Final Pinniped Monitoring Report
Missile Launches on San Nicolas Island, California, June 2019 – June 2020

Prepared by
NAVAIR Ranges Sustainability Office
575 I Avenue, Suite 1, Bldg. 53 A, Code EB2R00M
Point Mugu, CA, 93117

For

National Marine Fisheries Service
Silver Spring, MD

March 2021

Suggested format for citation:

U.S. Navy. Final Pinniped Monitoring Report, Missile Launches on San Nicolas Island, California, June 2019 – June 2020. Naval Air Warfare Center Weapons Division, Point Mugu, CA.

This Page Intentionally Blank

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

3-D	3-dimensional
ASL	above sea level
ATAR	Autonomous Terrestrial Acoustic Recorder
B807	Building 807
B809	Building 809
CFR	Code of Federal Regulations
cm	centimeter
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

This Page Intentionally Blank

EXECUTIVE SUMMARY

The U.S. Navy holds an Incidental Harassment Authorization (IHA) issued by the National Marine Fisheries Service (NMFS) (Appendix A, 84 FR 28462). The IHA allows for the 'take by harassment' of California sea lions (*Zalophus californianus*), Pacific harbor seals (*Phoca vitulina*) and northern elephant seals (*Mirounga angustirostris*) resulting from missile launches on San Nicolas Island (SNI), California, an island owned and managed by the Navy. Past IHAs and Letters of Authorizations (LOAs) allowed take of seals and sea lions (pinnipeds) for missile launches from SNI from July 2001 through June 2019 (66 FR 41834, 67 FR 56271, 68 FR 52132, 74 FR 26580, 79 FR 32678). The current IHA is valid from June 12, 2019 through June 11, 2020 and includes a provision that NMFS may issue a one-year renewal with an expedited public comment period if another year of identical or nearly identical activities is planned.

The Navy's application for the current IHA included provisions to monitor effects of missile launch activities on pinnipeds hauled out at SNI in a manner similar to pinniped monitoring that took place during Navy launch activities from 2001–2019. Pinniped species monitored on SNI include the California sea lion, Pacific harbor seal and northern elephant seal. This preliminary monitoring report includes data collected from June 2019 through June 2020. It is being provided to NMFS in support of the Navy's request for renewal of the current IHA.

Missiles Launched

From June 2019 through June 2020, twelve (12) missiles were launched from SNI. Eight (8) of these missiles were aerial targets, two were surface-to-surface missiles and two were surface-to-air missiles. All missiles crossed over SNI's shoreline on the western end of the island.

Monitoring Equipment deployed during Missile Launches

Up to three unattended video cameras were set up to monitor pinnipeds at different sites near the missile launch trajectory. Autonomous Terrestrial Acoustic Recorders (ATARs) were deployed next to the video cameras. An additional ATAR was deployed near the launch site for each missile. Beaches monitored during each launch varied based on presence of hauled out pinnipeds and proximity to the launch.

Estimated Numbers of Pinnipeds Affected

For each launch, the species, number of pinnipeds affected was estimated using the video recordings. Extrapolations of the number of pinnipeds affected were made when the field of view of the camera did not include the entire beach being monitored.

All pinnipeds became alert when a missile launch sound was audible on the video tape. When quantifying effects, only pinnipeds that moved more than 10 meters or entered the water were counted as being "taken" for the purposes of this permit. No evidence of pinniped injuries, fatalities or pup abandonment related to the monitored launches was observed during this or any other monitoring period since 2001.

Approximately 1680 California sea lions, 42 Pacific harbor seals and 4 northern elephant seals were estimated to have been affected during the June 2019 through June 2020 monitoring period. These figures are approximate and include extrapolations for pinnipeds on portions of the beach that were not within the field of view of the camera and likely include instances where the same individuals were counted more than once at different times and/or different days. These estimates correspond to an average rate of 140 sea lions, 3.5 harbor seals and 0.33 elephant seals affected per launch event.

The data collected during this monitoring period and pinniped monitoring data collected at SNI since 2001 suggest that any effects of the launch operations were minor, short-term, and localized. It is not likely

that any of the pinnipeds on SNI were adversely impacted by behavioral reactions to missile launches from the island.

The types of missiles launched during this monitoring period were the same as those launched in previous years. The two launch sites used this year were the same as those used for all previous reporting periods. Based on past data analyses, it is unlikely that any pinnipeds incurred any temporary threshold shift (TTS) during launches at SNI. If TTS were to occur, hearing loss would have presumably been mild and recoverable and thus not have caused permanent damage.

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 (B807) Launch Complex 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 California sea lions (*Zalophus californianus*), Pacific harbor seals (*Phoca vitulina*) and northern elephant seals (*Mirounga angustirostris*).

The U.S. Navy holds an Incidental Harassment Authorization (IHA) issued by the National Marine Fisheries Service (NMFS) (Appendix A, 84 FR 28462). The IHA allows for the 'take by harassment' of California sea lions, Pacific harbor seals, and northern elephant seals during missile launches on San Nicolas Island (SNI), California, an island owned and managed by the Navy. Past IHAs and Letters of Authorizations (LOAs) allowed take of pinnipeds for missile launches from SNI from July 2001 through June 2019 (66 FR 41834, 67 FR 56271, 68 FR 52132, 74 FR 26580, 79 FR 32678). The current IHA is valid from June 12, 2019 through June 11, 2020 and includes a provision that NMFS may issue a one-year renewal with an expedited public comment period if another year of identical or nearly identical activities is planned.

The Navy's application for the current IHA included provisions to monitor effects of missile launch activities on pinnipeds hauled out at SNI in a manner similar to pinniped monitoring that took place during Navy launch activities from 2001–2019. Pinniped species monitored on SNI include the California sea lion, Pacific harbor seal and northern elephant seal. In June 2010, a revised monitoring plan was submitted to NMFS that proposed the discontinuation of directed 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, beaches dominated by elephant seals were not usually targeted for monitoring after December 2010, but any reactions of elephant seals observed in the field of view of cameras monitoring other species was still recorded.

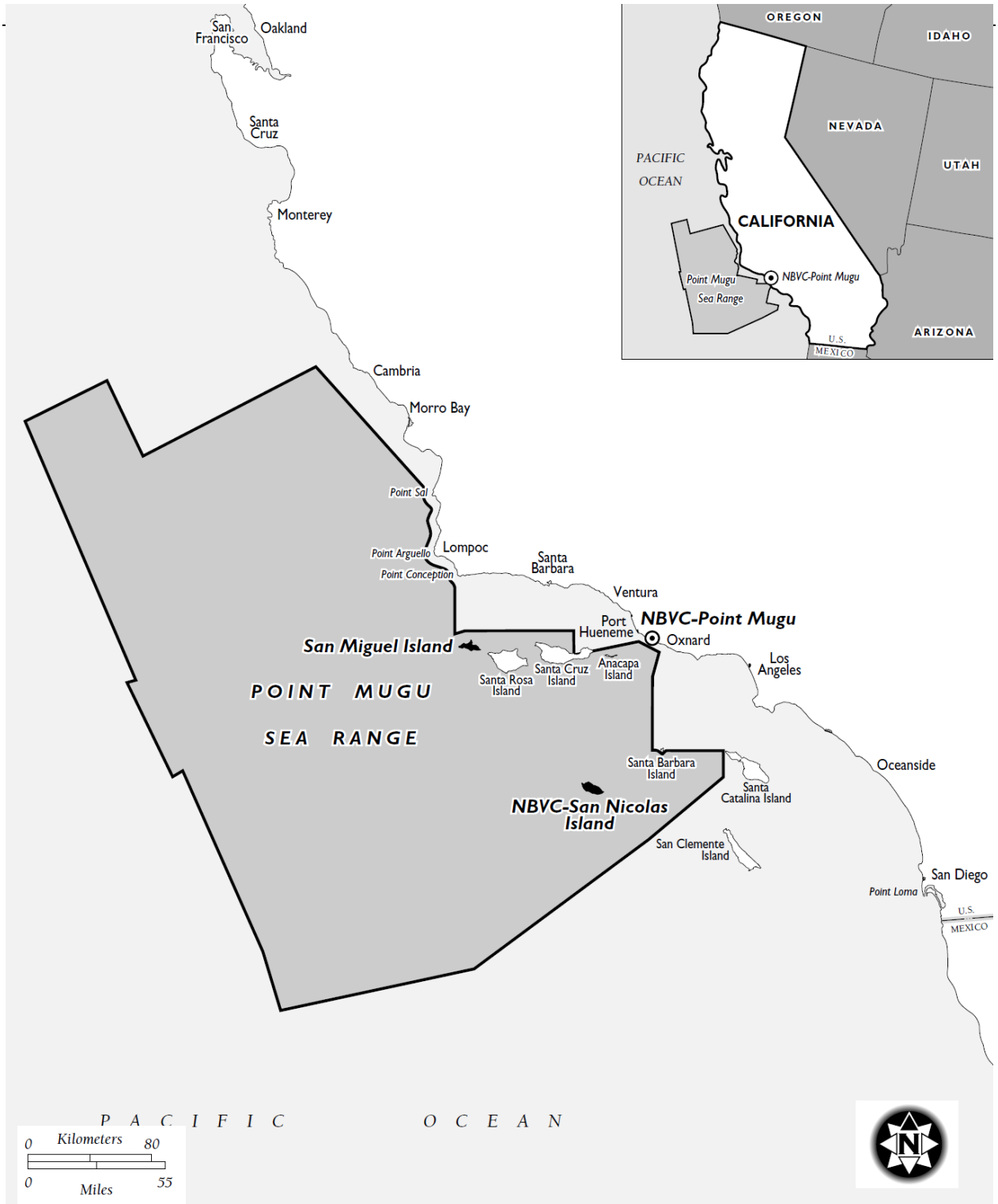


FIGURE 1.1. Regional site map of the Point Mugu Sea Range and San Nicolas Island, California

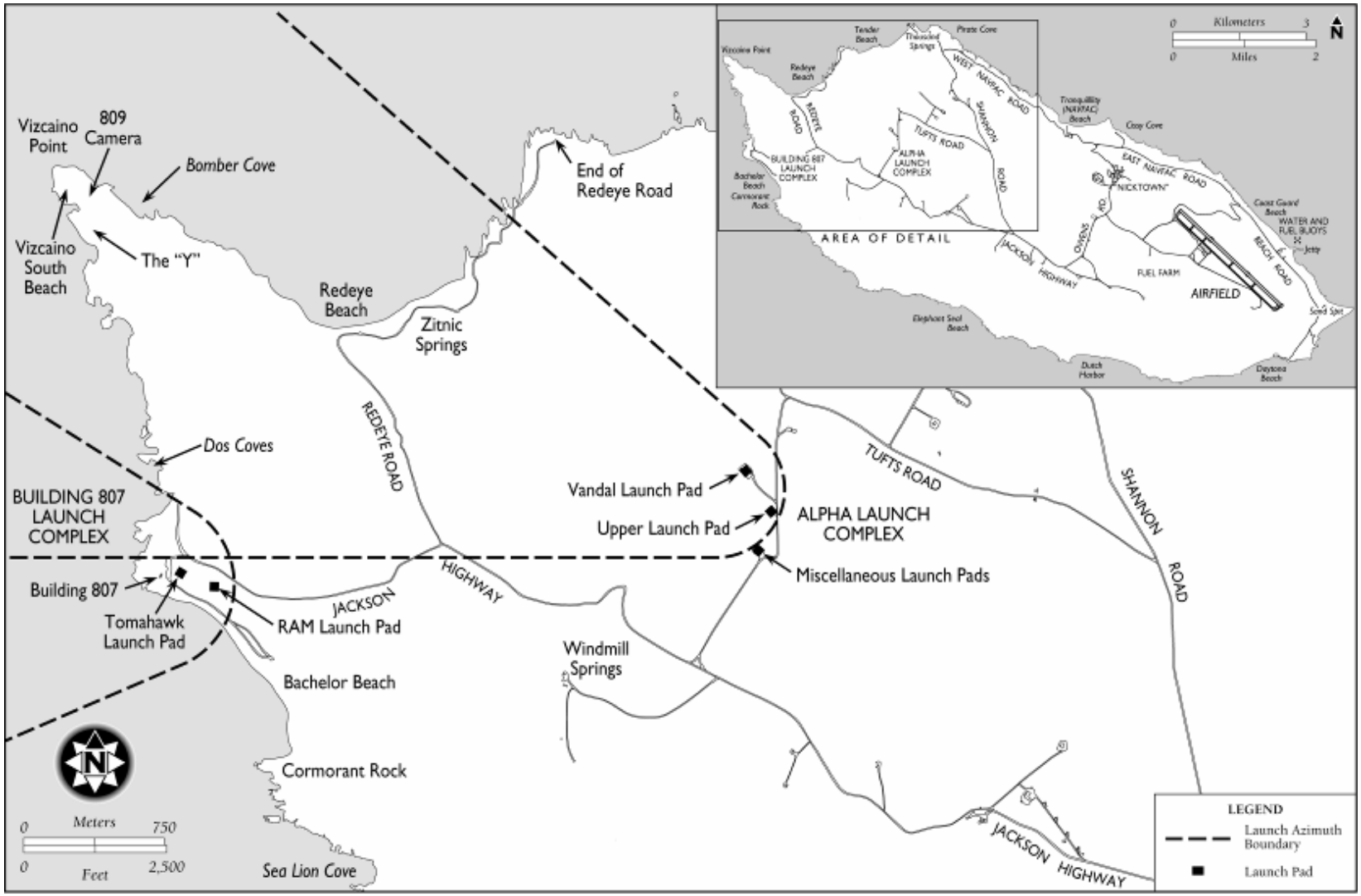


FIGURE 1.2. Map of San Nicolas Island, California, and the general launch azimuths (dashed lines) for each launch complex. These launch azimuths are typical, although occasionally launch paths could pass outside these boundaries.

The monitoring plan requires that, for each missile launched from SNI, simultaneous autonomous audio recording of launch sounds and video recording of pinniped behavior occur. Generally monitoring occurred at three haul outs 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 pinniped behavior resulting from missile launches, including the occurrence of stampedes (if any).

1.1.1 Audio Monitoring

During all launches in this monitoring period Autonomous Terrestrial Acoustic Recorders (ATARs) 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 also documented ambient noise levels prior to and following the launches. Objectives of the audio monitoring program included:

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 sounds; and
3. Determine if the sound levels from missile launches were high enough to have the potential to induce Temporary Threshold Shift (TTS) in pinnipeds exposed to launch sounds[1].

1.1.2 Visual Monitoring

Video and direct visual monitoring provides 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 documented 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. Ascertain periods or launch conditions when pinnipeds are most and least responsive to launch activities;
4. Document numbers of pinnipeds affected by missile launches and, although unlikely, any mortality or injury.

[1] Based upon available TTS information harbor seals might have TTS onset at a received SEL-M of >129 dB re 20 $\mu Pa^2 \cdot s$ and California sea lions at SEL-M > 159 dB re 20 $\mu Pa^2 \cdot s$. As a conservative measure, all species of pinnipeds were assumed to have the same TTS onset level as harbor seals (see Section 4.2.1)

1.2 Impact Estimates

The monitoring program for the missile launches on SNI was designed, in part, to provide data necessary to estimate the numbers of pinnipeds affected by launches and the manner in which they were affected. For military readiness activities, the MMPA defines harassment as:

"1) any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild; or, (2) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered." [10 USC Ch. 631§7235]

In this report, consistent with previous related reports, the Navy and NMFS agreed 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[2] or behavioral changes (such as pups separated from mothers) relative to their behavior immediately prior to the launch.

No pinnipeds are known to have been injured or killed since the 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 Launch Dates and Information

From June 2019 through June 2020, twelve (12) missiles were launched on 10 separate days (Table 1.1). Eight (8) of these missiles were aerial targets, two were surface-to-surface missiles and two were surface-to-air missiles. All missiles crossed SNI's shoreline on the island's western end of the island.

[2] Prolonged movement, for the purpose of the monitoring and this report, "prolonged movement" 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.

TABLE 1.1. Launch data for June 2019 through June 2020.

Launch Date	Launch Time (local)	Launch Complex	Pinniped Monitoring Locations		
07/12/2019	09:45	B807	Dos Coves	Red Eye East	Bachelor
07/14/2019	09:20	Alpha	Dos Coves	Bachelor	Phoca Reef
07/14/2019	10:30	Alpha	Dos Coves	Bachelor	Phoca Reef
08/12/2019	12:00	Alpha	Dos Coves	Red Eye West	Phoca Reef
08/18/2019	14:30	B807	Dos Coves	Red Eye West	Phoca Reef
09/26/2019	09:23	B807	Dos Coves	Red Eye West	Phoca Reef
10/03/2019	10:42	B807	Dos Coves	Red Eye West	
12/16/2019	11:55	Alpha	Dos Coves	Red Eye West	Red Eye East
12/20/2019	11:00	Alpha	Red Eye West		
01/26/2020	12:50	Alpha	Dos Coves	Vizcaino Point	Red Eye West
01/26/2020	14:00	Alpha	Dos Coves	Vizcaino Point	Red Eye West
01/31/2020	1230	Alpha	Dos Coves	Red Eye West	Red Eye East

2. ACOUSTIC MEASUREMENTS OF MISSILE LAUNCHES

2.1 Introduction

The acoustic measurement program for the monitoring period was consistent in approach and methodology with that used during the preceding years (Ugoretz 2016, Ugoretz 2015, Holst et al. 2011). Recordings of each missile's sound, as well as background sounds, were attempted at up to three pinniped haulout sites as well as the launch pad 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 in earlier reports (Ugoretz 2016, Ugoretz 2015, Holst et al. 2011).

Sound levels that might cause notable disturbance for each pinniped species are variable and context-dependent (Lawson et al. 1998). Lawson et al. (1998) estimated the minimum received level, on an A-weighted Sound Exposure Level (SEL-A, measuring the "loudness" of the sound) 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 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). 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 were positioned at the launch pad and near pinniped haul out sites at varying distances from the launch locations. The recordings provided data for later quantitative analysis of the levels and characteristics of the received flight sounds. ATARs were set up between one and four hours prior to the launch and retrieved in the hour following the launch. The ATAR units were deployed at sites

as close as practical to the pinniped haul-out sites being monitored with video cameras. The total number of sites monitored depended upon the presence of pinnipeds on beaches in the potentially impacted area.

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 an average of 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 the degree of harbor seal response and received sound level or distance from the closest point of approach of the vehicle.

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 past monitoring reports (Ugoretz 2016, Ugoretz 2015, Holst et al. 2011). Frequency-domain results included estimation of SPLs in one-third octave bands for center frequencies from 4 to 16,000 kHz. The following subsection describes how these values are defined

2.3.1 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[3]. For each launch whose sounds are reported, 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.

2.4 Acoustic Monitoring Results

2.4.1 Missile Flight Sounds

A detailed analysis of sound data collected from the ATARs during this period is provided in Appendix B of this report. The types of missiles launched during this monitoring period were the same as those launched in previous years. The two launch sites used this year were the same as those used for all previous reporting periods. Based on past data analyses, it is unlikely that any pinnipeds incurred any temporary threshold shift (TTS) during launches at SNI. If TTS were to occur, hearing loss would have presumably been mild and recoverable and thus not have caused permanent damage.

[3] 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.

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. No other pinniped species were observed during this or previous monitoring periods since August 2001 (Ugoretz 2016, Ugoretz 2015, 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, Pacific harbor seals often react strongly to launch sound. They commonly leave their haul-out sites to enter the water. Early monitoring reports suggested that harbor seals did not return to a haul out site for several hours or the next tide cycle (Holst et al. 2011). 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. Focused monitoring of harbor seals during this monitoring period indicate that harbor seals will return to their haul out within minutes of a launch. Distribution and abundance of harbor seals at the sites monitored appeared to be strongly influenced by the height of the tide.

Northern elephant seals are often startled by missile launch sounds but have otherwise shown little or no reaction to previous missile launches and directed monitoring of elephant seals was not required by the current IHA. During this monitoring period, elephant seals were present on many of the monitored haul-outs along with other species and were included in the camera's field of view. On most occasions, elephant seal 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.

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 are obtained via video cameras mounted on tripods at the monitoring locations. In addition, trained staff makes 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 recordings were 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 allowed for observations of up to three pinniped species during the same launch. The actual number of species observed depended on the number of video systems deployed during a launch and on the number of species hauled out at the monitoring sites (Table 3.1).

Cameras were placed at locations overlooking haul-out sites prior to each launch in a manner that minimized disturbance to pinnipeds. When the entire haul-out aggregation at a given site could not be captured in the camera's field of view, a representative focal subgroup within the haul-out aggregation was selected. The number of animals affected at a given location was estimated based on the percentage of beach observed and percentage of the focal group affected with the assumption that animals were equally distributed along the beach.

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 were also recorded. The audio data collected by the video cameras were used during behavioral analyses (e.g., to confirm the exact time when the missile was launched), but were not calibrated and not of sufficient quality to provide detailed launch sound information.

Video Monitoring Analysis

Digital video recordings were reviewed by an experienced biologist on a high-resolution color monitor. The recordings before, during, and up to 60 min after each launch were 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 overtly responded. The number, proportion and age class (adult or pup - where determinable) 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. Pinnipeds that move into the water or greater than 10 m (33 ft) along the beach are considered to have been affected.

3.4 Descriptions of Pinniped Behavior during Specific Launches

Video recordings of pinniped behavior were collected during all launch events from June 2019 through June 2020. The following are brief summaries of the observations made from viewing the video collected at the monitoring sites.

3.4.1 Launch from B807: July 12, 2019 (0945hrs)

- Dos Coves South - Camera lens obscured by water droplets (sea spray/fog) but outlines of sea lions could be seen. Entire beach was within the field of view of the camera with approximately 50 sea lions resting before launch (adult females with pups and several territorial males). All sea lions on the beach startled when missile launch sound was audible on the video. All sea lions moved in a direction up the beach and in the opposite direction of the launch site (B807). None entered the water. All animals stopped movement and began to return to prelaunch behavior within minutes of the launch. An estimated 40 sea lions moved more than 10 meters during the event.
- Red Eye East – About half the beach east of Red Eye in the field of view. Approximately 25 sea lions and 2 male elephant seals were in the field of view at any given time. Nearly all sea lions were adult males resting or interacting with each other prior to the launch. There was no missile launch noise audible on the video at the time of launch. No reactions of sea lions or elephant seals were observed at this location.
- Bachelor Beach – About one third of bachelor beach in the field of view. Approximately 40 sea lions and 2 elephant seals were resting or interacting with each other within the field of view prior to the launch. Nearly all sea lions were adult males. All pinnipeds on the beach alerted when missile launch noise was audible on the video. Virtually all sea lions stood their ground and there was little movement along the beach. Sea lions were more alert immediately after launch but return to pre-launch behavior within minutes of the launch. Two sea lions and one elephant seal entered the water during the launch.

3.4.2 Launch from Alpha: July 14, 2019 (0920hrs)

- Dos Coves South – Entire beach was within the field of view of the camera. Approximately 60 sea lions (Females with pups and a few territorial males) on and above the beach and one elephant seal on the beach before the launch. Initially some sea lion pups gathered together in groups near a few females then some traveled to the southern side of the beach. None entered the water. The lone elephant seal looked up then laid down and stayed in place. An estimated 15 sea lions moved more than 10 meters.
- Bachelor Beach – Foggy at time of launch but outlines of sea lions and elephant seals could be seen. About one third of the beach within the field of view of the camera. Approximately 30 adult male sea lions and 8 elephant seals resting or interacting on the beach prior to launch. All animals startled when the sound of the missile launch audible on the video. Many sea lions made initial start toward the water but stopped abruptly. Elephant seals relatively non-reactive. No pinnipeds entered the water or appeared to have traveled more than 10 meters.
- Phoca Reef – This reef is used exclusively for haul out by harbor seals. Entire reef within the field of view of the camera. Tide high and covering the reef during the time of the first launch. Launch sound is audible on the video but no harbor seals are hauled out on the reef at the time of the launch. One harbor seal was in the water near the reef at the time of launch with no reactions observed.

3.4.3 Launch from Alpha: July 14, 2019 (1030hrs)

- Dos Coves South – Entire beach was within the field of view of the camera. Approximately 70 sea lions (Females with pups and a few territorial males) on and above the beach immediately prior to launch. Somewhat stronger reaction than observed during the first launch of the day. Otherwise similar post-launch reaction, all sea lions startled with some grouping of pups with a few females and many pups traveling to the south side of the beach. None entered the water. Territorial males

appeared to maintain their stations before and after the launch event. An estimated 20 sea lions moved more than 10 meters.

- Bachelor Beach –About half of the beach within the field of view of the camera (fog lifted after first launch. Approximately 75 adult male sea lions and 50 elephant seals (far end of the beach) resting or interacting on the beach prior to launch. All pinnipeds startled when the sound of missile launch was audible on the video. Elephant seals did not move from their spots on the beach. Approximately 30 sea lions entered the water and/or moved more than 10 meters.

- Phoca Reef – The tide dropped between the first and second launches. Thirteen (13) harbor seals hauled out on the reef immediately prior to the second launch of the day. When missile launch sound was audible on the video, all harbor seals startled and 12 of the 13 seals moved into the water. Fifteen (15) minutes after launch, 10 harbor seals were hauled out on the reef. Ninety (90) minutes after launch, approximately 30 harbor seals were hauled out on the reef.

3.4.4 Launch from Alpha: August 12, 2019 (1200hrs)

- Dos Coves South – Entire beach within field of view. A group of western gulls roosting above the beach took flight approximately 3 seconds prior to the missile launch sound being audible on the video. Approximately 60 sea lions (about 10 adult females and 50 pups) and one elephant seal on the beach prior to the launch. When the launch sound was audible on the video, all pinnipeds startled. Six (6) of the adult females entered the water. Sea lion pups generally moved to the south side of the beach, forming groups. The lone elephant seal did not change position. An estimated 50 sea lions moved more than 10 meters or entered the water. Forty-five (45) minutes after launch it appears that the number of female sea lions returned to the pre-launch number. Many of the pups seen prior to the launch were not visible and moved outside the field of view of the camera (possibly under a ledge closest to the camera).

- Red Eye West – Entire beach within the field of view. A large group of brown pelicans roosting above the beach took flight approximately 3 seconds prior to the missile launch sound being audible on the video. Sea lions were resting on large cobble and rock near the water making accurate counts difficult. When the launch sound was audible on the video, approximately 100 sea lions entered the water while another 100 milled about on the beach over short distances(less than 10 meters). Forty-five (45) minutes after the launch, the number of sea lions on the beach appeared to be similar to the number prior to the launch.

- Phoca Reef – Nearly full reef within the field of view of the camera. Approximately 40 harbor seals hauled out on the reef. Strong startle response. Thirty –seven (37) of 40 seals entered the water when missile launch sound is audible on the video. Many seals were seen in the water, just outside the reef immediately after launch. Seals began to return to haul out just after launch. Fifteen (15) minutes after launch, approximately 10 seals hauled out on reef with many others staging to haul out. Approximately 25 seals hauled out on the reef 45 minutes after launch (a helicopter was audible on video with no reactions from the seals).

3.4.5 Launch from B807: August 18, 2019 (1430hrs)

- Dos Coves South – Entire beach within field of view of the camera. Approximately 100 sea lions (about 30 adult females and 70 pups) and two elephant seals on the beach prior to launch. About 9 minutes before the launch, a F-18 jet associated with the launch was circling nearby at an altitude of 1,500 feet. The sea lions reacted to the first pass of the jet, many heading toward the water with about 10 entering the water. Although many pups ran toward the water, they appeared reluctant to enter the water. When the missile launch sound was audible on the video, the sea lions moved up

the beach but then abruptly changed direction and moved back towards the water when the jet passed nearby just after the launch. It was estimated that all 100 of the sea lions on the beach either moved more than 10 meters or entered the water. The two elephant seals did not appear to be disturbed. Sea lions began to return to pre-launch behaviors within 1 hour of the launch.

- Red Eye West – Entire beach within field of view of the camera. Approximately 100 sea lions on the beach prior to launch. The sound from the first jet fly by startled 10 adult female sea lions causing them to leave the upper beach and heading toward the water. They moved quickly at first then slowly as they reached the water. Subsequent jet sounds audible on the video did not appear to affect the remaining animals. The missile launch sound was not audible on the video at the time of the launch. It was estimated that 10 sea lions moved more than 10 meters. Six (6) sea lions returned within 30 minutes to the upper beach that had been vacated earlier.

- Phoca Reef – Entire reef with field of view of the camera. Approximately 20 harbor seals hauled out prior to launch. Missile launch sound was not audible on the video and no reactions from harbor seals were observed. One hour after the launch the tide dropped slightly and approximately 25 harbor seals were hauled out on the reef.

3.4.6 Launch from B807: September 26, 2019 (0923hrs)

- Dos Coves South – Full beach within the field of view of the camera. Approximately 40 sea lions (adult females and pups) and 10 elephant seals on beach prior to launch. All pinnipeds startled when missile sound is audible on the video. Elephant seals remained in place. Approximately 30 sea lions on the beach moved more than 10 meters or entered the water (few). Over the 20 minutes post-launch, some sea lions were observed moving from the upper bench (outside field of view) and onto the beach.

- Red Eye West – Half the beach within the field of view of the camera. Approximately 40 sea lions (adult females and a few pups) on the beach prior to launch. Missile sound from launch was barely audible on the video. None of the sea lions reacted to the launch.

- Phoca Reef – Tide was covering the reef at the time of launch with one harbor seal in the water near the reef. Missile launch sound not audible on the video and no reactions of harbor seals observed. Approximately 90 minutes post-launch the tide had dropped and approximately 15 harbor seals hauled out on the reef with several more staging to haul out nearby.

3.4.7 Launch from 807: October 3, 2019 (1042hrs)

Note: Only two video cameras deployed. An attempt was made to place a camera at Vizcaino Point but access was blocked the morning of the launch. No time allowed for alternate placement of third camera.

- Dos Coves South – Full beach in the field of view of the camera. Approximately 70 sea lions (adult females and pups) and 35 elephant seals on beach prior to the launch. All pinnipeds startled when missile launch sound is audible on the video. Most adult female sea lions stand their ground while many pups moved about or entered the water. Elephant seals did not reposition or appear to be disturbed after initial startle. It was estimated that 35 sea lions moved more than 10 meters and/or entered the water.

- Red Eye West - Full beach in the field of view of the camera. Hard to get an accurate count of the sea lions on the beach and offshore reef given the positioning of the sea lions and the extremely limited response to the launch. Possibly 100 or more sea lions in the field of view. Missile launch sound barely audible on the video. At the time of launch, 6 sea lions moved more than 10 meters

down slope from the upper beach toward the water. Based on review of post-launch video, it was difficult to determine whether this movement was actually a result of the launch.

3.4.8 Launch from Alpha: December 16, 2019 (1155hrs)

- Dos Coves South – Full beach in field of view of the camera. Approximately 90 sea lions and 20 elephant seals on the beach prior to launch. Missile launch sound not very audible over ambient noise on video. No animals on the beach reacted to the launch. A very high tide, forcing pinnipeds to gather on the upper portion of the beach against a bluff and high ambient noise from high surf, wind and rolling cobble on the beach may have contributed to this lack of reaction from animals on the beach. There was a delayed response (about 1-3 minutes) with about 50 sea lions coming into the field of view and running from the top of the bench above the beach towards the water. Many of these sea lions eventually entered the water.

- Red Eye West – Full beach in field of view of the camera. Approximately 180 sea lions on beach prior to launch. All sea lions startled when missile the launch sound was audible on the video. Approximately 80 sea lions run towards the water, traveling more than 10 meters and/or entering the water. The animals remaining on the beach returned to resting behaviors within 15 minutes.

- Red Eye East – Full beach in field of view of the camera. Approximately 90 elephant seals on beach prior to launch. All elephant seals startled when missile launch sound was audible on video. One juvenile elephant seal moved more than 10 meters, all others returned to previous resting behavior immediately.

3.4.9 Launch from Alpha: December 20, 2019 (1100hrs)

Note: Three video cameras were deployed but two of the cameras' storage cards were not formatted correctly and the video recorded was not recoverable.

- Red Eye West – Full beach in the field of view of the camera. Approximately 75 sea lions on the beach (most densely packed on upper dune areas) and 15 elephant seals prior to launch. All animals startled about 3 seconds after the missile launch sound begins to be audible on the video. Approximately 50 sea lions on the upper dune areas ran down slope towards the beach with many entering the water. Several sea lions near the water had little reaction to the launch. Elephant seals returned to resting state immediately. Sea lion numbers at the top of the dunes did not return to pre-launch numbers within 15 minutes of the launch.

3.4.10 Launch from Alpha: January 26, 2020 (1250hrs)

- Dos Coves South – Full beach in the field of view within the camera. Camera lens partially obscured by water droplets. Approximately 200 sea lions and 10 elephant seals on the beach prior to launch. Strong reaction from sea lions on the beach followed by a stream of about 100 sea lions moving into the field of view from the upper bench to the water. Young sea lions lead the rush to the water with many adults remaining on the beach. It was estimated that 250 sea lions moved more than 10 meters and/or entered the water. Little to no reaction to the launch from elephant seals.

- Vizcaino Point South – About two thirds of the upper bench in the field of view of the camera. Approximately 300 sea lions resting in groups along the upper bench prior to the launch. All animals startled when missile launch sound is audible on the video. The sea lions first gather in large groups then begin to spread out. One large bull stands his ground in the center of a large group. An estimated 150 sea lions move more than 10 meters and/or enter the water.

- Red Eye West – Full beach within field of view of the camera. Lens obscured. Approximately 20 to 30 sea lions moving down the beach towards the water after the missile launch sound become audible on the video.

3.4.11 Launch from Alpha: January 26, 2020 (1400hrs)

- Dos Coves South – Full beach in the field of view within the camera. Camera lens obscured by water droplets. Similar observations as the launch earlier in the day. Approximately 130 sea lions and 10 elephant seals on the beach prior to the launch. Strong reaction from sea lions on the beach but few animals coming from the upper bench. It was estimated that 120 sea lions moved more than 10 meters and/or entered the water. Many of these animals were likely disturbed by the first launch as well. Little to no reaction to the launch from elephant seals.

- Vizcaino Point South – About two thirds of the upper bench in the field of view of the camera. Sea lions remaining on the bench after the first launch (approximately 150) startled and gather into large groups before dispersing. Approximately 40 sea lions move more than 10 meters during this launch.

- Red Eye West – Lens obscured. Launch audible on the video but not possible to see pinnipeds on the beach.

3.4.12 Launch from Alpha: January 31, 2020 (1230hrs)

- Dos Coves South – Entire beach within the field of view of the camera. Approximately 350 sea lions and 10 elephant seals on the beach prior to the launch. About 4-5 seconds prior to the launch gulls roosting on the bench above the beach take flight. About 10 sea lions startled by the gulls flying/calling overhead followed by a strong reaction of all sea lions on the beach when the missile launch sound is audible on the video. An estimated 300 sea lions entered the water.

- Red Eye West – About one third of the beach is within the field of view of the camera. Approximately 70 sea lions on the beach or on an offshore reef prior to the launch. Approximately 50 sea lions entered the water when the missile launch sound is audible on the video.

- Red Eye East – Full beach within field of view of the camera. Elephant seal beach at the peak of the pupping season (adult females, pups, territorial males, juvenile males). Approximately 300+ seals on the beach prior to the launch. All seals startled when missile launch sound is audible on the video. All elephant seals returned to previous behaviors immediately.

3.5 Implementation of Mitigation Measures

Table 3.1 shows a summary of the mitigation measures that were specified by NMFS in the IHA, and how they were implemented during the June 2019 through June 2020 monitoring period.

TABLE 3.1. Implementation of mitigation measures.

Mitigation Measure	Implementation
Personnel must not enter pinniped haul-outs. Personnel may be adjacent to haul-outs prior to and following a launch for monitoring purposes.	Personnel on San Nicolas Island were prohibited from entering pinniped haul-out areas. Monitoring personnel set up video and audio equipment near haul-outs without disturbing pinnipeds.
Missile must not cross over pinniped haul-outs at [altitudes] less than 305 meters (m) (1000 feet).	No missiles crossed over pinniped haul-outs at less than 1000 feet.

The Navy may not conduct more than 10 launch events at night.	No launches were conducted at night during this period
Launches must not occur February through April, to the maximum extent practicable.	No launches were conducted February through April during this period
Launches must be limited January through February and June through July, to the maximum extent practicable.	Three launch events were conducted in January and three launch events were conducted in July. Beyond a first startle response, there was little to no reaction to launches from elephant seals and their pups in January. For July launch events, female sea lions and pups reacted to launches but there was no indication of pup abandonment or mortality
All aircraft and helicopter flight paths must maintain a minimum distance of 305 m from recognized seal haul-out and rookeries, to the maximum extent practicable.	All aircraft maintained a minimum distance of 305 meters from recognized seal haul-out and rookeries.
For a species for which authorization has not been granted, or for a species for which authorization has been granted but authorized takes are met, the Navy must consult with NMFS before the next launch event.	No species for which authorization was not granted (e.g. Guadalupe fur seal, Steller sea lion) was observed during this period. Authorized take for other species not met.
The Navy must review launch procedure and monitoring methods, in cooperation with NMFS, if any injuries or mortality of a pinniped are discovered during post-launch surveys, or if surveys indicate possible effects to the distribution, size or productivity of the affected pinniped populations as a result of the specified activities.	No injured or dead pinnipeds were observed in post launch observations during the monitoring period. No evidence of effects to the distribution, size or productivity of affected pinniped populations.

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 vary between and within species, individuals, locations, and seasons. Reactions to the same missile types also varied from one launch to the next, possibly due to weather conditions, tide height, ambient noise or other factors. 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 but reaction to the sudden change in sound during a launch is likely the primary triggering factor. Furthermore, pinnipeds, at times, react to the sight and sound of seabirds and other pinnipeds 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 ranged from a momentary startle 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).

It is possible that pinnipeds exposed to launch noise might "stampede" from the haul-out sites in a manner that causes injury or mortality but this was not observed during monitoring of launches from SNI. During some launches in the 2002-2003 monitoring period, 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 though no injuries were observed (Holst 2008). 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.

Since no injuries or deaths were observed and no pups were abandoned 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, became the primary monitoring objective. The number of pinnipeds on the monitored beaches that may have been affected by the launches is 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, Ugoretz 2015, and Ugoretz 2016), it was assumed that only those pinnipeds meeting either of the following criteria were affected by launches:

1. Pinnipeds exposed to launch sounds strong enough to cause TTS; and
2. 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, since August 2001, no pinnipeds 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 (2) – the number that left the haul-out site, or exhibited prolonged movement.

The numbers of affected pinnipeds were calculated for both observed pinnipeds and pinnipeds on unobserved portions of beaches being monitored. Disturbance reactions were short-lived for California sea lions and did not appear to extend into subsequent days. Pacific harbor seals were present during three launches in this monitoring period. Those harbor seals that reacted moved into the water but began to return to haul out areas within minutes. Based on this and past monitoring, it is assumed that no long-term affects to pinnipeds occurred.

4.2 Possible Effects on Pinniped Hearing Sensitivity

Temporary or 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).

Various federal, state, and other organizations recommend specific acoustic thresholds for the onset of temporary threshold shift (TTS) and permanent threshold shift (PTS) in marine mammals. The thresholds cited below are for impulsive noise (noise with high peak sound pressure, short duration, fast rise-time, and broad frequency content) from the U.S. Navy technical report by J. Finneran, E. Henderson, D. Houser, K. Jenkins, S. Kotecki, and J. Mulsow, *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*, published by the Space and Naval Warfare Systems Center Pacific, San Diego, CA in June 2017.

As with Navy Phase II criteria (Finneran & Jenkins, 2012), auditory weighting functions were applied to acoustic data, prior to the calculation of acoustic metrics such as sound exposure level (SEL) and sound pressure level (SPL), to account for various species' frequency-dependent hearing sensitivity. However, unlike Navy auditory weighting functions for Phase II which were based on "M-weighting" curves for "functional hearing groups", Navy Phase III weighting functions are defined by a generic band-pass filter whose shape is determined by parameters specific to a slightly different classification of nine "marine species hearing groups".

In addition to differences in auditory weighting functions, TTS and PTS thresholds differ between Navy Phase II and Phase III. In Navy Phases II and III, pinnipeds were classified into two hearing groups based upon pinnipeds' two scientific families: Otariidae (eared seals: sea lions and fur seals) and Phocidae (earless seals, or true seals). However, in Navy Phase II, TTS thresholds were the same for both Otariids and Phocids in air, as were PTS thresholds. In Navy Phase III, different TTS and PTS thresholds are defined for Otariids in air (OA) and Phocids in air (PA). The Navy Phase III thresholds for pinnipeds in air are summarized below:

Navy Phase III TTS and PTS thresholds for pinnipeds in air.

Group	Non-impulsive		Impulsive			
			TTS Threshold		PTS threshold	
	TTS threshold SEL[a] (weighted)	PTS threshold SEL[a] (weighted)	SEL[a] (weighted)	Peak SPL[b] (unweighted)	SEL[b] (weighted)	Peak SPL[b] (unweighted)
OA[c]	157	177	146	170	161	176
PA[d]	134	154	123	155	138	161

[a] SEL thresholds are in dB re (20 µPa)^2·s
[b] SPL thresholds in dB re 20 µPa in air
[c] OA-Otariid in air (includes California sea lion)
[d] PA-Phocid in air (includes Pacific harbor seal)

During this monitoring period, no measured sound levels exceeding Otariid weighted or unweighted thresholds for TTS or PTS were recorded.

Two missile launches exceeded TTS weighted thresholds for Phocids at missile launch sites (B807) where no pinnipeds were present and at one monitoring site (Dos Coves) where 35 elephant seals and no harbor seals were in the field of view. None of the elephant seals reacted to sound from this launch.

One missile launch exceeded unweighted peak SPL for TTS in Phocids at the Red Eye West monitoring site on January 26, 2020. Condensation on the video lens (fog) prevented a clear view of the site during this launch but there were no elephant seals or harbor seals in the field of view. This measurement (157.3 dB re 20 µPa) was inconsistant with other measurements at this monitoring site for the same missile type and the ATAR failed within one hour of when the measurement was taken.

Additional information and all sound measurements taken at launch sites and monitoring sites are provided in Appendix B.

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.

4.3 Estimated Numbers of Pinnipeds Affected by Launches

The approach to estimating the numbers of pinnipeds affected by launches from June 2019 through June 2020 was based on 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. Pinnipeds on unobserved portions of beach were presumed to have reacted in the same manner and number as those whose responses were videotaped. For pinnipeds on the unobserved portion of beach, the percentage of the affected species on the observed portion of beach was applied to the unobserved beach.

When an entire beach was not within the field of view, the proportion of pinnipeds in the focal subgroups affected during each launch (based on the disturbance criteria listed in §4.1) were extrapolated to the estimate the total number of individuals affected in the unobserved area (Tables 4.1 and 4.2). It was not possible to extrapolate the proportions of pinnipeds affected on the monitored beaches to the entire island as not all beaches could be observed on the day of a launch. However, whenever possible, surveys of surrounding beaches were conducted during monitoring set up to determine if additional pinnipeds were in the area. Additionally, individual pinnipeds were likely affected on more than one occasion, but were counted here as separate individuals. The estimate of pinnipeds affected for the entire island may be underestimated but are representative of affects to pinnipeds overall.

Northern fur seals (*Callorhinus ursinus*), Guadalupe fur seals (*Arctocephalus townsendi*), Steller sea lions (*Eumetopias jubatus*) were not observed on SNI during launches during the June 2019 – June 2020 monitoring period, and none were evident in the video segments that were analyzed.

Observations from 2001-2020 indicate that all of the pinniped haul-out sites continue to be occupied on subsequent days following the launches. There is no evidence of injury or mortality during any launch event.

TABLE 4.1. Estimated number of pinnipeds affected by launches June 2019 through June 2020

Date/Time Location	Monitoring Locations	Species	Observed	Reacted[4]	Percent Reacted	Multiple[5]	Total
07/12/2019 0945hrs B807	Dos Coves South	Sea Lion	50	40	80%	1	40
	Red Eye East	Sea Lion	25	0	0%	2	0
		Elephant Seal	1	0	0%	2	0
	Bachelor Beach	Sea Lion	40	2	5%	3	6
		Elephant Seal	2	1	50%	3	3
07/14/2019 0920hrs Alpha	Dos Coves South	Sea Lion	60	15	25%	1	15
		Elephant Seal	1	0	0%	1	0
	Bachelor Beach	Sea Lion	30	0	0%	3	0
		Elephant Seal	8	0	0%	3	0
	Phoca Reef	Harbor Seal	0	0	0%	1	0
07/14/2019 01030hrs Alpha	Dos Coves South	Sea Lion	70	20	29%	1	20
		Elephant Seal	0	0	0%	1	0
	Bachelor Beach	Sea Lion	75	30	40%	2	60
		Elephant Seal	50	0	0%	2	0
	Phoca Reef	Harbor Seal	13	12	92%	1	12
08/12/2019 1200hrs Alpha	Dos Coves South	Sea Lion	60	50	83%	1	50
		Elephant Seal	1	0	0%	1	0
	Red Eye West	Sea Lion	200	100	50%	1	100
		Elephant Seal	0	0	0%	1	0
	Phoca Reef	Harbor Seal	40	37	93%	1	37
08/18/2019 1430hrs B807	Dos Coves South	Sea Lion	100	100	100%	1	100
		Elephant Seal	2	0	0%	1	0
	Red Eye West	Sea Lion	100	10	10%	1	10
		Elephant Seal	0	0	0%	1	0
	Phoca Reef	Harbor Seal	20	0	0%	1	0
09/26/2019 0923hrs B807	Dos Coves South	Sea Lion	40	30	75%	1	30
		Elephant Seal	10	0	0%	1	0
	Red Eye West	Sea Lion	40	0	0%	1	0
		Elephant Seal	0	0	0%	1	0
	Phoca Reef	Harbor Seal	0	0	0%	1	0

[4] "Reacted" defined as an animal moving more than 10 meters and/or entering the water.

[5] A multiplier of greater than 1 was applied when the entire monitored area was not within the field of view of the camera. Half area in field of view multiplier = 2, a third of the area =3, two thirds of the area = 1.33

Date/Time Location	Monitoring Locations	Species	Observed	Reacted	Percent Reacted	Multiple	Total
10/03/2019 1042hrs B807	Dos Coves South	Sea Lion	70	35	50%	1	35
		Elephant Seal	35	0	0%	1	0
	Red Eye West	Sea Lion	100	6	6%	1	6
		Elephant Seal	0	0	0%	1	0
12/16/2019 1155hrs Alpha	Dos Coves South	Sea Lion	140	50	36%	1	50
		Elephant Seal	20	0	0%	1	0
	Red Eye West	Sea Lion	180	80	44%	1	6
		Elephant Seal	0	0	0%	1	0
	Red Eye East	Elephant seal	90	1	1%	1	1
12/20/2019 1100hrs Alpha	Red Eye West	Sea Lion	75	50	67%	1	50
		Elephant Seal	15	0	0%	1	0
01/26/2020 1250hrs Alpha	Dos Coves South	Sea Lion	300	250	83%	1	250
		Elephant Seal	10	0	0%	1	0
	Vizcaino Point South	Sea Lion	300	150	50%	1.33	199
		Elephant Seal	0	0	0%	1.33	0
	Red Eye West	Sea Lion	unknown	30	XX	XX	30
01/26/2020 1400hrs Alpha	Dos Coves South	Sea Lion	130	120	92%	1	120
		Elephant Seal	10	0	0%	1	0
	Vizcaino Point South	Sea Lion	140	40	29%	1.33	53
		Elephant Seal	0	0	0%	1.33	0
	Red Eye West	Sea Lion	unknown	XX	XX	XX	XX
01/31/2020 1230hrs Alpha	Dos Coves South	Sea Lion	350	300	86%	1	300
		Elephant Seal	10	0	0%	1	0
	Red Eye West	Sea Lion	70	50	71%	3	150
		Elephant Seal	0	0	0%	3	0
	Red Eye East	Elephant seal	300	0	0%	1	0

TABLE 4.2. Comparison of June 2019 through June 2020 estimates with IHA allowances for pinniped disturbance

Species	Total Reactions observed	Average/event (12 events)	IHA Average/event	IHA Maximum/year (40 events)
CA Sea Lion	1680	140	275	11,000
N. Elephant Seal	4	0.33	0.61 (1)	40
P. Harbor Seal	49	3.5	2.39 (3)	120

4.4 Summary

No evidence of pinniped injuries or fatalities related to launch noises or other launch operations was evident, nor was it expected based on past measurements and observations. It is also unlikely that any pinnipeds were exposed to received levels of sound energy above levels at which PTS or TTS would occur.

In total, 1680 California sea lions, 49 Pacific harbor seals and 4 northern elephant seals are estimated to have been affected during the June 2019 through June 2020 monitoring period. These figures are approximate, because they (a) include extrapolations for pinnipeds on portions of beaches that were not in the field of view during a launch event, (b) very likely count some of the same individuals more than once, and (c) may 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 2019 through June 2020 monitoring period (and those from previous monitoring periods) suggest that any effects of the launch operations were minor, short-term, and localized. Some Pacific harbor seals left their haul-out site on offshore reefs, but numbers occupying haul-out sites shortly after a launch or the next day were comparable 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.

5. ACKNOWLEDGEMENTS

United States Navy biologist Greg Sanders identified monitoring sites, collected data, analyzed video and prepared this report. Navy staff Gina Smith, Lisa Thomas, and Damon Armstrong provided critical support collecting the audio and video recordings from SNI along with ancillary visual observations, weather data, and other information.

Bob Norman and Clay Rushing, consultants to Greeneridge Science Inc., were largely responsible for the design of the ATARs, and continue to improve their operation.

We are grateful to all concerned.

6. LITERATURE CITED

Barlow, J., K.A. Forney, P.S. Hill, R.L. Brownell Jr., J.V. Carretta, D.P. DeMaster, F. Julian, M.S. Lowry, T. Ragen, and R.R. Reeves. 1997. U.S. Pacific marine mammal stock assessments: 1996. NOAA-TM-NMFS-SWFSC-248. U.S. National marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, CA. 223 p.

Bowles, A.E., L. Wolski, E. Berg and P.K. Yochem. 1999. Measurement of impulse noise-induced temporary threshold shift in endangered and protected animals—two case studies. J. Acoust. Soc. Am. 105(2, Pt. 2):932.

Fluharty, M.J. 1999. Summary of Pacific harbor seal, *Phoca vitulina richardsi*, surveys in California, 1982 to 1995. Marine Region Administrative Report 99-1. California Department of Fish and Game. 49 pp.

Gentry, R., A. Bowles, W. Ellison, J. Finneran, C. Greene, D. Kastak, D. Ketten, J. Miller, P. Nachtigall, W.J. Richardson, B. Southall, J. Thomas and P. Tyack. 2004. Noise exposure criteria. Presentation to U.S. Mar. Mamm. Comm. Advis. Commit. on Acoustic Impacts on Marine Mammals, Plenary Meeting 2, Arlington, VA, April 2004. http://mmc.gov/sound/plenary2/pdf/gentryetal.pdf.

Greene Jr., C.R. 1999. Vandal missile target launch sound measurements recorded at San Nicolas Island on 22 and 26 August 1999. Greeneridge Rep. 231-01. Rep. from Greeneridge Sciences Inc., Santa Barbara, CA, for Naval Air Warfare Cent., Weapons Div., Point Mugu, CA. 8 p.

Greene, C.R., Jr. and C.I. Malme. 2002. Acoustic measurements of missile launches. p. 2-1 to 2-54 *In*: J.W. Lawson, E.A. Becker, and W.J. Richardson (eds.), Marine mammal and acoustical monitoring of missile launches on San Nicolas Island, August 2001 – July 2002. LGL Rep. TA2630-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Naval Air Weapons Station, China Lake, CA, and Nat. Mar. Fish. Serv., Silver Spring, MD. 103 p.

Harris, F.J. 1978. On the use of windows for harmonic analysis with the discrete Fourier transform. Proc. IEEE 66(1):51-83.

Holst, M. and J.W. Lawson. 2002. Behavior of pinnipeds during missile launches. p. 3-1 to 3-27 *In*: J.W. Lawson, E.A. Becker, and W.J. Richardson (eds.), Marine mammal and acoustical monitoring of missile launches on San Nicolas Island, August 2001–July 2002. LGL Rep. TA2630-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Naval Air Weapons Station, China Lake, CA, and Nat. Mar. Fish. Serv., Silver Spring, MD. 103 p.

Holst, M. and C.R. Greene, Jr., with W.J. Richardson, T.L. McDonald, K. Bay, R.E. Elliott, and R. Norman. 2008. Marine mammal and acoustical monitoring of missile launches on San Nicolas Island, California, August 2001 – March 2008. LGL Rep. TA4617-1. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Naval Air Warfare Center Weapons Division, Point Mugu, CA, and Nat. Mar. Fish. Serv., Silver Spring, MD, and Long Beach, CA. 116 p.

Holst, M., C.R. Greene, Jr. W.J. Richardson, T.L. McDonald, K. Bay, S.J. Schwartz, and G. Smith. 2011. Responses of Pinnipeds to Navy Missile Launches at San Nicolas Island, California. Aquatic Mammals, 37(2), 139-150.

Kastak, D., B. Southall, M. Holt, C. Reichmuth Kastak, and R. Schusterman. 2004. Noise-induced temporary threshold shifts in pinnipeds: effects of noise energy. J. Acoust. Soc. Am. 116(4, Pt. 2):2531-2532, plus oral presentation at 148th Meeting, Acoust. Soc. Am., San Diego, CA, Nov. 2004.

Kastak, D., B. Southall, R. Schusterman, and C. Reichmuth. 2005. Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. J. Acoust. Soc. Am. 118(5):3154-3163.

Kinsler, L.E., A.R. Frey, A.B. Coppens, and J.V. Sanders. 1982. Fundamentals of Acoustics. John Wiley & Sons, New York, NY. 480 p.

Kryter, K.D. 1985. The Effects of Noise on Man. Academic Press, Orlando, FL. 688 p.

Lawson, J.W. 2002. Estimated numbers of pinnipeds affected by missile launches. p. 4-1 to 4-5 *In*: J.W. Lawson, E.A. Becker, and W.J. Richardson (eds.), Marine mammal and acoustical monitoring of missile launches on San Nicolas Island, August 2001 – July 2002. LGL Rep. TA2630-3. Rep. from LGL Ltd., King City, Ont., and Greeneridge Sciences Inc., Santa Barbara, CA, for Naval Air Weapons Station, China Lake, CA, and Nat. Mar. Fish. Serv., Silver Spring, MD. 103 p.

Lawson, J.W., W.R. Koski, W.J. Richardson, D.H. Thomson, and C.I. Malme. 1998. Biological consequences for marine mammals. p. 183-279 (plus Appendices) *In:* Point Mugu Sea Range marine mammal technical report. Rep. from LGL Ltd., King City, Ont., for Naval Air Warfare Cent., Weapons Div., Point Mugu, CA. 322 p.

Le Boeuf, B.J., M.L. Bonnell, M.O. Pierson, D.H. Dettman, and G.D. Farrens. 1978. Final Report, 1975 - 1976, Marine Mammal and Seabird Survey of the Southern California Bight Area. Volume III - Principal Investigators' Reports. The Regents of the University of California, University of California, Santa Cruz, CA. 472 pp.

Lowry, M., Marine Mammal Turtle Division, Southwest Fisheries Science Center, National Marine Fisheries Service, NOAA, DOC, 14 November 2013, Personal Communication.

Lowry, M.S. 2002. Counts of northern elephant seals at rookeries in the southern California Bight: 1981-2001. NOAA-TM-NMFS-SWFSC-345, U.S. Dept. Comm., NOAA, NMFS, SWFSC.

Lowry, M. S. and O. Maravilla-Chavez. 2005. Recent Abundance of California Sea Lions in Western Baja California, Mexico and the United States. In D. K. Garcelon and C. A. Schwemm (editors), Proceedings of the Sixth California Islands Symposium, Ventura, California, December 1-3, 2003. p. 485-497. National Park Service Technical Publication CHIS-05-01, Institute for Wildlife Studies, Arcata, California.

Lowry, M.S., W.L. Perryman, M.S. Lynn, R.L. Westlake, and F. Julian. 1996. Counts of northern elephant seals, m*irounga angustirostris*, from large-format aerial photographs taken at rookeries in Southern California during the breeding season. Fish. Bull. 94:176-185.

Lowry, M.S., J.V. Carretta and K.A. Forney. 2008. Pacific Harbor Seal Census in California During May-July 2002 and 2004. California Fish and Game 94(4):180-193.

National Marine Fisheries Service (NMFS). 2000. Small takes of marine mammals incidental to specified activities; oil and gas exploration drilling activities in the Beaufort Sea. Fed. Regist. 65(197, 11 Oct.): 60407-60411.

NMFS. 2001. Small takes of marine mammals incidental to specified activities; missile launch operations from San Nicolas Island, California. Fed. Regist. 66(154, 9 Aug.): 41834-41841.

NMFS. 2002. Small takes of marine mammals incidental to specified activities; missile launch operations from San Nicolas Island, CA. Fed. Regist. 67(170, 3 Sep.): 56271-56276.

NMFS. 2010. Taking and importing marine mammals; taking marine mammals incidental to missile launch operations from San Nicolas Island, CA. Fed. Regist. 75(226, 24 Nov.): 71672-71674.

Reeves, R.R., R.J. Hofman, G.K. Silber, and D. Wilkinson (eds.). 1996. Acoustic deterrence of harmful marine mammal-fishery interactions: proceedings of a workshop held in Seattle, Washington, 20-22 March 1996. NOAA Tech. Memo NMFS-OPR-10. U.S. Dep. Commerce, Nat. Mar. Fish. Serv. 70 p.

Richardson, W.J., C.R. Greene Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego, CA. 576 p.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. Aquatic Mammals 33(4):i-iv, 411-522.

Ugoretz, J. and C.R. Greene, Jr. 2012. Pinniped Monitoring During Missile Launches on San Nicolas Island, California, September 2011 - September 2012. Naval Air Warfare Center Weapons Division, Point Mugu, CA. 65 p.

Ugoretz, J. 2013. Pinniped Monitoring During Missile Launches on San Nicolas Island, California, September 2012 - September 2013. Naval Air Warfare Center Weapons Division, Point Mugu, CA. 65 p.

Ugoretz, J. 2014. Final Comprehensive Report - Pinniped Monitoring During Missile Launches on San Nicolas Island, California, June 2009 - June 2014. Naval Air Warfare Center Weapons Division, Point Mugu, CA. 73 pp.

Ugoretz, J. 2015. Pinniped Monitoring During Missile Launches on San Nicolas Island, California, December 2014 - November 2015. Naval Air Warfare Center Weapons Division, Point Mugu, CA. 36 pp.

Ugoretz, J. 2016. Pinniped Monitoring During Missile Launches on San Nicolas Island, California, December 2015 – November 2016. Naval Air Warfare Center Weapons Division, Point Mugu, CA. 35 pp.

Welch, P.D. 1967. The use of FFT for the estimation of power spectra: a method based on time averaging over short modified periodograms. IEEE Trans. Audio Electroacoust. AU 15(2):70-73.

APPENDIX A:
INCIDENTAL HARRASSMENT AUTHORIZATION
12 JUNE 2019 – 11 JUNE 2020

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

JUN 12 2019

INCIDENTAL HARASSMENT AUTHORIZATION

The U.S. Navy (Navy) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA; 16 U.S.C. 1371(a)(5)(D)) to harass marine mammals incidental to target and missile launch activities on San Nicolas Island, California at the Naval Air Center Weapons Division, Point Mugu Sea Range, when adhering to the following terms and conditions.

1. This Incidental Harassment Authorization (IHA) is valid from June 12, 2019 to June 11, 2020.

2. This IHA is valid only for target and missile launch activities on San Nicolas Island, California, associated with defensive strategies and other weapons systems testing for the Naval Air Center Weapons Division, Point Mugu Sea Range.

3. General Conditions

   (a) A copy of this IHA must be in the possession of the Navy, its designees, work crew personnel, and Protected Species Observers (PSOs) operating under the authority of this IHA.

   (b) The species authorized for taking are California sea lions (*Zalophus californianus*), harbor seals (*Phoca vitulina*), and northern elephant seals (*Mirounga angustirostris*).

   (c) The taking, by Level B harassment only, is limited to the species listed in condition 3(b). Table 1 (attached) provides the authorized number of takes per species and stock.

   (d) The taking by Level A harassment (injury), serious injury, or death of any of the species listed in condition 3(b) of this IHA or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA.

   (e) The Navy may conduct a maximum of 40 launch events associated with target and missile launch activities.

4. Mitigation Measures

The holder of this IHA is required to implement the following mitigation measures:

(a) Personnel must not enter pinniped haul-outs. Personnel may be adjacent to pinniped haul-outs prior to and following a launch for monitoring purposes.

(b) Missiles must not cross over pinniped haul-outs at elevations less than 305 meters (m) (1,000 ft).

(c) The Navy may not conduct more than 10 launch events at night.

(d) Launches must not occur during February through April, to the maximum extent practicable.

(e) Launches must be limited during January through February and June through July, to the maximum extent practicable.

(f) All aircraft and helicopter flight paths must maintain a minimum distance of 305 m from recognized seal haulouts and rookeries, to the maximum extent practicable.

(g) If a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized takes are met, the Navy must consult with NMFS before the next launch event.

(h) The Navy must review the launch procedure and monitoring methods, in cooperation with NMFS, if any incidents of injury or mortality of a pinniped are discovered during post-launch surveys, or if surveys indicate possible effects to the distribution, size, or productivity of the affected pinniped populations as a result of the specified activities. If necessary, appropriate changes must be made through modification to this Authorization prior to conducting the next launch of the same vehicle.

5. Monitoring Measures

The Navy must obtain visual, video and audio, and acoustic data from up to three pinniped haulout monitoring sites during each launch event, to the maximum extent practicable. The holder of this IHA is required to abide by the following marine mammal and acoustic monitoring requirements:

(a) *Visual Monitoring* - Visual monitoring will be conducted during preparations for video and acoustic monitoring, as described in condition 5(b) of this Authorization.

i. Visual monitoring must be conducted before and after launches, including scanning the affected haulout beaches and counting the number and species of pinnipeds over a 15-30 minute period.

ii. Prior to a launch event, Navy personnel must make observations of the monitored pinniped haulout and record the numbers and species of pinnipeds observed on field data sheets.

iii. After a launch event, Navy personnel must return to the monitored pinniped haulout and record the numbers and species of pinnipeds that remain on the haul-out sites and any notable changes.

(b) *Video and Audio Monitoring* – Before each launch, Navy personnel must set up or activate up to three video cameras (either high-definition video cameras, or Forward-Looking Infrared Radiometer (FLIR) thermal imaging cameras for night launch events) such that they overlook the monitoring sites. Each camera will be set to record a focal group of pinnipeds within the haulout for the maximum recording time permitted by the camera capacity. Video and audio monitoring must be conducted by recording continuously from a minimum of 2 hours before the event to approximately 1 hour after the event in order to:

i. Determine the composition of the focal subgroup of pinnipeds (approximate numbers and sexes of each age class).

ii. Describe the launch event, including documenting the occurrence of a launch event, the type of target/missile launched, the timing of the event, and duration of audibility.

iii. Document movements of pinnipeds, including number and proportion moving, direction and distance moved, and pace of movement (slow or vigorous). In addition, the following variables concerning the circumstances of the observations must also be recorded from the videotape or from direct observations at the site:
   1. Study location
   2. Local time
   3. Weather (including an estimate of wind strength and direction, and presence of precipitation)
   4. Tide state.

iv. Identify and document any change in behavior or movements of pinnipeds that occurs at the time of the launch event;

v. 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 missile path during each launch; from the data accumulated across a series of launches, to attempt to establish the "dose-response" relationship for launch sounds under different launch conditions if possible;

vi. Ascertain periods or launch conditions when pinnipeds are most and least responsive to launch activities, and

vii. Document take by harassment

1. Pinnipeds that are exposed to launch sounds strong enough to cause TTS; or

2. Pinnipeds that leave the haulout site, or exhibit prolonged movement (greater than 10 m) or prolonged behavioral changes (such as pups separated from mothers) relative to their behavior immediately prior to the launch.

(c) *Acoustic Monitoring* - The Navy must use up to four autonomous audio recorders to make acoustical measurements. During each launch, these must be located as close as practicable to pinniped haulout monitoring sites and near the launch pad itself. The monitored pinniped haulout sites must typically include one site as close as possible to the missile's planned flight path and one or two locations farther from the flight path within the area of potential impact with pinnipeds present. Autonomous Terrestrial Acoustic Recorders must be deployed at the recording locations on the launch day well before the launch time, and must be retrieved later the same day. Acoustic measurements must be collected and reported consistent with section 13.2 of the Navy's application.

(d) Marine mammal monitoring must be conducted by qualified, trained protected species observers.

6. Reporting

The holder of this IHA is required to:

(a) Submit a draft report on all monitoring conducted under the IHA within ninety calendar days of the completion of marine mammal and acoustic monitoring or sixty days prior to the issuance of any subsequent IHA or incidental take regulations for this project, whichever comes first. A final report must be prepared and submitted within thirty days following resolution of comments on the draft report from NMFS. This report must contain the informational elements described in Section 5 of this Authorization.

(b) Reporting injured or dead marine mammals:

i. In the unanticipated event that the specified activity clearly causes the take of a marine mammal in a manner prohibited by this IHA, such as serious injury, or mortality, the Navy must immediately cease the specified activities and report the incident to the NMFS Office of Protected Resources (301-427-8401) and the West Coast Stranding Coordinator (562-980-3230). The report must include the following information:

1. Time and date of the incident;

2. Description of the incident;

3. Environmental conditions (e.g., wind speed and direction, cloud cover, and visibility);

4. Description of all marine mammal observations and active sound source use in the 24 hours preceding the incident;

5. Species identification or description of the animal(s) involved;

6. Fate of the animal(s); and

7. Photographs or video footage of the animal(s).

Activities must not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with the Navy to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. The Navy may not resume their activities until notified by NMFS.

ii. In the event the Navy discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (e.g., in less than a moderate state of decomposition), the Navy must immediately report the incident to the Office of Protected Resources, NMFS, and the West Coast Region Stranding Coordinator, NMFS. The report must include the same information identified in 6(b)(i) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with APPLICANT to determine whether additional mitigation measures or modifications to the activities are appropriate.

iii. In the event that the Navy discovers an injured or dead large whales or other cetaceans, and the lead observer determines that the injury or death is not associated with or related to the specified activities (e.g., previously

wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the Navy must report the incident to the Office of Protected Resources, NMFS, and the West Coast Region Stranding Coordinator, NMFS, within 24 hours of the discovery.

7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

8. Renewals - On a case-by-case basis, NMFS may issue a one-year IHA renewal with an expedited public comment period (15 days) when 1) another year of identical or nearly identical activities is planned or 2) the activities would not be completed by the time the IHA expires and a second IHA would allow for completion of the activities beyond that allowed for under this IHA, provided all of the following conditions are met:

   (a) A request for renewal is received no later than 60 days prior to expiration of the current IHA.

   (b) The request for renewal must include the following:

      i. An explanation that the activities to be conducted beyond the initial dates either are identical to the previously analyzed activities or include changes so minor (e.g., reduction in pile size) that the changes do not affect the previous analyses, take estimates, or mitigation and monitoring requirements.

      ii. A preliminary monitoring report showing the results of the required monitoring to date and an explanation showing that the monitoring results do not indicate impacts of a scale or nature not previously analyzed or authorized.

   (c) Upon review of the request for renewal, the status of the affected species or stocks, and any other pertinent information, NMFS determines that there are no more than minor changes in the activities, the mitigation and monitoring measures remain the same and appropriate, and the original findings remain valid.

Donna S. Wieting,
Director, Office of Protected Resources
National Marine Fisheries Service

6/12/19
Date

Attachment

Table 1. Authorized Take by Level B harassment.

Species	Authorized Level B harassment
California sea lion	11,000
Harbor seal	480
Northern elephant seal	40

APPENDIX B:

ACOUSTIC MEASUREMENTS OF SNI MISSILE LAUNCHES

JULY 2019 – JANUARY 2020

GREENRIDGE SCIENCES, INC.

GREENERIDGE SCIENCES, INC.
5266 HOLLISTER AVE, STE 107 • SANTA BARBARA, CALIFORNIA 93111 • TEL/FAX 805-967-7720

MEMORANDUM

To: Greg Sanders, NAVAIR Ranges Sustainability Office

From: Katherine H. Kim, Robert G. Norman

Date: 19 March 2021

Re: Acoustic Measurements of SNI Missile Launches: July 2019 – January 2020
[GSI Technical Memorandum 546-1], Revision 2

Introduction

The material in this document has been provided for inclusion in the technical report stipulated by NAVAIR's current Letter of Authorization under the Marine Mammal Protection Act. The material presents the results of sound measurements of twelve missile launches over pinniped haul-outs on San Nicolas Island on 12 July 2019, 14 July 2019, 12 August 2019, 18 August 2019, 26 September 2019, 3 October 2019, 16 December 2019, 20 December 2019, 26 January 2020, and 31 January 2020. Two dates—14 July 2019 and 26 January 2020—were "dual" launches: missiles launched 1 hr 10 min apart.

Methods

Various federal, state, and other organizations recommend specific acoustic thresholds for the onset of temporary threshold shift (TTS) and permanent threshold shift (PTS) in marine mammals. The thresholds cited in the *Results* section below are for impulsive noise (noise with high peak sound pressure, short duration, fast rise-time, and broad frequency content) from the U.S. Navy technical report by J. Finneran, E. Henderson, D. Houser, K. Jenkins, S. Kotecki, and J. Mulsow, *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)*, published by the Space and Naval Warfare Systems Center Pacific, San Diego, CA in June 2017.

As with Navy Phase II criteria (Finneran & Jenkins, 2012), auditory weighting functions were applied to acoustic data, prior to the calculation of acoustic metrics such as sound exposure level (SEL) and sound pressure level (SPL), to account for various species' frequency-dependent hearing sensitivity. However, unlike Navy auditory weighting functions for Phase II which were based on "M-weighting" curves for "functional hearing groups", Navy Phase III weighting functions are defined by a generic band-pass filter whose shape is determined by parameters specific to a slightly different classification of nine "marine species hearing groups".

In addition to differences in auditory weighting functions, TTS and PTS thresholds differ between Navy Phase II and Phase III. In Navy Phases II and III, pinnipeds were classified into two hearing groups based upon pinnipeds' two scientific families: Otariidae (eared seals: sea lions and fur seals) and Phocidae (earless seals, or true seals). However, in Navy Phase II, TTS thresholds were the same for both Otariids

and Phocids in air, as were PTS thresholds. In Navy Phase III, different TTS and PTS thresholds are defined for Otariids in air (OA) and Phocids in air (PA). The Navy Phase III thresholds for pinnipeds in air are summarized in the table below:

TABLE 1. Navy Phase III TTS and PTS thresholds for pinnipeds in air.

Group	Non-impulsive		Impulsive			
			TTS Threshold		PTS threshold	
	TTS threshold SEL[a] (weighted)	PTS threshold SEL[a] (weighted)	SEL[a] (weighted)	Peak SPL[b] (unweighted)	SEL[b] (weighted)	Peak SPL[b] (unweighted)
OA[c]	157	177	146	170	161	176
PA[d]	134	154	123	155	138	161

[a] SEL thresholds are in dB re (20 µPa)^2·s
[b] SPL thresholds in dB re 20 µPa in air
[c] OA-Otariid in air (includes California sea lion)
[d] PA-Phocid in air (includes Pacific harbor seal)

The TTS and PTS thresholds relevant to San Nicolas Island missile launches and utilized in this report are those listed under "Impulsive" in Table 1.

Results

*Measured missile sounds exceeding the level considered sufficient to cause **temporary threshold shift (TTS) in Otariids in air**, specifically, weighted sound exposure level (SEL) of 146 dB re 20 µPa^2-s or unweighted peak sound pressure level (SPL) of 170 dB re 20 µPa:*

No measured sound levels exceeded the weighted SEL nor unweighted peak SPL thresholds for TTS for Otariids.

*Measured missile sounds exceeding the level considered sufficient to cause **permanent threshold shift (PTS) in Otariids in air**, specifically, weighted SEL of 161 dB re 20 µPa^2-s or unweighted peak SPL of 176 dB re 20 µPa:*

No measured sound levels exceeded the weighted SEL threshold nor unweighted peak SPL thresholds for PTS for Otariids.

*Measured missile sounds exceeding the level considered sufficient to cause **TTS in Phocids in air**, specifically, weighted SEL of 123 dB re 20 µPa^2-s or unweighted peak SPL of 155 dB re 20 µPa:*

Three missile launches exceeded TTS thresholds for Phocids in air.

Two of these launches—occurring on 26 September 2019 and 3 October 2019—involved Class 14 vehicles which exceeded TTS thresholds based upon weighted SEL. These thresholds were exceeded at two monitoring sites—B807 and Dos Coves—with weighted SEL values of 129.4 (B807 on 26 September 2019), 131.7 (Dos Coves on 3 October 2019), and 129.7 dB re 20 µPa^2-s (B807 on 3 October 2019). It should be noted that B807 is a launch site, located at sea level and very near the beach.

The third of these launches—occurring on 26 January 2020—involved a Class 5 vehicle which exceeded TTS thresholds based upon unweighted peak SPL, with an unweighted peak SPL of 157.3 dB re 20 µPa measured at the Red Eye West monitoring site.

Measured missile sounds exceeding the level considered sufficient to cause **PTS in Phocids in air**, specifically, weighted SEL of 138 dB re 20 µPa^2-s or unweighted peak SPL of 161 dB re 20 µPa:

No measured sound levels exceeded the weighted SEL nor unweighted peak SPL thresholds for PTS for Phocids.

The highest levels measured for the twelve missile flights:

The highest measured, unweighted (flat weighting), sound levels—peak pressure, SPL, and SEL—were all measured at monitoring site Red Eye West for the first of two Vehicle Class 5 missile launches which took place on 26 January 2020.

Atypical processing of missile flights:

For the Vehicle Class 1 missile launch on 18 August 2019, detecting the missile launch on the recordings was difficult for two of the four monitoring sites (Phoca Reef and Red Eye West). At the Phoca Reef site, a very faint, low-frequency rumble (possibly wind noise) was detected at time 31:30–32:00 minutes into the recording but could not be definitively associated with the missile. At the Red Eye West site, jet sounds were heard passing by 5 to 6 times, but it was difficult to discern the launch event or missile.

For the Vehicle Class 14 missile launch on 26 September 2019, the recording from the Phoca Reef monitoring site revealed occasional, very faint, distant jet rumble (possibly wind noise), but no sounds were identifiable as launch-related. The recordings and analyses of this launch's other monitoring sites (Red Eye West, Dos Coves, and the launch site B807) were nominal.

For the Vehicle Class 14 missile launch on 3 October 2019, Autonomous Terrestrial Acoustic Recorder (ATAR) #3 was not deployed. Similarly, for the Vehicle Class 5 missile launch on 31 January 2020, there was no ATAR #3 recording corresponding to monitoring site Dos Coves.

On 26 January 2020, the ATAR located at the Alpha launch site for the Vehicle Class 5 dual launches appeared to suffer from a defective left channel (corresponding to the less sensitive of the two microphones). For the first launch at time 12:50:00 Local Time, the left channel showed sporadic, low-frequency outbursts which were not aligned to sounds on the right channel. The right channel, equipped with a sensitive microphone, was heavily overloaded, as is typical near the launch pad. Thus, this recording was unusable. For the second launch at time 14:00:00 Local Time, the left channel audio was badly distorted, with peak amplitude of only ±2 Pa, far below pressure levels expected near the launch site. Again, the recording from this site was not analyzed.

Also, on 26 January 2020 at time 14:00:00 Local Time, the recording from monitoring site Red Eye West was not suitable for analysis. The launch event occurred at 09:04 minutes into the recording. The audio file featured very loud sounds reminiscent of something nibbling on the event channel until approximately 21:30 minutes into the recording. There was no corresponding sound on the ambient noise channel.

In summary, 40 out of 48 total recordings of missiles/monitoring sites were analyzed and presented in this report.

TABLE 2. Pulse parameters for unweighted, OA-weighted, and PA-weighted sound from SNI missile launches, July 2019 – January 2020.

Launch Date & Monitoring Site	Unweighted sound				OA-weighted sound			PA-weighted sound		
	Pk	SPL	SEL	Dur	SPL	SEL	Dur	SPL	SEL	Dur
12 July 2019: Vehicle Class 1										
Red Eye East	105.9	90.2	99.6	8.8	68.0	77.4	8.8	74.6	84.1	8.8
Dos Coves	120.9	105.2	113.6	6.9	91.7	98.6	4.9	96.6	103.8	5.3
Bachelor	113.3	100.2	109.4	8.4	80.7	89.0	6.8	86.7	94.9	6.6
B807	140.7	120.7	127.2	4.5	110.3	116.5	4.1	114.3	120.5	4.2
14 July 2019: Vehicle Class 5										
Phoca Reef (1/2)	97.2	79.5	90.3	12.2	49.0	60.8	15.1	52.4	63.9	14.2
Phoca Reef (2/2)	99.9	78.7	87.3	7.3	49.1	58.2	8.2	53.5	62.6	8.1
Dos Coves (1/2)	143.5	134.2	120.6	0.0	106.2	98.2	0.2	109.2	102.3	0.2
Dos Coves (2/2)	144.0	132.1	120.5	0.1	104.5	97.0	0.2	108.6	101.4	0.2
Bachelor (1/2)	137.2	121.6	117.9	0.4	91.0	87.7	0.5	95.3	92.3	0.5
Bachelor (2/2)	134.3	118.8	115.7	0.5	88.4	85.7	0.5	92.6	90.2	0.6
Alpha (1/2)	132.5	115.5	119.8	2.7	89.2	93.2	2.5	95.3	99.0	2.4
Alpha (2/2)	133.1	115.0	119.1	2.5	86.8	91.2	2.7	92.4	96.7	2.7
12 August 2019: Vehicle Class 5										
Phoca Reef	102.8	90.5	101.3	12.0	62.7	72.9	10.6	67.9	78.1	10.4
Red Eye West	144.5	122.3	121.0	0.7	103.1	102.3	0.9	107.1	106.8	0.9
Dos Coves	140.8	130.6	119.0	0.1	100.9	91.4	0.1	106.6	96.9	0.1
Alpha	134.8	112.8	116.7	2.4	81.1	85.3	2.7	85.3	89.8	2.8
18 August 2019: Vehicle Class 1										
Phoca Reef	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Red Eye West	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dos Coves	123.9	107.3	115.9	7.2	93.5	101.0	5.6	99.1	106.6	5.6
B807	141.0	120.9	127.5	4.6	109.5	115.8	4.3	113.6	120.0	4.4
26 September 2019: Vehicle Class 14										
Phoca Reef	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Red Eye West	119.5	99.2	103.4	2.6	70.8	75.2	2.7	76.3	80.6	2.7
Dos Coves	122.9	107.9	110.4	1.8	97.0	98.9	1.5	101.3	103.3	1.8
B807	151.1	137.1	134.9	0.6	128.2	125.1	0.5	132.6	129.4	0.5
3 October 2019: Vehicle Class 14										
Dos Coves	148.9	134.6	136.2	1.5	124.9	126.5	1.4	130.2	131.7	1.4
Red Eye West	98.4	84.3	84.3	2.5	53.1	57.3	2.6	58.6	62.7	2.6
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B807	151.1	137.5	135.0	0.6	129.1	125.3	0.4	133.4	129.7	0.4
16 December 2019: Vehicle Class 5										
Red Eye East	116.5	101.7	107.4	3.7	86.0	91.2	3.3	90.2	95.6	3.4
Red Eye West	116.2	97.4	103.0	3.6	79.3	84.6	3.4	85.2	90.6	3.5
Dos Coves	96.2	78.6	89.2	11.3	60.1	67.5	5.5	65.9	73.6	5.8
Alpha	136.3	113.9	117.6	2.3	81.6	85.8	2.6	85.7	90.2	2.8
20 December 2019: Vehicle Class 5										
Red Eye East	134.8	118.7	122.7	2.5	103.9	107.6	2.4	110.3	114.1	2.4
Red Eye West	115.8	102.3	107.3	3.1	78.3	83.2	3.0	84.9	89.7	3.0
Dos Coves	136.5	122.7	116.6	0.2	94.3	87.4	0.2	97.7	92.2	0.3
Alpha	131.3	118.5	121.9	2.2	95.6	98.7	2.0	101.6	104.6	2.0

Launch Date & Monitoring Site	CPA (km)	Unweighted sound				OA-weighted sound			PA-weighted sound		
		Pk	SPL	SEL	Dur	SPL	SEL	Dur	SPL	SEL	Dur
26 January 2020: Vehicle Class 5											
Red Eye West (1/2)		157.3	137.7	136.7	0.8	112.7	113.4	1.2	117.0	117.6	1.2
Red Eye West (2/2)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vizcaino Point (1/2)		138.2	124.3	117.5	0.2	92.4	89.9	0.6	98.1	98.5	0.5
Vizcaino Point (2/2)		137.4	127.9	116.6	0.1	90.9	89.0	0.6	95.0	93.8	0.78
Dos Coves (1/2)		145.0	135.3	120.8	0.0	102.0	98.4	0.4	105.6	102.4	0.5
Dos Coves (2/2)		145.2	134.4	120.3	0.0	102.4	98.2	0.4	106.3	102.6	0.4
Alpha (1/2)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alpha (2/2)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
31 January 2020: Vehicle Class 5											
Red Eye East		129.5	115.0	120.0	3.2	92.5	97.0	2.8	99.1	103.6	2.8
Red Eye West		115.2	101.8	106.6	3.0	81.0	84.8	2.4	87.2	91.0	2.4
Dos Coves		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alpha		136.6	123.7	127.1	2.2	102.3	105.1	1.9	107.3	110.3	2.0å

Note: Peak levels (Pk) and SPLs are in dB relative to 20 µPa. SELs or energy levels are in dB re 20 $\mu Pa^2 \cdot s$. Durations (Dur) are in seconds. N/A = data not available.

TABLE 3. Ambient broadband (10–20,000 Hz) sound levels (in dB re 20 µPa) as recorded before launches.

Date	Vehicle Class	Site	Unweighted	OA-weighted	PA-weighted
12 July 2019	1	Red Eye East	59.6	42.0	47.5
		Dos Coves	71.0	44.5	50.0
		Bachelor	66.6	42.5	48.3
		B807	74.6	43.8	48.6
14 July 2019	5	Phoca Reef (1/2)	51.3	28.0	32.9
		Phoca Reef (2/2)	51.4	23.8	27.7
		Dos Coves (1/2)	63.6	49.4	56.1
		Dos Coves (2/2)	58.0	41.4	47.9
		Bachelor (1/2)	62.7	46.7	52.0
		Bachelor (2/2)	62.8	46.4	52.1
		Alpha (1/2)	42.7	19.5	20.3
		Alpha (2/2)	49.4	21.4	24.4
12 August 2019	5	Phoca Reef	51.9	29.2	33.2
		Red Eye West	66.7	35.8	40.5
		Dos Coves	57.7	42.0	48.3
		Alpha	48.2	20.4	21.6
18 August 2019	1	Phoca Reef	N/A	N/A	N/A
		Red Eye West	N/A	N/A	N/A
		Dos Coves	69.6	46.8	53.1
		B807	46.2	20.5	26.3
26 September 2019	14	Phoca Reef	N/A	N/A	N/A
		Red Eye West	64.5	34.2	39.5
		Dos Coves	63.9	41.0	47.1
		B807	64.7	48.5	54.8
3 October 2019	14	Dos Coves	55.4	36.8	42.8
		Red Eye West	52.3	31.3	37.9
		N/A	N/A	N/A	N/A
		B807	65.5	49.6	55.7
16 December 2019	5	Red Eye East	71.1	49.4	54.6
		Red Eye West	71.6	46.1	51.9
		Dos Coves	64.5	39.2	44.9
		Alpha	67.5	34.7	38.2
20 December 2019	5	Red Eye East	59.2	35.9	41.7
		Red Eye West	62.6	43.4	49.0
		Dos Coves	64.0	39.8	45.6
		Alpha	65.7	32.9	36.4
26 January 2020	5	Red Eye West (1/2)	78.9	47.5	51.9
		Red Eye West (2/2)	N/A	N/A	N/A
		Vizcaino Point (1/2)	73.6	41.2	45.0
		Vizcaino Point (2/2)	74.1	41.9	45.8
		Dos Coves (1/2)	69.7	49.9	55.1

Date	Vehicle Class	Site	Unweighted	OA-weighted	PA-weighted
		Dos Coves (2/2)	83.2	53.1	58.1
		Alpha (1/2)	N/A	N/A	N/A
		Alpha (2/2)	N/A	N/A	N/A
31 January 2020	5	Red Eye East	65.5	47.2	52.4
		Red Eye West	61.0	40.4	43.5
		Dos Coves	N/A	N/A	N/A
		Alpha	45.2	19.3	19.6

N/A = data not available.

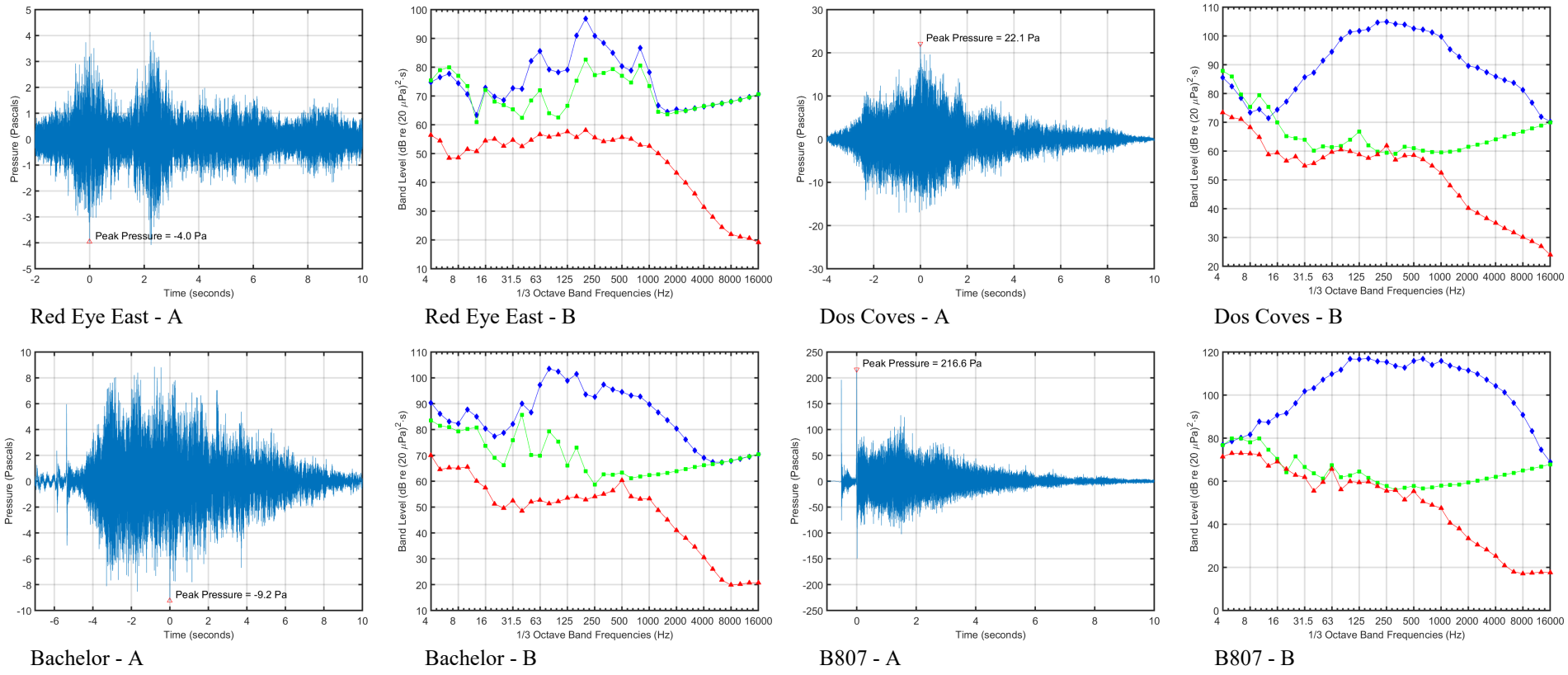
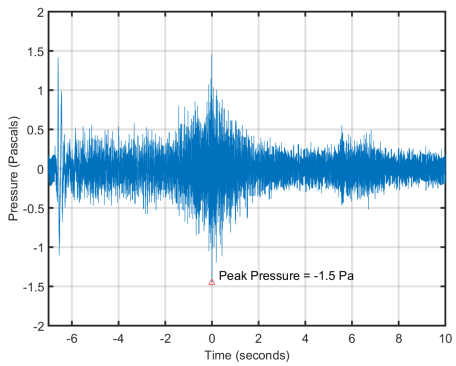
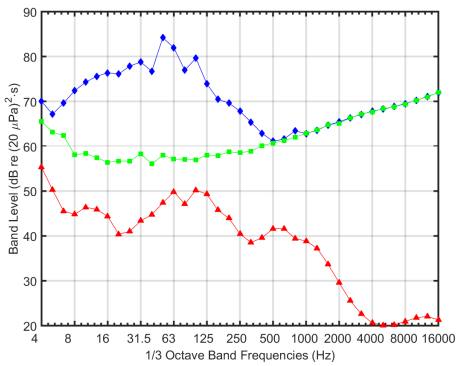


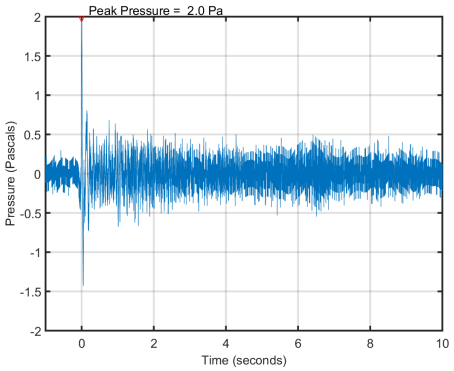
FIGURE 1. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 1 flight at 09:45:00 Local Time on 12 July 2019.
In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).



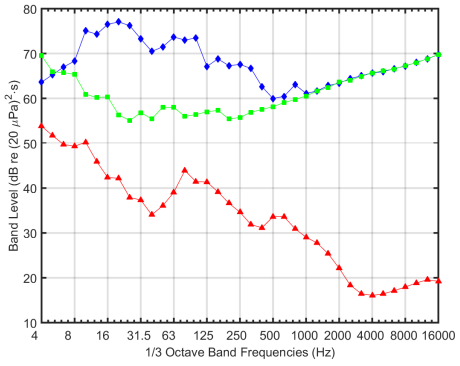
Phoca Reef (1/2) - A



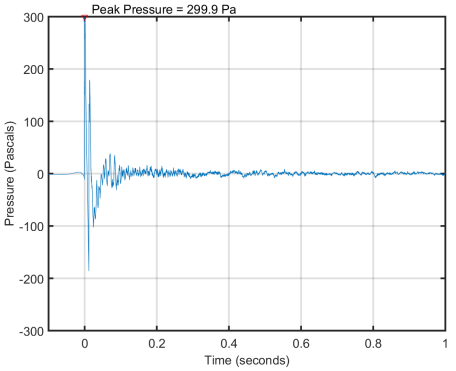
Phoca Reef (1/2) - B



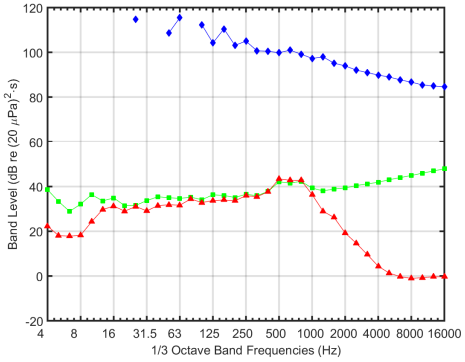
Phoca Reef (2/2) - A



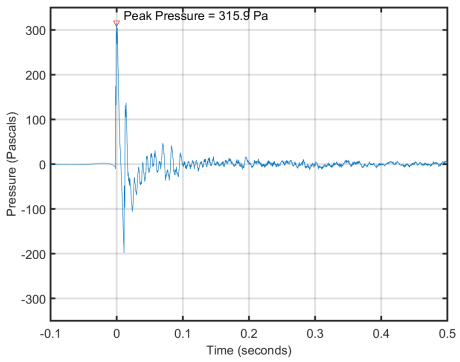
Phoca Reef (2/2) - B



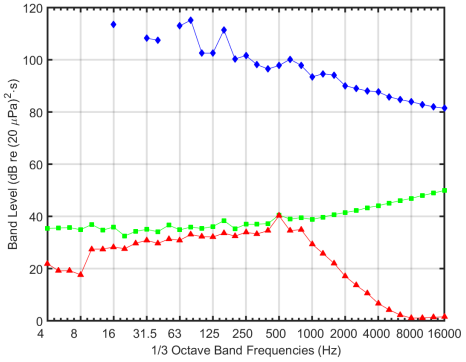
Dos Coves (1/2) - A



Dos Coves (1/2) - B

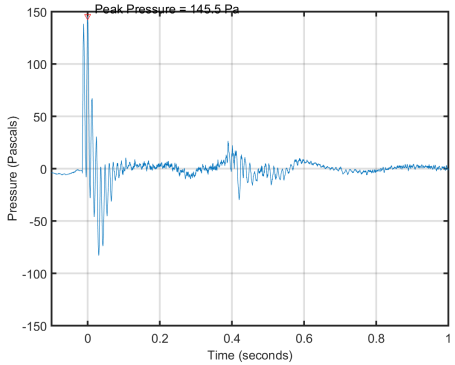


Dos Coves (2/2) - A

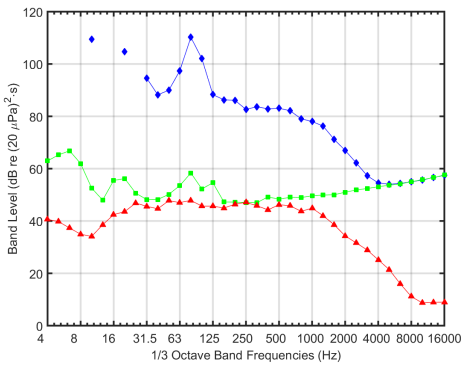


Dos Coves (2/2) - B

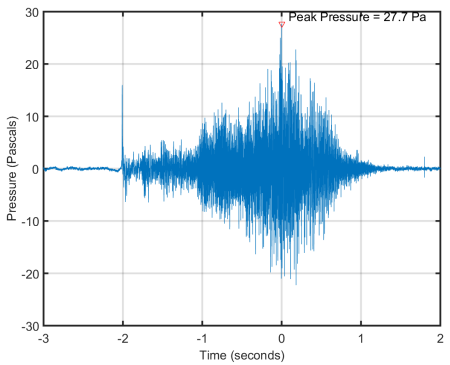
FIGURE 2A. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 5 x 2 flight at 09:20:00 Local Time on 14 July 2019. In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).



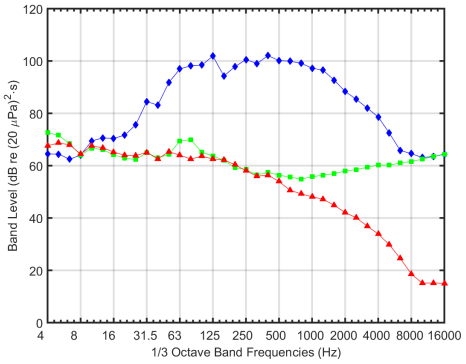
Bachelor (1/2) - A



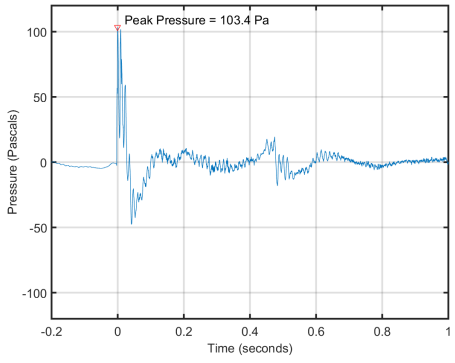
Bachelor (1/2) - B



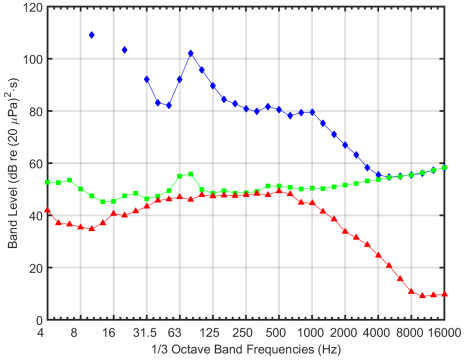
Bachelor (2/2) - A



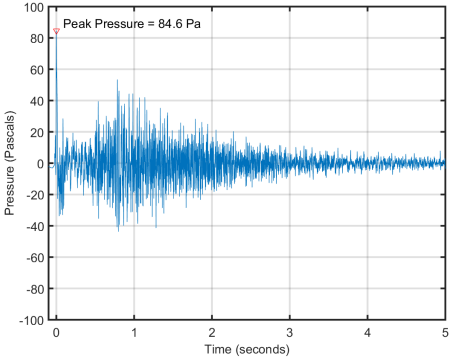
Bachelor (2/2) - B



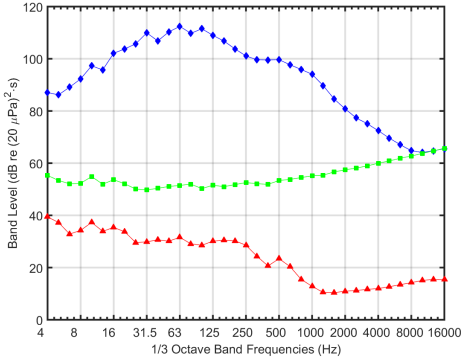
Alpha (1/2) - A



Alpha (1/2) - B



Alpha (2/2) - A



Alpha (2/2) - B

FIGURE 2B. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 5 x 2 flight at 09:20:00 Local Time on 14 July 2019. In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

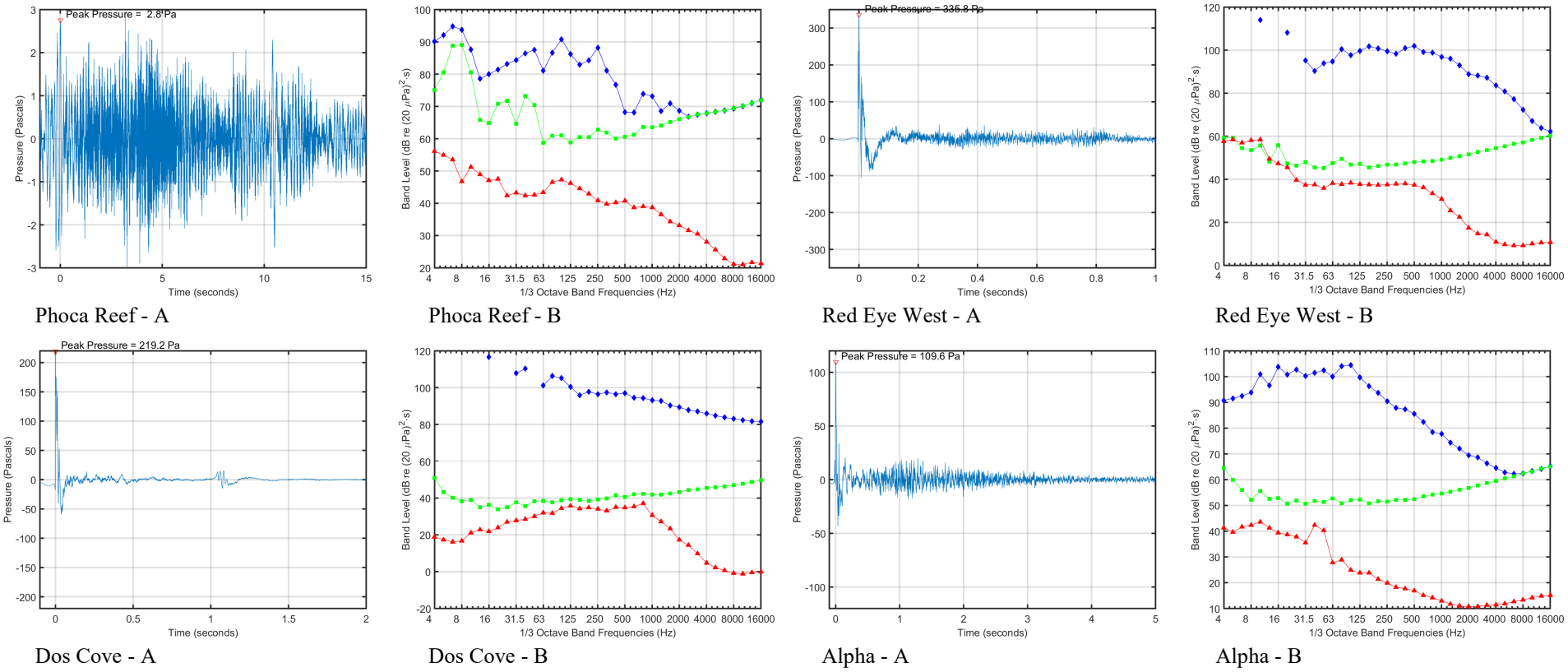
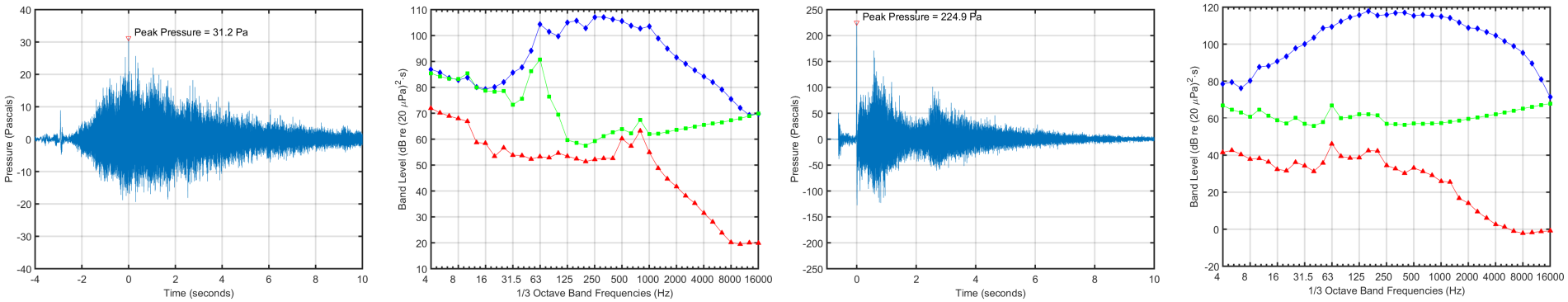
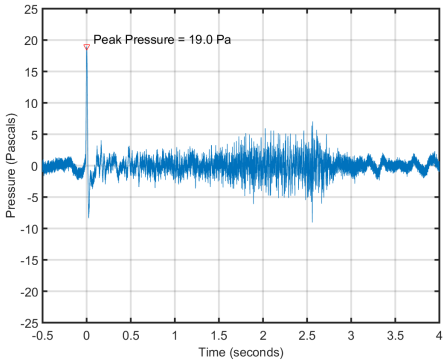


FIGURE 3. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 5 at 12:00:00 Local Time on 12 August 2019.
In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

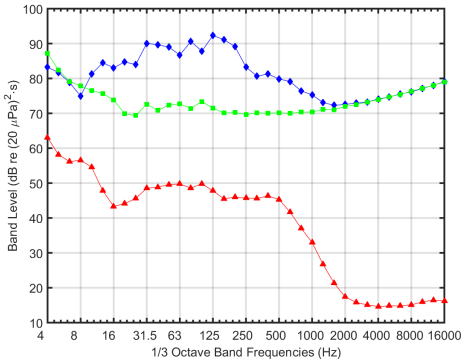


Dos Coves - A | Dos Coves - B | B807 - A | B807 - B

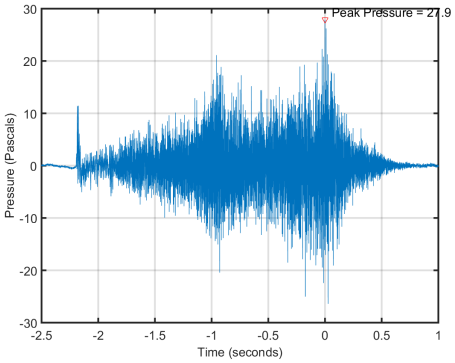
FIGURE 4. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 1 flight at 14:30:00 on 18 August 2019.
In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).



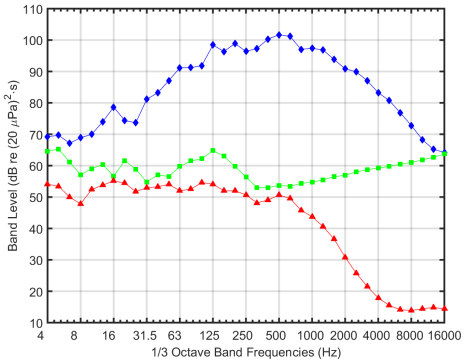
Red Eye West - A



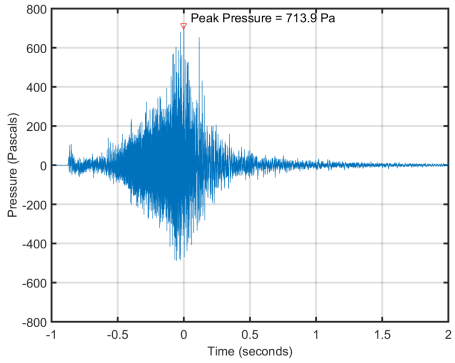
Red Eye West - B



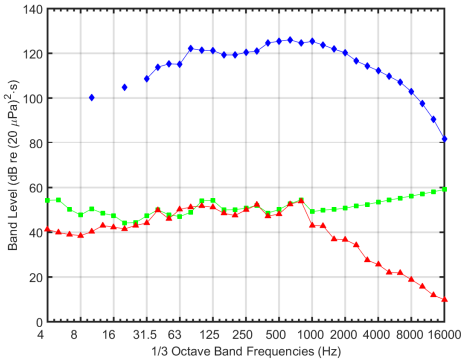
Dos Coves - A



Dos Coves - B

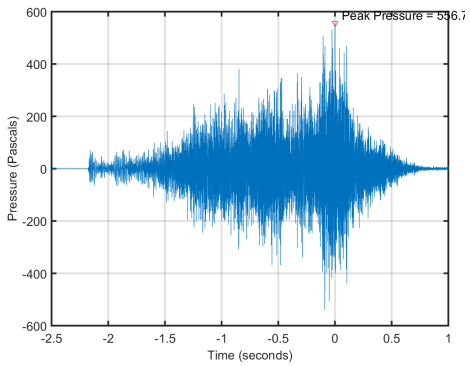


B807 - A

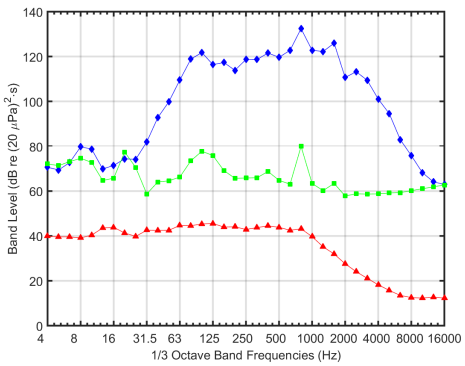


B807 - B

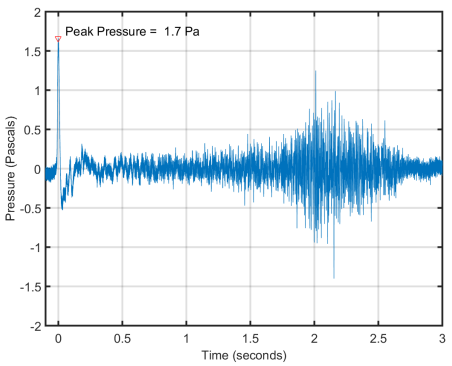
FIGURE 5. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 14 flight at 09:23:00 Local Time on 26 September 2019. In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).



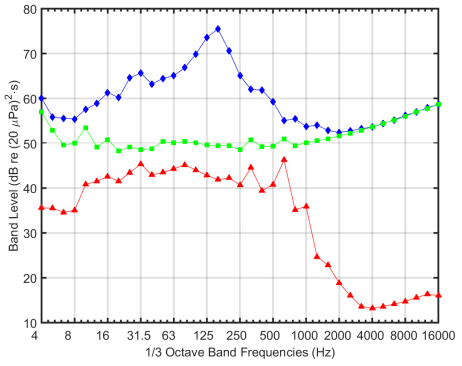
Dos Coves - A



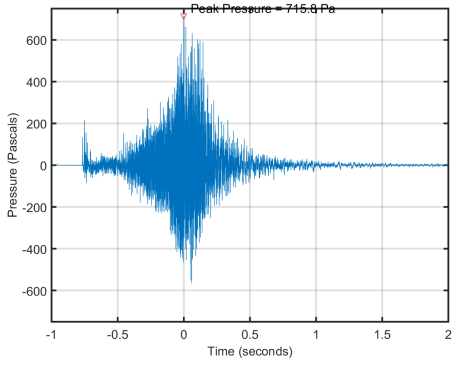
Dos Coves - B



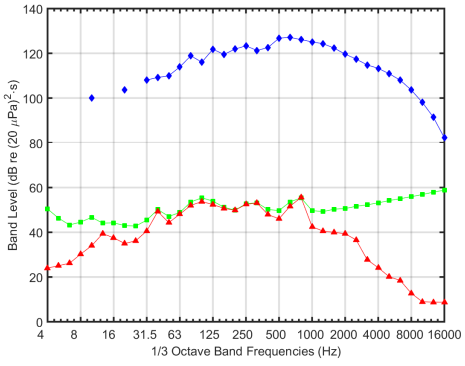
Red Eye West - A



Red Eye West - B



B807 - A



B807 - B

FIGURE 6. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 14 flight at 10:42:00 Local Time on 3 October 2019. In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

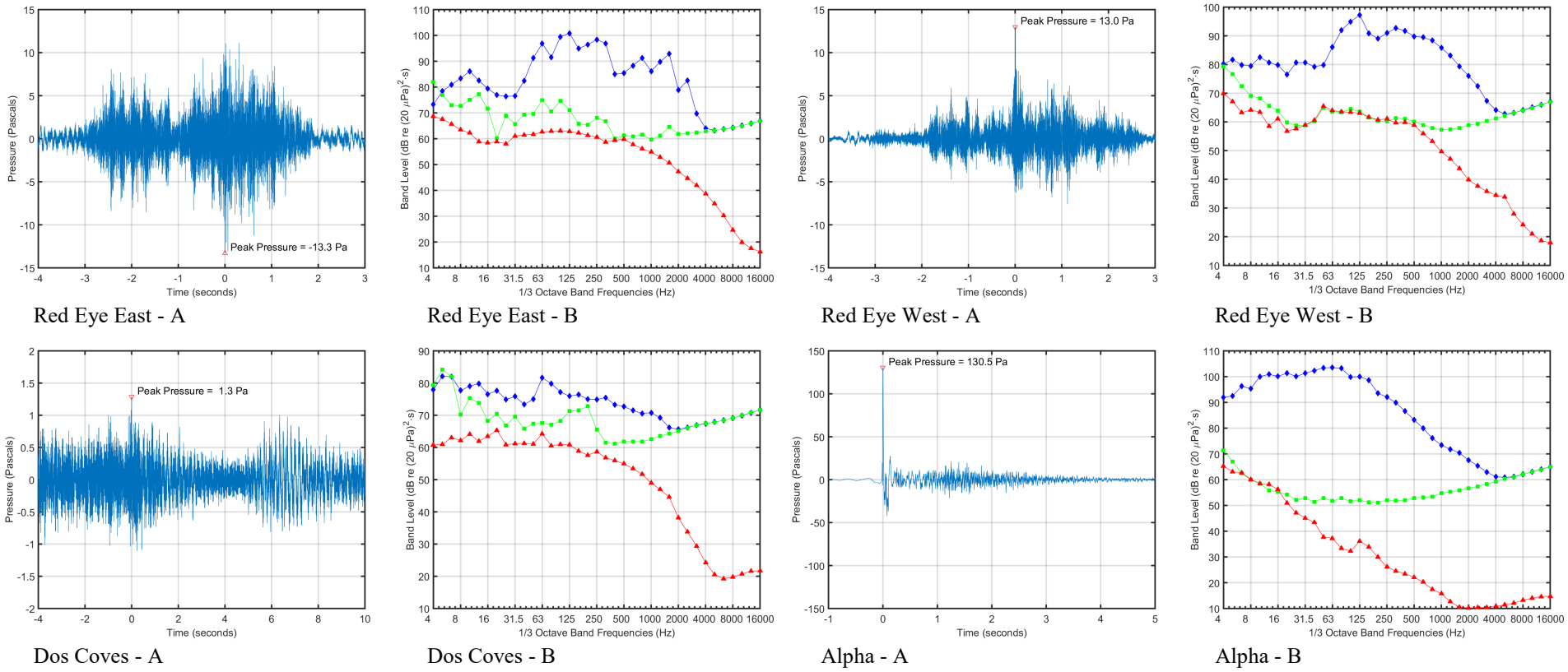


FIGURE 7. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 5 flight at 11:55:00 Local Time on 16 December 2019. In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

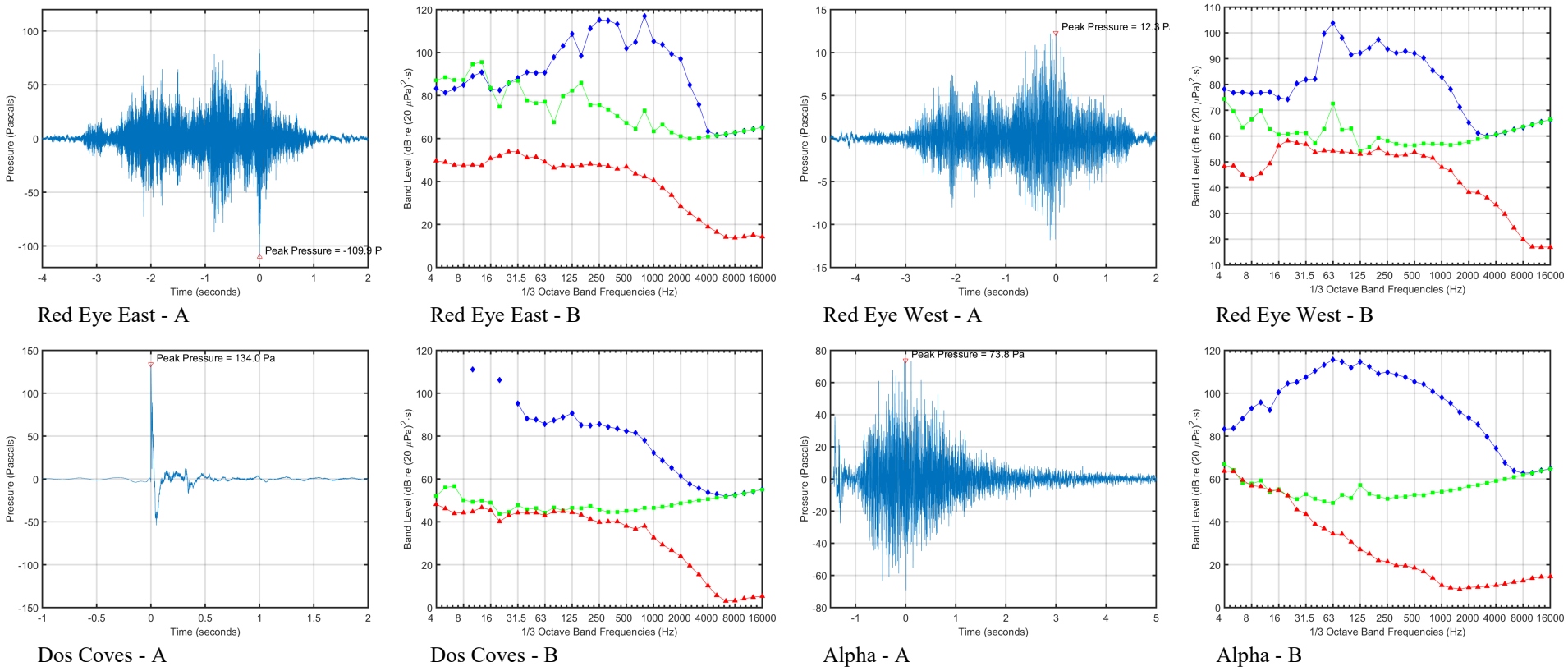
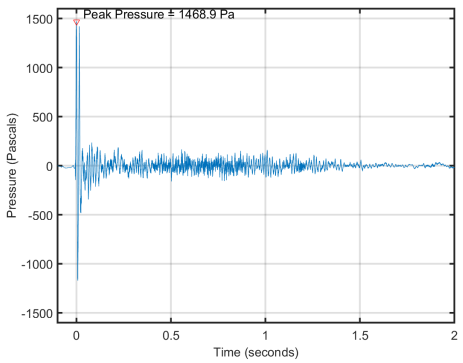
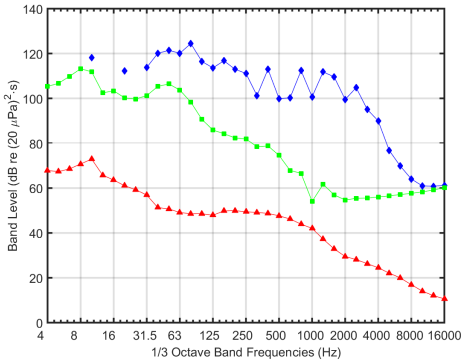


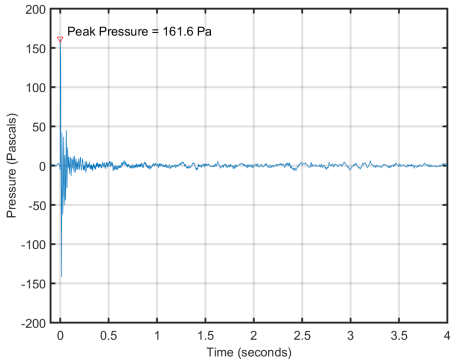
FIGURE 8. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 5 flight at 11:00:00 Local Time on 20 December 2019. In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).



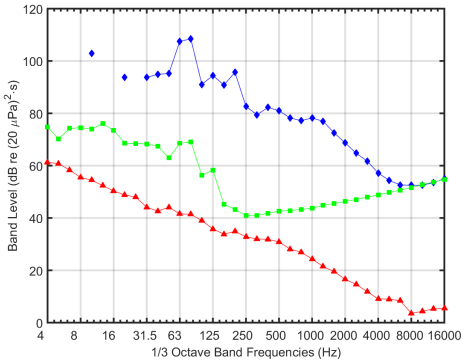
Red Eye West (1/2) - A



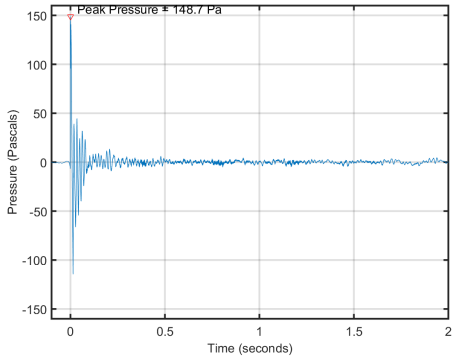
Red Eye West (1/2) - B



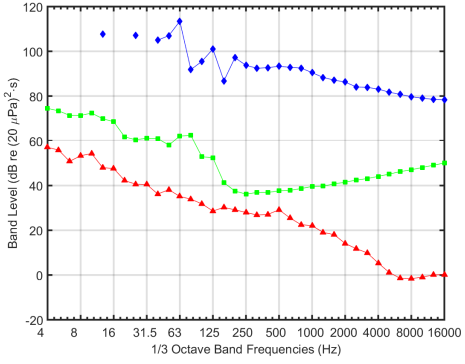
Vizcaino Point (1/2) - A



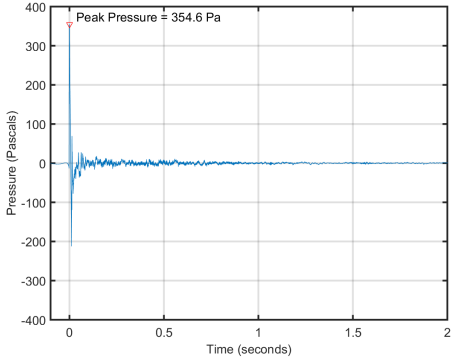
Vizcaino Point (1/2) - B



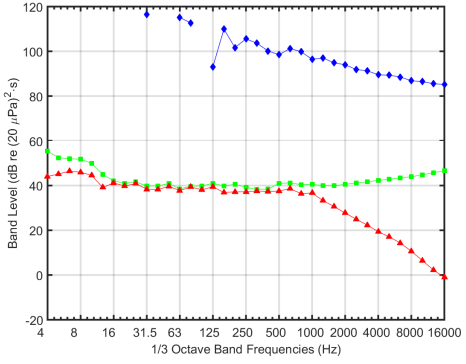
Vizcaino Point (2/2) - A



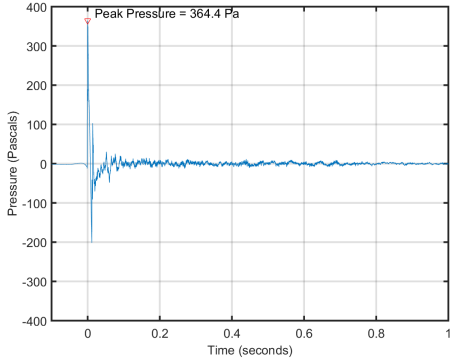
Vizcaino Point (2/2) - B



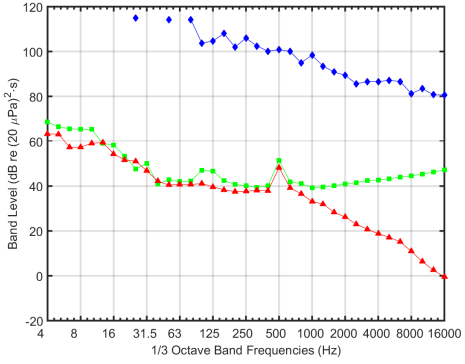
Dos Coves (1/2) - A



Dos Coves (1/2) - B



Dos Coves (2/2) - A



Dos Coves (2/2) - B

FIGURE 9. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 5 x 2 flight at 12:50:00 Local Time on 26 January 2020. In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).

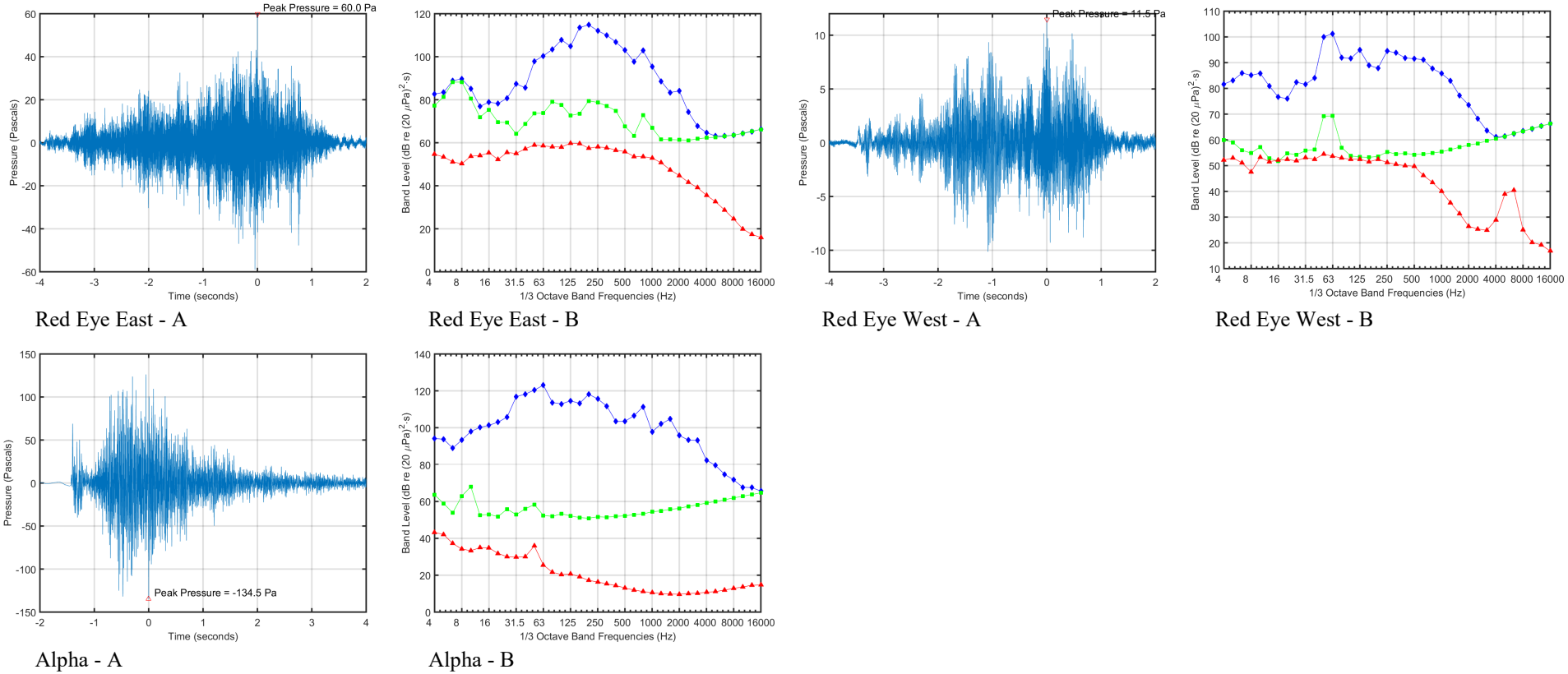


FIGURE 10. (A) Pressure waveform and (B) one-third octave band levels for a Vehicle Class 5 flight at 12:30:00 Local Time on 31 January 2020.
In (B), ◊ = missile sound energy; □ = instrumentation noise energy; Δ = ambient noise power. Band frequencies in Hertz (Hz).