

harass harbor seals. CALTRANS notes that land-based pile driving will involve hammers with less than 100 kJ of energy. CALTRANS believes that marine mammals are unlikely to be harassed by land-based pile driving and therefore, monitoring should apply only to in-Bay pile driving.

*Response:* NMFS agrees. During site visits, NMFS noted that a large hill (Yerba Buena Hill) was located between the YBI construction site and the YBI haulout. Therefore, with the combination of this permanent acoustic barrier and the low energy level for this pile driving activity, no impacts are anticipated at the YBI haulout and therefore monitoring by the SF-OBB monitoring team is not warranted.

However, the YBI haulout has been a pinniped control site for the monitoring program under CALTRANS' IHA for the Richmond San Rafael Bridge (see 67 FR 61323, September 30, 2002) for several years. Therefore this site will continue to be monitored by CALTRANS and any changes in harbor seal activity will be noted.

*Comment 4:* CG&S states that the source level of acoustic wave energy that will be generated in the water of SFB will be approximately 265 dB, and possibly greater. CG&S also states, that instantaneous lethal effects (rupturing of internal organs such as eyes and swim bladders) for aquatic organisms are well documented for energy levels of 204 dB, with delayed lethal effects occurring with energy levels down to 180 dB, and sub-lethal effects beginning as low as 170 dB.

*Response:* The PIDP had a measured pile-driver energy of 900 kJ with a measured underwater peak pressure of 207 dB (re 1 uPa) at a distance of 103 m (338 ft) and 191 dB at a distance of 358 m (1174.5 ft). Greene (2001) corrected for the larger hammer size expected to be used at SF-OBB and calculated excess attenuation of approximately 30 dB per tenfold increase in distance and, after applying the spreading loss formula, estimated that the pile driving source level (at 1 m (3.3 ft)) would be 268.5 dB (re 1 microPa) for the 1,700 kJ hammer. This 30-dB level is close to the 28-dB change observed at a Hong Kong refueling facility.

However, the estimated 268.5 dB (re 1 microPa) for the 1700 kJ hammer is made by taking measurements made in the far-field and extrapolating those measurements to the near-field. Estimating a source level from the far-field assumes that the sound emanates from a single point, and that the level reported is measured 1 m (3 ft) from that point. This method is useful for

comparing sound sources against each other. However, the 1700-kJ hammer is not a point source; there is no hypothetical location one meter from it where measurements could be made. Because of the dispersed nature of the sound, the procedure used in estimating a source level from the far-field gives a poor prediction of the levels an animal could actually receive in the near-field. Near-field received levels are expected to be considerably less than the far-field estimates predict.

Based on a formula provided by Greenridge Sciences, CALTRANS has made a rough extrapolation of the measurements made in the farfield back to 1 m (3.3 ft) that would put the source level at about 233 dB re 1 microPascal and an unmitigated underwater SPL for the 1700 kJ hammer to the 190-dB isopleth is estimated to be approximately 100 m (328 ft). This 190-dB isopleth is where current NMFS policy conservatively holds that onset of Level A harassment occurs for pinnipeds. Therefore, to the extent practicable, activities should avoid exposing pinnipeds to sound pressure levels exceeding this value in order to limit Level A harassment (injury). This does not mean that pinnipeds would be injured at the 190-dB isopleth distance, only that the 190-dB SPL is the point above which some potentially serious problems in the hearing capability of marine mammals could start to occur. We note that the 190 dB (re 1 uPa (rms)) criterion was established as an interim criterion that is still evolving. Newer information indicates that 190 dB is extremely conservative and that Level A harassment is unlikely to occur at that level.

Also, NMFS does not concur with the commenter that SPLs of 180 to 204 dB would necessarily result in lethal effects for fish. Studies suggest that intense sound may result in damage to the sensory hair cells in the ears of fish. Hastings *et al.* (1995, 1996) studied the effects of intense sound stimulation on the inner ear and lateral line of the oscar (*Astronotus ocellatus*) and Cox *et al.* (1986a, 1986b, 1987) exposed goldfish (*Carassius auratus*) to pure tones at 250 and 500 Hz at 204 and 197 dB, respectively. They found some indications of sensory hair cell damage. Enger (1981) determined that some ciliary bundles (the sensory part of the hair cell) on sensory cells of the inner ear of the cod (*Gadus morhua*) were destroyed when exposed to sounds at several frequencies from 50 to 400 Hz at 180 dB for 1–5 hours. In reviewing the results of their study and that of the previous studies, Hastings *et al.* (1996) suggested that sounds 90 to

140 dB above a fish's hearing threshold may potentially injure the inner ear of a fish. This suggestion was supported in the findings of Enger (1981) in which injury occurred only when the stimulus was 100 to 110 dB above threshold at 200 to 250 Hz for the cod. Hastings *et al.* (1996) derived the values of 90 to 140 dB above threshold by examining the sound levels that caused minimal injury in the oscar, and then hypothesizing that extensive injury would require more energy. They conservatively suggest that received levels (RLs) of 200 dB to 240 dB would potentially cause damage to sensory hair cells in non-hearing specialist fishes. Calculations for hearing specialist fish using the Hastings (1996) values (i.e., 90 to 140 dB above threshold) conservatively indicate RLs of 140 to 190 dB continuously for at least one hour would be necessary to induce hearing damage. Also Hastings *et al.* (1995) showed that the oscars recovered within 1 day, suggesting that the impairment was not permanent.

In addition, the primary potential for non-auditory impact to fishes would be resonance of fish swim bladders. Studies show that the resonant frequency of the swim bladder is considerably above the frequency of best hearing. It is not expected, therefore, that resonance of the swim bladder would play a significant role in response to low-frequency sound, especially since only larger fish would have swim bladders large enough to resonate. While NMFS does not believe the evidence supports a finding that instantaneous lethal effects are likely for energy levels of 180 to 204 dB, it does believe that mitigation measures implemented to reduce the impacts to marine mammals and threatened/endangered species will have benefits for other marine life as well.

#### Mitigation Concerns

*Comment 5:* The Commission believes that NMFS' preliminary determinations are reasonable provided all reasonable measures will be taken to ensure the least practicable adverse impact on affected species of marine mammals. In that regard, the Commission notes that CALTRANS indicates that a fabric barrier sound attenuation system proved effective in reducing SPLs generated during the PIDP. It is unclear however, whether this method will be employed during the proposed pile-driving operations, or, in the alternative, that CALTRANS has made a showing that using such a system is not practical.

*Response:* An explanation of the PIDP findings and CALTRANS analysis are provided here, followed in later comments and responses with