ATLANTIC COAST 2D

CONSISTENCY CERTIFICATION & SUPPORTING INFORMATION: N.C.DENR

BOEM APPLICATION E14-001

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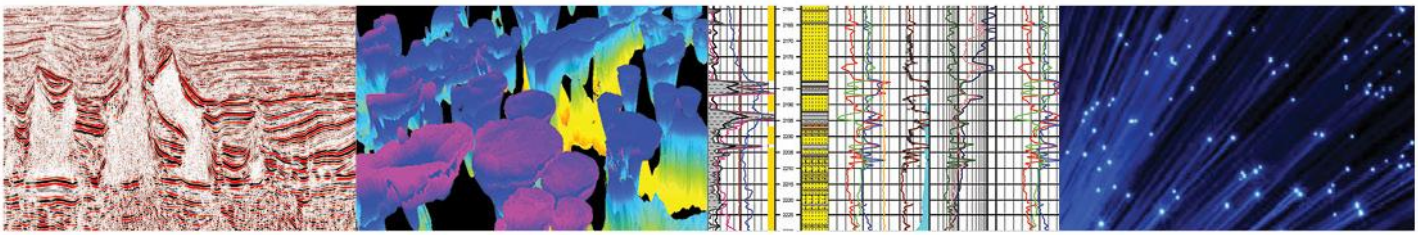

CONTENTS

1. Introduction & Certification 1
2. Project Overview 1
3. Project Location 2
   3.1 Project Location: Offshore North Carolina: 3
4. North Carolina Coastal Management Program 4
   4.1 Coastal Area Management Act 5
   4.2 Dredge and Fill Law 6
   4.3 Local Land use Plans 6
   4.4 Chapter 7, TItle 15a of north carolina administrate code 7
5. Description of Activities 11
   5.1 Operations Overview 11
   5.2 Vessels 12
   5.3 Helicopters 13
   5.4 Seismic Equipment 13
   5.5 Echosounders 14
6. Dates and Duration of activities 14
7. Potential impacts 15
   7.1 Impact on Corridors to Ports, Conflicts with Commercial Shipping and Military Operations 15
   7.2 Waste, Pollution, and Accidental Spills Impact 15
   7.3 Impacts to Benthic and Archeological Resources 16
   7.4 Impacts on Commercial and Recreational Fisheries 16
8. Mitigation measures 17
   8.1 Marine Mammals 17
      8.1.1 Closure Zones and Periods 19
      8.1.2 Vessel-Based Visual Marine Mammal Mitigation 21
      8.1.3 Passive Acoustic Mitigation 22
      8.1.4 Modeling, Establishment and Monitoring of Exclusion Zones 24
      8.1.5 Mitigation during Operations 26
      8.1.6 Speed or Course Alteration 27
      8.1.7 Power-down, Shut Down and Ramp-up Procedures 27
      8.1.8 Procedures for Species of Concern 30
      8.1.9 Time-Area/Speed Restrictions for North Atlantic Right Whales 30
      8.1.10 Communication Procedures 30

8.1.11 Monitoring Measures 30
8.1.12 Vessel-based Visual Monitoring 31
8.1.13 Protected Species Observer Protocol 32
8.1.14 Data Recording & Reporting 33
9. References 35
10. Appendices 36
10.1 BOEM Permit Application for TGS Permit E14-001: 36
10.2 IAGC Comments to OCM 75

1. INTRODUCTION & CERTIFICATION

The federal Coastal Zone Management Act (CZMA) of 1972 created a voluntary program for states to develop and administer coastal management programs. Individual states are given the responsibility of identifying priority issues for their respective coastal zones, and implementing their program using State laws and regulations.

Pursuant to 15 CFR 930.54, states may request approval from NOAA's Office of Coastal Management (OCM) to review certain federally permitted activities. OCM will grant state review if the state demonstrates that the permitted activity would have a reasonably foreseeable effect on any coastal use or resource.

When OCM grants a state's request to review an activity for consistency with the state coastal management program, the applicant must submit a consistency certification in a process known as "federal consistency". Federal consistency requires that federally permitted actions, within and outside the coastal zone, which have reasonably foreseeable effects on any coastal use (land or water) or natural resource of the coastal zone be consistent with the enforceable policies of a state's federally approved coastal management program.

TGS-NOPEC Geophysical Company (TGS) has requested a geophysical exploration permit from the Bureau of Ocean Energy Management (BOEM) and an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS). On November 18th, 2014, OCM approved the State of North Carolina's request to review the BOEM application (E14-001) for TGS' proposed seismic survey with respect to commercial and recreational fishing. TGS notes that OCM's approval of the State of North Carolina's request is limited to potential impacts to commercial and recreational fishing. Notwithstanding this limitation, TGS has included additional information in this document pertaining to mitigation measures applicable to marine mammals in order to provide context and to fully describe the scope of the proposed project. In the following sections, necessary data and information and analysis of North Carolina's enforceable policies has been provided in detail.

After thorough review and analysis, TGS has determined that the proposed activity complies with the enforceable policies of the State of North Carolina's approved management program, and will be conducted in a manner consistent with such program.

2. PROJECT OVERVIEW

TGS proposes to conduct approximately 55,512 linear km (34,493 miles [mi]) of 2D marine seismic surveys along pre-determined survey lines in the Mid- and South Atlantic Outer Continental Shelf (MSA OCS) (Figure 1) scheduled to commence upon IHA and BOEM permit approval. The purpose of the proposed seismic program is to gather geophysical data using a 4,808 cubic inch (in^3) seismic source array and a 12-km long hydrophone solid streamer

(streamer) towed by the seismic vessel. As the seismic source array is towed along the survey lines, the streamer receives returning acoustic signals and transfers the data to the on-board acquisition system which then records the data. Results of the 2D seismic program will be used to identify and map potential hydrocarbon-bearing formations and the geologic structures that surround them.

TGS' seismic operations will occur along pre-determined track lines at speeds of about 4-5 knots (kt) up to 24 hours (hr) per day as possible (except as potentially needed for shut-down mitigation for marine mammals). The full 4,808 in^3 sound source will be operated only during seismic acquisition operations on and near the end and start of survey lines; during turns and transits between seismic lines, a single "mitigation" source (90 in^3 or smaller) is proposed to be operated for mitigation purposes, as described in section 8.1 of this document.

3. PROJECT LOCATION

The seismic operations are proposed to occur in the Mid-Atlantic and South-Atlantic Planning Regions of the Atlantic Ocean, between the northern limit of 38.5°North [N] and the southern limit of 28°N, extending seaward to the U.S. Exclusive Economic Zone (EEZ) (offshore to the extended continental shelf (350 nm limit)) (Figure 1). No seismic activities will occur in state waters.

Generally, seismic lines are arranged in a crosshatch pattern running generally NE to SW and NW to SE, comprising three survey grids with differently spaced lines. The widest-spaced lines (100-km spacing) are located in the eastern approximately one-half of the project area. The closest-spaced lines (6-10 km spacing) follow the continental shelf drop-off near the center of the project area. Seismic lines along the western study area are spaced 25 km apart. The proposed seismic survey would consist of 227 individual seismic lines ranging in length from 22 to 1,037 km (mean line length 245 km). On average, seismic lines are located 40 km (~25 miles) from shore. Survey lines extend west to east from 40 to approximately 648 km offshore (40 to 400 mi), over water depths ranging from 20 to 5,629 meters (66 to 18,468 ft).

The proposed 2D survey will span across a total of approximately 1,600 km (roughly 1,000 mi) of US Atlantic coastline. The survey will occur in federal waters offshore of Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland and Delaware.

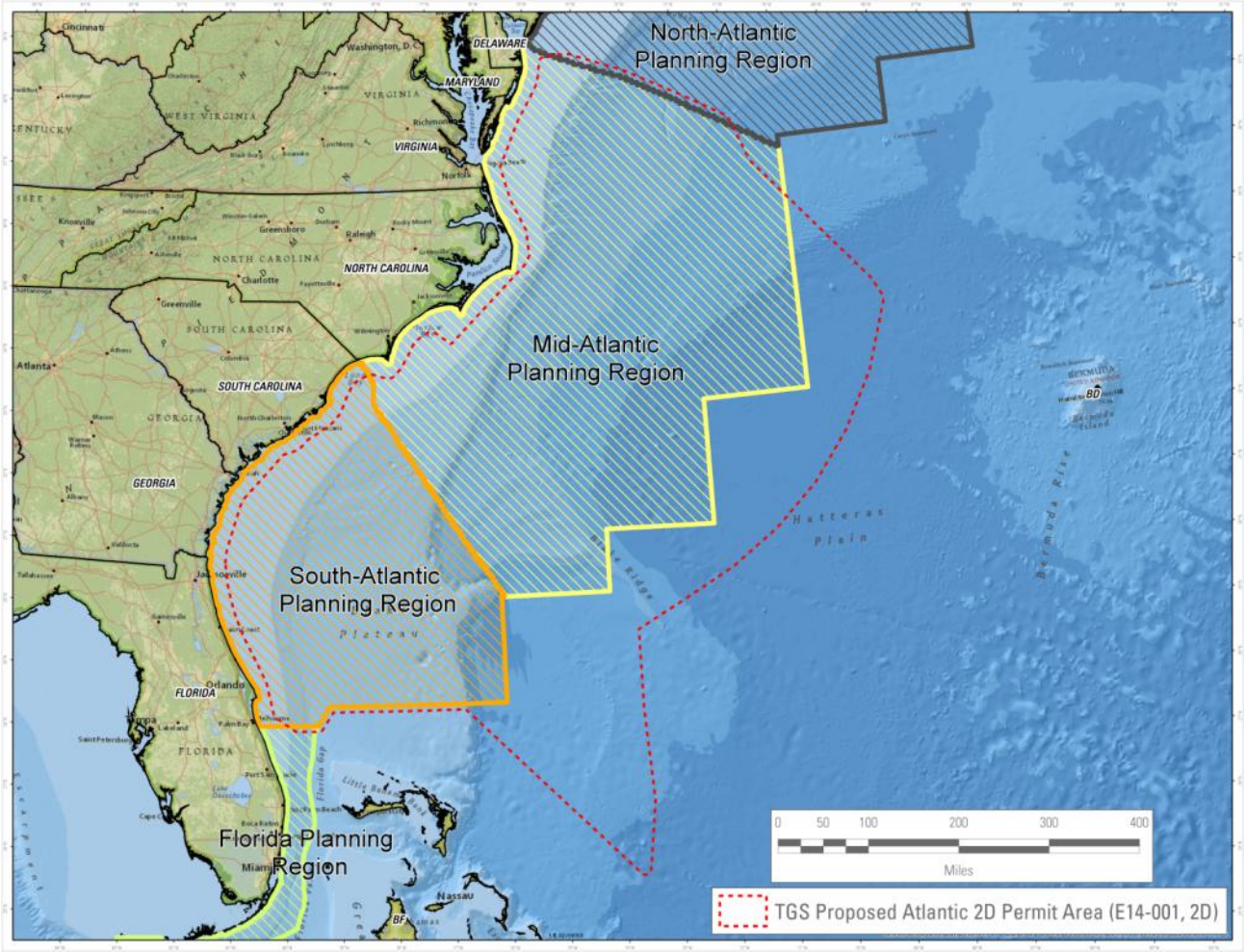

Figure 1. TGS' 2D proposed seismic survey area in the Mid- and South Planning Areas in the Atlantic Ocean.

3.1 PROJECT LOCATION: OFFSHORE NORTH CAROLINA:

Out of the abovementioned 1,600 km of coastline covered under BOEM permit E14-001, the proposed survey area includes federal waters adjacent to 484 km (~301 mi) of North Carolina's Atlantic coastline and state waters. As currently planned, lines are oriented NW to SE and SW to NE. To minimize impacts to commercial and recreational fishing, TGS has designed its survey such that no seismic line comes closer than 40 km (25 mi) from the coastline (Figure 2). As operations are transient and constantly moving, the majority of the operation will occur 40 km or more from the shoreline. Survey lines falling within North Carolina's administrative boundaries shown in figure 2 are designed and spaced at either 25x50 km (15.5x31 mi) or 6x12 km (3.7x7.5 mi) intervals. The proposed survey will not be conducted within North Carolina's coastal zone.

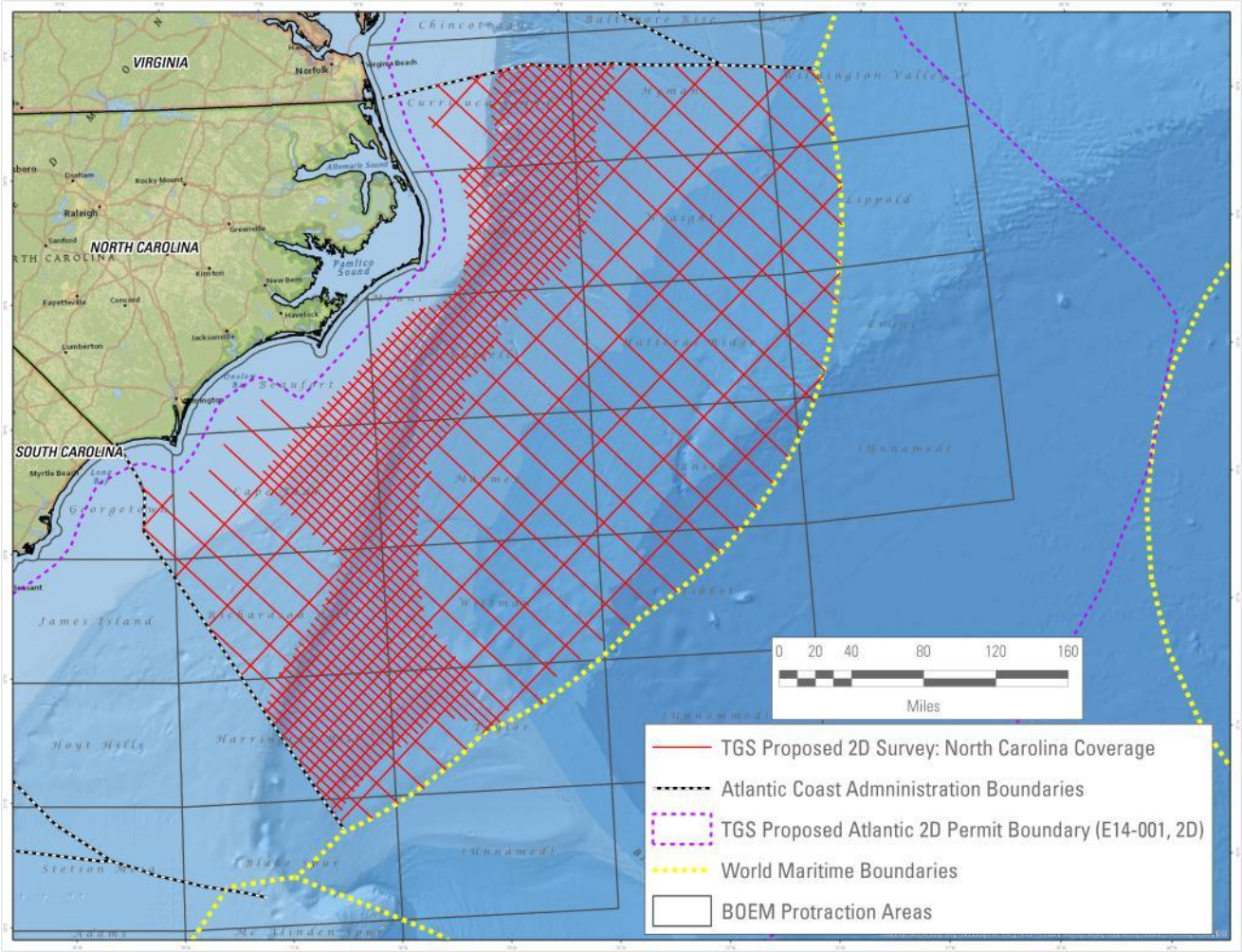

Figure 2. TGS' 2D proposed seismic lines off the North Carolina coastline and within North Carolina Administrative Boundaries.

4. NORTH CAROLINA COASTAL MANAGEMENT PROGRAM

For Federal consistency review, this document contains a detailed description of the proposed activity, its expected effects upon the land or water uses or natural resources of North Carolina's coastal zone, and an evaluation of the proposed activity in light of applicable enforceable policies.

The key elements of North Carolina's coastal management program include the Coastal Area Management Act (CAMA), the state Dredge and Fill Law, local land use plans of the 20 coastal counties certified by the Coastal Resources Commission (CRC), and Chapter 7 of Title 15A of North Carolina's Administrative Code. OCM has found that TGS's proposed geophysical survey may have reasonably foreseeable effects on commercial and recreational fishing important to the State of North Carolina, and approved North Carolina's request to review the application for

consistency with the enforceable policies of the North Carolina Coastal Management Program on that basis. TGS has evaluated its proposed geophysical project, with respect to impacts on commercial and recreational fishing, for consistency with the applicable enforceable policies and found that the proposed project will be conducted in a manner consistent with the applicable enforceable policies, as described below.

4.1 COASTAL AREA MANAGEMENT ACT

Policy

The Coastal Area Management Act (CAMA) establishes a cooperative program of coastal area management between local and state governments. Local government shall have the initiative for planning. State government shall establish areas of environmental concern. CAMA is the overarching statutory authority for: (1) the state guidelines adopted by regulations in Chapter 7 of Title 15A of North Carolina Administrative Code (NCAC), (2) local land use plans, and (3) the state permitting process for major development actions. The program is intended to provide a management system through policies, guidelines and standards to protect, preserve, and conserve the natural resources of the coastal area while providing for orderly and balanced use of coastal resources including economic development, recreation and tourist facilities, transportation, and historic, cultural, and scientific resources.

Analysis

TGS's proposed seismic activities will meet the requirements of CAMA through compliance with North Carolina's enforceable policies. TGS has evaluated the project for consistency with the enforceable policies regarding dredging, filling, local land use plans, and Chapter 7 of Title 15A of North Carolina's Administrative Code, which were identified by TGS as the policies applicable to the proposed project. This document describes how TGS will conduct the proposed seismic survey in a manner consistent with each of these enforceable policies.

No significant adverse impacts on North Carolina's coastal uses and resources are expected from TGS's proposed activities. Seismic survey activities proposed by TGS are not located within North Carolina state waters. Seismic lines are located at least 40 km (~25 mi) from shore. Survey lines extend west to east from at least 40 to approximately 700 km offshore of the North Carolina coastline (25 to 435 mi), over water depths ranging from 20 to 5,629 meters (66 to 18,468 ft). As most of the activity is located far offshore and is transient in nature, TGS anticipates minimal effects on North Carolina's coastal and marine resource uses and minimal contact with marine activities such as recreational and commercial fishing, recreational boating, diving or shipping. TGS will coordinate closely with NCDENR, BOEM, other appropriate regulatory agencies, and other ocean users to avoid interactions during the survey activity.

TGS will implement the following coordination measures:

- TGS will provide NCDENR with all vessel call signs, vessel names and the BOEM permit number prior to commencement of survey operations.
- TGS will notify NCDENR when commencing and completing survey activities in the offshore waters adjacent to North Carolina and will provide updates as to location of vessel(s) during survey operations, as needed and requested.
- All survey and support vessels will be equipped with fully functional Automatic Identification Systems (AIS).

TGS's proposed seismic survey will be performed consistent with policies, guidelines and standards established by North Carolina's Coastal Area Management Act.

4.2 DREDGE AND FILL LAW

Policy

North Carolina's Dredge and Fill Law regulates excavation or filling in estuarine waters, tidelands, marshlands, or State-owned lakes.

Analysis

No excavation or filling in North Carolina's coastal lands, estuarine waters, tidelands, marshlands, or State-owned lakes and water resources are proposed by TGS.

TGS's proposed seismic survey will be performed consistent with North Carolina's Dredge and Fill law.

4.3 LOCAL LAND USE PLANS

Policy

A land use plan is a collection of policies and maps that serves as a community's blueprint for growth. These plans are a fundamental element of coastal management in North Carolina.

The Coastal Area Management Act requires each of the 20 coastal counties to have a local land use plan in accordance with guidelines established by the Coastal Resources Commission.

At the local level, land use plans provide guidance for both individual projects and a broad range of policy issues, such as the development of regulatory ordinances and public investment programs.

The Division of Coastal Management provides technical assistance to local governments through its planners, who are located in the division's district offices.

Analysis

No impacts on North Carolina's local land use are expected from TGS's proposed activities. As proposed operations are limited to marine seismic surveying related to the collection of geophysical data in federal waters, TGS's proposed project will not have any direct impact to local land use.

Because the project is located in federal waters at least 40 km from the coastline and on average over 40 km offshore, local land use plans are not applicable to TGS's proposed activities.

TGS's proposed seismic survey will be consistent with policies listed under local land use plans administered by North Carolina's Coastal Resources Commission.

4.4 CHAPTER 7, TITLE 15A OF NORTH CAROLINA ADMINISTRATE CODE

Policy

Chapter 7 of the NCAC consists of several subchapters, two of which (7H and 7M) constitute enforceable policies which are applicable to TGS's proposed project. The remaining subchapters are not applicable to the project. Project consistency with Subchapters 7H and 7M is addressed below.

Title 15A NCAC 7H: State Regulations for Areas of Environmental Concern

These regulations designate Areas of Environmental Concern (AECs). An AEC is described in the CAMA Handbook for Development as an area of natural importance: it may be easily destroyed by erosion or flooding; or it may have environmental, social, economic or aesthetic values that make it valuable to the state. AECs cover almost all coastal waters of North Carolina.

The CRC designates areas as AECs to protect them from uncontrolled development which may cause irreversible damage to property, public health, or the environment. The CRC has established four (4) categories of AECs: the Estuarine and Ocean System, the Ocean Hazard System, Public Water Supplies, and Natural and Cultural Resource Areas.

1. The Estuarine and Ocean System AEC is the coast's broad network of brackish sounds, marshes and surrounding shores, normally found where rivers and streams meet the ocean. There are four components of this system: public trust areas including all waters of the Atlantic Ocean extending to the state's official boundary three miles offshore; estuarine waters consisting of the state's oceans, sounds, tidal rivers and their tributaries; coastal shorelines; and coastal wetlands.

2. The Ocean Hazard System AEC consisting of oceanfront lands and the inlets that connect the ocean to the sounds, including beaches subject to erosion and lands subject to flooding.
3. The Public Water Supply AEC protects certain coastal public water supplies from the negative effects of development.
4. The Natural and Cultural Resources AECs are specific sites designated because they contain environmental or cultural resources of statewide importance. The four (4) types are (1) coastal complex natural areas that provide habitats unchanged by human activity and support native plant and animal communities; (2) coastal areas that sustain remnant species provide habitat native plants or animals designated by the state or federal government as rare, threatened, or endangered; (3) unique coastal geologic formations; and (4) significant coastal archaeological resources.

Title 15A NCAC 7M: General Policy Guidelines for the Coastal Area

Subchapter 7M contains a series of policies to address different activities that may occur in coastal areas. The following nine (9) sections are not applicable to TGS's proposed geophysical survey activities:

.0200 Shoreline Erosion Policies
.0300 Shorefront Access Policies
.0400 Coastal Energy Policies
.0500 Post Disaster Policies
.0600 Floating Structure Policies
.0900 Policies on Use of Coastal Airspace
.1000 Policies on Water and Wetland Based Target Areas for Military Training Activities
.1100 Policies on Beneficial Use and Availability of Materials Resulting From the Excavation or Maintenance of Navigational Channels
.1200 Policies on Ocean Mining

The Mitigation Policy (.0700) requires that adverse impacts to coastal lands and waters be mitigated or minimized to protect coastal ecosystems. Project impacts must be avoided or minimized and then mitigation can be used to enhance coastal resources and offset any remaining potential losses that result from development.

The Coastal Water Quality Policies (.0800) are intended to maintain water quality such that traditional uses including commercial and recreational fishing, swimming, hunting, recreational boating, and commerce are not impaired. Sources of pollution are to be managed to preserve the quality of coastal waters. Improper operation of boats and their sanitation devices is recognized as a potential threat to water quality.

Analysis

TGS's proposed project will not occur in any state-designated AECs, and as such, will not cause irreversible damage to property, public health, or the environment related to estuarine and ocean systems, ocean hazard systems, public water supplies, and natural and cultural resources. In any case, even if the project area was considered as an AEC, the project would not impact the values for which the AECs were established.

Concerning mitigation of environmental impacts (Policy .0700) and Coastal Water Quality Policies (.0800), TGS has avoided and minimized impacts to the maximum practicable extent. TGS has also integrated mitigation measures into its project design to further ameliorate any potential adverse effects. Potential impacts and TGS' avoidance, minimization, and mitigation activities are described in sections 7 and 8 of this document. A brief summary of some of these measures is also provided below.

Per the PEIS, the sound source used for 2D seismic surveying is expected to have little or no impact on benthic resources, including native plants and animal communities, as well as archeological resources and geologic formations. The proposed 2D survey and its related activities will not involve any equipment being placed on the surface of, or beneath, the ocean floor. In other words, all equipment will either be above the water, or within the top 10-12 meters below the sea surface. Since survey lines extend over water depths ranging from 20 to 5,629 meters (66 to 18,468 ft), the equipment will not interact with the ocean bottom.

Concerning impacts on animals within AECs which are considered as being rare, threatened, or endangered, TGS has developed mitigation measures to reduce and minimize potential impacts to sea turtles and marine mammals by meeting or exceeding the associated mitigation and monitoring measures identified in the preferred alternative described in the PEIS and Record of Decision (ROD) (BOEM 2014a,b). These mitigation measures include visually surveying the exclusion zone (EZ) for 60 minutes and making sure that no marine mammals or sea turtles are present prior to starting a survey line. After the 60 minute period has passed, the acoustic source is then gradually ramped-up, starting with the smallest source volume, giving animals an opportunity to move away. Additionally, vessels will be required to have Protected Species Observers (PSOs) continuously monitoring the exclusion zone for sea turtles, whereby any sighting within the exclusion zone will result in the immediate shutdown of the acoustic source. Passive Acoustic Monitoring (PAM) will also be employed in order to detect and identify marine mammal vocalizations, and apply appropriate mitigation measures in case a detection is verified. For further details regarding TGS' proposed mitigation measures, see section 8.

With respect to the Coastal Water Quality Policies (.0800), section 4.1.1.2 of BOEM's PEIS concludes that geophysical activities are not expected to impact air and water quality. As

indicated in sections 1.6.9 and 1.6.10 of the final PEIS, TGS' proposed seismic activities are regulated by the Clean Air Act (CAA) and Clean Water Act (CWA) provisions regarding discharges of emissions and pollutants in US waters. All seismic vessels are required to have current certificates and comply with many international laws governing water quality. Vessels will strictly adhere to regulations set forth under the USEPA's NPDES, which applies to discharges incidental to the normal operation of all non-recreational, non-military vessels of 24 m (79 ft) or greater in length that discharge in U.S. waters (USEPA, 2011b).

TGS' activities are expected to have minimal to zero effect on estuarine and ocean systems, coastal lands, and coastal waters. On average, TGS vessels will be at least 40 km from the North Carolina coast and will comply with regulations set forth under the USEPA's National Pollutant Discharge Elimination System (NPDES) and National Ambient Air Quality Standards (NAAQS). In addition, all seismic vessels are required to have current certificates and comply with many international laws governing waste. These include: International Sewage Pollution Prevention, Shipboard Marine Pollution Emergency Plan, Garbage Manage Plan and Record Book, Oil Record Book. In addition, vessels will comply with the International Maritime Organization (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) to prevent pollution from sewage, oil, and garbage emissions, and wastewater discharges, including carrying Merchant Shipping Prevention of Oil Pollution Plan MARPOL certification. TGS will comply with other IMO international convention to control and manage ballast water and sediments.

Sanitary and domestic waste generated on survey vessels will be treated with US Coast Guard approved marine sanitation devices prior to discharge.

Atmospheric emissions will result from vessel and equipment exhaust. These emissions are minor and will be reduced through best management practices and preventative maintenance procedures. These include properly maintaining and routinely inspecting ship equipment, controlling vapor loss from fuel tanks, and avoiding engine idling when not in use. Emissions from ship engines and onboard equipment will comply as per the required and pertinent federal regulations and legislation.

All solid waste will be kept onboard and then transferred to shore and disposed of at an approved facility. Any hazardous materials (e.g., oily rags, chemicals) will be handled separately in hazardous materials containers. Sanitary and food wastes will be macerated to a particle size of 6 mm or less and then discharged as per the required and relevant federal regulations.

As per sections 3.5.1.6 and 3.5.1.7 of BOEM's final PEIS, all survey vessels will comply with the pertinent Code of Federal Regulations pertaining to disposal of solid wastes. As stated in the final PEIS, all authorizations for shipboard surveys would include guidance for marine debris

awareness. To ensure compliance with the BOEM's guidance, TGS will inform and brief all vessel operators, employees, and contractors on marine trash and debris awareness elimination. Also, TGS will ensure that its employees and contractors are made aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment where it could affect protected species.

In the last 33 years, TGS has successfully conducted geophysical surveys totaling 2.5 million kilometers of 2D seismic and over 200,000 square kilometers of 3D seismic, without any known significant or long term impact to the environment. TGS will adhere to all of the required mitigation measures imposed by regulatory authorities, and as recommended by any environmental impact assessments.

TGS's proposed seismic survey will be performed consistent with Title 15A NCAC 7H: State Regulations for Areas of Environmental Concern, as well as applicable policies .0700 and .0800 found in Title 15A NCAC 7M: General Policy Guidelines for the Coastal Area.

5. DESCRIPTION OF ACTIVITIES

5.1 OPERATIONS OVERVIEW

To image the subsurface geology, TGS will use modern 2D seismic vessels with dedicated seismic and maritime crews. The seismic vessels will operate alongside several chase and support vessels whose main purpose is to ensure the safety of the in-sea equipment. Chase and support vessels keep watch for nearby ships, help to transport the crew to and from shore, can tow the seismic vessel in case of emergencies due to power loss, scout for the area for other activity and navigational hazards, and can be used to transfer data shipments to shore. Similarly to the seismic vessels, the chase and support vessels will operate 24 hours a day.

Prior to mobilizing to the survey area, the vessels will spend 1-3 days in port in order to take on supplies, crew members, and make sure that all ship-related maintenance items are fulfilled. Furthermore, while the vessel is docked in port, a U.S. Coast Guard inspection of the seismic vessel will take place. Once the vessels are ready to depart, the fleet will mobilize to a pre-determined area and commence deployment of the in-sea seismic equipment. Pending on weather, currents, and other environmental factors, as well as equipment-related technical factors, the in-sea equipment will take approximately 8-10 hours to be fully deployed.

Crew change, resupply, and equipment transfer is estimated to be carried out in 5 week intervals. These operations will either take place at sea or in port. Specific timing for these operations is dependent on permit issuance, environmental factors, Health Safety and

Environment (HSE) concerns, and carefully planned logistics. For more information regarding general 2D seismic operations, please view appendix 10.2.

5.2 VESSELS

Two seismic vessels will be used during the survey. Both vessels will tow a seismic source array and a single 12-km-long streamer. When the two seismic vessels are used, they will operate simultaneously, but at very far distances from each other (at least 100 km apart) so as to not interfere with the other's activity and as a mitigation measure to allow a corridor between the activity areas for marine mammals, fisheries, vessel activity, and sea turtles. This is substantially larger than the BOEM Record of Decision (ROD) requirements that seismic vessels operate at least 40 km apart (BOEM 2014b). TGS will also coordinate with other seismic operators that may be in the region to maintain spacing of at least the minimum 40 km spacing between other operating seismic vessels.

Due to the size of TGS' current proposed survey, using two seismic vessels will allow TGS to acquire data within a one-year span (instead of over multiple years). Figure 3 displays an example of a typical 2D seismic vessel. The two seismic vessels will each be accompanied by a smaller chase vessel. The purpose of the chase vessel is to keep vigil and ensure the safety of the streamer, by warning and keeping nearby vessels away from the streamer vicinity. The two chase vessels may also help to transport passengers to and from shore, and tow the seismic vessel in case of emergency due to power loss. In addition to the two chase vessels, TGS may hire a support vessel to transport fuel and provisions to the seismic vessels approximately every 3-4 weeks.

Currently, no particular vessels are under contract with TGS for the survey. When contracts for each of these two seismic and chase vessels are secured, TGS can provide the full vessel specifications. The seismic and chase vessels will be self-contained and crew will live aboard these vessels following scheduled rotations.

Figure 3. Example of typical 2D seismic vessel.

5.3 HELICOPTERS

Helicopters may be used to transport crew to and from vessels during crew changes, which occur every five weeks. There is no certainty that TGS will use helicopters for their crew changes as the availability of helicopters in the area is currently uncertain. However, in the event that helicopters are used, it will be for a series of approximately 2 to 3 flights for 1 day, every 5 weeks. It should be noted that the crew change schedule is 5 weeks on, and 5 weeks off.

5.4 SEISMIC EQUIPMENT

The seismic vessel will tow a compressed-air seismic source array comprised of 48 single Sodera G-gun II seismic sources with a total combined discharge volume of 4,808 in³. Forty of the air sources will be used at one time. Each of the 48 seismic sources (including the 8 spares) range in volume from 22 to 250 in³. The maximum of 40 operating seismic sources within the full array are arranged in four subarrays totaling 1,202 in³ each. Seismic sources within each of the four subarrays are spaced 8 m apart. The full seismic source array will be towed behind the vessel at a water depth of approximately 7 m (+/- 1 m). The seismic source will discharge 64 pulses per statute linear mi (5,280 ft) with an air release distance interval of 25 m. The source array will be calibrated and fine-tuned to maximize subsurface illumination and minimize horizontal propagation of noise, as practicable. The seismic vessel has limited maneuverability while towing the hydrophone solid streamer and seismic source. To ascertain whether the

seismic source array is operating correctly, the full array volume will be enabled for 1 km before the start of every line (i.e., “run in” [constructing data capacity a certain distance before it reaches a particular coordinate, typically a half or full streamer length]). In addition, to ensure full-fold (maximum data capacity) data acquisition, the vessel will require a 6 km “run out” (deconstructing its data capacity before it reaches the next coordinate, typically half of a streamer length) at the end of each line with the seismic array operating at full volume. We anticipate that gravity and magnetic data will also be passively acquired during the survey by measuring gravity and magnetic variations while traversing the lines (no acoustics are emitted with these methods).

The seismic vessel will also tow a single 12 km-long Sercel hydrophone acquisition streamer behind it at a water depth of approximately 9 m (+/- 1 m). This streamer is capable of detecting and recording pressure fluctuations in the water caused by the reflected sound waves from water depths of at least 18,288 m (60,000 ft). The proposed streamer is quieter than typical streamers used during seismic operations because it contains gel or foam, which does not slush around the streamers and cause unnecessary ambient noise. This feature allows for a broader band of frequencies to be recorded, resulting in acquisition of finer-detailed geophysical data (i.e., ample sound wave penetration imaging). A Seal 428 high-resolution marine seismic recorder will be utilized to record seismic acquisition data (the latter equipment does not emit any sound).

5.5 ECHOSOUNDERS

Both vessels will use industry-standard echosounder/fathometer instruments and they will be used strictly for navigational purposes and not data acquisition. These instruments will obtain information on water depths and potential navigation hazards for vessel crews during routine navigation operations. Navigation echosounders direct a single acoustic signal focused in a narrow beam directly downward to the sea floor. The reflected sound energy is detected by the echosounder that then calculates and displays water depth to the user.

6. DATES AND DURATION OF ACTIVITIES

Upon receipt of all necessary approvals for geophysical activity off the US Atlantic Coast, seismic operations will occur over the Mid and South Atlantic Outer Continental Shelf for the period of 1 year. Seismic operations may occur 24 hour per day over this 365-day period, except for periods of poor weather, equipment repair, shut downs due to mitigation for marine mammals, sea turtles etc. Specific proposed project start and end dates are listed below, but are contingent on various factors:

1. Assuming seismic operations begin in the 3rd quarter of 2015, July 1st for example, the two TGS project vessels plan to depart approximately seven days prior, and arrive at the survey area approximately 7 days later.
2. Seismic line operations are proposed to begin approximately seven days after leaving the departure port.
3. Upon completion of data acquisition, all vessels will demobilize to the nearest suitable port (TBD, when appropriate); the associated return transit duration would depend upon distance to this port.

7. POTENTIAL IMPACTS

7.1 IMPACT ON CORRIDORS TO PORTS, CONFLICTS WITH COMMERCIAL SHIPPING AND MILITARY OPERATIONS

All seismic vessels are equipped with AIS systems which identify the vessels on standard radars. This allows for immediate identification of the seismic vessel to other vessels at a distance of at least 30 miles, which allows adequate time for both vessels to communicate and adjust course, and speed, to avoid any kind of interference. In addition, all seismic vessels are required to have very precise navigation equipment as part of the survey methodology, and typically carry the latest collision avoidance systems as required by the project safety plans, which allows for highly accurate positioning of all vessels in the vicinity. TGS has proposed a 2D survey which will remain, on average, approximately 40 kilometers away from any coast line and ports. The chances of any significant interference to vessels maneuvering in and out of ports will be very unlikely; it's critical to note that the seismic vessel is constantly moving and, on average, will be 100's of miles from any coastline for significant periods of time. It should also be noted that it is in the best interest of the seismic vessel to avoid any encounters with other shipping traffic due to the high cost of the trailing survey equipment, which may be exposed to severe damage by other vessels passing over it.

7.2 WASTE, POLLUTION, AND ACCIDENTAL SPILLS IMPACT

All seismic vessels are required to have current certificates and comply with many international laws governing waste, pollution, and spills. These include: International Oil Pollution Prevention, International Air Pollution Prevention, International Sewage Pollution Prevention, Shipboard Oil Pollution Plan, Shipboard Marine Pollution Emergency Plan, Garbage Manage Plan and Record Book, Oil Record Book. In addition, vessels carry Merchant Shipping Prevention of Oil Pollution Plan (MARPOL) certification. Furthermore to the certificate requirements, many

of the plans are drilled as required by regulatory authorities and by their own HSE management systems.

Over the last 33 years, TGS has successfully conducted geophysical surveys totaling 2.5 million kilometers of 2D seismic and over 200,000 square kilometers of 3D seismic, without any known significant or long term impact to the environment, or any observed direct harm or fatalities to marine mammals. At a minimum, TGS adheres to all of the required mitigation measures imposed by regulatory authorities, and as recommended by any environmental impact assessments.

7.3 IMPACTS TO BENTHIC AND ARCHEOLOGICAL RESOURCES

Per the PEIS, the sound source used for 2D seismic surveying is expected to have little or no impact on benthic resources. The proposed 2D survey and its related activities will not involve any equipment being placed on the surface of, or beneath, the ocean floor. In other words, all equipment will either be above the water, or within the top 10-12 meters below the sea surface. Since survey lines extend over water depths ranging from 20 to 5,629 meters (66 to 18,468 ft), the equipment will not interact with the ocean bottom. TGS is aware that some benthic features are well-known and designated as Habitat Areas of Particular Concern (HAPC). The PEIS concluded that negligible impacts to these areas are anticipated, see section 4.2.1 and 4.2.10 of the PEIS.

As detailed in section 2.1.2.3 of the PEIS, there are currently no restrictions in place for non-seafloor disturbing geological and geophysical activities proposed within or near known cultural resources (shipwrecks, prehistoric archaeological resources) and benthic communities (Habitat Areas of Particular Concern, Marine Protected Areas, etc.). However, TGS will comply with any permit conditions imposed by the BOEM to protect benthic and archeological resources.

7.4 IMPACTS ON COMMERCIAL AND RECREATIONAL FISHERIES

Although the proposed 2D survey spans across a large area, it is important to reiterate that the process in itself (seismic surveying) is a transitory, and a locally and temporally short-term, activity. To minimize impacts to commercial and recreational fishing, TGS has designed its survey such that no seismic line comes closer than 40 km (25 mi) from the coastline (Figure 2). In essence, the seismic vessel will traverse down designated sail lines at an average of 4-5 knots (4.6 to 5.7 mph), meaning that the activity will rapidly move in and out of any particular area, including potentially important commercial and recreational fishing areas. Additionally, for safety reasons and to protect the towed in-sea equipment, it is in a seismic vessel's best interest to stay clear of fishing gear and fishing vessels. Therefore, the seismic vessels are on constant watch, and in continuous communications with fishing authorities and fishing boats.

Furthermore, the seismic vessel will submit information to the local USCG office and the local harbormaster for issuance of a Local Notice to Mariners. Information will then be disseminated to commercial and recreational fisheries, specifying survey dates, vessel locations, and guidelines on avoidance requirements. Ultimately, and as stated in the PEIS, any impact to fishing activities would be localized and short-term, and thus expected to be, at most, minor.

Concerning impacts on fish, section 4.2.5.2.2 of the PEIS states that the most likely effect on fisheries would be behavioral responses. Initially, fish will likely move away from the sound source and could potentially exhibit short-term stress-related behavior that would pass as the seismic vessel left a particular area. Ultimately, the potential impact on fish and fisheries (both commercial and recreational) would be temporary and, at most, minor.

Lastly, for more information regarding impacts on fisheries from seismic activities, please see section III of the IAGC's Comments on States' Unlisted Activity Review Requests for BOEM Permits in appendix 10.2

8. MITIGATION MEASURES

8.1 MARINE MAMMALS

TGS has committed to certain mitigation measures in its IHA application to NMFS. TGS will abide by strict mitigation measures which have been developed to reduce and minimize potential impacts to marine mammals. TGS will either meet, or exceed, the associated mitigation and monitoring requirements identified in the preferred alternative, described in the PEIS and ROD. These measures include adjusting acquisition approach, timing and locations to minimize and avoid peak marine mammal migration and abundance periods, as practicable, and avoiding specific areas protected for North Atlantic right whales during their periods of expected use. As explained in TGS' IHA application, based on available studies, potential exposure to proposed project seismic sounds are expected to be temporary and not of biological significance to marine mammal populations.

TGS proposes to implement the following procedures to minimize, mitigate and avoid potential adverse impacts on marine mammal species, stocks and their habitats:

1. Implementing closure zone and period regulations and recommendations for marine mammals identified in the BOEM final PEIS, Appendix C, section 4.1 (BOEM 2014a) and finalized in the ROD (BOEM 2014b);

2. Conducting vessel-based monitoring (BOEM PEIS, Appendix C, section 3.2.2 [BOEM 2014a]) with both passive acoustic monitoring operators and protected species observers (PAM & PSOs) on the seismic vessel;
3. Establishing and monitoring conservative exclusion zones (EZs) and disturbance zones (DZs) (i.e., based on sound source verification (SSV) results for a larger-sized seismic source array than actually will be used by TGS) by implementing
    - an EZ of 799 m for the full 4,808 in^3 array resulting in a power down (BOEM PEIS, Appendix C, section 5.5 [BOEM 2014a]) to the 76-m EZ of the single mitigation air source, if marine mammals occur within or closely approach this 799 m EZ, a full power down would not be required if delphinids voluntarily approach the vessel or the vessels towed equipment or
    - a full power down if a non-delphinid cetacean occurs within this 76 m EZ;
4. Implementing standard seismic source mitigation measures related to seismic operations (e.g., a 60-min "all clear" pre-ramp up, ramp-up, and shutdown periods) as directed in the PEIS (BOEM 2014a) and ROD (BOEM 2014b);
5. Operating a single 90 in^3 mitigation seismic source during turns and transits between seismic lines to continuously produce a small amount of sound into the environment to alert marine mammals of the presence of a sound source in the environment (line changes/transits are estimated to require 4-10 hours);
6. Increasing inter-pulse intervals of seismic transmissions to 60 sec while the single mitigation seismic source is operating during turns and transits between seismic lines to reduce overall seismic noise (note this measure was approved by the NMFS Panel Review for TGS' seismic operations in the Chukchi Sea during late summer/fall 2013) (NMFS 2013);
7. Reducing the sound level of the seismic array, using the same shot interval as the seismic survey, to maintain a minimum sound level of 160 dB re 1 µPa m (rms) for the duration of operations during turns and transits between seismic lines (see condition 5 of PEIS Appendix C, Attachment 1 [BOEM 2014a]);
8. Implementing continual PAM with a towed hydrophone array deployed from the seismic vessel to complement visual monitoring and mitigation, particularly during periods of darkness and of low or no visibility/poor sighting conditions or when marine mammals are below the surface or beyond visual range.

The abovementioned mitigation measures are described in more detail below in separate subsections. These subsections provide thorough information about the measures that are an essential part of the planned activities. Proposed procedures include vessel-based marine mammal monitoring, establishing and monitoring of EZs, and mitigation prior to and during seismic source operations.

8.1.1 Closure Zones and Periods

BOEM is proposing to limit surveys using some active acoustic sound sources during critical times within and in proximity to North Atlantic right whale calving and nursing habitat, migratory pathways and when right whales are found aggregating in an area. These measures are meant to limit acoustic and vessel traffic disturbance and collision risk for North Atlantic right whales. The planned 2D seismic survey has been designed to minimize impacts to marine mammal species by implementing closure zones and periods identified in the PEIS (BOEM 2014a). TGS proposes the following measures:

1. No project seismic source operations would occur within the survey's maximum estimated 160-dB DZ distance from any designated right whale critical habitat area from November 15 through April 15 or within the mid-Atlantic and Southeast U.S. seasonal management area (SMA) south of Brunswick, Georgia (November 1 through April 30) and Additional 20 km Closure Zones North and South during the times when vessel speed restrictions are in effect (November 15 through April 15) from Delaware Bay to Wilmington, North Carolina and (November 1 through April 30) from offshore Florida adjacent to the North Atlantic right whale critical habitat between the Southeast U.S. SMA and the southern boundary of the Area of Interest (AOI) under the Right Whale Ship Strike Reduction Rule (50 CFR 224.105) (Silber et al. 2014) (BOEM 2014a, Appendix C, section 4.1). All vessels will abide by the speed restrictions of 10 kt or less in SMAs and dynamic management areas (DMAs). Within DMAs, all sound sources must cease within 24 hr of its designation (BOEM 2014b).
2. Additionally, no project seismic source operations would occur within the project's maximum estimated 160-dB DZ distance from active SMA or DMAs (areas where North Atlantic right whales are detected and no existing protective measure(s) are in place or in force) so as not to exceed the NMFS-designated Level B harassment threshold. These time-area closures combined with proposed mitigation and monitoring measures are expected to significantly reduce the risk of impacts to North Atlantic right whales based on the PEIS (BOEM 2014a) (Figure 4).

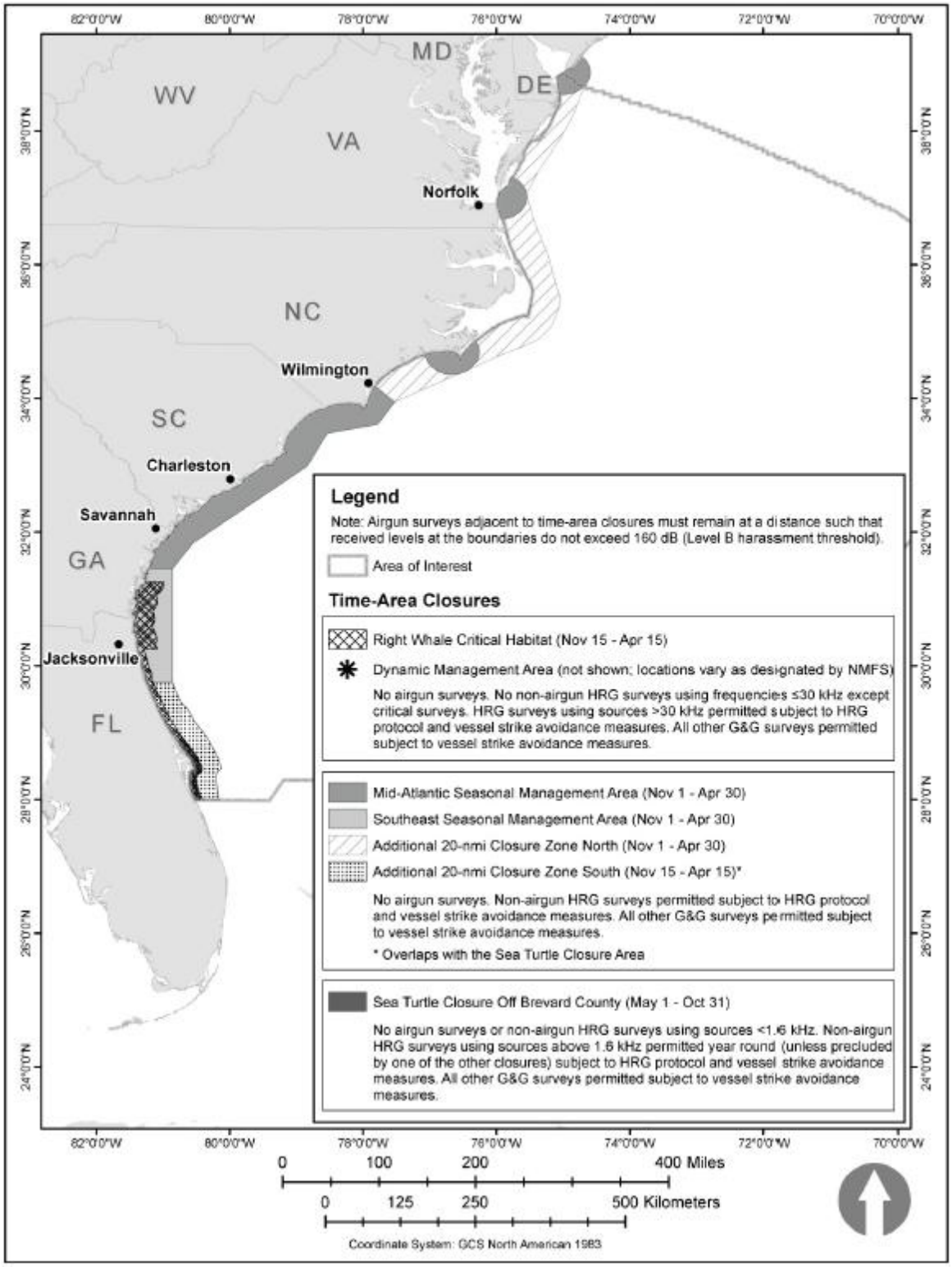

Figure 4. Time-area closures under alternative B, taken from the BOEM final PEIS (BOEM 2014a).

8.1.2 Vessel-Based Visual Marine Mammal Mitigation

TGS plans to conduct seismic operations 24-hr per day, including during nighttime. The main tasks of protected species observers (PSOs) are to monitor the acoustic exclusion zone (EZ) for protected species and to observe and document their presence and behavior to reduce incidental takes of marine mammals via exposure to seismic sounds during proposed surveys. This information will provide real-time data necessary to implement some of the key mitigation measures as explained below. Three visual PSOs will be aboard each seismic vessel to rotate through daylight watch periods and to assist with passive acoustic monitoring (PAM) being conducted by acoustic PSOs during seismic periods and during periods of darkness/poor visibility.

Visual PSOs will monitor for marine mammals as follows:

1. during all daytime (from civil twilight-dawn to civil twilight-dusk, 30 min before sunrise and 30 min after sunset) seismic source operations,
2. during a minimum 60-min pre-ramp up clearance period,
3. during ramp-up periods, after an extended (over 20 min) shutdown period,
4. when there has been no mitigation source element in operation for a minimum of 60-min prior to initiation of the seismic source (i.e., ramp up) after an extended (over 20 min) shutdown period,
5. during any nighttime start-up of the seismic source (unless nighttime vision is impaired or weather conditions make observations impossible) and
6. during all daylight periods to the maximum extent practicable when no seismic activities are occurring (i.e., during transits and periods of seismic source silence exceeding 20 min but ending not less than 60 min prior to next ramp-up).

When marine mammals are visually detected within or approaching the designated EZs, the seismic source will be powered down or shut down immediately (with the exception of dolphins approaching to bowride, for which no mitigation will be implemented as described in the ROD [BOEM 2014b]). PSOs will communicate mitigation measures to the seismic source operators and vessel captain/crew within one source pulse period.

If a single seismic source or a seismic source array has been operational before visibility decreased or before nightfall, the seismic source operations may continue even though the entire EZ may not be visible. Visual PSOs will not be required to observe during extended periods of darkness due to the ineffectiveness of night vision devices (NVD) to observe marine mammals at distance. However, a PAM PSO operator will remain on duty during darkness.

During darkness or other impaired visibility of the full EZ (e.g., poor weather), seismic operations may only commence:

1. Without a ramp up if the shutdown period is less than 20 min, and/or
2. With a ramp up if PAM has been continuously operating with no detections of calling marine mammals determined to be within the EZ for a 60-min period immediately prior to ramp up. In addition, the vessel captain/crew is to notify PSOs of any marine mammal observations during nighttime seismic operations.

Duties of PSOs monitoring from the seismic vessel will be to:

1. Document the occurrence of marine mammals within the survey area,
2. Assist in the implementation of required mitigation measures, and
3. Record any potential reactions of marine mammals to the seismic operations. On the seismic source vessel, two visual PSOs are proposed to simultaneously monitor for marine mammals within or approaching the EZ. The two observers will stand watch in a location that will not interfere with navigation or operation of the seismic vessel, while still providing an optimal view of the sea surface and a 360° view of the entire area around the seismic vessel; the latter is to ensure complete visual coverage of the EZ to the maximum extent practicable, given ongoing weather conditions.

While on duty, each visual PSO will scan the area of operations for marine mammals alternating between using reticle binoculars and the naked eye. One set of big-eye binoculars (25x150) will be used on the seismic vessel, with the two on-watch PSOs rotating through the big-eyes position to minimize eye fatigue. PSOs will use a laptop to record data, including species, group size/composition, location, distance from survey vessel, and behavior (and associated weather data).

8.1.3 Passive Acoustic Mitigation

Per the BOEM ROD (BOEM 2014b), the use of passive acoustic monitoring (PAM) is required as part of the seismic source survey protocol. The purpose of PAM is to improve detection of marine mammals prior to and during seismic source surveys so that impacts can be avoided by shutting down or delaying startup of seismic source arrays until the animals are outside the EZ. TGS proposes to conduct real-time mitigation using a hydrophone array towed from the seismic vessel.

PAM will be used to supplement visual monitoring and other mitigation measures, during active seismic survey operations and during some non-seismic periods when possible. PAM will be the

primary means of monitoring the exclusion zone at night or when sighting conditions are poor. Three trained Protected Species Acoustic Observers (PSAO) will be aboard each seismic vessel and will be assisted by PAM-trained visual PSOs as possible/as rotations allow. One PSAO will be monitoring at any given time. All PSAOs will be proficient in PAM monitoring and operations and methods.

The type of PAM chosen for use was based on:

1. Mitigation and monitoring priorities (e.g., real-time mitigation and monitoring of the 180-dB EZ),
2. The availability and suitability of the monitoring platform (e.g., the type, number and operational priorities of project vessels) from which PAM could be deployed and operated,
3. The cost-effectiveness of the technology,
4. The reliability of the technology,
5. The effectiveness of the technology for detecting marine mammals, particularly ESA-listed species,
6. The suitability of the equipment for the environmental conditions, including water depth,
7. The relative abundance and distribution of species to be monitored, and
8. The ability to detect species that cannot be easily or reliably detected by visual methods, especially elusive species and deep divers (e.g., sperm whales and beaked whales).

Based on the aforementioned considerations we selected real-time mitigation using a hydrophone array towed from the seismic vessel.

When a vocalization is detected during visual observations, the PAM operator will contact the lead visual PSO immediately, to alert him/her to the presence and estimated range to the vocalizing cetaceans (if they have not already been seen), to allow a power down or shut down to be initiated, if required.

TGS proposes to use a towed passive acoustic array to meet the PAM requirement identified in the ROD (BOEM 2014b). Per NMFS' guidance for mitigation and monitoring (http://www.nmfs.noaa.gov/pr/permits/incidental/instructions.htm#13), program monitoring should improve the understanding of one or more of the following:

- the likely occurrence of marine mammal species or stocks (e.g., presence, abundance, distribution, and/or density of species);
- the nature, scope, or context of the likely exposure of marine mammal species or stocks to any of the potential stressor(s), by understanding:
    - the action itself and the surrounding environment;
    - the affected species (life history, habitat use, hearing sensitivity);
    - the likely co-occurrence of marine mammal species or stocks with the action (in whole or part);
    - the likely biological or behavioral context of exposure to the stressor (e.g., age class or known calving or feeding areas);
- how marine mammals respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received levels);
- how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either:
    - the long-term fitness and survival of an individual or
    - the population, species, or stock (e.g., through effects on annual rates of recruitment or survival); and,
- an increase in our understanding of the effectiveness of mitigation and monitoring measures".

8.1.4 Modeling, Establishment and Monitoring of Exclusion Zones

Current NMFS guidelines (65 FR 16374) define "exclusion radii", hereafter referred to as EZs, for marine mammals around industrial sound to be 180 dB re 1 µPa (rms) for cetaceans. Such guidelines are in place to minimize disturbance or behavioral effects to marine mammals. This is based on NMFS' assumption that sound energy at lower received levels (RLs) will not impair their abilities to hear, but higher RLs may have such effects (NMFS 2005b).

Based on a review of available data on seismic source arrays and associated sound source verification (SSV) modeling, the 2D seismic source array closest in volume to TGS' proposed 4,808 in³ array was the larger 5,400 in³ seismic source array identified in the BOEM PEIS (BOEM 2014a). Therefore, TGS assessed potential effects of their proposed operations based on sound propagation modeling associated with this larger (by approximately 592 in³) 5,400 in³ seismic array.

The source levels for the 5,400 in³ seismic source array (acoustic directional) was predicted using JASCO's Applied Sciences (JASCO) acoustic array source model (AASM). To model sound propagation, data collected from 21 oceanographic sites throughout BOEM's AOI was entered

into the AASM. The estimated RL of the 5,400 in³ array at various distances away was then estimated using the Marine Operations Noise Model (MONM) (with the Range-dependent Acoustic Model (RAM) parabolic-equations model). MONM-RAM estimated RLs based on sound exposure levels (SELs) for low-frequency sources assuming clay or sand bottom composition. Water depths at the 21 example AOI sites varied from 30 to 5,400 m. JASCO applied its MONM to estimate distances from the proposed 5,400 in³ seismic source array to NMFS' standard 180 and 160 dB re 1 µPa (rms) isopleths.

The resulting modeled distances to the 180 dB "exclusion zone" (EZ) and the 160 dB re 1 µPa (rms) "disturbance zone" (DZ) for cetaceans differed with water depth. EZ distances modeled for the 5,400 in³ array ranged from 799 to 2,109 m for the 180-dB EZ and 5,184-15,305 m for the 160-dB DZ (Figure 5). To address this variation in modeled distances across the survey area, TGS used the mean of the 95 percent range values of the modeled RL for each of the 21 sites as the mitigation distances for the full seismic source.

Isopleth (dB re 1 µPa [rms])	Mean modeled distance for the full 5,400 in³ array (m*)**
180	904
160	6,838

Figure 5. Estimated distance from the full 5,400 in³ seismic source array to the NMFS-regulated 160 and 180 dB re 1µPa (rms) isopleths in the Mid- and South Atlantic Outer Continental Shelf waters based on results of JASCO Applied Sciences sound modeling.

For the single mitigation seismic source, estimated distance to the 180 dB re 1µPa (rms) isopleths was 76-186 m; estimated distance to the 160 dB isopleth was 1,294-3,056 m (all dB re 1 µPa [rms]) (Figure 6). As described above, TGS applied the mean of the 95 percent range values of the modeled RL for each of the 21 sites as the mitigation distances for the single seismic source and associated pre-clearance period.

Isopleth (dB re 1 µPa [rms])	Mean modeled distance for the single 90 in³ airgun (m*)**
180	126
160	1,486

Figure 6. Estimated mean distance from the 90 in³ single mitigation seismic source to the NMFS-regulated 160 and 180 dB re 1 µPa (rms) isopleths in the Mid- and South Atlantic Outer Continental Shelf waters based on results of JASCO Applied Sciences sound modeling.

PSOs aboard the seismic vessels will perform a substantial role in monitoring for marine mammals and implementing mitigation measures. Aboard the seismic vessel, PSOs will monitor for marine mammals prior to initiation of the seismic source to ensure none are detected within the specified EZs for at least a 60-min period prior to any seismic sources being turned on.

8.1.5 Mitigation during Operations

TGS will adhere to the following mitigation measures during seismic operations, when mobilizing to the survey area, when demobilizing from the survey area, and in the performance of any other operations in support of the 2D seismic program:

- Speed or course alterations for marine mammals, provided that doing so will not compromise safety of the operations.
- The seismic vessels will be staffed with PSOs and PSAOs who will alert the crew to the presence of marine mammals so that vessel and seismic source crews can implement the appropriate mitigation measures, including power-down, shut-down, and ramp-up procedures.
- Initiation of the seismic source will occur only after the 180 dB EZ is visible for 60-min immediately prior to seismic operations (i.e., the 'all-clear period') during day or at night using continuous PAM supplemented by visual monitoring.

During periods of limited visibility due to fog and/or darkness (nighttime), TGS will adhere to the following:

- If the entire 180 dB EZ is not visible for a minimum of 60 min prior to initiation of seismic operations, the seismic source will not operate unless PSAO's have monitored for the 60 min immediately prior to seismic operations with no marine mammal determined to be calling within the estimated EZ.
- If a single seismic source or source array has been operational before visibility decreased or before nightfall, seismic source operations may continue even though the entire EZ may not be visible.
- If limited visibility appears imminent due to inclement weather, the single mitigation source may be operated when the EZ has been continuously monitored and determined to be clear of visual sightings and localized calls of marine mammals for the 60 min immediately prior to initiation of the mitigation source.

8.1.6 Speed or Course Alteration

If marine mammals have been detected and seen outside the EZ but are likely to enter the EZ based on observed movements, the seismic vessel will adjust (increase or decrease) speed or change its course to avoid disturbing the marine mammals. This procedure will be conducted with safety and practicality in mind, and further course alterations or seismic source power downs will occur if necessary.

8.1.7 Power-down, Shut Down and Ramp-up Procedures

Power-down procedures include reducing the seismic source array volume (by reducing the number of active sources) thereby reducing the 180 dB to an extent that the marine mammal(s) are no longer within the applicable zone.

If marine mammals are detected *entering* the appropriate EZ (except when bowriding), a power down will be immediately requested by the PSO to power down to the 90 in^3 (or smaller) mitigation seismic source. Similarly, if marine mammals are detected *within* the appropriate EZ, a power down will be requested immediately as long as marine mammals are not within or approaching the reduced EZ of the single or mitigation seismic source. Measured reported distances for the 90 in^3 mitigation seismic source were reported in BOEM (2014a) as recorded by JASCO Applied Sciences as follows: 126 m for the 180 dB isopleth, and 1,486 m for the 160 dB isopleth. TGS will use the mean of the 95 percent range values of the modeled RL for each of the 21 sites of these distances for the purposes of mitigation and monitoring. If marine mammals continue to approach the reduced EZ of the single mitigation seismic source, this single seismic source will be shutdown.

Power downs may also occur when the seismic vessel is transitioning between survey lines. In this case, the seismic source will be reduced to a single 90 in^3 (or smaller) mitigation seismic source or optionally will shut down completely.

Once powered down, seismic source operations will only resume once the marine mammals have been confirmed outside the EZ. A marine mammal is considered to have cleared the zone if:

- it has been visually detected outside of the full-zone EZ;
- it has not been observed for 60-min;
- the vessel has moved outside the EZ

Shut-down procedures consist of a complete cessation of the seismic source. These procedures will be implemented if marine mammals are observed within the appropriate EZ. Once shut down, seismic source operations will only resume after the marine mammals have been confirmed to be outside the EZ and the zone has been clear for at least 60 min as described for

power downs. Exceptions will be made and shutdown is not required for delphinids (i.e., dolphins) that are approaching or remain near any vessel or the towed equipment (BOEM 2014b). The PSO and PSAOs must record the details of any non-shutdowns in the presence of delphinids, including the distance of the delphinid(s) from the vessel at the first sighting of the delphinid(s), their heading, where the delphinid positions itself relative to the vessel, how long they stay near the vessel, and any identifiable behaviors (BOEM 2014a). After a shutdown, the operator may recommence seismic operations with a ramp-up of the seismic source only when the acoustic EZ has been visually inspected for at least 60 min to help ensure the absence of all marine mammals (BOEM 2014a).

Shutdowns will occur immediately if observations are made or credible reports are received that one or more marine mammals within the seismic survey area are injured, dead, dying, or indicate acute distress due to seismic noise. In this case an emergency shutdown will be ordered and NMFS will be contacted immediately. If it can be determined that the marine mammal(s) injury or death is likely not due to seismic activities (e.g., obvious signs of killer whale predation, ship strikes), TGS will collect information, notify NMFS, and resume seismic activities. If cause of death cannot be attributed to causes other than the seismic program, the activities will not be restarted until approval has been given by NMFS.

Ramp-up (also known as soft start) procedures involve a stepwise increase in the number and volume of the seismic source to provide a gradual increase of sound levels into the environment until maximum levels are reached.

Operators will visually monitor the EZ and adjacent waters for the absence and/or presence of marine mammals for 60-min before initiating ramp-up procedures. If marine mammals are not detected, ramp-up procedures may begin. Ramp up at night or when the EZ cannot be visually monitored is not permitted if the minimum source level drops below 160 dB re 1 µPa m (rms). Chronological procedures of a ramp-up process are listed below.

1. Initiate ramp-up procedures by use of the single 90 in^3 mitigation source.
2. Continue ramp-up by gradually activating additional sources over a period of at least 20 min, but no longer than 40-min, until the desired operating level of the source array is obtained.
3. Immediately shut down all sources (i.e., stop seismic operations) any time marine mammals are detected entering or within the EZ. After a shutdown, ramp-up and seismic operations may restart only if the EZ has been visually inspected for at least 60-min prior to ensure the absence of marine mammals within the EZ.

4. After a complete shutdown, ramp-up procedures will not begin until the EZ for the full seismic array is visible and no marine mammals are present. In this case of a "cold start," the EZ must remain completely visible during the entire 60-min period. If marine mammals are observed within the appropriate EZ, a cold start may not be initiated until the animal is observed outside the EZ or not observed for at least 60-min.

Periods of source silence for ≤ 20-min in duration will not require ramp up to recommence seismic operations if (a) visual surveys are continued diligently throughout the silent period (requiring daylight and reasonable sighting conditions), and (b) no marine mammals are observed in the EZ (BOEM 2014a). If marine mammals are detected in the EZ during the short silent period, recommencement of seismic survey operations must be preceded by ramp up only after no marine mammals have been observed in the EZ for a period of 60-min (BOEM 2014a).

Array source levels may be reduced to maintain a minimum source level of 160 dB re 1 µPa-m (rms) for the duration of certain activities (BOEM 2014a). The 60-min visual clearance of the EZ before ramp up to full power is not required if the minimum source level of 160 dB re 1 µPa-m (rms) is maintained (BOEM 2014a). Activities that are appropriate for maintaining the minimum source level are (1) all turns between seismic survey lines, when a survey using the full seismic array is being conducted immediately prior to the turn and will be resumed immediately after the turn; and (2) unscheduled, unavoidable maintenance of the seismic source array that requires the interruption of a survey to shut down the seismic array. The survey should be resumed immediately after the repairs are completed, unless source silence lasted more than 20 minutes, in which case a full ramp-up would be necessary. Use of the minimum source level to avoid the 60-min visual clearance of the EZ is only for events that occur during a survey using the full power array. The minimum sound source level is not to be used to allow a later ramp up after dark or in conditions when ramp up would not otherwise be allowed.

To reduce the overall contribution of project-related seismic sounds, during turns and transits between survey lines while the single 90 in^3 mitigation source is operating, TGS proposes to decrease the seismic source pulse interval to 60-sec. The proportion of time that the seismic array will actually be operating (i.e., "on") is very small compared to the proportion of time that TGS will be in the survey area. This is because each pulse with the full seismic array lasts only about 3 milliseconds, and is repeated at an interval of approximately 10 sec. Furthermore, each 3-millisecond pulse by the single mitigation source is proposed to be spaced apart by 60-sec. The latter mitigation measure was recently approved by a NMFS review panel and thus

implemented for a seismic survey with a large seismic source array during a TGS seismic survey in the Chukchi Sea in summer-fall 2013.

8.1.8 Procedures for Species of Concern

If a North Atlantic right whale is encountered at any distance from the seismic vessel, seismic operations will be shut down immediately due to the rarity of this federally endangered species. It is not likely that concentrations (large amounts in one place) of humpback, fin, sperm, blue, or sei whales would be encountered, but if so, the appropriate mitigation measures will be implemented.

8.1.9 Time-Area/Speed Restrictions for North Atlantic Right Whales

Ten kt (18 km/hr) speed limits are in effect annually from November 15 to April 15 within the Southeast Seasonal Management Aare (SMA) (NMFS 2014). In the Mid-Atlantic SMA, the same speed restrictions are in effect annually from November 1 through April 30 (NMFS 2014). Within the North Atlantic right whale critical habitat off the southeast U.S. coast, the annual calving and nursing season extends from November 15 through April 15 (NMFS 2014). A minimum of 500 m must be maintained from any North Atlantic right whale that is sighted, 100 m from other whale species, and 50 m from all other marine mammals (BOEM 2014b). DMAs are designed to reduce the risk of whale-ship interactions when right whale(s) are found aggregating in an area. All project vessels will abide by these time-area /speed restrictions when they are in effect. Seismic operators will also be required to ensure that sound from surveys outside of North Atlantic right whale critical habitat, the SMAs, or DMAs does not exceed 160 dB at the boundaries of the time-closure areas (BOEM 2014b).

8.1.10 Communication Procedures

When PSOs and PSAOs detect marine mammals within or approaching the applicable EZ, the seismic source will be powered down or shut down immediately. To facilitate this, PSOs will establish a direct line of communication with the seismic source operators (i.e., traditionally via VHF radio). PSOs will continue to monitor the EZ after the power or shut down. The PSOs will communicate resumption of the array source if the marine mammal(s) is observed outside and moving away from the applicable EZ within five min of the power down or shut down. If over five min have elapsed since the seismic source was reduced in volume or shut down, then the EZ must be clear of marine mammals for at least 60-min or as stipulated in the NMFS-issued IHA. Once the PSO(s) has cleared the zone, they will communicate to the seismic source operators to initiate ramp-up procedures.

8.1.11 Monitoring Measures

TGS proposes to implement mitigation and monitoring measures that will contribute to increased knowledge of marine mammal species that are likely to be exposed to project-related seismic activity noise at received levels (RLs) of ≥ 160 dB re 1µPa (rms). The proposed means of increasing knowledge on marine mammals in the survey area include:

1. Visual observations of marine mammal species seasonal and geographical occurrence, location and behavior during periods with and without seismic operations, facilitating comparisons of these parameters relative to seismic activities;
2. Real-time PAM during periods with and without seismic operations to provide data on cetacean species calling patterns seasonally, geographically, behaviorally, and relative to seismic sounds; and
3. Coordinating monitoring efforts with other groups conducting research on and/or mitigation/monitoring of marine mammals in overlapping or nearby regions and periods.

These approaches and associated proposed survey techniques will be used to monitor and describe marine mammal movement, vocal and visually observed activity and behavior, habitat use, distribution, and density and abundance (sample sizes permitting) within the survey area relative to seismic operation as described in ensuing sections. The latter will include comparison of these aspects during periods with and without seismic transmissions, and other project conditions (e.g., ramp up, mitigation versus full seismic array operations) sample sizes permitting.

TGS understands that the monitoring plan described in this section will be subject to review by NMFS and others and that modification may be required. TGS is prepared to discuss coordination of its monitoring program with any related work that might be done by other groups insofar as this is practical. The latter would consist of communicating prior to and during the proposed seismic survey with entities involved in temporal-spatially overlapping research and monitoring. Goals would include coordinating timing and locations of TGS' proposed monitoring programs to complement one another and to address research and conservation needs as possible/applicable.

8.1.12 Vessel-based Visual Monitoring

Vessel-based PSOs will observe from the seismic vessels to monitor the presence and behavior of marine mammals during all daylight seismic operations. The primary purpose of the visual PSOs is to visually monitor the EZs and implement mitigation measures (e.g., ramp ups, power downs, and shut downs of the seismic source). All observer résumés will be submitted to BOEM and NMFS for approval prior to survey operations, as identified in the BOEM final PEIS (BOEM 2014a). Vessel-based visual monitoring by PSOs will provide:

- The foundation for real-time mitigation as required by the permitting agencies;

- Information necessary to estimate the number of "take" exposures of marine mammals to seismic operations noise that must and will be reported to NMFS;
- Information necessary to evaluate the impact of activities authorized by the IHA on marine mammals;
- Marine mammal distribution, movement, and behavioral data within view of the seismic vessels and PAM recording range when seismic source operations are on and off.

8.1.13 Protected Species Observer Protocol

To adequately monitor proposed EZs during all daylight and nighttime seismic operations and mitigation periods, three to five visual PSOs and two PSAOs are proposed to be aboard the seismic vessels, depending on the amount of daylight hours each day, and based on seasonal variation in the number of daylight hours. Aboard the seismic vessels, PSO rotations will be scheduled so that at least two PSOs will be on watch during all daylight periods (from civil twilight-dawn to civil twilight-dusk) with seismic operations as well as during the 60-min pre-ramp up "all clear" period and the ensuing ramp up; two PSOs will also be on watch aboard the seismic vessel during other non-seismic daylight periods to the maximum extent practicable, with at least one PSO on watch during meal times and restroom breaks. PSOs will also conduct monitoring while the seismic source vessel deploys and recovers the seismic source from the water (BOEM 2014a). Daily PSO rotations will be scheduled such that each PSO will be on continuous watch for no more than 4 hr at a time, and for no more than 12-hr total per 24-hr period to avoid and minimize PSO fatigue. A "lead PSO" will be designated for each vessel to oversee PSO data quality assurance / quality control (QA/QC) and compile and send any field reporting required per the NMFS IHA and BOEM.

They will receive a detailed manual summarizing PSO protocol and mitigation procedures as stipulated in the permits and IHA and as described in the BOEM final PEIS (2014a) and associated NMFS Biological Opinion (BOEM 2014a). The latter protocol will be provided to NMFS as requested. PSOs will follow the reporting requirements identified in the permits and issued IHA. Once onboard the vessels and prior to the survey's start, the lead PSO on the seismic vessel will communicate the role of the PSO teams to the vessel crew(s). This will include establishing an effective method of communication for relaying mitigation requests to the seismic source operators (see below).

Marine mammal visual observations will be conducted from the bridge or other suitable platform on the seismic vessels. On the seismic vessel, the two on-watch PSOs will scan waters within view for marine mammals: one PSO will alternate between the naked eye and handheld

reticle binoculars. Whichever PSO sights a marine mammal(s), the other will record sighting data on a GPS-connected laptop computer.

PSOs will record data on marine mammal sightings, vessel and seismic activities, and environmental conditions (every 30 min on the hr and half hr and when a sighting occurs). Specific data parameters that will be collected include species, group size/composition, location relative to the seismic array position, distance from the survey vessel, and behavior.

8.1.14 Data Recording & Reporting

The operator of the seismic vessel will maintain a log of seismic surveys, noting the date and time of all changes in seismic activity (ramp up, power down, shut down, changes in the active seismic source, etc.) and any corresponding changes in monitoring radii. Information collected during marine mammal observations will include the following:

- Vessel speed, position, and activity including seismic status;
- Date, time, and location of each marine mammal sighting relative to the seismic source(s) and/or array and PSO position;
- Number of marine mammals observed, and group size, sex, and age categories as possible;
- Observer's name and method of determining distance to the sighting (e.g., naked eye, reticle binoculars, Big Eye binoculars);
- Beaufort sea state, visibility distance, and weather conditions at the time of observation;
- Estimated distance, behavior state (e.g. traveling, resting) and relative heading of marine mammals at first-observed, last-observed, and closet point of observed approach (CPA), as applicable;
- Animal behavioral events (e.g., breach, tail slap) and any unusual behaviors;
- Description of the encounter;
- Duration of encounter; and
- Mitigation action(s) taken.

During the field season, brief summary reports will be provided to NMFS, as required per the IHA.

Results of the vessel-based PSO program, including estimates of exposures to seismic sounds, will be described in a report to be submitted within 90 days of the end of the program. This report will adhere to the requirements established by the NMFS IHA and will include the following:

- A summary of the monitoring effort.
- Analysis of factors affecting the visibility and detectability of marine mammals during monitoring.
- Analysis of distribution and abundance of marine mammal sightings, and description of marine mammal behavior and movement in relation to date, location, conditions, and operations including periods of seismic on and off.
- Estimates of numbers of exposures of marine mammals by species and NMFS exposure criteria based upon density estimates derived from visual (and if possible) passive acoustic monitoring and survey efforts (sample sizes permitting).
- Reporting of acoustic monitoring results to include: sound RLs of seismic source(s) and seismic vessels; acoustic detections of marine mammal; and continuous sound levels at the stationary recording locations.

  Estimates of directly observed exposures to seismic operations relative to NMFS exposure criteria.

9. REFERENCES

Bureau of Ocean Energy Management (BOEM). 2012. Draft White paper from BOEM's Mitigation and Monitoring Workshop for Marine Mammal Protection Act Rulemaking on Geological and Geophysical Activities in Federal Waters of the Gulf of Mexico. November 28-30, 2012. Herndon, VA. 42pp.

Bureau of Ocean Energy Management (BOEM), Gulf of Mexico OCS Region. 2014a. Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas. Final Programmatic Environmental Impact Statement. Prepared under GSA Task Order No. M11PD00013 by CSA Ocean Sciences Inc. 8502 SW Kansas Avenue, Stuart, Florida 34997.

Bureau of Ocean Energy Management (BOEM). 2014b. Record of Decision: Atlantic OCS Proposed Geological and Geophysical Activities Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement (PEIS). Issued 11 July 2014. http://www.boem.gov/Record-of-Decision-Atlantic-G-G/

National Marine Fisheries Service (NMFS). 2005b. Recovery Plan for the North Atlantic Right Whale (Eubalaena glacialis). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service (NMFS). 2013. Open Water Peer Review Panel Monitoring Plan Recommendations Report.

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Silber G.K., J.D. Adams, and C.J. Fonnesbeck. 2014. Compliance with vessel speed restrictions to protect North Atlantic right whales PeerJ 2:e399. http://dx.doi.org/10.7717/peerj.399.

Smultea, M.A., C.E. Bacon, T.F. Norris, D. Steckler, M.R. Moore, R.P. Walker, T.M. Yack, and K.J. Dunleavy. 2014. Request by TGS-NOPEC for an Incidental Harassment Authorization for the Incidental Take of Marine Mammals in Conjunction with a Proposed Marine 2D Seismic Program Mid- and South Atlantic Outer Continental Shelf, 2015. Prepared by Smultea Environmental Sciences and Bio-Waves, Inc. for TGS-NOPEC Geophysical Company. Submitted to National Marine Fisheries Service, Silver Spring, MD.

St. John, Karen, on behalf of the International Association of Geophysical Contractors (IAGC), sent to the Office of Ocean and Coastal Resource Management, National Ocean and Atmospheric Administration. RE: Comments on States' Unlisted Avtivity Review Requests for BOEM Permit Nos. E14-001 thru E14-009. (September 03, 2014).

10. APPENDICES

10.1 BOEM PERMIT APPLICATION FOR TGS PERMIT E14-001:

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OCEAN ENERGY MANAGEMENT

Atlantic OCS Region
(Insert Appropriate Regional Office)

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

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

TGS
(Name of Permitee)

10451 Clay Road
(Number and Street)

Houston, TX 77043
(City, State, and Zip Code)

PERMIT NUMBER: _____ **DATE:** _____

This permit is issued pursuant to the authority of the Outer Continental Shelf Lands Act, as amended, (43 U.S.C. 1331 et seq.), hereinafter called the "Act," and Title 30 Code of Federal Regulations Parts 251 and 551 (Geological and Geophysical (G&G) Explorations of the Outer Continental Shelf).

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

Form **BOEM-0328 (January 2012)** Previous Editions are Obsolete. Page 1 of 8

Section I. Authorization

The Government authorizes the permittee to conduct:

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

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

This permit authorizes the permittee to conduct the above geophysical activity during the period from TBD to TBD in the following area(s): Middle & South Atlantic Ocean Regions. Extensions of the time period specified above must be requested in writing. A permit plus extensions for activities will be limited to a period of not more than 1 year from the original issuance date of the permit. Inspection and reporting of geophysical exploration activities, suspension and cancellation of authority to conduct exploration or scientific research activities under permit, and penalties and appeals will be carried out in accordance with 30 CFR 551.8, 551.9, and551.10.

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

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

A. The permittee will employ the following type(s) of operations:
2D long offset seismic survey. Using 1 streamer vessel towing 1 streamer and a single source;

and will utilize the following instruments and/or technique(s) in such operations:
SEAL recording system and SERCEL streamers.

B. The permittee will conduct all activities in compliance with the terms and conditions of this permit, including the "Stipulations," "Special Provisions," and the approved "Application for Permit," which are attached to and incorporated into this permit.

C. The permittee will conduct all geophysical exploration or scientific research activities in compliance with the Act, the regulations in 30 CFR Parts 251 and 551, and other applicable statutes and regulations whether such statutes and regulations are enacted, promulgated, issued, or amended before or after this permit is issued. Some of the provisions of 30 CFR Parts 251 and 551 are restated in this permit for emphasis. However, all of the provisions of 30 CFR Parts 251 and 551 apply to this permit.

Section III. Reports on Operations

A. The permittee must submit status reports on a _____ basis in a manner approved or prescribed by the Regional Supervisor, Resource Evaluation (hereinafter referred to as Supervisor). The report must include a daily log of operations and a map (preferably on a scale of 1:_____) showing traverse lines according to Bureau of Ocean Energy Management (BOEM) area and block numbers.

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

1. A description of the work performed and areal extent including number of line miles for 2-D or high resolution surveys or OCS blocks for 3-D geophysical data acquired;

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

3. The dates on which the actual geophysical exploration or scientific research activities were performed;

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

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

6. A final edited navigation file on suitable storage medium of all data or sample locations in latitude/longitude degrees including datum used. The navigation for 2D lines should include line name and locations for the first, last and every tenth SP. For 3D surveys, please supply a navigation file for the acquired track lines that includes the location of the first and last SP and/or the corner locations for the area acquired. Contact the G&G permitting office for the specific navigation required for this permitted activity. The digital file is to be formatted in standard SEG-P1, UKOOA P1-90 or other current, standard industry format, coded in ASCII. A printed data listing and a format statement are to be included;

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

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

C. The last status report and the final report can be combined into one report.

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

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

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

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

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

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

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

4. With regard to license agreements, a permittee or third party that licenses data and information to a third party, within 30 days of a request by the Supervisor, must advise the Supervisor, in writing, of the license agreement, including the identity of the recipient of the data and information.

D. Each submission of geophysical data, processed geophysical information, and interpreted geophysical information must contain, unless otherwise specified by the Supervisor, the following:

1. An accurate and complete record of each geophysical survey conducted under the permit, including digital navigational data and final location maps of all surveys;

2. All seismic data developed under a permit presented in a format and of a quality suitable for processing;

3. Processed geophysical information derived from seismic data with extraneous signals and interference removed, presented in a format and of a quality suitable for interpretive evaluation, reflecting state-of-the-art processing techniques; and

4. Other geophysical data, processed geophysical information, and interpreted geophysical information obtained from, but not limited to, shallow and deep subbottom profiles, bathymetry, side-scan sonar, gravity, magnetic, and electrical surveys, and special studies such as refraction, shear wave, and velocity surveys.

Section V. Reimbursement to Permittees

A. After the delivery of geophysical data, processed geophysical information, and interpreted geophysical information requested by the Supervisor in accordance with subsection IV of this permit, and upon receipt of a request for reimbursement and a determination by BOEM that the requested reimbursement is proper, BOEM will reimburse the permittee or third party for the reasonable costs of reproducing the submitted data and information at the permittee's or third party's lowest rate or at the lowest commercial rate established in the area, whichever is less.

B. If the processing was in a form and manner other than that used in the normal conduct of the permittee's business at BOEM's request, BOEM will reimburse the permittee or third party for the reasonable costs of processing or reprocessing such data. Requests for reimbursement must identify processing costs separate from acquisition costs.

C. The permittee or third party will not be reimbursed for the costs of acquiring or interpreting geophysical information.

D. Data and information required under section IV.D.1. of this permit are not considered to be geophysical data or processed geophysical information and must be provided by the permittee at no cost to the Government.

Section VI. Disclosure of Data and Information to the Public

A. BOEM will make data and information submitted by a permittee available in accordance with the requirements and subject to the limitations of the Freedom of Information Act (5 U.S.C. 552) and the implementing regulations (43 CFR Part 2), the requirements of the Act, and the regulations contained in 30 CFR Parts 250 and 550 (Oil and Gas and Sulphur Operations in the Outer Continental Shelf), 30 CFR Parts 251 and 551, and 30 CFR Parts 252 and 552 (Outer Continental Shelf (OCS) Oil and Gas Information Program).

B. Except as specified in this section, or Section VIII, or in 30 CFR Parts 250, 252, 550, and 552, no data or information determined by BOEM or the Bureau of Safety and Environmental Enforcement to be exempt from public disclosure under subsection A of this section will be provided to any affected State or be made available to the executive of any affected local government or to the public, unless the permittee or third party and all persons to whom such permittee has sold, traded, or licensed the data or information under promise of confidentiality agree to such an action.

C. Geophysical data and processed or interpreted geophysical information submitted under a permit, and retained by BOEM, will be disclosed as follows:

1. Except for deep stratigraphic tests, BOEM will make available to the public geophysical data 50 years after the date of issuance of the permit under which the data were collected (see 30 CFR 551.12 (a) (b) (c) and (d)).

2. Except for deep stratigraphic tests, BOEM will make available to the public processed geophysical information and interpreted geophysical information 25 years after the date of issuance of the permit under which the original data were collected (see 30 CFR 551.12(a), (b), (c) and (d)).

3. BOEM will make available to the public all geophysical data and information and geophysical interpretations related to a deep stratigraphic test, at the earlier of the following times: (a) 25

years after the completion of the test, or (b) for a lease sale held after the test well is completed, 60 calendar days after the Department of the Interior executes the first lease for a block, any part of which is within 50 geographic miles (92.6 kilometers) of the site of the completed test.

D. All line-specific preplot or postplot plat(s), and navigation tapes, including but not limited to seismic survey traverses and shotpoint locations, submitted as a requirement of 30 CFR 251.7, 551.7 or 551.12, will be considered as "PROPRIETARY INFORMATION." Such information will not be made available to the public without the consent of the permittee for a period of 25 years from the date of issuance of the permit, unless the Director, BOEM, determines that earlier release is necessary for the proper development of the area permitted.

E. All other information submitted as a requirement of 30 CFR 551.8 and determined by BOEM to be exempt from public disclosure will be considered as "PROPRIETARY." Such data and information will not be made available to the public without the consent of the permittee for a period of up to 25 years from the date of issuance of the permit as addressed in 30 CFR 551.14, unless the Director, BOEM, determines that earlier release is necessary for the proper development of the area permitted. The executed permit will be considered as "PROPRIETARY" except the public information copy which will be available to the public upon request.

F. The identities of third party recipients of data and information collected under a permit will be kept confidential. The identities will not be released unless the permittee and the third parties agree to the disclosure.

Section VII. Disclosure to Independent Contractors

BOEM reserves the right to disclose any data or information acquired from a permittee to an independent contractor or agent for the purpose of reproducing, processing, reprocessing, or interpreting such data or information. When practicable, BOEM will advise the permittee who provided the data or information of intent to disclose the data or information to an independent contractor or agent. BOEM's notice of intent will afford the permittee a period of not less than 5 working days within which to comment on the intended action. When BOEM so advises a permittee of the intent to disclose data or information to an independent contractor or agent, all other owners of such data or information will be deemed to have been notified of BOEM's intent. Prior to any such disclosure, the contractor or agent will be required to execute a written commitment not to sell, trade, license, or disclose any data or information to anyone without the express consent of BOEM.

Section VIII. Sharing of Information with Affected States

A. At the time of soliciting nominations for the leasing of lands within 3 geographic miles of the seaward boundary of any coastal State, BOEM, pursuant to the provisions of 30 CFR Parts 252.7 552.7 and subsections 8(g) and 26(e) (43 U.S.C. 1337(g) and 1352(e)) of the Act, will provide the Governor of the State (or the Governor's designated representative) the following information that has been acquired by BOEM on such lands proposed to be offered for leasing:

1. All information on the geographical, geological, and ecological characteristics of the areas and regions proposed to be offered for leasing;

2. An estimate of the oil and gas reserves in the area proposed for leasing; and

3. An identification of any field, geological structure, or trap located within 3 miles of the seaward boundary of the State.

B. After the time of receipt of nominations for any area of the OCS within 3 geographic miles of the seaward boundary of any coastal State and Area Identification in accordance with the provisions of Subparts D and E of 30 CFR Part 556, BOEM, in consultation with the Governor of the State (or the Governor's designated representative), will determine whether any tracts being given further consideration for leasing may contain one or more oil or gas reservoirs underlying both the OCS and lands subject to the jurisdiction of the State.

C. At any time prior to a sale, information acquired by BOEM that pertains to the identification of potential and/or proven common hydrocarbon-bearing areas within 3 geographic miles of the seaward boundary of any such State will be shared, upon request by the Governor and pursuant to the provisions of 30 CFR Parts 252.7 and 552.7 and subsections 8(g) and 26(c) of the Act, with the Governor of such State (or the Governor's designated representative).

D. Knowledge obtained by a State official who receives information under subsections A, B, and C of this section will be subject to the requirements and limitations of the Act and the regulations contained in 30 CFR Parts 250, 251, 252, 550, 551, and 552.

Section IX. Permit Modifications

The Department will have the right at any time to modify or amend any provisions of this permit, except that the Department will not have such right with respect to the provisions of Sections VI, VII, and VIII hereof, unless required by an Act of Congress.

IN WITNESS WHEREOF the parties have executed this permit and it will be effective as of the date of signature by the Supervisor.

PERMITTEE: **THE UNITED STATES OF AMERICA:**

(Signature of Permittee)

(Signature of Regional Supervisor)

Gabriel Rolland
(Type or Print Name of Permittee)

(Type or Print Name of Regional Supervisor)

Marine Acquisition QC Specialist
(Title)

(Date)

03-18-14
(Date)

OMB Control Number: 1010-0048
OMB Approval Expires: 1/31/15

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OCEAN ENERGY MANAGEMENT

Atlantic OCS Region
(Insert Appropriate Regional Office)

Requirements for Geological and Geophysical Explorations or Scientific Research on the Outer Continental Shelf

Application for Permit to Conduct Geological or Geophysical Exploration for Mineral Resources or Scientific Research on the Outer Continental Shelf
(Attachment 1)

Nonexclusive Use Agreement for Scientific Research
(Attachment 2)

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

Paperwork Reduction Act of 1995 (PRA) Statement: The PRA (44 U.S.C. 3501 et seq.) requires us to inform you that the Bureau of Ocean Energy Management (BOEM) collects this information to evaluate applications for permits to conduct pre-lease exploration offshore and to monitor activities of scientific research conducted under notices. BOEM uses the information to ensure there is no environmental degradation, personnel harm, damage to historical or cultural sites, or interference with other uses. Responses are mandatory or to obtain or retain a benefit. Proprietary information is protected in accordance with standards established by the Federal Oil and Gas Royalty Management Act of 1982 (30 U.S.C. 1733), the Freedom of Information Act (5 U.S.C. 552(1), (4)), and Department regulations (43 CFR 2). An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid Office of Management and Budget control number. The reporting burden for this form is estimated to average 3 hours per response, including the time for reviewing instructions, gathering and maintaining data, and completing and reviewing the form. Direct comments regarding the burden estimate or any other aspect of this form to the Information Collection Clearance Officer, Bureau of Ocean Energy Management, 381 Elden Street, Herndon, VA 20170.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OCEAN ENERGY MANAGEMENT

REQUIREMENTS FOR GEOLOGICAL AND GEOPHYSICAL EXPLORATIONS OR SCIENTIFIC RESEARCH ON THE OUTER CONTINENTAL SHELF

Authority

You must perform all geological and geophysical explorations or scientific research activities authorized and conducted in the Outer Continental Shelf (OCS) according to the OCS Lands Act, 30 CFR Parts 251, 551, and other applicable Federal statutes and regulations, and amendments thereto.

General Requirements of Permits and Notices

You must conduct geological and geophysical activities for mineral exploration or scientific research activities authorized under 30 CFR Parts 251 and 551 so that those activities do not:

A. Interfere with or endanger operations under any lease or right-of-way or permit issued or maintained pursuant to the OCS Lands Act;
B. Cause harm or damage to aquatic life or to the marine, coastal, or human environment;
C. Cause pollution;
D. Create hazardous or unsafe conditions;
E. Unreasonably interfere with or harm other uses of the area; or
F. Disturb archaeological resources.

Any person conducting geological or geophysical activities for mineral exploration or scientific research under 30 CFR Parts 251 and 551 must immediately report to the Director, BOEM:

A. Detection of hydrocarbon occurrences;
B. Encounters of environmental hazards that constitute an imminent threat to human activity; or
C. Activities that adversely affect the environment, aquatic life, archaeological resources, or other uses of the area in which the exploration or scientific research activities are conducted.

Any person conducting shallow or deep stratigraphic test drilling activities under a permit for mineral exploration or scientific research under 30 CFR Parts 251 and 551 must utilize the best available and safest technologies that BOEM determines to be economically feasible.

The authorization that BOEM grants you under 30 CFR Parts 251 and 551 to conduct geological and geophysical explorations for minerals or for scientific research does not confer a right to any discovered oil, gas, or other minerals, or to a lease under the OCS Lands Act.

Time Restriction for Permits and Notices

Permitted activities approved for a specified period, including requests for extensions, and activities under a notice may not exceed 1 year.

Geological and Geophysical Activities Requiring Permits and Notices

Geological and Geophysical Explorations for Mineral Resources

You may not conduct geological and geophysical explorations for mineral resources in the OCS without an approved permit unless you conduct such activities pursuant to a lease issued or maintained under the OCS Lands Act. You must obtain separate permits for either geological or geophysical explorations for mineral resources. If BOEM disapproves an application, the statement of rejection will state the reasons for the denial and will advise the applicant of those changes needed to obtain approval.

Geological and Geophysical Scientific Research

You may not conduct geological and geophysical scientific research related to oil, gas, and sulphur in the OCS without an approved application for permit or filing of a notice. You must obtain separate permits for geological and geophysical scientific research that involves the use of solid or liquid explosives or the drilling of a deep stratigraphic test. If BOEM disapproves an application for permit, the statement of rejection will state the reasons for the denial and will advise the applicant of the changes needed to obtain approval.

You must file a notice with the BOEM at least 60 days before you begin scientific research not requiring a permit. We may inform you of all environmental laws and regulations pertaining to the OCS.

Information Required for Permits

Each applicant for a permit must complete the applicable sections of the Application for Permit (Attachment 1) and must include a public-information, page-size plat(s) showing the location of the proposed area of activity (Section B.2 or C.2). In addition, each applicant for a geological or geophysical permit must submit the appropriate attachment to section D of the application. This includes a detailed map of the proposed activity for Section D.8 (Geological Application) or Section D.12 (Geophysical Application). Only applicants for a notice of scientific research must complete a Nonexclusive Use Agreement (Attachment 2).

The information provided on the Application for Permit (excluding section D) and on the Nonexclusive Use Agreement, including continuation sheets and the page-size plat(s), is considered NON-PROPRIETARY INFORMATION. These non-proprietary portions of the application constitute the "public information" copy of Form BOEM-0327 and with the executed permit will be available to the public upon request.

The information listed in section D is considered PROPRIETARY INFORMATION and you should NOT attach it to the public information copy. BOEM will not make this information available to the public without the consent of the potential permittee or for a period mandated by law or regulation. However, BOEM may determine that earlier release is necessary for the proper development of the area permitted.

Modifications to Approved Permits

The BOEM Regional Supervisor must approve any modification to the permitted operations.

Filing Locations for Permits to Conduct Explorations for Mineral Resources and for Permits or Notices to Conduct Scientific Research

File each notice or application for a permit with an original plus three copies, totaling four copies, which include one digital copy and one public information copy (all with original signatures) at the following locations at least 60 days before you begin operations:

A. For the OCS off the State of Alaska:

Regional Supervisor for Resource Evaluation
Bureau of Ocean Energy Management
Alaska OCS Region
3801 Centerpoint Drive
Suite #500
Anchorage, Alaska 99503-5823

B. For the OCS in the Gulf of Mexico and off the Atlantic Coast:

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

C. For the OCS off the States of California, Oregon, Washington, or Hawaii:

Regional Supervisor, Office of Strategic Resources
Bureau of Ocean Energy Management
Pacific OCS Region
770 Paseo Camarillo
Camarillo, California 93010-6092

Attachment 1

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF OCEAN ENERGY MANAGEMENT

Atlantic OCS Region
(Insert Appropriate Regional Office)

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

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

TGS
Name of Applicant

10451 Clay Road
Number and Street

Houston, TX 77043
City, State, and Zip Code

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

_____Geological exploration for mineral resources

_____Geological scientific research

__X__Geophysical exploration for mineral resources

_____Geophysical scientific research

Submit: Original plus three copies, totaling four copies, which include one digital copy, and one public information copy.

To be completed by BOEM

Permit Number: _____ **Date:** _____

A. General Information

1. The activity will be conducted by:

TBD Service Company Name	For TGS Purchaser(s) of the Data
TBD **Address**	10451 Clay Road **Address**
TBD City, State, Zip	Houston, TX 77043 City, State, Zip
TBD Telephone/FAX Numbers	713-860-2122 Telephone/FAX Numbers
TBD E-Mail Address	Gabriel.Rolland@TGS.com E-Mail Address

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

   ____ Scientific research

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

   Minimum to no adverse effects expected on the environment. To minimize adverse effects, PSO operators and PAM will be implemented. The PSO and PAM standards will be as per new Atlantic guidelines

4. The expected commencement date is: TBD, dependent on IHA & EA Assessments

   The expected completion date is: TBD, dependent permit issue date

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

   May be contacted at:
   10451 Clay Road, Houston, TX 77043 USA

   Telephone (Local) 936-203-2267 (Marine) 713-860-2122

   Email Address: Gabriel.Rolland@TGS.com Radio call sign ____

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

Name (s)	Registry Number(s)	Registered owners)
TBD		

7. The port from which the vessel(s) will operate is: TBD

8. Briefly describe the navigation system (vessel navigation only):
DGPS

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

1. The type of operation(s) to be employed is: (check one)

   (a) _____ Deep stratigraphic test, or

   (b) _____ Shallow stratigraphic test with proposed total depth of _____, or

   (c) _____ Other _____

2. Attach a page-size plat showing: 1) The generalized proposed location for each test, where appropriate, a polygon enclosing the test sites may be used, 2) BOEM protraction areas; coastline; point of reference; 3) Distance and direction from a point of reference to area of activity.

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

1. The type(s) of operation(s) to be employed is (are):
   a) Acquisition method (OBN, OBC, Streamer): Streamer
   b) Type of acquisition: (High Resolution Seismic, 2D Seismic, 3D Seismic, gravity, magnetic, CSEM, etc.)
   2D Seismic

2. Attach a page-size plat showing:
   a) The generalized proposed location of the activity with a representative polygon,
   b) BOEM protraction areas; coastline; point of reference,
   c) Distance and direction from a point of reference to area of activity.

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

Air gun arrays

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

Type _____ Pounds _____ Equivalent Pounds of TNT _____

D. Proprietary Information Attachments

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

E. Certification

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

Print Name: Gabriel Rolland

SIGNED _____ **DATE** 03-17-14

TITLE Marine Acquisition QC Specialist

COMPANY NAME: TGS

TO BE COMPLETED BY BOEM

Permit No. _____ **Assigned by** _____ **Date** _____
of BOEM

This application is hereby:

a. _____ Accepted

b. _____ Returned for reasons in the attached

SIGNED _____ **TITLE** Regional Supervisor **DATE** _____

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

1. Description of proposed coring, drilling or sampling method. Include heat flow measurements and depth of penetration.

   _____

   _____

2. Description of coring, drilling or sampling equipment to be used:

   _____

   _____

   _____

3. List proposed coring, drilling or sample location(s) with their latitude and longitude coordinates and the total number of samples to be acquired. These locations may be sent digitally on a CD. (Attach separate page if necessary): _____

   _____

4. Navigation system or method to be used to position sample locations: _____

   _____

   _____

5. Method of sample storage, and handling: _____

   _____

6. List each test to be conducted on the samples with a brief description of its objective:

   _____

   _____

   _____

7. Estimated date on which samples, logs, and analyzed and/or processed data will be ready for inspection: _____

8. Attach map(s), plat(s), and chart(s) (preferably at a scale of 1:250,000) and/or an electronic version of same showing latitude and longitude, scale, protraction areas, specific block numbers, and specific sample location(s) in latitude(s) and longitude(s) for each of the proposed sample site(s). The map, plat or chart should be submitted at a sufficient size and scale to make out all details of the activities shown. Along with the hardcopy map, submit on CD, the ArcGIS shape files needed to reproduce the map of the proposed sample site(s) including individual site names in the attribute table.

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

1. Detailed narrative, modeling of sound propagation, and visual description of the energy source(s) and streamer(s) (receiving array): Please see enclosed narrative for source and streamer.

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

   Number of chase vessels are TBD

3 List each energy source to be used (e.g., airgun, airgun array(s), sparker, towed dipole, side scan sonar, sub bottom profiler, etc.). Indicate the source's manufacturer, model, total energy output per impulse in dB (RMS), peak to peak in db, frequency in Hz (if applicable) etc.

Energy Source	Manufacturer	Model	Gun Size (cu. in.)	Total Energy Output Peak to Peak in db, Amp, etc.	Total Energy Output rms in db	Frequency (Hz-kHz range)
Air gun array	Sodera	G-gunII	4808	262 db re	240 db re	0-125 Hz
				1 muPa at 1m	1 muPa @ 1m	

4. Shot (energy pulse) frequency per linear mile (statute):
   Approximately 64 energy pulses per linear mile

5. Towing depth (ft/m) of the energy source:
   7 meters (+/-1 meter)

6. Towing depth (ft/m) of the receiver(s):
   9 meters (+/-1 meter)

7. CSEM, OBN, Magnetotelluric, and OBC surveys: Describe the node deployment and retrieval procedures. Indicate the location (latitude and longitude coordinates), number and spacing of any ocean bottom receivers, cables, and anchors. If anchors will not be retrieved, provide their physical composition and rate of decomposition. Location data may be submitted digitally on a CD (attach separate page if necessary).

8. Navigation/positioning system or method used to position shotpoint locations and or ocean bottom receivers:
DGPS for vessels, RGPS for front/tail buoys & Sonardyne SIPS 2

9. Proposed areal extent (blocks) for 3D surveys or total number of line miles proposed for 2D or high resolution survey: 34,478 miles of 2D data

10. Provide the company identification name of the proposed survey (e.g. Deep Six Survey). List all proposed initial and final processed data sets that will result from acquisition under this activity (e.g. 3D Time Migration processed as Kirchhoff Depth Migration, Wave Equation Migration, etc).

Atlantic East Coast 2D Survey

Reverse Time and Kirchhoff Depth Migration

11. Estimated date (month and year) on which initial and final processing will be available for all proposed processed data sets:
12 months after survey completion

12. Attach map(s), plat(s), and chart(s) (preferably at a scale of 1:250,000) and an electronic version of same showing latitude and longitude, scale, specific protraction areas, block numbers. The map, plat or chart should be submitted at a sufficient size and scale to make out all details of the activities shown. For 2D data acquisition provide specific track lines with line identifications with the total number of line miles proposed or a representative polygon and total number of blocks for 3D surveys. Along with the hardcopy map, submit on CD, the necessary ArcGIS shape files to reproduce the map for 2D track lines including individual line names in the attribute table. For 3D surveys provide a representative polygon as an ArcGIS shape file.

GUNDALF array modelling suite - Array report

Gundalf revision AIR8.1c, Date 2013-04-30, Epoch 2012-10-12

Thu Mar 20 20:40:28 W. Europe Standard Time 2014 (Jan Langhammer)

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Report pre-amble

Author: Jan Langhammer

Author Organisation: TGS

Contents

- Signature filtering policy
- Some notes on the modelling algorithm
- Array summary
- Array geometry and gun contribution
- Array centres and timing
- Array directivity
- Signature characteristics
- Acoustic energy characteristics
- Drop-out characteristics
- Inventory usage
- Physical parameters
- Gundalf calibration details

Signature filtering policy

For marine environmental noise reports, Gundalf performs no signature filtering other than that inherent in modelling at a sample interval small enough to simulate an airgun array signature at frequencies up to 100kHz.

For all other kinds of reports, Gundalf performs filtering in this order:-

- If a pre-conditioning filter is chosen, for example, an instrument response, it is applied at the modelling sample interval.
- If the output sample interval is larger than the modelling sample interval, Gundalf applies appropriate anti-alias filtering. (This can be turned off in the event that anti-alias filtering is included in the pre-conditioning filter, in which case Gundalf will issue a warning.)
- Finally, Gundalf applies the chosen set of post-filters, Q, Wiener and band-pass filtering as specified, at the output sample interval. If none are specified, (often known as unfiltered), only the above anti-alias and/or pre-conditioning are applied.

In reports, when filters are applied, they are applied to the notional sources first so that signatures, directivity plots and spectra are all filtered consistently. The abbreviation muPa is used for microPascal throughout.

Finally note that modelled signatures always begin at time zero for reasons of causality.

Anti-alias and pre-condition filtering

In this case, no pre-conditioning filter has been applied.

In this case, an anti-alias filter has been applied with the following parameters:-

High-cut, 75 % Nyquist; Slope, 72 db/oct;

Post filtering

Details of the post-filtering used in this report follow. Post filters are applied at the output sample interval after any pre-conditioning and anti-alias filters have been applied.

Q filtering

No Q filtering performed.

Wiener filtering

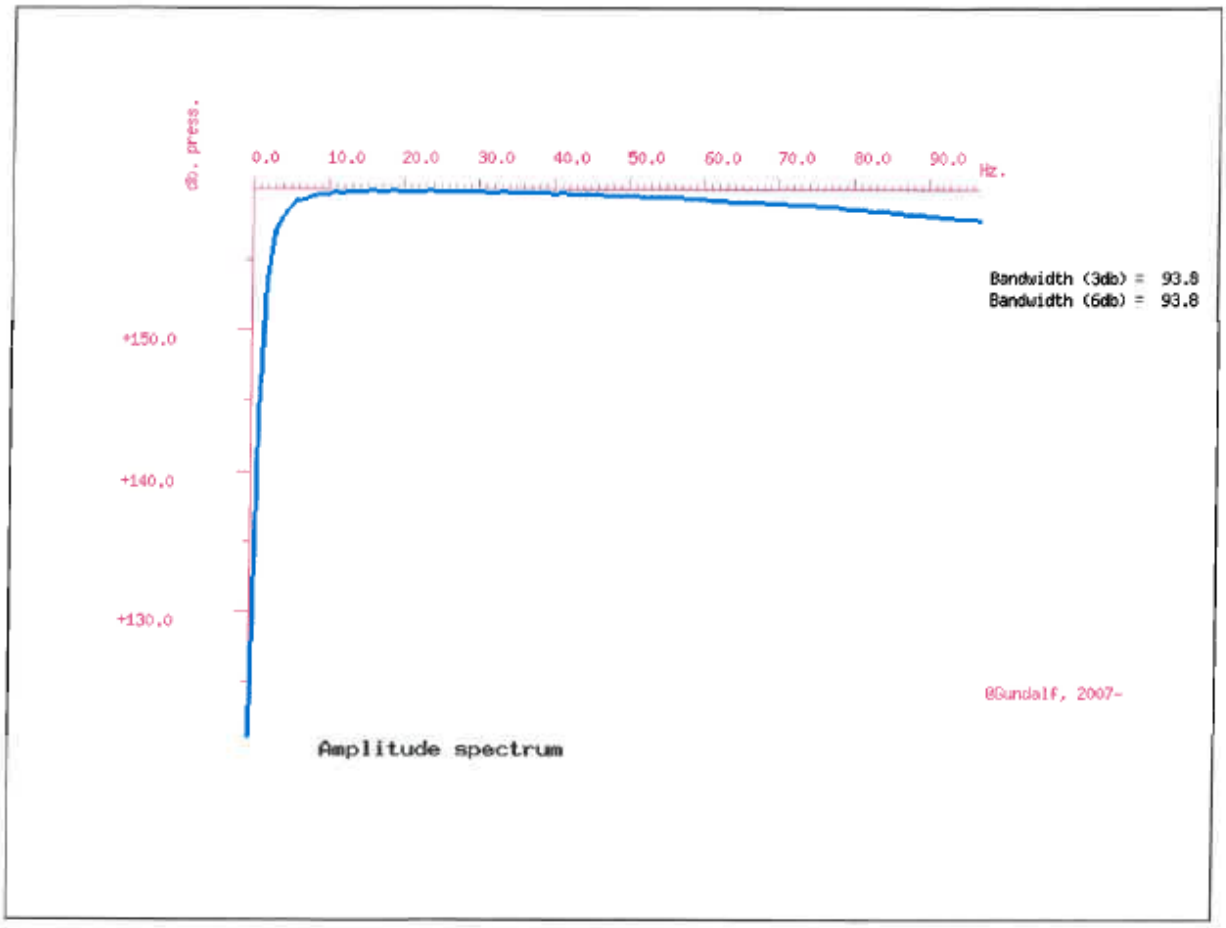
No Wiener filtering performed.

Band-pass filtering

Signatures were band-passed filtered **using the following parameters:-**

Filter file : dfsv_0-0_128-72.flt

The amplitude spectrum of the band-pass filter used is shown below.



Some notes on the modelling algorithm

The Gundalf airgun modelling engine is the end-product of 15 years of state of the art research. It takes full account of all air-gun interactions including interactions between sub-arrays. No assumptions of linear superposition are made. This means that if you move sub-arrays closer together, the far-field signature will change. The effect is noticeable even when sub-arrays are separated by as much as 10m.

The engine is capable of modelling airgun clusters right down to the 'super-foam' region where the bubbles themselves collide and distort. It has been calibrated against both single and clustered guns for a number of different gun types under laboratory conditions and accurately predicts peak to peak and primary to bubble parameters across a very wide range of operating conditions.

In many cases, the predicted signatures are good enough to be used directly in signature deconvolution procedures.

Array summary

The following table lists the statistics for the array quoted in various commonly used units for convenience. Note that the rms value is computed over the entire modelled signature. Conservative error bounds for the main signature characteristics of peak to peak, primary to bubble and bubble period are also shown. These represent 95% confidence intervals for the Gundalf model against its calibration data.

Array parameter	Array value

Number of guns	**40**
Total volume (cu.in).	4808.0 (78.8 litres)
Peak to peak in bar-m.	126 +/- 1.04 (12.6 +/- 0.104 MPa, ~ 262 db re 1 muPa. at 1m.)
Zero to peak in bar-m.	57.8 (5.78 MPa, 255 db re 1 muPa. at 1m.)
RMS pressure in bar-m.	9.71 (0.971 MPa, 240 db re 1 muPa. at 1m.)
Primary to bubble (peak to peak)	**15.5 +/- 4.13**
Bubble period to first peak (s.)	0.072 +/- 0.0151
Maximum spectral ripple (dB): 10.0 - 50.0 Hz.	7.45
Maximum spectral value (dB): 10.0 - 50.0 Hz.	216
Average spectral value (dB): 10.0 - 50.0 Hz.	214
Total acoustic energy (Joules)	448236.8
Total acoustic efficiency (%)	41.2

Array geometry and gun contribution

The following table lists all the guns modelled in the array along with their characteristics. The last column is completed only if the array has actually been modelled during the interactive session and contains the approximate contribution of that gun as a percentage of the peak to peak amplitude of the whole array. Please note the following:-

- The peak to peak varies only as the cube root of the volume for the same gun type so that even small guns contribute significantly. This is particularly relevant to drop-out analysis.
- The peak to peak can also be depressed due to clustering effects as reported by Strandenes and Vaage (1992), "Signatures from clustered airguns", First Break, 10(8).

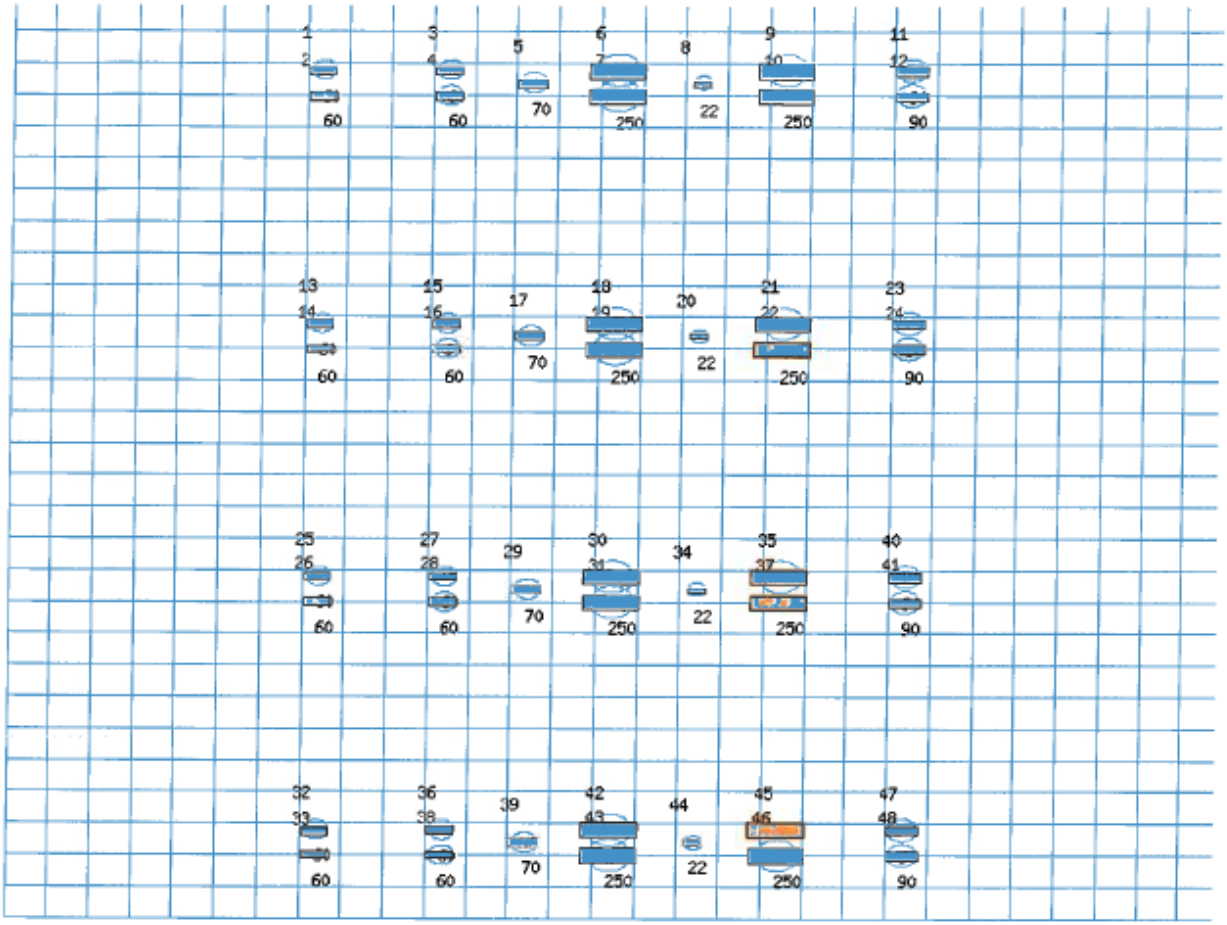
Gun	Pressure (psi)	Volume (cuin)	Type	x (m.)	y (m.)	z (m.)	delay (s.)	sub-array	p-p contrib (pct.)
1	2000.0	60.0	G-GUN	0.000	-12.400	7.000	0.00000	1	2.2
2	2000.0	60.0	G-GUN	0.000	-11.600	7.000	0.00000	1	DROPPED OUT
3	2000.0	60.0	G-GUN	3.000	-12.400	7.000	0.00000	1	2.0
4	2000.0	60.0	G-GUN	3.000	-11.600	7.000	0.00000	1	2.0
5	2000.0	70.0	G-GUN	5.000	-12.000	7.000	0.00000	1	2.1
6	2000.0	250.0	G-GUN	7.000	-12.400	7.000	0.00000	1	3.3
7	2000.0	250.0	G-GUN	7.000	-11.600	7.000	0.00000	1	3.3
8	2000.0	22.0	G-GUN	9.000	-12.000	7.000	0.00000	1	1.4
9	2000.0	250.0	G-GUN	11.000	-12.400	7.000	0.00000	1	3.7
10	2000.0	250.0	G-GUN	11.000	-11.600	7.000	0.00000	1	DROPPED OUT
11	2000.0	90.0	G-GUN	14.000	-12.400	7.000	0.00000	1	2.3
12	2000.0	90.0	G-GUN	14.000	-11.600	7.000	0.00000	1	2.3
13	2000.0	60.0	G-GUN	0.000	-4.400	7.000	0.00000	2	2.3
14	2000.0	60.0	G-GUN	0.000	-3.600	7.000	0.00000	2	DROPPED OUT
15	2000.0	60.0	G-GUN	3.000	-4.400	7.000	0.00000	2	2.0
16	2000.0	60.0	G-GUN	3.000	-3.600	7.000	0.00000	2	2.0
17	2000.0	70.0	G-GUN	5.000	-4.000	7.000	0.00000	2	2.2
18	2000.0	250.0	G-GUN	7.000	-4.400	7.000	0.00000	2	3.4

19	2000.0	250.0	G-GUN	7.000	-3.600	7.000	0.00000	2	3.4
20	2000.0	22.0	G-GUN	9.000	-4.000	7.000	0.00000	2	1.4
21	2000.0	250.0	G-GUN	11.000	-4.400	7.000	0.00000	2	3.8
22	2000.0	250.0	G-GUN	11.000	-3.600	7.000	0.00000	2	DROPPED OUT
23	2000.0	90.0	G-GUN	14.000	-4.400	7.000	0.00000	2	2.4
24	2000.0	90.0	G-GUN	14.000	-3.600	7.000	0.00000	2	2.4
25	2000.0	60.0	G-GUN	0.000	3.600	7.000	0.00000	3	2.3
26	2000.0	60.0	G-GUN	0.000	4.400	7.000	0.00000	3	DROPPED OUT
27	2000.0	60.0	G-GUN	3.000	3.600	7.000	0.00000	3	2.0
28	2000.0	60.0	G-GUN	3.000	4.400	7.000	0.00000	3	2.0
29	2000.0	70.0	G-GUN	5.000	4.000	7.000	0.00000	3	2.2
30	2000.0	250.0	G-GUN	7.000	3.600	7.000	0.00000	3	3.4
31	2000.0	250.0	G-GUN	7.000	4.400	7.000	0.00000	3	3.4
32	2000.0	60.0	G-GUN	0.000	11.600	7.000	0.00000	3	2.2
33	2000.0	60.0	G-GUN	0.000	12.400	7.000	0.00000	3	DROPPED OUT
34	2000.0	22.0	G-GUN	9.000	4.000	7.000	0.00000	3	1.4
35	2000.0	250.0	G-GUN	11.000	3.600	7.000	0.00000	3	3.8
36	2000.0	60.0	G-GUN	3.000	11.600	7.000	0.00000	3	2.0
37	2000.0	250.0	G-GUN	11.000	4.400	7.000	0.00000	3	DROPPED OUT
38	2000.0	60.0	G-GUN	3.000	12.400	7.000	0.00000	3	2.0
39	2000.0	70.0	G-GUN	5.000	12.000	7.000	0.00000	3	2.1
40	2000.0	90.0	G-GUN	14.000	3.600	7.000	0.00000	3	2.4
41	2000.0	90.0	G-GUN	14.000	4.400	7.000	0.00000	3	2.4
42	2000.0	250.0	G-GUN	7.000	11.600	7.000	0.00000	3	3.3
43	2000.0	250.0	G-GUN	7.000	12.400	7.000	0.00000	3	3.3
44	2000.0	22.0	G-GUN	9.000	12.000	7.000	0.00000	3	1.4
45	2000.0	250.0	G-GUN	11.000	11.600	7.000	0.00000	3	DROPPED OUT
46	2000.0	250.0	G-GUN	11.000	12.400	7.000	0.00000	3	3.7
47	2000.0	90.0	G-GUN	14.000	11.600	7.000	0.00000	3	2.3
48	2000.0	90.0	G-GUN	14.000	12.400	7.000	0.00000	3	2.3

The array is shown graphically below.

Hydrophone position: Infinite vertical far-field

<----- Direction of travel ----- --, (1m. grid, plan view)



The red circles denote the maximum radius reached by the bubble. Please note that pressure-field interactions take place over a much larger distance than this, (typically 10 times larger). However when bubbles touch or overlap, super-foam interaction can be expected. In this zone, significant peak AND bubble suppression will normally be observed.

Note also that a green rectangle represents a single gun and an orange rectangle indicates that the gun is currently dropped out. Where present, a yellow rectangle represents a vertical cluster (V.C.) of guns. Please see the geometry table above for more details. The small number to the above left of each gun is its reference number in this table. For clusters of guns, these reference numbers mirror the symmetry of the cluster.

Back to top

Array centres and timing

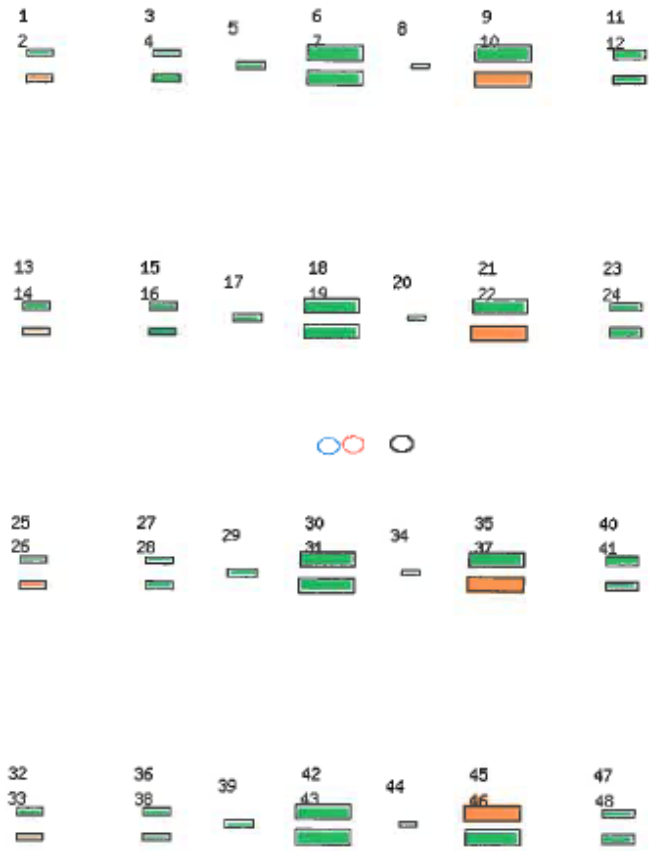
The following diagram shows the array geometric centre, the centre of pressure and the centre of energy defined as follows:-

- The array geometric centre is defined to be the centre of the rectangle formed by the largest and smallest x and y values of the active guns (non-active guns are ignored). This is shown as a blue circle.
- The centre of pressure is defined to be the array centre when each active gun position is weighted by its contribution to the overall peak to peak pressure value. This is shown as a red circle.
- The centre of energy is computed by weighting the coordinates by the self-energy of the active gun at that position. In an interacting array this may be a long way from the centre of pressure as some guns may absorb energy giving a negative self-energy. This is shown as a black circle.

Depending on how first breaks are calculated, these can be used for first break analysis.

Dropped out guns are shown as orange rectangles whilst live guns are shown as green rectangles.

Array centres



The geometric centre is at (7, 0, 7)

The centre of pressure is at (7.59, -0.0656, 7)

The centre of energy is at (8.73, -0.101, 7)

Note that Gundalf by default uses the deepest gun to define time zero for the vertical far-field and it uses the nearest gun to the observation point to define time zero if an observation point is specified. This means that if one gun is accidentally run deep, this will cause the bulk of the signature to appear to be delayed. It is still a research question how an airgun array should be timed. There are several candidates as defined above but it is not currently clear which if any is appropriate in complex scenarios such as Ocean Bottom Deployment.

Back to top

Array directivity

The following tables show the inline and crossline directivity of the array in both (angle-frequency) and (angle-amplitude) form and optionally, the azimuthal directivity (theta-phi) form.

Note that the effects of cable ghosting if present are not shown in Gundalf directivity displays although source ghosting is included. This matches common practice in such displays.

For inline directivity displays, the x-axis is the inline angle from the vertical with the word fore indicating the end nearest the boat. For crossline directivity displays, the x-axis is the crossline angle from the vertical with the word port indicating the port side.

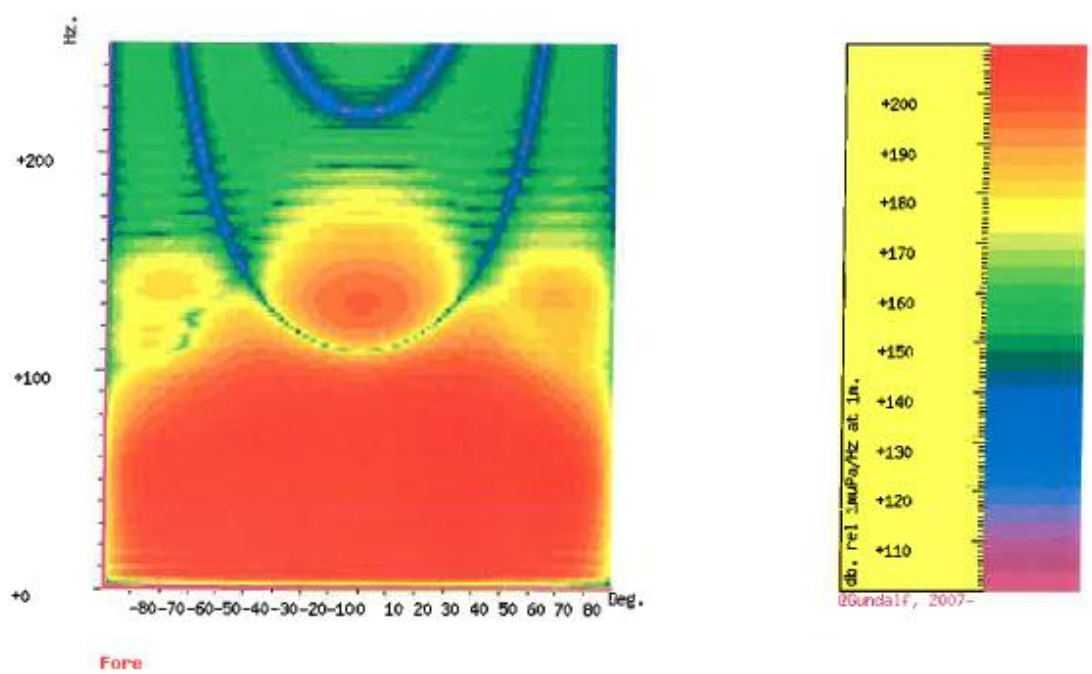
Note that *inline* is used nominally to mean any angle within +/- 45 degrees of the boat direction (which corresponds to a bearing of zero degrees). Similarly, *crossline* is used nominally to mean any angle within +/- 45 degrees of the perpendicular to the boat direction which is measured as a bearing of 90 degrees, (i.e. starboard). The nominal inline and crossline angles can be set by the user in the report options. The values used are indicated in the diagram titles below as bearings.

Where shown, the azimuthal plots show contours at four chosen frequencies as a function of phi (angle from the x-axis, opposite to the boat direction) and theta (the angle from the vertical). A bearing of zero degrees corresponds to a value of phi of 180 degrees.

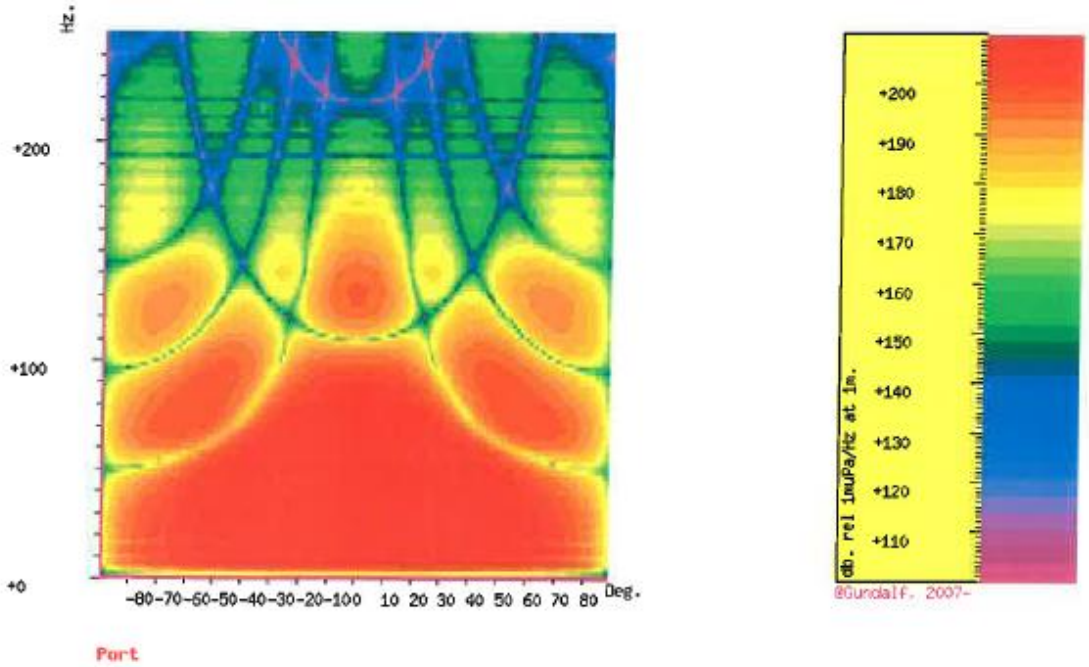
Angle-frequency form

The following tables show the inline and crossline directivity of the array in (dip angle-frequency) form. Both plots are scaled as dB. relative to 1 microPa. per Hz. at 1m.

Inline directivity, bearing = 0 degrees



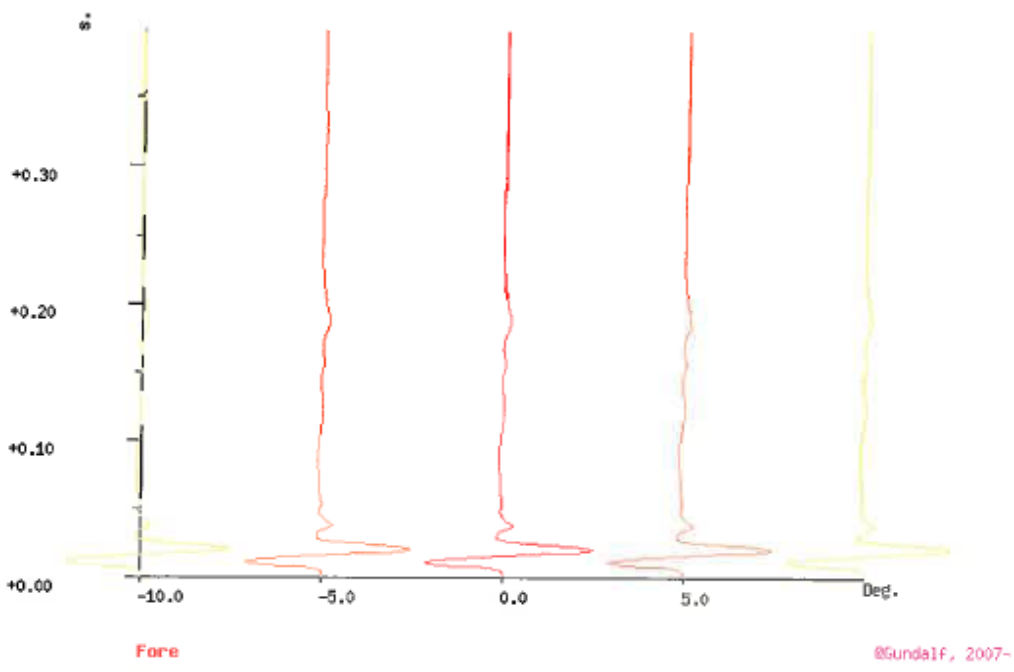
Crossline directivity, bearing = 90 degrees



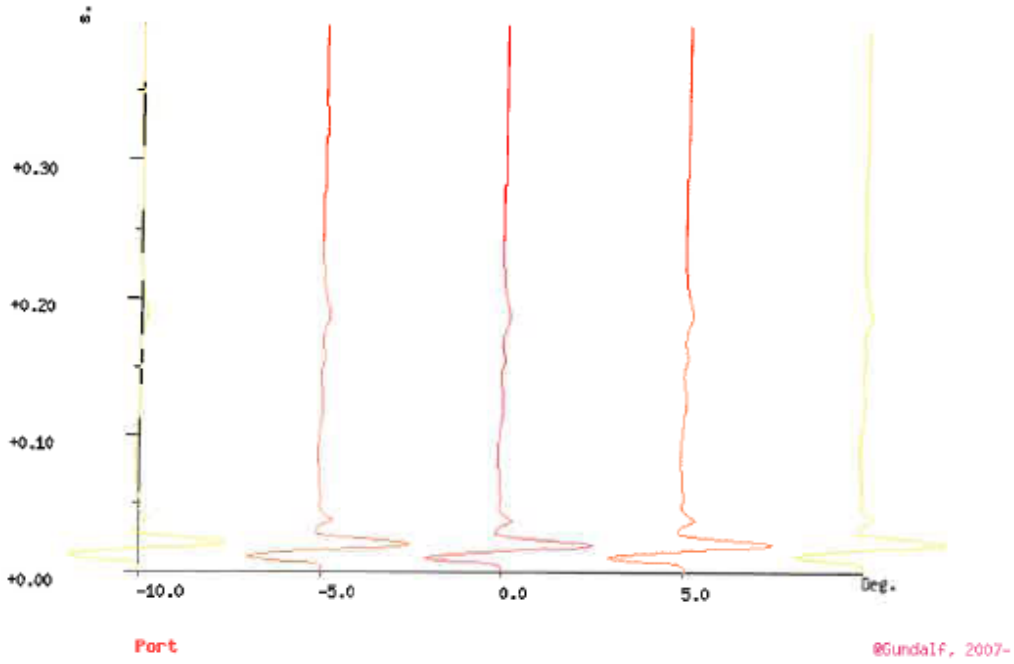
Angle-amplitude form

The following tables show the inline and crossline directivity of the array in (dip angle, amplitude) form. The computed signature (or under option the amplitude spectrum) for each angle is shown in colour varying form with red signatures shown in the centre, shading to blue at the furthest angles computed. The vertical scale indicates the type of plot, time or frequency. Both types of plot are individually scaled and plotted with the same units as the corresponding plots in the Signature Characteristics section.

Inline directivity, bearing = 0 degrees



Crossline directivity, bearing = 90 degrees



Back to top

Signature characteristics

The following tables show the signature parameters, the signature and the amplitude spectrum of the modelled signature.

The amplitude spectrum is shown in units of dB. relative to 1 microPa. per Hz. at 1m.

The position of the bubble by default is determined internally but can be overridden by interacting with the modelled signature using the right hand mouse button to determine the start of the bubble.

Signature ghost information

The source ghost has been included. The source ghost was input directly with the value -1.0.

The cable ghost has been switched off.

Output signature parameters

Signature filtering details	Number of samples in signature	Sample interval (s.)	Hydrophone position
dfsv_0-0_128-72.flt	400	0.001	Infinite vertical far-field

Signature and statistics

In this case, the bubble position was determined internally. The start of the search window for the bubble was: 0.04 (s.)

The following table includes error bounds for the primary characteristics of an airgun signature: peak to peak, primary to bubble and bubble period.

Airgun modelling programs like Gundalf must be calibrated against real data and no computational model is any better than the quality of that calibration. Calibration datasets however are themselves subject to experimental error so Gundalf is calibrated to best fit the various datasets which are used across the extensive range of volumes, pressures and depths available.

In practice, such experimental errors arise for a variety of reasons including

- Depth inaccuracies. These are usually around 3-5% even in the best facilities particularly if there is sea surface movement.
- How frequently the gun is being cycled during measurement. This is rarely recorded but a warmed up gun might be 50deg C warmer than the sea, changing its normal peak-to-peak and other parameters by 5-10% compared with when it is first fired.
- Filtering differences. Filtering is recorded but filtering errors are still more frequent than we would like and analog filter v. digital filter differences are also sometimes a factor.

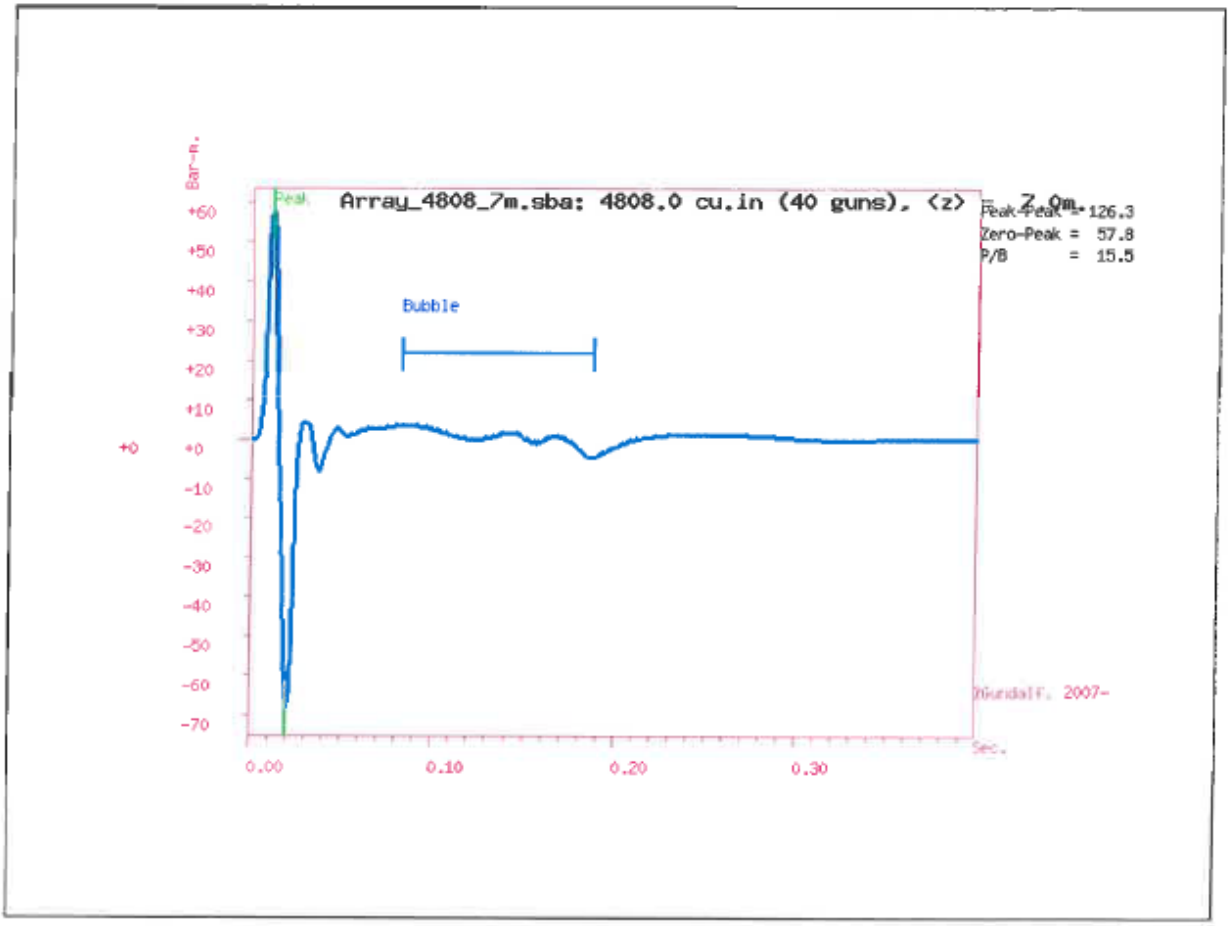
As a guideline, typical individual errors across different measurement datasets for the best-calibrated guns are of the order of 5% for peak to peak, 15% for primary to bubble and 2% for bubble periods.

Individual gun errors are calculated from the data shown in Help -> Calibration (which themselves accumulate gun data from different sources) and the resulting array error bounds are calculated by accumulating these errors for each gun in the array. The error bounds

are calculated as 95% error bounds and for simplicity assume that errors are non-correlated although in practice some are systematic. The total error bound is always greater than any of the individual error bounds and is strongly influenced by the largest gun contributions.

The error bounds simply mean that *it is very likely that the true values for these primary characteristics will be within the ranges shown, but it is not possible to be more precise*. If other comparison data or models indicate values outside this range, this means that those data or models are very likely to be *incompatible* with Gundalf's calibration data. This may be due to several causes as described above. For more on calibration see Gundalf's calibration Help pages.

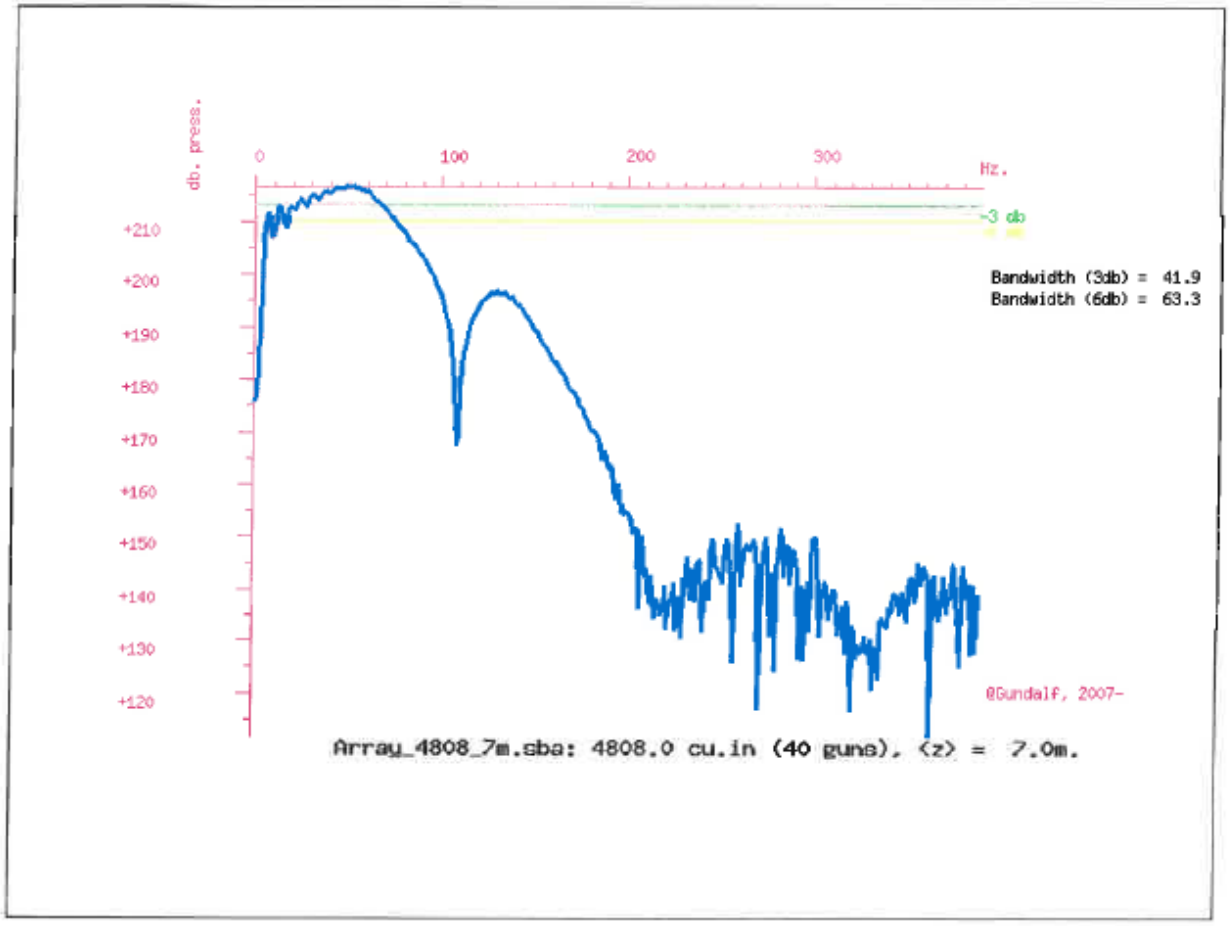
Peak to peak in bar-m.	Zero to peak in bar-m.	Primary to bubble (peak to peak)	Bubble period to first peak (s.)
126 +/- 1.04	57.8 +/- 0.519	15.5 +/- 4.13	0.072 +/- 0.0151



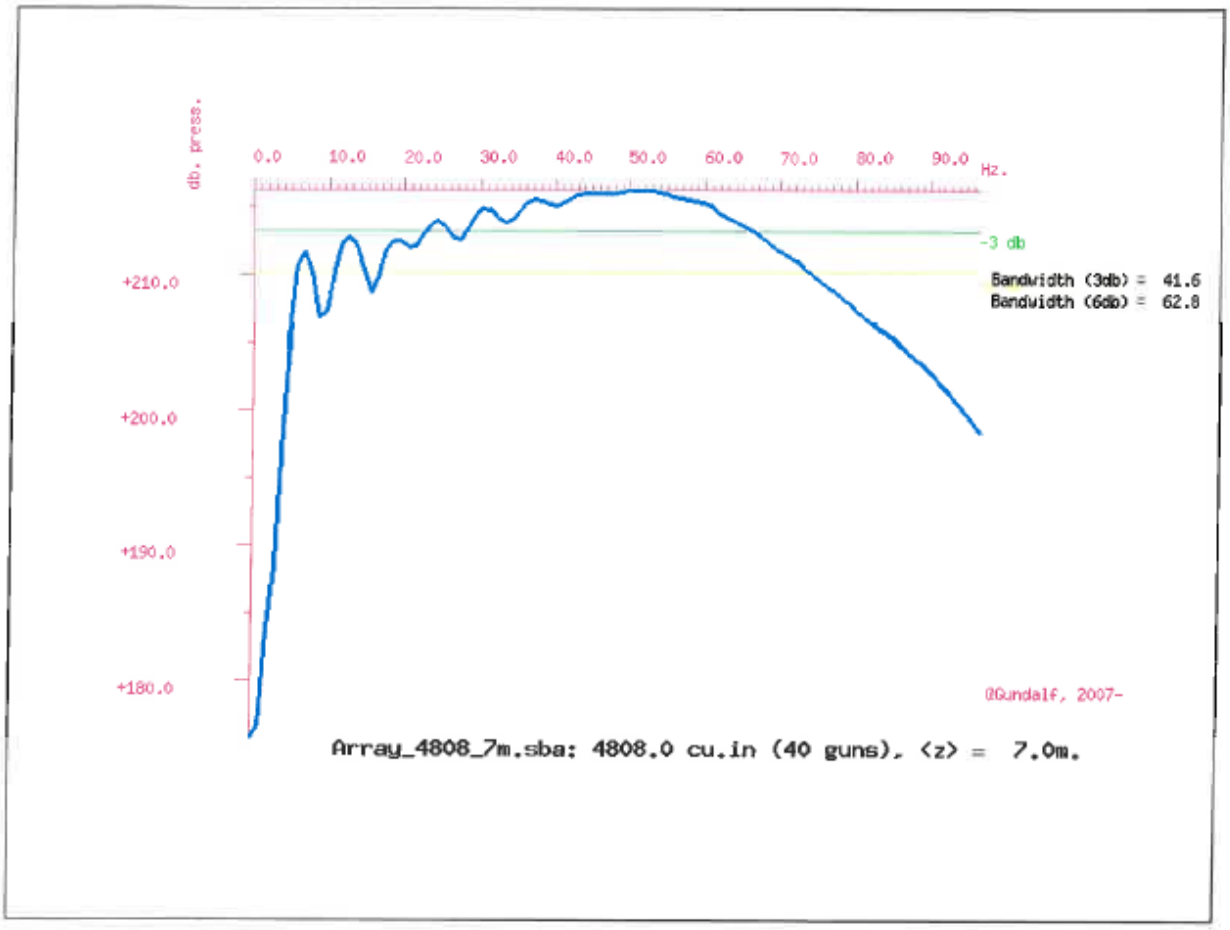
Band-pass filter: dfsv_0-0_128-72.flt

Filtered amplitude spectrum

Amplitude spectrum. Amplitude Units are dB. relative to 1 muPa / Hz. at 1m.



Close up of amplitude spectrum



Back to top

Acoustic energy characteristics

The following table lists the individual gun contributions to the acoustic energy field in joules. A negative value means the gun is actually absorbing energy. This is very common in interacting arrays. It does not however mean that the gun is damaging the array performance. Rather it is acting as a catalyst to allow the other guns to perform more efficiently. The total acoustic energy gives the

true performance of the array as a whole. See Laws, Parkes and Hatton (1988) Energy-interaction: The long-range interaction of seismic sources, Geophysical Prospecting (36), p333-348 and 38(1) 1990 p.104 for more details. Note that internal energy is not included in the data below. The true acoustic efficiency of airgun arrays is typically < 5% of the total initial energy.

Overall acoustic energy contribution

Total acoustic energy output (j.)	Acoustic energy output due to energy-interaction (j.)	Total potential energy available in array(j.)	Percentage of total potential energy appearing as acoustic energy
448236.8	**21674.6**	1087477.3	**41.2%**

Individual acoustic energy contributions

Volume (cuin)	x (m.)	y (m.)	z (m.)	Acoustic energy contribution (j.)
60.0	0.00	-12.40	7.00	**13310.2**
DROPPED OUT	-	-	-	-
60.0	3.00	-12.40	7.00	13403.7
60.0	3.00	-11.60	7.00	14177.9
70.0	5.00	-12.00	7.00	23152.0
250.0	7.00	-12.40	7.00	-23413.8
250.0	7.00	-11.60	7.00	-26598.6
22.0	9.00	-12.00	7.00	12966.3
250.0	11.00	-12.40	7.00	34823.3
DROPPED OUT	-	-	-	-
90.0	14.00	-12.40	7.00	18941.4
90.0	14.00	-11.60	7.00	19645.8
60.0	0.00	-4.40	7.00	16121.5
DROPPED OUT	-	-	-	-
60.0	3.00	-4.40	7.00	16747.5
60.0	3.00	-3.60	7.00	17472.7
70.0	5.00	-4.00	7.00	26817.1
250.0	7.00	-4.40	7.00	-28123.0
250.0	7.00	-3.60	7.00	-27276.6
22.0	9.00	-4.00	7.00	15322.5
250.0	11.00	-4.40	7.00	40742.1
DROPPED OUT	-	-	-	-
90.0	14.00	-4.40	7.00	22228.6
90.0	14.00	-3.60	7.00	23017.6
60.0	0.00	3.60	7.00	16247.9
DROPPED OUT	-	-	-	-
60.0	3.00	3.60	7.00	***16905.0***
60.0	3.00	4.40	7.00	17248.4
70.0	5.00	4.00	7.00	26758.5

250.0	7.00	3.60	7.00	-27978.9
250.0	7.00	4.40	7.00	-26421.5
60.0	0.00	11.60	7.00	13629.0
DROPPED OUT	-	-	-	-
22.0	9.00	4.00	7.00	15341.4
250.0	11.00	3.60	7.00	40796.3
60.0	3.00	11.60	7.00	13604.4
DROPPED OUT	-	-	-	-
60.0	3.00	12.40	7.00	13979.8
70.0	5.00	12.00	7.00	23092.6
90.0	14.00	3.60	7.00	22339.1
90.0	14.00	4.40	7.00	22700.4
250.0	7.00	11.60	7.00	-26637.0
250.0	7.00	12.40	7.00	-22410.3
22.0	9.00	12.00	7.00	12938.4
DROPPED OUT	-	-	-	-
250.0	11.00	12.40	7.00	34342.5
90.0	14.00	11.60	7.00	19410.7
90.0	14.00	12.40	7.00	18872.0
The red entries denote guns which are catalysing the array by absorbing energy.				

Back to top

Drop-out characteristics

Information not requested

Back to top

Inventory usage

Information not available

Back to top

Physical parameters

The following table summarises the physical parameters used in modelling.

Sea temperature (C)	Velocity of sound in water (m./s.)	Expected dominant frequency in signature (Hz)	Observed wave height (m)
20	1522	20.0	0.0

Note that the gun controller variation was set to 0.0 (s.)

Back to top

Gundalf calibration details

All modelling software requires calibration against convincing experimental data. Gundalf provides accurate modelling of airguns across a wide range of gun types, gun parameters and operating environments, however, we do not expect you to take this simply on trust. It is therefore our policy to keep users of Gundalf aware of its latest calibration status and up to date information is available under Help -> Calibration.

The latest information, including technical references can be found here.

For sales enquiries please contact: Gundalf sales.

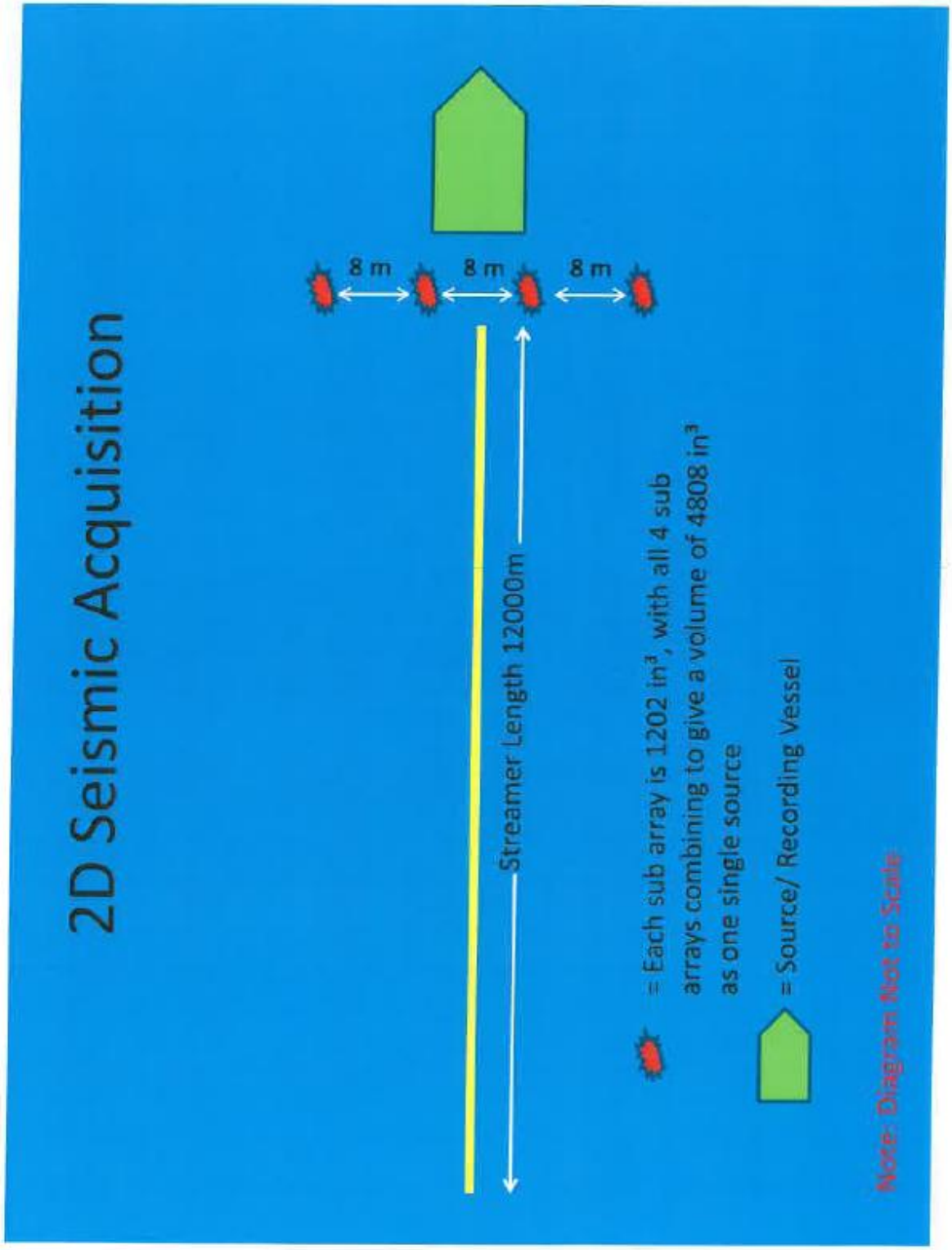
Back to top

Product code : GDF8.1Optimiser

Licenced to : jan.langhammer@tgs.com

Organisation : TGS

Maximum users : 1


2D Seismic Acquisition
8 m
8 m
8 m
Streamer Length 12000m
= Each sub array is 1202 in³, with all 4 sub arrays combining to give a volume of 4808 in³ as one single source
= Source/ Recording Vessel
Note: Diagram Not to Scale

10.2 IAGC COMMENTS TO OCM

International Association IAGC of Geophysical Contractors

September 3, 2014

Paul Scholz, Acting Director, *via e-mail*
Office of Ocean and Coastal Resource Management
National Ocean and Atmospheric Administration
1305 East-West Highway, Room 11321
Silver Spring, MD 20910-3281

Re: Comments on States' Unlisted Activity Review Requests for BOEM Permit Nos. E14-001 thru E14-009

Dear Mr. Scholz:

The International Association of Geophysical Contractors ("IAGC") appreciates the opportunity to comment on requests from Atlantic coastal states to review proposed geological and geophysical survey activities ("G&G activities") in the Mid- and South Atlantic (i.e., BOEM Permit Nos. E14-001 thru E14-009). IAGC is the international trade association representing the industry that provides geophysical services (geophysical data acquisition, processing and interpretation, geophysical information ownership and licensing, associated services and product providers) to the oil and natural gas industry. IAGC member companies play an integral role in the successful exploration and development of offshore hydrocarbon resources through the acquisition and processing of geophysical data. IAGC members have expressed interest in conducting geophysical activities on the Atlantic OCS, and the current applicants with pending G&G permits before Bureau of Ocean Energy Management ("BOEM") are IAGC members. We appreciate consideration of the comments set forth below.

Pursuant to 15 CFR 930.54, states may request the Office of Coastal Resource Management's ("OCRM") approval to review unlisted federally permitted activities, such as G&G activities, with an assertion that the proposed activities' coastal effects are "reasonably foreseeable." The sole basis for OCRM's approval or disapproval of a state's request depends on "whether the proposed activity's coastal effects are reasonably foreseeable." Federal regulations define "coastal effect" as "any reasonably foreseeable effect on any coastal use or resource" resulting from the proposed activity. In their requests for review, many of the states assert a lack of information regarding the proposed G&G operations and state concerns regarding presumed environmental effects to fish and marine mammal populations. IAGC's members take concerns related to the potential impact of their surveys seriously and are committed to conducting their operations in an

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environmentally responsible manner. Experience shows that seismic activities, tourism, fisheries, and marine life can and do coexist successfully.[1]

I. DESCRIPTION OF GEOPHYSICAL SURVEYS

Seismic surveys are the only feasible technology available to accurately image the subsurface before a single well is drilled. BOEM currently estimates that the Mid- and South Atlantic OCS holds at least 4.72 billion barrels of oil and 37.5 trillion cubic feet of natural gas. Although these estimates are impressive, it is widely believed that modern seismic imaging using the latest technology will enable BOEM to more accurately evaluate the Atlantic OCS resource base. The industry's advancements in geophysical technology – including seismic reflection and refraction, gravity, magnetics, and electromagnetic – will provide more realistic estimates of the potential resource. By utilizing these tools and by applying increasingly accurate and effective interpretation practices, IAGC's members can better locate and dissect prospective areas for exploration.

For the energy industry, modern seismic imaging reduces risk by increasing the likelihood that exploratory wells will successfully tap hydrocarbons and decreasing the number of wells that need to be drilled in a given area, reducing associated safety and environmental risks and the overall footprint for exploration. The use of modern seismic technology is similar to ultrasound technology—a non-invasive mapping technique built upon the simple properties of sound waves. Because survey activities are temporary and transitory, it is the least intrusive and most cost-effective means to understanding where recoverable oil and gas resources likely exist in the Mid- and South Atlantic OCS.

To carry out these surveys, marine vessels use acoustic arrays, most commonly as a set of compressed air chambers, to create seismic pulses. A predominantly low-frequency sound pulse is generated by releasing compressed air into the water as the vessel is moving. The pulses are bounced off the layers of rock beneath the ocean floor. The returning sound waves are detected and recorded by hydrophones that are spaced along a series of cables that are towed behind the survey ship. Seismologists then analyze the information with computers to visualize the features that make up the underground structure of the ocean floor. Once the data is processed, geophysicists interpret it and integrate other geoscientific information to make assessments of where oil and gas reservoirs may be accumulated. Based largely on this information, exploration companies will decide where, or if, to conduct further exploration for oil and gas.

Currently, three types of surveys are proposed in the Atlantic OCS: 2D seismic surveys, a 3D seismic survey, and an airborne gravity and magnetic survey. These surveys are described in more detail below.

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[1] *See, e.g.*, BOEM, *Final EIS for Gulf of Mexico OCS Oil and Gas Eastern Planning Area Lease Sales 225 and 226*, at 2-22 (2013) ("Within the [Central Planning Area], which is directly adjacent to the [Eastern Planning Area], there is a long-standing and well-developed OCS program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting marine mammal populations.").

A. 2D Seismic Surveys – Towed Streamers

Two-dimensional surveys are so-called because they only provide a 2D cross-sectional image of the Earth's structure. These surveys are typically used for geologic research, initial exploration of a new region, and to determine data quality in an area before investing in a 3D survey. 2D towed-streamer surveys are acquired with a single vessel usually towing a single air source array and a single streamer cable. The streamer is a polyurethane-jacketed cable containing several hundred to several thousand sensors, most commonly hydrophones. The air source array directs energy downward towards the ocean floor. An integrated navigational system is used to keep track of where the air sources are activated, the positions of the streamer cable, and the depth of the streamer cable. The end of the cable is tracked with global positioning system (GPS) satellites, and tail buoys are attached at the end. Radar reflectors are routinely placed on tail buoys for detection by other vessels, and automatic identification system (AIS) devices are also routinely integrated into the tail buoys.

Ships conducting 2D surveys are typically 30-90 m (100-300 ft) long and tow a single-source array 200-300 m (656-984 ft) behind them approximately 5-10 m (16-33 ft) below the sea surface. The source array often consists of three subarrays, with six to twelve air source elements each, and measures approximately 12.5-18 m (41-60 ft) long and 16-36 m (52-118 ft) wide. Following behind the source array by 100-200 m (328-656 ft) is a single streamer approximately 5 to 12 or more km (3.1-7.5 mi) long. The ship tows this apparatus at a speed of approximately 3 to 5 knots. Approximately every 10-15 seconds (i.e., a distance of 23-35 m [75-115 ft] for a vessel traveling at 4.5 kn [8.3 km/hr]), the air source array is activated. The actual time between activations varies depending on ship speed and the desired spacing.

Typical spacing between ship-track lines for 2D surveys, which is also the spacing between adjacent streamer line positions, is greater than a kilometer. Lines can transect each other and can be parallel, oblique or perpendicular to each other. 2D towed-streamer surveys are normally regional, covering a large area of ocean so that activity is not always limited to a particular area. 2D surveys can provide high resolution imaging with tight line spacing intervals in shallow areas.

2D surveys can cover a larger area with less data density in less detail, resulting in a lower cost per area covered. Geophysical contractors often have proprietary methods of data acquisition that may vary depending on their seismic target and data-processing capabilities, making each contractor's dataset unique. While surveying, and after a prescribed ramp-up of the output of the array to full-operation intensity, a vessel will travel along a linear track for a period of time until a full line of data is acquired. Upon reaching the end of the track, the ship takes typically 2 - 6 hr to turn around and start along another track, varying depending on the spacing between track lines, the length of track lines, and the objectives of a specific survey. Some 2D surveys might include only a single long line. Others may have numerous lines, with line spacings of 2 km in some cases, and 10 km in other cases. Data acquisition generally takes place day and night and may continue for days, weeks, or months, depending on the size of the survey area. Data acquisition is not, however, continuous. A typical seismic survey experiences approximately 20 to 30 percent

of non-operational downtime due to a variety of factors, including technical or mechanical problems, standby for weather or other interferences, and performance of mitigation measures (e.g., ramp-up, pre-survey visual observation periods, and shutdowns).

B. 3D Seismic Surveys – Towed Streamers

3D towed-streamer seismic surveys enable industry to image the subsurface geology with much greater clarity than 2D data because of the much denser data coverage. The quality is such that 3D data can often indicate hydrocarbon-bearing zones from water-bearing zones. Because 3D seismic data has been continuously and rapidly improving since its introduction in the 1970's, areas covered by 3D data shot only a few years ago may be reshot with current, improved technology, offering greater clarity than previous surveys. In addition, areas already covered using 2D techniques may be resurveyed with 3D. Further, 3D surveys may be repeated over producing fields at successive calendar times (at 6-month to several-year intervals) to better characterize and record changes over producing reservoirs. These 4D, or time-lapse 3D, surveys are used predominantly as a reservoir monitoring tool to detect and evaluate reservoir changes over time. Conventional, single-vessel 3D surveys are referred to as narrow azimuth 3D surveys.

The current state-of-the-art ships conducting 3D surveys are purpose-built vessels with much greater towing capability than the vessels conducting 2D surveys. While these vessels are generally 60 - 120 m long, with the largest vessels over 120 m (ft) in length and greater than 65 m (230 ft) wide at the back deck. These seismic ships typically tow two parallel source arrays 200-300 m (656-984 ft) behind them. The two source arrays are identical to each other and are the same as those used in the 2D surveys described previously. Following 100-200 m (328-656 ft) behind the dual source arrays are the streamers.

Most 3D ships can tow eight or more streamers at a time, with the total length of streamers (number of streamers multiplied by the length of each one) exceeding 80 km (50 mi). The theoretical towing maximum today is 24 streamers, each of which can be up to 12 km (7.5 mi) long, for a total of 288 km (179 mi). Towing 8-14 streamers that are each 3-8 km (1.9-5 mi) long is normal practice. Towing 10 streamers that are separated by 75-150 m (246-492 ft) means that a swath 675-1,350 m (2,215-4,429 ft) wide is covered on the sea surface in one pass of the ship along its track line. Other streamer configurations (number of streamers and their separation distance) can produce narrower or wider swaths. The survey ship tows the apparatus at a speed of 3 to 5.5 kn during production. Approximately every 11 - 15 s (i.e., a distance of 25 m [82 ft] for a vessel traveling at 4.5 kn [8.3 km/hr]), one of the dual air source arrays is fired. The other array is fired 11 - 15 s later. To achieve the desired spacing, the time between firings depends on the ship speed. While surveying, a ship travels along a track for 12-20 hr (i.e., a distance of 100-167 km [62 - 104 mi] at 4.5 kn [8.3 km/hr]), depending on the size of the survey area. Upon reaching the end of the track, the ship takes 3 to 5 hr to turn around and start along another track. This procedure takes place day and night, and may continue for days, weeks, or months, depending on the size of the survey area. Data acquisition is not, however, continuous. A typical seismic survey experiences approximately 20 to 30 percent of non-

operational downtime due to a variety of factors, including technical or mechanical problems, standby for weather or other interferences, and performance of mitigation measures (e.g., ramp-up, pre-survey visual observation periods, and shutdowns).

C. Non-Seismic Gravity and Magnetic Surveys

Both conventional gravity surveys and gravity gradiometry surveys are conducted today, most often by fixed-wing aircraft, or where required, by marine vessel deployment. There is no sound source associated with gravity or magnetic surveys. The dimensions of the gravity instruments and stand are approximately 1 m by 1 m by 1.5 m high (3 ft by 3 ft by 5 ft) and the total weight is approximately 150 kg (330 lb). The survey acquisition grid is similar to ship-based seismic surveys, generally with flight-line spacing of 0.5-3 km (0.3-2 mi). Surveys of 500 sq. km (180 sq. mi) can be completed in a few hours, with the aircraft flying at an altitude of 70-300 m (230-1,000 ft). The objectives of the survey will determine the flight-line spacing (distance between flight lines) and the altitude at which the survey will be conducted.

Measurements of the earth's magnetic field are useful in helping to determine geologic structures and stratigraphy in the subsurface in frontier exploration areas, such as the Atlantic OCS, and as a complement to existing seismic data. There are at least five types of magnetometers, three of which are commonly used in airborne magnetic surveying. In addition to the different types of magnetometers, there are also several different configurations that can be used on the aircraft. These configurations include: (1) a single sensor, typically a tail installation; (2) two horizontally separated magnetometers, usually wingtip pod sensors; (3) two vertically separated sensors, usually tail-mounted; and (4) a total magnetic intensity configuration, typically involving three, but potentially four, magnetic sensors. The sensor pods are cylindrical in shape, and typically 1-2 m (3.3-6.6 ft) long and several centimeters (several inches) in diameter.

The objectives of the survey (such as the amount of area to be covered, the desired detail to be obtained, etc.) and the cost determine three of the most important factors to be specified for any given survey: (1) the altitude at which the survey will be conducted; (2) the flight-line separation; and (3) the flight-line orientation, or direction. Recent surveys done in the Gulf of Mexico have been flown at altitudes of 60-300 m (200-1,000 ft), at speeds of 110 knots (250 km/hr), and with line spacings of 0.5-2 km (0.3-1.3 mi). Similar surveys were recently completed offshore Greenland and offshore Honduras.

II. MARINE MAMMALS & SEA TURTLES

More than four decades of worldwide seismic surveying and scientific research indicate that the risk of direct physical injury to marine mammals is extremely low, and currently there is no scientific evidence demonstrating biologically significant negative impacts on marine life populations. *See, e.g.*, 77 Fed. Reg. 25,829, 25,838 (May 1, 2012) (issuance of IHA for Beaufort Sea seismic activities ("To date, there is no evidence that serious injury, death, or stranding by marine mammals can occur from exposure to air-gun pulses, even in the case of large air-gun arrays."); *DEIS for Gulf of Mexico OCS Eastern*

Planning Areas Lease Sales 225 and 226 (BOEM 2013-0116) ("Within the [Gulf of Mexico Central Planning Area],...there is a long-standing and well-developed OCS Program (more than 50 years); there are no data to suggest that activities from the preexisting OCS Program are significantly impacting marine mammal populations."); LGL Ltd., *Environmental Assessment of a Low-Energy Marine Geophysical Survey in the Northwestern Gulf of Mexico,* at 30 (Apr.- May 2013) ("[T]here has been no specific documentation of [temporary threshold shift] let alone permanent hearing damage, i.e., [permanent threshold shift], in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions.").

While seismic operations can be detected at great distances under certain oceanographic conditions and locations, so can sound waves generated by earthquakes and baleen whale calls.[2] The deep sound channel in the Atlantic OCS, often cited for the notion that sound from seismic operations can be detected outside of a survey's established exclusion zone, does not extend onto the continental shelf off the mid-Atlantic region. Furthermore, marine animals would need to be present in the deep sound channel to receive the higher levels of sound in the deep sound channel and few species dive that deep in the Atlantic sites of interest; this is especially true for the baleen whale species of greatest concern. Seismic sound is expected to decline to ambient levels within tens of kilometers, not thousands. The seismic air source array is engineered to direct its energy downward, rather than laterally, which the National Marine Fisheries Service admits is in itself a mitigation measure.[3] In addition, seismic energy sources are predominantly low frequency, below the hearing range of many marine species. For any sound that is transmitted horizontally, the signal strength decreases rapidly and even in these unusual circumstances, is at such low frequency that it does not cause injury to marine mammals. Sound that is below 100 dB in water – even if it travels hundreds or thousands of km – is about the equivalent to a whisper, since normal baseline sound levels in the ocean, at frequencies below 200-300 HZ, are generally 80-90 dB (in some areas such as the busy ports of the Atlantic coast, ambient sound may be as high as 110-120 dB due to ship noise).[4]

What evidence there is of potential behavioral disturbance from seismic operations suggests minor and transitory effects, such as temporarily leaving the survey area, and these

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[2] Nieukirk, SL, Mellinger DK, Moore SE, Klinck K, Dziak RP, and Goslin J. 2012. Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999-2009. J Acoust Soc Am 131(2):1102-1112; Munk W, Worcester P, and Wunsch C. 1995. Ocean Acoustic Tomography. Cambridge U Press, Cambridge, UK.

[3] *New Jersey v. National Science Foundation*, 3:14-cv-0429 (US Dist. Ct. New Jersey), Federal Defendants' Brief in Opposition to Plaintiffs' Motion for Declaratory and Injunctive Relief at 25 (July 7, 2014).

[4] Richardson WJ, Greene Jr. CR, Malme CI, and Thomson DH. 1995. Marine Mammals and Noise. Academic Press, NY. *See also* Acoustic Ecology Institute, *Seismic Surveys at Sea: The contributions of airguns to ocean noise.* August 2005 (An air source array with a source level of 200 – 230 dB "drops quickly to under 180 dB (usually within 50- 500 m depending on source level and local conditions), and continues to drop more gradually over the next few kilometers, until leveling off at somewhere near 100 dB."); IAGC. 2014. Fundamentals of Sound in the Marine Environment (Due to the different environmental properties of water and air, "62 dB must be subtracted from any sound measurement under water to make it equal to the same sound level in the air."), available at: http://www.iagc.org/files/5043/; University of Rhode Island, *Sound levels of common sounds in air re 20 μPa*, 2013, available at: http://www.dosits.org/science/soundsinthesea/airwater.

effects "have not been linked to negative impacts on populations."[5] Nevertheless, industry funds independent research to further our understanding of the effects of seismic surveys on marine life. This is helping to remove uncertainties about possible effects of seismic surveys.

In addition, the best available science indicates that seismic surveys, even in preexisting active OCS programs in the Gulf of Mexico, do not result in any significant impact to sea turtles. *See supra* note 1 at 2-23 ("no significant cumulative impacts to sea turtles would be expected as a result of the proposed exploration activities when added to the impacts of past, present, or reasonably foreseeable oil and gas development in the area, as well as other ongoing activities in the area"); BOEM, *Final EIS for Gulf of Mexico OCS Oil and Gas Western Planning Area Lease Sales 229, 233, 238, 246, and 248 and Central Planning Area (CPA) Lease Sales 227, 231, 235, 241, and 247,* at 4-235, 4-741 ("[T]here are no data to suggest that routine activities from the preexisting OCS Program are significantly impacting sea turtle populations."). Furthermore, sea turtles are not as sensitive to sound as marine mammal species. *See* PEIS, Appx. I. Regardless, seismic surveys shutdown for sea turtles detected within a designated exclusion zone and work with NMFS to employ any necessary protective measures, such as time-area closure for nesting sea turtles off of Brevard County, Florida.

Finally, site-specific environmental assessments and consultation pursuant to the Endangered Species Act will be conducted for each proposed G&G permit, and the permittee must obtain a Marine Mammal Protection Act ("MMPA") authorization ensuring the proposed surveys will have no more than a negligible impact on marine mammal stocks.

III. FISH & INVERTEBRATES[6]

Marine seismic surveys have been conducted since the 1950s and experience shows that fisheries and seismic activities can and do coexist. There has been no observation of direct physical injury or death to free-ranging fish caused by seismic survey activity, and there is no conclusive evidence showing long-term or permanent displacement of fish. Any impacts to fish from seismic surveys are short-term, localized and are not expected to lead to significant impacts on a population scale.

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[5] BOEM, *The Science Behind the Decision: Answers to Frequently Asked Questions about the Atlantic Geological and Geophysical Activities Programmatic Environmental Impact Statement,* August 22, 2014.

[6] For more information, *see* Science for Environment Policy, Future Brief: Underwater Noise, European Commission, June 2013: http://ec.europa.eu/environment/integration/research/newsalert/pdf/FB7.pdf; "Stocks at a Glance – Status of Stocks" 2011, U.S.Department of Commerce, NOAA: www.nmfs.noaa.gov/stories/2012/05/05_14; Boeger, W.A., Pie, M.R., Ostrensky, A., Cardoso, M.F., 2006. The Effect of Exposure to Seismic Prospecting on Coral Reef Fishes; Brazil. J. Oceanogr. 54, 235-239; 3D marine seismic survey, no measurable effects on species richness or abundance of a coral reef associated fish community. Mar. Pollut. Bull. (2013), http://dx.doi.org/10.1016/j.marpolbul.2013.10.031; Hassel, A., Knutsen, T., Dalen, J., Skaar, K., Lokkeborg, S., Misund, O.A., Osten, O., Fonn, M., Haugland, E.K., 2004. Influence of seismic shooting on the lesser sand eel. ICES J. Mar. Sci. 61, 1165-1173; Pena, H., Handegard, N.O. and Ona, E. 2013. Feeding herring schools do not react to seismic air gun surveys. ICES J. Mar. Sci, http://icesjms.oxfordjournals.org/content/70/6/1174.short?rss=1; Saetre, R. and E. Ona, 1996. Seismic investigations and damages on fish eggs and larvae; an evaluation of possible effects on stock level. Fisken og Havet 1996:1-17, 1-8.

As discussed in detail above, seismic vessels move along a survey tract in the water creating a line of seismic impulses. As the seismic vessel is in motion, each signal is short in duration, local and transient. Fish will often react to these pulses by temporarily swimming away from the seismic air source. Since seismic surveys are a moving sound source, impacts on fish are inherently local and short-term. While some studies have shown that various life stages of fish and invertebrate can be physically affected by exposure to seismic surveys, in all of these cases, the subjects were very close to the seismic source or subjected to exposures that are virtually impossible to occur under natural conditions. In addition, many marine crustaceans such as horseshoe crabs congregate in bays and nearshore areas where seismic activities are not proposed to occur.

In the past it was often speculated that sounds from seismic surveys could harm fish, especially eggs and larvae, over long distances. However, recent studies have shown that this only can occur at extreme short-ranges. Fish eggs, larvae and fry do not have the ability to move away from a loud sound source, and may be injured if they are within a few meters of the seismic source. The impact of this damage, however, is insignificant on a population scale compare to the high natural mortality rate of eggs, larvae and fry.

Sounds from active acoustic sound sources such as seismic surveys may result in fish temporarily moving away from the sound source, potentially causing a localized reduction in fish catch in close proximity to the seismic source. There is no conclusive evidence, however, showing long-term or permanent displacement of fish. Similar seismic surveys conducted for research in the Atlantic OCS in the past did not result in any noticeable effects on commercial or recreational fish catches (based on a review of NMFS data from months surveys were conducted and noting "there was absolutely no evidence of harm to marine species" nor fish).[7] During seismic surveys, a vessel exclusion zone is maintained around the survey vessel and its towed streamer arrays to avoid interruption of commercial fishing operations, including setting of fishing gear.

In addition, because the sound output from a seismic survey is immediate and local, there is no contaminate residue or destruction of habitat. However, prior to G&G permit approval in the Atlantic OCS, site-specific environmental assessments will include an Essential Fish Habitat ("EFH") assessment to determine whether the specific activity and location would cause a significant adverse effect to fisheries and EFH.

IV. MITIGATION MEASURES

IAGC supports implementation of mitigation measures that are commensurate to the potential risk and supported by the best available science, and its members comply with mitigation and monitoring measures required after BOEM and NMFS conduct site-specific environmental assessments. Measures commonly used by the seismic industry including timing seismic surveys to avoid known areas of biological significance, such as whale foraging or breeding areas or avoiding seasonal marine life occurrences and known migration areas, such as the North Atlantic Right Whale time-area closures identified in the Final Programmatic Environmental Impact Statement for Proposed G&G Activities in the Mid- and South Atlantic OCS ("PEIS"). *See* 79 Fed. Reg. 13,074 (Mar. 7, 2014).

[7] *See, supra,* note 3 at 25-26, citing Exhibit D, Higgins Decl. ¶ 21, Exhibit D, Mountain Decl. ¶ 8.

Before a seismic survey begins, visual monitoring is undertaken to check for the presence of marine mammals and other marine species within a specific precautionary, or exclusion zone, often using dedicated marine mammal observers (MMOs) or protected species observers (PSOs). Soft-start, or ramp-up, procedures provide a gradual build-up of the seismic sound source and allow marine life to swim away before starting the survey. Further monitoring may be conducted using passive acoustic monitoring technology (PAM), which may detect vocalizing marine mammals during periods of low visibility. In the event marine mammals are detected in the exclusion zone, seismic operations will not begin for a certain time period until the marine mammal moves away. Similarly, a seismic survey will shut down if the marine mammal is observed entering the exclusion zone once operations have begun.

The mitigation measures implemented in the Atlantic OCS will be similar, if not more stringent, than measures previously employed by the industry. And in these past surveys, there have been no observations of injury, death, or stranding to marine life. Conservative acoustic thresholds adopted by the agencies and preventative mitigation measures are intended to prevent any potential impact to marine life. Subsequent environmental impact assessment specific to each pending G&G permit will satisfy NEPA, MMPA and ESA requirements, including evaluation of essential fish habitat and avoidance of disturbance to "special areas, such as sensitive benthic (seafloor) biological communities, national marine sanctuaries, historic and prehistoric sites, and cable or other infrastructure."[8] Extensive mitigation and monitoring efforts will ensure any significant impacts will be avoided and seismic activities will have no more than a negligible impact on marine mammal stocks.

Thank you for the opportunity to comment on requests from Atlantic coastal states to review proposed G&G activities in the mid- and south Atlantic OCS. IAGC may submit supplemental comments as additional state requests are filed. Should you wish to discuss our submission in more detail please do not hesitate to contact myself or Nikki Martin, Director- Environmental Regulatory & Legal Affairs (Nikki.martin@iagc.org).

Yours sincerely,

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[8] BOEM. Record of Decision, Atlantic OCS Proposed Geological and Geophysical Activities, Mid-Atlantic and South Atlantic Planning Areas, Final Programmatic Environmental Impact Statement, at 2 (August 11, 2014). In addition, BOEM's Record of Decision and PEIS outlines guidance to prevent discharge of trash and marine debris and requires coordination with Department of Defense and NASA to avoid conflicts with military operations.