

system also results in lower deployment logistics when moving it around to other piles to be driven. Once deployed, the air bubble system requires minimal inspection. With easier deployment, maneuverability, and minimal inspection, the chances for costly project delays will be decreased. In addition, a fabric barrier/air bubble system would have to be designed to surround the entire template and pile cap (4 or 6 pile group of piles driven through sleeves in the pile cap). This would require the use of larger or more compressors to the extent that it may require multiple barges for support. This could cause significant congestion around the footing and additional delays related to installing and moving the bubble curtain, installing the piles, and completing construction of the footing.

In order to adjust the fabric barrier/air bubble system for the varying bathymetry in the Bay, the system would have to be removed from the Bay and reconfigured to meet the bathymetric conditions at each pier. An air bubble curtain will allow for a consistent close fit of the bottom of the curtain to the bay mud.

A fabric barrier/air bubble system would require a complete redesign and construction of a new system of false work for the support of the pile cap-footing box due to the large lateral forces that would be applied to this structure by the flow of Bay currents against the fabric. The placement of the fabric barrier/air bubble curtain can be expected to only be possible at slack tides, with very low winds due to the sail effect of the fabric barrier. This too, will cause delays in placement of the system and the driving of the piles.

As a result of this analysis, NMFS determined that the air bubble curtain had the potential to provide the means for effecting the least practicable adverse impact on the affected species and stocks of marine mammals, but wanted CALTRANS to provide another demonstration of the air bubble curtain's effectiveness in water currents than was shown at the PIDP.

Subsequent testing of the air bubble curtain has indicated that it will effectively attenuate sound (see Response to Comment 6).

*Comment 6:* CG&S states that based on the PIDP "the unconfined air bubble system provided little or no attenuation of harmful energy levels; however, CALTRANS is proposing this type system for the entire East Bay project. CG&S believes that the use of the confined air bubble system with fabric curtain would not only reduce energy levels but also serve as a

physical barrier to exclude (marine mammal) entry into the project area.

*Response:* CALTRANS has proposed to use the air bubble curtain to construct eastbound and westbound piers E6 through E3. CALTRANS would also construct eastbound and westbound piers E16 through E7 (in cofferdams, not using an air bubble curtain). Work done within cofferdams would use a 500-kJ hammer whenever possible, but switching to the 1700 kJ hammer only if stiffer sub-bottom sediments are encountered.

NMFS believes that the PIDP did not provide an accurate assessment of the capability of the air bubble curtain due to the failure to compensate for the currents in the area. One of the problems noted during the PIDP was that the air bubbles did not completely enclose the piles during periods with tidal currents. As a result, CALTRANS redesigned the air bubble curtain system and tested that system in 2002 and again in 2003 so that the new design of the bubble curtain completely enclosed all permanent in-water piles/pile groups during the pile driving process. One reason for the delay in issuing this IHA was our review of the redesigned air bubble curtain to ensure that marine mammals would be protected to the greatest extent practicable. That report was released on July 23, 2003. In summary, the effectiveness of a bubble curtain consisting of two or more rings over the single-bubble curtain used in the PIDP for reducing underwater sound pressures during marine pile driving was assessed through underwater sound pressure measurements. This was conducted when the three 108-m long, 2.4 m diameter piles driven in 2000 as part of the PIDP, were restruck in December, 2002. During the measurements, the bubble curtain system was turned on and off. The restrike involved driving the piles at refusal with the hammer at maximum energy (1600–1740 kJ).

The reduction in sound pressures provided by the bubble curtain system ranged considerably. The direct reduction in sound pressures for piles 1 and 2 was 6 to 17 dB for peak pressures and 3 to 10 dB for RMS SPLs. Piles 1 and 2 were next to each other. SPL reductions at Pile 3, which was in shallower water, were over 20 dB for both peak pressures and RMS SPLs on the north side. However, reductions on the south side were much less. Close to pile 3 on the south side, the reductions were on the order of 5 to 7 dB. Further away at about 450 m (1476 ft) south, the reductions were only about 2 dB. Uneven bottom topography around pile 3, which could have compromised the

bubble curtain performance near the bay bottom is suspected to have resulted in lower reductions to the south.

Analysis of individual pile strike impulses indicates that the bubble curtain reduced sound pressure at all measurement positions at frequencies above 1 kHz. There was a reduction in sound pressures below 500 Hz where the bubble curtain worked particularly well.

Measurements of peak pressures made at about 100 m (328 ft) were consistent with the measurements made during the PIDP in 2000. Those measurements were the basis for predictions of the maximum peak pressures during the SF-OB east span construction. With the exception of the 450 m (1476 ft) south position, predicted peak pressures used in the NMFS October 30, 2001 Biological Opinion on the effects of construction of the East Span of the SFOBB on listed species were lower than those measured. At 450 m (1476 ft) south, measured peak pressures were 5 to 8 dB higher than predicted. Conversely, peak pressures at 450 m (1476 ft) to 500 m (1640 ft) north were 0 to 6 dB lower than predicted.

RMS SPLs did not exceed 190 dB at any of the measurement positions (between 65 and 500 m) when the bubble curtain was operating. SPLs of 180 dB RMS did not extend out to the 450 m (1476 ft) south for pile 1, but did not exceed 172 dB at 450 m (1476 ft) north. With the bubble curtain off, the 190-dB RMS SPLs extended out to somewhere between 200 m (656 ft) to 300 m (984 ft) for piles 1 and 2, and less than 100 m (328 ft) for pile 3.

*Comment 7:* On December 17, 2001, CALTRANS requested that the paragraph in the proposed authorization notice regarding barrier systems be removed since the marine pile-driving attenuator system that will be installed by CALTRANS is to protect fish and is not intended to protect marine mammals.

*Response:* While the CALTRANS application did not indicate that a sound-attenuating device would be installed during pile driving at SF-OB, by the time the proposed authorization notice was published on November 26, 2001, the NMFS Biological Opinion on CALTRANS' construction of a replacement bridge for the East Span of the SF-OB had been issued. That document notes that "application of an air bubble curtain to attenuate sound is expected to restrict th[e] area of direct mortality [i.e., for fish], a radius of approximately 69 meters and the proposed monitoring program will allow for confirmation of the bubble curtain's effectiveness." Therefore,