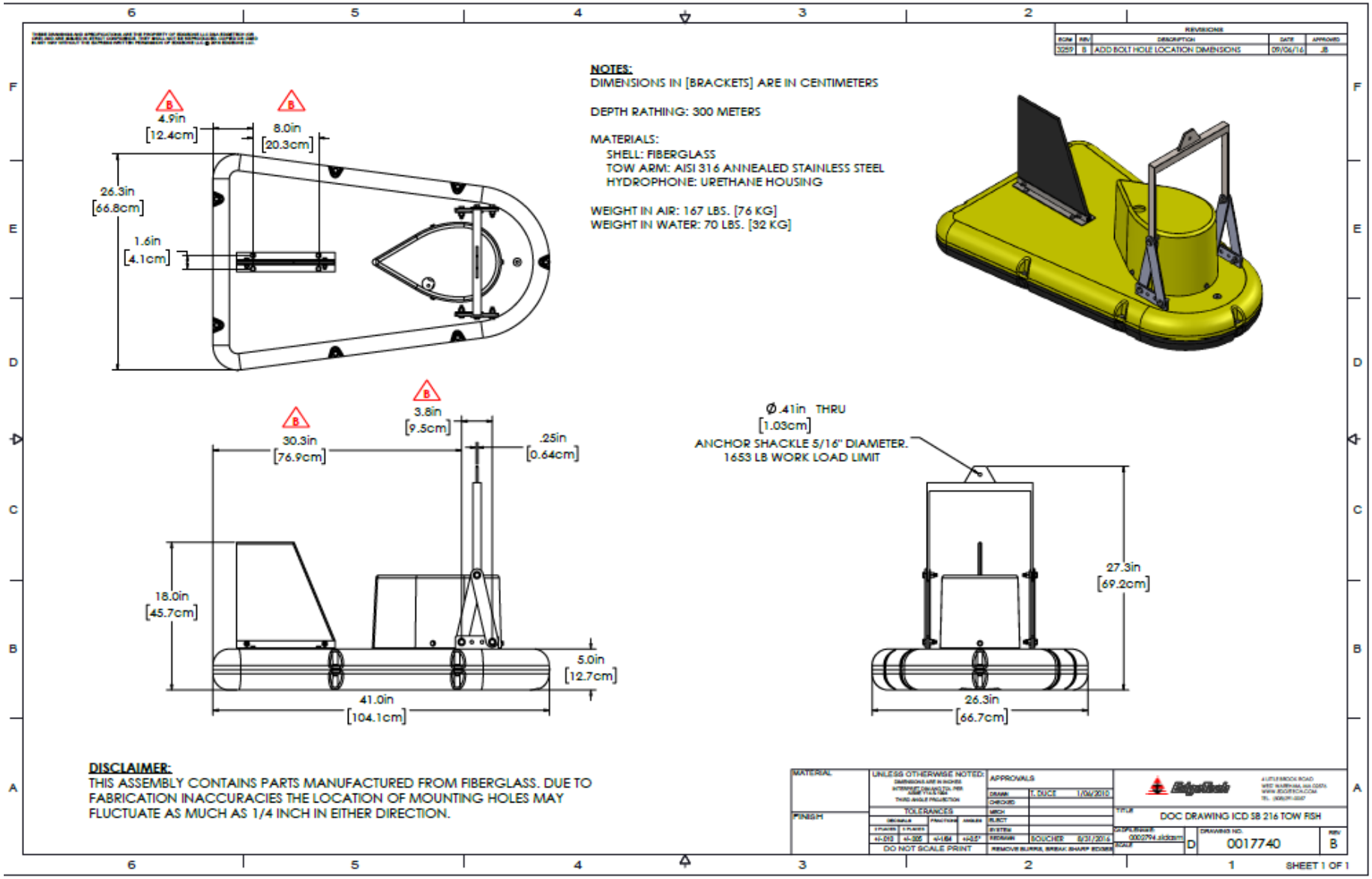


Figure 2-5: SB-216 Towfish Outline Drawing

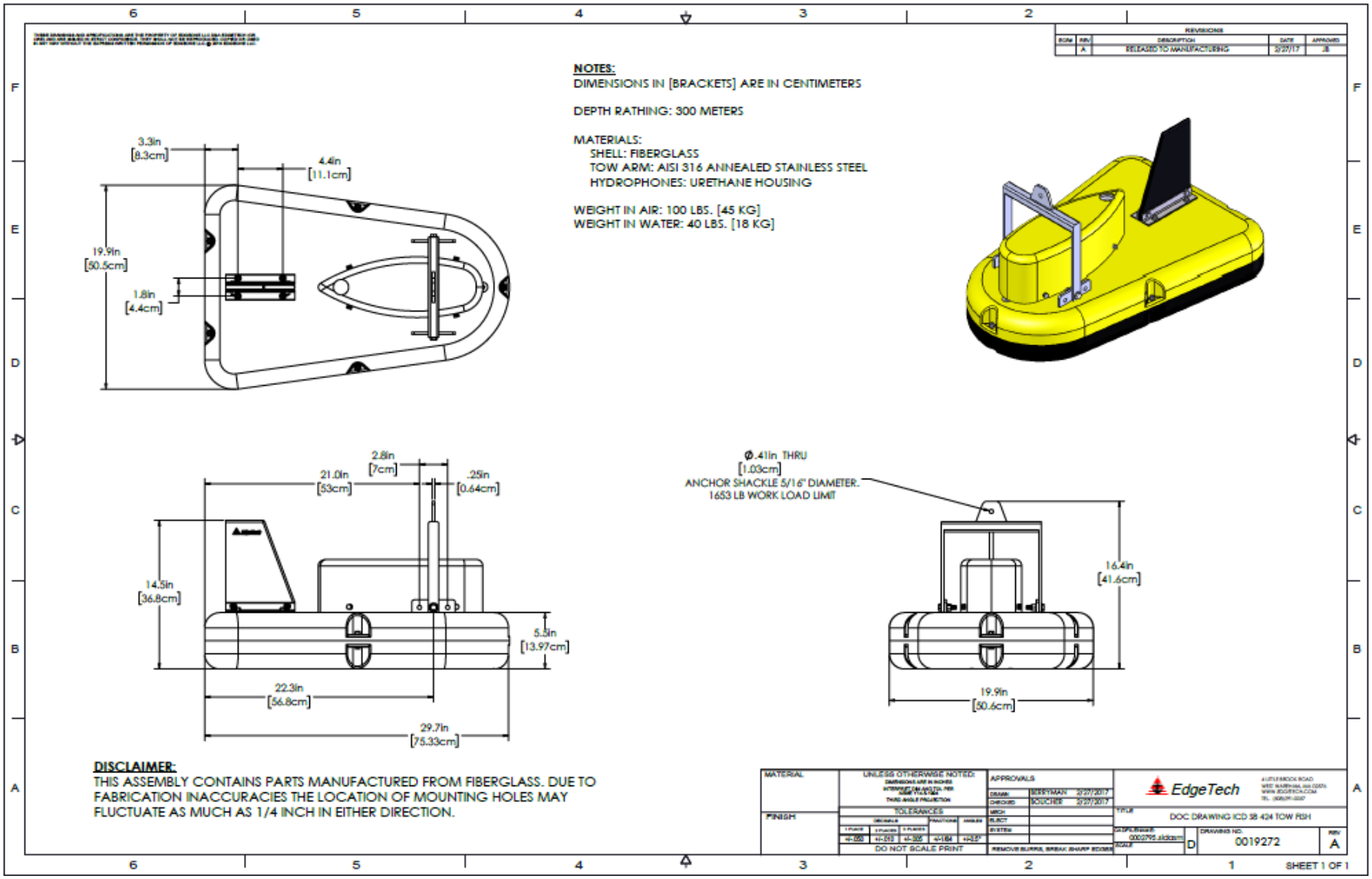


Figure 2-6: SB-424 Towfish Outline Drawing

2.2.1 35-Meter Kevlar Reinforced Tow Cable Specifications

The general specifications for the 35-Meter Kevlar Reinforced Tow Cable are shown in TABLE 2-6.

SPECIFICATION	VALUE
Twisted-shielded wire pairs:	(1) # 16 AWG (2) # 20 AWG
Breaking strength:	1,500 kg (3,300 lb) minimum
Working strength:	300 kg (660 lb)
Weight in air:	94 kg/100 m (207 lb/1000 ft)
Voltage rating:	600 volts
Bending radius:	25 cm (10 in.) minimum
Length:	35 m (115 ft) standard

Table 2-6: 35-Meter Kevlar Reinforced Tow Cable Specifications

NOTE: Cables do not come standard with the system and must be specified upon purchase. For more information about cable options, contact EDGETECH CUSTOMER SERVICE.

SECTION 3: SETUP AND ACTIVATION

Setup and test of the EdgeTech 3100-P Sub-Bottom Profiling System involves:

1. Unpacking, inspecting, and connecting the system components.
2. Connecting a navigation system and external sonar systems if required
3. Activating the system
4. Verifying operation using the EdgeTech DISCOVER SB software.

This section provides instructions on how to perform these tasks, as well as information on how to deploy and tow the tow vehicle.

3.1 Unpacking and Inspection

The 3100-P Portable Topside; SB-424 or SB-216S Tow Vehicle; and 35-Meter Kevlar-Reinforced Tow Cable are shipped in separate, reusable, heavy-duty transport cases. Essential cables and documentation are also included.

Before unpacking the system components, inspect the shipping containers for any damage. Report any damage to the carrier and to EdgeTech. If the shipping containers appear free of damage, carefully unpack the components, and inspect them for damage. Also check the packing list and verify that all the items on the list are included.

Again, if any damage is found, report it to the carrier and to EdgeTech. If any items are missing, immediately contact EdgeTech. Do not install or operate any equipment that appears to be damaged.

Although the items shipped may vary, depending on the customer requirements, the 3100-P Sub-Bottom Profiling System typically includes the following:

- 3100-P Portable Topside
- Laptop Computer
- SB-424 or SB-216S Tow Vehicle
- 35-Meter Kevlar Reinforced Tow Cable
- AC power cords (1)
- DC power / Ethernet cable
- Recovery thumb drive
- Software CDs and Electronic Manuals
- Consumables kit

After unpacking the system components, be sure to safely store the shipping containers, including any packing materials, for later use. When transporting or storing the system, all items should be packed in

their original shipping containers in the same way they were originally shipped, and always store the system in a dry environment when not in use.

3.2 Power Requirements

The 3100-P power requirements are 120–220 VAC, 50/60 Hz or a 12 to 15 VDC power supply. The input voltage is auto sensing.

3.2.1 Use of an Uninterruptable Power Supply

The power source should be continuously free of high amplitude, high frequency transients, as this type of interference could cause degraded performance or damage to the equipment. An uninterruptable power supply (UPS) with power surge protection is recommended for powering the equipment.

However, whether or not a UPS is used, the power source should never be the same as that being used to power electric motors, such as pumps and winches, on the survey vessel.

3.2.2 Changing to a Non-US Power Plug

An AC power cord is provided for connecting the 3100-P Portable Topside to a standard U.S. 3-pronged outlet. For non-U.S. power outlets, you can modify this cord by cutting off the 3-pronged plug and attaching the appropriate plug. Refer to **Table 3-1** for connection information.

AC POWER CORD WIRE COLOR	FUNCTION
Black	AC line
White	AC neutral
Green	Earth ground

Table 3-1: AC Power Cord Wiring

3.3 Navigation Interface

The 3100-P Sub-Bottom Profiling System accepts all standard National Marine Electronics Association (NEMA) 0183 message sentence formats from a connected global positioning system (GPS) or integrated navigation system.

3.4 3100-P Portable Topside Placement

Ideally, the portable topside will always be located in a dry, sheltered area that is protected from weather and water spray. However, the rugged design of the unit allows it to be exposed to light precipitation when the case is sealed.

> **CAUTION!**
>
> Never operate or open the unit where it can become wet from sea spray or precipitation.

The unit should also be placed in an area where the temperature is consistently between 0°C and 40°C (32°F and 104°F). Avoid areas of direct sunlight, especially in tropical environments, as heat buildup could occur and viewing the laptop display and status indicators could be difficult. The location should also enable direct communications with the deck crew that is handling the tow vehicle.

3.5 Topside Controls and Indicators

The 3100-P Portable topside controls and indicators are called out in **FIGURE 3-1**, and are as follows:

POWER SWITCH: Turns on the system.

READY INDICATOR: Green LED that lights up solid and remains on when the system is ready to run.

PING INDICATOR: Yellow LED lights up during startup to show that the system is initializing, then shuts off. Once the system has begun pinging, the LED blinks continuously.

POWER INDICATOR: Red LED that indicates the system has power going to it.

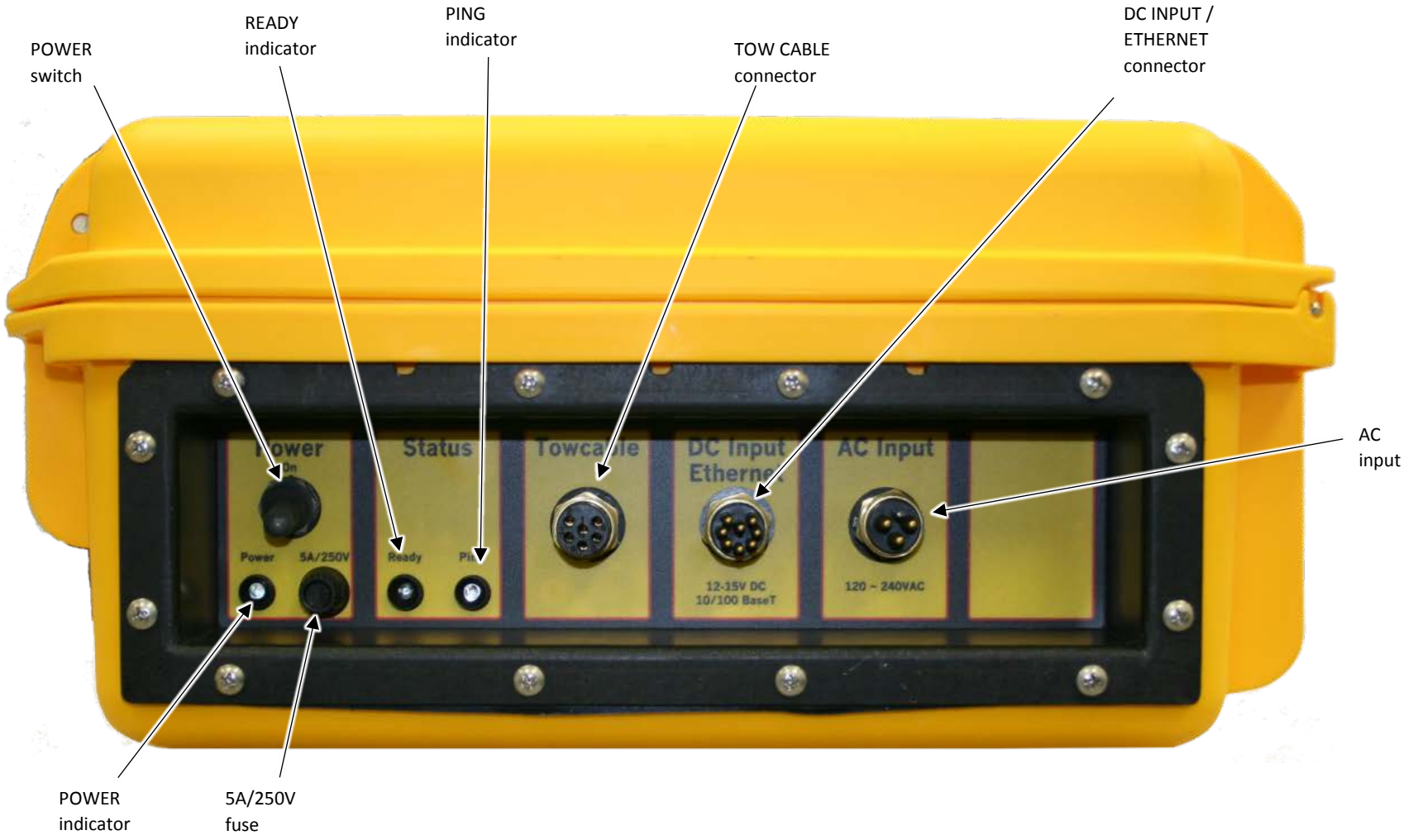


Figure 3-1: 3100-P Portable Topside Side Panel

3.6 Topside Connections

The connections for the 3100-P Portable Topside Processor are called out in FIGURE 3-1 explained below:

TOW CABLE: 6-prong female connector where the tow cable enters the portable topside.

DC INPUT/ETHERNET: 8-prong male input where DC power cable can be connected. Also used for creating a wired connection with the laptop computer.

AC INPUT: 3-prong male connector that attaches to the AC input wire.

5A / 250 V FUSE: Fuse access for the topside to be replaced in the event of a short.

3.7 Connecting the System Components

WARNING!

Do not connect the tow cable to the 3100-P Portable Topside before connecting it to the tow vehicle, otherwise injury or death can occur if the exposed connector on the tow cable is energized. Always connect the tow cable to the tow vehicle first.

3.7.1 Connecting and Attaching the Tow Cable to the Tow Vehicle

A 35-Meter Kevlar Reinforced Tow Cable is shown connected and attached to a SB-216S Tow Vehicle in FIGURE 3-2, and is similar to that for the SB-424 Tow Vehicle. Shown in FIGURE 3-3 is the recommended method for dressing and strain relieving the tow cable.

To connect and attach the tow cable to the tow vehicle:

1. Verify that the tow cable is not connected to the portable topside.
2. Coil the tow cable in a figure eight configuration.
3. Verify that the tow cable and tow vehicle connectors are free of corrosion or dirt. If dirty, clean them with an alcohol wipe.
4. Apply a thin film of silicone grease to the pins of the tow vehicle tow cable connector.
5. Mate the connectors by pressing them firmly together. Do not wiggle the connectors.
6. Mate the connector locking sleeves.
7. Connect the eyelet of the cable grip to the shackle on the tow bridle and secure them with seizing wire or a tie wrap.

8. Secure the tow cable to the tow bridle using tie wraps. Electrical tape can also be used for this purpose.

9. Secure the cable pigtail to tow bridle ensuring that there is proper strain relief and that the connector does not strum or move in the water current.

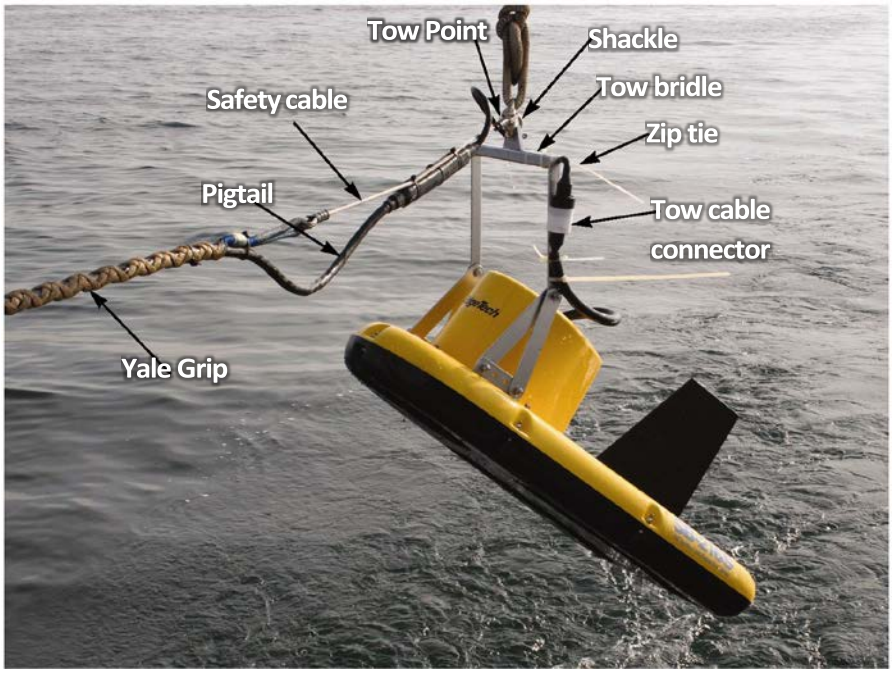


Figure 3-2: Reinforced Cable Attached to SB-216S Tow Vehicle

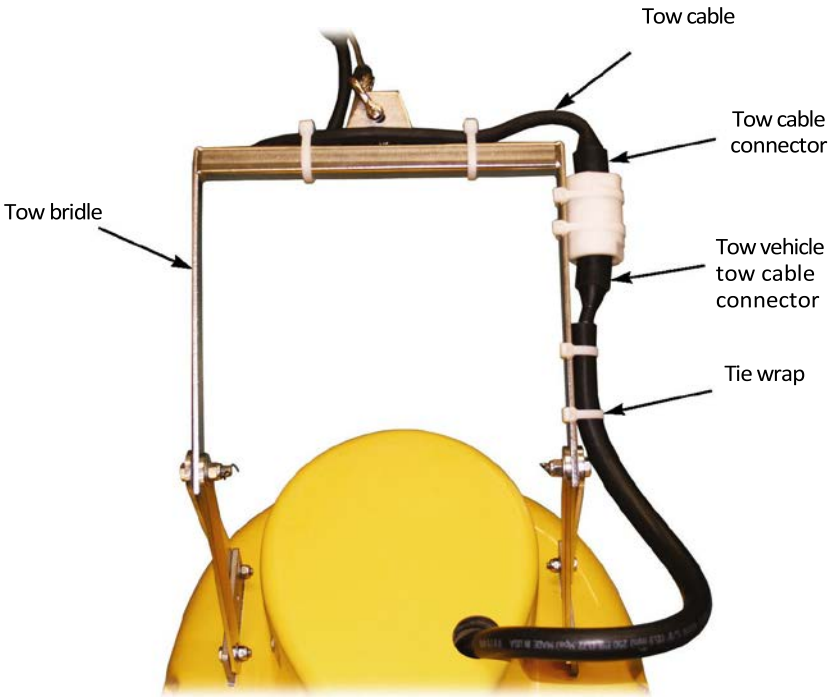


Figure 3-3: Recommended Method for Dressing and Strain Relieving Tow Cable

3.7.2 3100-P Portable Topside Connection and Activation

The following procedure describes how to connect the 3100-P Portable Topside configured system.

3.7.2.1 Connecting

1. Check that the unit power is turned OFF (switch position = DOWN).
2. Connect the 3100-P Topside to a source of AC and/or DC power using either the DC Power & Ethernet cable or the AC power cable. (Check system power specifications).

> **WARNING!**
>
> Do not extend the DC power leads of the DC Power and Ethernet Cable.

3. Connect the 3100-P Topside via the Tow cable connection to the Tow Vehicle using the supplied tow cable.
4. Connect the Notebook Computer to the 3100-P Topside using either the Wireless connection, or via the 100BaseT direct Ethernet cable (which is part of the DC Power & Ethernet cable assembly).

   The Ethernet cable may be extended up to 100 feet using a Category 5 Ethernet patch cable and Ethernet connector. A crossover or direct cable may be used. (See the following section for more details).

3.7.2.2 Making an Ethernet Connection

The 3100-P Topside processor is assigned a static (fixed) IP Address of 192.9.0.31 at Port 1620.

EdgeTech assigns static (fixed) TCP/IP addresses for all Ethernet devices in a 3100-P Topside, and reserves all TCP/IP addresses in ranges 192.9.0.0 to 192.9.0.63 and 192.9.0.101 to 192.9.0.255 for this purpose.

EdgeTech advises that any Notebook (or Desktop) Computer intended to connect to the 3100-P Topside must therefore use a TCP/IP address 192.9.0.xxx where xxx is in the range 64 to 100. EdgeTech Factory defaults for EdgeTech Notebook (or Desktop) computers are 192.9.0.100 for Wireless Networking and 192.9.0.99 for the Ethernet LAN.

> **NOTE:** The Notebook (or Desktop) computer may have only one Ethernet connection enabled or connected to the 3100-P Topside at any one time: either the Ethernet LAN connection, or else the Wireless Networking connection, but not both simultaneously.

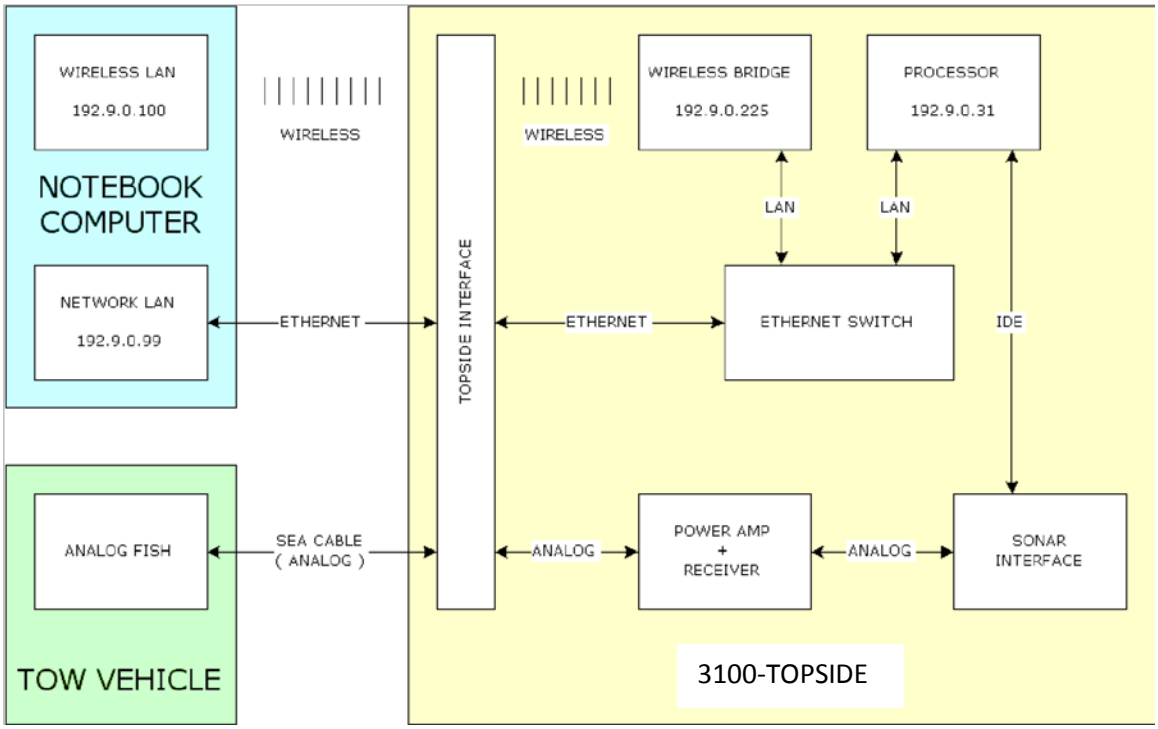


Figure 3-4: 3100-P Network Configuration Diagram

ETHERNET LAN CONNECTION:

The Ethernet LAN connection is made using a physical wired connection via the DC Power & Ethernet cable. This cable provides a standard RJ-45 Ethernet plug for direct connection to the RJ-45 LAN jack a Notebook (or Desktop) computer. The 3100-P Topside auto-senses straight and crossover Ethernet cables. The following steps should be taken on the Notebook (or Desktop) computer to use the Ethernet LAN connection:

1. Disable Wireless Networking: Locate Wireless Networking on Windows Desktop or the System Tray, then click it and Disable it, OR, if there is a switch, turn OFF the Wireless Networking functionality on the Notebook Computer.
2. Insert the RJ-45 plug of the supplied DC Power & Ethernet cable into the RJ-45 LAN jack of the Notebook (or Desktop) computer.
3. Enable the Ethernet LAN: Locate the Ethernet LAN on Windows Desktop or the System Tray, then click and Enable it.

If the Ethernet LAN does not indicate "Connected" status in the Local Area Network Properties Box, check all hardware connections, LAN IP address (see Section 7), and make sure that Wireless Networking is Disabled, that the Ethernet LAN is Enabled, and that the 3100-P Topside is powered on.

NOTE: DISCOVER software will indicate that it is in restricted mode until a valid connection is made between the Laptop and the 3100-P topside.

WIRELESS NETWORK CONNECTION:

The Wireless Networking connection is made using the wireless networking capability of the Notebook Computer. The following steps should be taken on the Notebook Computer to use the Wireless Networking connection:

1. Disable the Ethernet LAN: Locate the Ethernet LAN on Windows Desktop or the System Tray, then click and Disable it, OR simply unplug the Ethernet cable from the Notebook Computer's RJ-45 jack.
2. Enable Wireless Networking: Locate Wireless Networking on Windows Desktop or the System Tray, then click and Enable it, AND if there is a switch, turn ON the Wireless Networking functionality on the Notebook Computer.

The IP Address for Wireless Networking is fixed at 192.9.0.100, and should not be changed. Ethernet LAN. The IP Address for Ethernet LAN is fixed at 192.9.0.99, and should not be changed. The Ethernet LAN can be configured for Auto or 100Mbit/s link speed for short (8m/25ft) cables. For longer cables EdgeTech recommends a setting of 10Mbit/s, Half Duplex mode.

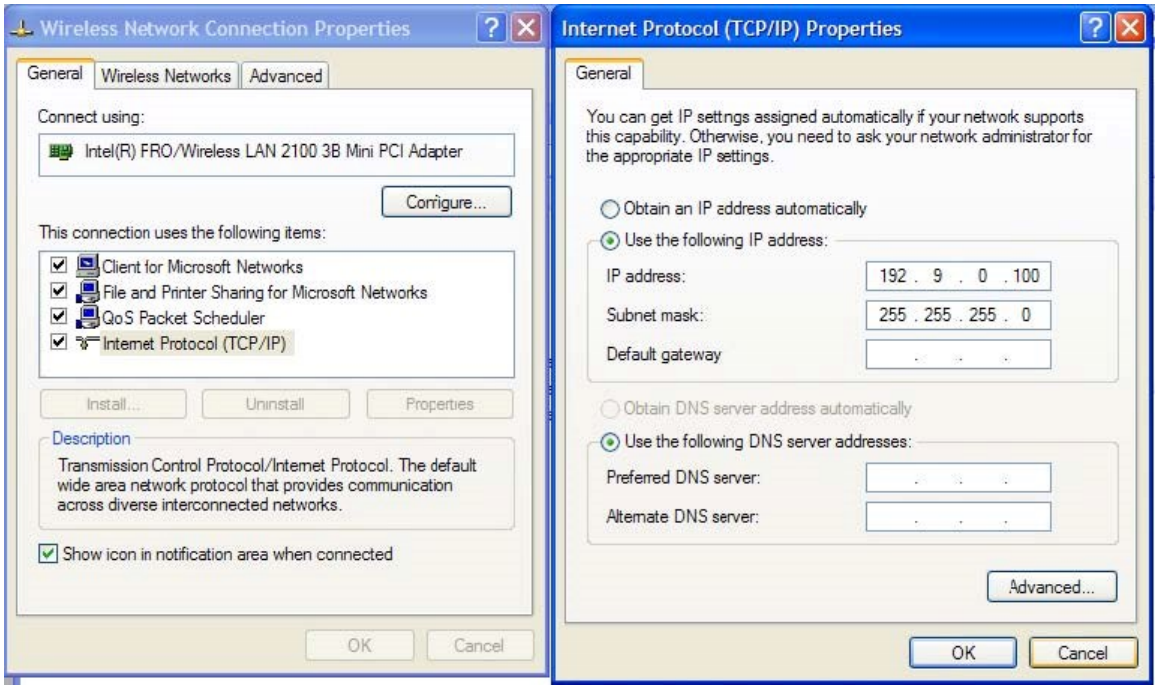


Figure 3-5: Wireless TCP/IP Address

3.7.2.3 Activating The System

To activate the 3100-P Portable Sub-Bottom Profiling System after making all necessary connections:

1. Operate the ON/OFF switch to the ON position (switch position = UP).

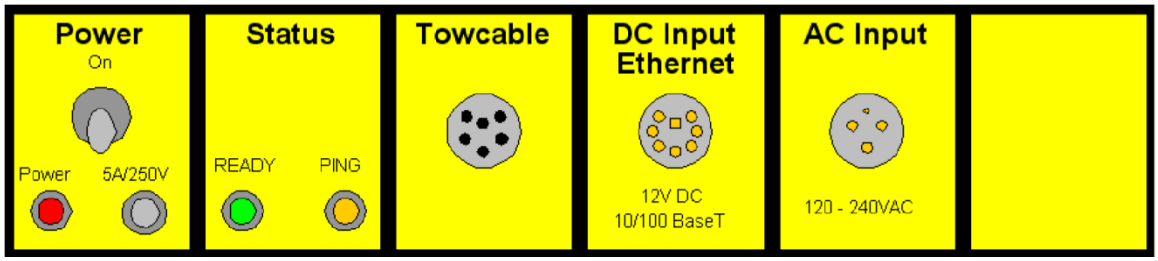


Figure 3-6: Portable Processor Case Interface

> **NOTE:** The ON/OFF switch operates in both the AC and DC power input modes.

2. Observe the side panel LEDs. The desired LED status for normal operation should be:

   Power RED = ON

   System Ready GREEN = ON

   Ping (transmit) YELLOW = OFF or FLASHING

3. The LEDs on the topside processor should display the following under normal circumstances:

RED LED = Power

The RED Power LED should always light up when power (AC or DC) is applied to the 3100-P Topside and the side panel power switch is in the ON position.

If the RED Power LED does not light up when power is applied, check the position of the side panel ON/OFF switch and all power connections to the unit. If the RED Power LED does not light up when power is applied, but the YELLOW LED still lights up to indicate system initialization, the most likely cause is that the RED Power LED or its own circuitry is faulty, in which case the rest of the system might still be fully operational.

> **NOTE:** Listen for cooling fan activity inside the unit to determine if the unit is fully powered.

GREEN LED = System Ready

The GREEN System Ready LED lights up solidly, and remains on, when the system is ready to run. On startup, the GREEN System Ready LED is off while the system performs power-on self-tests. If any of these self-tests fail, the GREEN System Ready LED remains off. If all self-tests pass, the GREEN System Ready LED lights up and remains on. Since these power-on self-tests also test the Tow Vehicle interface, the Tow Vehicle must be attached to the 3100-P Portable Topside for these power-on self-tests to pass.

If the GREEN System Ready LED never lights up, but stays OFF permanently, check the Tow Vehicle cabling. If a problem is found and corrected, then cycle power to run the power-on self-tests again.

YELLOW LED = Ping

The YELLOW Ping LED lights up during startup to indicate that the system is initializing. After the system has initialized the yellow light turns off. The YELLOW Ping LED flashes while the 3100-P Topside is pinging (sonar transmitting). The flashing rate of the YELLOW Ping LED does not always match the actual ping rate (this is normal behavior).

If the YELLOW Ping LED never lights up during startup or pinging, but stays dark permanently, the most likely cause is that the YELLOW Ping LED or its own circuitry is faulty, in which case the rest of the system might still be fully operational.

3.8 Pre-Deployment Tests

Pre-deployment checks should be performed ***before*** the tow vehicle is deployed and ***after*** the system is activated. Pre-Deployment checks involve:

1. Listening for the transmitted pulses from the transducers on the tow vehicle
2. Tapping the fiberglass shell with a hand or, gently, with a screwdriver handle near the hydrophone arrays while observing the Waterfall Display in DISCOVER, ensuring it plays back and navigation is present. DISCOVER is shown in **FIGURE 3-7**. An example Tap Test is shown in **FIGURE 3-11.**

> **NOTE:** See EdgeTech DISCOVER Sub-Bottom software manual, 0019800, for additional software information.

Based on default installation, DISCOVER and SONAR.EXE start automatically.

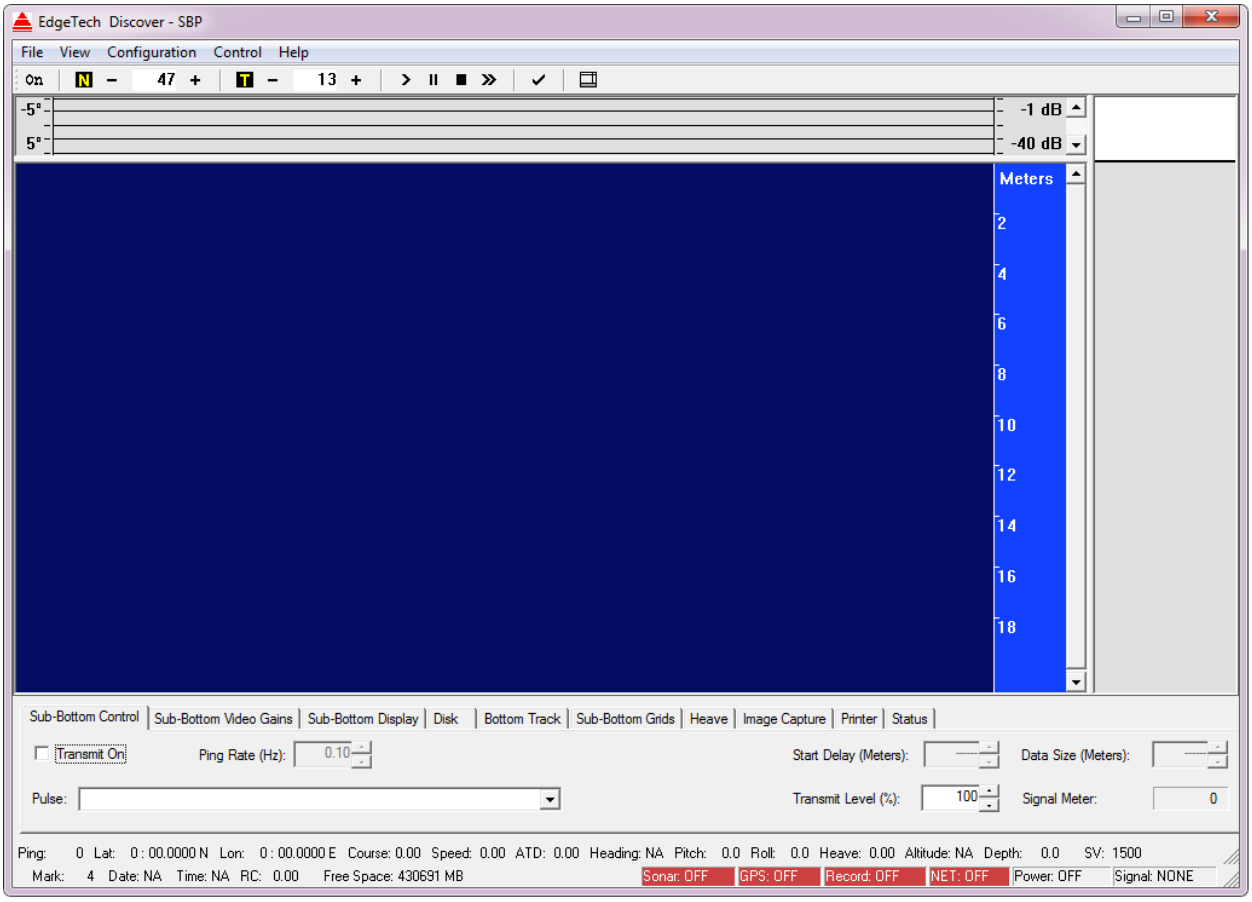


Figure 3-7: The DISCOVER Sub-Bottom Main Window

To perform the pre-deployment checks:

1. Follow the instructions in **ACTIVATING THE SYSTEM**.
2. SONAR.EXE runs a self-test, with an audible chirp, indicating the test passed. A successful test is shown in **FIGURE 3-8**.
    a. If the test fails, the SONAR.EXE window will remain on the desktop, and the failure mode will be described in the window.

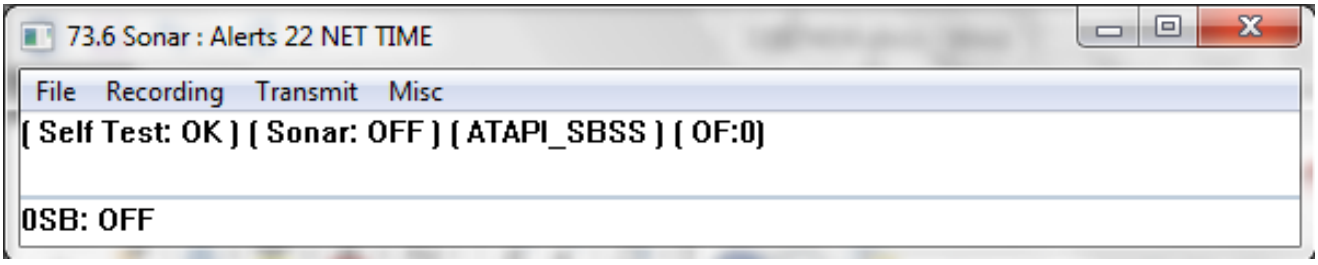


Figure 3-8: Successful Self-Test

3. The NET status in DISCOVER should change from NET OFF to NET ON, as shown in **FIGURE 3-9**.

Figure 3-9: NET: ON

4. Next, you should run a Tap Test. To do this, navigation to the Sub-Bottom Control Tab, shown in **FIGURE 3-10.**

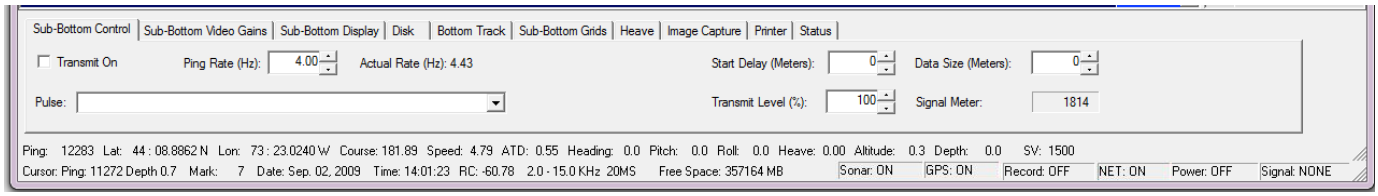


Figure 3-10: The Sub-Bottom Control Tab

5. In the Shortcut Toolbar, set Gain to either 0 or -3 dB, and then click Normalize Gain Button.

> **CAUTION!**
> Do not allow the transducers on the tow vehicle to continuously transmit in air for an extended period, as damage to the transducers could occur.

6. In the Sub-Bottom Control Tab, select a Transmit Pulse using the "Pulse" drop down. Set "Transmit Level (%)" to "0". Select the "Transmit On" checkbox.

7. The transducers on the tow vehicle should begin transmitting (at zero power) and receive data should begin scrolling on the display in the DISCOVER Main window from right to left.

8. Tap the underside of the tow vehicle near the hydrophones with the handle of a screw driver, while observing the Waterfall Display in the DISCOVER window. Streaks or noise spikes should be visible in the Waterfall Display, as shown in **FIGURE 3-11.** This verifies the receive channel is operating.

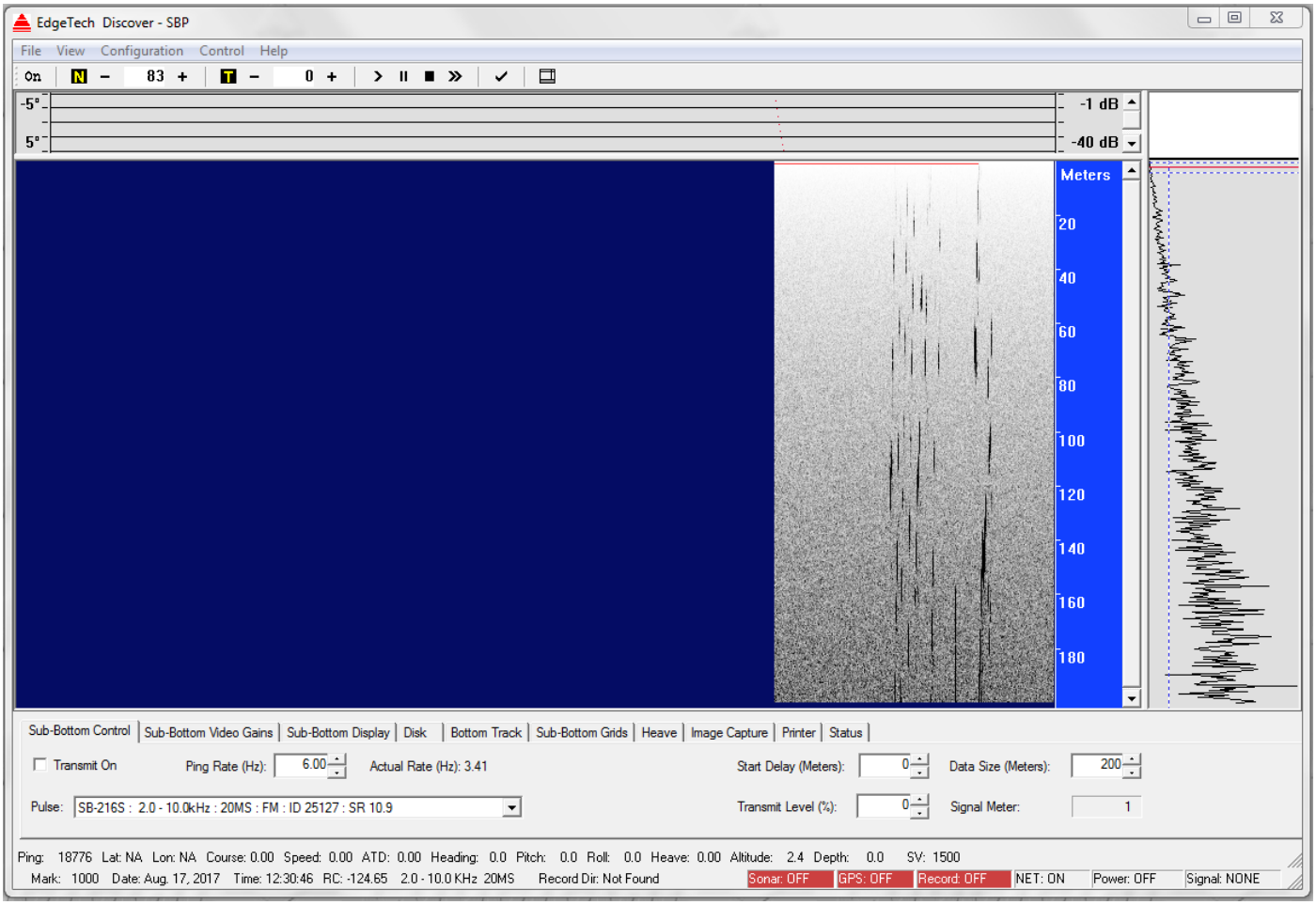


Figure 3-11: Tap Test

3.9 Tow Vehicle Deployment

The SB-424 and SB-216S Tow Vehicles can be towed using the 35-Meter Kevlar Reinforced Tow Cable. A steel cable can also be to increase the life of the tow cable. For towing in deep water, a single, armored tow cable is required. The steel cable can be secured to the tow cable using electrical tape, making sure there is enough built-in slack in the tow cable so that the entire load is supported by the steel cable.

CAUTION!

Do not tow the tow vehicle too close to the survey vessel. Towing in this manner can cause the tow vehicle to be pulled in against the hull of the ship due to the low pressure of the propeller wash and the effect of the water flowing by the hull. In addition, sonar reflections from the hull may be evident in the records.

The tow vehicle may be towed at speeds of up to 10 knots. However, to optimize performance and minimize flow noise, it is recommended that the tow vehicle be towed at speeds of less than 5 knots. Lead ballast in the nose of the tow vehicle provides towing stability by allowing the tow point to be placed as far forward as possible and by making the tow point well above the center of gravity of the tow vehicle. The tow point is factory adjusted so that the tow vehicle is level when it is towed in the water at 3 to 5 knots.

CAUTION!

Do not tow the tow vehicle with the nose angled up or down. Doing so can degrade the sonar imagery. Before towing the tow vehicle, verify that it is as level as possible when towing the tow vehicle at 3 to 5 knots.

3.9.1 Obtaining the Best Sonar Imagery When Towing

To generate good sonar imagery, the pitch of the vehicle, which is how much in degrees the nose is angled up or down, must be less than one half of the -6 dB beam width of the acoustic pulse at its highest frequency—and less at lower frequencies. As a rule of thumb, for a 0.5-meter long hydrophone array, the -6 dB beam width at 10 kHz is 20 degrees. For

example, if you are transmitting a 2 to 15 kHz FM pulse using a tow vehicle with a 0.5-meter long receiving array, such as in the SB-216S or SB-216D Tow Vehicle, you must keep the tow vehicle from pitching more than about 7 degrees in either direction, or

$$\frac{\frac{1}{2} x\ 20\ degrees\ x\ 10\ kHz}{15\ kHz} = 6.6\ degrees$$

Equation 1

The same criteria apply to vehicle roll, which is how much in degrees it is listing to port or starboard. Sensors can be installed on the tow vehicle to measure its pitch and roll under various towing conditions.

3.9.2 Conducting Sediment Classification Surveys When Towing

To conduct sediment classification surveys, the reflection coefficient should be measured with better than 10% accuracy. The normal component of the sea floor reflection must arrive within the angle corresponding to one half of the -1 dB beam width of the acoustic axis of the vehicle at the center frequency of the pulse, the frequency where most of the acoustic energy is concentrated and where the reflection coefficient is measured. As a rule of thumb, for a 0.5-meter long hydrophone array, the -1 dB beam width at 10 kHz is 4 degrees.

For example, if the sea floor is expected to have slopes of up to 5 degrees during the survey, and a vehicle with a 0.5-meter hydrophone array and a 2 to 10 kHz FM pulse is selected, the -1 dB beam width should be at least 10 degrees at 6 kHz. For this pulse and receiving array, the -1 dB beam width at 6 kHz is about 7 degrees, or

$$\frac{4\ degrees\ x\ 10\ kHz}{6\ kHz} = 6.6\ degrees$$

Equation 2

Therefore, only reflection coefficient measurements made when the sea floor slope is within 3.5 degrees of horizontal will be accurate within 10% (1 dB).

The attitude of the tow vehicle with respect to the horizontal plane must meet the -1 dB criteria described above for sediment classification surveys. Rough sea conditions tend to move the vehicle up and down vertically, causing oscillations in the images. DISCOVER 3100-P SB has a swell filter that will help reduce the heave effect on the record. Refer to the “DISCOVER 3100-P SB Sub-Bottom Software User’s Manual” for details. For sediment classification, the tow fish pulses must be calibrated by the end user. This calibration procedure is described in the software manual.

SECTION 4: MAINTENANCE

The 3100-P Sub-Bottom Profiling System is ruggedly designed and built, therefore requiring little maintenance. To ensure long lasting and reliable service, however, some periodic maintenance is recommended. This section provides some maintenance recommendations and includes instructions on how to disassemble and reassemble a tow vehicle should it be required to replace internal components.

4.1 Portable Topside

The 3100-P Portable Topside requires no maintenance.

4.2 Cleaning the Tow Vehicle and Tow Cable after Use

After retrieving the tow vehicle from the water, use a hose to wash it down, along with the tow cable, with clean, fresh water. Thoroughly spray the transducers and the hydrophone arrays from underneath the tow vehicle and remove any buildup of debris that may have been trapped inside. Inspect the inside of the tow vehicle, especially the transducers, the hydrophone arrays and the cables for any damage and for any loose connectors. Also inspect the tow cable and the connectors on each end.

After washing down the tow vehicle, clean the transducers and hydrophone arrays using a mild, non-abrasive detergent and water. Do not use any abrasive detergents or ammonia based cleaners. After cleaning, thoroughly spray the transducers and hydrophones again with fresh water.

4.3 Inspecting and Cleaning the Underwater Connectors

Regularly inspect the contacts on the male pins of each underwater connector in the tow vehicle and on the tow cable for corrosion or oxidation. To remove any oxidation, rub the contacts lightly with 800 grit emery cloth cut into strips equal to or less than the width of a contact. A pencil eraser can also be used for this purpose. The female sockets can be cleaned using a cotton swab and rubbing alcohol. A .22 caliber bore brush with only nylon bristles can be used to remove light oxidation.

To extend the life and increase the reliability of the connectors, apply a thin film of silicone dielectric grease, such as Novagard G624 general purpose silicone grease or an equivalent, to the entire surface of each male pin. A small amount of grease should also be applied to the opening of each female socket.

> **NOTE:** Remember to always install dummy connectors on the connectors of the tow cable and the tow vehicle tow cable connector.

4.4 Storage

When not in use, all the components of the 3100-P Sub-Bottom Profiling System should be packed in their original shipping containers, in the same manner in which they were originally shipped, and stored in a dry area.

4.5 Restoring the Operating System

An image file of the 80-GB hard drive is provided on a flash drive. This flash drive can be used to completely restore the hard drive to its original shipped factory configuration in the unlikely event of its failure. For instructions on how to restore the operating system hard drive, refer to **APPENDIX A: SYSTEM RESTORE**.

4.6 Disassembling and Reassembling a Tow Vehicle

The procedures below describe how to disassemble and reassemble a tow vehicle to access the transducers, hydrophones, transformers, inductors, spider boxes, spider arrays, and preamplifiers. The tools required are a socket wrench, 7/16 and 1/2-inch sockets, and a small flat screw driver.

CAUTION!

Disassembling a tow vehicle may void its warranty. If in doubt, contact **EDGETECH CUSTOMER SERVICE** for more information.

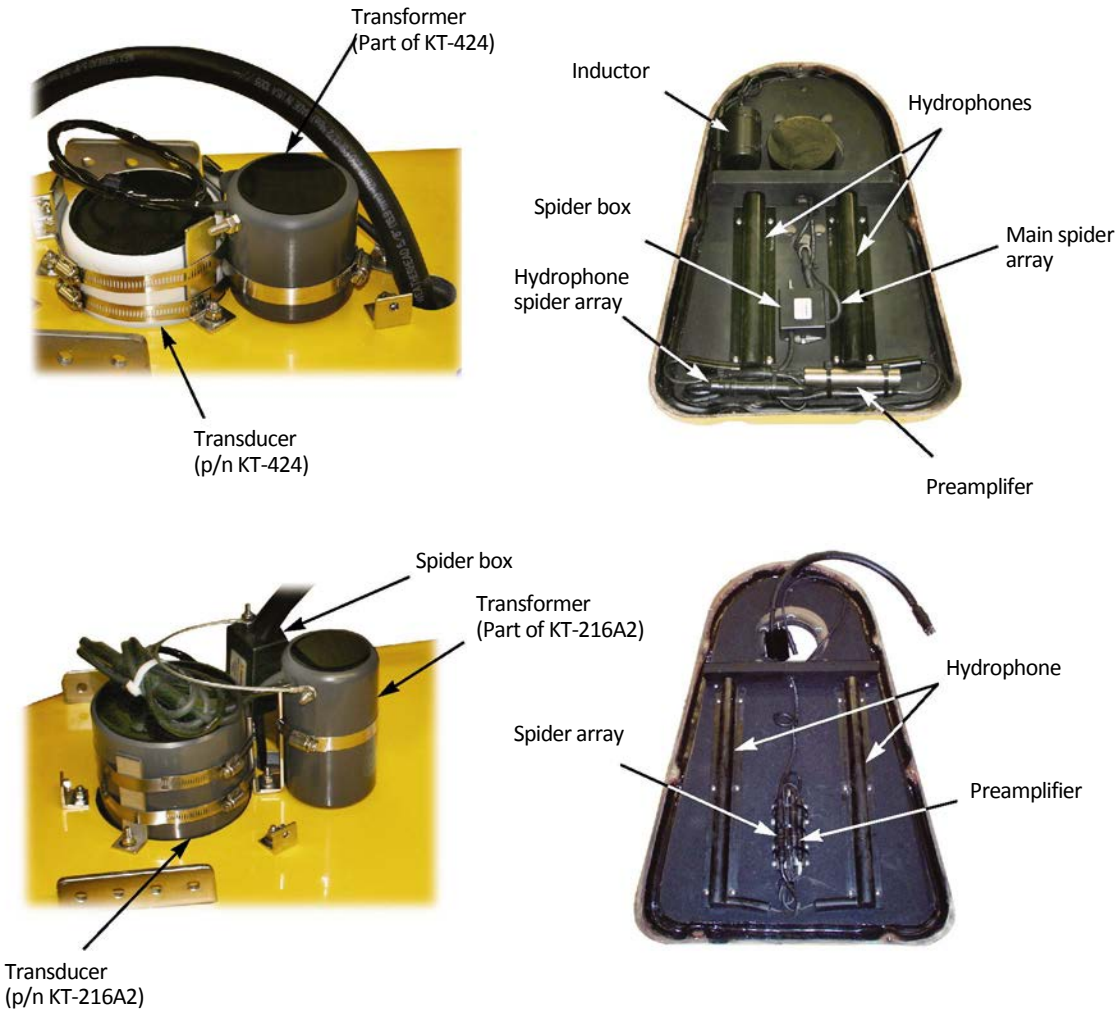


Figure 4-1: SB-424 and SB-216S Tow Vehicle Internals

4.6.1 Disassembling a Tow Vehicle

> **NOTE:** Some of the images shown below are of a 216SB vehicle being disassembled, whilst not the exactly like the 424 vehicle the overall disassembly procedure is similar.

To disassemble a sub-bottom tow vehicle:

1. Using the blade of the screw driver, pry out the retaining ring from the locking sleeve as shown in FIGURE 4-2.

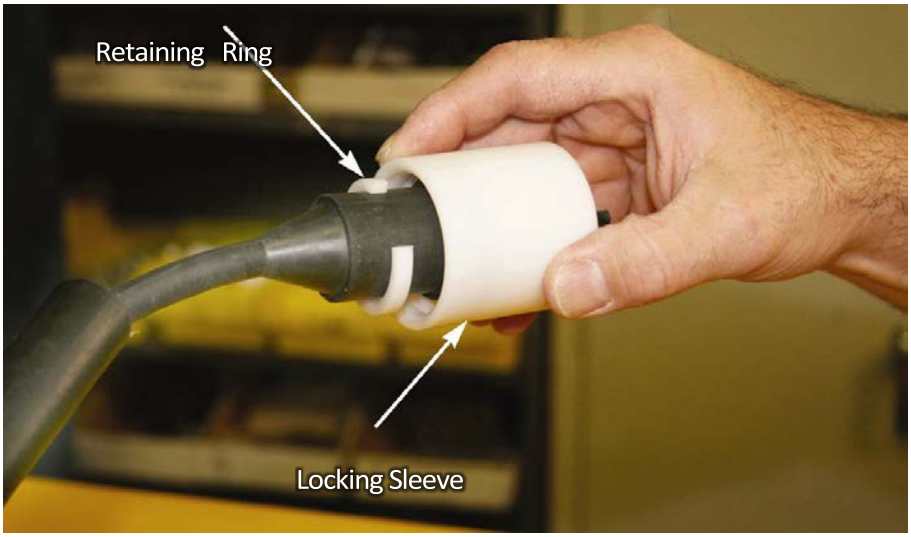


Figure 4-2: Retaining Ring and Locking Sleeve Removed

2. Remove the retaining ring and the locking sleeve from the connector as shown in FIGURE 4-3.

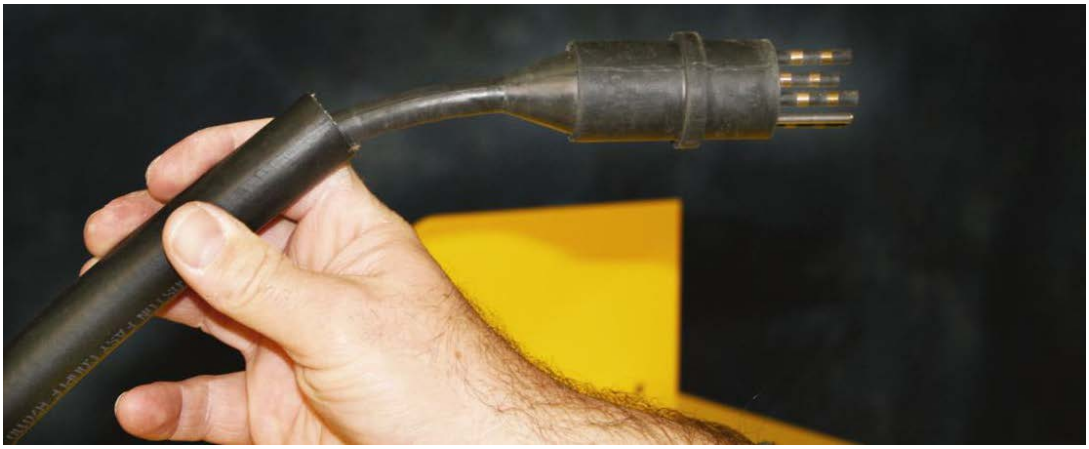


Figure 4-3: Male Connector

3. Using the socket wrench with the 7/16-inch socket, remove all the bolts securing the teardrop cover to the body of the tow vehicle as shown in **FIGURE 4-4**.

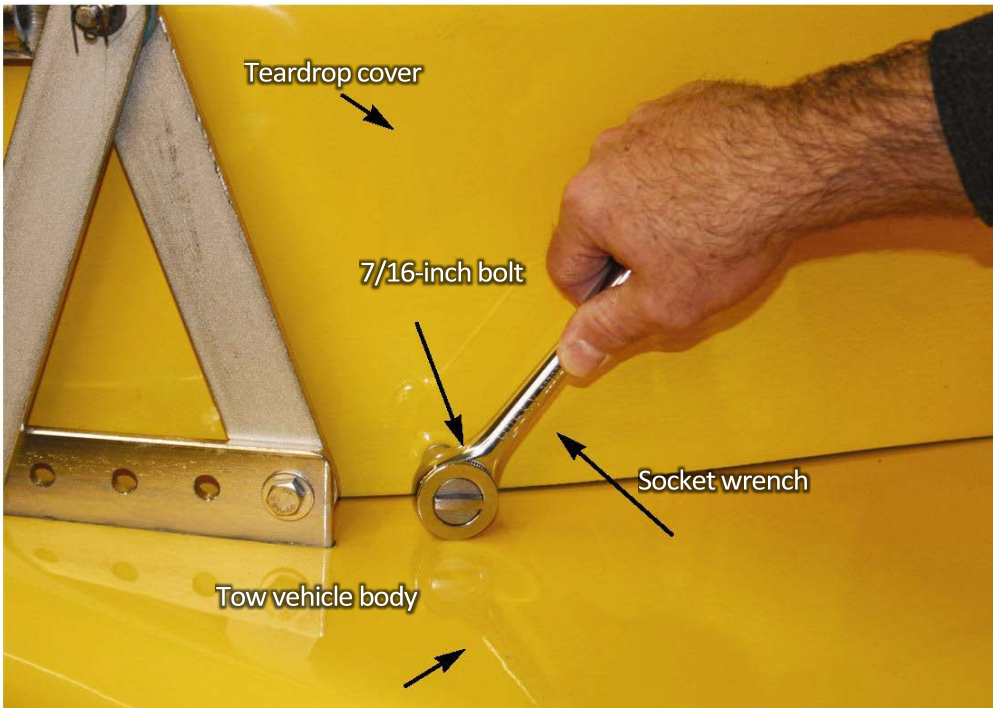


Figure 4-4: Removing the 7/16-Inch Bolts Securing the Teardrop Cover to the Tow Vehicle

4. Remove the teardrop cover as shown in **FIGURE 4-5**.

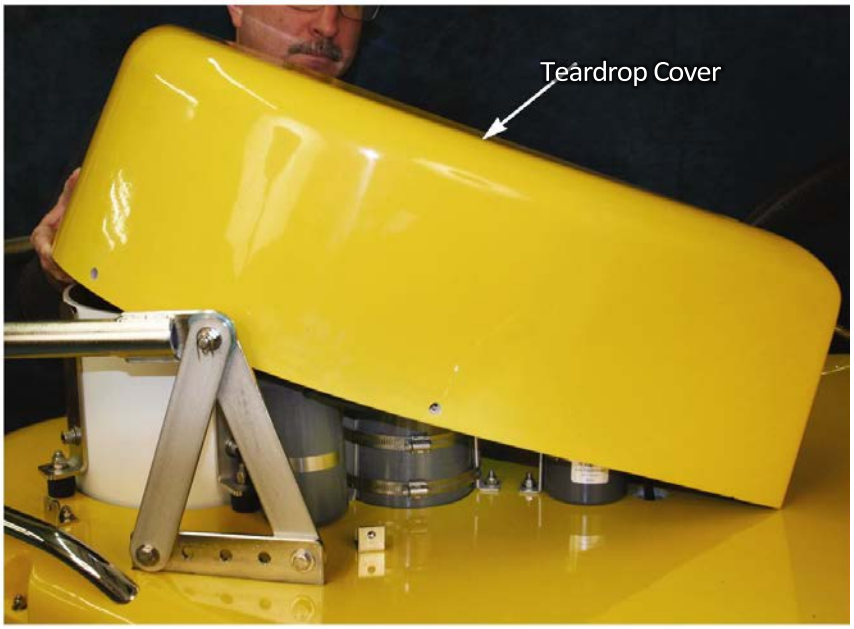


Figure 4-5: Removing the Teardrop Cover

5. Push the main spider assembly pigtail through the hole in the teardrop cover in FIGURE 4-6.

Figure 4-6: Teardrop Cover Removed

6. Using the socket wrench with the 7/16th-inch socket, remove all of the bolts and nuts securing the front half of the top cover of the tow vehicle body as shown in FIGURE 4-7. Continue with the rear half using a 1/2 –inch socket.

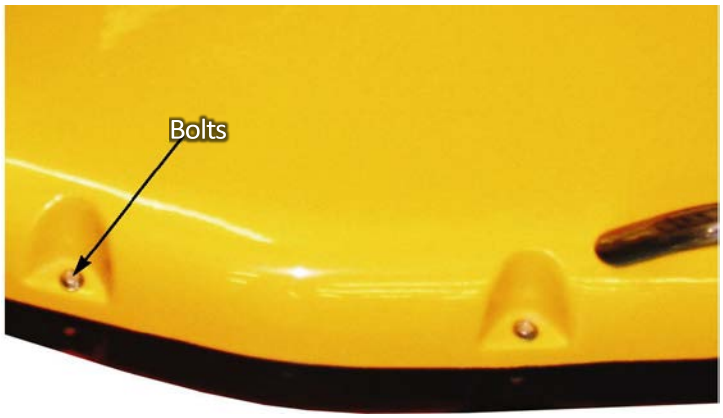


Figure 4-7: Removing 7/16 and ½ Inch Bolts and Nuts

7. Lift the top cover off, turn it over, and disconnect the spider cable from the hydrophones and the preamp components.

4.6.2 Reassembling a Tow Vehicle

To reassemble the tow vehicle, reverse the disassembly procedure described above.

SECTION 5: TROUBLESHOOTING

Should some operational or performance problems occur with the 3100-P Sub-Bottom Profiling System, it may be possible to correct them using the troubleshooting guide provided below.

This troubleshooting guide identifies some symptoms that could occur and presents one or more possible causes and the recommended corrective action for each. When using the troubleshooting guide, perform the corrective action for any given symptom in the order of possible causes, which generally corresponds to the degree of troubleshooting difficulty, from the simple to the more complex.

Before proceeding with any corrective action, verify the following:

- The topside is plugged into an appropriate power source.
- The 3100-P Portable Topside is switched on.

> **NOTE:** Be sure to also verify that all the cables in the topside and the tow vehicle are properly mated and are not loose or damaged. Most causes of operational or performance problems are a result of poor connection.

5.1 3100-P Portable Topside Troubleshooting

A table of troubleshooting procedures for the 3100P Topside is provided below:

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
RED POWER LED indicator on the topside does not turn on when the switch is turned on.	LED is defective	Replace the bulb. The Power Amplifier will operate with the bulb burnt out.
	AC fuse is blown.	Check the 5A/250V fuse in the topside connector box. If blown, replace the fuse.
	DC fuse is blown	Check the 20A fuse inside the 3100P topside. To access remove Top cover. If blown, replace the fuse. Use a 20A supplied.
The green Ready LED indicator on the 3100P Topside Processor does not illuminate	AC power is not connected.	Check the AC power cables and verify that the Deck Unit is connected to AC power.
	The indicator is not operating.	Open the 3100P Topside Processor and check the indicator and replace LED.
When performing the pre-deployment tests, transmissions from the transducers are not heard.	The tow cable is disconnected.	Check the tow cable and verify that it is properly connected on both ends.
	The tow cable is damaged.	Check the tow cable connectors for excessive corrosion or a broken pin. If corrosion or a broken pin is not found, check the continuity of the conductors in the tow cable.
		The topside spider has failed, replace spider assembly
		The transducer has failed, replace transducer .
	The Power Amplifier has failed.	Replace the Power Amplifier.
	The Tiger board has failed.	1. Check the sonar.exe program to see what it is reporting for a fault if any. 2. Check connectors to board 3. If these solutions fail, Contact EdgeTech about replacing the Tiger Board
When performing the pre-deployment tests, signals in the Sonar display are not present	Tow vehicle cable harness connections are loose.	Verify that all the cable harness connectors in the tow vehicle are properly mated.
	12 VDC power for the preamplifier is not present.	Check the sonar.exe program for 12 VDC If 12 VDC is not present replace the Tiger board.

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
	5 VDC from the preamplifier in the tow vehicle is not present.	Measure voltage between TOWFISH PREAMP 5 VDC test point and PREAMP COMMON test point on back of Deck Unit. Voltage should be 5 VDC.If 5 VDC is not present, check tow cable and spider mold in tow vehicle, repair or replace as needed. If 5 VDC still not present, replace tow vehicle's preamplifier.
Vertical black streaks are present in the Sonar display.	One or more of the underwater connectors are loose or have corroded contacts.	Inspect and clean the connectors. Reconnect the connectors.
	Extended use has caused a conductor in the tow cable or the cable harness in the tow vehicle to break.	Check the continuity of the conductors in the tow cable and in the cable harness.
There is white data dropout in the Sonar display.	A connector is loose or flooded.	Wiggle the tow cable connections and the connectors of the cable harness in the tow vehicle while watching the Sonar display for white streaks. If white streaks are present, refer to "Inspecting and Cleaning the Underwater Connectors" on page 4-2 and inspect and clean the connectors. Reconnect the connectors, and if necessary, secure them using electrical tape or locking sleeves. Possible spider assembly problem.
There are periodic streaks in the Sonar display from AC noise.	The system is not properly grounded.	Check the continuity between the GND connection on the back of the Deck Unit to ship's ground.
	The return signals from the hydrophone arrays are being clipped.	Reduce the preamplifier gain or the transmit power, or both.
Noise is present in the Sonar display.	Engine noise is coupling into the sonar frequency band.	Isolate the engine noise.
	Tow vehicle is in or near the ship's wake.	Tow the tow vehicle at a deeper depth and farther away from ship.
	The tow vehicle is not level when being towed.	Level the tow vehicle by adjusting the tow point such that the tow vehicle is level when moving through the water at 3 to 5 knots.
	The tow vehicle is being towed too fast.	Lower the speed of the tow vehicle.

Table 5-1: 3100-P Portable Topside Troubleshooting

5.2 Wiring and Connector Pin out Drawings

Included in the following pages are the 3100-P Sub-Bottom Profiling System diagrams for the 35-meter cable, portable topside, and towfish.

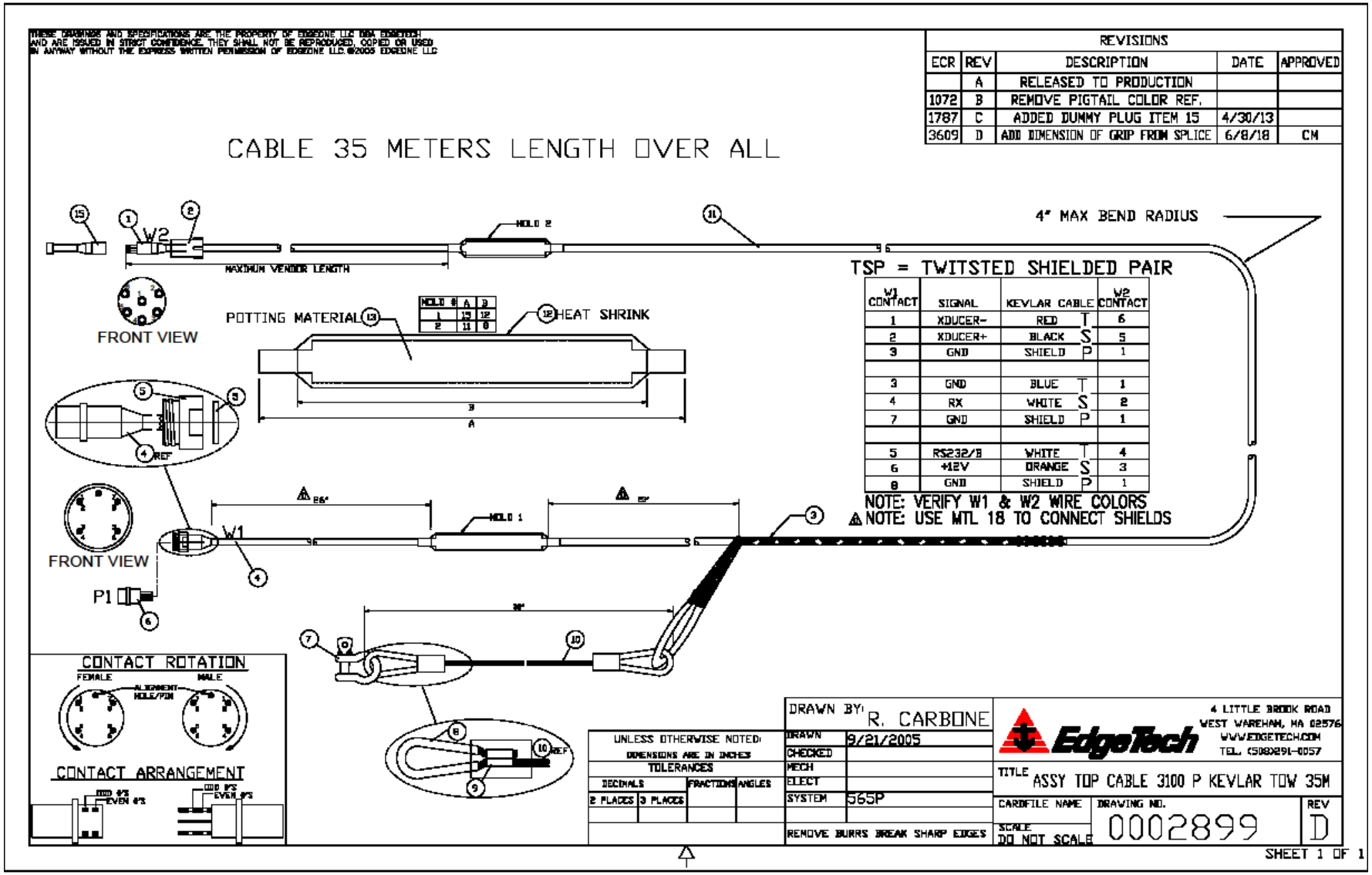


Figure 5-1: 35M Tow Cable Diagram – 0002899

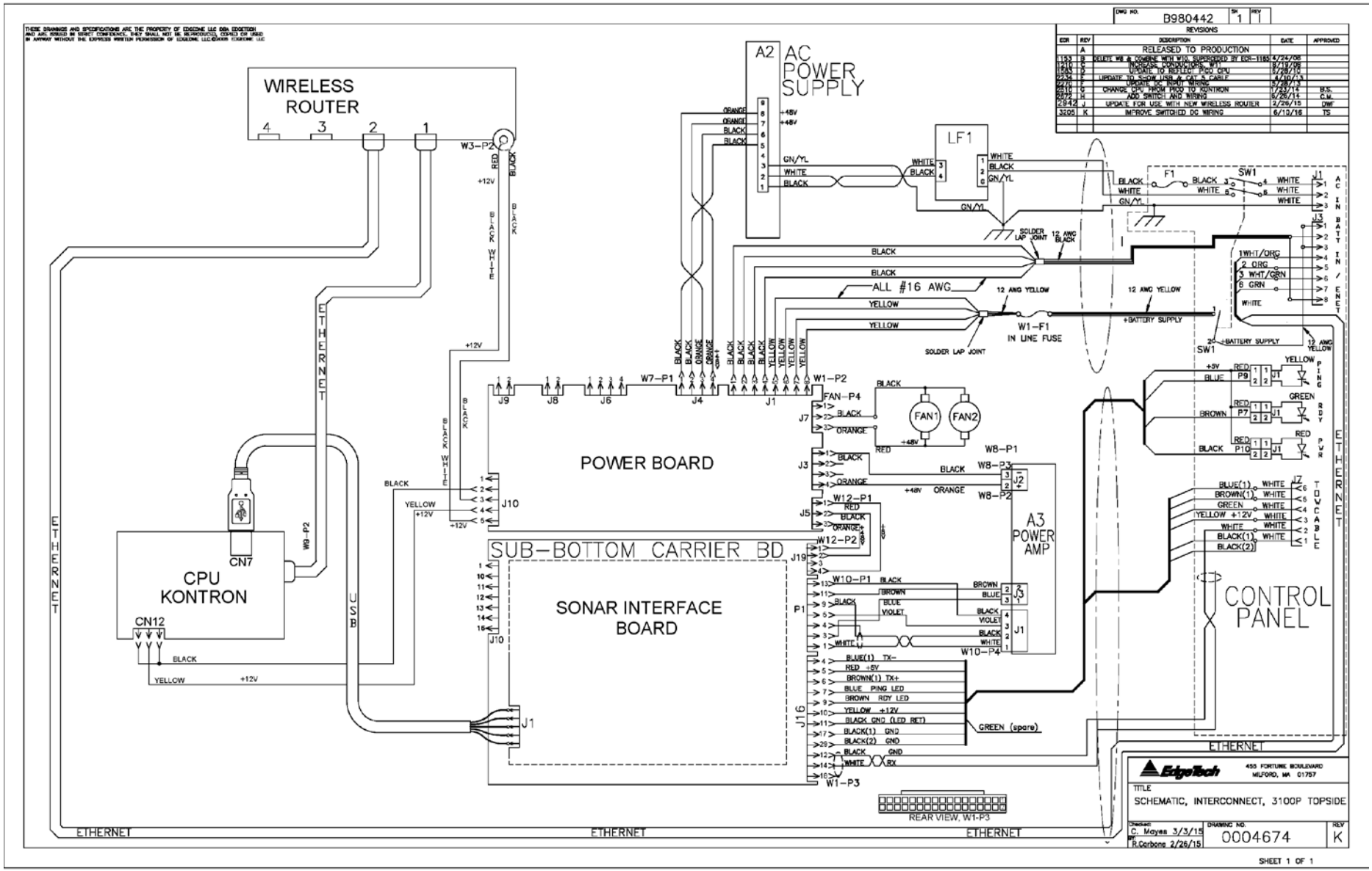


Figure 5-2: 3100-P Topside Interconnect – 0004674

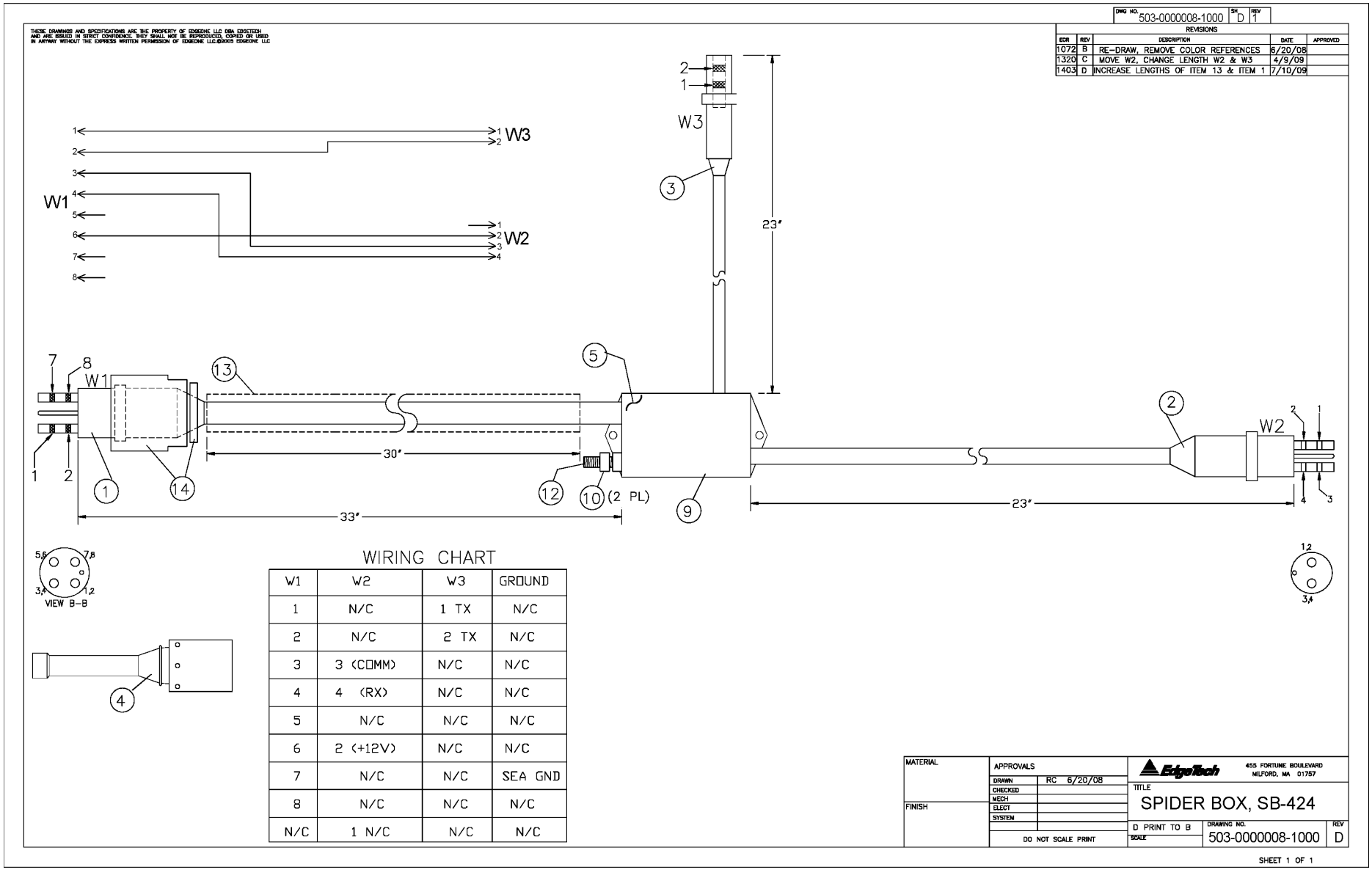


Figure 5-3: Wiring Diagram, Spider Box, SB-424 Tow Vehicle

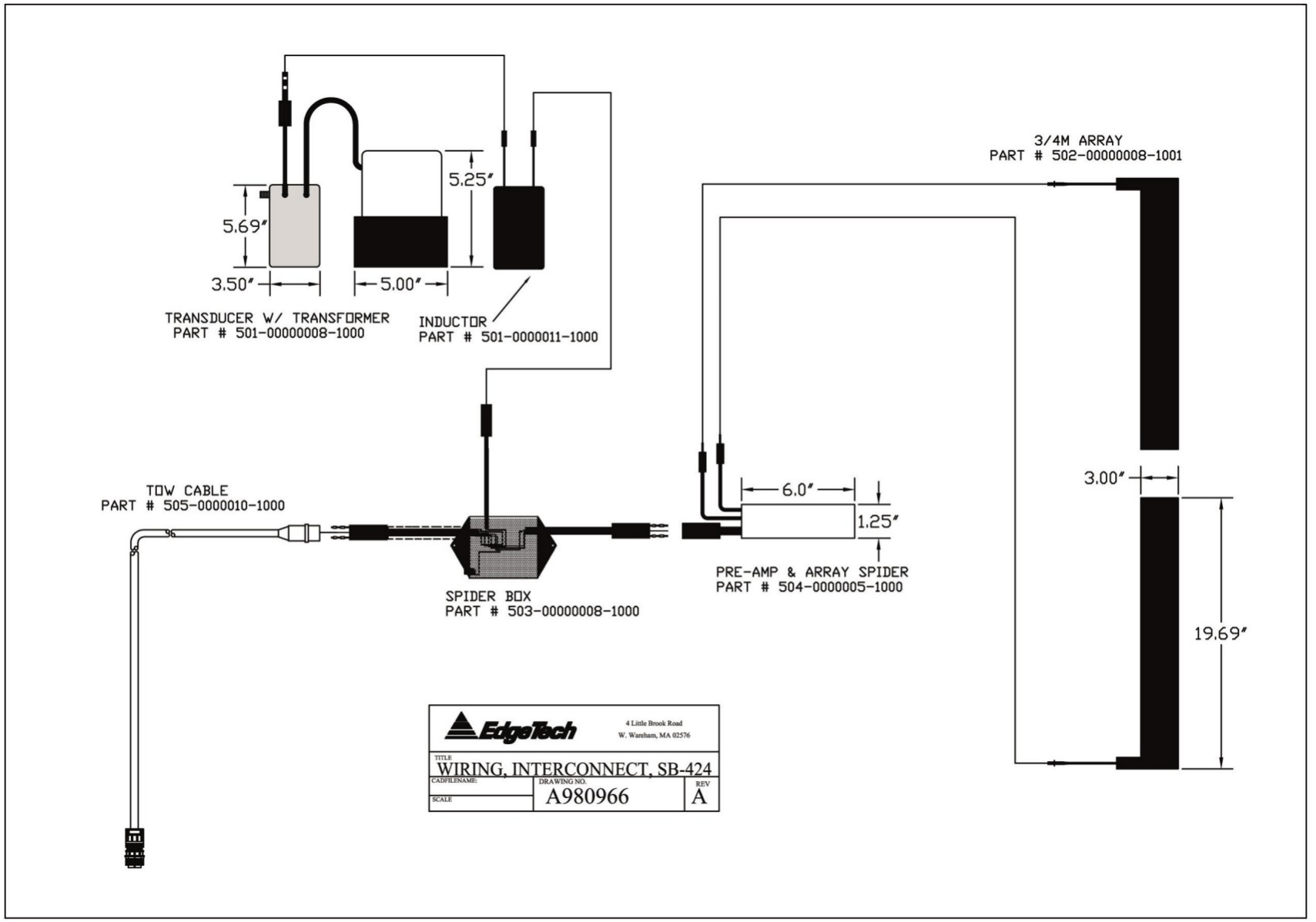
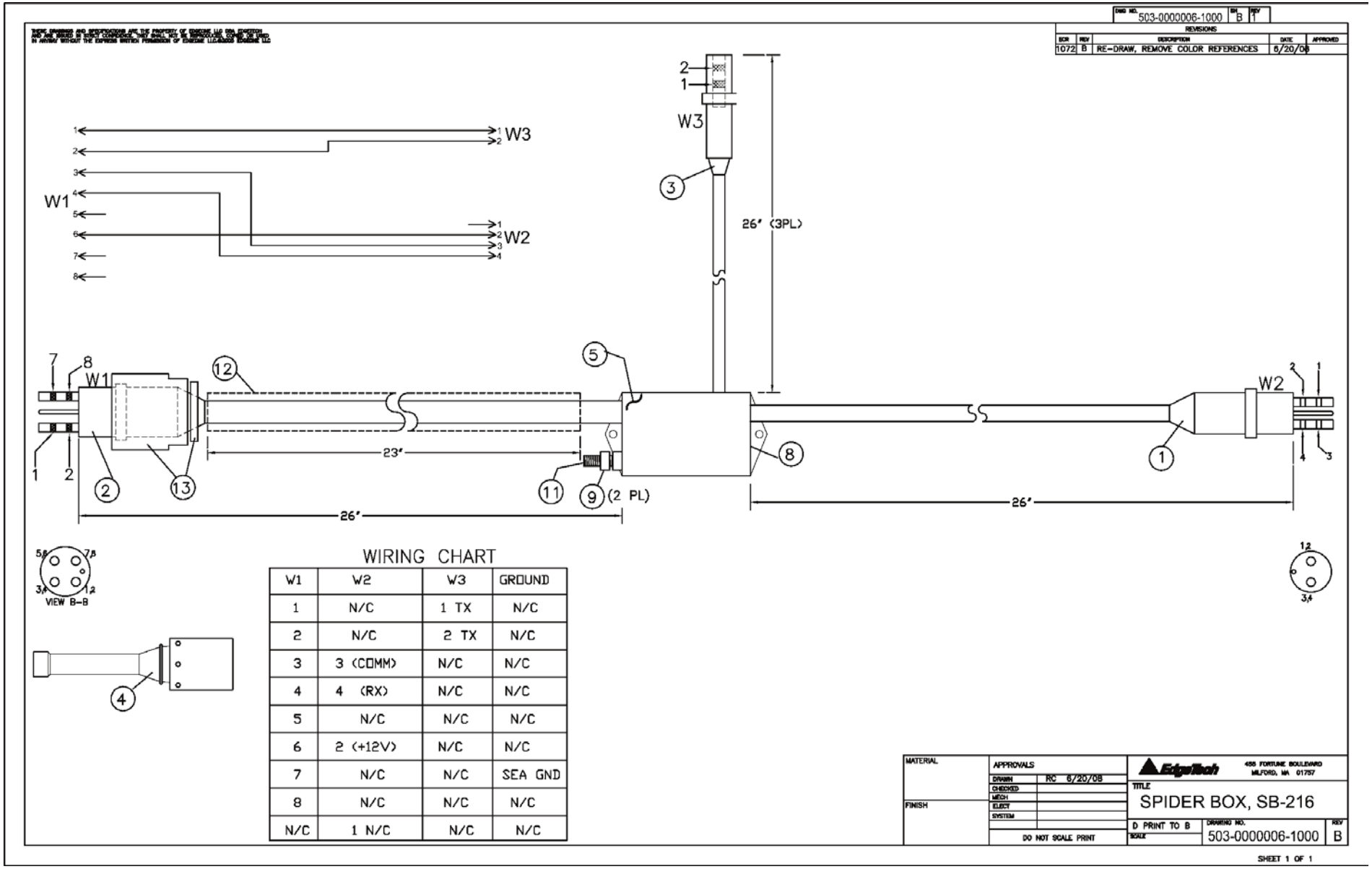


Figure 5-4: Wiring Diagram, SB-424 Tow Vehicle



W1	W2	W3	GROUND
1	N/C	1 TX	N/C
2	N/C	2 TX	N/C
3	3 (COMM)	N/C	N/C
4	4 (RX)	N/C	N/C
5	N/C	N/C	N/C
6	2 (+12V)	N/C	N/C
7	N/C	N/C	SEA GND
8	N/C	N/C	N/C
N/C	1 N/C	N/C	N/C

Figure 5-5: Wiring Diagram, Spider Box, SB-216S Tow Vehicle

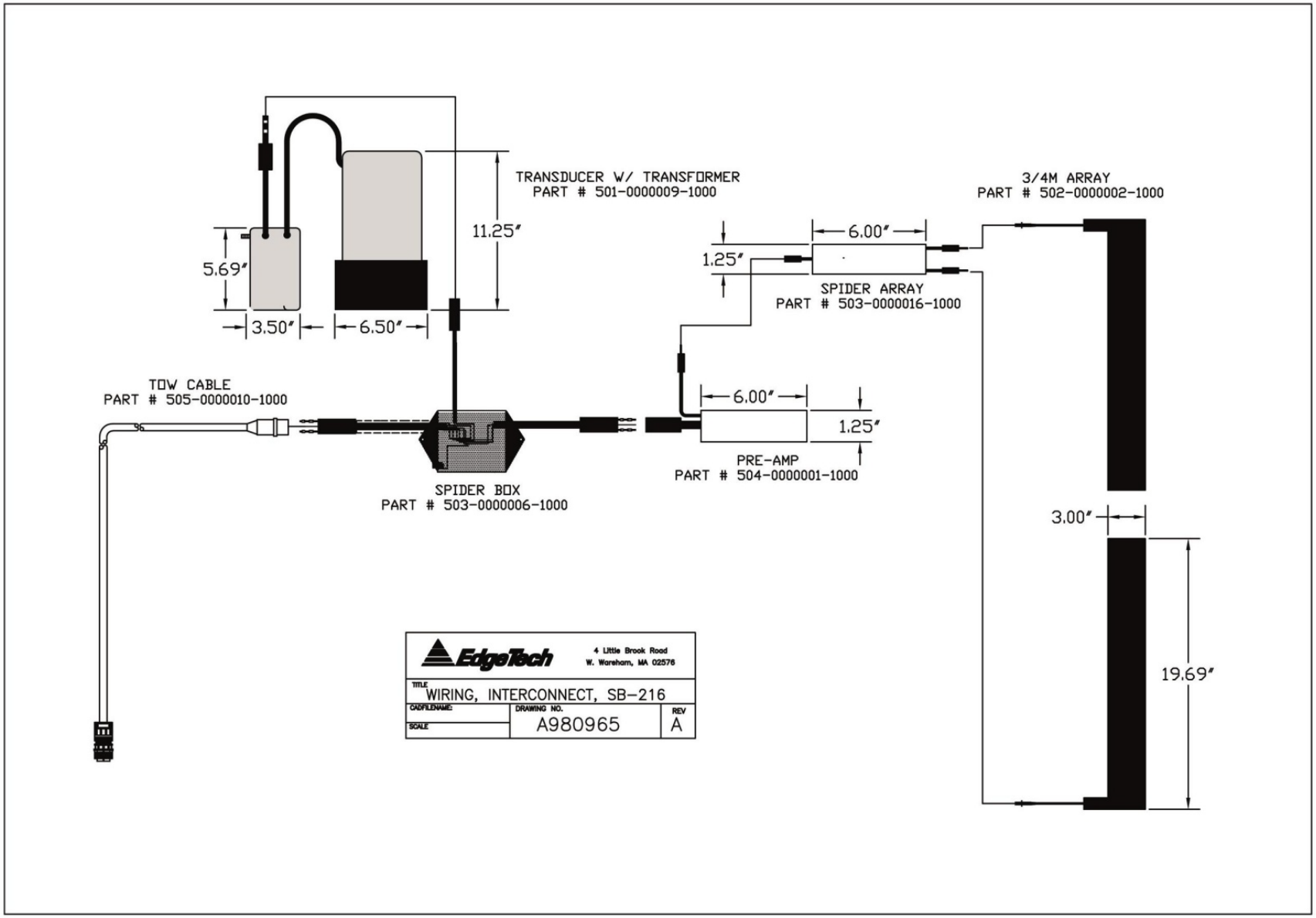


Figure 5-6: Wiring Diagram, SB-216S Tow Vehicle

APPENDIX A: SYSTEM RESTORE

The following section outlines the procedures for backing up and restoring the system drive.

CAUTION!

All data will be lost upon restoring the system to factory settings. Be sure to backup all data before preforming the procedure below.

1. Ensure that topside is off.
2. Insert USB3 flash drive in blue USB3 port.
3. Start topside and be prepared to press **F⋆⋆** key when prompted:
   a. If the topside is rack mount, press **F11**.
   b. If the topside is a laptop, press **F12**.
4. Under **Please select boot device:** By using up/down arrow keys, select **EUFI: Corsair Voyager 3.0 000A,** then press **Enter**.
5. Wait for **Paragon Backup & Recovery 14 Home** screen to appear, then click **Restore** icon.
6. On **Welcome to the Restore Wizard** screen click **Next**.
7. On **Browse for Archive** screen, drag down menu and click on ⊞ to the left of **(E:)**. Click on folder named as a variation of **V⋆.⋆.⋆_⋆⋆⋆⋆R** for rack mounts, or **V⋆.⋆.⋆_⋆⋆⋆⋆P** for laptops. When **Archive File Details** window appears, click **Next**.
8. At **What to restore** window, click **Basic MBR Hard Disk 0**, click **Next**.
9. At **Where to restore** window, ensure that **Basic MBR Hard Disk 0** is already selected (brown box around it). If it is not, use up/down arrow keys to select. Click **Next**.
10. At **Restore results** window, make no selection and click **Next**.
11. At the **Ready to restore from the archive** window, select ʘ **Yes, apply the changes physically.** Click **Next**. *Restoring will begin.*
12. At **Completing the restore wizard**, click **Finish**. Click **Shutdown**.
13. Remove USB3 flash drive and restart topside.

4205

TRI-FREQUENCY / MOTION TOLERANT SIDE SCAN SONAR SYSTEM

FEATURES

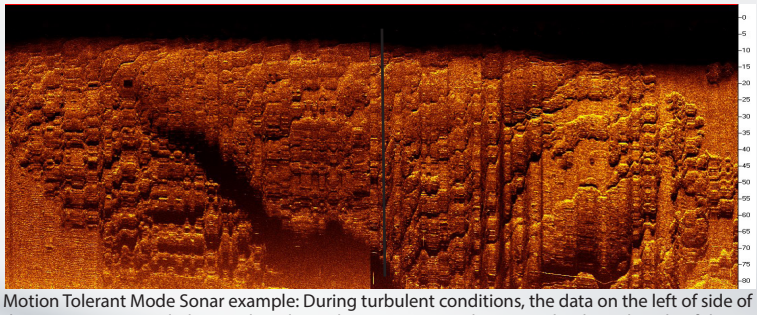
- Tri frequency side scan sonar
- Motion tolerant mode
- Improved target positioning
- Crisp, high resolution CHIRP imagery
- Increased towfish power to support wider range of 3rd party sensors
- Single pulse high resolution mode

APPLICATIONS

- Cable & pipeline surveys
- Geological/geophysical surveys
- Mine countermeasures (MCM)
- Geohazard surveys
- Channel clearance
- Search and recovery
- Archeological surveys

The next generation 4205 is a versatile side scan sonar system that can be configured for almost any survey application from shallow to deep water operations. The 4205 utilizes EdgeTech's Full Spectrum® CHIRP technology to provide crisp, high resolution imagery at ranges up to 50% greater than non-CHIRP systems; thus allowing customers to cover larger areas and save money spent on costly surveys. In addition to the high-resolution imagery that EdgeTech is known for, the 4205 comes with a number of new features which makes the system even more flexible and powerful in offshore operations. The 4205 is available in either a tri-frequency side scan sonar configuration or motion tolerant and multi-pulse configuration. The tri-frequency version allows surveyors the option to operate any two frequencies simultaneously from the tri-frequency system. Long range operations for example can be achieved with a selection of 230/540 kHz combination. Then, on-demand the system can be changed to a 540/850kHz system for an even higher resolution survey. The 4205 motion tolerant configuration with multi-pulse provides surveyors the ability to operate either at faster survey speeds or in more adverse weather conditions while still obtaining high quality underwater imagery. Additionally, this configuration can be operated in a single pulse high-resolution mode for those operations that require an even more finite view of the seafloor.

In both the tri-frequency and motion tolerant/ multi-pulse configurations, towfish and target positioning has been improved with the integration of a more accurate heading sensor. Additionally, all systems now come with increased towfish power to support a wider range of additional 3rd party sensors. All EdgeTech 4205 systems are comprised of a topside system and a reliable stainless steel towfish. Topside processors are rack mountable and come with easy-to-use GUI software that can be installed on the optional industrial workstation, laptop or customer provided PC.



Motion Tolerant Mode Sonar example: During turbulent conditions, the data on the left of side of this image was recorded using the EdgeTech 4205 Motion Tolerant mode. The right side of the image, depicting motion induced striping was captured without the Motion Tolerant mode for comparison.

For more information please visit EdgeTech.com

info@EdgeTech.com | USA 1.508.291.0057

4205

TRI-FREQUENCY / MOTION TOLERANT SIDE SCAN SONAR SYSTEM

KEY SPECIFICATIONS

SONAR SPECIFICATIONS	4205 TRI-FREQUENCY	4205 MULTI-PULSE/MOTION TOLERANT (MP/MT) AND HIGH DEFINITION MODE	
Frequency	Choice of either 120/410/850 kHz or 230/540/850 kHz	Choice of either 120/410 kHz, 230/540 kHz, 540/850 kHz or 230/850 kHz	
Operating Range (meters/side)	120 kHz: 600m, 230 kHz: 350m, 410 kHz: 200m, 540 kHz: 150m, 850 kHz: 90m		
		MP/MT	HDM
Horizontal Beam Width	120 kHz: 0.70° 230 kHz: 0.44° 410 kHz: 0.28° 540 kHz: 0.26° 850 kHz: 0.23°	120 kHz: 0.95° 230 kHz: 0.62° 410 kHz: 0.40° 540 kHz: 0.36° 850 kHz: 0.33°	0.70° 0.44° 0.28° 0.26° 0.23°
		MP/MT	HDM
Resolution Along Track	120 kHz: 2.4m @ 200m 230 kHz: 1.2m @ 150m 410 kHz: 0.5m @ 100m 540 kHz: 0.45m @ 100m 850 kHz: 0.20m @ 50m	120 kHz: 3.3m @ 200m 230 kHz: 1.7m @ 150m 410 kHz: 0.7m @ 100m 540 kHz: 0.6m @ 100m 850 kHz: 0.26m @ 50m	2.4m @ 200m 1.2m @ 150m 0.5m @ 100m 0.45m @ 100m 0.20m @ 50m
Resolution Across Track	120 kHz: 8cm; 230 kHz: 3cm; 410 kHz: 2 cm; 540 kHz: 1.5cm; 850 kHz: 1cm		
Vertical Beam Width	50°		
Depression Angle	Tilted down 25°		
TOWFISH	STAINLESS STEEL		
Diameter	12cm (4.75 inches)		
Length	140cm (55 inches)		
Weight in Air	52 kg (115 pounds)		
Depth Rating (Max)	2,000m		
Standard Sensors	Heading, pitch & roll		
Optional Sensor Port	(1) Serial – RS 232C, Bi-directional & 28 VDC +/- 4%		
Options	Pressure Sensor, Magnetometer interface, USBL Responder interface, Depressor, Power Loss Pinger and Custom Sensors		
TOPSIDE PROCESSOR	4205 INTERFACE		
Hardware	19" rack mount interface (150 watt or 400 watt)		
Display & Interface	Optional industrial workstation, laptop or customer provided PC		
Power Input	115/230 VAC		
File Format	Native JSF or XTF		
Sensor Interfaces	Ethernet, RS 232		
TOW CABLE			
	Coaxial Kevlar or double-armored up to 6,000m, winches available		

EdgeTech
An Affiliate of ORE Offshore

3100

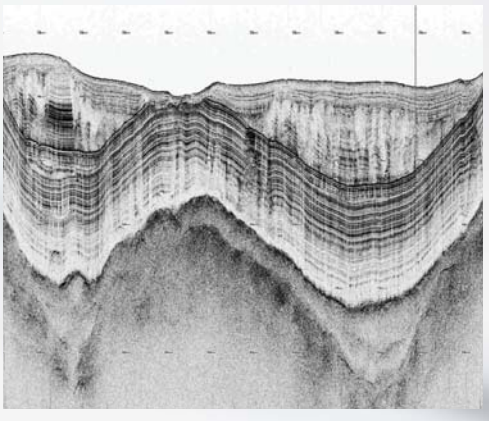
PORTABLE SUB-BOTTOM PROFILING SYSTEM

FEATURES

- Portable
- Low power requirement (runs on AC or DC)
- Choice of towfish depending on the application
- Pole mount option for shallow water surveys
- Easy to setup and operate

APPLICATIONS

- Geological Surveys
- Geohazard Surveys
- Buried Object Location
- Mining/Dredging Surveys
- Bridge/Shoreline Scour Surveys
- Pipeline and Cable Location



The 3100 is EdgeTech's portable version of their highly successful sub-bottom profiler product line. The system utilizes EdgeTech's Full Spectrum CHIRP technology which provides higher resolution imagery of the sub-bottom structure and greater penetration.

The 3100 is ideally suited for use in rivers, lakes, ponds and shallow water ocean applications up to 300m max depth. The system was designed for customers that require a portable system that can be used from smaller boats while not wanting to sacrifice image quality.

A 3100 system comes with a choice of two towfish; either the SB-424 or SB-216S. These towfish operate at different frequency ranges and selection between the two depends on the type of application. The 424 operates at 4-24 kHz and will provide slightly higher resolution but less penetration. The 216S operates at 2-16 kHz and provides slightly less resolution but greater penetration. Along with a towfish, the 3100 system comes with a portable splash-proof topside processor with laptop computer running EdgeTech's DISCOVER software for display of the sonar data. The system comes standard with a 35m tow cable with customer-specified lengths also available.

EdgeTech
An Affiliate of ORE Offshore

3100
PORTABLE SUB-BOTTOM PROFILING SYSTEM

KEY SPECIFICATIONS

TOWFISH	SB- 216S	SB- 424
Frequency Range	2-16 kHz	4-24 kHz
Vertical Resolution (depends on pulse selected)	6-10 cm	4-8 cm
Penetration		
In coarse calcareous sand	6m	2m
In clay	80m	40m
Size		
Length	105 cm	77 cm
Width	67 cm	50 cm
Height	40 cm	34 cm
Weight	76 kg	45 kg
Operating Depth (max)	300 meters	
TOPSIDE PROCESSOR		
Hardware	Rugged, portable splashproof enclosure	
Operating System	Windows XP	
Display	Splashproof semi-rugged laptop	
Archive	DVD-R/W	
File Format	SEG-Y	
I/O	Ethernet	
Power Input	110/220 VAC or 12 VDC	

SB-216S TOWFISH

SB-424 TOWFISH

MENU

Home > Products > High Power > "deep-36" SBP

Innomar "deep-36" Sub-Bottom Profiler

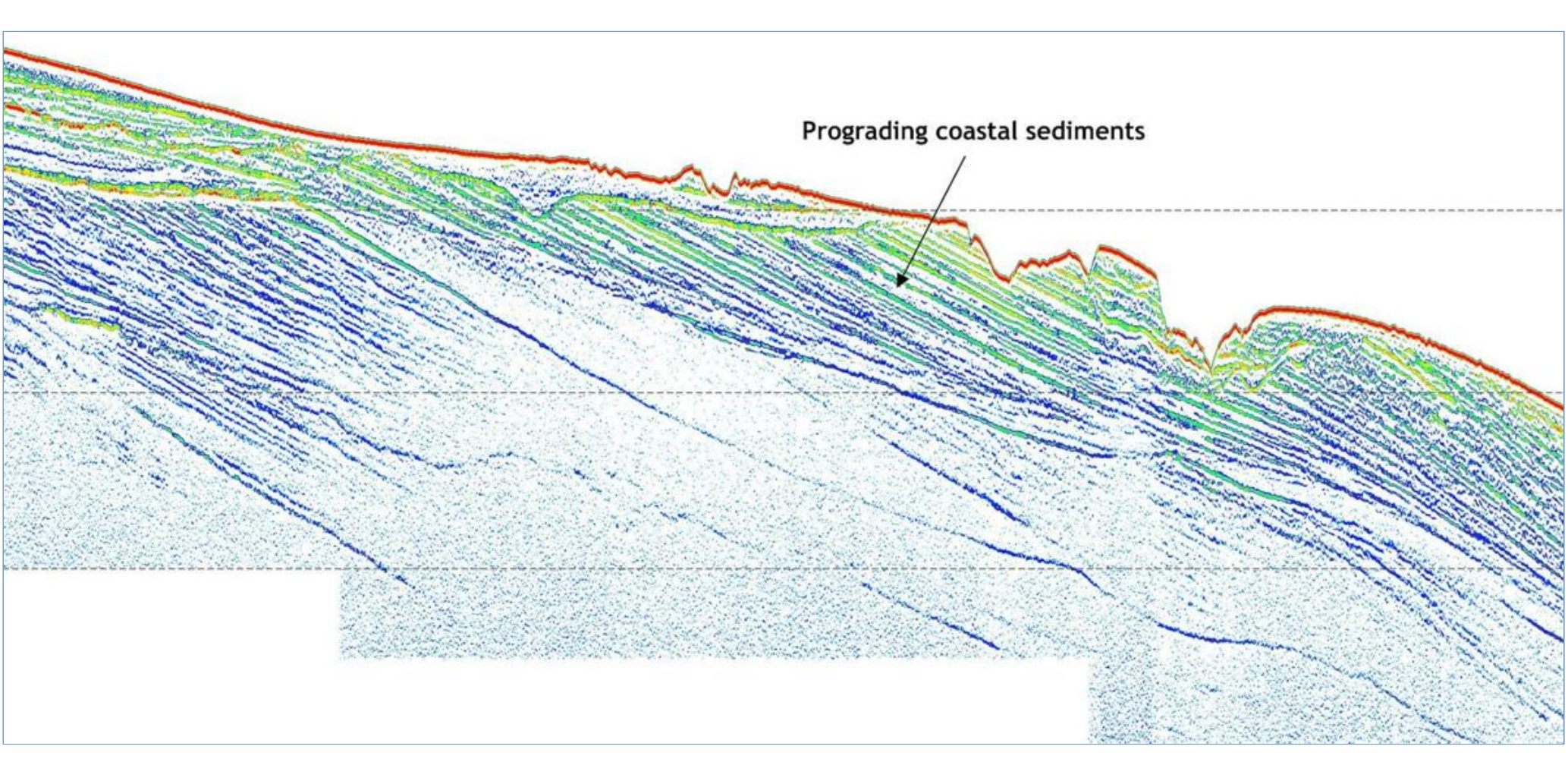
Innomar "deep-36" SBP

The **Innomar "deep-36"** parametric sub-bottom profiler is designed for offshore applications down to 6,000m water depth.

This model is available in two versions. The basic version features heave and roll compensation while the "RP" version offers additional pitch compensation.

The **Innomar "deep-36"** SBP acquires full-waveform data that can be processed with any seismic software (SEG-Y format). **Innomar** also provides the ISE post-processing software specialized on the **Innomar SBP** data.

The first generation of this model has been launched in 2007 as "SES-2000 deep-36", **the latest generation was introduced in 2021.**



Innomar "deep-36" SBP data example from Korea (pulse 4kHz / 750µs; depth range 130–210m)

Technical Specification

Water Depth Range	5 – 6,000 m below transducer
Sediment Penetration	up to 150 m (depending on sediment type and noise)
Sample / Range Resolution	c. 1 cm / up to 15 cm (depending on pulse settings)
Transmit Beam Width (-3dB)	c. ±1.5° for all frequencies / footprint c. 5.5% of water depth
Ping Rate	up to 40 pings/s
Heave / Roll / Pitch Compensation	heave + roll + optional pitch (depending on external sensor data)
Primary Frequencies (PHF)	c. 36 kHz (frequency band 30 – 42 kHz)
PHF Source Level / Acoustic Power	>246 dB//µPa re 1m / c. 9 kW
Secondary Low Frequency (SLF)	centre frequency user selectable: 2, 3, 4, 5, 6, 7 kHz
SLF Total Frequency Band	1 – 10 kHz
SLF Pulse Type	Ricker, CW, LFM Chirp
Pulse Width	user selectable 0.15 – 1.5 ms (CW); 5 ms (chirp)
Data Acquisition and Recording	digital 24 bit / 75 kHz (SLF full waveform, PHF envelope)
Data File Format	Innomar "SES3" (24 bit), "SEGY" (via SESconvert)
External Sensor Interfaces	HRP (motion), GNSS position, depth (all RS232 / UDP), trigger (BNC)
Bottom Detection	internal (PHF and SLF data) or external depth
Depth Accuracy	(5 cm @ 36 kHz / 10 cm @ 4 kHz) + 0.04% of water depth
Remote Control / Survey Integration	KVM / basic functions via COM or Ethernet (UDP), NMEA
Topside Unit (Transceiver)	W 52 cm × D 50 cm × H 50/63 cm (19'' / 10/13U) / weight c. 56/66 kg
Transducer (incl. 30 m cable)	W 88 cm × D 92 cm × H 18 cm / weight c. 245 kg (excl. cables)
Transducer Depth Rating	Surface
Power Supply	100–240 V AC
Power Consumption	<900W
Control / Data Storage PC	integrated PC (MS Windows 10/11 OS)
First / Latest Product Generation	2007 / 2021

Included Features

- Heave / Roll beam stabilization
- SLF full waveform data acquisition (sub-bottom data) / Innomar "RAW" data format
- 24 bit SLF full waveform data acquisition / Innomar "SES3" data format
- Multi-ping mode for maintaining a high pulse rate in deep waters
- Multi-frequency signals
- LFM chirp (2 – 7 kHz)
- KVM extender for remote control
- SESWIN basic remote-control via COM / UDP (e.g. line start/stop, line name)
- Transducer frame with integrated shock absorbers for hull-mounting

Optional Features

- SESWIN extended remote-control via Ethernet (TCP/IP)
- Pitch beam stabilization
- internal 10'' TFT display
- Bottom slope control
- Tranducer ice protection (acoustic window)

Software

- **SESWIN** data acquisition software
- **SES Convert** data converter software (RAW to SEG-Y, XTF, ASCII)
- **SES NetView** for online data and system information display on remote computers
- **ISE** post-processing software

Technical specifications are subject of change without notice.

Product overview

"medium-100" SBP

"medium-70" SBP

"deep-36" SBP

"deep-15" SBP

Shallow Water

High Power

Remotely Operated

Multi-Transducer

Innomar Software

Innomar Technologie GmbH

Schutower Ringstr. 4
18069 Rostock, Germany
Phone: +49 381 440 790

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Innomar's R&D is co-funded by the European Union
(European Regional Development Fund)

MENU

Home > Products > High Power > "medium-100" SBP

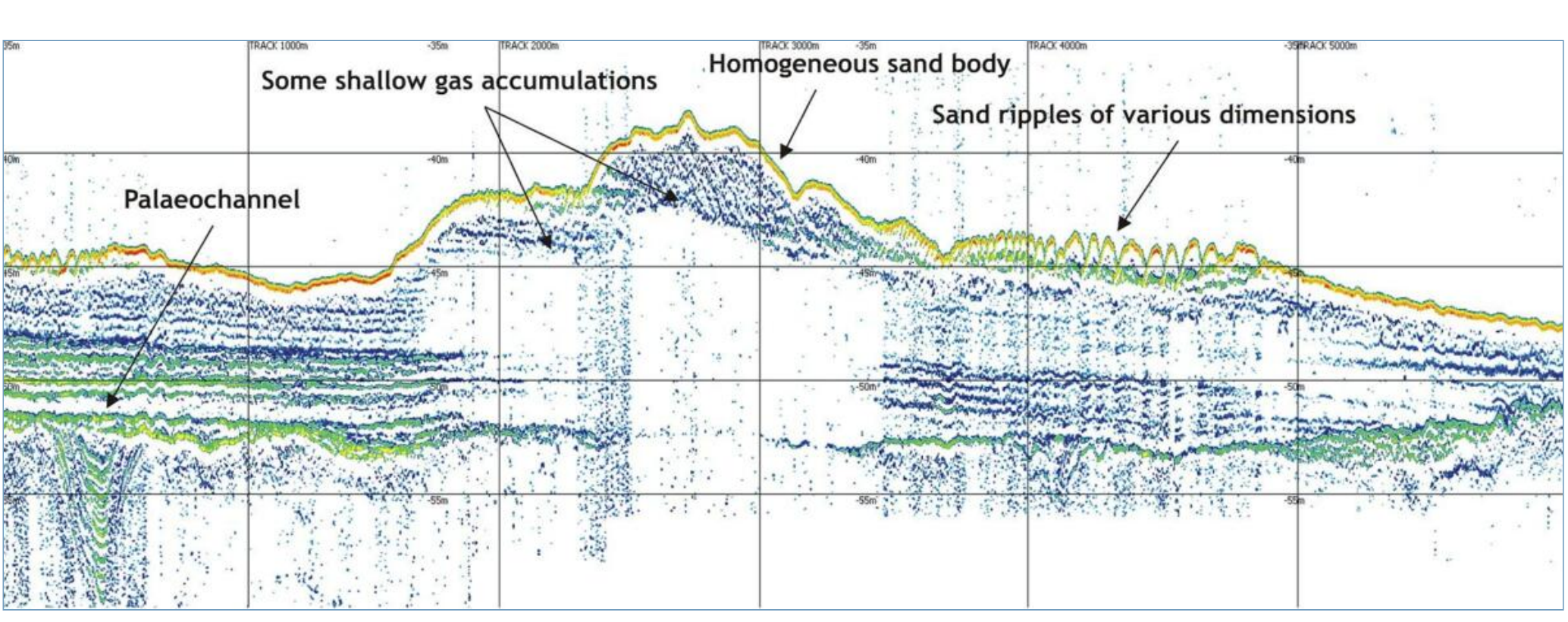
Innomar "medium-100" Sub-Bottom Profiler

Innomar "medium-100" SBP

The **Innomar "medium-100"** parametric sub-bottom profiler is designed for offshore applications down to 2,000m water depth. The transducer can be either mounted over-the-side or in the hull.

The **Innomar "medium-100"** SBP acquires full-waveform data (24 bit) that can be processed with any seismic software (SEG-Y format). **Innomar** also provides the ISE post-processing software specialized on the **Innomar** SBP data.

The first generation of this SBP model was introduced in 2004 ("SES-2000 medium"), while the **latest generation has been launched in 2020**.



Innomar "medium-100" SBP data example from rather shallow water in the North Sea (pulse 8kHz / 250µs; depth range 35–60m)

Technical Specification

Water Depth Range	2 – 2,000 m below transducer
Sediment Penetration	up to 70 m (depending on sediment type and noise)
Sample / Range Resolution	<1 cm / up to 5 cm (depending on pulse settings)
Transmit Beam Width (-3dB)	c. ±1° for all frequencies / footprint c. 3.5% of water depth
Ping Rate	up to 40 pings/s
Heave / Roll / Pitch Compensation	heave + roll (depending on external sensor data)
Primary Frequencies (PHF)	c. 100 kHz (frequency band 85 – 115 kHz)
PHF Source Level / Acoustic Power	>247 dB//µPa re 1m / c. 5.5 kW
Secondary Low Frequency (SLF)	centre frequency user selectable: 4, 5, 6, 8, 10, 12, 15 kHz
SLF Total Frequency Band	2 – 22 kHz
SLF Pulse Type	Ricker, CW, LFM Chirp
Pulse Width	user selectable 0.07 – 1.0 ms (CW); 3.5 ms (chirp)
Data Acquisition and Recording	digital 24 bit / 96 kHz (SLF full waveform, PHF envelope)
Data File Format	Innomar "SES3" (24 bit) and "RAW" (16 bit), "SEGY" (via SESconvert)
External Sensor Interfaces	HRP (motion), GNSS position, depth (all RS232 / UDP), trigger (BNC)
Bottom Detection	internal (PHF and SLF data) or external depth
Depth Accuracy	(2 cm @ 100 kHz / 4 cm @ 10 kHz) + 0.02% of water depth
Remote Control / Survey Integration	KVM / basic functions via COM or Ethernet (UDP), NMEA
Topside Unit (Transceiver)	W 52 cm × D 40 cm × H 44 cm (19'' / 9U) / weight c. 44 kg
Transducer (incl. 30 m cable)	W 50 cm × D 50 cm × H 12 cm / weight c. 60 kg
Transducer Depth Rating	Surface
Power Supply	100–240 V AC
Power Consumption	<400W
Control / Data Storage PC	integrated PC (MS Windows 10/11 OS) with 10'' TFT display
First / Latest Product Generation	2004 / 2020

Included Features

- Heave / Roll beam stabilization
- SLF full waveform data acquisition (sub-bottom data) / Innomar "RAW" data format
- 24 bit SLF full waveform data acquisition / Innomar "SES3" data format
- Multi-ping mode for maintaining a high pulse rate in deep waters
- Multi-frequency signals
- LFM chirp (5 – 15 kHz)
- KVM extender for remote control
- SESWIN basic remote-control via COM / UDP (e.g. line start/stop, line name)

Optional Features

- SESWIN extended remote-control via Ethernet (TCP/IP)
- Rugged housing with shock absorbers (MIL standard, IP65)
- Transducer frame with integrated shock absorbers for hull-mounting

Software

- **SESWIN** data acquisition software
- **SES Convert** data converter software (RAW to SEG-Y, XTF, ASCII)
- **SES NetView** for online data and system information display on remote computers
- **ISE** post-processing software

Technical specifications are subject of change without notice.

Product overview

"medium-100" SBP

"medium-70" SBP

"deep-36" SBP

"deep-15" SBP

Shallow Water

High Power

Remotely Operated

Multi-Transducer

Innomar Software

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EM® 2040 MKII

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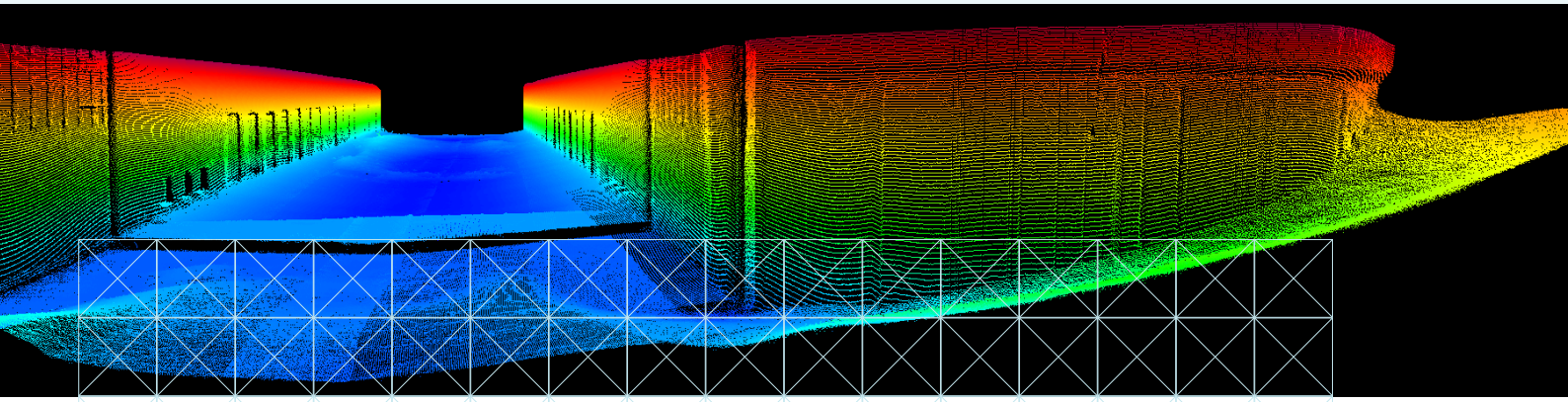


MULTIBEAM ECHO SOUNDER

The EM 2040 MKII is a true wide band high resolution shallow water multibeam echo sounder, an ideal tool for any high resolution mapping and inspection application. With this release, Kongsberg Maritime has upgraded the hardware and software to increase the swath and improve the data quality of our EM 2040 series.

Key facts

The system fulfils, and even surpasses, IHO-S44 Exclusive Order and the more stringent LINZ specification.

The EM 2040 was the first 3-sector broadband multibeam echo sounder in the market, now available as a 200 - 700 kHz system. The operator can on the fly choose the best operating frequency for the application: 300 kHz for near bottom, 200 kHz for deeper waters and 400 - 700 kHz for very high resolution inspection. 600 kHz wide area high frequency mapping mode offers an unprecedented 100 - 120° swath width. 700 kHz inspection mode provides the highest resolution available contained within a narrow 30° swath.

By alternating between the frequency modes per ping, the system is capable of providing the operator with Multi Frequency Backscatter of up to 5 frequencies in a single pass. The same functionality allows the system to alternate between a full swath mode and a high resolution mode providing full coverage while maintaining ultra high resolution over a target.

Due to the large operating bandwidth, the system has an output sample rate up to 60 kHz. The system can effectively operate with very short pulse lengths, the shortest pulse being 14 microseconds giving a raw range resolution (CT/2) of 10.5 mm.

The angular coverage for the 200 and 300 kHz is up to 170° on slopes and piersides, with coverage up to 8 times water depth on a flat bottom. For a dual transducer system, 220° angular coverage or 10 times the water depth is achieved on a flat bottom.

Components

The EM 2040 MKII is a modular system, fully prepared for upgrading to cater for more demanding applications. The basic system has four units: a transmit transducer, a receive transducer, a processing unit and a hydrographic workstation.

The EM 2040 MKII receiver is 0.5° and is delivered with a 0.25° or 0.5° transmitter(s). The transmit fan is divided into three sectors pinging simultaneously at separate frequencies ensuring a strong and beneficial dampening of multibounce interference.

As an option the EM 2040 MKII can be delivered with dual swath capability, allowing a sufficient sounding density to meet survey coverage standards along track while maintaining a high vessel speed. A single transmitter with dual receiver setup fully exploits the unique angular coverage of our three-sector transmitter for full 220° angular coverage per ping.

The specialised dual transmitter and receiver setup is ideal where mounting requires a large separation of receivers, where mounting the transmitter at the keel is not an option or for ROV pipeline surveying and free span detection. This configuration transmits on a single sector per transmitter with selectable frequency in steps of 10 kHz from 200 to 400 kHz.

The standard depth rating of the EM 2040 MKII transducers is 6000 m, making it ideal for operation on subsea vehicles such as ROVs or AUVs.

443810 /H December 2021

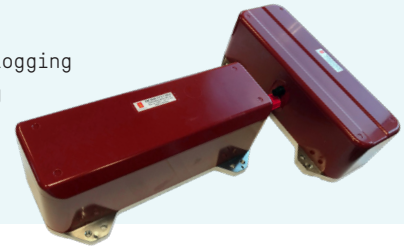
FEATURES

Included Features

- 200-400 kHz wide frequency range
- Seabed image
- Water column display and logging for SIS users
- FM chirp
- Roll, pitch and yaw stabilisation
- Short pulse lengths, large bandwidth
- Transmit and receive nearfield focusing
- Depth rated to 6000 m

Optional features

- Dual swath
- 600 kHz and 700 kHz modes
- EM® MultiFrequency Mode
- Water column display and logging
- Water column phase logging
- Extra detections
- Dual RX
- Dual TX



TECHNICAL SPECIFICATIONS

Frequency range	200 to 700 kHz
Max ping rate	50 Hz
Swath coverage sector	Up to 170° (single receiver) / 220° (dual receiver)
Depth Rating	6000 metres and 50 metres versions available
Beam patterns	Equiangular, equidistant high density and ultra high density
No. of beams per ping	512 (Single RX)/1024 (Single RX, Dual Swath)/2048 (Dual RX, Dual Swath)
Roll stabilised beams	± 15°
Pitch stabilised beams	± 10°
Yaw stabilised beams	± 10°

Coverage example for EM 2040 with bottom type rock (BS = - 10 dB), NL = 45 dB, FM enabled

Operating mode	Cold ocean water			Cold fresh water		
EM 2040-04:	**Max depth**	**Max coverage single RX**	**Max coverage dual RX**	**Max depth**	**Max coverage single RX**	**Max coverage dual RX**
200 kHz	635 m	920 m	980 m	1360 m	1990 m	2110 m
300 kHz	480 m	670 m	760 m	740 m	1100 m	1270 m
400 kHz	315 m	410 m	430 m	430 m	570 m	610 m
600 kHz	95 m	130 m	-	115 m	150 m	-
700 kHz	55 m	27 m	-	60 m	30 m	-
EM 2040-07:						
200 kHz	600 m	880 m	930 m	1300 m	1870 m	2000 m
300 kHz	465 m	640 m	725 m	700 m	1050 m	1200 m
400 kHz	300 m	385 m	410 m	375 m	540 m	570 m
600 kHz	85 m	120 m	-	105 m	140 m	-
700 kHz	50 m	25 m	-	55 m	28 m	-

Pulse lenghts

200 kHz		300 kHz		400 kHz	600 kHz	700 kHz
CW	**FM**	**CW**	**FM**	**CW**	**CW**	**CW**
19 to 324 µs	1.5 to 12 ms	19 to 324 µs	1.5 to 6 ms	14 to 108 µs	100 to 410 µs	70 µs

	Beamwidth					**Physical dimensions (excluding connectors and mounting arrangements)**	
	200 kHz	**300 kHz**	**400 kHz**	**600 kHz**	**700 kHz**	**Dimensions**	**Weight**
TX EM 2040-04	0.7°	0.5°	0.4°	0.25°	0.225°	727 x 142 x 150 mm (LxWxH)	45 kg
TX EM 2040-07	1.5°	1°	0.7°	0.5°	0.45°	407 x 142 x 150 mm (LxWxH)	23 kg
RX	1.5°	1°	0.7°	0.5°	0.45°	407 x 142 x 136 mm (LxWxH)	22 kg
Processing Unit (2U for 19" rack)						482.5 x 424 x 88.6 mm (WxDxH)	10.5 kg
Portable Processing Unit (IP67)						370 x 390 x 101 mm (WxDxH)	10.5 kg

Laptop, Hydrographic Work Station (HWS) and monitor can be delivered on request.

Specifications subject to change without any further notice.

Front page: Curtesy of Port of London.

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Attachment 2
NMFS Spreadsheet Results for Distance to Level A Thresholds

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

VERSION 2.2: 2020

KEY

	Action Proponent Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	**Attentive Energy HRG Surveys**
PROJECT/SOURCE INFORMATION	**Dual Geo-Spark 2000X (400 tip/800J)**

Please include any assumptions

PROJECT CONTACT	**Sarah Courbis/Melissa Snover**

CONVERSIONS

Source Level ($L_{p,pk-pk}$)			
Source Level ($L_{p,0-pk}$)	-6	**Source Level ($L_{p,0-pk}$)**	
Source Level (L_{rms})	-12	**Source Level (L_{rms})**	-6
Source Level ($L_{E,p,\ single\ shot}$)	-22	**Source Level ($L_{E,p,\ single\ shot}$)**	-16

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Weighting Factor Adjustment (kHz)¥	1	Specify if relying on source-specific NMFS recommended

¥ Broadband: 95% frequency contour percentile (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 68), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: METHOD F1 is PREFERRED method when SEL-based source levels are available (because pulse duration is not required). Only use method F2 if SEL-based source levels are not available.

F1: METHOD[1] TO CALCULATE PK and SEL_{cum} (SINGLE SHOT/PULSE EQUIVALENT) PREFERRED METHOD (pulse duration not needed)

SEL_{cum}		PK		
Source Level ($L_{E,p,\ single\ ping/pulse/shot}$)	173.4	**Source Level ($L_{p,0-pk}$)**		211
Source Velocity (meters/second)	2.06			
1/Repetition rate^ (seconds)	0.25			
Source Factor	8.75105E+17			

loss of 20 log R; Activity duration (time)

^Time between onset of successive pulses (inverse of repetition rate or inter-pulse interval).

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS SEL_{cum} Isopleth to threshold (meters)	**0.7**	**0.0**	**0.1**	**0.1**	**0.0**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**2.8**	**NA**	**NA**

*"NA": PK source level is < to the threshold for that marine mammal hearing group.

D: MOBILE SOURCE: Non-Impulsive, Intermittent ("SAFE DISTANCE" METHODOLOGY)

VERSION 2.2: 2020

KEY

	Action Proponent Provided Information
	NMFS Provided Information (Technical Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Attentive Energy HRG Survey
PROJECT/SOURCE INFORMATION	Innomar Sub-Bottom Profiler
Please include any assumptions	
PROJECT CONTACT	Sarah Courbis/Melissa Snover

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		alternative weighting/dB adjustment, or if
Weighting Factor Adjustment (kHz)¥	85	Lower end of source-specific operation frequeny range

¥ 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 61), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: METHOD D1 is PREFERRED method when SEL-based source levels are available (because pulse duration is not required). Only use method D2 if SEL-based source levels are not available.

D1: METHOD† (SINGLE PING/PULSE EQUIVALENT) PREFERRED METHOD (pulse duration not required)

Source Level ($L_{E,p,\ single\ ping/pulse}$)	178
Source Velocity (meters/second)	2.06
1/Repetition rate^ (seconds)	0.025
Source Factor	2.52383E+19

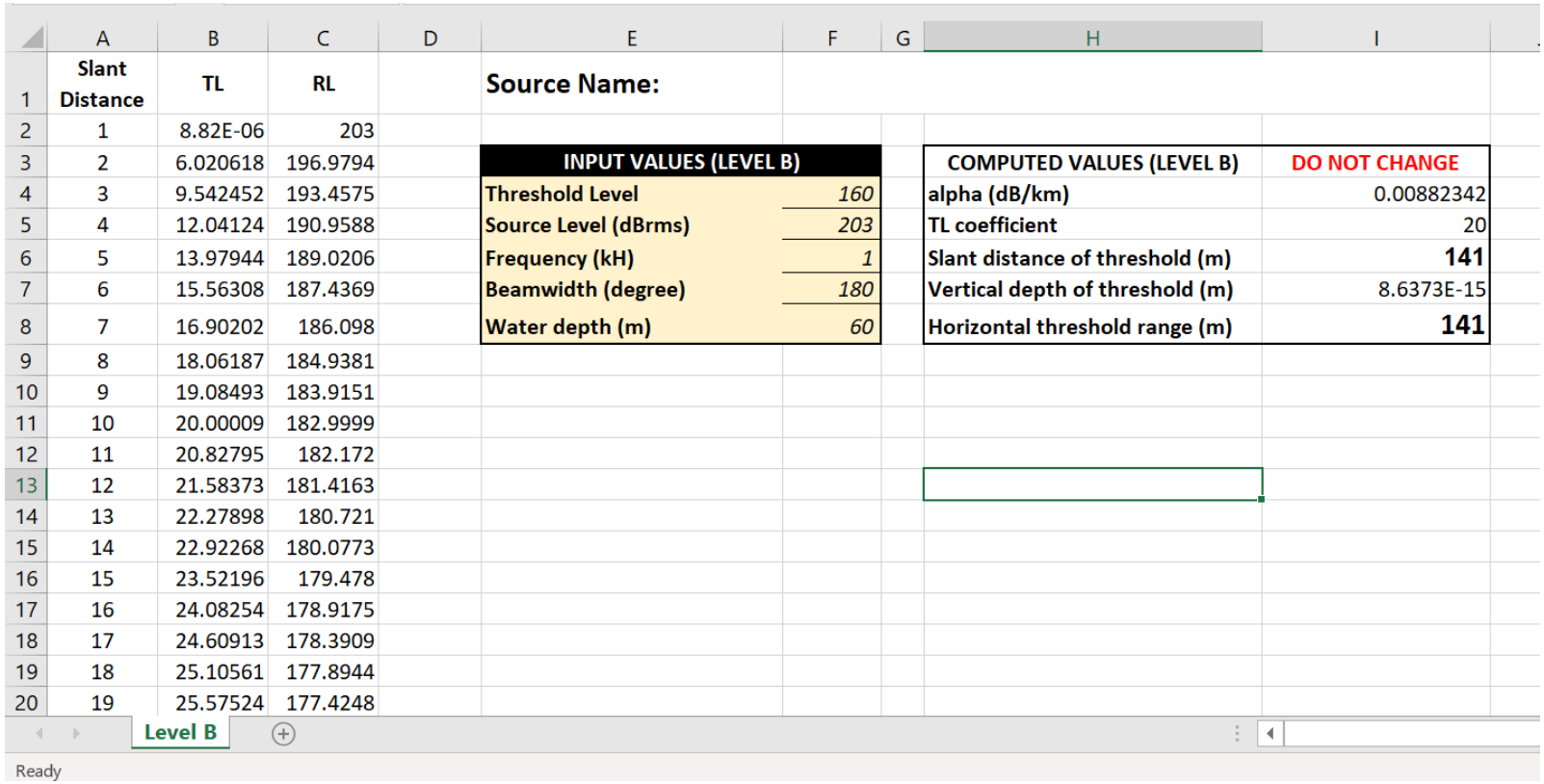
†Methodology assumes propagation loss of 20 log R; Activity duration (time) independent

^Time between onset of successive pulses (inverse of repetition rate or inter-pulse interval).

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	0.0	0.3	135.9	0.0	0.0



	A	B	C	D	E	F	G	H	I
1	Slant Distance	TL	RL		Source Name:				
2	1	8.82E-06	203						
3	2	6.020618	196.9794		INPUT VALUES (LEVEL B)			COMPUTED VALUES (LEVEL B)	DO NOT CHANGE
4	3	9.542452	193.4575		Threshold Level	160		alpha (dB/km)	0.00882342
5	4	12.04124	190.9588		Source Level (dBrms)	203		TL coefficient	20
6	5	13.97944	189.0206		Frequency (kH)	1		Slant distance of threshold (m)	141
7	6	15.56308	187.4369		Beamwidth (degree)	180		Vertical depth of threshold (m)	8.6373E-15
8	7	16.90202	186.098		Water depth (m)	60		Horizontal threshold range (m)	141
9	8	18.06187	184.9381						
10	9	19.08493	183.9151						
11	10	20.00009	182.9999						
12	11	20.82795	182.172						
13	12	21.58373	181.4163						
14	13	22.27898	180.721						
15	14	22.92268	180.0773						
16	15	23.52196	179.478						
17	16	24.08254	178.9175						
18	17	24.60913	178.3909						
19	18	25.10561	177.8944						
20	19	25.57524	177.4248						

Level B

Ready

Attachment 3
Mean Group Size Assessment

Table A3-1 Summary of group and individual numbers of sightings used to estimate group size in the Large Whales

					Species - Large Whales											
Source	Year of Survey(s)	Survey Platform	Season	Location	Right Whale Groups	Right Whale Individuals	Humpback Whale Groups	Humpback Whale Individuals	Fin Whale Groups	Fin Whale Individuals	Sei Whale Groups	Sei Whale Individuals	Minke Whale Groups	Minke Whale Individuals	Sperm Whale Groups	Sperm Whale Individuals
Palka et al. 2017	2010-2013	Ship	Summer	Northeast	2	4	57	83	92	127	9	10	29	29	138	208
Palka et al. 2017	2010-2013	Ship	Summer	Southeast	1	1	1	1	5	8	---	---	---	---	52	126
Palka et al. 2017	2010-2013	Ship	Fall	Southeast	---	---	---	---	3	9	---	---	---	---	13	42
Palka et al. 2017	2010-2013	Aerial	Spring	Northeast	3	3	13	16	23	24	5	6	7	7	3	3
Palka et al. 2017	2010-2013	Aerial	Summer	Northeast	1	1	28	35	17	17	2	2	23	23	3	6
Palka et al. 2017	2010-2013	Aerial	Fall	Northeast	1	1	29	43	25	26	3	9	20	31	4	4
Palka et al. 2017	2010-2013	Aerial	Winter	Northeast	---	---	1	1	1	1	3	6	1	1	---	---
Palka et al. 2017	2010-2013	Aerial	Spring	Southeast	5	10	6	7	8	11	---	---	5	6	6	6
Palka et al. 2017	2010-2013	Aerial	Summer	Southeast	---	---	---	---	4	5	---	---	---	---	2	2
Palka et al. 2017	2010-2013	Aerial	Fall	Southeast	---	---	2	2	6	10	---	---	3	3	---	---
Palka et al. 2017	2010-2013	Aerial	Winter	Southeast	---	---	3	3	3	3	---	---	---	---	---	---
Palka et al. 2017	2014	Aerial	Spring	Southeast	2	2	3	5	2	4	---	---	2	2	2	2
Palka et al. 2017	2014	Aerial	Spring	Northeast	8	19	---	---	2	2	---	---	3	4	---	---
Palka et al. 2017	2014	Ship	Spring	Northeast	33	44	60	93	46	61	13	14	11	15	46	57
Palka et al. 2017	2014	Ship	Summer	Northeast	---	---	1	1	17	30	---	---	1	1	19	38
Palka et al. 2021	2015-2019	Ship	Summer	Northeast	2	4	157	370	345	533	20	28	32	32	298	491
Palka et al. 2021	2015-2019	Ship	Fall	Northeast	---	---	---	---	1	1	---	---	---	---	27	45
Palka et al. 2021	2015-2019	Ship	Spring	Southeast	---	---	45	76	34	48	28	33	8	11	38	55
Palka et al. 2021	2015-2019	Ship	Summer	Southeast	1	1	1	1	5	8	---	---	1	1	70	156
Palka et al. 2021	2015-2019	Ship	Fall	Southeast	---	---	---	---	3	9	---	---	---	---	12	38
Palka et al. 2021	2015-2019	Aerial	Spring	Northeast	9	9	13	20	25	36	13	33	10	11	---	---
Palka et al. 2021	2015-2019	Aerial	Summer	Northeast	1	1	68	88	31	31	5	6	60	65	---	---
Palka et al. 2021	2015-2019	Aerial	Fall	Northeast	3	3	75	101	55	60	6	12	37	52	---	---
Palka et al. 2021	2015-2019	Aerial	Winter	Northeast	4	9	7	10	4	4	2	5	5	5	---	---
Palka et al. 2021	2015-2019	Aerial	Spring	Southeast	1	5	8	9	16	21	---	---	11	14	7	7
Palka et al. 2021	2015-2019	Aerial	Summer	Southeast	---	---	---	---	5	7	---	---	---	---	3	3
Palka et al. 2021	2015-2019	Aerial	Fall	Southeast	---	---	3	6	6	10	---	---	3	3	---	---
Palka et al. 2021	2015-2019	Aerial	Winter	Southeast	1	2	2	2	1	2	---	---	1	1	---	---
CETAP 1982	1978-1981	Ship and	ear-roun	Atlantic	119	197	416	1054	734	2175	7	16	158	280	144	485
				Sum	197	316	999	2027	1519	3283	116	180	431	597	887	1774
				Mean Group Size	**1.6**		**2.0**		**2.2**		**1.6**		**1.4**		**2.0**	

Table A3-2 Summary of group and individual numbers of sightings used to estimate group size in small Whales/Dolphins

					Species - Small Whales/Dolphins											
Source	Year of Survey(s)	Survey Platform	Season	Location	Risso's Dolphins Groups	Risso's Dolphins Individuals	Long-finned Pilot Whale Groups	Long-finned Pilot Whale Individuals	White-sided Dolphin Groups	White Sided Dolphin Individuals	Common Dolphin Groups	Common Dolphin Individuals	Spotted Dolphin Groups	Spotted Dolphin Individuals	Bottlenose Dolphin Groups	Bottlenose Dolphin Individuals
Palka et al. 2017	2010-2013	Ship	Summer	Northeast	224	1215	1	17	---	---	239	7967	46	1334	188	2014
Palka et al. 2017	2010-2013	Ship	Summer	Southeast	21	254	44	829	---	---	2	269	---	---	102	149
Palka et al. 2017	2010-2013	Ship	Fall	Southeast	5	44	35	467	---	---	---	---	---	---	35	695
Palka et al. 2017	2010-2013	Aerial	Spring	Northeast	11	33	3	4	37	366	5	49	---	---	34	176
Palka et al. 2017	2010-2013	Aerial	Summer	Northeast	1	15	2	3	25	408	16	672	---	---	3	51
Palka et al. 2017	2010-2013	Aerial	Fall	Northeast	18	143	8	45	13	315	64	1436	---	---	29	370
Palka et al. 2017	2010-2013	Aerial	Winter	Northeast	23	61	5	6	18	132	17	569	---	---	---	---
Palka et al. 2017	2010-2013	Aerial	Spring	Southeast	22	106	1	135	---	---	68	3229	32	481	219	2046
Palka et al. 2017	2010-2013	Aerial	Summer	Southeast	11	162	20	538	---	---	7	510	33	861	222	2760
Palka et al. 2017	2010-2013	Aerial	Fall	Southeast	1	5	16	268	---	---	3	89	22	234	146	1875
Palka et al. 2017	2010-2013	Aerial	Winter	Southeast	---	---	---	---	---	---	2	61	7	385	82	542
Palka et al. 2017	2014	Aerial	Spring	Southeast	3	26	4	43	---	---	31	1221	1	40	67	719
Palka et al. 2017	2014	Aerial	Spring	Northeast	---	---	---	---	24	162	---	---	---	---	4	50
Palka et al. 2017	2014	Ship	Spring	Northeast	24	112	60	396	31	328	103	2746	1	7	32	439
Palka et al. 2017	2014	Ship	Summer	Northeast	18	120	4	28	---	---	26	683	1	35	9	145
Palka et al. 2021	2015-2019	Ship	Summer	Northeast	486	3131	41	666	3	61	444	19802	60	1760	345	3865
Palka et al. 2021	2015-2019	Ship	Fall	Northeast	23	218	---	---	---	---	5	61	3	75	16	186
Palka et al. 2021	2015-2019	Ship	Spring	Southeast	18	91	44	312	27	261	63	1648	---	---	26	390
Palka et al. 2021	2015-2019	Ship	Summer	Southeast	26	292	---	---	---	---	6	575	76	2817	134	2352
Palka et al. 2021	2015-2019	Ship	Fall	Southeast	12	120	---	---	---	---	---	---	31	959	55	1213
Palka et al. 2021	2015-2019	Aerial	Spring	Northeast	14	34	6	7	62	536	8	215	---	---	38	256
Palka et al. 2021	2015-2019	Aerial	Summer	Northeast	22	249	18	86	82	929	223	5570	---	---	28	178
Palka et al. 2021	2015-2019	Aerial	Fall	Northeast	55	481	19	78	144	2675	223	5823	---	---	46	623
Palka et al. 2021	2015-2019	Aerial	Winter	Northeast	24	61	2	3	25	208	136	3558	---	---	7	36
Palka et al. 2021	2015-2019	Aerial	Spring	Southeast	36	207	---	---	---	---	125	6520	70	1346	466	4139
Palka et al. 2021	2015-2019	Aerial	Summer	Southeast	14	227	---	---	---	---	11	784	64	1259	312	3144
Palka et al. 2021	2015-2019	Aerial	Fall	Southeast	2	10	---	---	---	---	5	254	37	580	212	2233
Palka et al. 2021	2015-2019	Aerial	Winter	Southeast	8	105	---	---	---	---	36	1625	5	71	83	812
CETAP 1982	1978-1981	Ship and	ear-roun	Atlantic	183	3911	275	5190	190	10109	164	7674	67	4916	477	6466
				Sum	1305	11433	608	9121	681	16490	2032	73610	556	17160	3417	37924
				Mean Group Size	**8.8**		**15.0**		**24.2**		**36.2**		**30.9**		**11.1**	

Table A3-3 Summary of group and individual numbers of sightings used to estimate group size in Harbor Porpoise and Seals

					Species - Small Whales/Dolphins									
Source	Year of Survey(s)	Survey Platform	Season	Location	Harbor Porpoise Groups	Harbor Porpoise Individuals	Seal Groups	Seal Individuals	Gray Seal Groups	Gray Seal Individuals	Harbor Seal Groups	Harbor Seal Individuals	Seals Combined Groups	Seals Combined Individuals
Palka et al. 2017	2010-2013	Ship	Summer	Northeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2017	2010-2013	Ship	Summer	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2017	2010-2013	Ship	Fall	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2017	2010-2013	Aerial	Spring	Northeast	125	175	88	117	---	---	---	---	205	322
Palka et al. 2017	2010-2013	Aerial	Summer	Northeast	347	1232	47	51	---	---	---	---	98	149
Palka et al. 2017	2010-2013	Aerial	Fall	Northeast	50	128	10	34	---	---	---	---	44	78
Palka et al. 2017	2010-2013	Aerial	Winter	Northeast	66	88	---	---	---	---	---	---	---	---
Palka et al. 2017	2010-2013	Aerial	Spring	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2017	2010-2013	Aerial	Summer	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2017	2010-2013	Aerial	Fall	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2017	2010-2013	Aerial	Winter	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2017	2014	Aerial	Spring	Southeast	2	3	---	---	---	---	---	---	---	---
Palka et al. 2017	2014	Aerial	Spring	Northeast	47	72	45	45	---	---	---	---	90	135
Palka et al. 2017	2014	Ship	Spring	Northeast	12	22	4	4	14	15	7	7	51	98
Palka et al. 2017	2014	Ship	Summer	Northeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Ship	Summer	Northeast	4	6	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Ship	Fall	Northeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Ship	Spring	Southeast	11	21	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Ship	Summer	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Ship	Fall	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Aerial	Spring	Northeast	181	264	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Aerial	Summer	Northeast	341	757	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Aerial	Fall	Northeast	390	1547	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Aerial	Winter	Northeast	135	258	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Aerial	Spring	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Aerial	Summer	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Aerial	Fall	Southeast	---	---	---	---	---	---	---	---	---	---
Palka et al. 2021	2015-2019	Aerial	Winter	Southeast	---	---	---	---	---	---	---	---	---	---
CETAP 1982	1978-1981	Ship and	ear-roun	Atlantic	187	702	---	---	---	---	---	---	---	---
				Sum	1898	5275	194	251	14	15	7	7	215	273
				Mean Group Size	**2.8**		**1.3**		**1.1**		**1.0**		**1.3**	