

weather conditions of the need to repeat some lines if data quality is substandard.

The *R/V Maurice Ewing* will be used as the source vessel. It will tow the 20-airgun array and a streamer containing hydrophones along predetermined lines. During seismic acquisition, the vessel will travel at 4–5 knots (7.4–9.3 km/hr). During the MCS survey, the airgun array to be used will consist of 20 2000-psi Bolt airguns. The standard 20-gun array will include airguns ranging in chamber volume from 80 to 850 in³, with a total volume of 8,575 in³. These airguns will be spaced in an approximate rectangle of dimensions of 35 m (115 ft) (across track) by 9 m (30 ft) (along track). Seismic pulses will be emitted at intervals of approximately 20 seconds. The 20-sec spacing corresponds to a shot interval of about 50 m (164 ft). After the line has been surveyed using MCS, the hydrophone streamer will be retrieved and OBH's will be deployed. During the OBH refraction survey, an augmented 20-gun array will be used and configured for a total volume of approximately 11,000 in³ by changing smaller gun chambers for larger volume chambers (ranging from 145 to 875 in³) after the completion of the MCS reflection lines. Seismic pulses will be emitted at intervals of 240 seconds during OBH acquisition. LDEO believes that even though the augmented 20-gun array will have a total air discharge volume of approximately 2400 in³ more than the standard 20-gun array, this will not significantly increase the source output since the number of guns has a greater effect on source output than discharge volume.

The dominant frequency components for both airgun arrays is 0 – 188 Hz. The standard 20-airgun array (MCS survey) will have a peak sound source level of 255 dB re 1 µPa or 262 dB peak-to-peak (P-P), and will be towed at a depth of 7.5 m (24.5 ft). The augmented 20-airgun array (OBH survey) will have a peak sound source level of 256 dB re 1 µPa or 263 dB P-P, and will be towed at a depth of 9.0 m (29.5 ft). Because the actual source is a distributed sound source (20 guns) rather than a single point source, the highest sound levels measurable at any location in the water will be less than the nominal source level. Also, because of the directional nature of the sound from the airgun array, the effective source level for sound propagating in near-horizontal directions will be substantially lower.

Along with the airgun operations, two additional acoustical data acquisition systems will be operated during most or all of the cruise. The ocean floor will be mapped with an Atlas Hydrosweep DS-

2 multibeam 15.5-kHz bathymetric sonar, and a 3.5-kHz sub-bottom profiler will also be operated along with the multi-beam sonar. These mid-frequency sound sources are commonly operated from the *Maurice Ewing* simultaneous with the airgun array.

The Atlas Hydrosweep is mounted in the hull of the *R/V Maurice Ewing*, and it operates in three modes, depending on the water depth. The first is a shallow-water mode when water depth is <400 m (1312.3 ft). The source output is 210 dB re 1 µPa-m rms and a single 1-millisecond pulse or "ping" per second is transmitted, with a beamwidth of 2.67 degrees fore-aft and 90 degrees in athwartship. The beamwidth is measured to the 3 dB point, as is usually quoted for sonars. The other two modes are deep-water modes. The Omni mode is identical to the shallow-water mode except that the source output is 220 dB rms. The Omni mode is normally used only during start up. The Rotational Directional Transmission (RDT) mode is normally used during deep-water operation and has a 237-dB rms source output. In the RDT mode, each "ping" consists of five successive transmissions, each ensonifying a beam that extends 2.67 degrees fore-aft and approximately 30 degrees in the cross-track direction. The five successive transmissions (segments) sweep from port to starboard with minor overlap, spanning an overall cross-track angular extent of about 140 degrees, with tiny (<1 millisecond) gaps between the pulses for successive 30-degree segments. The total duration of the "ping", including all 5 successive segments, varies with water depth but is 1 millisecond in water depths <500 m (1640.5 ft) and 10 millisecond in the deepest water. For each segment, ping duration, is 1/5th of these values or 2/5th for a receiver in the overlap area ensonified by two beam segments. The "ping" interval during RDT operations depends on water depth and varies from once per second in <500 m (1640.5 ft) water depth to once per 15 seconds in the deepest water.

The sub-bottom profiler is normally operated to provide information about the sedimentary features and bottom topography that is simultaneously being mapped by the Hydrosweep. The energy from the sub-bottom profiler is directed downward by a 3.5-kHz transducer mounted in the hull of the *Maurice Ewing*. The output varies with water depth from 50 watts in shallow water to 800 watts in deep water. Pulse interval is 1 second but a common mode of operation is to broadcast five pulses at 1-s intervals followed by a 5-s pause. Most of the energy in the sound pulses emitted by this multi-beam sonar is at

mid-frequencies, centered at 3.5 kHz. The beamwidth is approximately 30° and is directed downward. Maximum source output is 204 dB re 1 µPa, 800 watts, while nominal source output is 200 dB re 1 µPa, 500 watts. Pulse duration will be 4, 2, or 1 ms, and the bandwidth of pulses will be 1.0 kHz, 0.5 kHz, or 0.25 kHz, respectively.

Along the two selected seismic lines, data will first be acquired using multibeam sonar, multichannel seismic, and sonobuoys. A total of 96 sonobuoys will be available, and the *Ewing* system allows two sonobuoys to be recorded at any time. The sonobuoy profiles will be analyzed during the MCS shooting and streamer recovery on each line. The preliminary results from the sonobuoy refraction will be used to plan the OBH deployment pattern on the subsequent deep refraction survey. Twenty OBH's will be deployed for each line.

Additional information on the airgun arrays, Atlas Hydrosweep, and sub-bottom profiler specifications is contained in the application, which is available upon request (see ADDRESSES).

Description of Habitat and Marine Mammals Affected by the Activity

A detailed description of the Northwest Atlantic Ocean and its associated marine mammals can be found in a number of documents referenced in the LDEO application as well as in the LDEO application itself, and is not repeated here. Approximately 32 species of cetaceans may be found within the proposed study area near Bermuda. These species are the sperm whale (*Physeter macrocephalus*), pygmy sperm whale (*Kogia breviceps*), dwarf sperm whale (*Kogia sima*), Cuvier's beaked whale (*Ziphius cavirostris*), True's beaked whale (*Mesoplodon mirus*), Gervais' beaked whale (*Mesoplodon europaeus*), Sowerby's beaked whale (*Mesoplodon bidens*), Blainville's beaked whale (*Mesoplodon densirostris*), rough-toothed dolphin (*Steno bredanensis*), bottlenose dolphin (*Tursiops truncatus*), Pantropical spotted dolphin (*Stenella attenuata*), Atlantic spotted dolphin (*Stenella frontalis*), spinner dolphin (*Stenella longirostris*), clymene dolphin (*Stenella clymene*), striped dolphin (*Stenella coeruleoalba*), short-beaked common dolphin (*Delphinus delphis*), Fraser's dolphin (*Lagenodelphis hosei*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), Risso's dolphin (*Grampus griseus*), melon-headed whale (*Peponocephala electra*), pygmy killer whale (*Feresa attenuata*), false killer whale (*Pseudorca crassidens*), killer whale (*Orcinus orca*), long-finned pilot whale (*Globicephala melas*), short-