Pinniped Monitoring during Missile Launches on San Nicolas Island, California, June 2014 - November 2014

Naval Air Warfare Center Weapons Division
Point Mugu, California

For Submittal To

National Marine Fisheries Service
Silver Spring, Maryland, and Long Beach, California

30 December 2014

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ACRONYMS AND ABBREVIATIONS

3-D	3-dimensional
ASL	above sea level
ATAR	Autonomous Terrestrial Acoustic Recorder
B807	Building 807
CFR	Code of Federal Regulations
cm	centimeter
CPA	Closest Point of Approach
dB	decibel
dBA	decibel, A-weighted, to emphasize mid-frequencies and to de-emphasize low and high frequencies to which human (and pinniped) ears are less sensitive
F	Fahrenheit
FOV	field of view
ft	feet
FLIR	Forward Looking Infrared
hr	hour
Hz	Hertz
IHA	Incidental Harassment Authorization
in	inches
kg	kilogram
kHz	kilohertz
km	kilometer (1 km = 3281 ft, 0.62 mi, or 0.54 n.mi)
kts	knots or nautical miles per hour
lb	pounds
LOA	Letter of Authorization
m	meter
mi	mile
min	minute
mm	millimeter
MMPA	Marine Mammal Protection Act
M_{pa}	Frequency weighting appropriate for pinnipeds in air (see Gentry et al. 2004; Southall et al. 2007)
NAWCWD	Naval Air Warfare Center Weapons Division
nm	nautical miles
NMFS	National Marine Fisheries Service
PTS	Permanent Threshold Shift
rms	root mean square (a type of average)
s	second
SEL	sound exposure level
SEL-A	A-weighted sound exposure level
SEL-M	M_{pa}-weighted sound exposure level
SNI	San Nicolas Island
SPL	sound pressure level
SPL-f	flat-weighted sound pressure level
TTS	Temporary Threshold Shift
µPa	micropascal

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EXECUTIVE SUMMARY

The Naval Air Warfare Center Weapons Division (NAWCWD) holds Letters of Authorization (LOAs) issued by the National Marine Fisheries Service (NMFS) allowing non-lethal takes of pinnipeds incidental to the Navy's missile launch operations on San Nicolas Island (SNI), California. Past LOAs span the periods of June 2009 through June 2014. New small take regulations and an associated LOA for the period of June 2014 through June 2019 were issued pursuant to 50 Code of Federal Regulations (CFR) 216.151–158 and §101(a)(5)(A) of the Marine Mammal Protection Act (MMPA), 16 United States Code (USC) §1371(a)(5)(A). Those regulations were initially issued for the period 2 October 2003 through 2 October 2008, and were reissued for the periods 2 June 2009 through 2 June 2014 and 3 June 2014 through 3 June 2019. The regulations and associated LOAs allow for the 'take by harassment' of small numbers of northern elephant seals (*Mirounga angustirostris*), Pacific harbor seals (*Phoca vitulina*), and California sea lions (*Zalophus californianus*) during routine launches on Navy-owned SNI.

In the Navy's Petition for Regulations that led to promulgation of 50 CFR 216.151–158 a Monitoring Plan and subsequent reporting was proposed to NMFS. The Plan includes provisions to monitor any effects of missile launch activities on pinnipeds hauled out at SNI in a manner similar to preliminary pinniped monitoring that took place during Navy activities from 2001–2008. Pinniped species monitored on SNI during that period included the Pacific harbor seal, northern elephant seal, and California sea lion. In June 2010, a revised Monitoring Plan was submitted to NMFS proposing discontinuation of monitoring for northern elephant seals, as this species had shown little or no reaction to most missile launches. NMFS accepted this proposed change to the Monitoring Plan (NMFS 2010) and issued the new LOA to acknowledge the change. Thus, elephant seal responses are not discussed in detail in this report.

Missiles Launched

This report describes the results of the visual and acoustic Monitoring Plan for missile launches from SNI between June 2014 and November 2014. It includes results from five missile launches on four separate days. During this monitoring period no dual launches – those consisting of two missiles launched in rapid succession (e.g., less than 1 minute apart) – occurred. Missiles launched included the Aegis Readiness Assessment Vehicle (ARAV), Accelerated Improved Intercept Initiative missile (AI3), and GQM 163A "coyote" (GQM). All missiles were launched during daytime hours.

The launch azimuths result in missiles crossing SNI's shoreline on the island's western end and passing over and/or near various pinniped haul-outs. Monitoring sites are surveyed and established at beaches occupied by pinnipeds. Autonomous Terrestrial Acoustic Recorders (ATARs) and video systems are deployed at ideal observation points to collect data. Audio recordings document launch sound at several distances from the launch trajectory of the missile. Audio, video and direct visual monitoring provide data on the behavioral reactions of pinnipeds hauled out during launches.

Pinniped Behavior during Missile Launches

Behavior of pinnipeds (California sea lions and Pacific harbor seals) hauled out on SNI beaches during missile launches is monitored by unattended video cameras set up before each launch. Video data are supplemented by direct visual scans of the haul-out groups several hours prior to the launches and following the launches. Monitoring is attempted at up to three sites during each launch, with launch-to-launch variation in the locations monitored and number of locations depending upon presence of hauled out pinnipeds. For each launch, the number, proportion, and maturity (where determinable) of individual pinnipeds that responded in various ways is tabulated using the video recordings, along with comparable data, for those that do not respond overtly. No evidence of injury, mortality, pup abandonment, or other

significant impact beyond movement was observed during or immediately succeeding any launches for the monitored pinniped species.

Estimated Numbers of Pinnipeds Affected

No evidence of pinniped injuries or fatalities related to missile launches was evident, nor was it expected, during the monitoring period. According to Navy monitoring, Approximately 923 California sea lions, 50 Pacific harbor seals, and no northern elephant seals were estimated to have been affected during the June 2014 to November 2014 monitoring period. These figures are approximate and likely over- or underestimate pinnipeds affected because they; (a) include extrapolations for pinnipeds on beaches that were not monitored on any given launch day, (b) very likely count some of the same individuals more than once, and (c) also exclude pinnipeds on some beaches that were not monitored. The pinnipeds included in these estimates either left the haul-out site in response to the launch, or exhibited prolonged movement or behavioral changes relative to their behavior immediately prior to the launch.

The results from the 2014 monitoring period (and those from previous monitoring periods) suggest that any effects of the launch operations were minor, short-term, and localized, at least for northern elephant seals and California sea lions. Some Pacific harbor seals may have left their haul-out site until the following low tide, but numbers occupying haul-out sites shortly after a launch or the next day, were generally similar to pre-launch levels. It is not likely that any of the pinnipeds on SNI were adversely impacted by such behavioral reactions. While sound levels for four launches exceeded those which might cause temporary threshold shift (TTS) at 129 dB re 20 μPa^2-s Sound Exposure Level (SEL) for M-weighting (SEL-M), in two cases these measurements were taken adjacent to the launch pad and launch sounds near the pinniped haul outs were below the range that would be likely to cause TTS or permanent hearing damage. In the other two, where the measurement was at a pinniped haulout site, the measurement was taken on the cliff above the haulout and only marginally above the level where TTS may occur. In the unlikely event that any pinnipeds did incur TTS during launches at SNI, this would have presumably been mild and recoverable and thus not have caused permanent damage. No measured sound levels exceeded the SEL-M criterion for permanent threshold shift. However, peak pressure levels (flat weighting) exceeded the PTS threshold for two recordings; peak pressure levels (flat weighting) of 161.3 and 161.8 dB re 20 µPa were both measured at Dos Coves for the two GQM-163A missile launches that occurred on 4 September 2014. Again, these recordings were taken on the cliff above the monitored site and it is likely that the rocks would mask the sound on the haul out beach. Peak pressure levels (flat weighting) were below the 149 dB re 20 µPa PTS threshold for the remaining recordings of missiles/monitoring sites.

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1. MONITORING PROGRAM AND MISSILE LAUNCHES DESCRIBED

1.1 Monitoring Program

San Nicolas Island (SNI) is located approximately 65 miles (m) (~100 kilometers (km)) from the mainland coast of southern California (Fig. 1.1). Missiles are launched from one of two land-based launch complexes on the western part of SNI: Building 807 Launch Complex (B807) is located on the west coast of SNI, approximately 35 feet (ft) (11 meters (m)) above sea level (ASL), and the Alpha Launch Complex is located approximately 625 ft (190.5 m) ASL on the west-central part of SNI (Fig. 1.2). The missiles pass over or near pinniped haul-out sites located around the northwestern periphery of SNI. The pinniped species that commonly occur on SNI include northern elephant seals (*Mirounga angustirostris*), Pacific harbor seals (*Phoca vitulina*), and California sea lions (*Zalophus californianus*).

The Naval Air Warfare Center Weapons Division (NAWCWD) holds a Letter of Authorization (LOA) issued by the National Marine Fisheries Service (NMFS) allowing non-lethal takes of pinnipeds incidental to the Navy's missile launch operations on San Nicolas Island (SNI), California. This LOA span the period of June 2014 through June 2019. The LOA was issued pursuant to 50 Code of Federal Regulations (CFR) 216.151–158 and §101(a)(5)(A) of the Marine Mammal Protection Act (MMPA), 16 United States Code (USC) §1371(a)(5)(A). Those regulations were initially issued for the period 2 October 2003 through 2 October 2008 and were reissued for the period 2 June 2009 through 2 June 2014 and 3 June 2014 through 3 June 2019. The regulations and associated LOA allows for the 'take by harassment' of small numbers of northern elephant seals (*Mirounga angustirostris*), Pacific harbor seals (*Phoca vitulina*), and California sea lions (*Zalophus californianus*) during routine launches on Navy-owned SNI.

Previously, separate LOAs were issued for this purpose for the periods October 2003 to October 2004, October 2004 to October 2005, February 2006 to February 2007, February 2007 to February 2008, February to October 2008, June 2009 to June 2010, June 2010 to June 2011 (later superseded by a December 2010 to November 2011 LOA), December 2011 to November 2012, December 2012 to November 2013, and December 2013 to June 2014. No launches took place during the February to October 2008 LOA period or during two intervals between expiry of one LOA and issuance of another (8 October 2005 to 2 February 2006 and 3 October 2008 through 3 June 2009).

A Monitoring Plan was proposed in the Petition for Regulations under which the LOAs were issued. The purpose of the monitoring was to characterize any effects of missile launch activities on Pacific harbor seals, northern elephant seals, and California sea lions hauled out at SNI. In June 2010, a revised Monitoring Plan was submitted to NMFS that proposed the discontinuation of monitoring for northern elephant seals, as this species had shown little reaction to most missile launches at SNI. NMFS accepted this proposed change to the Monitoring Plan (NMFS 2010); thus, elephant seals were not targeted for monitoring after December 2010, but occurred in the field of view (FOV) of some cameras monitoring other species.

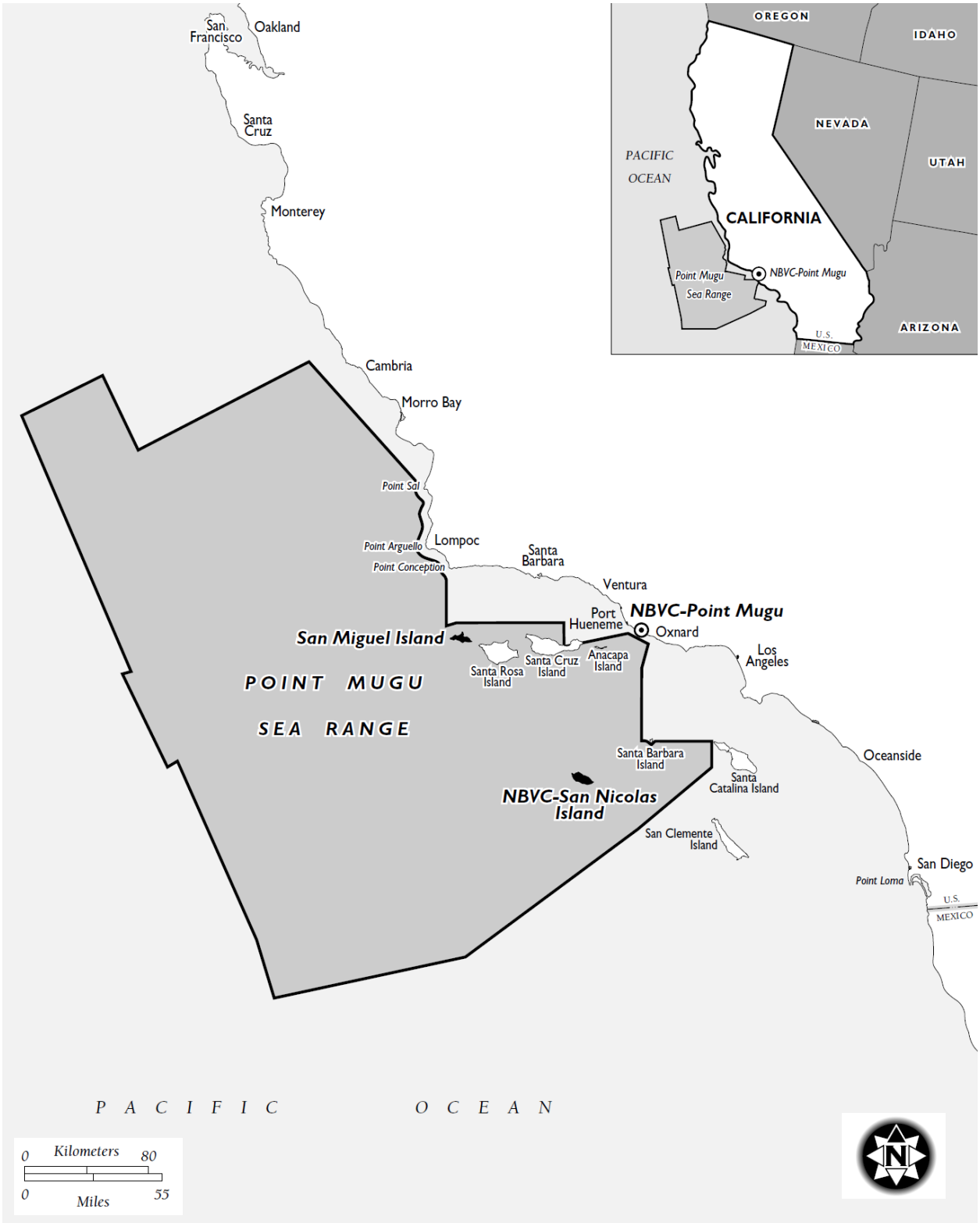

FIGURE 1.1. Regional site map of the Point Mugu Sea Range and San Nicolas Island, California (map by TEC, Inc.).

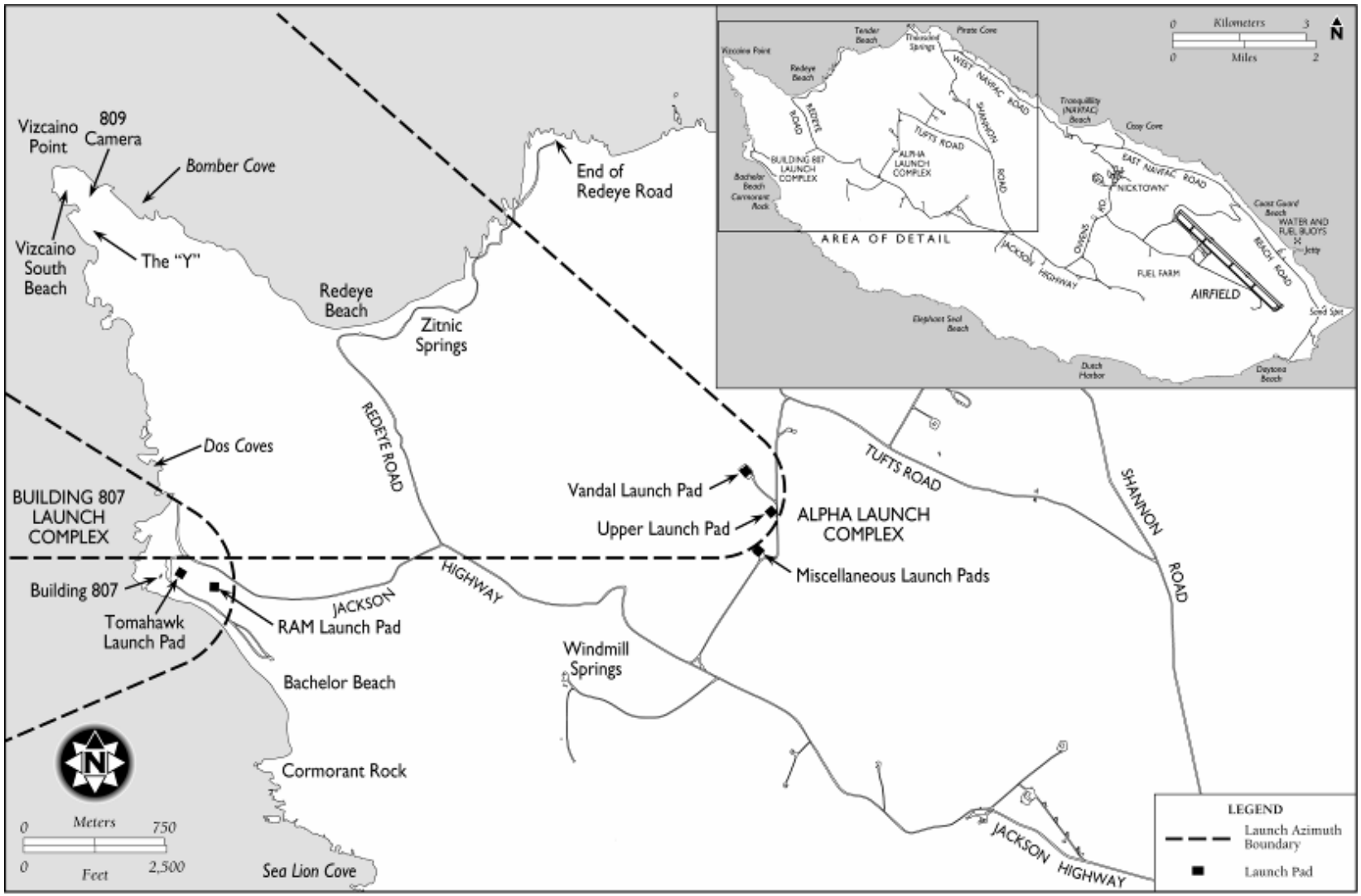

FIGURE 1.2. Map of San Nicolas Island, California, and the anticipated launch azimuths (dashed lines) for each launch complex. These launch azimuths are typical, although occasionally launch paths could pass outside these boundaries.

The Monitoring Plan requires that, for each missile launched from SNI, simultaneous autonomous audio recording of launch sounds and video recording of sea lion and harbor seal behavior occur. Generally monitoring will occur at three sites during each launch, dependent upon the presence of pinnipeds in various locations. This land-based monitoring provides data required to characterize the extent and nature of "taking". In particular, it provides information needed to document the nature, frequency, occurrence, and duration of any changes in sea lion and harbor seal behavior resulting from missile launches, including the occurrence of stampedes (if any). These video and audio records are used to further document sea lion and harbor seal responses to the launches. Documentation includes the following components:

- Identify and document any change in behavior or movement that may occur at the time of the launch;
- Compare pre- and post-launch behavioral data on each launch day to quantify the interval required for pinniped numbers and behavior to return to normal[1] if there is a change as a result of launch activities;
- Compare received levels of launch sound with pinniped responses, based on acoustic and behavioral data from up to three monitoring sites at different distances from the launch site and flightline during each launch; from the data accumulated across a series of previous and future launches, establish the "dose-response" relationship[2] for launch sounds under different launch conditions;
- Ascertain periods or launch conditions when pinnipeds are most and least responsive to launch activities, and
- Document take by harassment and, although unlikely, any mortality or injury.

This report describes the missiles launched, the associated monitoring program, and the monitoring program results for 2014. During the monitoring period, five missiles were launched on four separate days: 17 June, 5 August, 6 August and two missiles on 4 September. This report includes four chapters: (1) background, introduction, and description of the Navy's missile launches; (2) acoustical monitoring during the missile launches; (3) visual monitoring of pinnipeds during those launches; and (4) estimated numbers of pinnipeds affected by the missile sounds during launches.

1.1.1 Audio Monitoring

Audio recordings attempt to document launch sounds at several distances from the launch trajectories of the missiles (See Chapter 2 for details). During all launches in this monitoring period audio recorders were placed in the same location as video cameras documenting pinniped reactions, thus obtaining paired acoustic and pinniped-response data. In addition to recording launch sounds, these audio recordings document ambient noise levels prior to and following launches. Objectives of the audio monitoring program include:

1. Document levels and characteristics of launch sounds at several distances from the missile paths;
2. Document levels and characteristics of ambient sounds at the same locations as launch sounds, as a measure of the background noise against which the pinnipeds will (or will not) detect the launch

[1] If numbers and/or behavior have not returned to "normal" within the duration of the autonomous recording, the duration of the period with reduced numbers will be reported as "greater than *x* minutes".

[2] This is equivalent to estimating behavioral zones of influence by comparing pinnipeds' reactions to varying received levels of launch sounds.

sounds; and

3. Determine the sound levels from missile overflights were high enough to have the potential to induce Temporary Threshold Shift (TTS) in pinnipeds exposed to launch sounds[3].

1.1.2 Visual Monitoring

Video and visual monitoring provide data on focal groups of pinnipeds hauled out on SNI during launches (See Chapter 3 for details). The accumulation of such data across numerous launches provides information necessary to characterize the nature and extent of disturbance effects. In particular, it provides the information needed to document the nature, frequency, occurrence, and duration of any changes in pinniped behavior resulting from the missile launches, including the occurrence of stampedes from haul-out sites if they occur.

Video records document pinniped responses to missile launches. Objectives include the following:

1. Identify and document any change in behavior or movements that occurred at the time of the launch;
2. Quantify the interval required for pinniped numbers and behavior to return to normal if there was a change as a result of launch activities;
3. Compare received levels of launch sound with pinniped responses, based on acoustic and behavioral data from monitoring sites at different distances from the launch site and flightline during each launch; from the data accumulated across a series of launches, establish the "dose-response" relationship[4] for missile sounds under different launch conditions[5];
4. Ascertain periods or launch conditions when pinnipeds are most and least responsive to launch activities[4];
5. Document numbers of pinnipeds affected by missile launches and, although unlikely, any mortality or injury.

1.2 Impact Estimates

The monitoring program for the missile launches on SNI is designed, in part, to provide data necessary to estimate the numbers of pinnipeds affected by launches and the manner in which they were affected. Pinnipeds are assumed to be 'taken by harassment' if there is a reason to believe that auditory impairment (TTS) occurred as a result of a launch, or if biologically significant behavioral patterns of pinnipeds are disrupted. NMFS (2000) defines a biologically significant behavioral response as one "…that affects biologically important behavior[s], such as survival, breeding, feeding and migration, which have the potential to affect the reproductive success of the animal." As a corollary of that, NMFS (2002) states that "…one or more pinnipeds blinking its eyes, lifting or turning its head, or moving a few feet along the beach as a result of a human activity are not considered a 'take' under the MMPA definition of harassment."

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[3] Based upon TTS information for harbor seals as a conservative estimate, it is assumed that all three species might have TTS onset at a received SEL-M of >129 dB re 20 $\mu Pa^2 \cdot s$ (see Section 4.2.1)

[4] This is equivalent to estimating behavioral zones of influence by comparing pinnipeds' reactions to varying received levels of launch sounds.

[5] Determination of objective 3 and objective 4 requires consideration of additional data, including data from the previous years of monitoring and data from planned future monitoring. Therefore, objectives (3) and (4) are not addressed in the present report. However, an analysis using data from previous monitoring years can be found in Holst et al. (2008).

In this report, consistent with previous related reports, it is assumed that only those animals that met the following criteria count as affected by launches:

1. Pinnipeds injured or killed during launches, if any (e.g., by stampedes);
2. Pinnipeds exposed to launch sounds strong enough to cause permanent or temporary auditory impairment (permanent threshold shift [PTS] or TTS);
3. Pinnipeds that left the haul-out site, or exhibited prolonged movement[6] or behavioral changes (such as pups separated from mothers) relative to their behavior immediately prior to the launch.

In practice, no pinnipeds are known to have been injured or killed since launch monitoring began in August 2001, and few, if any, are believed to have received sounds strong enough to elicit TTS (Holst, et al. 2011). Thus, the number of pinnipeds counted as potentially affected during the current monitoring period was primarily based on criterion 3 above – the number that left the haul-out site, or exhibited prolonged movement or other behavioral changes relative to their behavior in the hours preceding the launch.

1.3 Missile Types Launched During the Monitoring Period

Aegis Readiness Assessment Vehicle (ARAV)

The ARAV is a short range ballistic target missile. The ARAV is a solid fueled rocket used to emulate ballistic missile threats. The rocket consists of the Terrier Mark 70 booster (body diameter of 45.7 centimeter [cm]) attached to the Oriole second stage (56 cm diameter).

Accelerated Improved Intercept Initiative (AI3)

The AI3 is a precision missile system based on the AIM 9M, Sidewinder. The system includes the missile, a modified Avenger launcher and Counter Rockets Artillery Mortar (C-RAM) command and control system. The rocket consists of a 5 in (13 cm) diameter round propelled by a solid fuel rocket with a total length of 9 feet 11 inches (3 meters [m]).

GQM-163A "Coyote" Supersonic Sea-Skimming Target (GQM)

The Navy/Orbital Sciences Corp. GQM-163A "Coyote" missile is an expendable target powered by a ducted-rocket ramjet. It is capable of flying at low altitudes (13 ft or 4 m cruise altitude) and supersonic speeds (Mach 2.5) over a flight range of 45 nautical miles (nm, 83 km) (Fig. 1.3). The GQM is designed to provide a ground launched aerial target system to simulate a supersonic, sea-skimming Anti-Ship Cruise Missile (ASCM) threat. The GQM was developed to replace the Vandal missile target.

The GQM missile assembly consists of two primary subsystems: MK 12 or MK 70 solid propellant booster, and the GQM-163A target missile. The solid-rocket booster is about 18 inches (in) (46 cm) in diameter and is of the type used to launch the Navy's Standard surface-to-air missile. The GQM-163A target missile is 18 ft (5.5 m) long and 14 in (36 cm) in diameter, exclusive of its air intakes. It consists of a solid-fuel Ducted Rocket (DR) ramjet subsystem, Control and Fairing Subassemblies, and the Front End Subsystem (FES). Included in the FES is an explosive destruct system to terminate flight if required.

[6] Prolonged movement, for the purpose of the monitoring and this report, is defined as one or more animals moving in a directed manner either more than 10 m (33 ft) onshore or moving any distance from the shore and entering the ocean.

1.4 Launch Dates and Information

Between June 2014 and November 2014 there were five missile launches from SNI on four separate days (Table 1.1). These launches all involved single missiles launched at least several hours apart. Missiles launched included one ARAV, two AI3, and two GQM. All launches occurred during daylight hours (between 0800 and 1800 local time). Weather during the launches ranged 63° to 67° Fahrenheit (F) at the control room, with winds between 8 and 20 knots (kts) and skies ranging from clear and sunny to complete overcast (Table 1.1).

ARAV

A single ARAV missile launch occurred on 17 June 2014. The missile was launched at 1458 local time. The ARAV launched from the Building 807 Launch Complex (B807) located on the west coast of SNI, approximately 33 ft (11 m) ASL. The missile was launched on an azimuth of 253° True at an elevation angle of 68° above horizontal and crossed the shoreline at approximately 300 ft (100 m) ASL (Table 1.1). This missile launch was previously analyzed in the comprehensive report detailing launches between 2009 and 2014, but is included in this report as it occurred during the current LOA period.

AI3

Single launches of AI3 missiles occurred on 5 and 6 August 2014. The missiles were launched at 1142 and 1332 local time. The AI3s were launched from the B807 Launch Complex. Both missiles were launched on azimuths of 215° True at an elevation angle of 15° above horizontal and crossed the shoreline at approximately 300 ft (100 m) ASL (Table 1.1).

GQM

Two separate GQM missiles were launched on 4 September 2014 at 14:36 and 17:30 local time. The GQMs were launched from the Alpha Launch Complex located approximately 625 ft (190.5 m) ASL on the west-central part of SNI. Both GQMs were launched on azimuths of 270º true at an elevation angle of 14º above horizontal. The missiles crossed the west end of SNI at altitudes of approximately 2,600 ft (800 m) ASL (Table 1.1). Elevation angle does not necessarily translate to a straight line for altitude change for GQM, as the missiles may actively alter the rate of climb achieving a higher than expected altitude for a given launch angle and distance from the launcher.

TABLE 1.1. Launch data for the June 2014 – November 2014 report period.

Launch Date	Launch Time (local)	Missile Type	Launch Complex	Launch Azimuth (true)	Elevation Angle / Altitude Over Beach (Feet)	Weather at Control Room (Max Wind speed in knots)[1]	Video Quality	Audio Quality
6/17/2014	14:58	ARAV	B807	253°	67° / 300	20 NW / 66°	Good	Good
8/5/2014	11:42	AI3	B807	215°	15° / 300	10 W / 65°	OK	Good
8/6/2014	13:32	AI3	B807	215°	15° / 300	8 SW / 67°	Good	Good
9/4/2014	14:36	GQM	Alpha	270°	14° / 2,600	8 W / 63°	Good	Good
9/4/2014	17:30	GQM	Alpha	270°	14° / 2,600	8 W / 63°	Good	Good

[1] The weather data were collected at the launch control room located between 2 and 5 kilometers from the missiles' closest point of approach to the shoreline; therefore weather conditions at pinniped haul-out sites near the closest point of approach may have differed.

2. ACOUSTICAL MEASUREMENTS OF MISSILE LAUNCHES

2.1 Introduction

The acoustic measurement program for the monitoring period is consistent in approach and methodology with that used during the preceding years (Ugoretz 2014, Holst et al. 2011). Recordings of each missile's sound, as well as background sounds, were attempted at up to four sites during each missile flight. ATARs were developed for this purpose by the Navy's acoustical contractor, Greeneridge Sciences Inc. of Santa Barbara, California. The specific design of the ATARs was described previously (Ugoretz 2014, Holst et al. 2011). Maps of the launch azimuths and monitoring locations are provided in Chapter 3 (Fig. 3.1). Nineteen recordings were obtained during the monitoring period (Table 2.1).

Based on a review of the literature (Lawson et al. 1998) completed prior to the start of monitoring, sound levels that might cause notable disturbance for each pinniped species are variable and context-dependent. Lawson et al. (1998) estimated the minimum received level, on an A-weighted Sound Exposure Level (SEL-A) basis, that might elicit substantial disturbance as 100 A-weighted decibels (dBA) reference 20 micropascals squared second (re 20 $\mu Pa^2 \cdot s$) for all pinnipeds. The 100 dBA re 20 $\mu Pa^2 \cdot s$ SEL pertains to exposures to prolonged sounds, which were taken to last at least several seconds. Measured durations of sound from various types of missiles launched from SNI typically range from less than 1 second (s) up to 21 s (Holst et al. 2008). In any event, the assumption that reactions might occur at distances up to those where received levels diminished to 100 dBA SEL (see Fig. 2.39 *in* Greene and Malme 2002) was one influencing factor in selecting acoustic (and video) monitoring sites during the first year of monitoring (2001). Sites at distances up to ~4 km from the launcher and/or launch trajectory are currently monitored, though closer sites are selected when animals are present.

After reviewing video recordings of pinnipeds during launches at SNI during 2001–2002 (Holst and Lawson 2002), the 100-dBA SEL is reasonable as a minimum received level that might elicit disturbance of California sea lions. However, 90 dBA SEL is more appropriate for Pacific harbor seals, as they showed a strong response to most launches, including a number of launches where received levels were <100 dBA SEL. In contrast, the majority of northern elephant seals usually exhibited little or no reaction to launch sounds. The received levels of sounds from the larger missiles, as measured in the first year of monitoring, indicated that levels at or above 90 dBA SEL could be expected out to distances of ~4 km from the launch trajectory (see Fig. 2.39 *in* Greene and Malme 2002). Thus, monitoring at sites located ~4 km from the launcher and/or launch trajectory continued during subsequent years. Continuing data collection and monitoring shows some behavioral responses may extend to received sound levels lower than 90 dBA SEL.

Southall et al. (2007) note that M_{pa}-weighted (i.e., frequency-weighted appropriately for pinnipeds in air) SELs of 100 dB re 20 $\mu Pa^2 \cdot s$ could result in takes by harassment for pinniped species (M-weighted values are greater than A-weighted SELs for launch sounds; see Chapter 2). Previous monitoring at SNI shows that California sea lions and Pacific harbor seals typically move along the beach and/or enter the water at M_{pa}-weighted SELs ≥100 dB re 20 $\mu Pa^2 \cdot s$. In fact, both species can be disturbed at lower levels. For example, Holst et al. (2008) noted that some Pacific harbor seals leave the haul out site and/or enter the water at SELs as low as 60 dB M_{pa}.

2.2 Field Methods

2.2.1 Deployment of ATARs

Prior to each launch, ATARs are positioned at the launch pad and near pinniped haul out sites at varying distances from the planned launch azimuth, specifically at locations where pinniped responses were monitored previously (Table 2.1). The recordings provide data for quantitative analysis of the levels and characteristics of the received flight sounds.

ATARs are set up several hours prior to the launch and retrieved following the launch. The ATAR units are deployed by Navy biologists at sites as close as practical to as many as three pinniped haul-out sites at various distances from the launch site and launch trajectory. The total number of sites monitored depends upon the presence of pinnipeds on beaches in the potentially impacted area. Over the entire monitoring period (since August 2001), the Navy has distributed the ATARs such that, for types of missiles that are commonly launched at SNI, recordings provide data for a variety of distances and locations relative to the flight trajectories and the launch pad.

In addition to providing information on the magnitude, characteristics, and duration of sounds to which pinnipeds are exposed, acoustic data and monitoring provide associated pinniped behavioral data. These data have contributed to a longer-term dataset, intended to help determine if there is a "dose-response" relationship between received sound levels and pinniped behavioral reactions. Measured sound levels at various microphone locations can be used to characterize sound exposure vs. distance downrange and laterally from the launch azimuth.

Analyses of acoustic data collected between August 2001 and October 2008 were reported by Holst et al. (2011). In those analyses, factors considered included missile type, launch azimuth, launch characteristics (e.g., low- vs. high-angle launch), as well as weather, which has important effects on the received sounds. Holst et al. reported that the majority of observed California sea lions startled and showed increased vigilance up to 2 min after each launch; responses often included movement on the beach or into the water and were significantly related to received sound level and distance from the vehicle's closest point of approach. Most observed northern elephant seals showed little reaction to launches and merely raised their heads briefly. Nonetheless, their responses were also related to received sound level and distance from vehicle trajectory. Pacific harbor seals were the most responsive with the majority (average 68%; range 7 to 100%) of observed harbor seals within ~4 km of the launch trajectory departing haul-out sites by entering the water. Within the range of conditions studied, there was no clear correlation between harbor seal response and received sound level or distance from the closest point of approach of the vehicle. Given the limited number of launches during the current monitoring period, no corresponding acoustic data analysis occurred for these launches.

TABLE 2.1. Monitored Missile launches and ATAR recording sites (also see Fig. 3.1).

Launch Date	Missile	ATAR Locations	Recording Status
6/17/2014	ARAV	B807, Dos Coves, B809, Redeye Beach	4 of 4 OK
8/5/2014	AI3	B807^, Dos Coves, B809*, Rock Crusher	4 of 4 OK
8/6/2014	AI3	B807, Dos Coves, B809, Bachelor Beach	4 of 4 OK
9/4/2014	GQM	Alpha Pad, Dos Coves^, B809, Redeye Beach	4 of 4 OK
9/4/2014	GQM	Alpha Pad, Dos Coves^, B809, Redeye Beach	4 of 4 OK

* Launch event not above ambient sounds at monitoring location.
^ Measured sounds exceeded level where TTS may occur (129 dB re 20 μPa^2·s SEL-M) by ~1.5 dB (see Section 4.2.1).

2.3 Audio Data Analysis Methods

Both time-series and frequency-domain analyses are performed on the acoustic data. Time-series results included signal waveform and duration, peak pressure level (peak), root mean square (rms) sound pressure level (SPL), and SEL. SPL and SEL were determined with three alternative frequency weightings: flat-weighted (SPL-f and SEL-f), A-weighted (SPL-A and SEL-A), and M_{pa}-weighted (SPL-M and SEL-M) basis. The M_{pa}-weighting procedure, appropriate for pinnipeds in air, is described in Southall et al. (2007) and in §2.3.3 below. Frequency-domain results included estimation of SPLs in one-third octave bands for center frequencies from 4 to 16,000 kHz. The following subsections describe how these values are defined and calculated.

2.3.1 Time-Series Analysis

All missile launch sound analyses require identification of a signal's beginning and end. This identification can be complicated by background noise (whether instrumental or ambient), poorly-defined signal onsets, and gradually diminishing signal "tails". To obtain a consistent measure of signal duration for each flight, we first defined a "net energy" E. This measure of energy in excess of background was calculated as the cumulative signal energy above mean background energy:

$$E = \frac{1}{fs}\sum_{i=1}^{N} (x_i^2 - \langle n^2 \rangle) \text{ Pa}^2 \text{ s}$$

where x represents all data points in an event file, n represents only background noise data points before the flight sound, N is the total number of samples in the event file, and f_s is the sampling rate.

Based on this consistent definition of net energy E, the beginning and end of a flight sound is defined as the times associated with the accumulation of 5% and 95% of E.

Duration is defined as the difference between these start and end times.

Sound exposure is defined as 90% of E, representing total sound exposure in units of Pa^2·s. **SEL** was determined from 10·log (sound exposure).

Sound pressure is defined as the square root of the sound exposure divided by the duration. Sound pressure is equivalent to the rms value of the signal, less background noise, over the duration. **SPL** was determined from 20·log (sound pressure).

Peak instantaneous pressure is defined as the largest sound pressure magnitude (positive or negative) exhibited by the signal, even if the signal reached that level only momentarily.

Peak instantaneous pressure level is determined from 20 log (peak instantaneous pressure).

2.3.2 Frequency-Domain Analysis

Frequency-domain analysis is used to estimate how signal power is distributed in frequency. Flat-weighting is used for all frequency-domain analysis. Welch's (1967) "Weighted Overlapped Segment Averaging" (WOSA) method is used to generate representative power spectral densities in each case. Power spectral densities are calculated for the signal and pre-signal background noise on the low-sensitivity channel and for background noise on the high-sensitivity channel. These spectral density values are then summed into one-third octave bands.

For these analyses the "signal" is defined as consisting of the recorded data (missile signal plus background noise). This time series is segmented according to duration (determined from the broad-band time series analysis) as follows:

- For duration > 1 s, use 32,768-sample blocks of total length 0.74 s with Blackman-Harris (Harris 1978) minimum three-term window, overlapped by 50%. This results in frequency cells spaced by 1.35 Hz and an effective cell width (resolution) of 2.3 Hz.
- For 0.0929 s < duration < 1 s, use 4096-sample blocks of total length 0.0929 s with Blackman-Harris minimum three-term window, overlapped by 50%. This results in frequency cells spaced by 10.77 Hz and an effective cell width (resolution) of 18.3 Hz.
- For duration < 0.0929 s, use the samples spanning the signal duration and apply a uniform window. This results in cell spacing in hertz given by the reciprocal of the record length in seconds. The cell width (resolution) is the same as the cell spacing.

Background noise data recorded on the high sensitivity channel, consisting of 4 s of data selected from before the missile signal, were segmented into 44,100-sample blocks overlapped by 50% and weighted by the Blackman-Harris minimum three-term window. This resulted in 1-Hz cell spacing and 1.7-Hz cell width, or resolution.

The spectral density values are integrated across standard one-third octave band frequencies to obtain summed SPLs for each band. This analysis is performed for the signal, the noise on the signal channel (low sensitivity channel), and the background noise (high sensitivity channel). When the cell spacing was broad, the lowest frequency one-third octave bands can not be computed. However, the cases of broad cell spacing correspond to cases of very short duration signals. Low frequencies are not important for short duration sounds.

2.3.3 Frequency Weighting

Frequency weighting is a form of filtering that serves to measure sounds over a broad frequency band with various schemes for de-emphasizing sounds at frequencies not heard well and retaining sounds at frequencies that animals hear well. The concept is that sound at frequencies not heard by animals is less likely to injure or disturb them, and therefore such sounds should not be included in measurements

relevant to those animals. Time-series results for the full 3 to 20,000 Hz bandwidth are calculated for flat-, A-, and M_{pa}-weightings.

Flat-weighting leaves the signal spectrum unchanged. For instantaneous peak pressure, where the highest instantaneous pressure is of interest, it is not useful to diminish the level with filtering, so only the flat-weighted instantaneous peak pressure is relevant. Also, non-uniform weighting is not useful when reporting results for specific frequencies or narrow frequency bands. Therefore, only flat-weighting is used for frequency-domain analyses.

A-weighting shapes the signal's spectrum based on the standard A-weighting curve (Kinsler et al. 1982, p. 280; Richardson et al. 1995, p. 99). This slightly amplifies signal energy at frequencies between 1 and 5 kHz and attenuates signal energy at frequencies outside this band. This process is designed to mimic the frequency response of the human ear to sounds at moderate levels. It is a standard method of presenting data on airborne sounds. The relative sensitivity of pinnipeds listening in air to different frequencies is more-or-less similar to that of humans (Richardson et al. 1995), so A-weighting may be relevant to pinnipeds listening to moderate-level sounds , as a first approximation,.

M_{pa}-weighting arose from the ongoing effort to develop science-based guidelines for regulating sound exposures (Gentry et al. 2004; Southall et al. 2007). During this process, separate weighting functions were developed for five categories of marine mammals, with these functions being appropriate in relation to the hearing abilities of those groups of mammals (Gentry et al. 2004; Southall et al. 2007). Two of these categories are pinnipeds hearing in water and in air, for which the weighting functions were designated M_{pw} and M_{pa}, respectively. The five "M-weighting" functions are almost flat between the known or inferred limits of functional hearing for the species in each group, but down-weight ("attenuate") sounds at higher and lower frequencies. As such, they are analogous to the C-weighting function that is often applied in human noise exposure analyses where the concern is about potential effects of high-level sounds. With M_{pa}-weighting, the lower and upper "inflection points" are 75 Hz and 30 kHz[7]. For each launch whose sounds are reported here, we include the M_{pa}-weighted results as well as flat- and A-weighted results. Acoustic data based on M_{pa}-weighting are included because these values are likely to be needed in the future for purposes of assessing impacts on pinnipeds of sounds with high received levels, such as those during some missile overflights.

Measurement data from each launch are presented by one-third octave band in Appendix B. Thus, other weighting methods (e.g., C-weighting or species-specific weighting functions) could be applied to these data in the future if needed.

2.3.4 Closest Point of Approach by the Missile

To relate missile sounds to the proximity of the missile's trajectory, the 3-dimensional (3-D) distance from the recording site to the closest point of approach (CPA) of the missile is calculated for each launch date and sound monitoring site. In some cases, the CPA is at the launch pad, depending upon monitoring location and missile trajectory.

[7] The data obtained during the current monitoring period were only recorded at frequencies up to 20 kHz, so the (probably negligible) energy at 20–30 kHz is not included in calculating the M_{pa} (or other) measures.

2.4 Results

2.4.1 Missile Flight Sounds

Acoustic monitoring results for all five monitored launches are presented in Table 2.2. Four parameters are reported for the missile flight sounds: peak pressure level, SPL, SEL, and duration. The last three parameters are based on flat-, A-, and M_{pa}-weighting. These values are similar to sound levels recorded during previous launches from SNI (Ugoretz 2014, Holst et al. 2011). It was expected that A- and M_{pa}-weighted levels would be less than flat-weighted levels, consistent with the greater de-emphasis of low frequency components by A-weighting. Generally, sonic boom noise is strong at frequencies below 1000 Hz, which are de-emphasized with A- and (to a lesser degree) M_{pa}-weighting.

Two graphs are presented in Appendix B for each location where the missile launch sounds were recorded. For each monitored location, both graphs are based on flat-weighted data; no graphs are presented for A- or M_{pa}-weighted waveforms. One graph presents the pressure signature (pressure vs. time waveform). The second presents the SELs by one-third octave band for each of three signals: (1) the missile sounds; (2) the background instrumentation noise from the low-sensitivity channel (the same sensor used to measure the missile sounds but using data recorded before the missile sounds); and (3) the background noise levels from the high-sensitivity channel (i.e., the ambient SPLs). Because the ambient sounds are continuous, expressing them as SELs is unconventional. However, for purposes of comparison with the transient missile sounds, one can consider the SPLs for ambient noise to be the SELs in a 1-s period.

2.4.2 Ambient Noise Levels

Background sounds are recorded on the second channel of each ATAR using a higher sensitivity microphone. As expected, this channel overloaded during the brief time while the missile flight sounds were received, but at other times reliably recorded the background sounds (i.e., at levels above the self-noise [instrumentation noise] of the sensing and recording electronics). The sound levels for the 10-20,000 Hz band are determined using an averaging time of 4.0 s. Flat-, M_{pa}-, and A-weighted ambient noise levels for the missile launches are presented in Table 2.3. The measured A-weighted values are low and comparable to sound levels expected in quiet residential areas. Much of the background sound is infrasonic energy in the 10-20 Hz band, mainly attributable to wind noise. When the 10-20 Hz components are excluded, broadband levels are typically 10 dB lower than those quoted for the 10-20,000 Hz band.

TABLE 2.2. Pulse parameters for flat-, A-, and M_{pa}-weighted sound from SNI missile launches, June 2014 – November 2014.
Values highlighted in green exceeded the level at which TTS onset might occur[1].

Launch: Missile & Monitoring Site	CPA (km)	Flat-weighted sound				A-weighted sound			M_{pa}-weighted sound		
		Pk	SPL	SEL	Dur	SPL	SEL	Dur	SPL	SEL	Dur
17 June 2014: ARAV											
Redeye	1.5	117.1	98.3	106.4	6.5	90.7	97.0	4.3	96.2	103.8	5.8
B809	1.5	140.5	127.3	134.9	5.7	111.1	117.6	4.5	115.5	123.6	6.5
Dos Coves	0.6	125.0	111.2	116.9	3.7	103.3	108.5	3.3	109.1	114.5	3.5
Near Launcher		145.3	133.7	132.9	0.8	125.3	124.3	0.8	131.9	130.5	2.3
5 August 2014: AI3											
Dos Coves	0.6	113.3	89.7	96.3	4.5	83.7	89.2	3.5	87.5	94.0	4.4
Rock Crusher	0.2	142.4	121.0	129.0	6.3	126.1	127.6	1.4	127.1	128.4	1.4
B809	1.6	100.8	76.2	85.1	7.7	69.5	76.3	4.8	75.6	82.8	5.2
B807		148.0	134.8	130.5	0.4	132.6	127.8	0.3	134.4	129.9	0.4
6 August 2014: AI3											
Dos Coves	0.6	114.7	88.8	95.2	4.3	81.9	87.2	3.4	85.7	92.3	4.6
Bachelor Beach	0.6	123.4	107.2	113.7	4.4	104.1	109.7	3.6	106.6	112.9	4.2
B809	1.6	101.4	75.6	84.6	8.0	69.9	76.4	4.5	74.3	81.6	5.4
B807		148.8	132.0	128.3	0.4	127.7	123.8	0.4	130.9	127.2	0.4
4 September 2014: GQM (first of two)											
B809 Vizcaino Pt	1.2	137.3	126.7	113.1	0.0	102.5	98.6	0.4	118.7	105.8	0.1
Dos Coves	0.8	161.3	140.6	136.9	0.4	135.5	133.5	0.6	137.4	135.2	0.6
Redeye Beach	0.7	139.9	130.2	118.0	0.1	104.4	101.0	0.5	110.9	106.8	0.4
Alpha Pad		136.4	118.9	122.3	2.2	105.5	109.2	2.3	113.6	117.1	2.2
4 September 2014: GQM (second of two)											
B809 Vizcaino Pt	1.2	139.6	128.1	114.9	0.0	111.0	102.0	0.1	124.4	108.1	0.0
Dos Coves	0.8	161.8	141.3	138.1	0.5	136.9	135.3	0.7	138.8	136.5	0.6
Redeye Beach	0.7	139.4	130.2	118.0	0.1	104.4	100.8	0.4	111.3	106.5	0.3
Alpha Pad		137.2	119.4	122.5	2.0	108.5	111.0	1.8	114.4	117.2	1.9

[1] Assumed TTS onset at a received SEL-M of >129 dB re 20 µPa2•s (see Section 4.2.1)
Note: Peak levels (Pk) and SPLs are in dB relative to 20 µPa. SELs or energy levels are in dB re 20 μPa^2·s. Durations (Dur) are in seconds.
N/A = data not available.

TABLE 2.3. Ambient broadband (10-20,000 Hz) sound levels (in dB re 20 µPa) as recorded before launches.

Date	Missile	Site	Flat-weighted	A-weighted	M_{pa}-weighted
17 June 2014	ARAV	Redeye	62.4	45.8	52.5
		B809	85.6	62.7	67.1
		Dos Coves	71.4	56.2	59.4
		Near Launcher	72.2	43.8	50.1
5 August 2014	AI3	Dos Coves	70.1	61.5	64.0
		Rock Crusher	80.5	44.2	55.6
		B809	83.0	46.8	62.3
		Near Launcher	68.3	46.2	58.0
6 August 2014	AI3	Dos Coves	68.9	60.3	62.1
		Bachelor Beach	69.5	58.9	63.8
		B809	69.6	46.1	48.5
		Near Launcher	64.8	49.8	60.1
4 September 2014 First of two	GQM	B809 Vizcaino Pt	73.5	45.8	50.8
		Dos Coves	61.9	54.1	58.3
		Redeye Beach	71.5	54.0	58.7
		Near Launcher	58.5	22.6	35.1
4 September 2014 Second of two	GQM	B809 Vizcaino Pt	60.2	44.9	48.8
		Dos Coves	64.0	53.2	57.8
		Redeye Beach	64.7	54.1	59.7
		Near Launcher	56.0	21.5	31.2

2.5 Discussion and Summary

During the June 2014 to November 2014 period, the sound levels received from the five monitored missile launches were comparable to those recorded from previous launches at SNI (Ugoretz 2014, Holst et al. 2011). The highest measured sound levels at or near monitored pinniped haul-out beaches were 134.9 dB re 20 µPa^2·s SEL on a flat-weighted basis, 127.8 dBA SEL, and 136.5 dB re 20 µPa^2·s SEL on an M_{pa}-weighted basis (Table 2.2, B809 - 17 June 2014, B807 - 05 August 2014, Dos Coves - 04 September 2014, respectively). Sounds of 130.5, 129.9, 135.2, and 136.5 dB re 20 µPa^2·s SEL-M were recorded near the launcher during the ARAV launch and one AI3 launch and on the cliff above Dos Coves for the two GQM launches (Table 2.2, 17 June, 05 August, and 04 September, 2014 respectively). These four launches exceeded 129 dB re 20 µPa^2·s SEL-M, the energy level at which TTS onset may occur in the Pacific harbor seal (Southall et al. 2007, see Section 4.2.1) by up to 7.5 dB on the cliff above Dos Coves beach. During this launch sounds were recorded above the beach in a more exposed location. Sounds at the haul out were necessarily lower and sound pressure would be blocked by the terrain. None of the recorded sounds exceeded the SEL-M criterion for PTS (144 dB - Southall et al. 2007). However, peak pressure levels (flat weighting) exceeded the PTS threshold (149 dB - Southall et al. 2007) for two recordings; peak pressure levels (flat weighting) of 161.3 and 161.8 dB re 20 µPa were both measured at Dos Coves for the two GQM-163A missile launches that occurred on 4 September 2014 (Table 2.2). Peak pressure levels (flat weighting) were below the 149 dB re 20 µPa PTS threshold for the remaining recordings of missiles/monitoring sites. While these peak pressures exceeded the PTS threshold, they were measured on the exposed ground above the monitored beach and, as noted, the SEL-M level was not exceeded. Geographic features would likely have masked much of this sound on the beach itself. Therefore, it is unlikely that any pinnipeds experienced launch sounds that could have caused TTS or PTS. The possibility of TTS and PTS occurring in pinnipeds hauled out on SNI during missile launches is further discussed in Chapter 4.

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3. PINNIPED BEHAVIOR DURING MISSILE LAUNCHES

3.1 Introduction

Three species of pinnipeds are common on SNI beaches – California sea lion, Pacific harbor seal, and northern elephant seal. Northern elephant seals have shown little reaction to previous missile launches and monitoring for elephant seals is not required by the current LOA. Therefore this report only details reactions of Pacific harbor seals and California sea lions. Elephant seals were present on some of the monitored haul-outs along the other species and were included in the camera's FOV. On these occasions, reactions were similar to those in the past (generally no movement or very minor movement down the beach) reconfirming their lack of reaction to missile launches. No other pinniped species were recorded during this or previous monitoring since August 2001 (Ugoretz 2014, Holst et al. 2011).

California sea lions often show startle responses to launches and movement along the beach. In most cases, sea lion behavior returns to pre-launch levels within seconds or minutes following the launches (Holst et al. 2011). Behavior as well as numbers of sea lions hauled-out several hours after a launch appears similar to the behavior and numbers observed before a launch. In contrast, when Pacific harbor seals react to launches, they commonly leave their haul-out sites to enter the water and do not return for several hours or the next tide cycle (Holst et al. 2011). Nonetheless, Holst and Lawson (2002) noted that the behavior and numbers of Pacific harbor seals hauled out on the day following a launch were similar to those on the day of the launch. This pattern was confirmed by launch monitoring on multiple days by Navy biologists.

Due to operational needs, some launches during the current regulation period occurred during California sea lion breeding and pupping season. No evidence of injury, mortality, or pup abandonment was observed on the day of any launch during the monitoring period, nor was any launch-related injury or mortality expected based on prior monitoring results.

3.2 Field Methods

The launch monitoring program is based primarily on remote video recordings and later analysis. Remote cameras are essential because, during missile launches, safety requirements prevent personnel from being present in many of the areas of interest. Video data is obtained via portable cameras that are set up temporarily at any ideal monitoring location. In addition, trained biologists make notes on the status of pinnipeds on monitored beaches as well as other locations around the island prior to and following launches.

3.2.1 Visual Observations

Video observations are obtained before, during, and after each missile launch. Navy biologists also make direct visual observations of the pinniped groups prior to deployment of the cameras and ATARs as well as after the launch when collecting equipment. Records from these visual observations include the local weather conditions, the type of launch activity planned, types and locations of any pinnipeds hauled out and notable impacts if any, as well as notes on tidal changes or other confounding factors.

Video recordings continue for approximately 15-60 min or more after the launch. If reactions to the launch occur, recordings during the after-launch period determine how quickly animals returned to pre-launch behaviors. These recordings also help determine whether the relative number of pinnipeds at the haul-out site have changed, and if there was obvious evidence of recent injury or mortality. In addition,

Navy biologists perform visual scans while retrieving video equipment to determine the relative number of hauled-out pinnipeds as compared to pre-launch numbers.

During the launches described in this report, use of video methods allows for observations of up to three pinniped species during the same launch. The actual number of species observed depends on the number of video systems deployed during each launch and on the number of species hauled out at those sampling sites (Table 3.1).

Navy biologists place cameras at locations overlooking haul-out sites prior to each launch. Cameras are placed in a manner to minimize disturbance to pinnipeds. The entire haul-out aggregation at a given site cannot be recorded, as the wide-angle view necessary to encompass an entire beach generally will not allow detailed behavioral observations. Thus, cameras are set to record a focal subgroup within the haul-out aggregation. Prior to selecting a focal subgroup, however, video pans of the entire area are made to allow computation of total animals in the area. Video pans are repeated after the launch to provide information on changes in total numbers of animals present. The number of animals affected at a given location is calculated based on the percentage of the total group monitored and the percentage of the focal group affected.

Video and audio recordings are usually attempted at locations with varying distances from the missile flight path, depending upon the presence of pinnipeds at haul-outs. Figure 3.1 shows the monitoring locations relative to the launch azimuths.

3.2.2 Digital Video Cameras

To monitor daytime launches, Navy biologists place up to three portable Sony high definition digital video cameras (HDR-CX160) on tripods overlooking haul-out sites. Missile and other sounds detected by the microphones built into these cameras are also recorded. The audio data are used during behavioral analyses (e.g., to confirm the exact time when the missile passed), but are not calibrated and not of sufficient quality to provide launch sound information.

3.2.3 FLIR Cameras

To monitor nighttime launches, Navy biologists place up to three FLIR Systems HS-324 Command thermal imaging cameras on tripods overlooking haul-out sites. The thermal imaging cameras have a FOV of 24°×18°. When a 2X extender lens is used with the cameras, the FOV is reduced to 12°×9°. The cameras record video data internally onto a Secure Digital (SD) card and can store more than 5 hr of video but do not collect or record audio data. No night launches occurred during this monitoring period.

TABLE 3.1. Video monitoring locations and pinniped species present.

	Video Recording Location By Species						
	California Sea Lion					Pacific Harbor Seal	
Launch Date	Dos Coves	B809	Redeye Beach	Bachelor Beach	Rock Crusher	Redeye Beach	B809
6/17/2014	X	X	X			X	
8/5/2014	X	X			X†		
8/6/2014	X	X		X†			
9/4/2014*	X	X	X				X

X - focal group videotaped; † - No pinnipeds visible at time of launch; ^ - Digital camera failed; * - Two launches this date

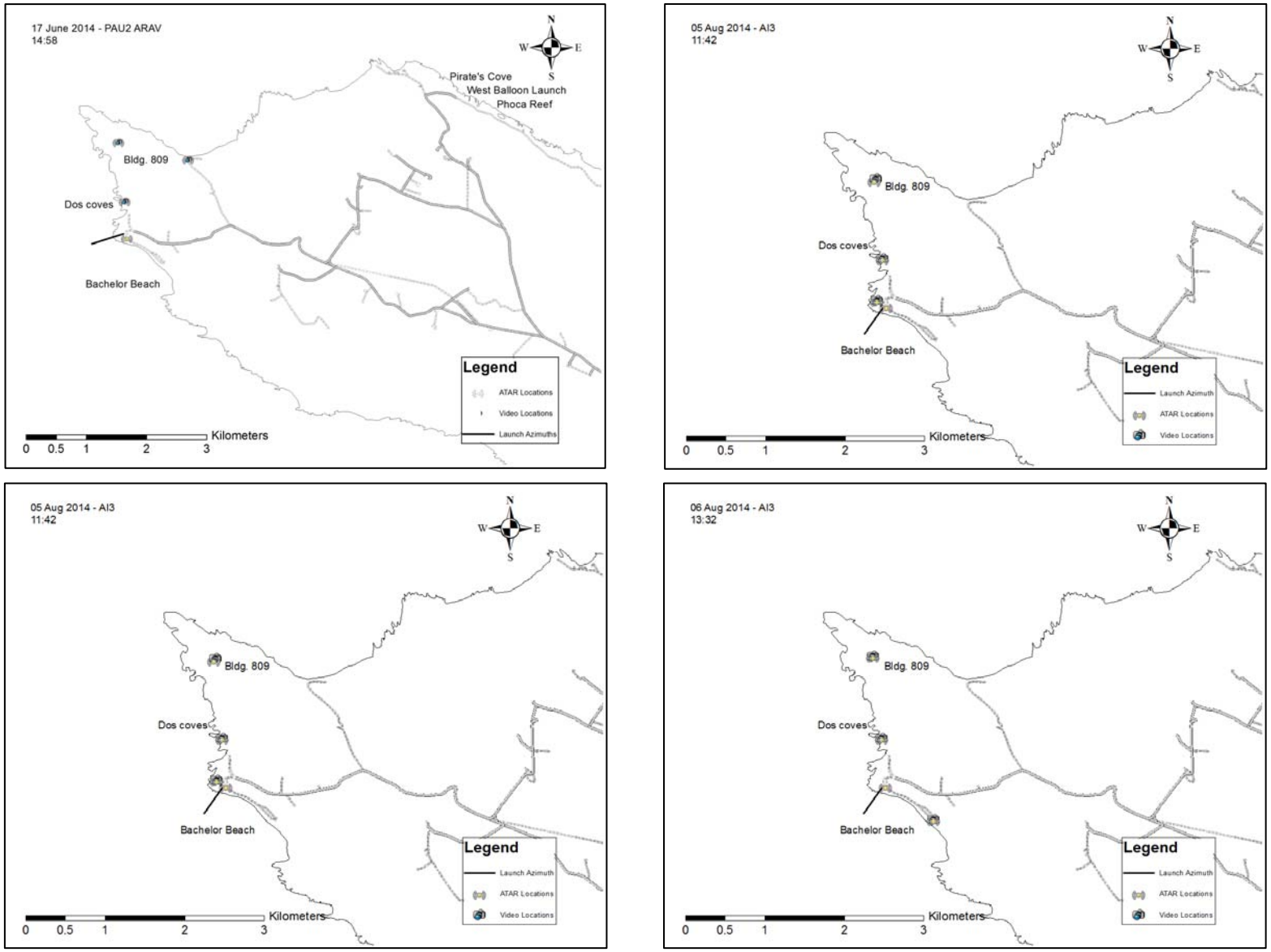

FIGURE 3.1. Launch azimuths, acoustic recording sites (ATARs), and video recording sites.

3.3 Video Monitoring Analysis

Digital video data is reviewed by an experienced biologist on a high-resolution color monitor. The data before, during, and up to 60 min after each launch is reviewed to document the types and numbers of pinnipeds present, the nature of any overt responses to the launch, and the number of pinnipeds that responded overtly. The number, proportion and (where determinable) age class (adult or dependent pup) of the individuals that responded in various ways is determined from the video, along with comparable data for those that did not respond. Following NMFS [2002], subtle behavioral reactions persisting for only a few minutes are considered unlikely to have biologically significant consequences for the pinnipeds. To relate pinniped behavior to the proximity of the missile launch, the 3-D distance from the recording site to the CPA of the missile is calculated

3.4 Descriptions of Pinniped Behavior during Specific Launches

Video recordings of pinniped behavior during launches from June 2014 to November 2014 were successfully collected on all four dates for California sea lions and on two dates for Pacific harbor seals (Table 3.1). California sea lions were monitored at five haul-outs and Pacific harbor seals were monitored at two haul-outs. The video recordings generally provided data on the responses of a focal portion of the total pinnipeds present on a given beach, though on some occasions all animals in the area were recorded.

3.4.1 ARAV Launch, 17 June 2014

The ARAV missile was launched at 14:58 local time from Building 807. The missile was launched with a 68º elevation angle and an azimuth of 253º (Fig. 3.1). Video recordings of California sea lions were made at Dos Coves (CPA ≈ 0.6 km), Building 809 (Vizcaino Pt., CPA ≈ 1.5 km) and Redeye Beach (CPA ≈ 1.5 km) (Table 3.1). Sea lions and harbor seals were not present at other beaches in the potential area of influence.

California sea lions. Approximately 80 sea lions were in the vicinity of Dos Coves during the launch with 40 in the camera's FOV. All of the animals on the beach moved in response to the launch, with a generally short distance of movement. Approximately 20 sea lions moved into the water with a second wave of movement. Based on this, it is estimated that 40 of the entire group of animals were affected by the launch [(20/40)*80]. Approximately 200 sea lions were in the vicinity of Redeye Beach with 10 in the camera's FOV. Eight of the focal animals moved a short distance and another approximately 20 entered the FOV. Of those entering the FOV, 5 passed through the FOV and are assumed to have entered the water. Therefore it is estimated that 100 of the entire group of animals were affected by the launch, being conservative by assuming those that left the FOV were part of the original focal group (5/10*200). Approximately 250 sea lions were in the vicinity of B809 (Vizcaino Pt.) with 60 in the FOV. All of the animals moved in response to the launch, primarily as a result of a second wave of animals entering the FOV. Of these, 37 entered the water. It is estimated that 154 animals in the area were affected by the launch (37/60*250). Therefore a total of 294 sea lions are estimated to have been impacted by the launch.

Pacific harbor seals. 10 harbor seals were present in the vicinity of Redeye beach with 4 in the camera's FOV. All four moved into the water in response to the launch. Therefore it is assumed that all 10 of the harbor seals present were impacted by the launch.

3.4.2 AI3 Launch, 5 August 2014

The AI3 missile was launched at 11:42 local time from Building 807. The missile was launched with a 15º elevation angle and an azimuth of 215º (Fig. 3.1). Video recordings of California sea lions were attempted at Dos Coves (CPA ≈ 0.6 km), Building 809 (Vizcaino Pt., CPA ≈ 1.6 km) and Rock Crusher (CPA ≈ 0.2 km) (Table 3.1). Sea lions and harbor seals were not present at other beaches in the potential area of influence.

California sea lions. Approximately 65 sea lions were in the vicinity of Dos Coves during the launch with 35 in the camera's FOV. Most of the animals on the beach moved in response to the launch, with a generally short distance of movement. Eight sea lions moved into the water following a second wave of movement. Based on this, it is estimated that 15 of the entire group of animals were affected by the launch [(8/35)*65]. Approximately 200 sea lions were in the vicinity of Building 809. The video camera battery failed, so focal animal responses were not captured. Based upon the limited response of animals at Dos Coves, number of animals present following the launch and the subsequent observations on 6 August for the same missile type (see 3.4.3 below), it is estimated that none of the animals were affected by the launch. No sea lions were present at Rock Crusher at the time of the launch. Therefore a total of 15 sea lions are estimated to have been impacted by the launch.

Pacific harbor seals. Harbor seals were not present in the area of potential influence during the launch, likely due to the relative tide height (High - 2.73' at 06:29 and Low - 2.16' at 10:50).

3.4.2 AI3 Launch, 6 August 2014

The AI3 missile was launched at 13:32 local time from Building 807. The missile was launched with a 15º elevation angle and an azimuth of 215º (Fig. 3.1). Video recordings of California sea lions were attempted at Dos Coves (CPA ≈ 0.6 km), Building 809 (Vizcaino Pt., CPA ≈ 1.6 km) and Bachelor Beach (CPA ≈ 0.6 km) (Table 3.1). Sea lions and harbor seals were not present at other beaches in the potential area of influence.

California sea lions. Approximately 52 sea lions were in the vicinity of Dos Coves during the launch with 43 in the camera's FOV. Approximately ½ of the animals on the beach moved in response to the launch, with a generally short distance of movement and settled immediately. Ten sea lions slowly and deliberately moved into the water over the next minute. Based on this, it is estimated that 12 of the entire group of animals were affected by the launch [(10/43)*52]. Approximately 430 sea lions were in the vicinity of Building 809. Almost all animals in the FOV and many from outside the FOV moved into the water prior to 1-hour before the launch. Five animals remained in the FOV. None of the animals remaining in the FOV moved in response to the launch and none entered the FOV. Therefore, it is estimated that none of the animals were affected by the launch. Three sea lions initially present at Bachelor Beach departed the area prior to the launch. Therefore a total of 12 sea lions are estimated to have been impacted by the launch.

Pacific harbor seals. Harbor seals were not present in the area of potential influence during the launch, likely due to the relative tide height (High = 3.03' at 07:32 and Low = 2.10' at 12:08).

3.4.2 GQM Launches, 4 September 2014

The GQM missiles were launched at 14:36 and 17:30 local time from the Alpha Launch Complex. Both missiles were launched with a 14º elevation angle and an azimuth of 270º (Fig. 3.1). Video recordings of California sea lions were attempted at Dos Coves (CPA ≈ 0.8 km), Building 809 (Vizcaino Pt., CPA ≈ 1.2 km) and Redeye Beach (CPA ≈ 0.7 km) (Table 3.1). Harbor seals were present at Vizcaino Point near B809, but were not in the camera FOV. Sea lions and harbor seals were not present at other beaches in the potential area of influence.

California sea lions. Approximately 55 sea lions were in the vicinity of Dos Coves during the first launch with all 55 in the camera's FOV. All of the animals on the beach moved in response to the launch, with 35 moving into the water. As all animals were in the camera's FOV, it is known that 35 were affected by the launch. Between the first and second launch, the remaining sea lions departed the FOV and one new animal entered. This single sea lion was affected by the second launch and moved into the water in response. Shortly after the second launch other sea lions were present on the cliffs surrounding the area and it is unlikely that other animals were affected. Approximately 450 sea lions were in the vicinity of Building 809, with 33 in the camera's FOV during the first launch. Most of these animals reacted by moving a few to several feet and settling back to normal behavior almost immediately. 18 animals moved more than 10 m. Therefore, it is conservatively estimated that 245 sea lions were affected by the first launch [(18/33)*450]. Between the first and second launch additional sea lions moved into the FOV, with 73 present at the time of the second launch. Again, most animals moved a few to several feet and settled almost immediately. About 50 were significantly affected by the launch, moving greater than 10 m. Therefore, it is conservatively estimated that 308 sea lions were affected by the second launch [(50/73)*450]. It should be noted that this is most certainly an overestimate, as it is highly likely that many of the same sea lions were present during both launches and those affected may have been counted twice. Approximately 15 sea lions were in the vicinity of Redeye Beach during the first launch with all 15 in the FOV. All animals were affected, moving rapidly into the water in response to the launch and not returning prior to the second launch. During the second launch a single sea lion entered the FOV and continued into the water. Therefore a total of 605 sea lions are estimated to have been affected by the two launches.

Pacific harbor seals. Approximately 40 harbor seals were present at Vizcaino Point, near Building 809, prior to the first launch. These animals were visible during the pre-launch pan of the area but not in the FOV during the launch. Based on the strong reaction of sea lions in the area and past data on harbor seal reactions, it is assumed that all animals were affected by the launch. Therefore, a total of 40 harbor seals are estimated to have been affected by the two launches.

3.5 Implementation of Mitigation Measures

Table 3.2 shows a summary of the mitigation measures that were specified by NMFS in the LOA, and how they were implemented during the June 2014 - November 2014 monitoring period.

TABLE 3.2. Implementation of mitigation measures.

Mitigation Measure	Implementation
No personnel at haul-out sites 2 hr before launch	Personnel were prohibited from accessing the haul-out sites at least 2 hr before all launches.
Avoid launches during Pacific harbor seal pupping season	Launches did not occur during harbor seal pupping season.
Limit launch activities during other pinniped pupping season	Launch occurred on one date early in California sea lion pupping season (June 17). This launches had to occur at this time due to operational need. No sea lion pups were abandoned and no pinniped injury or mortality occurred.
No launches of missiles at low elevation from Alpha Launch Complex	All missiles launched from the Alpha Launch Complex passed over the shoreline at an elevation of approximately 2,600 ft.
Avoid multiple launches in quick succession, especially when pups present	No dual launches occurred.
Limit launches during nighttime	No night launches occurred.
Ensure aircraft maintain an altitude of 1000 ft from haul outs	No aircraft were flown near haul-out areas during or immediately following launch operations.
Review launch procedure and monitoring methods with NMFS if pinniped injury or mortality are discovered.	No injured or dead pinnipeds were seen during the monitoring period.

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4. TOTAL ESTIMATED NUMBERS OF PINNIPEDS AFFECTED

4.1 Pinniped Behavioral Reactions to Noise and Disturbance

Some of the pinnipeds on the beaches at SNI exhibit disturbance reactions to missile launches, but others do not. The levels, frequencies, and types of noise that elicit a response are known or expected to vary between and within species, individuals, locations, and seasons. Also, it is possible that pinnipeds hauled out on land may react to the sight (light at night), or the combined sight plus sound, of a missile launch. Furthermore, pinnipeds, at times, react to the sight and sound of seabirds reacting to a launch. Thus, responses are not expected to be a direct function of received sound level. However, some correlation between pinniped responses and received sound level has been shown, at least for California sea lions and elephant seals, based on data from previous monitoring periods (Holst et al. 2011).

For pinnipeds hauled out on land, behavioral changes range from a momentary alert reaction or an upright posture to movement – either abrupt or deliberate – into the water. Previous studies indicate that the reaction threshold and degree of response are related to the activity of the pinniped at the time of the disturbance. In general, there is much variability and pinnipeds often show considerable tolerance of noise and other forms of human-induced disturbance, though at other times certain pinnipeds can be quite responsive (Richardson et al. 1995; Reeves et al. 1996; Lawson et al. 1998).

Although it is possible that pinnipeds exposed to launch noise might "stampede" from the haul-out sites in a manner that causes injury or mortality, this was judged unlikely prior to the monitoring program. Review of video records of pinnipeds during launches at SNI indicates that this assumption was generally correct. However, monitoring conducted during 2002-2003 showed that, in some cases, several Pacific harbor seal pups were knocked over by adult seals as both pups and adults moved toward the water in response to the launch (Holst 2008) though no injuries were observed. Similarly, during the 2004-2005 monitoring period, several California sea lion pups were knocked over by adult sea lions as the adults moved along the beach in response to a launch (Holst and Greene 2008). The pups were momentarily startled, but did not appear to be injured. No such cases have been noted since 2005.

Since no injuries or deaths were observed during the monitored launches in either this monitoring period or earlier monitoring dating back to August 2001, determining disturbance level, rather than injury or mortality, is the primary monitoring objective. The numbers of pinnipeds on the monitored beaches that might have been affected significantly by the launches was estimated. Estimates were always conservative, assuming the highest possible level of impact. The Navy, consistent with NMFS (2002), assumes that a pinniped blinking its eyes, lifting or turning its head, or moving a few feet along the beach as a result of a human activity is not significantly affected (i.e., not harassed).

In this report, consistent with previous related reports (Holst et al., 2008, 2011; Ugoretz and Greene 2012, Ugoretz, 2013, Ugoretz 2014), it is assumed that only those animals meeting the following criteria are affected by launches:

1. Pinnipeds that were injured or killed during launches (e.g., by stampedes);
2. Pinnipeds exposed to launch sounds strong enough to cause TTS; and
3. Pinnipeds that left the haul-out site, or exhibited prolonged movement (> 10 m) or prolonged behavioral changes (such as pups separated from mothers) relative to their behavior immediately prior to the launch.

In practice, no pinnipeds are known or suspected to have been injured or killed during the monitored launches since August 2001, no pups have been permanently separated from mothers, none

have received sounds strong enough to elicit PTS, and few if any are believed to have received sounds strong enough to elicit TTS (see §4.2, below). Thus, the number of pinnipeds counted as potentially affected during the monitoring period was based on criterion (3) – the number that left the haul-out site, or exhibited prolonged movement.

The numbers of such affected pinnipeds were calculated for the each launch during the June 2014 to November 2014 period. Disturbance reactions were short-lived for California sea lions and did not appear to extend into subsequent days. Some Pacific harbor seals left their haul-out site during the launches and it is not known if they returned on subsequent days. Based on past monitoring, it is assumed that no long-term affects occurred.

4.2 Possible Effects on Pinniped Hearing Sensitivity

Temporary or perhaps permanent hearing impairment is a possibility when pinnipeds are exposed to very strong sounds in air. Based on data from terrestrial mammals, the minimum sound level necessary to cause PTS is presumed to be higher, by a variable and generally unknown amount, than the level that induces barely-detectable TTS. Given what is known about the thresholds for TTS and PTS in terrestrial mammals and humans, the PTS threshold is expected to be well above the TTS threshold for non-impulsive sounds. For impulsive sounds, such as sonic booms and artillery shots, the difference may be smaller (Kryter 1985; Southall et al. 2007).

4.2.1 Temporary Threshold Shift

There are few published data on TTS thresholds for pinnipeds in air exposed to impulsive or brief non-impulsive sounds. J. Francine, quoted in NMFS (2001, p. 41837), has mentioned evidence of mild TTS in captive California sea lions exposed to a 0.3 s transient sound with an SEL of 135 dBA re 20 $\mu Pa^2 \cdot s$ (see also Bowles et al. 1999). Katsak, et al. (2007) estimated TTS onset for California sea lions in air at 159 dB re 20 $\mu Pa^2 \cdot s$. However, mild TTS may occur in harbor seals exposed to received levels lower than 135 dB SEL (A. Bowles, pers. comm., 2003). Initial evidence from more prolonged (non-pulse) exposures suggests that the TTS threshold on an SEL basis may actually be around 129–131 dB re 20 $\mu Pa^2 \cdot s$ (M_{pa}-weighted) for harbor seals, within their frequency range of good hearing (Kastak et al. 2004; Southall et al. 2007). The same research teams have found that the TTS thresholds of California sea lions and northern elephant seals exposed to strong sounds are higher as compared to harbor seals (Kastak et al. 2005). Based on these studies and other available data, Southall et al. (2007) proposed that sounds may induce mild TTS if the received peak pressure is ~143 dB re 20 μPa, or if received SEL-M is ~129 dB re 20 $\mu Pa^2 \cdot s$ (for pulses) or 131 dB re 20 $\mu Pa^2 \cdot s$ (for non-pulses received in air). Those levels apply specifically to harbor seals and are not expected to elicit TTS in elephant seals or California sea lions (Southall et al. 2007). Thus, as a conservative estimate, it is assumed that all three species might have TTS onset at a received SEL-M of >129 dB re 20 $\mu Pa^2 \cdot s$.

The sounds received from missile launches on SNI are sometimes impulse sounds (e.g., when there is a sonic boom or near the launcher). At other times and locations they are non-impulsive. During past monitoring of missile launches from SNI during 2001-2013, few if any pinnipeds were exposed to sound levels above 122 dB SEL-M (Ugoretz 2014, Holst et al. 2008, 2011). In addition, peak pressure levels at pinniped haul-out beaches were generally <143 dB re 20 μPa, although for some launches that produced a sonic boom (impulse), peak pressure levels were as high as 150 dB (Holst et al. 2008). Thus, it is possible that a few pinnipeds, particularly Pacific harbor seals, may incur TTS during some missile launches (especially of larger missiles and targets) from SNI. Because of their higher TTS thresholds, it is likely

that fewer California sea lions and northern elephant seals may incur TTS as compared to Pacific harbor seals.

During the June 2014 to November 2014 monitoring period, SEL-M near pinniped beaches reached up to 136.5 dB and peak pressure levels were as high as 161.8 dB re 20 µPa. However, these maximums were recorded on open ground on a cliff above the beach at Dos Coves. Pinnipeds present in the area were below this cliff and sheltered from direct launch sounds by it. Thus, it is unlikely that any animals incurred TTS during the monitoring period.

4.2.2 Permanent Threshold Shift

Southall et al. (2007) estimate that received SELs would need to exceed the TTS threshold by at least 15 dB for pulses and 13.5 dB for non-pulses in air for there to be risk of PTS. In the harbor seal, the SEL-M that is estimated to result in onset of PTS is 144 dB re 20 $\mu Pa^2 \cdot s$ (Southall et al. 2007). As already noted above, the SEL-M measurements nearshore did not exceed the SEL-based TTS threshold let alone the PTS threshold. Even SEL-M measurements taken close to the launcher were far less than 144 dB re 20 $\mu Pa^2 \cdot s$, with a maximum of 136.5 dB (Table 2.2).

However, there is some possibility that a few pinnipeds at SNI might receive peak pressures exceeding those that elicit onset of TTS or perhaps even PTS. In animals (or humans) exposed to strong impulsive sound (e.g., close to an artillery shot), there is a possibility of PTS as a result of the high peak pressure even if the received energy did not exceed the SEL criterion for PTS onset. When considering peak pressures rather than energy levels, PTS onset may occur when the received level is as little as 6 dB higher than the TTS threshold, or 149 dB re 20 µPa in the case of the harbor seal (Southall et al. 2007). During the June 2014 - November 2014 monitoring period, peak pressure exceeded 149 dB re 20 µPa on one occasion (at Dos Coves 161.3 and 161.8 dB re 20 µPa, Table 2.2). As previously discussed, given the location of animals on the beach below the cliff where the ATAR was located and thus sheltered from the sound by the topography, it is unlikely that they were exposed to sounds at this level.

Given the higher TTS thresholds in northern elephant seals and California sea lions than in harbor seals, PTS thresholds in those other species are also expected to be higher than in the harbor seal. Thus, it is unlikely that PTS occurred in California sea lions or northern elephant seals during those launches. Pacific harbor seal haul-out sites are located at least 1.5 km from the launch complexes at SNI, so peak levels at haul-out locations will be lower than near the launcher. Thus, Pacific harbor seals are also unlikely to incur PTS during launches at SNI. During the monitoring period, it is unlikely that the sounds were strong enough at pinniped haul-out sites to have induced PTS in any pinniped species.

4.2.3 Conclusions Regarding Effects on Pinniped Hearing Sensitivity

Overall, the results to date indicate that there is little potential for appreciable TTS or PTS in pinnipeds hauled out on SNI near the missile launch paths during launch operations. This conclusion is necessarily speculative given the limited TTS data (and lack of PTS data) for pinnipeds in air exposed to strong sounds for brief periods. In the event that levels are occasionally sufficiently high to cause TTS, these levels probably would be only slightly above the presumed thresholds for mild TTS. Thus, in the event that TTS did occur, it would typically be mild and reversible and thus PTS would necessarily not occur. Given the relatively infrequent launches from SNI, the low probability of TTS during any one launch, and the fact that a given pinniped is not always present on land, there appears to be no likelihood of PTS from the cumulative effects of multiple launches.

If there is any reason to be concerned about auditory effects, it would be during either of two types of launches: (1) When artillery shots occur at beach locations and pinnipeds are present nearby, and (2) When a large missile travels at supersonic speed over a pinniped beach at relatively low altitude. These types of events did not occur during the current monitoring period.

4.3 Estimated Numbers of Pinnipeds Affected by Launches

The approach to estimating the numbers of pinnipeds affected by launches between June 2014 and November 2014 was based on audio, video, and direct observations of pinnipeds, combined with estimates of the numbers of hauled out pinnipeds in the same general vicinity not videotaped but exposed to the same launches. The latter animals are presumed to have reacted in the same manner as those whose responses were videotaped. For pinniped groups that extended farther along the beach than encompassed by the FOV of the video camera, an estimate of the total number of individuals that were hauled out was made based on a pre-launch video pan of the area.

The proportions of animals in the focal subgroups affected during each launch (based on the disturbance criteria listed in §4.1) are extrapolated to the estimated total number of individuals hauled out in this area (Tables 4.1 and 4.2). It is not possible to extrapolate the proportions of animals affected on the monitored beaches to the entire island as not all beaches can be observed on the day of a launch. However, whenever possible surveys of surrounding beaches are conducted during monitoring set up to determine if additional pinnipeds are in the area. Additionally, individual pinnipeds may be affected on more than one occasion, but are counted here as separate individuals. Thus, while the overall estimate of pinnipeds affected may be over- or underestimated it is likely that the totals presented here are overestimates.

Navy biologists did not observe any northern fur seals (*Callorhinus ursinus*) or Guadalupe fur seals (*Arctocephalus townsendi*) on SNI during launches in the June 2014 - November 2014 monitoring period, and none were evident in the video segments that were analyzed.

Observations from 2001-2014 continue to show that all of the haul-out sites continue to be occupied on subsequent days following the launches. There was no evidence of injury or mortality during any of the launches.

TABLE 4.1. Estimated numbers of California sea lions harassed by launches from the Navy's SNI missile launch program between June 2014 and November 2014.

Launch Date	Missile Type	Monitoring Site	# of Focal Animals Potentially Affected	Total # Potentially Affected in Area	Monitoring Period Totals
Number of California sea lions potentially harassed					
17 June 2014	ARAV	Dos Coves	20	*40*	
		Redeye Beach	5	*100*	
		B809	37	*154*	
5 August 2014	AI3	Dos Coves	8	*15*	
		B809	-	*0*	
		Rock Crusher	0	0	
6 August 2014	AI3	Dos Coves	10	*12*	
		B809	0	0	
		Bachelor Beach	0	0	
4 September 2014	GQM (1st of 2)	Dos Coves	35	35	
		B809	18	*245*	
		Redeye Beach	15	15	
4 September 2014*	GQM (2nd of 2)	Dos Coves	1	1	
		B809	50	*308*	
		Redeye Beach	1	1	
			Total number of sea lions potentially affected:		***923***

Note: Numbers in italics are estimates based upon the proportion of pinnipeds affected within a focal group and expanded to the entire number of animals present in the area. Dash (-) - unknown number hauled out during the launch.

* It is likely that these numbers overestimate individuals affected as it is likely that the same individuals were hauled out in the FOV during both launches.

TABLE 4.2. Estimated numbers of Pacific harbor seals harassed by launches from the Navy's SNI missile launch program between June 2014 and November 2014.

Launch Date	Missile Type	Monitoring Site	# of Focal Animals Potentially Affected	Total # Potentially Affected in Area	Monitoring Period Totals
Number of California sea lions potentially harassed					
17 June 2014	ARAV	Redeye Beach	4	*10*	
5 August 2014	AI3	All Areas	0	0	
6 August 2014	AI3	All Areas	0	0	
4 September 2014	GQM (1st of 2)	Vizcaino Pt.	*40*	*40*	
4 September 2014	GQM (2nd of 2)	Vizcaino Pt.	0	0	
			Total number of harbor seals potentially affected:		***50***

Note: Numbers in italics are estimates based upon the proportion of pinnipeds affected within a focal group and expanded to the entire number of animals present in the area. Dash (-) - unknown number hauled out during the launch.

4.4 Summary

No evidence of pinniped injuries or fatalities related to launch noises or other launch operations was evident, nor was it expected. The specific received levels of transient airborne sound that cause the onset of TTS in pinnipeds are not well documented. For the purposes of this report, it is assumed that TTS onset occurs at 129 dB re 20 µPa dB, the level measured for Pacific harbor seals. Few, if any, pinnipeds were exposed to received levels of sound energy above 118 dB re $(20\ \mu Pa)^2 \cdot s$ M_{pa}-weighted. However, on two occasions near the B807 launch pad and two occasions on the cliff above Dos Coves, the peak pressure level exceeded 129 dB re 20 µPa dB. Pinniped haul-out sites are located at least 0.6 km from the B807 Launch Complex and the measurement at Dos Coves was taken on open ground on a cliff above the haul out. Thus, TTS is considered unlikely during the June 2014 to November 2014 monitoring period. In the event TTS did occur, it would be mild and quickly recoverable and PTS would not have occurred.

Approximately 923 California sea lions, 50 Pacific harbor seals, and no northern elephant seals were estimated to have been affected during the June 2014 to November 2014 monitoring period. These figures are approximate, because they (a) include extrapolations for pinnipeds on beaches that were not monitored on any given launch day, (b) very likely count some of the same individuals more than once, and (c) also exclude pinnipeds on some beaches that were not monitored. The pinnipeds included in these estimates left the haul-out site in response to the launch, or exhibited prolonged movement or behavioral changes relative to their behavior immediately prior to the launch.

The results from the June - November 2014 monitoring period (and those from previous monitoring periods) suggest that any effects of the launch operations were minor, short-term, and localized, at least for northern elephant seals and California sea lions. Some Pacific harbor seals may have left their haul-out site until the following low tide, but numbers occupying haul-out sites shortly after a launch or the next day are generally similar to pre-launch levels. It is not likely that any of the pinnipeds on SNI were adversely impacted by such behavioral reactions.

These results are supported by continuing population increases of pinnipeds on San Nicolas Island. Counts of all three species of pinnipeds have significantly increased on SNI over the past three decades (Barlow, et al., 1997, Fluharty, 1999, Le Boeuf, et al., 1978, Lowry 2002, Lowry and Maravilla, 2005, Lowry, et al., 1996 and 2008 and Lowry, Pers. Comm.). This includes increases in pinniped counts in the portions of the island closest to the missile launch trajectories.

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APPENDIX A:
SMAL TAKE REGULATIONS
3 JUNE 2014 – 3 JUNE 2019

Title 50: Wildlife and Fisheries
Subpart F—Taking of Marine Mammals Incidental To Target and Missile Launch Activities From San Nicolas Island, CA

Source: 79 FR 32684, June 3, 2014, unless otherwise noted.

Effective Date Note: At 79 FR 32684, June 3, 2014, subpart F was added, effective June 3, 2014, through June 3, 2019.

§217.50 Specified activity and specified geographical region.

(a) Regulations in this subpart apply only to the incidental taking of marine mammals specified in paragraph (b) of this section by the Naval Air Warfare Center Weapons Division, U.S. Navy, and those persons it authorizes to engage in target missile launch activities and associated aircraft and helicopter operations at the Naval Air Warfare Center Weapons Division facilities on San Nicolas Island, California.

(b) The incidental take of marine mammals under the activity identified in paragraph (a) of this section is limited to the following species: Northern elephant seals (*Mirounga angustirostris*), harbor seals (*Phoca vitulina*), and California sea lions (*Zalophus californianus*).

(c) This Authorization is valid only for activities associated with the launching of a total of 40 vehicles (e.g., RAM, Coyote, MSST, Terrier, SM-3, or similar) from Alpha Launch Complex and smaller missiles and targets from Building 807 on San Nicolas Island, California.

§217.51 Effective dates.

Regulations in this subpart are effective from June 3, 2014, through June 3, 2019.

§217.52 Permissible methods of taking.

(a) Under Letters of Authorization issued pursuant to §216.106 and 217.57 of this chapter, the Holder of the Letter of Authorization may incidentally, but not intentionally, take marine mammals by harassment, within the area described in §217.50, provided the activity is in compliance with all terms, conditions, and requirements of the regulations and the appropriate Letter of Authorization.

(b) The activities identified in §217.50 must be conducted in a manner that minimizes, to the greatest extent practicable, any adverse impacts on marine mammals and their habitat.

(c) The incidental take of marine mammals is authorized for the species listed in §217.50(b) and is limited to Level B Harassment.

§217.53 Prohibitions.

Notwithstanding takings contemplated in §217.50 and authorized by a Letter of Authorization issued under §§216.106 and 217.57 of this chapter, no person in connection with the activities described in §217.50 may:

(a) Take any marine mammal not specified in §217.50(b);

(b) Take any marine mammal specified in §217.50(b) other than by incidental, unintentional harassment;

(c) Take a marine mammal specified in §217.50(b) if such taking results in more than a negligible impact on the species or stocks of such marine mammal; or

(d) Violate, or fail to comply with, the terms, conditions, and requirements of this subpart or a Letter of Authorization issued under §§216.106 and 217.57 of this chapter.

§217.54 Mitigation.

(a) When conducting operations identified in §217.50(c), the mitigation measures contained in the Letter of Authorization issued under §§216.106 and 217.57 must be implemented. These mitigation measures include, but are not limited to:

(1) The holder of the Letter of Authorization must not enter pinniped haul-out sites below the missile's predicted flight path for 2 hours prior to planned missile launches.

(2) The holder of the Letter of Authorization must avoid, whenever possible, launch activities during harbor seal pupping season (February to April), unless constrained by factors including, but not limited to, human safety, national security, or for vehicle launch trajectory necessary to meet mission objectives.

(3) The holder of the Letter of Authorization must limit, whenever possible, launch activities during other pinniped pupping seasons, unless constrained by factors including, but not limited to, human safety, national security, or for vehicle launch trajectory necessary to meet mission objectives.

(4) The holder of the Letter of Authorization must not launch vehicles from the Alpha Complex at low elevation (less than 1,000 feet (305 m)) on launch azimuths that pass close to pinniped haul-out sites when occupied.

(5) The holder of the Letter of Authorization must avoid, where practicable, launching multiple target missiles in quick succession over haul-out sites, especially when young pups are present.

(6) The holder of the Letter of Authorization must limit launch activities during nighttime hours, except when required by the test objectives.

(7) Aircraft and helicopter flight paths must maintain a minimum altitude of 1,000 feet (305 m) from pinniped haul-outs and rookeries, except in emergencies or for real-time security incidents (e.g., search-and-rescue, fire-fighting), which may require approaching pinniped haul-outs and rookeries closer than 1,000 feet (305 m).

(8) If post-launch surveys determine that an injurious or lethal take of a marine mammal has occurred or there is an indication that the distribution, size, or productivity of the potentially affected pinniped populations has been affected, the launch procedure and the monitoring methods must be reviewed, in cooperation with NMFS, and, if necessary, appropriate changes must be made through modification to a Letter of Authorization, prior to conducting the next launch of the same vehicle under that Letter of Authorization.

(9) Additional mitigation measures as contained in a Letter of Authorization.

(b) [Reserved]

§217.55 Requirements for monitoring and reporting.

(a) Unless specified otherwise in the Letter of Authorization, the Holder of the Letter of Authorization must notify the Administrator, West Coast Region, NMFS, by letter or telephone, at least 2 weeks prior to activities possibly involving the taking of marine mammals. If the authorized activity identified in §217.50 is thought to have resulted in the mortality or injury of any marine mammals or in any take of marine mammals not identified in §217.50(b), then the Holder of the Letter of Authorization must notify the Director, Office of Protected Resources, NMFS, or designee, by telephone (301-427-8401), and the Administrator, West Coast Region, NMFS, or designee, by telephone (562-980-3232), within 48 hours of the discovery of the injured or dead animal.

(b) The National Marine Fisheries Service must be informed immediately of any changes or deletions to any portions of the proposed monitoring plan submitted, in accordance with the Letter of Authorization.

(c) The holder of the Letter of Authorization must designate biologically trained, on-site individual(s), approved in advance by NMFS, to record the effects of the launch activities and the resulting noise on pinnipeds.

(d) The holder of the Letter of Authorization must implement the following monitoring measures:

(1) Visual land-based monitoring.

(i) Prior to each missile launch, an observer(s) will place three autonomous digital video cameras overlooking chosen haul-out sites located varying distances from the missile launch site. Each video camera will be set to record a focal subgroup within the larger haul-out aggregation for a maximum of 4 hours or as permitted by the videotape capacity.

(ii) Systematic visual observations, by those individuals, described in paragraph (c) of this section, of pinniped presence and activity will be conducted and recorded in a field logbook a minimum of 2 hours prior to the estimated launch time and for no less than 1 hour immediately following the launch of target missiles.

(iii) Systematic visual observations, by those individuals, described in paragraph (c) of this section, of pinniped presence and activity will be conducted and recorded in a field logbook a minimum of 2 hours prior to launch, during launch, and for no less than 1 hour after the launch of the BQM-34, BQM-74, Tomahawk, RAM target and similar types of missiles.

(iv) Documentation, both via autonomous video camera and human observer, will consist of:

(A) Numbers and sexes of each age class in focal subgroups;

(B) Description and timing of launch activities or other disruptive event(s);

(C) Movements of pinnipeds, including number and proportion moving, direction and distance moved, and pace of movement;

(D) Description of reactions;

(E) Minimum distances between interacting and reacting pinnipeds;

(F) Study location;

(G) Local time;

(H) Substratum type;

(I) Substratum slope;

(J) Weather condition;

(K) Horizontal visibility; and

(L) Tide state.

(2) Acoustic monitoring. (i) During all target missile launches, calibrated recordings of the levels and characteristics of the received launch sounds will be obtained from three different locations of varying distances from the target missile's flight path. To the extent practicable, these acoustic recording locations will correspond with the haul-out sites where video and human observer monitoring is done.

(ii) Acoustic recordings will be supplemented by the use of radar and telemetry systems to obtain the trajectory of target missiles in three dimensions.

(iii) Acoustic equipment used to record launch sounds will be suitable for collecting a wide range of parameters, including the magnitude, characteristics, and duration of each target missile.

(e) The holder of the Letter of Authorization must implement the following reporting requirements:

(1) For each target missile launch, the lead contractor or lead observer for the holder of the Letter of Authorization must provide a status report to NMFS, West Coast Regional Office, providing reporting items found under the Letter of Authorization, unless other arrangements for monitoring are agreed upon in writing.

(2) The Navy shall submit an annual report describing their activities and including the following information:

(i) Timing, number, and nature of launch operations;

(ii) Summary of mitigation and monitoring implementation;

(iii) Summary of pinniped behavioral observations; and

(iv) Estimate of the amount and nature of all takes by harassment or by other means.

(3) The Navy shall submit a draft comprehensive technical report to the Office of Protected Resources and West Coast Regional Office, NMFS, 180 days prior to the expiration of the regulations in this subpart, providing full documentation of the methods, results, and interpretation of all monitoring tasks for launches to date plus preliminary information for missile launches during the first 6 months of the regulations.

(4) A revised final comprehensive technical report, including all monitoring results during the entire period of validity of the Letter of Authorization, will be due 90 days after the end of the period of effectiveness of the regulations in this subpart.

(5) The final report will be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final comprehensive technical report prior to acceptance by NMFS.

(f) Activities related to the monitoring described in paragraphs (c) and (d) of this section, or in the Letter of Authorization issued under §§216.106 and 217.57 of this chapter, including the retention of marine mammals, may be conducted without the need for a separate scientific research permit.

(g) In coordination and compliance with appropriate Navy regulations, the NMFS may, at its discretion, place an observer on San Nicolas Island for any activity involved in marine mammal monitoring either prior to, during, or after a missile launch in order to monitor the impact on marine mammals.

§217.56 Applications for Letters of Authorization.

To incidentally take marine mammals pursuant to the regulations in this subpart, the U.S. citizen (as defined by §216.6 of this chapter) conducting the activity identified in §217.50 (the U.S. Navy) must apply for and obtain either an initial LOA in accordance with §217.57 or a renewal under §217.58.

§217.57 Letters of Authorization.

(a) A Letter of Authorization, unless suspended or revoked, will be valid for a period of time not to exceed the period of validity of this subpart.

(b) Each Letter of Authorization will set forth:

(1) Permissible methods of incidental taking;

(2) Means of effecting the least practicable adverse impact on the species, its habitat, and on the availability of the species for subsistence uses (i.e., mitigation); and

(3) Requirements for mitigation, monitoring, and reporting.

(c) Issuance and renewal of the Letter of Authorization will be based on a determination that the total number of marine mammals taken by the activity as a whole will have no more than a negligible impact on the affected species or stock of marine mammal(s).

§217.58 Renewals and Modifications of Letters of Authorization.

(a) A Letter of Authorization issued under §§216.106 and 217.57 of this chapter for the activity identified in §217.50 will be renewed or modified upon request of the applicant, provided that:

(1) The proposed specified activity and mitigation, monitoring, and reporting measures as well as the anticipated impacts, are the same as those described and analyzed for these regulations (excluding changes made pursuant to the adaptive management provision of this chapter), and;

(2) NMFS determines that the mitigation, monitoring, and reporting measures required by the previous LOA under these regulations were implemented.

(b) For LOA modification or renewal requests by the applicant that include changes to the activity or the mitigation, monitoring, or reporting measures (excluding changes made pursuant to the adaptive management provision of this chapter) that do not change the findings made for the regulations or result in no more than a minor change in the total estimated number of takes (or distribution by species or years), NMFS may publish a notice of proposed LOA in the Federal Register, including the associated analysis illustrating the change, and solicit public comments before issuing the LOA.

(c) An LOA issued under §§216.106 and 217.57 of this chapter for the activity identified in §217.50 may be modified by NMFS under the following circumstances:

(1) Adaptive management. NMFS may modify (including augment) the existing mitigation, monitoring, or reporting measures (after consulting with the Navy regarding the practicability of the modifications) if doing so creates a reasonable likelihood of more effectively accomplishing the goals of the mitigation and monitoring set forth in the preamble for these regulations.

(i) Possible sources of data could contribute to the decision to modify the mitigation, monitoring, and reporting measures in an LOA:

(A) Results from the Navy's monitoring from the previous year(s);

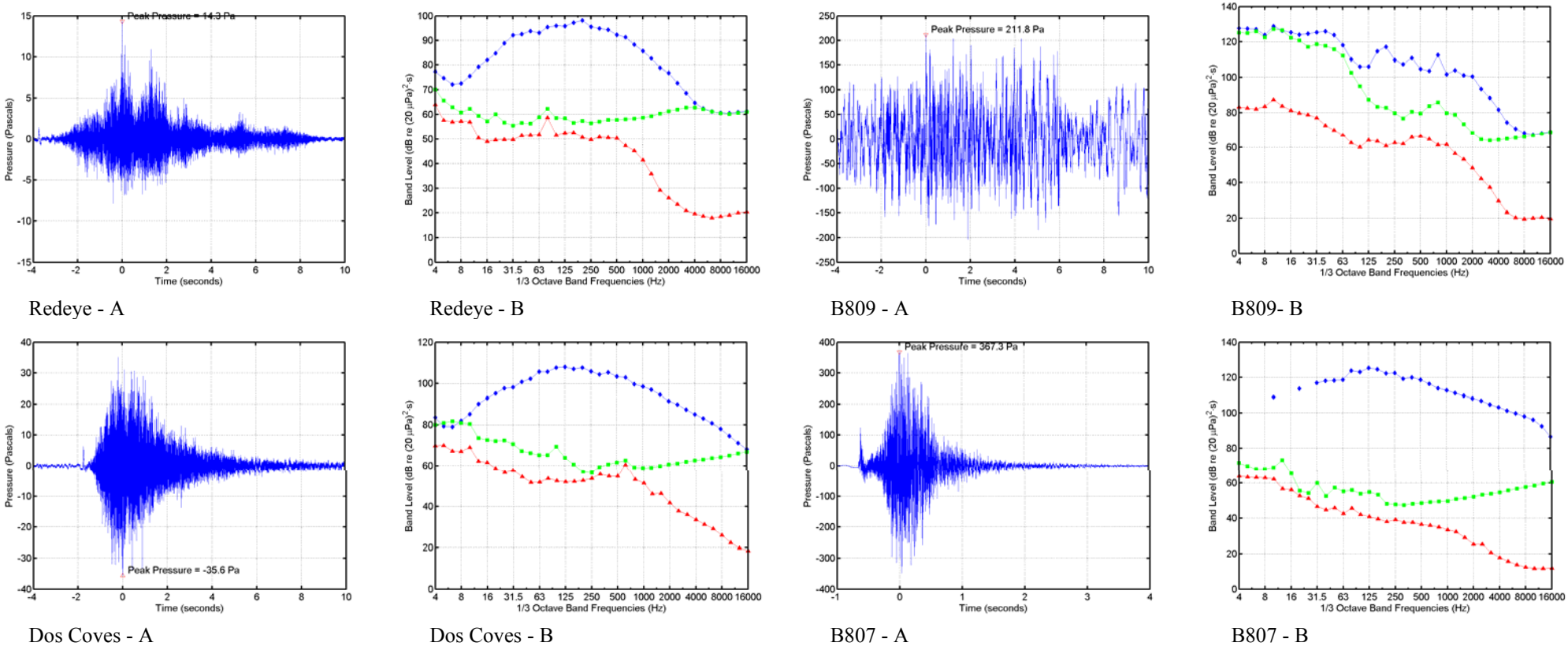
(B) Results from other marine mammal and/or sound research or studies; or

(C) Any information that reveals marine mammals may have been taken in a manner, extent, or number not authorized by these regulations or subsequent LOAs.

(ii) If, through adaptive management, the modifications to the mitigation, monitoring, or reporting measures are substantial, NMFS will publish a notice of proposed LOA in the Federal Register and solicit public comment.

(2) Emergencies. If NMFS determines that an emergency exists that poses a significant risk to the well-being of the species or stocks of marine mammals specified in §217.50(b), a Letter of Authorization may be modified without prior notice or opportunity for public comment. Notice would be published in the Federal Register within 30 days of the action

APPENDIX B:
ACOUSTIC DATA
FOR MISSILE LAUNCHES BETWEEN
JUNE 2014 – NOVEMBER 2014



Redeye - A | Redeye - B | B809 - A | B809- B

Dos Coves - A | Dos Coves - B | B807 - A | B807 - B

FIGURE B-1. (A) Pressure waveform and (B) one-third octave band levels for a PAU 2 ARAV (Terrier MK 70 Booster) flight at 14:58:00 on 17 June 2014. In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

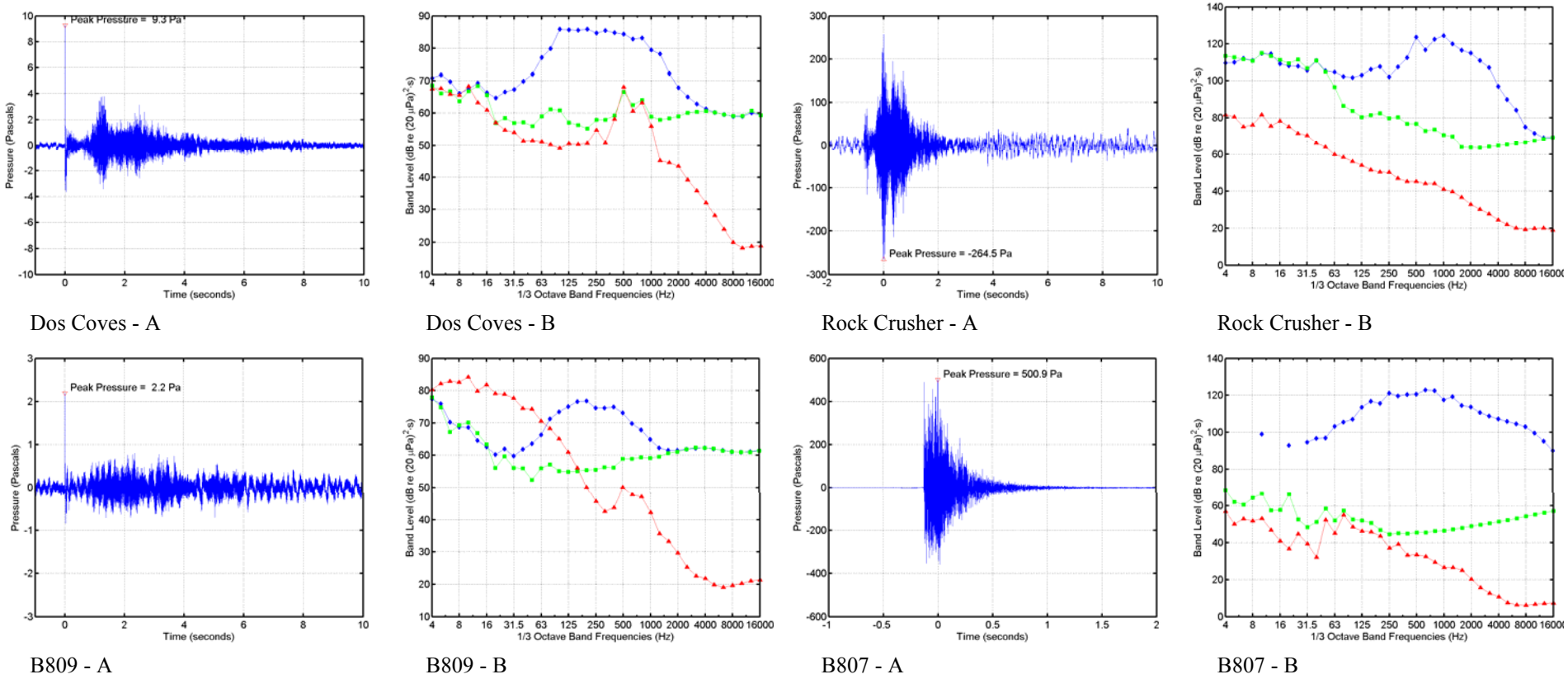
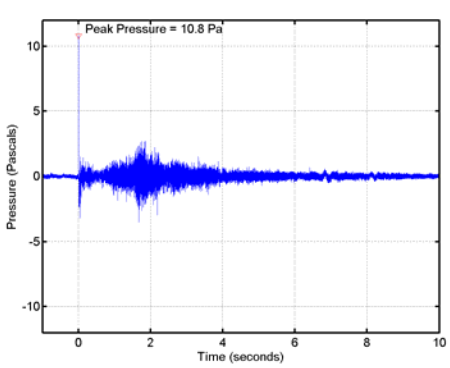
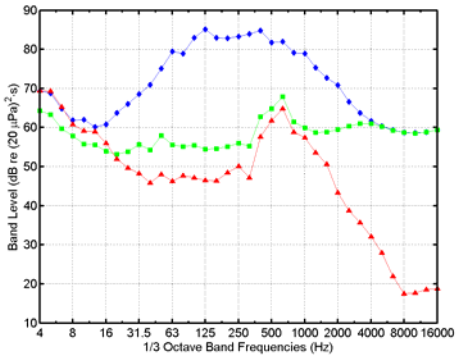


FIGURE B-2. (A) Pressure waveform and (B) one-third octave band levels for an AI3 flight at 11:42:00 on 5 August 2014.

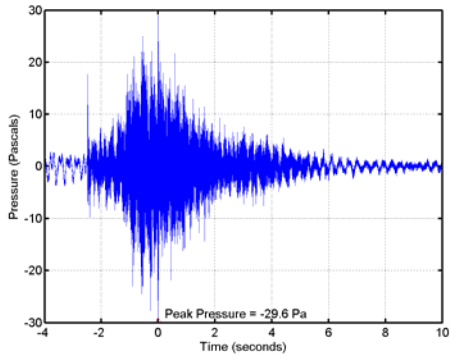
In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).



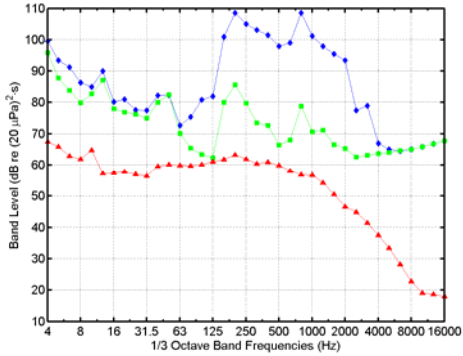
Dos Coves - A



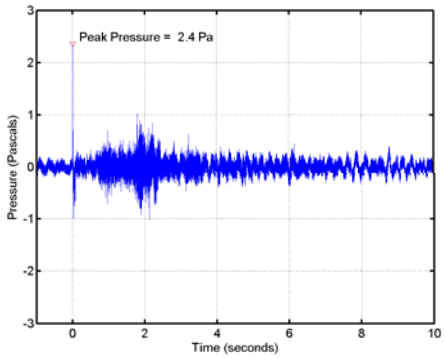
Dos Coves - B



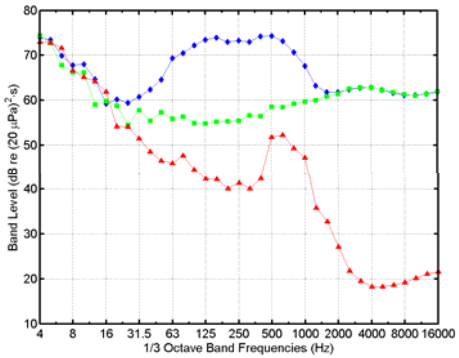
Bachelor Beach - A



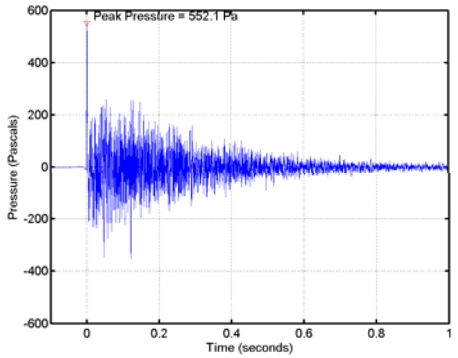
Bachelor Beach - B



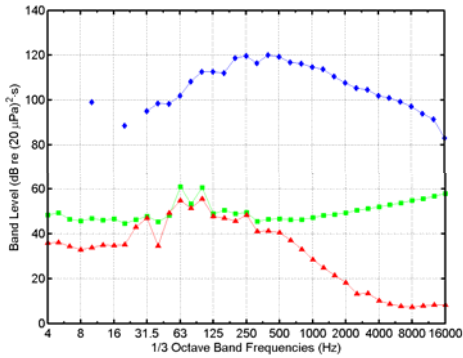
B809 - A



B809 - B



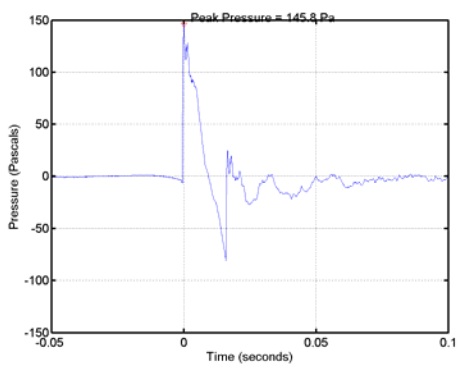
B807 - A



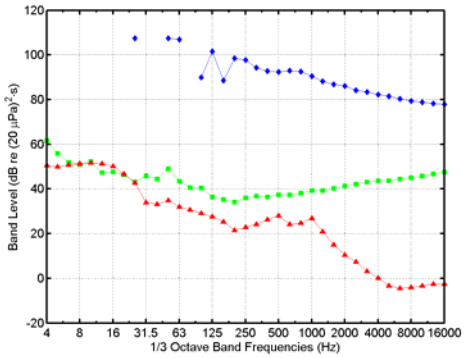
B807 - B

FIGURE B-3. (A) Pressure waveform and (B) one-third octave band levels for an AI13 flight at 13:32:00 on 6 August 2014.

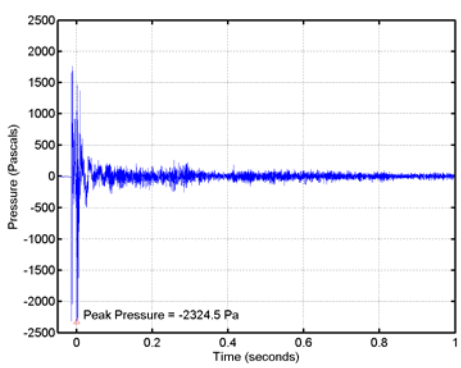
In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).



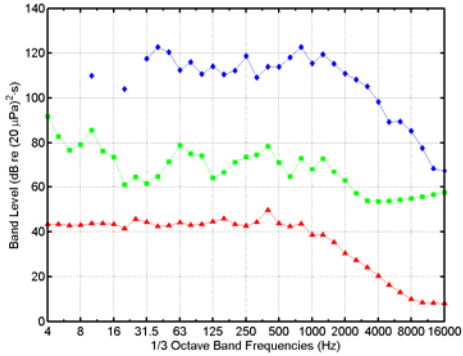
B809 Vizcaino Point - A



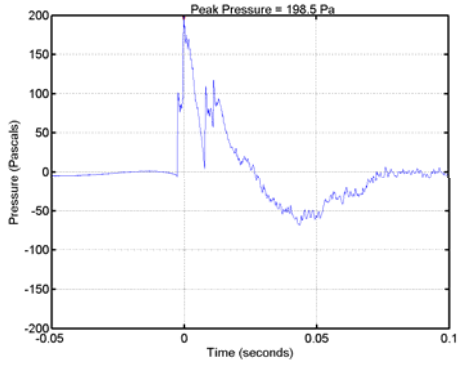
B809 Vizcaino Point - B



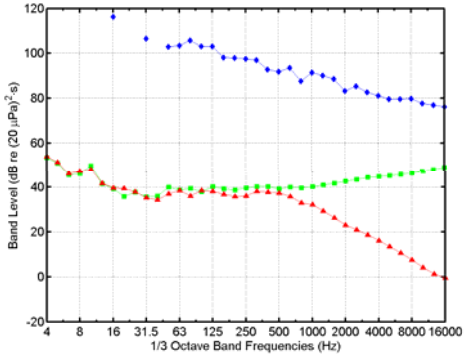
Dos Coves - A



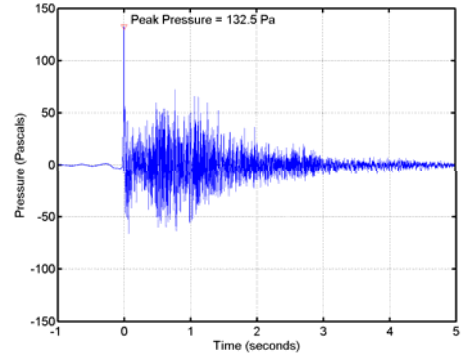
Dos Coves - B



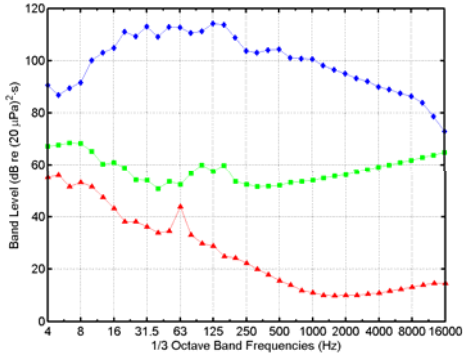
Redeye Beach - A



Redeye Beach - B



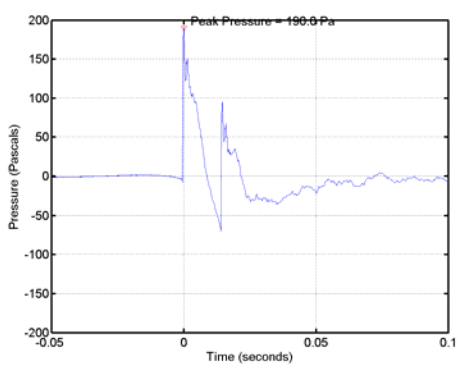
Alpha Pad - A



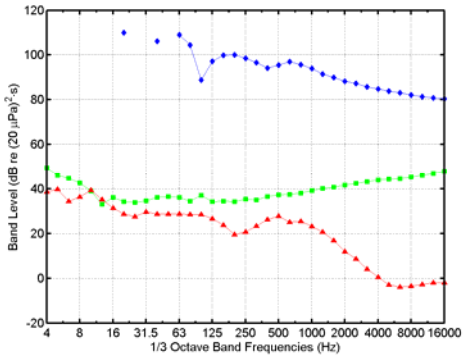
Alpha Pad - B

FIGURE B-4. (A) Pressure waveform and (B) one-third octave band levels for a GQM-163A flight at 14:36:00 on 4 September 2014.

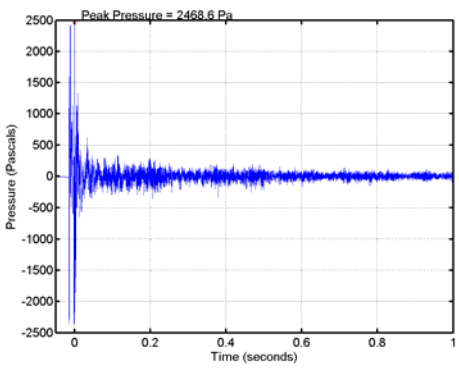
In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).



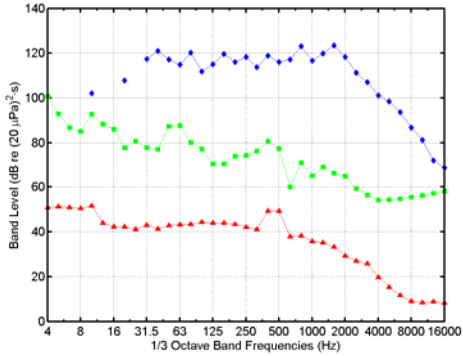
B809 Vizcaino Point - A



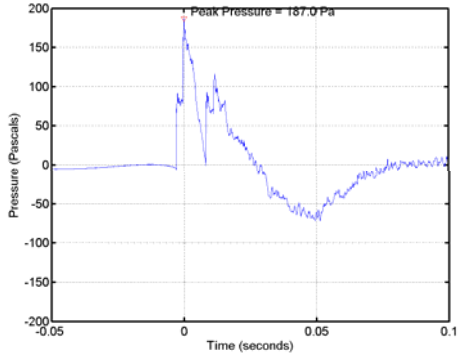
B809 Vizcaino Point - B



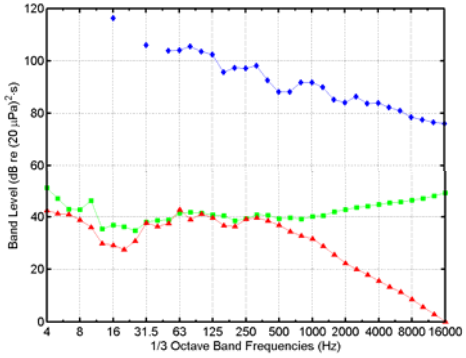
Dos Coves - A



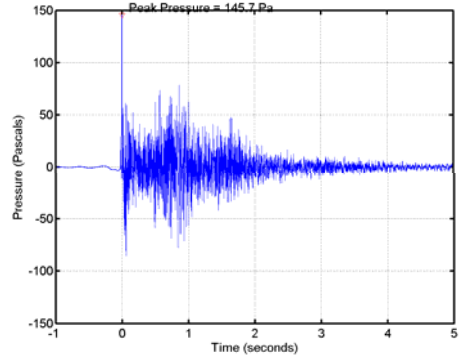
Dos Coves - B



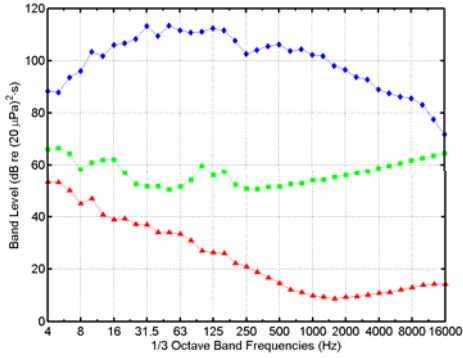
Redeye Beach - A



Redeye Beach - B



Alpha Pad - A



Alpha Pad - B

FIGURE B-5. (A) Pressure waveform and (B) one-third octave band levels for a GQM-163A flight at 17:30:00 on 4 September 2014.
In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).