

in size from 80 to 850 in3, with total volumes of the arrays being 3005 and 3721 in3 for the 10- and 12-gun arrays, respectively.

The 10-airgun array will have a peak sound source level of 248 dB re 1  $\mu$ Pa or 255 dB peak-to-peak (P-P). The 12-airgun array will have a peak sound source level of 250 dB re 1  $\mu$ Pa or 257 dB P-P. These are the nominal source levels for the sound directed downward, and represent the theoretical source level close to a single point source emitting the same sound as that emitted by the array of 10 or 12 sources. Because the actual source is a distributed sound source (10 or 12 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 downward directional nature of the sound from these airgun arrays, the effective source level for sound propagating in near-horizontal directions will be substantially lower.

Along selected lines, OBSs will be positioned by the *R/V Maurice Ewing* prior to the time when it begins airgun operations in that area. After OBS lines are shot, the *R/V Maurice Ewing* will retrieve the OBSs, download the data, and refurbish the units.

Along with the airgun operations, one additional acoustical data acquisition activity will occur throughout most of the cruise. The ocean floor will be mapped with an Atlas Hydrosweep DS-2 multi-beam 15.5-kHz bathymetric sonar. 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 mode is when water depth is <400 m (1312.3 ft). The source output is 210 dB re 1  $\mu$ Pa-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 beamwidth. 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 (1640.4 ft) and 10 milliseconds in the deepest water. Additional information on the airgun array and Atlas Hydrosweep 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 Eastern Equatorial Pacific Ocean and its associated marine mammals can be found in a number of documents referenced in the LDEO application and is not repeated here. Approximately 27 species of cetaceans and possibly two species of pinnipeds may inhabit the area of the Hess Deep. These species are the sperm whale (*Physeter macrocephalus*), pygmy sperm whale (*Kogia breviceps*), dwarf sperm whale (*Kogia sima*), Cuvier's beaked whale (*Ziphius cavirostris*), Longman's beaked whale (*Indopacetus pacificus*), pygmy beaked whale (*Mesoplodon peruvianus*), Ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*), Blainville's beaked whale (*Mesoplodon densirostris*), rough-toothed dolphin (*Steno bredanensis*), bottlenose dolphin (*Tursiops truncatus*), pantropical spotted dolphin (*Stenella attenuata*), spinner dolphin (*Stenella longirostris*), striped dolphin (*Stenella coeruleoalba*), short-beaked common dolphin (*Delphinus delphis*), Fraser's dolphin (*Lagenodelphis hosei*), Risso's dolphin (*Grampus griseus*), melon-headed whale (*Peponocephala electra*), pygmy killer whale (*Feresa attenuata*), false killer whale (*Pseudorca crassidens*), killer whale (*Orcinus orca*), short-finned pilot whale (*Globicephala macrorhynchus*), humpback whale (*Megaptera novaeangliae*), minke whale (*Balaenoptera acutorostrata*), Bryde's whale (*Balaenoptera edeni*), sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus*), and the blue whale (*Balaenoptera musculus*), Galapagos fur seal (*Arctocephalus galapagoensis*) and Galapagos sea lion (*Zalophus wollebaeki*). Additional information on most of these species is contained in Caretta *et al.* (2001, 2002) which is available at: [http://www.nmfs.noaa.gov/prot\\_res/PR2/Stock\\_Assessment\\_Program/sars.html](http://www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/sars.html).

#### Potential Effects on Marine Mammals

As outlined in several previous NMFS documents, the effects of noise on marine mammals are highly variable, and can be categorized as follows (based on Richardson *et al.*, 1995):

(1) The noise may be too weak to be heard at the location of the animal (i.e., lower than the prevailing ambient noise level, the hearing threshold of the animal at relevant frequencies, or both);

(2) The noise may be audible but not strong enough to elicit any overt behavioral response;

(3) The noise may elicit reactions of variable conspicuousness and variable relevance to the well being of the marine mammal; these can range from temporary alert responses to active avoidance reactions such as vacating an area at least until the noise event ceases;

(4) Upon repeated exposure, a marine mammal may exhibit diminishing responsiveness (habituation), or disturbance effects may persist; the latter is most likely with sounds that are highly variable in characteristics, infrequent and unpredictable in occurrence (as are vehicle launches), and associated with situations that a marine mammal perceives as a threat;

(5) Any anthropogenic noise that is strong enough to be heard has the potential to reduce (mask) the ability of a marine mammal to hear natural sounds at similar frequencies, including calls from conspecifics, and underwater environmental sounds such as surf noise;

(6) If mammals remain in an area because it is important for feeding, breeding or some other biologically important purpose even though there is chronic exposure to noise, it is possible that there could be noise-induced physiological stress; this might (in turn) have negative effects on the well-being or reproduction of the animals involved; and

(7) Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity. In terrestrial mammals, and presumably marine mammals, received sound levels must far exceed the animal's hearing threshold for there to be any temporary threshold shift (TTS). For transient sounds, the sound level necessary to cause TTS is inversely related to the duration of the sound. Received sound levels must be even higher for there to be risk of permanent hearing impairment. In addition, intense acoustic or explosive events may cause trauma to tissues associated with organs vital for hearing, sound production, respiration and other functions. This trauma may include minor to severe hemorrhage.