REQUEST FOR A LETTER OF AUTHORIZATION FOR THE INCIDENTAL TAKING OF MARINE MAMMALS RESULTING FROM TESTING AND TRAINING ACTIVITIES CONDUCTED IN THE EGLIN GULF TEST AND TRAINING RANGE (EGTTR)

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

96 RANSS	96th Range Support Squadron
96 TW	96th Test Wing
96 TW/SEU	96th Test Wing/Eglin Test and Range Safety Office
AFB	Air Force Base
AGL	above ground level
AFOTEC	Air Force Operational Test and Evaluation Center
AFSOC	Air Force Special Operations Command
AGM	Air-to-Ground Missile
ASEP	Advanced Systems Employment Project
BA	Biological Assessment
cal	caliber
CBU	Cluster Bomb Unit
CCF	Central Control Facility
CONEX	Container Express
CV	Coefficient of Variation
dB re 1 μPs^2-s	decibel referenced to one squared microPascal-second
E	Endangered
EA	Environmental Assessment
EFD	Energy Flux Density
EFH	Essential Fish Habitat
EGTTR	Eglin Gulf Test and Training Range
EO	Electro Optical
EOD	Explosive Ordnance Disposal
ESA	Endangered Species Act
FLTS	Flight Test Squadron
FMC	Fishery Management Council
FMP	Fishery Management Plan
FU	full up round
FWS	Fighter Weapons Squadron
ft	feet
GBU	Guided Bomb Unit
GMFMC	Gulf of Mexico Fishery Management Council
GRATV	Gulf Range Armament Test Vessel
GSMFC	Gulf States Marine Fisheries Commission
HAPC	Habitat Area of Particular Concern
HEI	High Explosive Incendiary
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HOB	height of burst
HSMST	High Speed Maneuverable Surface Target
ILAST	Integrated Laser Targeting
in	inch
in-lb/in^2	inch-pound per square inch
IMV	Instrumented Measurement Vehicle
IR	infrared
J/in^2	Joules per square inch
JASSM	Joint Air-to-Surface Standoff Missile
JDAM	Joint Direct Attack Munition
JUON	Joint Urgent Operational Need
kg	kilogram
kHz	kilohertz
KIAS	knots indicated air speed
km	kilometer
km^2	square kilometer
lbs	pounds
LJDAM	Laser Joint Direct Attack Munition

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS, CONT'D

LOA	Letter of Authorization
LOAL	Lock On After Launch
LOBL	Lock On Before Launch
LSDB	Laser Small Diameter Bomb
m	meters
mi	mile
min	minute
mm	millimeter
MMPA	Marine Mammal Protection Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEW	net explosive weight
NM	nautical mile
NM^2	square nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOTMAR	Notice to Mariners
Pa-s	Pascal-second
PBR	Potential Biological Removal
PEA	Programmatic Environmental Assessment
PGU	Projectile Gun Unit
psi-msec	pounds per square inch-millisecond
PSW	Precision Strike Weapon
PTS	Permanent Threshold Shift
REA	Range Environmental Assessment
SDB	Small Diameter Bomb
SEFSC	Southeast Fisheries Science Center
SOCOM	United States Special Operations Command
SOPGM	Stand-Off Precision Guided Munitions
SST	Sea Surface Temperature
T	Threatened
TA	Test Area
TD&E	Test Development and Evaluation
TM	telemetry
TR	Training Round
TS	Test Squadron
TTP	Tactics, Techniques, and Procedures
TTS	Temporary Threshold Shift
USFWS	U.S. Fish and Wildlife Service
UXO	Unexploded Ordnance
WSEP	Weapons System Evaluation Program
ZOI	Zone of Influence

EXECUTIVE SUMMARY

With this submittal, Eglin Air Force Base (AFB) requests a Letter of Authorization (LOA) for the incidental taking, but not intentional taking (in the form of acoustic-related impacts), of marine mammals incidental to air-to-surface testing and training missions conducted in the Eglin Gulf Test and Training Range (EGTTR), as permitted by the Marine Mammal Protection Act (MMPA) of 1972, as amended. Mission activities are described in the Proposed Action of the *Eglin Gulf Test and Training Range Environmental Assessment* (REA), and are presented in Section 1 of this document. This LOA request would extend authorizations for ongoing mission activities and future actions proposed for the next five years (2018-2023).

Mission activities proposed within the EGTTR involve the employment of multiple types of live (explosive) and inert (non-explosive) munitions against various surface targets. Munitions may be delivered by multiple types of aircraft including, but not limited to, fighter jets, bombers, and gunships. Munitions consist of bombs, missiles, rockets, and gunnery rounds. The targets may vary, but primarily consist of stationary, towed, or remotely controlled boats, inflatable targets, or marking flares. Net explosive weight of live ordnance ranges from 0.067 pounds for gunnery rounds to 945 pounds for bombs. Detonations may occur in the air, at the water surface, or approximately 10 feet below the surface. Testing and training missions would be conducted during any time of the year. Missions involving live ordnance would primarily be conducted during daylight hours, except for missions involving live gunnery rounds, which may occur during the day or night. To avoid impacts to deep-water cetacean species, live ordnance detonations associated with air-to-surface missions would only occur shoreward of the 200-meter isobath. Missions that involve inert munitions and in-air detonations may occur anywhere in the EGTTR. Aside from gunnery operations, mission activities that release live ordnance resulting in surface or subsurface detonations would be conducted at a pre-determined location approximately 17 miles offshore of Santa Rosa Island, in a water depth of about 35 meters (115 feet). Since 2013, this location has been used for other activities, including Maritime Strike Operations and Maritime Weapon Systems Evaluation Program (WSEP) Operations, for which Eglin has received authorizations from the National Marine Fisheries Service.

Mission activities proposed in the EGTTR have the potential to expose cetaceans to sound or pressure levels currently associated with mortality, Level A harassment, and Level B harassment, as defined by the MMPA. Specifically, air-to-surface missions that involve live ordnance employment with detonations on and below the water surface were determined to be the only activities with potential for adverse impacts to marine species, as analyzed in the associated REA. Mission-day scenarios were developed to assess acoustic impacts from multiple detonations occurring within a 24-hour period. Criteria and thresholds were provided by National Marine Fisheries Service (2016) and Finneran and Jenkins (2012) to determine zones of impact (ZOIs) for each mission-day scenario, which accounts for accumulated energy from multiple detonations. Density estimates for each potentially impacted species (common bottlenose dolphin and Atlantic spotted dolphin) were obtained from the Duke University Marine Geospatial Ecology Lab Reports (Roberts et al. 2016) and were used to estimate the potential number of animals exposed to sound and/or pressure thresholds. No marine mammals are expected to be exposed to the impulse pressure level associated with mortality. Up to 12 individuals (bottlenose and Atlantic spotted dolphins combined) could potentially be exposed to injurious (permanent threshold shift) Level A

harassment. A maximum of approximately 305 dolphins could potentially be exposed to non-injurious (temporary threshold shift) Level B harassment. Approximately 435 animals could potentially be exposed to energy levels corresponding to the behavioral harassment threshold. Based on the methodology used to calculate take estimates, the resulting exposures shown in Section 6 represent the maximum number of animals that could be affected. Mitigation measures described in Section 11 will be implemented to decrease the potential for adverse impacts, particularly within the mortality and Level A harassment zones.

Two marine mammal species may potentially be impacted by the proposed activities in the EGTTR: the common bottlenose dolphin and the Atlantic spotted dolphin. Four bottlenose dolphin stocks may occur in the EGTTR where mission activities would be conducted which include the Northern Gulf of Mexico Oceanic stock (not strategic), Northern Gulf of Mexico Continental Shelf stock (not strategic), the Gulf of Mexico Northern Coastal stock (strategic), and the Bay, Sound, Estuarine (BSE) stocks (strategic). In addition the Northern Gulf of Mexico stock (not strategic) of Atlantic spotted dolphin stock occurs within the EGTTR, where testing and training activities would be conducted. The depth range for locations where live ordnance would be employed primarily corresponds with the Northern Gulf of Mexico Continental Shelf stock of bottlenose dolphins (20 to 200 meters depth), which is not a strategic stock. Potential exposures to acoustic thresholds associated with Level A Harassment for all bottlenose dolphins would not exceed the Potential Biological Removal (PBR) for Northern Gulf of Mexico Continental Shelf stock; these exposures moreover do not account for the mitigation measures to be taken as described in Section 11. Bottlenose dolphins from the surrounding Gulf of Mexico Northern Coastal and the BSE stocks may enter the EGTTR; both of which are considered strategic. However, based on their limited occurrence within the action area, the potential for impacts to individuals from these stocks is considered low. Individuals from the Northern Gulf of Mexico Oceanic stock, which is not considered strategic, are unlikely to enter the EGTTR area, as this stock is defined beyond the 200-meter isobath. No long-term population level effects are anticipated to any stocks of bottlenose and Atlantic spotted dolphins.

The information and analyses provided in this application are presented to fulfill the permit request requirements of Title I, Sections 101(a)(5)(A) and 101(a)(5)(F) of the MMPA.

1. DESCRIPTION OF ACTIVITIES

Due to threats to national security, increased testing and training missions involving air-to-surface weapons employment have been directed by the Department of Defense. In this document, air-to-surface activities refer to the firing or dropping of munitions including bombs, missiles, rockets, and gunnery rounds from aircraft toward targets located on the Gulf of Mexico surface. Depending on the requirements of a given mission, munitions may be inert (contain no or very little explosive charges) or live (contain explosive charges). Live munitions may detonate above, at, or slightly below the water surface. As described in the associated *Eglin Gulf Test and Training Range (EGTTR) Range Environmental Assessment* (REA) (U.S. Air Force, 2015), the Air Force determined that other types of activities, primarily air-to-air testing and training, would result in only a negligible risk of harm to marine mammals, and these missions are therefore not included in this LOA application. All activities described in this document will occur within the boundaries of the EGTTR, which is shown in Figure 1-2. The EGTTR is subdivided into various Warning Areas and Water Test Areas, with many of these blocks divided into smaller sections. The EGTTR is described in more detail in Section 2, *Duration and Location of the Activities*.

In most cases, missions consisting of live bombs, missiles, and rockets that detonate at or below the water surface will occur at a site in W-151A that has been designated specifically for these types of activities. This site is located approximately 17 miles offshore from Santa Rosa Island, at a water depth of about 35 meters (m) (115 feet [ft]). Typically, test data collection is conducted from an instrumentation barge known as the Gulf Range Armament Test Vessel (GRATV) (Figure 1-1) anchored on-site, which provides a platform for cameras and weapon-tracking equipment. Therefore, the mission area is referred to as the GRATV target location. The target location site within W-151A is shown on Figure 1-3. It should be noted that alternative site locations may be selected within a 5-mile radius around the GRATV point. This alternative area is shown on Figure 1-3 as the Alternative Target Location Area. Gunnery operations are limited to occur only over continental shelf waters (shoreward of the 200-meter bathymetry line). Missions that involve inert munitions and in-air detonations may occur anywhere in the EGTTR, but are typically conducted in W-151. Detailed descriptions for each individual mission activity are included in the following sections, organized by action proponent or user group. Detonations of live munitions at or below the water surface have the potential to affect marine mammals that may be present in the action area.

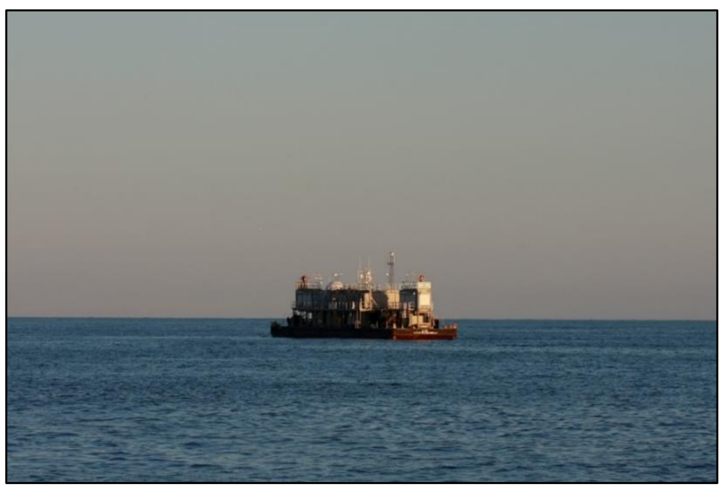

Figure 1-1. Gulf Range Armament Test Vessel (GRATV)

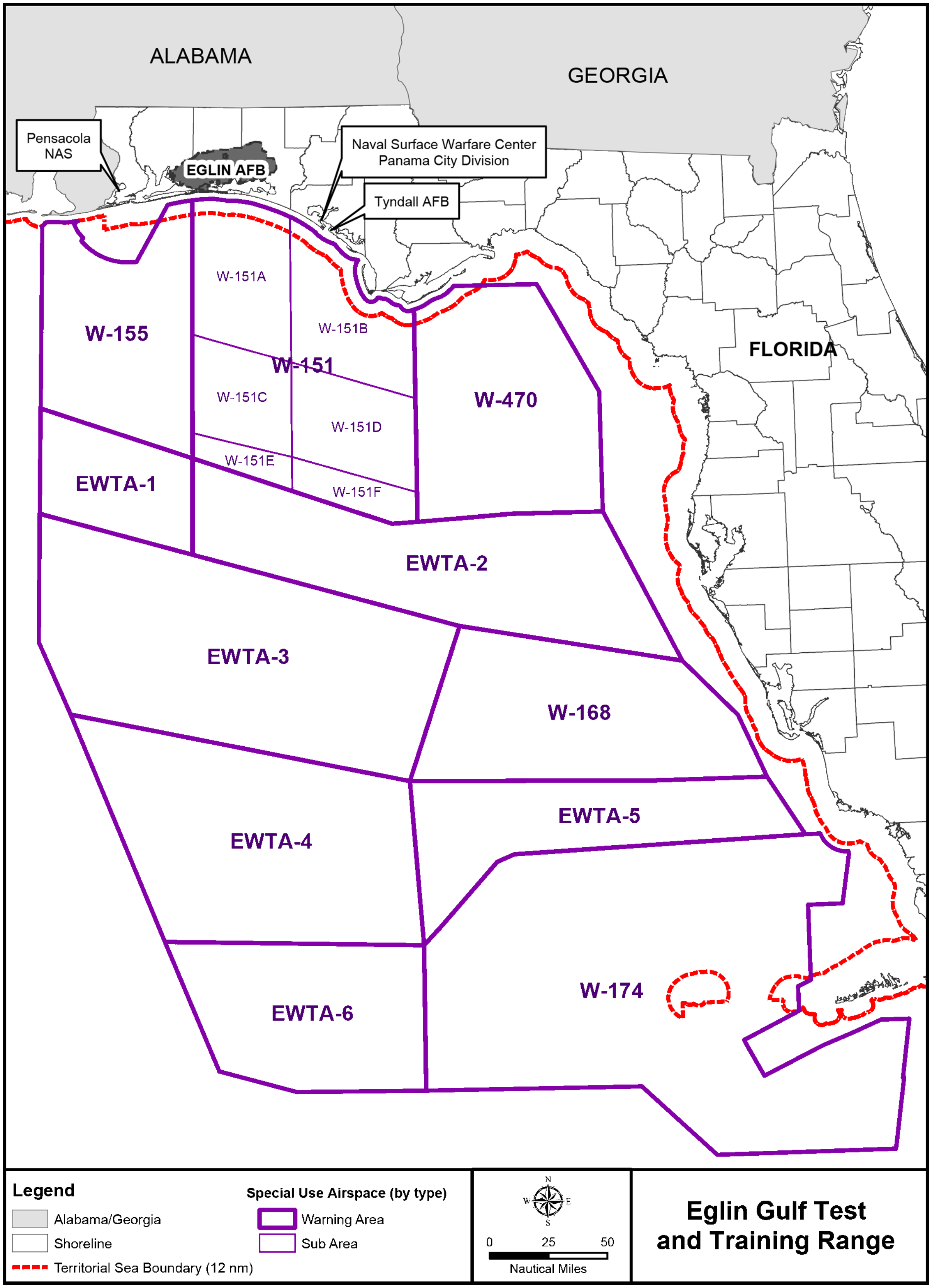

Figure 1-2. Eglin Gulf Test and Training Range

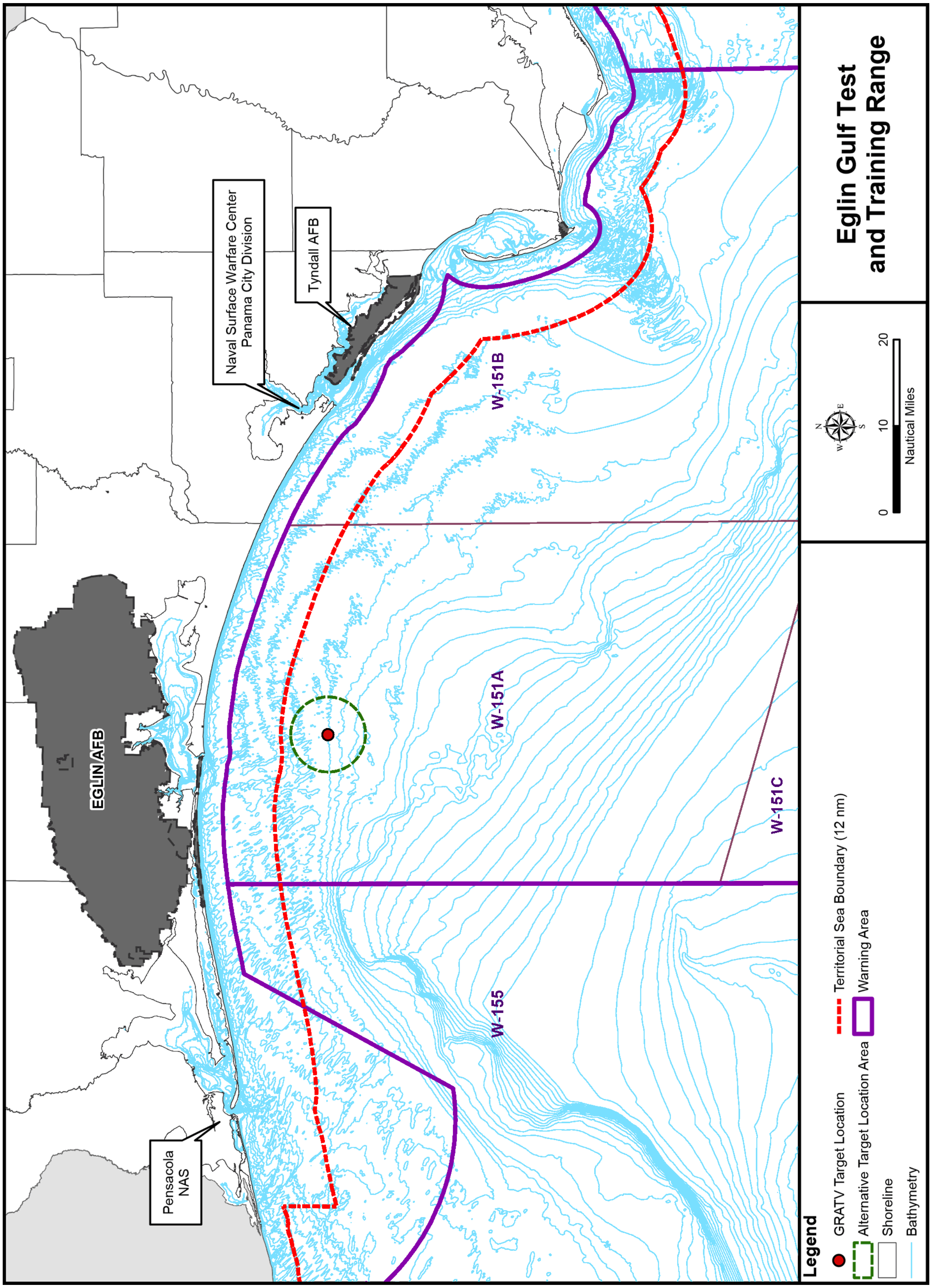

Figure 1-3. GRATV Target Location

1.1 MISSION-DAY CATEGORIZATIONS

For this LOA request, descriptions of mission activities that involve in-water detonations include a subsection called Mission-Day Categorization. This subsection describes the mission-day scenario used for acoustic modeling and is based on the estimated number of weapons released per day. This approach is meant to satisfy NMFS requests to analyze and assess acoustic impacts associated with accumulated energy from multiple detonations occurring over a 24-hour timeframe. Eglin Natural Resources used all available information to develop each mission-day scenario, including historical release records; however, these scenarios may not represent exact weapon releases because military needs and requirements are in a constant state of flux. The mission-day categorizations provide high-, medium-, and low-intensity mission-day scenarios for some groups and an average scenario for other groups. Mission-day scenarios vary for each user group, are described in the following sections, and are summarized in Section 1.8 (Summary of Expendables Used in Air-to-Surface Testing and Training).

1.2 86TH FIGHTER WEAPONS SQUADRON MARITIME WEAPONS SYSTEM EVALUATION PROGRAM

1.2.1 Live and Inert Munitions Testing

The 86th Fighter Weapons Squadron (86 FWS) proposes to continue the use of multiple types of live and inert munitions in the EGTTR against small boat targets for the Maritime Weapons System Evaluation Program (WSEP) Operational Testing Program. The purpose of the testing is to continue the development of tactics, techniques and procedures (TTP) for U.S. Air Force strike aircraft to counter small maneuvering surface vessels (Figure 1-4) in order to better protect vessels or other assets from small boat threats. Damage effects of these munitions must be known to generate TTPs to engage small moving boats. The test objectives are to (1) develop TTPs to engage small boats in all weather; and (2) determine the impact of TTPs on Combat Air Force training. The test results would be used to develop publishable TTPs for inclusion in Air Force TTP 3-1 series manuals. Maritime WSEP testing is considered a high national defense priority. Incidental Harassment Authorizations have been issued in 2015, 2016, and 2017 for Maritime WSEP activities.

Figure 1-4. Intact Small Boat Targets in the EGTTR

Proposed aircraft and munitions associated with Maritime WSEP activities are shown in Table 1-1. Because the focus of the tests would be weapon/target interaction, no particular aircraft would be specified for a given test as long as it met the delivery requirements. Various U.S. Air Force active duty units, National Guard, Navy, and Air Force reserve units would participate as interceptors and weapons release aircrews, with multiple types of aircraft typically operating within the same airspace.

Tests would be conducted at the GRATV target location in various sea states and weather conditions, up to a wave height of 4 ft. Live munitions would be deployed against static (anchored), towed, and remotely controlled boat targets. Static and controlled targets would consist of stripped boat hulls with plywood simulated systems and, in some cases, heat sources. Moving targets would be towed by remotely controlled High Speed Maneuverable Surface Target (HSMST) boats. Damaged boats would be recovered for data collection. Test data collection would be conducted from the GRATV. HSMST boats would be remotely controlled from a facility on Eglin main base and would follow set track lines with specific waypoints at least 2 to 3 nautical miles (NM) away from the GRATV. Additional air assets such as chase aircraft or unmanned aerial vehicles would transit to the target area and set up flight orbits to provide aerial video of the mission site including weapon impacts on boat targets and assisting with range clearing activities. Missions would be controlled and monitored from the Eglin Central Control Facility (CCF) on the main base.

Table 1-1. Maritime WSEP Munitions and Example Aircraft

Munitions	Aircraft
AGM-114 (Hellfire)	F-15 fighter aircraft
AGM-176 (Griffin)	F-16 fighter aircraft
AGM-65 (Mavericks)	F-18 fighter aircraft
AIM-9X	F-22 fighter aircraft
BDU-56	F-35 fighter aircraft
CBU-105 (WCMD)	AC-130 gunship
GBU-12/GBU-54	A-10 fighter aircraft
GBU-10/GBU-24	B-1 bomber aircraft
GBU-31	B-52 bomber aircraft
GBU-38	B-2 bomber aircraft
PGU-13/B	MQ-1
PGU-27	MQ-9
2.75 in Rockets	
7.62mm/50 Cal	
GBU-39 (Laser SDB)	
GBU-53 (SDB II)	

AGM = air-to-ground missile; AIM = air intercept missile; BDU = Bomb, Dummy Unit; GBU = Guided Bomb Unit; PGU = Projectile Gun Unit; CBU= Cluster Bomb Unit; WCMD = Wind-Corrected Munitions Dispenser; mm=millimeters; SDB = Small Diameter Bomb

Live munitions would be set to detonate either in the air, instantaneously upon contact with a target boat, or after a slight delay (up to 10 millisecond) after impact, which would correspond to a water depth of about 5 to 10 ft. The annual number, height or depth of detonation, explosive material, and net explosive weight (NEW) of each live munition associated with Maritime WSEP is provided in Table 1-2. The quantity of live munitions tested is considered necessary to provide the intended level of tactics and weapons evaluation, including a number of replicate tests sufficient for an acceptable confidence level regarding munitions capabilities.

In addition to the live munitions described above, 86 FWS also proposes to expend inert munitions in W-151. The expected number of each munition type expended during a typical year is included in Table 1-2. Use of inert munitions was analyzed in the 2002 *Eglin Gulf Test and Training Range (EGTTR) Programmatic Environmental Assessment* (2002 PEA) and found to have no significant environmental impact (U.S. Air Force, 2002). The 2002 PEA estimated that a maximum of 0.2 marine mammals could potentially be struck by projectiles, falling debris, and inert munitions each year. This calculation assumed there would be over 600 events conducted per year which accounted for the maximum annual number of expendables over a five year period (1995-1999), totaling over 626,000 inert items. Live gunnery rounds (e.g., 25-mm, 40-mm, 105-mm) were not included in the direct physical impact analysis since the acoustic analyses constituted a more conservative assessment for exploding rounds. Since 1999, Range Utilization Reports have shown through 2010 the annual average number of inert expendables has decreased to approximately 311,000 items, about 50% of the maximum annual number used for calculations for the 2002 PEA. The additional use of inert munitions under the Proposed Action for the 2015 EGTTR Programmatic EA would add another 76,000 items, resulting in a 19% increase in inert expendables, based on the annual average from 1999 through 2010. This proposed increase compared to historic use is still less than the maximum baseline levels analyzed in 2002, therefore the potential for direct physical impacts is not expected to increase and is similarly considered

discountable. Actual numbers of inert releases may vary somewhat from those shown in the table. However, the items are included in this LOA in order to document the programmatic use of the EGTTR.

Table 1-2. Maritime WSEP Munitions Use in the EGTTR

Type of Munition	# Munitions	Detonations Scenario	Warhead – Explosive Material	NEW (lbs)
GBU-10 or GBU-24	2	Surface or Subsurface	MK-84 - Tritonal	945
GBU-49	4	Surface	Tritonal	300
JASSM	4	Surface	Tritonal	240
GBU-12 / -54 (LJDAM) / -38 / -32 (JDAM)	10	Surface or Subsurface	MK-82 - Tritonal	192
AGM-65 (Maverick)	8	Surface	WDU-24/B penetrating blast-fragmentation warhead	86
CBU-105	4	Airburst	10 BLU-108 submunitions with 4 projectiles, parachute, rocket motor & altimeter. 10.69 lbs NEW/submunition (includes 2.15lbs/projectile)	107.63
GBU-39 (LSDB)	4	Airburst, Surface, or Subsurface	AFX-757 (Insensitive munition)	37
AGM-114 (Hellfire)	30	Airburst or Surface, Subsurface	High Explosive Anti-Tank (HEAT) tandem anti-armor metal augmented charge.	29
GBU-53 (SDB II)	4	Airburst, Surface or Subsurface	PBX-N-109 Aluminized Enhanced Blast, Scored Frag Case, Copper Shape Charge	22.84
AIM-9X	2	Surface	PBXN-3	7.9
AGM-176 (Griffin)	10	Airburst or Surface	Blast fragmentation	4.58
Rockets (including APKWS)	100	Surface	Comp B-4 HEI	10
PGU-13 HEI 30 mm	1,000	Surface	30 x 173 mm caliber with aluminized RDX explosive. Designed for GAU-8/A Gun System	0.1
GBU-10	21	Inert	N/A	N/A
GBU-12	27	Inert	N/A	N/A
GBU-24	17	Inert	N/A	N/A
GBU-31	6	Inert	N/A	N/A
GBU-38	3	Inert	N/A	N/A
GBU-54	16	Inert	N/A	N/A
BDU-56	13	Inert	N/A	N/A
AIM-9X	3	Inert	N/A	N/A
PGU-27	46,000	Inert	N/A	N/A

AGM = air-to-ground missile; AIM = air intercept missile; BDU = Bomb, Dummy Unit; CBU = Cluster Bomb Unit; GBU = Guided Bomb Unit; HEI = high explosive incendiary; lbs = pounds; LJDAM = laser joint direct attack munition; LSDB = Laser Small Diameter Bombs; MK = mark; mm = millimeters; NEW = Net Explosive Weight; PGU = Projectile Gun Unit; RDX = research department explosive; SDB = Small Diameter Bomb

1.2.2 Mission-Day Categorization

Mission-day categorizations of weapon releases listed in Table 1-3 were developed based on historical mission data, project engineer input, and future Maritime WSEP requirements. Categories of missions were grouped first using historical weapon releases per day (refer to Maritime Strike and Maritime WSEP annual reports for 2014, 2015, and 2016). Next, the most recent weapons evaluation needs and requirements were considered to develop three different scenarios: Categories A, B, and C. Mission-day Category A represents munitions with larger NEW (192 to 945 pounds) with both surface and subsurface detonations. This category includes future requirements and provides flexibility for the military mission. To date, Category A levels of activity have not been conducted under the 86 FWS Maritime WSEP missions, and is considered a worst-case scenario. Category B represents munitions with medium levels of NEW (20 to 86 pounds) including surface and subsurface detonations. Category B was developed using actual levels of weapon releases during Maritime WSEP missions (refer to Maritime WSEP annual reports for 2015 and 2016). Category C represents munitions with smaller NEW (0.1 to 13 pounds) and includes surface detonations only.

Table 1-3. Maritime WSEP Munitions Categorized as Representative Mission Days

Mission Category	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
A	GBU-10/-24/-31	945	Subsurface (10-ft depth)	1	2	2
	GBU-49	300	Surface	2		4
	JASSM	240	Surface	2		4
	GBU-12 / -54 (LJDAM) / -38 / -32 (JDAM)	192	Subsurface (10-ft depth)	5		10
B	AGM-65 (Maverick)	86	Surface	2	4	8
	GBU-39 (SDB)	37	Surface	1		4
	AGM-114 (Hellfire)	20	Subsurface (10-ft depth)	5		20
C	AGM-176 (Griffin)	13	Surface	5	2	10
	2.75 rockets	12	Surface	50		100
	AIM-9X	7.9	Surface	1		2
	PGU-12 HEI 30 mm	0.1	Surface	500		1,000

AGM = air-to-ground missile; CBU = Cluster Bomb Unit; GBU = Guided Bomb Unit; HEI = high explosive incendiary; JDAM = Joint Direct Attack Munition; LJDAM = Laser Joint Direct Attack Munition; lbs = pounds; NEW = net explosive weight; PGU = Projectile Gun Unit; mm = millimeter; SDB = Small Diameter Bomb

1.2.3 Pre-Test Target Area Clearance Procedures for Public Safety and Protected Marine Species

A human safety zone will be established around the test area prior to each mission, and will be enforced by up 25 safety boats. The size of this zone may vary, depending upon the particular munition and delivery method used in a given test. A composite safety footprint has been developed for previous tests using live munitions.. This composite safety footprint consisted of a circle with a 29 mile-wide diameter circle (14.5 mile-wide radius), which was converted to an octagon shape for ease of support vessel placement and range clearance. The GRATV is located approximately 2 miles north of the center of the octagon. Other than the types of vessels identified

in 33 CFR 334.720, all non-participating vessels (such as recreational fishing vessels) will be excluded from entering the safety footprint while it is active, which is expected to be up to four hours per mission on test days (multiple munitions may be deployed within the four-hour time period). The Eglin Test and Range Safety Office (96 TW/SEU) will position the safety support vessels around the safety footprint to ensure commercial and recreational boats do not accidentally enter the area. Before delivering the ordnance, mission aircraft may make a dry run (no munitions deployed) over the target area to ensure that it is clear of non-participating vessels, although this action is not necessarily performed before all releases. The Eglin Test and Range Safety Office will monitor real-time activity of surface craft and use this information to make clear-to-arm and clear-to-fire calls as appropriate. To inform the public, the Eglin Test and Range Safety Office will request that the Coast Guard release a Notice to Mariners (NOTMAR) prior to the closure of the safety footprint around the target location. In addition, the 96th Range Support Squadron (96 RANSS) personnel will also distribute flyers with maps at public docks and to vessels in Destin Pass showing the closed area and explaining why it is closed.

In addition to actions carried out to ensure human safety during live missions, measures designed to avoid or minimize impacts to protected marine species have been developed in cooperation with NMFS. A separate zone around the target will be established for marine species protection, based on the distance to which energy- and pressure-related impact zones could extend for the various types of live ordnance. The dimensions of this zone will be different than those of the human safety zone, and will depend on the specific munitions being released that day. Trained marine species observers will survey the protection zone before each mission.

Up to four video cameras will also be positioned on the GRATV anchored on-site. The cameras will primarily be used to document the weapons' performance against targets and to help clear the range of unauthorized vessels. They are also used to monitor for the presence of protected species. An Eglin Natural Resources representative will be located in Eglin's CCF on main base, along with mission personnel, to view the live video feed before and during test activities. All cameras have a zoom capability of up to at least a 300 millimeter (mm) equivalent. At this setting, when targets are at a distance of 2 NM from the GRATV, the field of view would be 195 ft by 146 ft. Video observers can detect an item with a minimum size of 1 square foot up to 4,000 meters away. The Air Force is in the process of acquiring cameras with even greater zoom capability (up to a 1200 mm zoom lens). Missions will not proceed until the target area is confirmed to be clear of protected species (when live munitions are used) and unauthorized vessels. In addition, the test will not be conducted if all video cameras are not operational.

1.2.4 Post-Test Activities

Potential post-test activities consist of Air Force Explosive Ordnance Disposal (EOD) personnel detonating in place any munitions components or items remaining on the target boats that would be considered unexploded ordnance (UXO), debris retrieval, and post-mission protected species surveys. Unexploded bombs, missiles, or other similarly large items would sink to the seafloor and would not be recovered or detonated. However, smaller unexploded items such as cluster bomb submunitions could remain intact on target boats. Each CBU-105 contains 10 submunition

cylinders, and each cylinder contains 4 sub-submunitions (skeets), which fire inert projectiles. Therefore, there are a total of 40 skeets per bomb. On test days involving the release of CBU-105s, the Eglin EOD team would be on hand to inspect floating targets and identify and render safe any UXO, including fuzes, classified components, or intact munitions. In the rare instance that UXO cannot be removed, proper disposal methods would be employed (typically accomplished by use of C-4 explosive) (Figure 1-5); however these types of scenarios are not considered likely. Once the area has been cleared by the Eglin EOD team (typically one hour after the release of CBU-105s), the range will be re-opened for the debris clean-up team and the protected species survey vessels (when live munitions are used). Depending on the specific weapon system used and the location or position of the UXO, the test area could be closed for an extended period of time.

Figure 1-5. Target Boat after UXO Disposal with C-4 Explosive

Following completion of the live mission (and declaration of the target area by EOD as safe, when applicable), several Air Force vessel crews would engage in target debris retrieval. Large, mostly intact damaged target vessels may be towed, while smaller pieces of debris would be netted or lifted aboard Air Force vessels and taken to shore for disposal. Figure 1-6 shows debris and damaged target vessels from a similar exercise conducted in 2013. The Air Force would also conduct post-mission monitoring for protected species once the range is confirmed to be safe to enter.

Pre-test and post-test management actions, including human safety zone enforcement and protected species protection measures, are described in detail in Section 11, *Means of Affecting the Least Practicable Adverse Impacts*.

Figure 1-6. Debris and Target Vessels from Previous Similar Mission

1.2.5 Swarm Missions

To counter small boat threats, aircrews would test and train in performing electronically simulated targeting and attack techniques (no ordnance is used, either live or inert) against groups of fast moving, human-piloted boats simulating a coordinated attack on an objective in the Gulf of Mexico. These missions are called “swarm” missions due to the number of boats involved. The target fleet typically consists of up to 30 boats (the actual number may vary) divided into multiple squadrons of 4 or 5 boats that travel along predetermined transects and possibly perform predetermined maneuvers as directed by Air Force personnel. The boats would range in size from 20 to 45 ft and would travel at speeds of 20 to 40 knots, depending on sea state. Additional numbers of vessels, formations and maneuvers are possible depending on real-world threats and situations.

Aircraft would be directed in the CCF by the 86 FWS mission director. Aircraft would perform tactical maneuvers including dives, dive recoveries, and pull-up procedures in accordance with aircraft 3-1 manuals and AFI 11-214 publications. Aircraft would fly no lower than altitudes specified in AFI 11-214 and 3-1 manuals commensurate with the simulated weapon delivery. Aircraft would not carry bombs, and aircraft guns would be mechanically “safed” (unable to fire). Due to the lack of munitions (live or inert), the pre- and post-mission activities described for live testing would not be required. Specifically, there would be no need for safety zone establishment, EOD clearance, debris retrieval, or protected species surveys.

1.3 ADVANCED SYSTEMS EMPLOYMENT PROJECT

The proposed Advanced Systems Employment Project (ASEP) action includes evaluating upgrades to numerous research and development, as well as Air Force hardware and software, initiatives. F16, F15E, and BAC1-11 aircraft would be used to deploy a variety of pods, air-to-air missiles, bombs, and other munitions. Many of the missions are conducted over Eglin land ranges. However, inert instrumented Mk-84 Joint Direct Attack Munition (JDAM) bombs would be expended in W-151 under the Proposed Action. Bombs would be dropped on target boats located 20 to 25 miles offshore. A maximum of 12 over-water missions could be conducted annually, although the number could be as low as 4. There would be no live ordnance associated with ASEP actions in the EGTTR.

1.4 AIR FORCE SPECIAL OPERATIONS COMMAND TRAINING

The Air Force Special Operations Command (AFSOC) conducts various training activities with multiple types of munitions in nearshore waters of the EGTTR (W-151). Training activities include air-to-surface gunnery and small diameter bomb/Griffin/Hellfire missile proficiency training. The following subsections describe the proposed actions included in this LOA request.

1.4.1 AC-130 Air-To-Surface Gunnery

Air-to-surface gunnery missions involve firing of live gunnery rounds at targets on the water surface in the EGTTR. Ordnance used in this training includes 25 mm high explosive incendiary (HEI), 30 mm HEI, 40 mm HEI, and 105 mm HEI rounds. NEW ranges from about 0.07 to 4.7 pounds. The Air Force has developed a 105 mm training round (TR) that contains less than 10 percent of the amount of explosive material contained in the 105 mm full up (FU) round. The TR variant was developed as a means to mitigate acoustic impacts on marine mammals that could not be adequately surveyed at night by aircraft sensors. Today's AC-130 sensors allow for effective nighttime visual surveys but with reduced explosive material the TR rounds remain a valuable mitigation for reducing acoustic impacts.

Water ranges within the EGTTR that are typically used for gunnery operations include W-151A, W-151B, W-151C, and W-151D. However, W-151A is the most frequently used water range due to its proximity to Hurlburt Field (where the gunnery flights originate). AC-130s normally transit from Hurlburt Field to the water ranges at a minimum of 4,000 ft above surface level. Potential target sites are typically established at least 15 miles from the coast (beyond the 12 NM territorial sea boundary). Such a location places most mission activities over shallower continental shelf waters where marine mammal densities are typically lower, and thus avoids the slope waters where more sensitive species (e.g., Endangered Species Act [ESA]-listed sperm whale) generally reside. Targets consist of either an MK-25 floating flare or an inflatable target. For missions where flares are used, the aircrew scans a 5-NM radius around the potential target area to ensure it is clear of surface craft, protected species, and other objects that would make the site unsuitable. Scanning is accomplished using radar, Electro Optical (EO), infrared (IR) sensors, and visual means. An alternative area is selected if any non-mission vessels or protected marine species are detected within the 5 NM search area. Once the scan is completed, the marking flare is dropped onto the

water surface. The flare's burn time is typically 10 to 20 minutes, but could be less if actually hit by one of the rounds. However, flares may burn as long as 40 minutes.

Missions using an inflatable target proceed under the same general protocol. A tow boat transits to a potential target site located at least 15 miles from the coast. The AC-130 then arrives at the site and, as with missions using flares, the aircrew scans an appropriate area around the potential target area (5 NM radius for non-mission vessels and protected species) using visual observation and the aircraft's sensors. An alternative area would be selected if any protected marine species or non-mission vessels were detected within the search area. Once the scan is complete, the 20-foot target is inflated and deployed into the water. The tow boat then proceeds to pull the target, which is attached to a 2,200-foot cable. The target continues to float even when struck by ordnance and deflated. After the mission, the tow boat recovers any debris produced by rounds striking the target, although little debris is expected.

After target deployment, the firing sequence is initiated. A typical gunship mission lasts approximately five hours without air-to-air refueling, and six hours when refueling is accomplished. A typical mission includes:

- 30 minutes to take off and perform airborne sensor alignment; align visual sensor and EO to heads-up display.
- 1½ to 2 hours of dry fire (no ordnance expended); this time includes transition time.
- 1½ to 2 hours of live fire; this time includes clearing the area and transiting to and from the range; actual firing activities typically do not exceed 30 minutes.
- 1 hour air-to-air refueling, if included in the mission.
- 30 minutes transition work (takeoffs, approaches, landings, and pattern work).

The guns are fired during the live fire phase of the mission. The actual firing can last from 30 to 90 minutes but is typically completed in 30 minutes. The number and type of munitions deployed during a mission varies with each type of mission flown. The 105-mm TR variants are used during nighttime training.

Live fire events are continuous, with pauses during the firing usually well under a minute and rarely from two to five minutes. Firing pauses would only exceed 10 minutes in one of the following situations: 1) surface boat traffic caused the mission to relocate; 2) aircraft, gun, or targeting system malfunction occurs; or 3) more flares needed to be deployed. The 96 TW/SEU has described the gunnery missions as having 95 percent containment within a 5-meter radius around the target (i.e., 95 percent of the rounds strike the water within 5 meters of the target).

Gunnery missions could occur any season of year, during daytime or nighttime hours. As a conservation measure to avoid impacts to the federally listed sperm whale and other deep water marine mammal species, AFSOC would conduct all gunnery missions within (shoreward of) the 200-meter water depth contour, which transects portions of W-151A, W-151D, and W-151F. All of W-151B lies shoreward of the shelf break. As a further conservation measure, only the 105 mm TR would be used during nighttime missions.

The quantity of live rounds expended is based on estimates provided by AFSOC regarding the annual number of missions and number of rounds per mission. The 105 mm FU rounds would typically be used during daytime missions, while the 105 mm TR variants would be used at night.

On March 5, 2014, NMFS issued a 5-year LOA in accordance with the MMPA for AFSOC's air-to-surface gunnery activities and is valid through March 4, 2019. This LOA request would supersede that authorization for AC-130 air-to-surface gunnery activities for another five years (2018-2023); it incorporates the updated approach to analysis requested by NMFS, and applies the most recent criteria and thresholds adopted by NMFS (NMFS, 2016; Finneran and Jenkins, 2012). No significant changes to these mission activities are anticipated in the foreseeable future. The analysis in Section 6 is based on acoustic modeling that incorporates these new requirements. Table 1-4 shows the annual number of missions and gunnery rounds currently authorized under the existing LOA, which will be carried forward for this LOA request.

Table 1-4. Summary of Annual AFSOC AC-130 Gunnery Operations

Munition	NEW (lbs)	Total Munitions/Year	Number of Daytime Missions	Number of Nighttime Missions
105 mm HE (FU)	4.7	750	25	45
105 mm HE (TR)	0.35	1,350		
40 mm HE	0.87	4,480		
30 mm HE	0.1	35,000		
25 mm HE	0.067	39,200		
Total		**80,780**		

HE = High Explosive; lbs = pounds; mm = millimeter; NEW = net explosive weight; TR = Training Round; FU = Full Up

1.4.1.1 Mission-Day Categorization

Two mission-day scenarios were developed to represent the average number of gunnery rounds expended during daytime and nighttime AC-130 air-to-surface gunnery missions; category D for daytime missions and category E for nighttime missions. Eglin Natural Resources coordinated with the AFSOC Planning Office to confirm that annual allotments provided in Table 1-4 would still meet their training needs and averaged the annual number of each gunnery round with the annual number of mission days proposed for daytime and nighttime. The mission-day scenarios developed for AC-130 air-to-surface gunnery missions are shown in Table 1-5.

Table 1-5. AC-130 Gunnery Operations Categorized as Representative Mission Days

Mission Category	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
D	105 mm HE (FU)	4.7	Surface	30	25	750
	40 mm HE	0.87	Surface	64		1,600
	30 mm HE	0.1	Surface	500		12,500
	25 mm HE	0.067	Surface	560		14,000
E	105 mm HE (TR)	0.35	Surface	30	45	1,350
	40 mm HE	0.87	Surface	64		2,880
	30 mm HE	0.1	Surface	500		22,500
	25 mm HE	0.067	Surface	560		25,200
Total					**70**	**80,780**

HE = High Explosive; lbs = pounds; mm = millimeter; NEW= net explosive weight; TR = Training Round; FU = Full Up

Measures designed to avoid or minimize potential impacts to marine mammals are summarized here and described in detail in Section 11. The primary management measure would consist of pre- and post-mission visual monitoring, which could also be supplemented with IR and EO monitoring as applicable. After arriving at the target site, aircrews would commence visual scans and continue observing during ascending orbits until reaching operational altitude. Monitoring would continue throughout the mission and during a post-mission descent to an altitude of approximately 6,000 ft. If marine mammals are detected at any time, the mission would halt immediately and relocate as necessary or be suspended until the animal(s) have left the area. Additional management measures would include complying with sea state restrictions, use of the 105 mm TR at night, use of ramp-up procedures (beginning with the smallest round during calibration and proceeding to increasingly larger rounds), and complying with the requirement to conduct all missions shoreward of the 200-meter isobath. No mortality or injury to protected marine species has been documented as a result of previous AFSOC gunnery missions.

1.4.2 Small Diameter Bomb and Griffin/Hellfire Missile Training

AFSOC has been tasked to develop TTPs and training for strike aircraft to counter small maneuvering maritime targets in order to better protect U.S. and other vessels or assets from small boat threats. Training involves the use of live AGM-114P/R Hellfire Missiles, AGM-176 Griffin Missiles, and GBU-39 small diameter bomb (SDB) munitions in the EGTTR against small towed boats. AFSOC expects to expend up to 100 AGM-114P/R missiles, 200 AGM-176 missiles, and 30 GBU-39 laser or GPS guided SDBs annually. All weapons are capable of airburst, point, or delayed fuzing detonations. However, only airburst detonations would occur under the proposed action.

The capability to counter small vessels is categorized as a Joint Urgent Operational Need (JUON). A JUON is defined as an urgent operation need identified by a combatant commander that, if not addressed immediately, would seriously endanger personnel or pose a major threat to ongoing operations. Currently, the majority of AFSOC crews deploy into combat with no actual experience in AGM-176, AGM-114P/R, or GBU-39 weapons delivery, significantly increasing the potential to miss their intended targets during combat missions.

Management practices, described in detail in Section 11, would be implemented for live detonations. Although munitions would be detonated in the air and no acoustic impacts to marine mammals are anticipated, pre- and post-mission surveys would be conducted aerially from the AC-130 aircraft, using the same procedures outlined for AFSOC gunnery activities summarized above and discussed in detail in Section 11. Human safety measures would also be carried out.

1.4.3 CV-22 Training

The 8th Special Operations Squadron (SOS) proposes to conduct CV-22 training in W-151 (primarily W-151A and W-151F), which would involve the firing of .50 caliber (cal)/7.62 mm ammunition at flares floating on the water surface. There would be approximately 50 training missions annually, with 300 each of .50 cal and 7.62 mm rounds used per mission. Therefore, a total of 30,000 rounds would be expended annually. Flight procedures for CV-22 training would be similar to those described for AC-130 gunnery missions above, except that CV-22 aircraft

typically operate at much lower altitudes (100 to 1,000 ft above surface level) than AC-130 gunships. Aircrews would maintain Visual Flight Rules cloud clearances and a minimum altitude of 100 ft above water height at all times. Weather must be sufficient to maintain a 3-NM clearance around the target area. Live fire would be conducted only when sea surface conditions do not exceed Beaufort sea state 4 (wind speed 16 knots, wave height 3 ft, fairly frequent white caps). Similar to AC-130 missions, crews would conduct a visual survey of the target area (3 NM radius for non-mission vessels and a protected species zone based on requirements described in Section 11) at a maximum altitude of 1,000 ft to ensure the area is clear of marine mammals and indicators before live-fire begins. Pre- and post-live fire clearing searches are anticipated to take about five minutes to accomplish. After live fire operations, the crew would scan the target area utilizing all available visual scanners and operable sensors for any injured or dead marine species. Missions would only be conducted shoreward of the 200-meter depth contour, as described for AC-130 gunnery training above. Since the .50 caliber and 7.62 mm gunnery rounds contain no high explosives, no acoustic impacts from these arounds are anticipated and are not included in the acoustic analysis outlined in Section 6.

1.5 413TH FLIGHT TEST SQUADRON

The United States Special Operations Command (SOCOM) has requested the 413th Flight Test Squadron (413 FLTS) to demonstrate the feasibility and capability of the Precision Strike Package and the Stand-Off Precision Guided Munitions (SOPGM) missile system on the AC-130 aircraft. SOCOM, in conjunction with A3 Operations at Wright-Patterson Air Force Base (AFB), is fielding the new AC-130J for flight characterization, as well as testing and evaluation. AFSOC is integrating some of the same weapons on the AC-130W. Therefore, the activities described below for the 413 FLTS may involve either of these aircraft variants.

1.5.1 AC-130J Precision Strike Package Testing

The proposed AC-130J gunnery testing associated with the 413 FLTS's Precision Strike Package would be similar to that described above for AFSOC AC-130 gunnery training in terms of location and general procedures. Testing would occur in W-151A and would involve firing either 1) PGU-44/B (105 mm HE] with FMU-153/B point detonation/delay fuse) or PGU-43B Target Practice (TP) rounds (105 mm TR) from a 105 mm M102 (U.S. Air Force designation M137A1) light-weight Howitzer cannon, or 2) PGU-13 HEI, PGU-46 HEI rounds, or PGU-15 TP rounds (inert) from a 30 mm GAU-23/A gun system. A MK-25 flare would be dropped prior to firing and used as a target. Management measures would be the same as those described for AFSOC's AC-130 gunnery missions.

1.5.1.1 Mission-Day Categorization

413 FLTS mission day scenarios were developed based on the number of mission days planned annually. Up to eleven mission days are planned for 413 FLTS operations annually, therefore total number of munitions were averaged over each day and are shown in Table 1-6. All missions would be conducted shoreward of the continental shelf break/200 m isobath (Figure 1-7).

Table 1-6. 413 FLTS Precision Strike Package Gunnery Testing Categorized as Representative Mission Days

Mission Category	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
F	30 mm	0.1	Surface	33	3	99
G	105 mm FU	4.7	Surface	15	4	60
H	105 mm TR	0.35	Surface	15	4	60

FU = full up; lbs = pounds; mm = millimeter; NEW = net explosive weight; TR = Training Round

1.5.2 AC-130J and AC-130W Stand-Off Precision Guided Munitions Testing

The SOPGMs proposed for use in this testing include AGM-176 Griffin missiles, AGM-114 Hellfire missiles, GBU-39/B SDBs, and GBU-39B/B Laser Small Diameter Bombs (LSDBs). The purpose of this testing is to demonstrate the feasibility and capability of the SOPGMs on AC-130 aircraft. Initial actions would consist of various ground tests (not included as part of this LOA request) including systems testing and static drops. After ground testing is completed, captive carry, store separation, and weapon employment tests would be conducted. Captive-carry missions would be conducted with an Instrumented Measurement Vehicle (IMV) to collect environmental data or an inert telemetry (TM) missile in order to evaluate the integration of the SOPGM with the AC-130J. Store separation missions would require a TM missile with an inert warhead and a live motor, if applicable, to verify that the weapon can be employed without significant risk to the aircraft.

Weapon employment missions would be flown using any combination of inert and/or live weapons for a final end-to-end check of the system. Missions could be conducted over land or water ranges, with water ranges used for SDB/LSDB and Griffin missile tests. It is expected that over-water testing would be conducted at the GRATV target location. The target will be laser designated with a standard range instrumentation designator. Plywood targets, as well as stationary and moving vehicles, will be used for the end-to-end functionality tests. They will be set up so that the Integrated Laser Targeting camera (ILAST) can capture the laser spot on the target, and so that the high speed digital video can record the impact. The ILAST cameras and digital cameras will be mounted in such a way as to have a clear view of the target while being a safe distance from any debris from the impact.

Similar to preceding mission descriptions, pre- and post-test surveys will be conducted within the applicable human and protected species safety zones. Surveys would be conducted from vessels, aircraft, and possibly live video feed. Survey requirements are described in detail in Section 11.

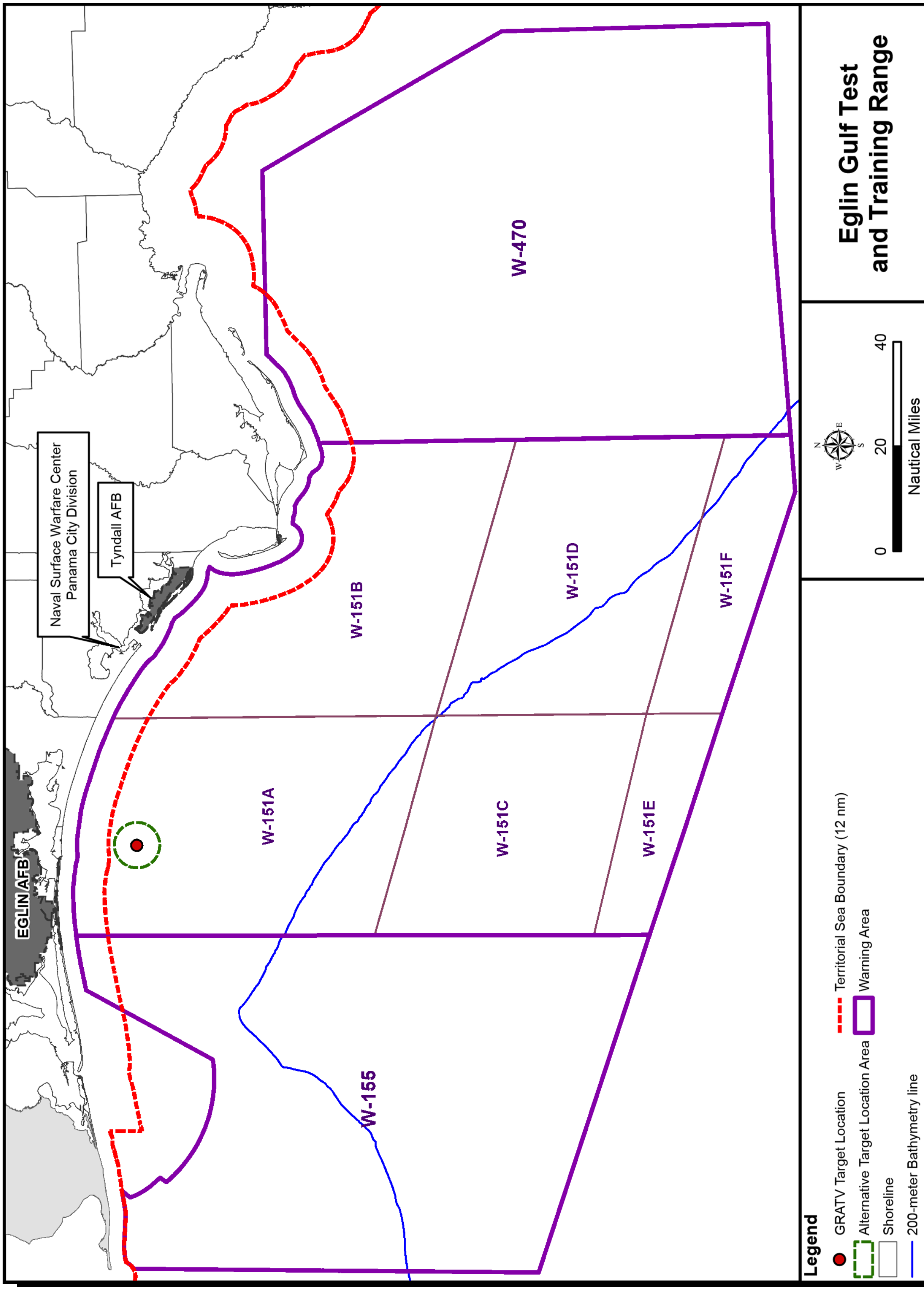

Figure 1-7. 200-Meter Isobath Boundary

1.5.2.1 Mission-Day Categorization

Table 1-7 shows the mission-day scenarios and annual number of munitions expended annually for SOPGM testing. The 413 FLTS provided the number of munitions required over a span of four years. The numbers in the table represent the average per year (total number of munitions divided by four).

Table 1-7. 413 FLTS SOPGM Annual Testing Categorized as Representative Mission Days

Mission Category	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
I	AGM-176 (Griffin)	4.58	Surface	5	2	10
J	AGM-114 (Hellfire)	29	Surface	5	2	10
K	GBU-39 (SDB I)	36	Surface	3	2	6
L	GBU-39 (LSDB)	36	Surface	5	2	10

AGM = Air-To-Ground Missile; GBU = Guided Bomb Unit; lbs = pounds; LSDB = Laser Small Diameter Bomb; SDB = Small Diameter Bomb

1.6 780TH TEST SQUADRON

Testing activities conducted by the 780th Test Squadron (780 TS) include Precision Strike Weapon, Longbow missile littoral testing, and several other various future actions. Each activity category is described below.

1.6.1 Precision Strike Weapon

The U.S. Air Force Life Cycle Management Center and U.S. Navy, in cooperation with the 780 TS, conducts Precision Strike Weapon (PSW) test missions utilizing resources within the Eglin Military Complex, including sites in the EGTTR. The weapons used in testing are the AGM-158 A and B (Joint Air-to-Surface Standoff Missile [JASSM]), and the GBU-39/B (SDB I).

Figure 1-8. Joint Air-to-Surface Stand-off Missile (JASSM)

The JASSM (Figure 1-8) is a precision cruise missile designed for launch from outside area defenses against hardened, medium-hardened, soft, and area type targets. The JASSM has a range of more than 200 NM and carries a 1,000-pound warhead. The JASSM has approximately 240 pounds of 2,4,6-trinitrotoluene (TNT) equivalent NEW. The specific explosive used is AFX-757, a type of plastic bonded explosive (PBX). The JASSM would be launched more than 200 NM from the target location. Platforms for the launch would include B-1, B-2, B-52, F-16, F-18, and F-15E aircraft. Launch from the aircraft would occur at

altitudes greater than 25,000 ft. The JASSM would cruise at altitudes greater than 12,000 ft for the majority of the flight profile until making the terminal maneuver toward the target.

The SDB (Figure 1-9) is a guided bomb that is an important element of the Air Force's Global Strike Task Force. The SDB I carries a 217-pound warhead with approximately 37 pounds NEW. The explosive used is AFX-757. The SDB I may be launched from over 50 NM away from the target location. Platforms for the launch include F-15E, F-16, and AC-130W aircraft. Launch from the aircraft occurs at altitudes greater than 5,000 ft above ground level (AGL). The SDB I then commences a non-powered glide to the intended target.

Figure 1-9. Small-Diameter Bomb (SDB)

Up to two live and four inert JASSM missiles per year may be launched to impact a target at the GRATV target location. The JASSM missile would detonate upon impact with the target. Although impact would typically occur about 5 ft (1.5 m) above the water surface, detonations are assumed to occur at the water surface for purposes of impacts analysis.

Additionally, up to 6 live and 12 inert SDBs could also be deployed against targets in the same target area. Two SDB-Is could be launched simultaneously during two of the live missions and four of the inert missions. Detonation of the SDBs would occur under one of two scenarios:

- Detonation upon impact with the target.
- Height of burst (HOB) test, which involves detonation 7 to 14 ft (2.2 to 4.5 m) in the air above the surface target.

There would generally be only one detonation per test event, and thus no more than one detonation in any 24-hour period. In instances of a simultaneous SDB launch scenario, two bombs are deployed from the same aircraft at nearly the same time to strike the same target. It is expected that the bombs would strike the target within five seconds or less of each another. Under this scenario, the detonations are considered a single event (NEW is doubled) for the purpose of acoustic modeling and marine species impacts analysis. Modeling both detonations as a single event results in a conservative impact estimate. Refer to Appendix A for a complete description

of the acoustic modeling conducted in support of this document. PSW munitions are shown in Table 1-8.

Table 1-8. Summary of Annual Precision Strike Weapon Tests

Munitions	# of Live Tests/Year	Total # of Live Munitions	# of Inert Tests/Year	Total # of Inert Munitions
AGM-158 (JASSM)	2	2	4	4
GBU-39 (SDB I) Single Launch	2	2	4	4
GBU-39 (SDB I) Simultaneous Launch	2	4	4	8

JASSM = Joint Air-To-Surface Stand-Off Missile; SDB = Small Diameter Bomb

Chase aircraft, consisting of F-15, F-16, and/or T-38, would accompany each launch. These aircraft would follow the test items during captive carry and free flight but would not follow either item below a predetermined altitude as directed by Flight Safety. Other assets on site could include an E-9 turboprop aircraft circling around the target location. Tanker aircraft including KC-10s and KC-135s would also be used. The GRATV could also be on location to hold instrumentation, and would be anchored up to 1,000 ft away from the target location.

Based on availability, one of two potential target types would be used during PSW tests. The first is a Container Express (CONEX) target (Figure 1-10) that consists of up to five containers strapped, braced, and welded together to form a single structure. The dimensions of each container are approximately 8 ft by 8 ft by 40 ft. Each container contains 200 55-gallon steel drums (filled with air and sealed) to provide buoyancy. The second type of target is a hopper barge, which is a non-self-propelled vessel typically used for transportation of bulk cargo (Figure 1-11). A typical hopper barge is approximately 30 ft by 12 ft by 125 ft. The targets are held in place by a four-point anchoring system using cables.

Figure 1-10. Example of a CONEX Target

Figure 1-11. Typical Hopper Barge

The CONEX target would be constructed on land and shipped to the target location two to three days prior to the test. The barge target would also be stationed at the target location two to three days prior to the test. During an inert mission, the JASSM would pass through the target and the warhead would sink to the bottom of the Gulf. Immediately following impact, the JASSM recovery team would pick up surface debris originating from the missile and target. Depending on the test schedule, the target could remain in the Gulf of Mexico for up to one month at a time. If the target is significantly damaged, and it is deemed impractical and unsafe to retrieve it, the target remains could be sunk through coordination with the U.S. Coast Guard or Tyndall AFB. Coordination with the U.S. Army Corps of Engineers would be required prior to sinking a target.

PSW test activities would occur in W-151 at the GRATV target location. Targets are located in approximately 115 to 120 ft of water, about 17 miles offshore of Test Area A-3 on Santa Rosa Island (actual distance could range from 15 to 24 miles offshore). This area is the same as the Maritime WSEP test site, which is located 17 miles offshore. Test missions could occur during any time of the year, but during daylight hours only.

PSW missions are currently authorized to be conducted in the EGTTR. An Environmental Assessment (EA) was prepared and completed in November 2005. In association with that EA, a Biological Opinion was issued by the USFWS on March 14, 2005 (Consultation No. F/SER/2004/00223) in accordance with the ESA. More recently, on March 5, 2014, NMFS issued a 5-year LOA in accordance with the MMPA for the 780th’s PSW testing activities, as described above. Since then, new acoustic thresholds and criteria have been adopted by NMFS to analyze acoustic impacts to marine mammals from exposure to explosive sources. The analysis in Section 6 incorporates these new requirements. The 2014 LOA includes specific measures including pre- and post-test surveys, marine species observer training, and reporting requirements. All of these requirements are described in detail in Section 11, *Means of Affecting the Least Practicable Adverse Impacts*.

In addition to the above description, future (Phase 2) testing of the SDB is planned by the Air Force Operational Test and Evaluation Center (AFOTEC) (Table 1-9). AFOTEC proposes to expend two live and one inert GBU-53 (SDB II) weapons in the EGTTR. The live weapons would be deployed against moving boats with a length of 30 to 40 ft, while the inert weapon would be used against a smaller fiberglass boat.

Table 1-9. Summary of Phase 1 and Phase 2 Precision Strike Weapon Live Tests

Weapon	NEW (lbs)	# of Live Munitions Released	# of Inert Munitions Released
AGM-158 (JASSM)	240	2	4
GBU-39 (SDB I)	37	2	4
GBU-39 (SDB I) Double Shot*	74	2	4
GBU-53 (SDB II)	22.84	2	1

AGM = Air-To-Ground Missile; GBU = Guided Bomb Unit; JASSM = Joint Air-To-Surface Standoff Missile; lbs = pounds; SDB = Small Diameter Bomb
*NEW is doubled for each simultaneous launch

1.6.1.1 Mission-Day Categorization

The 780 TS/OGMT missions have been categorized based on the number of weapons released per day, assuming three mission days are planned annually. Representative mission days are shown in Table 1-10.

Table 1-10. 780 TS/OGMT Precision Strike Weapon Testing Catergorized as Representative Mission Days

Mission Category	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
M	AGM-158 (JASSM)	240	Surface	2	1	2
N	GBU-39 (SDB I)	37	Surface	2	1	2
	GBU-39 (SDB I) Double Shot*	74	Surface	2		2
O	GBU-53 (SDB II)	22.84	Surface	2	1	2

AGM = Air-To-Ground Missile; GBU = Guided Bomb Unit; JASSM = Joint Air-To-Surface Standoff Missile; lbs = pounds; SDB = Small Diameter Bomb
*NEW is doubled for each simultaneous launch

1.6.2 Longbow Littoral Testing

The 780 TS/OGMT proposes to collect data on the ability of the Longbow missile (AGM-114L) to track and impact moving boat targets in both the Lock On Before Launch (LOBL) and Lock On After Launch (LOAL) modes, and at varying launch elevation angles. A secondary objective of the tests is to acquire telemetry data in order to evaluate tracking quality. Missiles would be typically launched from an Avenger system (a mobile missile launch system) mounted to a High Mobility Multipurpose Wheeled Vehicle (HMMWV). The HMMWV would be located either at the shoreline of Eglin's Santa Rosa Island property or on a barge or boat in W-151A. Missiles could also be launched from an AH-64D Apache helicopter. Missiles launched from Santa Rosa Island would be outside the EGTTR boundary and effects from the missile launch are analyzed separately in the *Santa Rosa Island Testing and Training Activities Biological Opinion* (U.S. Fish and Wildlife Service, 2014). However all missiles that impact targets placed in the EGTTR are

included in this analysis. The targets consist of small (approximately 25 ft in length), remotely controlled fiberglass boats. The distance between the targets and the missile launch platform would be either 1.5 or 4 kilometers (km) (0.9 or 2.5 miles).

Up to 16 live Longbow missiles could be launched annually into the EGTTR (Table 1-11). The NEW of each missile is 35.95 pounds. All missiles would contain a proximity fuse, with detonations occurring at a minimum height of 1 to 3 meters (3.3 to 9.8 ft) above the water. Since no detonations would occur on or below the water surface, no acoustic impacts from these arounds are anticipated. Therefore Longbow missile tests are not included in the acoustic analysis outlined in Section 6. Management actions include human safety zone clearance and pre- and post-mission protected marine species surveys, as described in Section 11.

Table 1-11 Annual Longbow Munitions

Type of Munition	Total # of Live Munitions	# of Detonations by Height/Depth	Warhead – explosive material	NEW (lbs)
AGM-114 L (Longbow)	16	1 to 3 meter height (airburst)	High Explosive Anti-Tank (HEAT) tandem anti-armor metal augmented charge.	35.95

AGM = Air-To-Ground Missile; lbs = pounds; NEW = net explosive weight

1.6.3 Future Actions

The 780 TS plans to conduct other various testing activities that involve targets on the water surface in the EGTTR. Many of the missions would target small boats or barges. Weapons would primarily be delivered by aircraft, although a rail gun would be used for one test. Live warheads would be used for some missions, while others would involve inert warheads with a live fuse (typically contains a very small NEW). Total future munitions for 780 TS are listed in Table 1-12. As with the preceding missions using live weapons, safety zone enforcement and pre- and post-mission marine species monitoring would be required.

Table 1-12. 780 TS Annual Munitions, Other Future Actions

Munition	NEW (lbs)	Number of Releases	Proposed Location	Target Type	Detonation Type
Joint Air-Ground Missile	27.41	2	W-151 (subareas A, S5, and S6)	HSMST or Boston Whaler type boat	1 – Point Detonation 1 - Airburst
Navy Rail Gun	Inert	19	W-151	Barge	Penetrating Rod
	1	5	W-151	Barge	Airburst
JDAM – Extended Range	Inert	3	W-151	Water surface (2) Barge (1)	Inert
Navy HAAWC	Inert	2	W-151	Water surface	Inert
Laser SDB (live fuse only)	0.4	4	W-151A	Small boats	Airburst or Surface
SDB II Guided Test Vehicle (live fuse only)	0.4	4	W-151A	Small boats	Surface

HAAWC = High Altitude Anti-Submarine Warfare Weapon Capability; HSMT = High Speed Maneuverable Surface Target; JDAM = Joint Direct Attack Munition; NEW = net explosive weight; SDB = Small Diameter Bomb

1.6.3.1 Mission-Day Categorization

The 780 TS/OGMT future missions primarily consist of one-day test events for each type of munition. Inert munitions and munitions being detonated as airbursts were not included in the development of these scenarios because no in-water acoustic impacts are anticipated. Therefore representative mission days were developed for live munitions resulting in surface detonations, as shown in Table 1-13.

Table 1-13. 780 TS Other Future Actions Categorized as Representative Mission Days

Mission Category	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
P	Joint Air-Ground Missile	27.41	Surface	1	1	1
Q	Laser SDB (fuse only) and SDB II Guided Test Vehicle (fuse only)	0.4	Surface	2	4	8

HAAWC = High Altitude Anti-Submarine Warfare Weapon Capability; HSMT = High Speed Maneuverable Surface Target; JDAM = Joint Direct Attack Munition; N/A = not applicable; NEW = net explosive weight; SDB = Small Diameter Bomb

1.7 96TH TEST WING INERT MUNITIONS

The 96th Test Wing (96 TW), Eglin's host wing, provides developmental test and evaluation for a wide variety of air-delivered weapons and other systems. The 96 TW proposes to expend approximately nine inert bombs yearly in the EGTTR. The weight of each bomb would be 2,000 pounds, but there would be no warhead. Use of inert munitions was analyzed in the 2002 PEA and found to have no significant environmental impact. Therefore, there is no limit on the number of inert items that may be expended, and actual numbers used by the 96 TW may vary. However, the bombs are included in this EA in order to document the programmatic use of the EGTTR.

1.8 96 OPERATIONS GROUP

The 96 Operations Group (OG), which conducts the 96 TW's primary missions of developmental testing and evaluation of conventional munitions, and command and control systems, anticipates support of air-to-surface missions for several user groups on an infrequent basis. As the organization that oversees all users of Eglin ranges, they have the authority to approve new missions that could be conducted in the EGTTR. Specific details on mission descriptions under this category have not been determined, as this is meant to capture future unknown activities. Sub-surface detonations would be at 5 to 10 ft below the surface. Projected annual munitions expenditures and detonation scenarios are listed in Table 1-14.

Table 1-14 Annual Munitions for 96th Operations Group Support

Munition	NEW (lbs)	Detonation Scenario	# Annual Releases
GBU-10 or GBU-24	945	Subsurface	1
AGM-158 (JASSM)	240	Surface	1
GBU-12 or GBU-54	192	Subsurface	1
AGM-65 (Maverick)	86	Surface	2

Munition	NEW (lbs)	Detonation Scenario	# Annual Releases
GBU-39 (SDB I or LSDB)	37	Subsurface	4
AGM-114 (Hellfire)	20	Subsurface	20
105 mm full-up	4.7	Surface	125
40 mm	0.9	Surface	600
Live fuse	0.4	Surface	200
30 mm	0.1	Surface	5,000

AGM = air-to-ground missile; GBU = Guided Bomb Unit; lbs = pounds; LSDB = Laser Small Diameter Bomb; SDB = Small Diameter Bomb

The 96th Operations Group will control the allocation of the munitions listed in Table 1-14 to user groups operating in the EGTTR. Mitigation and monitoring measures for these unknown missions would be determined by Eglin Natural Resources to ensure the user groups follow the requirements in the LOA, which will be based on the mission description provided through Eglin's Environmental Impact Analysis Process.

1.8.1 Mission-Day Categorization

The 96 OG future missions have been categorized based on the number of weapons released per day, instead of treating each weapon release as a separate event. This approach is meant to satisfy NMFS requests for analysis and modeling of accumulated energy from multiple detonations over a 24-hour timeframe. Eglin AFB used all available information to determine these daily estimates, including historic release reports; however, these scenarios may not represent exact weapon releases because military needs and requirements are in a constant state of flux. The mission day scenarios for 96 OG annually are shown in Table 1-15.

Categories of missions for 96 OG were grouped (similar to Maritime WSEP) first using historical weapon releases per day. Next, the most recent weapons evaluation needs and requirements were considered to develop three different scenarios: Categories R, S, and T. Mission-day Category R represents munitions with larger NEW (192 to 945 pounds) and both surface and subsurface detonations. This category includes future requirements and provides flexibility for the military mission. To date, Category R levels of activity have not been conducted under 96 OG missions, and is considered a worst-case scenario. Category S represents munitions with medium levels of NEW (20 to 86 pounds) including surface and subsurface detonations. Category T represents munitions with smaller NEW (0.1 to 13 pounds) and includes surface detonations only.

Table 1-15. 96 OG Future Missions Categorized as Representative Mission Days

Mission Category	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
R	GBU-10/-24	945	Subsurface (10-ft depth)	1	1	1
	AGM-158 (JASSM)	240	Surface	1		1
	GBU-12 or GBU-54	192	Subsurface (10-ft depth)	1		1
S	AGM-65 (Maverick)	86	Surface	1	2	2

Mission Category	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
	GBU-39 (SDB I or LSDB)	37	Subsurface	2		4
	AGM-114 (Hellfire)	20	Subsurface (10-ft depth)	10		20
T	105 mm full-up	4.7	Surface	13	10	130
	40 mm	0.9	Surface	60		600
	Live fuse	0.4	Surface	20		200
	30 mm	0.1	Surface	500		5,000

AGM = air-to-ground missile; GBU = Guided Bomb Unit; HEI = high explosive incendiary; JDAM = Joint Direct Attack Munition; LJDAM = Laser Joint Direct Attack Munition; LSDB = Laser Small Diameter Bomb; lbs = pounds; PGU = Projectile Gun Unit; mm = millimeter; SDB = Small Diameter Bomb

1.9 SUMMARY OF MISSION-DAY CATEGORIZATIONS FOR ALL AIR-TO-SURFACE TESTING AND TRAINING IN THE EGTTR

Table 1-16 shows a comprehensive list of all EGTTR testing and training mission activities characterized as mission-day scenarios. Inert weapons, airburst scenarios, and other items that have no acoustic impact to the underwater environment are not included in this table.

Table 1-16. EGTTR Testing and Training Activities Categorized as Representative Mission Days

Mission Groups	Mission Category Day	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
86 FWS Maritime WSEP	A	GBU-10/-24/-31	945	Subsurface*	1	2	2
		GBU-49	300	Surface	2		4
		AGM-158 (JASSM)	240	Surface	2		4
		GBU-12/-54 (LJDAM)/-38/-32 (JDAM)	192	Subsurface*	5		10
	B	AGM-65 (Maverick)	86	Surface	2	4	8
		GBU-39 (SDB)	37	Surface	1		4
		AGM-114 (Hellfire)	20	Subsurface*	5		20
	C	AGM-176 (Griffin)	13	Surface	5	2	10
		2.75 rockets	12	Surface	50		100
		AIM-9X	7.9	Surface	1		2
		PGU-12 HEI 30 mm	0.1	Surface	500		1,000
AFSOC Air-to-Surface Gunnery	D	105 mm HE (FU)	4.7	Surface	30	25	750
		40 mm HE	0.87	Surface	64		1,600
		30 mm HE	0.1	Surface	500		12,500
		25 mm HE	0.067	Surface	560		14,000
	E	105 mm HE (TR)	0.35	Surface	30	45	1,350
		40 mm HE	0.87	Surface	64		2,880
		30 mm HE	0.1	Surface	500		22,500
		25 mm HE	0.067	Surface	560		25,200
413 FLTS PSP Gunnery	F	30 mm HE	0.1	Surface	33	3	99
	G	105 mm FU	4.7	Surface	15	4	60
	H	105 mm TR	0.35	Surface	15	4	60
413 FLTS SOPGM	I	AGM-176 (Griffin)	4.58	Surface	5	2	10
	J	AGM-114 (Hellfire)	20	Surface	5	2	10
	K	GBU-39 (SDB I)	36	Surface	3	2	6
	L	GBU-39 (LSDB)	36	Surface	5	2	10
780 TS Precision Strike Weapon	M	AGM-158 (JASSM)	240	Surface	2	1	2
	N	GBU-39 (SDB I)	37	Surface	2	1	2
		GBU-39 (SDB I) Double Shot*	74	Surface	2		2
	O	GBU-53 (SDB II)	22.84	Surface	2	1	2
780 TS Other Tests	P	Joint Air-Ground Missile	27.41	Surface	1	1	1
	Q	LSDB and SDB II (live fuse only)	0.4	Surface	2	4	8

Mission Groups	Mission Category Day	Munition	NEW (lbs)	Detonation Type	Munitions per Day	Mission Days/Year	Total Munitions/Year
96 OG Future Missions	R	GBU-10/-24	945	Subsurface*	1	1	1
		AGM-158 (JASSM)	240	Surface	1		1
		GBU-12 or GBU-54	192	Subsurface*	1		1
	S	AGM-65 (Maverick)	86	Surface	1	2	2
		GBU-39 (SDB I or LSDB)	37	Subsurface*	2		4
		AGM-114 (Hellfire)	29	Subsurface*	10		20
	T	105 mm HE (FU)	4.7	Surface	13	10	130
		40 mm HE	0.9	Surface	60		60
		Live fuse	0.4	Surface	20		200
		30 mm HE	0.1	Surface	500		5,000

AGM = air-to-ground missile; CBU = Cluster Bomb Unit; FU = Full-Up; FWS = Fighter Weapons Squadron; GBU = Guided Bomb Unit; GTV = Guided Test Vehicle; HEI = high explosive incendiary; JASSM = Joint Air-to-Surface Stand-off Missile; JDAM = Joint Direct Attack Munition; lbs = pounds; LJDAM = Laser Joint Direct Attack Munition; LSDB = Laser Small Diameter Bomb; lbs = pounds; mm = millimeter; NEW = net explosive weight; OG = Operations Group; PGU = Projectile Gun Unit; PSP = Precision Strike Package; SDB = Small Diameter Bomb; TR = Training Round; TS = Test Squadron

* Subsurface detonations occur at 10 feet water depth

2. DURATION AND LOCATION OF THE ACTIVITIES

Due to the total number and variability in types of air-to-surface test and training missions included in this LOA request, missions may occur during any season or month. Missions involving the use of live bombs, missiles, and rockets will occur during daylight hours. However, some activities, such as gunnery training, may occur during day or night. Missions are typically conducted on weekdays, with one or two missions occurring per day. All activities will take place within the EGTTR, which is defined as the airspace over the Gulf of Mexico controlled by Eglin AFB, beginning at a point 3 NM from shore. This airspace is controlled by the Federal Aviation Administration, but scheduled by Eglin AFB. The EGTTR is subdivided into blocks consisting of Warning Areas W-155, W-151, W-470, W-168, and W-174, as well as Eglin Water Test Areas 1 through 6 (Figure 1-2). Most of the blocks are further sub-divided into smaller airspace units for scheduling purposes (for example, W-151A, B, C, and D). Warning Area W-155 is controlled by the U.S. Navy but is used occasionally to support missions scheduled through Eglin. Over 102,000 square nautical miles (NM^2) of Gulf of Mexico surface waters occur under the EGTTR airspace. However, most of the activities described in this document will occur in W-151, and the great majority will occur specifically in sub-area W-151A due to its proximity to shore (Figure 1-3). Descriptive information for all of W-151 and for W-151A specifically is provided below.

2.1 W-151

The inshore and offshore boundaries of W-151 are roughly parallel to the shoreline contour. The shoreward boundary is 3 NM from shore, while the seaward boundary extends approximately 85 to 100 NM offshore, depending on the specific location. W-151 covers a surface area of approximately 10,247 NM^2 (35,145 square kilometers [km^2]), and includes water depths ranging from about 20 to 700 m (66 to 2,297 ft). This range of depth includes continental shelf and slope waters. Approximately half of W-151 lies over the shelf.

2.2 W-151A

W-151A, which occurs directly south of Eglin AFB, extends approximately 60 NM offshore and has a surface area of 2,565 NM^2 (8,797 km^2). Water depths range from about 30 to 350 m (98 to 1,148 ft) and include continental shelf and slope zones. However, most of W-151A occurs over the continental shelf, in water depths less than 250 m (820 ft). Most of the air-to-surface missions described in Section 1 occur in the shallower, northern inshore portion of the sub-area (Maritime WSEP test site), in a water depth of about 35 m (115 ft).

As a conservation measure to avoid impacts to deep water marine mammal species, all gunnery missions will be conducted within (shoreward of) the 200-m water depth contour, which transects portions of W-151A, W-151D, and W-151F. All of W-151B lies shoreward of the shelf break. The 200-m contour is shown on Figure 1-7.

3. MARINE MAMMAL SPECIES AND NUMBERS

Marine mammals that potentially occur within the northeastern Gulf of Mexico include numerous species of cetaceans and one sirenian, the Florida manatee (*Trichechus manatus latirostris*). Manatees primarily inhabit coastal and inshore waters, and are rarely sighted offshore. Most air-to-surface test and training missions will be conducted at least 15 miles off the coast. Therefore, manatee occurrence is considered unlikely in the EGTTR, and further discussion of marine mammal species is limited to cetaceans.

Up to 28 cetacean species occur in the northern Gulf of Mexico, from deep offshore waters to shallow estuarine environments. Distribution is influenced by factors such as prey availability and environmental conditions, among many others. Distribution in the northern Gulf may be broadly categorized as those species occurring over the continental shelf (typically considered to be water depths of about 100 to 200 m [328 to 656 ft] or less) and those occurring at and beyond the continental shelf break (water depths greater than about 200 m [656 ft]). Although AFSOC missile tests may occur beyond the 200-m (656 ft) isobath, the missions would involve in-air detonations only. Airbursts are not considered to affect marine mammals because there is little transmission of pressure or energy across the air/water interface. All other types of missions will occur in water depths of less than 200 m (656 ft). Therefore, only marine mammal species typically occurring over the continental shelf are included in this LOA request. Two species, the common bottlenose dolphin (*Tursiops truncatus*) and Atlantic spotted dolphin (*Stenella frontalis*), are frequently sighted in shelf waters. Dwarf sperm whales (*Kogia sima*), pygmy sperm whales (*Kogia breviceps*), and rough-toothed dolphins (*Steno bredanensis*) are occasionally sighted over the shelf but are not considered regular inhabitants (Fulling et al., 2003; Davis et al., 2000). The remaining cetacean species are primarily considered to occur at and beyond the shelf break. Therefore, only the bottlenose dolphin and Atlantic spotted dolphin are included in this LOA request.

The number of marine mammals within the project area may be considered in terms of density. Bottlenose and Atlantic spotted dolphin density estimates used in this document were obtained from Duke University Marine Geospatial Ecology Lab Reports (Roberts et al. 2016) which integrated 23 years of aerial and shipboard surveys, linked them to environmental covariates obtained from remote sensing and ocean models, and built habitat-based density models using distance sampling methodology. For bottlenose dolphins, geographic modeling strata from MMPA stock boundaries and seasonal strata were not defined because of the lack of information about seasonality in the Gulf of Mexico, as well as substantial spatial and seasonal biases in survey efforts (Roberts et al 2015a). Therefore bottlenose dolphin numbers were modeled in the Gulf of Mexico using a single year-round model. Similarly for Atlantic spotted dolphins, there is no evidence that this species migrates or exhibits seasonal patterns in the Gulf of Mexico, so a single, year-round model that incorporated all available survey data was used (Roberts et al 2015b). The model results are available at the OBIS-SEAMAP repository found online (http://seamap.env.duke.edu/).

Density models for bottlenose dolphins and Atlantic spotted dolphins accounted for perception and availability biases, typically captured as g(0) estimates. Perception bias refers to the failure of observers to detect animals that are present in the survey area and available to be seen. Availability bias refers to animals that are in the survey area, but are not able to be seen because they are

submerged when observers are present. Perception and availability bias result in the underestimation of abundance and density numbers (negative bias).

There are no published g(0) estimates for any shipboard surveys in the Gulf of Mexico, therefore the model used Barlow and Forney (2006) estimates for delphinids produced from surveys that utilized similar protocols. These estimates only accounted for perception bias, but since dive times for dolphins are generally short in duration, availability bias is not expected to be significant (Roberts et al., 2015a,b). For aerial surveys, Palka (2006) g(0) estimates were used for the availability bias component of g(0) which was 1 for large groups and Carreta et al. (2000) estimates were used for the perception bias component of g(0) for large groups, which is slightly less than 1.

Two marine mammal density estimates were calculated for this LOA. One density estimate is considered a large-scale estimate and is used for missions that could occur anywhere in W-151A, shoreward of the 200-m isobath. The mission sets that utilize the entire W-151A area include AFSOC's Air-to-Surface Gunnery Training Operations and 413 FLTS's AC-130J Precision Strike Package Gunnery Testing (Scenarios D, E, F, G, and H). The other density estimate is considered a fine-scale estimate and is used for missions that are proposed specifically around the GRATV target area. The mission sets that utilize the nearshore GRATV target location (Figure 1-3) are 86th FWS Maritime WSEP, 413 FLTS AC-130J and AC-130W Stand-Off Precision Guided Munitions Testing, 780th TS Precision Strike Weapons, 780 TS/OGMT future missions, and 96th OG future missions (Scenarios A, B, C, and I through T). Using two different density estimates based on the mission locations accounts for the differences between inshore and offshore distribution of bottlenose and Atlantic spotted dolphins, and provides more realistic take calculations.

Raster data provided online from the Duke University Marine Geospatial Ecology Lab Report was imported into ArcGIS and overlayed onto the W-151A area. Density values for each species were provided in 10 km^2 boxes. The large-scale estimates for W-151A were obtained by averaging the density values of all 10 km^2 boxes within the W-151A boundaries and converted to number of animals per km^2. Fine-scale estimates were calculated by selecting nine 10 km^2 boxes centered around the GRATV target location and averaging the density values from those boxes. Large-scale and fine-scale density estimates are provided in Table 3-1.

Table 3-1. Marine Mammal Density Estimates for EGTTR Testing and Training Activities

Species	Large-Scale Density Estimate[a] (animals per km^2)	Fine-Scale Density Estimate[b] (animals per km^2)
Bottlenose dolphin[c]	0.276	0.433
Atlantic spotted dolphin[d]	0.160	0.148

[a] Large-scale estimates incorporate the entire W-151A area
[b] Fine-scale estimates incorporate the nine 10 km^2 boxes centered around the GRATV location
[c] Densities derived from Roberts et al. 2015a
[d] Densities derived from Roberts et al. 2015b

4. AFFECTED SPECIES STATUS AND DISTRIBUTION

Information on each marine mammal species, including general descriptions, status, and occurrence, is provided below. Descriptions include Potential Biological Removal (PBR). PBR is defined as the maximum number of animals that may be removed, not including natural mortalities, from a stock while allowing that stock to reach or maintain its optimal sustainable population. Historically, PBR has primarily been used in assessing marine mammal impacts associated with commercial fishing. However, the number is provided in this document as a point of reference. To facilitate management of marine mammals under the MMPA, NMFS has identified various stocks, which are defined as groups of mammals of the same species occurring in the same area, and which interbreed when mature. A stock may be categorized as a *strategic stock*, which is defined as a marine mammal stock considered likely to be listed under the ESA, currently listed under the ESA, currently listed as depleted under the MMPA, or for which the level of non-natural mortality or serious injury (e.g. from commercial fishing) exceeds the PBR level.

Distribution of cetaceans in the Gulf may be influenced by hydrographic and bathymetric features. The dominant hydrographic feature in the Gulf is the Loop Current that, though generally south of the continental slope, can generate anti-cyclonic (clockwise circulating) and cyclonic (counterclockwise) eddies that move onto or influence the slope and shelf regions. Davis et al. (2000) noted during 1997-1998 surveys of the northern Gulf of Mexico that cetaceans were concentrated along the continental slope and in or near cyclonic eddies. Cetaceans may also be associated with seafloor features such as the DeSoto Canyon, Florida Escarpment, Mississippi Canyon, and Mississippi River Delta. These and other bathymetric features are shown on Figure 4-1.

4.1 COMMON BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*)

Status and management - This species is not listed under the ESA but is protected under the MMPA. Along the United States east coast and northern Gulf of Mexico, the bottlenose dolphin stock structure is well studied. There are currently 34 management stocks identified by NMFS in northern Gulf of Mexico, including oceanic, continental shelf, coastal, and estuarine stocks (Waring et al. 2016)

Habitat and Geographic Range - The bottlenose dolphin occurs in tropical to temperate waters of the Atlantic Ocean as well as inshore, nearshore, and offshore waters of the Gulf of Mexico and United States east coast (Waring et al. 2016). They generally do not range north or south of 45° latitude (Jefferson et al. 2015; Wells and Scott 2008). They occur in most enclosed or semi-enclosed seas in habitats ranging from shallow, murky, estuarine waters to deep, clear offshore waters in oceanic regions (Jefferson et al. 2015; Wells et al. 2009). Open ocean populations occur far from land; however, population density appears to be highest in nearshore areas (Scott and Chivers 1990).

There are two morphologically and genetically distinct bottlenose dolphin morphotypes (distinguished by physical differences) (Duffield 1987; Duffield et al. 1983) described as coastal and offshore forms. Both inhabit waters in the Gulf of Mexico (Curry and Smith 1997; Hersh and Duffield 1990; Mead and Potter 1995). The coastal morphotype of bottlenose dolphin is continuously distributed along the Atlantic coast south of Long Island, New York, around the Florida peninsula, and along the Gulf of Mexico coast. Five stocks of bottlenose dolphins are identified in the Gulf of Mexico: Continental Shelf, Eastern Coastal, Northern Coastal, Western Coastal, and Oceanic (Waring et al. 2016). Residency patterns of dolphins in bays, sounds, and estuaries range from transient to seasonally migratory to stable resident communities, and various stocks may overlap at times. Year-round residency patterns of some individual bottlenose dolphins in bays, sounds, and estuaries have been reported for almost every survey area where photo-identification or tagging studies have been conducted (LaBrecque et al. 2015). Based on photo-identification studies, satellite telemetry data, and genetics studies, LaBrecque et al. (2015) described 32 small and resident population areas for bottlenose dolphins within the Gulf of Mexico, all consistent with the Bay, Sound, and Estuary Stocks. Of the 32 stocks of Bay, Sound and Estuary (BSE) bottlenose dolphins recognized by NMFS, only 11 met the criteria for small and resident populations as a biologically important area. The Choctawhatchee Bay Stock has published data suggesting small and resident populations, however it was one of the 21 remaining stocks that did not meet the biologically important area criteria (LaBrecque et al. 2015). Therefore, no biologically important areas have been identified within or around the EGTTR Study Area.

Gulf of Mexico – The bottlenose dolphin is the most widespread and common cetacean in coastal waters of the Gulf of Mexico (Würsig et al., 2000). The species is abundant in continental shelf waters throughout the northern Gulf of Mexico (Fulling et al., 2003; Waring et al. 2016), including the outer continental shelf, upper slope, nearshore waters, the DeSoto Canyon region, the West Florida Shelf, and the Florida Escarpment. Mullin and Fulling (2004) noted that in oceanic waters, bottlenose dolphins are encountered primarily in upper continental slope waters (less than 1,000 m [3281 ft] in bottom depth) and that highest densities are in the northeastern Gulf. Significant occurrence is expected near all bays in the northern Gulf.

The results of a survey effort of nearshore and continental shelf waters of the eastern Gulf of Mexico (Garrison, 2008) identified four areas where bottlenose dolphins were clustered in winter: nearshore waters off Louisiana, the Florida Panhandle, north of Tampa Bay, and southwestern Florida. Dolphins were also common over the entire shelf. In summer, the number of group sightings was comparatively lower than in winter, and bottlenose dolphins were more evenly distributed throughout coastal and shelf waters.

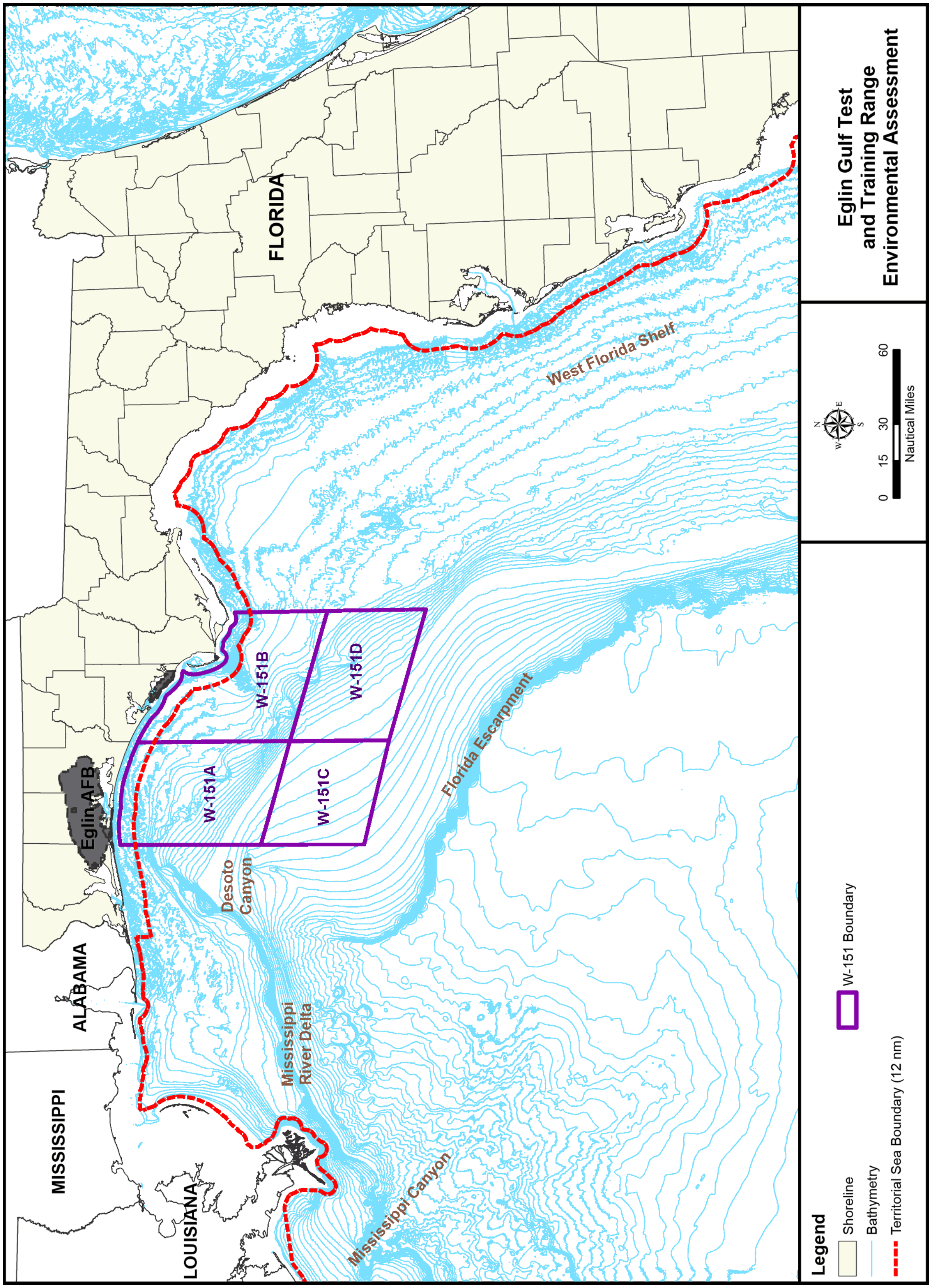

Figure 4-1. Topographical Features of the Gulf of Mexico in Relation to W-151

Table 4-1. Common Bottlenose Dolphin Stocks in the North-Central Gulf of Mexico

Stock		Distribution	Strategic Stock	Estimated Abundance	PBR
Bay, Sound, & Estuarine Stocks:	Choctawhatchee Bay	Areas of contiguous, enclosed, or semi-enclosed water bodies	Yes	179	1.7
	Pensacola/East Bay		Yes	33	U
	St. Andrew Bay		Yes	124	U
Gulf of Mexico Northern Coastal		Waters from shore to the 20-meter (66-foot) isobath, from the Mississippi River delta to the Florida Big Bend region	Yes	7,185	60
Northern Gulf of Mexico Continental Shelf		Waters between the 20- and 200-meter (66- and 656-foot) isobaths, from Texas to Key West	No	51,192	469
Northern Gulf of Mexico Oceanic		Waters from the 200-meter (656-foot) isobath to the seaward extent of the U.S. Exclusive Economic Zone	No	5,806	42

PBR = Potential Biological Removal; U = undetermined
Source: Waring et al. 2016

Genetic, photo-identification, and tagging data support the concept of relatively discrete bay, sound, and estuary stocks (Waring et al. 2016; Duffield and Wells 2002). NMFS has provisionally identified 31 such stocks which inhabit areas of contiguous, enclosed, or semi-enclosed water bodies adjacent to the northern Gulf of Mexico. The stocks are based on a description of dolphin communities in some areas of the Gulf coast. A community is generally defined as resident dolphins that regularly share a large portion of their range; exhibit similar genetic profiles; and interact with each other to a much greater extent than with dolphins in adjacent waters. Although the shoreward boundary of W-151 is beyond these environments, individuals from these stocks could potentially enter the project area. Movement between various communities has been documented (Waring et al., 2016), and Fazioli et al. (2006) reported that dolphins found within bays, sounds, and estuaries on the west central Florida coast move into the nearby Gulf waters used by coastal stocks. Air-to-surface activities will occur directly seaward of the area occupied by the Choctawhatchee Bay stock. The best abundance estimate for this stock, as provided in the Stock Assessment Report, is 179. Stocks immediately to the west and east of Choctawhatchee Bay include Pensacola/East Bay and St. Andrew Bay stocks. PBR for the Choctawhatchee Bay stock is 1.7 individuals. NMFS considers all bay, sound, and estuary stocks to be strategic.

Three coastal stocks have been identified in the northern Gulf of Mexico, occupying waters from the shore to the 20-meter (66-foot) isobath: Eastern Coastal, Northern Coastal, and Western Coastal stocks. The Western Coastal stock inhabits nearshore waters from the Texas/Mexico border to the Mississippi River Delta. The Northern Coastal stock's range is considered to be from the Mississippi River Delta to the Big Bend region of Florida (approximately 84°W). The Eastern Coastal stock is defined from 84°W to Key West, Florida. Of the coastal stocks, the Northern Coastal Stock is geographically associated with the GRATV target location. PBR is 60 individuals. Prior to 2012, this stock was not considered strategic. However, beginning 1 February 2010 an Unusual Mortality Event of unprecedented size and duration has been ongoing (Litz et al. 2014) that has resulted in NMFS' reclassification of this stock as strategic.

The Northern Gulf of Mexico Continental Shelf stock is defined as bottlenose dolphins inhabiting the waters from the Texas/Mexico border to Key West, Florida, between the 20- and 200-meter (66- and 656-foot) isobaths. The continental shelf stock probably consists of a mixture of coastal and offshore ecotypes. PBR is 469 individuals, and the stock is not considered strategic.

The Northern Gulf of Mexico Oceanic stock is provisionally defined as bottlenose dolphins inhabiting waters from the 200-meter (656-foot) isobath to the seaward extent of the U.S. Exclusive Economic Zone. This stock is believed to consist of the offshore form of bottlenose dolphins. The continental shelf stock may overlap with the oceanic stock in some areas and may be genetically indistinguishable. PBR is 42 individuals, and the stock is not considered strategic.

Diving Behavior – Dive durations as long as 15 minutes are recorded for trained individuals (Ridgway et al., 1969). Typical dives, however, are more shallow and of a much shorter duration. Mean dive durations of Atlantic bottlenose dolphins typically range from 20 to 40 seconds at shallow depths (Mate et al., 1995) and can last longer than 5 minutes during deep offshore dives (Klatsky et al., 2005). Offshore bottlenose dolphins regularly dive to 450 meters (1,476 ft) and possibly as deep as 700 meters (2,297 ft) (Klatsky et al., 2005).

Acoustics and Hearing – Sounds emitted by bottlenose dolphins have been classified into two broad categories: pulsed sounds (including clicks and burst-pulses) and narrow-band continuous sounds (whistles), which usually are frequency modulated. Clicks and whistles have a dominant frequency range of 110 to 130 kiloHertz (kHz) and a source level of 218 to 228 decibels referenced to one micropascal-meter (dB re 1 μPa-m peak-to-peak) (Au, 1993) and 3.4 to 14.5 kHz and 125 to 173 dB re 1 μPa-m peak-to-peak, respectively (Ketten, 1998). Whistles are primarily associated with communication and can serve to identify specific individuals (i.e., signature whistles) (Janik et al., 2006). Sound production is influenced by group type (single or multiple individuals), habitat, and behavior (Nowacek, 2005). Bray calls (low-frequency vocalizations; majority of energy below 4 kHz), for example, are used when capturing fishes in some regions (Janik, 2000). Additionally, whistle production has been observed to increase while feeding (Acevedo-Gutiérrez and Stienessen, 2004; Cook et al., 2004). Whistles and clicks may vary geographically in terms of overall vocal activity, group size, and specific context (e.g., feeding, milling, traveling, and socializing) (Jones and Sayigh, 2002; Zaretsky et al., 2005; Baron, 2006).

Bottlenose dolphins can hear within a broad frequency range of 0.04 to 160 kHz (Au, 1993; Turl, 1993). Electrophysiological experiments suggest that the bottlenose dolphin brain has a dual analysis system: one specialized for ultrasonic clicks and another for lower-frequency sounds, such as whistles (Ridgway, 2000). Scientists have reported a range of highest sensitivity between 25 and 70 kHz, with peaks in sensitivity at 25 and 50 kHz (Nachtigall et al., 2000). Recent research on the same individuals indicates that auditory thresholds obtained by electrophysiological methods correlate well with those obtained in behavior studies, except at lower (10 kHz) and higher (80 and 100 kHz) frequencies (Finneran and Houser, 2006).

Temporary threshold shifts (TTS) in hearing have been experimentally induced in captive bottlenose dolphins using a variety of noises (i.e., broad-band, pulses) (Ridgway et al., 1997; Schlundt et al., 2000; Nachtigall et al., 2003; Finneran et al., 2005; Mooney et al., 2005; Mooney, 2006). Preliminary research indicates that TTS and recovery after noise exposure are frequency

dependent and that an inverse relationship exists between exposure time and sound pressure level associated with exposure (Mooney et al., 2005; Mooney, 2006). Observed changes in behavior were induced with an exposure to a 75 kHz one-second pulse at 178 dB re 1 μPa-m (Ridgway et al., 1997; Schlundt et al., 2000).

4.2 ATLANTIC SPOTTED DOLPHIN (*STENELLA FRONTALIS*)

Status and Management – The Atlantic spotted dolphin occurs in two forms that may be distinct subspecies (Perrin et al. 1987,1994; Rice 1998; Viricel and Rosel 2014): the large, heavily spotted form, which inhabits the continental shelf and is usually found inside or near the 200-m isobath; and the smaller, less spotted island and offshore form, which occurs in the Atlantic Ocean but is not known to occur in the Gulf of Mexico (Fulling et al. 2003; Mullin and Fulling 2003, 2004; Viricel and Rosel 2014).

Habitat and Geographic Range – The Atlantic spotted dolphin is found in nearshore tropical to warm-temperate waters, predominantly over the continental shelf and upper slope (Waring et al. 2016). In the Gulf of Mexico, for instance, the species often occurs over the mid-shelf (Griffin and Griffin 2003). In the western Atlantic, this species is distributed from New England to Brazil and is found in the Gulf of Mexico as well as the Caribbean Sea (Perrin 2008a). The large, heavily spotted coastal form of the Atlantic spotted dolphin typically occurs over the continental shelf but usually at least 4.9 to 12.4 mi. offshore (Davis et al. 1998; Perrin 2002; Perrin et al. 1994a). Higher numbers of spotted dolphins are reported over the west Florida continental shelf from November to May than during the rest of the year, suggesting that this species may migrate seasonally (Griffin and Griffin 2003). In the Gulf of Mexico, Atlantic spotted dolphins occur primarily from continental shelf waters 10-200 meters deep to slope waters less than 500 meters deep (Fulling et al. 2003; Mullin and Fulling 2004; Maze-Foley and Mullin 2006). Atlantic spotted dolphins were seen in all seasons during GulfCet aerial surveys of the northern Gulf of Mexico from 1992 to 1998 (Hansen et al. 1996; Mullin and Hoggard 2000). It has been suggested that this species may move inshore seasonally during spring, but data supporting this hypothesis are limited (Caldwell and Caldwell 1966; Fritts *et al.* 1983). Because there are confirmed records from the southern Gulf of Mexico beyond U.S. boundaries (e.g., Jefferson and Schiro 1997, Ortega Ortiz 2002), this may be a transboundary stock.

The most recent abundance estimate is 37,611 individuals in the northern Gulf of Mexico (outer continental shelf and oceanic waters) and is derived from fall surveys in 2000 – 2011 and spring/summer surveys in 2003 – 2004. According to the 2015 Stock Assessment Report, since these data are more than 8 years old, the current best population estimate is unknown (Waring et al. 2016). The northern Gulf of Mexico population is considered to be genetically distinct from western North Atlantic populations. PBR for this species is undetermined, and the stock is not considered strategic.

Diving Behavior – Information on diving depth for this species is available from a satellite-tagged individual in the Gulf of Mexico (Davis et al., 1996). This individual made short, shallow dives to less than 10 meters (33 ft) and as deep as 60 meters (197 ft), while in waters over the continental shelf.

Acoustics and Hearing – A variety of sounds including whistles, echolocation clicks, squawks, barks, growls, and chirps have been recorded for the Atlantic spotted dolphin. Whistles have dominant frequencies below 20 kHz (range: 7.1 to 14.5 kHz) but multiple harmonics extend above 100 kHz, while burst pulses consist of frequencies above 20 kHz (dominant frequency of approximately 40 kHz) (Lammers et al., 2003). Other sounds typically range in frequency from 0.1 to 8 kHz (Thomson and Richardson, 1995). Recorded echolocation clicks had two dominant frequency ranges at 40 to 50 kHz and 110 to 130 kHz, depending on source level (Au and Herzing, 2003). Echolocation click source levels as high as 210 dB re 1 μPa-m peak-to-peak have been recorded (Au and Herzing, 2003). Spotted dolphins in the Bahamas were frequently recorded during aggressive interactions with bottlenose dolphins (and their own species) to produce squawks (0.2 to 12 kHz broad band burst pulses; males and females), screams (5.8 to 9.4 kHz whistles; males only), barks (0.2 to 20 kHz burst pulses; males only), and synchronized squawks (0.1-15 kHz burst pulses; males only in a coordinated group) (Herzing, 1996).

Hearing ability for the Atlantic spotted dolphin is unknown. However, odontocetes are generally adapted to hear in relatively high frequencies (Ketten, 1997).

Distribution **–** Atlantic spotted dolphins are distributed in warm-temperate and tropical Atlantic waters from northern New England to Venezuela, including the Gulf of Mexico and the Caribbean Sea (Perrin et al., 1987). Atlantic spotted dolphins may occur in both continental shelf and offshore waters (Perrin et al., 1994). In oceanic waters, this species usually occurs near the shelf break and upper continental slope waters (Davis et al., 1998; Mullin and Hansen, 1999).

4.2.1.1 Gulf of Mexico

The Atlantic spotted dolphin is the second most abundant cetacean in the nearshore waters of the northern Gulf of Mexico. In the Gulf, Atlantic spotted dolphins are most abundant east of Mobile Bay (Fulling et al., 2003). On the West Florida shelf, spotted dolphins are more common in deeper waters than bottlenose dolphins (Griffin and Griffin, 2003).

5. TAKE AUTHORIZATION REQUESTED

The MMPA established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters under U.S. jurisdiction. The act further regulates "takes" of marine mammals in the high seas by vessels or persons under U.S. jurisdiction. The term *take,* as defined in Section 3 (16 United States Code [USC] 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." *Harassment* was further defined in the 1994 amendments to the MMPA, which provided for two levels: Level A (potential injury) and Level B (potential disturbance).

The National Defense Authorization Act of fiscal year 2004 (Public Law 108-136) amended the definition of harassment for military readiness activities. Military readiness activities, as defined in Public Law 107-314, Section 315(f), includes all training and operations related to combat, and the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat. This definition, therefore, includes air-to-surface test and training activities occurring in the EGTTR. The amended definition of harassment for military readiness activities is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"), or
- 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 ("Level B harassment") (16 USC 1362 [18][B][i],[ii]).

Section 101(a)(5) of the MMPA directs the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity (exclusive of commercial fishing) within a specified geographic region. These incidental takes may be allowed if NMFS determines the taking will have a negligible impact on the species or stock and the taking will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

Pursuant to Section 101(a)(5), a LOA for the incidental taking (but not intentional taking) of marine mammals is requested for air-to-surface test and training activities within the EGTTR. The results of acoustic modeling for surface and subsurface detonations indicate the potential for mortality (less than two animals), as well as Level A and Level B (physiological and behavioral) harassment, and take is requested for these levels of impact. However, it is expected that the mitigation measures identified in Section 11 will substantially decrease the number of impacts, and mortality takes are unlikely. The subsequent analyses in this request will identify the applicable types of take.

6. NUMBERS AND SPECIES TAKEN

Potential marine mammal impacts are considered to occur as a result of pressure and noise generated by detonations at or under the water surface. The potential for ordnance to physically strike marine mammals was evaluated in the 2002 PEA. The analysis concluded the potential for a direct strike was improbable even without taking into consideration that units actively survey and avoid marine species and target specific items and that animals spend most of the time submerged. While the quantity of expended gunnery rounds and inert bombs and missiles would increase over the annual average from 1999 through 2010, the total amount is still less than the maximum baseline levels analyzed in 2002. In addition, the direct strike calculations provided in the 2002 PEA included all cetacean species potentially present in the northern Gulf of Mexico, whereas only two species are included in this LOA request. Therefore, potential impacts resulting from direct strikes are not considered further.

Dolphins spend their entire lives in the water and are submerged below the surface for much of the time. As a result, dolphins located near an underwater or surface detonation would be exposed to the resulting shock wave and underwater noise effects. Animals located near a detonation may experience tissue damage, eardrum rupture, or other physical impacts that can result in death or injury. As the pressure and sound waves spread away from the detonation point, they lose energy. Therefore, at increasing distances from a detonation, effects may include temporary or permanent hearing threshold shifts or behavioral reactions, such as startle effects or disruption of normal activities. The potential numbers and species taken are assessed in this section. Appendix A includes a detailed description of the acoustic modeling methodology used to estimate exposures. Three sources of information are necessary for estimating potential noise effects on marine mammals: 1) the zone of influence (ZOI), which is the distance from the explosion to which particular levels of impact would extend; 2) the density of animals within the ZOI; and 3) the number of detonations (events). Noise and pressure effects are evaluated only for detonations occurring at and beneath the water surface. In-air detonations are not included in impacts analysis because of the negligible transmission of energy and pressure across the air-water interface.

6.1 ZONE OF INFLUENCE (ZOI)

The ZOI is defined as the area or volume of ocean in which marine mammals could be exposed to various pressure or noise energy levels caused by exploding ordnance. The size of the ZOI was calculated based on explosive acoustic characteristics, sound propagation, and sound transmission loss in the EGTTR Study Area, which incorporates water depth, sediment type, wind speed, bathymetry, and temperature/salinity profiles. Refer to Appendix A for a more detailed description of the method used to calculate impact volumes for explosives. The pressure and energy levels considered in these calculations are defined in terms of metrics, criteria, and thresholds. A *metric* is a technical standard of measurement that describes the noise and pressure at a given location. *Criteria* are the types of possible impact and include mortality, injury, and harassment. A *threshold* is the level of pressure or noise above which the impact criteria are reached. The analysis of potential impacts to marine mammals utilizes criteria and thresholds presented in Finneran and Jenkins (2012) and NMFS's Technical Guidance (NMFS, 2016). The paragraphs below provide

a general discussion of the various metrics, criteria, and thresholds used for impulsive noise impact assessment. More detailed information is provided in Appendix A.

6.2 METRICS

Standard impulsive and acoustic metrics were used for the analysis of underwater energy and pressure waves in this document. Several different metrics are important for understanding risk assessment analysis of impacts to marine mammals.

SPL (sound pressure level): A ratio of the absolute sound pressure and a reference level. Units are in decibels referenced to 1 micropascal (dB re 1 µPa).

SEL (sound exposure level): SEL is a measure of sound intensity and duration. When analyzing effects on marine animals from multiple moderate-level sounds, it is necessary to have a metric that quantifies cumulative exposures. SEL can be thought of as a composite metric that represents both the intensity of a sound and its duration. SEL is determined by calculating the decibel level of the cumulative sum-of-squared pressures over the duration of a sound, with units of decibels referenced to 1 micropascal-squared seconds (dB re 1 $\mu Pa^2 \cdot s$) for sounds in water.

Positive impulse: This is the time integral of the pressure over the initial positive phase of an arrival. This metric represents a time-averaged pressure disturbance from an explosive source. Units are typically pascal-seconds (Pa·s) or pounds per square inch per millisecond (psi·msec). There is no decibel analog for impulse.

6.3 CRITERIA AND THRESHOLDS

The criteria and thresholds used to estimate potential pressure and energy impacts to marine mammals resulting from detonations were obtained from Finneran and Jenkins (2012) and NMFS Technical Guidance (NMFS, 2016). Criteria used to analyze impacts to marine mammals include mortality, injurious harassment (Level A), and non-injurious harassment (Level B). Each category is discussed below with additional details provided in Appendix A.

6.3.1 Mortality

Mortality risk assessment may be considered in terms of direct injury, which includes primary blast injury and barotrauma. The potential for direct injury of marine mammals has been inferred from terrestrial mammal experiments and from post-mortem examination of marine mammals believed to have been exposed to underwater explosions (Finneran and Jenkins, 2012; Ketten et al., 1993; Richmond et al., 1973). Actual effects on marine mammals may differ from terrestrial animals due to anatomical and physiological differences, such as a reinforced trachea and flexible thoracic cavity, which may decrease the risk of injury (Ridgway and Dailey, 1972).

Primary blast injuries result from the initial compression of a body exposed to a blast wave, and is usually limited to gas-containing structures (e.g., lung and gut) and the auditory system (U.S. Department of the Navy, 2001b). Barotrauma refers to injuries caused when large pressure changes

occur across tissue interfaces, normally at the boundaries of air-filled tissues such as the lungs. Primary blast injury to the respiratory system may be fatal depending upon the severity of the trauma. Rupture of the lung may introduce air into the vascular system, producing air emboli that can restrict oxygen delivery to the brain or heart.

Whereas a single mortality threshold was previously used in acoustic impacts analysis, species-specific thresholds are currently required. Thresholds are based on the level of impact that would cause extensive lung injury to one percent of exposed animals (i.e., an impact level from which one percent of exposed animals would not recover). (Finneran and Jenkins, 2012). The threshold represents the expected onset of mortality, where 99 percent of exposed animals would be expected to survive. Most survivors would have moderate blast injuries. The lethal exposure level of blast noise, associated with the positive impulse pressure of the blast, is expressed as Pa·s and is determined using the Goertner (1982) modified positive impulse equation. This equation incorporates source/animal depths and the mass of a newborn calf for the affected species. The threshold is conservative because animals of greater mass can withstand greater pressure waves, and newborn calves typically make up a very small percentage of any cetacean group.

For the actions described in this LOA request, two species are expected to occur within the EGTTR Study Area: the bottlenose dolphin and the Atlantic spotted dolphin. Finneran and Jenkins (2012) provide known or surrogate masses for newborn calves of several cetacean species. For the bottlenose dolphin, this value is 14 kilograms (kg) (31 pounds). Values are not provided for the Atlantic spotted dolphin and, therefore, a surrogate species, the striped dolphin (*Stenella coeruleoalba*), is used. The mass provided for a newborn striped dolphin calf is 7 kg (15 pounds). Impacts analysis for the unidentified dolphin group (assumed to consist of bottlenose and Atlantic striped dolphins) conservatively used the mass of the smaller spotted dolphin. The Goertner equation, as presented in Finneran and Jenkins (2012) is used in the acoustic model to develop impacts analysis in this LOA request. The equation is provided in Table 6-1 and Appendix A.

6.3.2 Injury (Level A Harassment)

Finneran and Jenkins (2012) recognizes two types of blast related injury: gastrointestinal (GI) tract injury and slight lung injury, while NMFS Technical Guidance (2016) addresses irrecoverable auditory damage. These injury categories are all types of Level A harassment as defined in the MMPA.

6.3.2.1 Slight Lung Injury

This threshold is based on a level of lung injury from which all exposed animals are expected to survive (zero percent mortality) (Finneran and Jenkins, 2012). Similar to the mortality determination, the metric is positive impulse and the equation for determination is that of the Goertner injury model (1982), corrected for atmospheric and hydrostatic pressures and based on the cube root scaling of body mass (Richmond et al., 1973; U.S. Department of the Navy, 2001b). The equation is provided in Table 6-1 and Appendix A.

6.3.2.2 Gastrointestinal Tract Injuries

GI tract injuries are correlated with the peak pressure of an underwater detonation. GI tract injury thresholds are based on the results of experiments in the 1970s in which terrestrial mammals were exposed to small charges. The peak pressure of the shock wave was found to be the causal agent in recoverable contusions (bruises) in the GI tract (Richmond et al., 1973, in Finneran and Jenkins, 2012). The experiments found that a peak SPL of 237 dB re 1 μPa predicts the onset of GI tract injuries, regardless of an animal's mass or size. Therefore, the unweighted peak SPL of 237 dB re 1 μPa is used in explosive impacts assessments as the threshold for slight GI tract injury for all marine mammals.

6.3.2.3 Auditory Damage (Permanent Threshold Shift)

Another type of injury, permanent threshold shift or PTS, is auditory damage that does not fully recover and results in a permanent decrease in hearing sensitivity. As there have been no studies to determine the onset of PTS in marine mammals, this threshold is estimated from available information associated with TTS. The NMFS Technical Guidance (2016) defines PTS thresholds differently for three groups of cetaceans based on their hearing sensitivity: low frequency, mid-frequency, and high frequency. Bottlenose and Atlantic spotted dolphins that are the subject of the EGTTR acoustic impacts analysis both fall within the mid-frequency hearing category. The PTS thresholds use dual criteria, one based on cumulative SEL and one based on peak SPL of an underwater blast. For a given analysis, the more conservative of the two is applied to afford the most protection to marine mammals. The mid-frequency cetacean criteria for PTS are provided in Table 6-1 and Appendix A.

6.3.3 Non-Injurious Impacts (Level B Harassment)

Two categories of non-injurious Level B harassment are currently recognized: temporary threshold shift (TTS) and behavioral impacts. Although TTS is a physiological impact, it is not considered injury because auditory structures are temporarily fatigued instead of being permanently damaged.

6.3.3.1 Temporary Threshold Shift (TTS)

Non-injurious effects on marine mammals, such as TTS, are generally extrapolated from data on terrestrial mammals (Southall et al., 2007). Similar to PTS, dual criteria are provided for TTS thresholds, and the more conservative is typically applied in impacts analysis. TTS criteria are based on data from impulse sound exposures when available. According to the most recent NMFS Technical Guidance (NMFS, 2016) the TTS onset thresholds for mid-frequency cetaceans are based on TTS data from a beluga whale exposed to an underwater impulse produced from a seismic watergun. The TTS thresholds consist of the SEL of an underwater blast weighted to the hearing sensitivity of mid-frequency cetaceans and an unweighted peak SPL measure. The dual thresholds for TTS in mid-frequency cetaceans are provided in Table 6-1 and Appendix A.

6.3.3.2 Behavioral Impacts

Behavioral impacts refer to disturbances that may occur at sound levels below those considered to cause TTS in marine mammals, particularly in cases of multiple detonations. During an activity

with a series of explosions (not concurrent multiple explosions shown in a burst), an animal is expected to exhibit a startle reaction to the first detonation followed by a behavioral response after multiple detonations. At close ranges and high sound levels, avoidance of the area around the explosions is the assumed behavioral response in most cases. Other behavioral impacts may include decreased ability to feed, communicate, migrate, or reproduce, among others. Such effects, known as sub-TTS Level B harassment, are based on observations of behavioral reactions in captive dolphins and beluga whales exposed to pure tones, a different type of noise than that produced from an underwater detonation (Finneran and Schlundt, 2004; Schlundt et al., 2000). For multiple, successive detonations (i.e., detonations happening at the same location within a 24-hour period), the threshold for behavioral disturbance is set 5 dB below the SEL-based TTS threshold, unless there are species- or group-specific data indicating that a lower threshold should be used. This is based on observations of behavioral reactions in captive dolphins and belugas occurring at exposure levels approximately 5 dB below those causing TTS after exposure to pure tones (Finneran and Jenkins, 2012; Finneran and Schlundt, 2004; Schlundt *et al.*, 2000). The behavioral impacts thresholds for marine mammals are provided in Table 6-1 and Appendix A.

6.3.4 Summary of Criteria and Thresholds

Table 6-1 summarizes the thresholds and criteria discussed above and are used to estimate potential acoustic impacts to marine mammals resulting from detonations.

Table 6-1. Criteria and Thresholds Used for Impact Analyses

Mortality*	Level A Harassment			Level B Harassment	
	Slight Lung Injury*	GI Tract Injury	PTS	TTS	Behavioral
$91.4M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$	$39.1M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$	Unweighted SPL: 237 dB re 1 μPa	Weighted SEL: 185 dB re 1 $\mu Pa^2 \cdot s$ Unweighted SPL: 230 dB re 1 μPa	Weighted SEL: 170 dB re 1 $\mu Pa^2 \cdot s$ Unweighted SPL: 224 dB re 1 μPa	Weighted SEL: 165 dB re 1 $\mu Pa^2 \cdot s$

D = water depth (meters); dB re 1 μPa = decibels referenced to 1 micropascal; dB re 1 $\mu Pa^2 \cdot s$ = decibels referenced to 1 micropascal-squared second; *M* = animal mass based on species (kilograms); PTS = permanent threshold shift; SEL = sound exposure level; SPL = sound pressure level; TTS = temporary threshold shift

1. Expressed in terms of acoustic impulse (pascal seconds [Pa·s])

6.4 MARINE MAMMAL DENSITY

Density estimates for marine mammals occurring in the EGTTR are provided in Table 3-1**Error! Reference source not found.**. Densities were derived from the results of published documents authored by NMFS personnel. Density is nearly always reported for an area (e.g., animals per square kilometer). Although the study area appears to represent only the surface of the water (two-dimensional), density actually implicitly includes animals anywhere within the water column under that surface area. Density estimates usually assume that animals are uniformly distributed within the prescribed area, even though this is likely rarely true. Marine mammals are often clumped in areas of greater importance, for example, in areas of high productivity, lower predation, safe calving, etc. Density can occasionally be calculated for smaller areas, but usually there are insufficient data to calculate density for such areas. Therefore, assuming an even distribution within the prescribed area is the typical approach.

In addition, assuming that marine mammals are distributed evenly within the water column does not accurately reflect behavior. Databases of behavioral and physiological parameters obtained through tagging and other technologies have demonstrated that marine animals use the water column in various ways. Some species conduct regular deep dives while others engage in much shallower dives, regardless of bottom depth. Assuming that all species are evenly distributed from surface to bottom can present a distorted view of marine mammal distribution in any region. Based on current guidance from NMFS, density is assumed to be two-dimensional, and exposure estimates are, therefore, simply calculated as the product of affected area, animal density, and number of events. The resulting exposure estimates are considered conservative, because all animals are presumed to be located at the same depth, where the maximum sound and pressure ranges would extend from detonations, and would, therefore, be exposed to the maximum amount of energy or pressure. In reality, it is highly likely that some portion of marine mammals present near the impact area at the time of detonation would be at various depths in the water column and not necessarily occur at the same depth corresponding to the maximum sound and pressure ranges.

6.5 NUMBER OF EVENTS

Historically, the Air Force has conservatively used the number of live weapons deployed (a per-detonation analysis that assumes a fresh population of marine mammals for each detonation) as the number of events. However a mission-day based analysis was requested by NMFS in order to model accumulated energy over a 24-hour timeframe where each mission-day scenario would be considered a separate event. As shown in Table 1-16 (EGTTR Testing and Training Activities Categorized as Representative Mission Days), Eglin developed multiple mission-day categories separated by mission groups and estimated the number of days each category would be executed annually. In total, there are 20 different mission-day scenarios included in the acoustic analysis (Labeled A-T in Table 1-16).

6.6 EXPOSURE ESTIMATES

Table 6-2 shows the maximum estimated range, or radius, from the detonation point to which the various thresholds extend, based on calculation methods described in Appendix A.

Table 6-2. Threshold Radii (in kilometers) for EGTTR Air-to-Surface Testing and Training Ordnance

Mission-Day Category	Mortality	Level A Harassment				Level B Harassment		
	Modified Goertner Model 1	Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
		Modified Goertner Model 2	237 dB SPL	185 dB SEL	230 dB Peak SPL	170 dB SEL	224 dB Peak SPL	165 dB SEL
Bottlenose Dolphin								
A	0.193	0.534	0.18	1.039	0.705	5.001	1.302	8.155
B	0.11	0.18	0.156	0.43	0.18	2.245	0.18	3.959
C	0.037	0.073	0.083	0.32	0.169	1.128	0.18	1.863
D	0.024	0.053	0.059	0.254	0.12	0.982	0.18	1.413
E	0.01	0.024	0.034	0.232	0.069	0.878	0.126	1.252
F	0.003	0.007	0.016	0.055	0.033	0.218	0.062	0.373
G	0.024	0.053	0.059	0.157	0.12	0.552	0.18	0.809
H	0.006	0.015	0.025	0.059	0.051	0.229	0.093	0.432
I	0.023	0.053	0.059	0.09	0.119	0.328	0.18	0.572
J	0.045	0.082	0.096	0.157	0.18	0.555	0.18	0.812
K	0.055	0.094	0.117	0.153	0.18	0.541	0.18	0.795
L	0.055	0.094	0.117	0.2	0.18	0.654	0.18	0.953
M	0.088	0.14	0.18	0.211	0.18	0.761	0.18	1.123
N	0.067	0.11	0.149	0.202	0.18	0.671	0.18	0.982
O	0.047	0.085	0.101	0.108	0.18	0.432	0.18	0.64
P	0.05	0.088	0.107	0.079	0.18	0.271	0.18	0.527
Q	0.007	0.016	0.026	0.025	0.053	0.127	0.098	0.207
R	0.193	0.534	0.18	0.811	0.705	4.316	1.302	6.883
S	0.147	0.18	0.156	0.692	0.18	3.941	0.442	5.132
T	0.024	0.053	0.059	0.224	0.12	0.837	0.18	1.209
Atlantic Spotted Dolphin								
A	0.193	0.534	0.18	1.039	0.705	5.001	1.302	8.155
B	0.11	0.18	0.156	0.43	0.18	2.245	0.18	3.959
C	0.037	0.073	0.083	0.32	0.169	1.128	0.18	1.863

Mission-Day Category	Mortality	Level A Harassment				Level B Harassment		
	Modified Goertner Model 1	Slight Lung Injury	GI Tract Injury	PTS		TTS		Behavioral
		Modified Goertner Model 2	237 dB SPL	185 dB SEL	230 dB Peak SPL	170 dB SEL	224 dB Peak SPL	165 dB SEL
D	0.024	0.053	0.059	0.254	0.12	0.982	0.18	1.413
E	0.01	0.024	0.034	0.232	0.069	0.878	0.126	1.252
F	0.003	0.007	0.016	0.055	0.033	0.218	0.062	0.373
G	0.024	0.053	0.059	0.157	0.12	0.552	0.18	0.809
H	0.006	0.015	0.025	0.059	0.051	0.229	0.093	0.432
I	0.023	0.053	0.059	0.09	0.119	0.328	0.18	0.572
J	0.045	0.082	0.096	0.157	0.18	0.555	0.18	0.812
K	0.055	0.094	0.117	0.153	0.18	0.541	0.18	0.795
L	0.055	0.094	0.117	0.2	0.18	0.654	0.18	0.953
M	0.088	0.14	0.18	0.211	0.18	0.761	0.18	1.123
N	0.067	0.11	0.149	0.202	0.18	0.671	0.18	0.982
O	0.047	0.085	0.101	0.108	0.18	0.432	0.18	0.64
P	0.05	0.088	0.107	0.079	0.18	0.271	0.18	0.527
Q	0.007	0.016	0.026	0.025	0.053	0.127	0.098	0.207
R	0.193	0.534	0.18	0.811	0.705	4.316	1.302	6.883
S	0.147	0.18	0.156	0.692	0.18	3.941	0.442	5.132
T	0.024	0.053	0.059	0.224	0.12	0.837	0.18	1.209

1

AGM = air-to-ground missile; AIM = air intercept missile; cal = caliber; dB = decibels; FU = full up; GBU = Guided Bomb Unit; GI = gastrointestinal; lbs = pounds; LSDB = Laser Small Diameter Bomb; mm = millimeters; NEW = net explosive weight; SDB = small diameter bomb; PTS = permanent threshold shift; TR = training round; TTS = temporary threshold shift

[1]Unidentified dolphin can be either bottlenose or Atlantic spotted dolphin. Mortality and slight lung injury criteria are conservatively based on the mass of a newborn Atlantic spotted dolphin (striped dolphin surrogate).

The ranges presented above were used to calculate the total area (circle) of the zones of influence for each criterion/threshold. To eliminate "double-counting" of animals, impact areas from higher impact categories (e.g., mortality) were subtracted from areas associated with lower impact categories (e.g., Level A harassment). The estimated number of marine mammals potentially exposed to the various impact thresholds was calculated with a two-dimensional approach, as the product of the adjusted impact area, animal density, and annual number of events for each mission-day category. The calculations generally resulted in decimal values, suggesting that, in most cases, a fraction of an animal was exposed. The results were therefore rounded at the annual mission-day level and then summed for each criterion to obtain total annual take estimates from all EGTTR mission activities. A "take" is considered to occur for SEL metrics if the received level is equal to or above the associated threshold within the appropriate frequency band of the sound received, adjusted for the appropriate weighting function value of that frequency band. Similarly, a "take" would occur for impulse and peak SPL metrics if the received level is equal to or above the associated threshold. For impact categories with multiple criteria (e.g., slight lung injury, GI tract injury, and PTS for Level A harassment) and criteria with two thresholds (e.g., 187 decibels [dB] SEL and 230 peak SPL for PTS), the criterion and/or threshold that yielded the higher exposure estimate was used for detonation impact analyses. Table 6-3 shows the total numbers of marine mammals potentially affected by all EGTTR testing and training mission activities annually. These exposure estimates do not take into account the required mitigation and monitoring measures described in Chapter 11 of this document; these measures are expected to decrease the potential for impacts.

Acoustic analysis results indicate the potential for injury and non-injurious harassment (including behavioral harassment) to marine mammals *in the absence of mitigation measures*. Mortality was calculated as zero (0) for bottlenose dolphin**s,** zero (0) for Atlantic spotted dolphin. It is expected that, with implementation of the mitigation and monitoring measures outlined in Section 11**Error! Reference source not found.**, there would be no likelihood for mortality takes and the potential for Level A harassment takes would be significantly reduced.

Table 6-3. Total Number of Marine Mammals Potentially Affected Annually by Air-to-Surface Testing and Training Missions in the EGTTR

Species	Mortality	Level A Harassment (PTS)	Level B Harassment (TTS)	Level B Harassment (Behavioral)
Bottlenose dolphin	0	9	220	315
Atlantic spotted dolphin	0	3	85	120
Total	**0**	**12**	**305**	**435**

PTS = permanent threshold shift; TTS = temporary threshold shift

7. IMPACTS TO MARINE MAMMAL SPECIES OR STOCKS

Based on acoustic modeling and in the absence of mitigation measures, no dolphins are expected to be impacted by impulse pressure levels associated with mortality.

A maximum of up to approximately 12 marine mammals could potentially be exposed to injurious Level A harassment (approximately 9 bottlenose dolphins and 3 Atlantic spotted dolphins). Level A harassment could result from slight lung injury, peak SPL resulting in GI track injury, or one of the two thresholds resulting in the onset of PTS. Since the threshold with the highest exposure estimates was used to determine takes, impacts are associated with the 187 dB SEL threshold, which corresponds to the onset of PTS, or a permanent decrease in hearing sensitivity.

A maximum of approximately 305 marine mammals could potentially be exposed to non-injurious (TTS) Level B harassment. TTS results from fatigue or damage to hair cells or supporting structures and may cause disruption in the processing of acoustic cues. However, hearing sensitivity is recovered within a relatively short time. Similar to Level A harassment, the SEL metric results in higher exposure estimates compared with the peak SPL metric.

Approximately 435 animals could potentially be exposed to noise corresponding to the behavioral SEL threshold during air-to-surface test and training missions. Behavioral harassment occurs at distances beyond the range of structural damage and hearing threshold shift. Possible behavioral responses to a detonation include panic, startle, departure from an area, and disruption of activities such as feeding or breeding.

None of the above estimates take into account the mitigation measures outlined in Section 11, which are expected to reduce the number of exposures.

Atlantic spotted dolphins potentially affected by air-to-surface activities conducted in the EGTTR would likely be part of the Northern Gulf of Mexico stock, which is considered to occur over the continental shelf from 10 to 200 meters depth and onto the continental slope. This stock is not considered strategic and PBR has not been determined. Potential impacts to these individuals would primarily result from Level A and Level B Harassment. With the implementation of mitigation measures described in Section 11, impacts to the stock would be recoverable and no adverse population level effects are anticipated.

Four bottlenose dolphin stocks occur in the north-central Gulf of Mexico and could potentially be affected by EGTTR activities. The Choctawhatchee Bay stock boundary is approximately 3 NM north of the EGTTR boundary and is considered strategic. It is not probable that large numbers of dolphins from this stock would be affected, given that most activities will occur at least 17 miles south of Choctawhatchee Bay. However, individuals may move into deeper water at times therefore, there is some potential for occurrence. In addition, individuals from other adjacent BSE stocks (primarily Pensacola/East Bay and St. Andrew Bay), which are also considered strategic, could potentially transit areas inside the EGTTR boundary. Given the geographical location,

impacts to BSE stocks of bottlenose dolphins are not likely to occur and there would be no population level effects.

The Gulf of Mexico Northern Coastal Stock boundary includes waters from the shoreline out to the 20-meter isobaths and is considered strategic. The stock boundaries overlap with the EGTTR but is slightly north of the W-151A boundary, where the majority of activities are proposed to occur. Similar to the Choctawhatchee Bay stock, individuals from the Gulf of Mexico Northern Coastal Stock are not likely to be affected given that most activities will occur farther offshore than the stock boundary, as defined by NMFS. Therefore population level impacts to the Northern Coastal Stock of bottlenose dolphins are not anticipated.

Bottlenose dolphins affected by activities are most likely to be associated with the Northern Gulf of Mexico Continental Shelf stock (20- to 200-meter depth; not considered strategic) since this stock's boundaries overlap with areas where EGTTR activities are proposed to occur. While individuals from this stock may be more likely to be exposed to detonation effects resulting in mortality, Level A, and Level B Harassment, the estimated number of mortality and Level A exposures does not exceed the PBR for this stock (estimated at 469) therefore long-term population level impacts are not anticipated. Adherence to mitigation measures in Section 11 will further reduce the potential for adverse population level effects.

Individuals from the Northern Gulf of Mexico Oceanic Stock, which is not strategic, are unlikely to be affected because of their distribution beyond the 200-meter isobaths, and occurrence of this stock is outside the area where the majority of impacts from EGTTR activities would occur. Therefore, no population level effects are anticipated.

8. IMPACT ON SUBSISTENCE USE

Potential impacts resulting from the proposed activities will be limited to individuals of bottlenose dolphin and Atlantic spotted dolphin stocks located in nearshore waters of the northeastern Gulf of Mexico. These species have no subsistence requirements. Therefore, no impacts on the availability of species or stocks for subsistence use are considered.

9. IMPACTS TO MARINE MAMMAL HABITAT AND THE LIKELIHOOD OF RESTORATION

The primary sources of marine mammal habitat impact are noise and pressure waves resulting from live weapon detonations. However, neither the noise nor overpressure constitutes a long-term physical alteration of the water column or ocean floor. Further, these effects are not expected to substantially affect prey availability, are of limited duration, and are intermittent. Impacts to marine fish were analyzed in the *Eglin Gulf Test and Training Range Environmental Assessment* (Department of the Air Force, 2015). While detonations of live ordnance from EGTTR activities have the potential to kill or injure marine fish, most fish species experience large numbers of natural mortalities. Any behavioral reactions of fish in the vicinity of underwater detonations would be relatively short term, localized, and are not expected to have lasting effects on the survival, growth, or reproduction of fish populations. Additionally, the relatively small levels of mortality potentially caused by EGTTR missions would not likely affect fish populations as a whole and would therefore not limit prey availability for marine mammals.

Surface vessels associated with the missions are present in limited duration and are intermittent as well. Therefore, it is not anticipated that marine mammals will stop utilizing the waters of W-151 or any other portion of the Gulf of Mexico, either temporarily or permanently, as a result of mission activities.

Other factors related to air-to-surface activities that could potentially affect marine mammal habitat include the introduction of metals, explosives and explosion by-products, other chemical materials, and debris into the water column and substrate due to the use of munitions and target vessels. The effects of each were analyzed under National Environmental Policy Act documentation (*Eglin Gulf Test and Training Range Environmental Assessment*; in preparation) and were determined to not be significant. The analysis in the REA is provided in the following paragraphs.

9.1.1.1 Metals

Various metals would be introduced into the water column through expended munitions. The casings, fins, or other parts of large munitions such as bombs and missiles are typically composed primarily of steel but usually also contain small amounts of lead, manganese, phosphorus, sulfur, copper, nickel, and several other metals (U.S. Navy, 2013). Many smaller caliber rounds contain aluminum, copper, and zinc. Aluminum is also present in some explosive materials such as tritonal and PBXN-109. Lead is present in batteries typically used in vessels such as the remotely controlled target boats. Many metals occur naturally in seawater at varying concentrations and some, such as aluminum, would not necessarily be detrimental to the substrate or water column. However, at high concentrations, a number of metals (e.g., lead) may be toxic to microbial communities in the substrate.

Munitions and other metal items would sink to the seafloor and would typically undergo one of three processes: 1) enter the sediment where there is reduced oxygen content, 2) remain exposed on the ocean floor and begin to react with seawater, or 3) remain exposed on the ocean floor and become encrusted with marine organisms. The rate of deterioration would therefore depend on

the specific composition of an item and its position relative to the seafloor/water column. Munitions located deep in the sediment would typically undergo slow deterioration. Some portion of the metal ions would become bound to sediment particles. Metal materials exposed to seawater would begin to slowly corrode. This process typically creates a layer of corroded material between the seawater and metal, which slows the movement of the metal ions into the adjacent sediment and water column. Therefore, elevated levels of metals in sediment would be restricted to a small zone around the munitions, and releases to the overlying water column would be diluted. A similar process would occur with munitions that become covered by marine growth. Direct exposure to seawater would be reduced, thereby decreasing the rate of corrosion.

Munitions that come to rest on the seafloor would slowly corrode and would release small amounts of metals to adjacent sediment and the water column. Metal particles that migrate into the water column would be diluted by diffusion and water movement. Elevated concentrations would be localized and would not be expected to significantly affect overall local or regional water quality. This expectation is supported by the results of two U.S. Navy studies related to munitions use and water quality, as summarized in U.S. Navy (2013). In one study, water quality sampling for lead, manganese, nickel, vanadium, and zinc was conducted at a shallow bombing range in Pamlico Sound off North Carolina immediately following a bomb training event with inert practice munitions. With the exception of nickel, all water quality parameters tested were within the state limits. The nickel concentration was significantly higher than the state criterion, although the concentration did not differ significantly from a control site located outside the bombing range. This suggests that bombing activities may not have been responsible for the elevated nickel concentration. The second study, conducted by the U.S. Marine Corps, included sediment and water quality sampling for 26 munitions constituents at several water training ranges. Metals included lead and magnesium. No levels were detected above screening values used at the water ranges.

9.1.1.2 Explosives and Explosion Byproducts

Chemical materials with potential to affect substrates and the water column include explosives, explosion by-products, and fuel, oil, and other fluids (including battery acid) associated with vessel operations and the use of remotely controlled target boats. Explosives are complex chemical mixtures that may affect water or sediment quality through the by-products of their detonation and the distribution of unconsumed explosives. Some of the more common types of explosive materials used in air-to-surface activities include tritonal and research department explosive (RDX). Tritonal is primarily composed of 2,4,6-trinitrotoluene (TNT). Therefore, discussion in the remainder of this section will consider TNT and RDX to be representative of all explosives. During detonation, energetic compounds may undergo high-order (complete) detonation or low-order (incomplete) detonation, or they may fail to detonate altogether. High-order detonations consume almost all of the explosive material, with the remainder released into the environment as discrete particles. Analysis of live-fire detonations on terrestrial ranges have indicated that over 99.9 percent of TNT and RDX explosive material is typically consumed during a high-order detonation (USACE, 2003). Pennington et al. (2006) reported a median value of 0.006 percent and 0.02 percent for TNT and RDX residue, respectively, remaining after detonation. The annual total NEW for all combined munitions is 30,488 pounds. Using the more conservative (higher) value of 0.02 percent for residual material, a total of about 6.1 pounds of explosive material could

be deposited into the EGTTR annually. For purposes of analysis, it may be conservatively assumed that all residual materials are deposited simultaneously and remain within W-151A and within the top 10 ft of the water column (10 ft is the maximum detonation scenario for any munition). In this case, the resulting concentration of explosive material would be about 8×10^{-8} milligrams/liter (mg/L). In reality, the materials would be dispersed throughout a larger surface area and water volume by currents, waves, and wind (for in-air detonations). Although there are no regulatory standards specifically for explosive materials in marine waters, this value may be compared with the Department of Defense Range and Munitions Use Working Group marine screening value for the amount of C-4 (another type of explosive composed of mostly RDX) remaining after detonation (as provided in U.S. Navy, 2013). The screening value is 5 mg/L, which is many orders of magnitude greater than the concentration calculated above.

Various by-products are produced during and immediately after detonation of TNT and RDX. During the brief time that a detonation is in progress, intermediate products may include carbon ions, nitrogen ions, oxygen ions, water, hydrogen cyanide, carbon monoxide, nitrogen gas, nitrous oxide, cyanic acid, and carbon dioxide (Becker, 1995). However, reactions quickly occur between the intermediates, and the final products consist mainly of carbon (i.e., soot), carbon dioxide (CO_2), water, carbon monoxide (CO), and nitrogen gas (Swisdak, 1975). These substances are natural components of seawater. Other products, occurring at substantially lower concentrations, include hydrogen, ammonia, methane, and hydrogen cyanide, among others.

After detonation, the residual explosive materials and detonation by-products would be dispersed throughout the northern Gulf of Mexico by diffusion and by the action of wind, waves, and currents. A portion of the carbon compounds, such as CO and CO_2, would likely become integrated into the carbonate system (alkalinity and pH buffering capacity of seawater). Some of the nitrogen and carbon compounds would be metabolized or assimilated by phytoplankton and bacteria. Most of the gas products that do not react with the water or become assimilated by organisms would be released to the atmosphere. In addition, many of the detonations would occur in the air or at the water surface. In these cases, some portion of the by-products could be widely distributed by wind. Given that the residual concentration of explosive material would be small, that most of the explosion by-products would be harmless or natural seawater constituents, and that by-products would dissipate or be quickly diluted, impacts resulting from high-order detonations would be negligible.

Low-order detonations consume a lower percentage of the explosive and, therefore, a portion of the material is available for release into the environment. If the ordnance fails to detonate, the entire amount of energetic compound remains largely intact and is released to the environment over time as the munition casing corrodes. The likelihood of incomplete detonations is not quantified; however, the portion of munitions that could fail to detonate (i.e., duds) has been estimated at between about 3 and 5 percent (USACE, 2007; Rand Corporation, 2005). Due to the potential dud rate, number of live munitions included in the 2015 REA, and NEW in each munition, an un-estimable but small amount of explosive material (TNT and RDX, among others) could enter the EGTTR annually through unexploded munitions. However, most of this material would not be available to the marine environment immediately. Explosive material would diffuse into the water through screw threads, cracks, or pinholes in the munition casings. Therefore,

movement of explosive material into the water column would likely be a slow process, potentially ranging from months to decades.

After leaving the munition casing, explosive material would enter the sediment or water column. Similar to the discussion of explosive by-products above, chemical materials in the water column would be dispersed by currents and would eventually become uniformly distributed throughout the northern Gulf of Mexico. Explosive materials in the water column would also be subject to biotic (biological) and abiotic (physical and chemical) transformation and degradation, including hydrolysis, ultraviolet radiation exposure, and biodegradation. The results of a recent investigation suggest that TNT is rapidly degraded in marine environments by biological and photochemical processes (Walker et al., 2006). Marine ecosystems are generally nitrogen limited compared with freshwater systems, and marine microbes such as bacteria may therefore readily use TNT metabolites (e.g., ammonia and ammonium). TNT that is not biodegraded may sorb (bind to by absorption or adsorption) onto particulates, break down into dissolved organic matter, or dissolve into the water column. TNT is also subject to photochemical degradation, known as photolysis, whereby the ultraviolet component of sunlight degrades the compound into products similar to those produced by biodegradation. Photolysis is more effective in waters of shallower depth and/or with greater clarity. Uptake and metabolism of TNT has also been noted in phytoplankton. It is assumed that similar processes could affect other explosives such as RDX.

The results of studies of UXO in marine environments generally suggest that there is little overall impact to water quality resulting from the leaching of explosive material. Various researchers have studied an area in Halifax Harbor, Nova Scotia, where UXO was deposited in 1945. Rodacy et al. (2000) reported that explosives signatures were detectable in 58 percent of water samples, but that marine growth was observed on most of the exposed ordnance. TNT metabolites, suspected to result from biological decomposition, were also detected. In an earlier study (Darrach et al. 1998), sediment collected near unexploded (but broken) ordnance did not indicate the presence of TNT, whereas samples near intact ordnance showed trace explosives in the range of low parts per billion or high parts per trillion. The authors concluded that, after 50 years, the contents of broken munitions had dissolved, reacted, biodegraded, or photodegraded and that intact munitions appear to be slowly releasing their contents through corrosion pinholes or screw threads.

Hoffsommer et al. (1972) analyzed seawater (as well as sediment and ocean floor fauna) at known munitions dumping sites off Washington State and South Carolina for the presence of TNT, RDX, tetryl, and ammonium perchlorate. None of these materials were found in any of the samples. Walker et al. (2006) sampled seawater and sediment at two offshore sites where underwater demolition was conducted using 10-pound charges of TNT and RDX. Residual TNT and RDX were below the detection limit in seawater, including samples collected in the plume within five minutes of detonation.

9.1.1.3 Other Chemical Materials

Additional materials produced during air-to-surface activities would include petroleum products (primarily fuel and oil in target boats), battery acid, and plastics. Increased use of remotely controlled target boats and mission support vessels would increase the potential for fuel, oil, and battery acid to be deposited in the water (primarily through destruction of target boats). When hydrocarbons enter the ocean, the lighter-weight components evaporate, degrade by sunlight, and

undergo chemical degradation. Many constituents are also consumed by microbes. Higher-weight molecular compounds are more resistant to degradation and tend to persist after these processes have occurred. Microbial breakdown of PCBs has been documented in estuarine and marine sediments (Agency for Toxic Substances and Disease, 2000). In addition, currents would disperse any hydrocarbons produced during test and training activities. It is anticipated that potential impacts to water quality due to petroleum-based products would be insignificant. Similarly, battery acid, while possibly having a temporary and local effect on the water column, would be quickly dispersed and diluted by water currents.

Missions that involve target boat destruction could result in generation of plastic or fiberglass debris. Because of their buoyancy and resistance to degradation, many types of plastic float and may travel long distances in the ocean (U.S. Commission on Ocean Policy, 2004). Plastics may serve as vehicles for transport of various pollutants, whether by binding them from seawater or from the constituents of the plastics themselves. However, it is anticipated that plastic items would eventually break down into smaller particles due to photolysis and mechanical wear (Law et al., 2010). Plastics may also wash ashore over time. In addition, for some missions involving target boat destruction, the Air Force would perform debris cleanup at the water surface.

9.1.1.4 Debris

Debris deposited on the seafloor would include spent munitions fragments and possibly pieces of targets (fiberglass, plywood, etc.). Debris would not appreciably affect the sandy seafloor. Debris moved by water currents could scour the bottom, but sediments would quickly refill any affected areas, and overall effects to benthic communities would be minor. Large pieces of debris would not be as prone to movement on the seafloor and could result in beneficial effects by providing habitat for encrusting organisms, fish, and other marine fauna. Target boats have foam-filled hulls and most of the pieces are designed to float in order to facilitate collection for a damage assessment. Overall, the quantity of material deposited on the seafloor would be small compared with other sources of debris in the Gulf of Mexico. Hardbottom habitats and artificial reefs would be avoided when possible through location of target sites and training missions and would not be likely to be affected by debris. There is a potential for some debris to be carried by currents and interact with the substrate, but damage to natural or artificial reefs is not expected and the impacts would not be significant.

10. IMPACTS TO MARINE MAMMALS FROM LOSS OR MODIFICATION OF HABITAT

Based on the discussions in Section 9, long-term impacts to marine mammal habitat including water quality, sediment quality, and prey availability are not anticipated as a result of EGTTR air to surface activities. Therefore no permanent loss or modification of habitat would occur and there would be no indirect impacts to marine mammals from altered habitat conditions.

11. MEANS OF AFFECTING THE LEAST PRACTICABLE ADVERSE IMPACTS

The potential takes discussed in Section 6 represent the maximum expected number of animals that could be exposed to particular noise and pressure thresholds. The impact estimates do not take into account measures that will be employed to minimize impacts to marine species. Eglin proponents have a range of options available to support mitigation and monitoring efforts based on the types of assets (aircraft, surface vessels, etc.) available for specific test or training missions. Section 11.1 summarizes each of these measures, Section 11.2 describes monitoring options available for air-to-surface missions, and Section 11.3 outlines the implementation plan for executing them based on mission criteria.

11.1 GENERAL REQUIREMENTS FOR ALL AIR-TO-SURFACE ACTIVITIES

All air-to-surface testing and training missions in the EGTTR involving live ordnance will incorporate required monitoring and mitigation measures. These measures will include trained observers, pre- and post-mission monitoring from various platforms, and sea state restrictions. These measures are summarized below and will be implemented as described in Section 11.2.

11.1.1 Trained Observers

All monitoring will be conducted by personnel who have completed Eglin's Marine Species Observer Training Course, which was developed in cooperation with the National Marine Fisheries Service. This training includes a summary of environmental laws, consequences of non-compliance, description of an observer's role, pictures and descriptions of protected species and protected species indicators, survey methods, monitoring requirements, and reporting procedures. The training will be provided to user groups either electronically or in person by an Eglin Natural Resources representative. Any person acting as an observer for a particular mission must have completed the training within the year prior to the mission. Names of personnel who have completed the training will be submitted to Eglin Natural Resources along with the date of completion. In cases where multiple survey platforms are required to cover large survey areas, a Lead Biologist will be designated to lead all monitoring efforts and coordinate sighting information with the Test Director or Safety Officer (see Section 11.2.2).

11.1.2 Pre- and Post-Mission Monitoring

For each live mission, at a minimum, pre- and post-mission monitoring will be required. Monitoring will be conducted from a given platform depending on the specific mission. The purposes of pre-mission monitoring are to 1) evaluate the mission site for environmental suitability and 2) verify that the ZOI is free of visually detectable marine mammals and potential marine mammal indicators. The duration of pre-mission surveys will depend on the area required to be surveyed, survey platforms (vessels versus aircraft), and any potential lapse in time between the end of the surveys to the beginning of the mission. This lapse would typically occur when survey vessels are required to vacate the human safety zone prior to the aircraft releasing the munitions.

All marine mammal sightings including the species (if possible), number, location, and behavior of the animals will be documented on report forms that will be submitted to Eglin Natural Resources after each mission. Missions may be postponed, relocated, or cancelled based on the presence of protected species within the survey areas.

Post-mission monitoring is designed to determine the effectiveness of pre-mission mitigation by reporting sightings of any dead or injured marine mammals. The duration of post-mission surveys will vary based on survey platform and any potential time lapse between the last detonation of the mission and when the post-mission surveys can begin. This lapse typically occurs when survey vessels are stationed on the perimeter of the human safety zone and are required to wait until the range has been declared clear. Similar to pre-mission surveys, all sightings would be properly documented on report forms and submitted to Eglin Natural Resources.

If any marine mammals are killed or injured as a result of the mission, Eglin Natural Resources would be contacted immediately. Observers would document the species or description of the animal, location, and behavior and, if practicable, take pictures and maintain visual contact with the animal. Eglin Natural Resources would then contact the local Marine Mammal Stranding Coordinator and either await further instructions or the arrival of a response team on-site, if feasible. Last known GPS points would be provided to the Stranding Coordinator.

11.1.3 Sea State Conditions

Weather conducive to marine mammal monitoring is required to effectively conduct the pre- and post-mission surveys. Wind speed and the resulting surface conditions are critical factors affecting observation effectiveness. Higher winds typically increase wave height and create "whitecap" conditions, both of which limit an observer's ability to locate marine species at or near the surface. Air-to-surface missions will be delayed or rescheduled if the sea state is greater than number 4, as listed on Table 11-1, at the time of the mission. Protected species observers or the Lead Biologist will make the final determination of whether or not conditions are conducive to sighting protected species. In addition, the missions will occur no earlier than two hours after sunrise and no later than two hours prior to sunset to ensure adequate daylight for pre- and post-mission monitoring, with the exception of AFSOC and the 413 FLTS gunnery missions. In those cases, aircrews will utilize aircraft instrumentation and sensors to monitor the area.

Table 11-1. Sea State Scale for EGTTR Pre-Mission Surveys

Sea State Number	Sea Conditions
0	Flat, calm, no waves or ripples
1	Light air, winds 1–2 knots; wave height to 1 foot; ripples without crests
2	Light breeze, winds 3–6 knots; wave height 1–2 feet; small wavelets, crests not breaking
3	Gentle breeze, winds 7–10 knots; wave height 2–3.5 feet; large wavelets, scattered whitecaps
4	Moderate breeze, winds 11–16 knots; wave height 3.5–6 feet; breaking crests, numerous whitecaps

Visibility is also a critical factor for flight safety issues when aerial surveys are being conducted. Therefore, a minimum ceiling of 305 m (1,000 ft) and visibility of 5.6 km (3 NM) is required to support monitoring efforts and flight safety concerns.

11.1.4 Determination of Survey Areas

Each threshold range listed in Table 6-2 in Section 6.6 represents a radius of impact for a given threshold of each munition/detonation scenario. These ranges will be used for determining the size of the area required to be monitored during pre-mission surveys for each activity. For any mission involving live munitions other than gunnery rounds, an area extending out to the Atlantic spotted dolphin Level A PTS harassment range for the corresponding mission-day scenario will be completely cleared of marine mammals prior to release of the first live ordnance. Depending on the mission-day scenario, the corresponding radius could be between 25 m for a live fuse surface detonation associated with mission-day scenario F, and 1,039 m associated with mission-day scenario A. This would help ensure that no marine mammals will be within any of the Level A harassment or mortality zones during a live detonation event.

As described in Section 2, some missions will be delayed to allow survey platforms to evacuate the human safety zone after pre-missions surveys are completed. For these delayed missions, Eglin proposes to include a buffer around the survey area that would extend to the Level B TTS harassment zone for the corresponding mission-day scenario. In all cases, this would more than double the survey area from that of the Level A PTS zone, increasing the survey area from 126 to 461 percent. This buffer will mitigate for the potential that an animal outside the area during pre-mission surveys would enter the Level A harassment or mortality zones during a mission. However, missions that consist solely of gunnery testing and training operations will actually survey larger areas based on previously established safety profiles and the ability to conduct aerial surveys of large areas from mission aircraft. These ranges are shown in Table 11-2. Monitoring procedures for gunships are described in Section 11.2.2. Comparing the monitoring area below with Level B behavioral harassment threshold radii for mission-day categories D through H provided in

Table 6-2 (between 0.4 km and 1.4 km [0.2 and 0.8 NM]) shows that a much larger area will be covered by this monitoring procedure.

Table 11-2. Monitoring Area Radii for Gunnery Missions

Aircraft	Gunnery Round	Monitoring Area	Monitoring Altitude	Operational Altitude
AC-130 gunship	25 mm, 30 mm, 40 mm, 105 mm (FU and TR)	5 NM (9,260 m)	6,000 ft	15,000 – 20,000 ft
CV-22 Osprey	.50 cal, 7.62 mm	3 NM (5,556 m)	1,000 ft	1,000 ft

cal = caliber; ft = feet; FU = full up; m = meters; mm = millimeter; NM = nautical miles; TR = Training Round

11.2 DESCRIPTION OF MONITORING ACTIVITIES

The following monitoring options have been developed to support various types of air-to-surface mission activities that may be conducted in the EGTTR. Eglin users covered by this LOA request must meet specific test or training objectives and safety requirements and have different assets available to execute the pre- and post-mission surveys. The monitoring options and mitigation measures described in the subsections below balance all mission-essential parameters with measures that will provide adequate protection to marine mammals.

11.2.1 Vessel-based Monitoring

Pre-mission surveys conducted from surface vessels will typically begin at sunrise. Trained observers will be aboard designated vessels to conduct protected species surveys before and after each mission. These vessels will be dedicated solely to monitoring for protected marine species and species indicators during the pre-mission surveys. For missions that require multiple vessels to conduct surveys based on the size of the survey area, a Lead Biologist will be designated to coordinate all survey efforts, compile sighting information from the other vessels, function as the point of contact between the survey vessels and Tower Control, and provide final recommendations to the Safety Officer/Test Director on the suitability of the mission site based on environmental conditions and survey results.

Survey vessels will run pre-determined line transects, or survey routes, that will provide sufficient coverage of the survey area. Monitoring activities will be conducted from the highest point feasible on the vessels (Figure 11-1). There will be at least two dedicated observers on each vessel, and they will utilize optical equipment with sufficient magnification to allow observation of surfaced animals.

Figure 11-1. Marine Species Observer

11.2.1.1 Roles and Responsibilities

All sighting information from pre-mission surveys will be communicated to the Lead Biologist on a pre-determined radio channel to reduce overall radio chatter and potential confusion. After compiling all the sighting information from the other survey vessels, the Lead Biologist will inform Tower Control on whether the area is clear of protected species or not. If the range is not clear, the Lead Biologist will provide recommendations on whether the mission should be delayed or cancelled. For example, a mission delay would be recommended if a small number of protected species are in the ZOI but appear to be on a heading away from the mission area. The delay would

continue until the Lead Biologist has confirmed that the animals are no longer in the ZOI and traveling away from the mission site. On the other hand, a mission cancellation could be recommended if one or more protected species in the ZOI are found and there is no indication that they would leave the area on their own within a reasonable timeframe. Tower Control will relay the Lead Biologist's recommendation to the Safety Officer. The Safety Officer and Test Director will collaborate regarding range conditions based on the information provided by the Lead Biologist and the status of range clearing vessels. Ultimately, the Safety Officer will have final authority on decisions regarding delays and cancellations of missions.

11.2.1.2 Human Safety Zone Enforcement

For missions that occur relatively close to shore and, therefore, have the potential to endanger civilian boat traffic, a large number of range clearing boats (approximately 20 to 25) will be stationed around the mission site to prevent non-participating vessels from entering the human safety zone. Based on a composite footprint from previous similar missions, range clearing boats would be located approximately 24 kilometers (15 miles) from the detonation point (Figure 11-2). Actual distance will vary based on the type of munition being deployed and its release parameters. These range clearing boats are typically at their guard stations (as shown in the figure below) by sunrise before commercial and recreational boaters have an opportunity to enter the safety zone. Two range clearing boats are stationed in the East Pass to distribute flyers and maps to civilian boaters as they exit the pass and enter the Gulf of Mexico, informing them of the area closures.

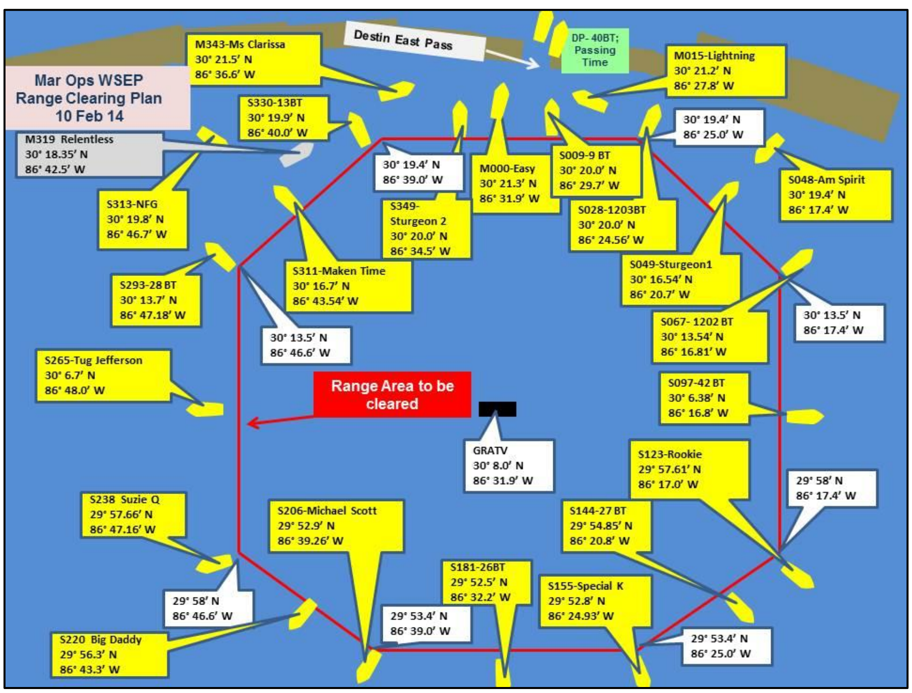

Figure 11-2. Example Range Area to Be Cleared for Human Safety Zone

Survey vessels are also required to abide by the human safety zone enforcement. When feasible, they typically aim to complete the pre-mission surveys at least 30 minutes prior to mission start to transit from the end point of their survey routes to the safety zone periphery. Observers will continue monitoring for marine mammals from outside the safety zone during the mission, but

effectiveness will be limited because each vessel will remain at a designated station to assist with range clearing activities. Additional measures are taken to address this time lapse, which may include surveying an additional buffer area or employing supplemental monitoring as described later in this section.

11.2.1.3 Air Force Support Vessels

Air Force support vessels will consist of a combination of Air Force and civil service/civilian personnel responsible for mission site/target setup and range clearing activities. Air Force personnel will be within the mission area (on boats and the GRATV) for each mission well in advance of weapon deployment, typically near sunrise. They will perform a variety of tasks including target preparation, equipment checks, etc., and will observe for marine mammals and indicators as feasible throughout test preparation. However, such observations are considered incidental and would only occur as time and schedule permits. Any sightings would be relayed to the Lead Biologist.

The Eglin Safety Officer, in cooperation with the Santa Rosa Island Tower Control at Test Site A-13B and CCF, will coordinate and manage all range clearing efforts and be in direct communication with the survey vessel team, typically through the Lead Biologist. All support vessels will be in radio contact with one another and with Tower Control on the government VHF channel 81a or 82a. The Safety Officer will monitor all radio communications, but Tower Control will relay messages between the vessels and the Safety Officer. The Safety Officer and Tower Control will also be in continual contact with the Test Director throughout the mission and will convey information regarding range clearing progress and protected species survey status. Final decisions regarding mission execution, including possible mission delay or cancellation based on protected species sightings or civilian boat traffic interference, will be the responsibility of the Safety Officer, with concurrence from the Test Director.

11.2.2 Aerial-based Monitoring

Aircraft typically provide an excellent viewing platform for detection of marine mammals at or near the surface. Depending on the mission, the aerial survey team will either consist of Eglin Natural Resources personnel or their designees aboard a non-mission aircraft or the mission aircrew who have completed the Marine Species Observer Training. A description of each follows.

11.2.2.1 Non-Mission Aircraft

For non-mission aircraft, the pilot will be instructed in protected marine species survey techniques and will be familiar with marine species expected to occur in the area. One person in the aircraft will act as data recorder and is responsible for relaying the location, species (if possible), direction of movement, and number of animals sighted to the Lead Biologist. The aerial team will also identify protected species indicators such as large schools of fish and large, active groups of birds. Pilots will fly the aircraft in such a manner that the entire ZOI (and a buffer, if required) is monitored. Marine mammal sightings from the aerial survey team will be compiled by the Lead Biologist and communicated to the Test Director or Safety Officer. Similar to survey vessel requirements, all non-mission personnel will be required to exit the human safety zone before the mission can commence. As a result, the ZOI may not be monitored up to immediate deployment

of live weapons. Due to this fact, the aerial team may be required to survey an additional buffer zone (as described in Section 11.1.4), unless other monitoring assets, such as live video monitoring, can be employed.

11.2.2.2 Mission Aircraft

Some mission aircraft have the capability to conduct aerial surveys immediately prior to releasing munitions. In those instances, aircrews that have completed the marine species observer training will make several passes over the target area to ensure the area is clear of all protected species. For mission aircraft in this category, aircrews will operate at reasonable and safe altitudes (dependent on the aircraft) appropriate to either visually scan the sea surface or utilize available instrumentation and sensors to detect protected species. Typical missions in this category are air-to-surface gunnery operations from AC-130 and CV-22 gunships. In some cases, other aerial platforms may be available to supplement monitoring activities for pre-mission surveys and during the missions.

AC-130 and CV-22 Gunship Procedures

After arriving at the mission site and prior to initiating firing events, gunships will conduct at least two complete orbits around the survey area at a minimum safe airspeed around the mission site at the appropriate monitoring altitude. Provided that marine mammals (and other protected species or indicators) are not detected, the aircraft will then begin the ascent to operational altitude, continuing to orbit the target area as it climbs. The initial orbits occur over a timeframe of approximately 10 to 15 minutes. Monitoring for marine mammals, vessels, and other objects will continue throughout the mission. If a towed target is used, mission personnel will ensure that the target remains in the center portion of the survey area to ensure gunnery impacts do not extend past the ZOI.

During the low-altitude orbits and climb, the aircrew will visually scan the sea surface within the aircraft's orbit circle for the presence of marine mammals. The surface scan will primarily be conducted by the flight crew in the cockpit and personnel stationed in the tail observer bubble and starboard viewing window. During nighttime missions, crews will use night vision goggles during observation. In addition to visual surveys, aircraft optical and electronic sensors will also be used for site clearance. AC-130 gunships are equipped with low-light TV cameras and AN/AAQ-26 infrared detection sets (IDSs). The TV cameras operate in a range of visible and near-visible light. Infrared systems are capable of detecting differences in temperature from thermal energy (heat) radiated from living bodies or from reflected and scattered thermal energy. In contrast to typical night-vision devices, visible light is not necessary for object detection. Infrared systems are equally effective during day or night use. The IDS is capable of detecting very small thermal differences. See the Notice of IHA (73 FR 246, December 22, 2008) for a further description of AC-130 sensor capabilities. CV-22 aircraft have similar visual scanners and operable sensors, however, they operate at a much lower altitudes than the AC-130 gunships, and no HE rounds will be fired from these aircraft.

If any marine mammals are detected during pre-mission surveys or during the mission, activities will be immediately halted until the ZOI area is clear of all marine mammals, or the mission will be relocated to another target area. If the mission is relocated, the pre-mission survey procedures

will be repeated. In addition, if multiple firing missions are conducted within the same flight, clearance procedures will precede each mission.

Gunship crews will conduct a post-mission survey beginning at the operational altitude and proceeding through a spiraling descent to the designated monitoring altitude. It is anticipated that the descent will occur over a three- to five-minute time period. During this time, aircrews will use similar equipment and instrumentation to scan the water surface for animals that may have been impacted during the gunnery exercise. During daytime missions, visual scans will be used as well.

Other Mission Aircraft

For missions other than gunnery activities, at least two ordnance delivery aircraft will typically participate in each live weapon release. Prior to the release, Air Force pilots aboard mission aircraft may make a dry run over the target area to ensure it is clear of non-participating vessels before ordnance is deployed. Observation effectiveness may vary among aircraft types. Jets will fly at a minimum speed of 300 knots indicated air speed (approximately 345 miles per hour, depending on atmospheric conditions) and at a minimum altitude of 1,000 ft (305 meters). Due to the limited flyover duration and potentially high speed and altitude, observation for marine species would probably be marginally effective at best and, therefore, pilots will not participate in species surveys.

11.2.3 Video-based Monitoring

Video-based monitoring may be accomplished via live high-definition video feed transmitted to CCF. Video monitoring typically facilitates data collection for the mission but can also allow remote viewing of the area for determination of environmental conditions and the presence of marine species up to the release time of live munitions. There are multiple sources of video that can be streamed to multiple monitors within CCF. When authorized for specific missions (e.g., Maritime WSEP), a trained marine species observer from Eglin Natural Resources will monitor all live video feed transmitted to CFF and will report any marine mammal sightings to the Safety Officer, who will also be at CCF. Employing this measure typically resolves any lapse between the time survey vessels or aircraft leave the safety zone after completing pre-mission surveys but before the mission actually begins.

The primary platform for video monitoring would be through the GRATV. Four video cameras are typically positioned on the GRATV (anchored on-site) to allow for real-time monitoring and data collection during the mission. The cameras will also be used to monitor for the presence of protected species. All cameras have a zoom capability of up to at least a 300-mm equivalent. At this setting, when targets are at a distance of 2 NM from the GRATV, the field of view would be 195 ft by 146 ft. Video observers can detect an item with a minimum size of 1 square foot up to 4,000 meters away. The Air Force is in the process of acquiring cameras with even greater zoom capability (up to a 1,200-mm zoom lens) to support future missions. The GRATV will typically be located about 183 meters (600 ft) from the target area; this range is well within the zooming capability of the video cameras. All cameras have a zoom capability of up to at least a 300 millimeter (mm) equivalent. At this setting, when targets are at a distance of 2 NM from the GRATV, the field of view would be 195 ft by 146 ft. Video observers can detect an item with a minimum size of one square foot up to 4,000 meters away. Over the next five years, it is possible

that the Air Force may acquire new cameras with even greater zoom capability, increasing the effectiveness to monitor the targets and surrounding areas. Representative screen shots from three different cameras are shown in Figure 11-3 through Figure 11-5.

Figure 11-3. Representative Screen Shot Camera 1

Figure 11-4. Representative Screen Shot Camera 2

Figure 11-5. Representative Screen Shot Camera 3

Supplemental video monitoring can also be accomplished through the employment of additional aerial assets, when available. Eglin's aerostat balloon provides aerial imagery of weapon impacts and instrumentation relay. When utilized, it is tethered to a boat anchored near the GRATV but outside weapon impact areas. The balloon can be deployed to an altitude up to 2,000 ft above sea level. It is equipped with a high-definition camera system that is remotely controlled to pivot and focus on a specific target or location within the mission site. The video feed from the camera system is transmitted to CCF. Eglin may also employ other assets such as intelligence, surveillance, and reconnaissance aircraft to provide real-time imagery or relay targeting pod videos from mission aircraft. Unmanned aerial vehicles may also be employed to provide aerial video surveillance. While each of these platforms may not be available for all missions, they typically

can be used in combination with each other and with the GRATV cameras to supplement marine mammal monitoring efforts.

Even with a variety of platforms potentially available to supply video feeds to CCF, the entire zone of influence may not be visible for the entire duration of the mission. However, the targets and immediately surrounding areas will typically be in the field of view of the GRATV cameras and the observer will be able to identify any protected species that may enter the target area before weapon releases. In addition, the observer will be able to determine if any animals were injured immediately following the detonations. Should a protected marine species be detected on the live video, the weapon release can be stopped almost immediately because the video camera observer is in direct contact with Test Director and Safety Officer at CCF.

The protected species survey vessels and the video camera observer will have open lines of communication to facilitate real-time reporting of marine mammals and other relevant information, such as safety concerns and presence of non-participating vessels in the human safety zone. Direct radio communication between all surface vessels, GRATV personnel, and the Tower Control will be maintained throughout the mission. The Range Safety Officer will monitor all radio communications from CCF, and information between the Safety Officer and the support vessels will be relayed via Tower Control.

11.3 OPERATIONAL MITIGATION MEASURES FOR GUNNERY ACTIONS

Eglin AFB has identified and required implementation of three operational mitigation measures for gunnery missions, including development of the 105-mm TR, use of ramp-up procedures, and eliminating missions conducted over waters beyond the continental shelf. The largest type of ammunition used during gunnery missions is a 105-mm round, which contains 4.7 pounds of high explosive (HE). This is several times more HE than that found in the next largest round (40 mm). As a mitigation technique, the Air Force developed a 105-mm TR that contains only 0.35 pounds of HE. The training round was developed to substantially reduce the risk of harassment during nighttime operations, when visual surveying for marine mammals is of limited effectiveness (however, monitoring by use of the AC-130's instrumentation, as described in Section 11.2.2 above, is effective at night).

Ramp-up procedures refer to the process of beginning with the least impactive action and proceeding to more impactive actions. In the case of A/S gunnery activities, ramp-up procedures entail beginning a mission with the lowest caliber munition and proceeding to the highest, which means the munitions would be fired in the order of 25 mm, 40 mm, and 105 mm. The rationale for the procedure is that this process may allow marine species to perceive steadily increasing noise levels and to react, if necessary, before the noise reaches a threshold of significance.

The AC-130 gunship weapons are used in two phases. First, the guns are checked for functionality and calibrated. This step requires an abbreviated period of live fire. After the guns are determined ready for use, the aircraft deploys a flare onto the surface of the water as a target, and the mission proceeds under various test and training scenarios. This second phase involves a more extended period of live fire and can incorporate use of one or any combination of the munitions available (25-mm, 40-mm, and 105-mm rounds).

The ramp-up procedure will be required for the initial calibration phase and, after this phase, the guns may be fired in any order. Eglin AFB believes this process will allow marine species the opportunity to respond to increasing noise levels. If an animal leaves the area during ramp-up, it is unlikely to return during the live-fire mission. This protocol provides a more realistic training experience for aircrews. In combat situations, gunship crews would not necessarily fire the complete ammunition load of a given caliber gun before proceeding to another gun. Rather, a combination of guns might be used as required by real-time situations. An additional benefit of this protocol is that mechanical or ammunition problems with an individual gun can be resolved while live fire continues with functioning weapons. This diminishes the possibility of a lengthy pause in live fire which, if greater than 10 minutes, would necessitate reinitiation of protected species surveys.

Many marine mammal species found in the Gulf of Mexico, including the federally listed sperm whale, occur with greater regularity in waters over and beyond the continental shelf break. As a conservation measure to avoid impacts to the sperm whale, AFSOC has agreed to conduct all gunnery missions within (shoreward of) the 200-meter isobath, which is considered to be the shelf break for purposes of this document. This measure will incidentally provide greater protection to several other species as well. The 200-meter depth contour is shown on Figure 1-7 (in Section 1).

11.4 COORDINATION WITH EGLIN NATURAL RESOURCES OFFICE FOR IMPLEMENTATION OF MONITORING REQUIREMENTS

Prior to conducting live missions, proponents will coordinate with Eglin Natural Resources to be briefed on their mitigation and monitoring requirements. Throughout coordination efforts, mission assets available for monitoring will be identified and an implementation plan will be developed. Based on the assets, survey routes will be designed to incorporate the size of the monitoring area and determine whether a buffer will be required. Training and reporting requirements will also be communicated to the proponents.

A following section is an example mitigation plan that would generally be applicable to air-to-surface missions incorporating vessel-based pre-mission surveys and video monitoring. While most or all of the described elements could be implemented for many missions, there may be instances where specific actions are not feasible. However, the detailed plan is provided here to illustrate the types of actions that would typically be employed. All mitigation activities will be regulated by Air Force safety parameters. Any mission may be delayed or cancelled due to technical issues or range clearing issues. Should a delay occur during pre-mission surveys, all mitigation procedures will continue either for the duration of the delay or until the mission is cancelled.

11.4.1 Example Mitigation Plan

To ensure the safety of survey personnel, the team will depart the mission area approximately 30 minutes before live ordnance delivery is scheduled to begin. Stepwise mitigation procedures are outlined below.

(a) Sunrise or Two Hours Prior to Mission

Air Force range clearing vessels and protected species survey vessels will be on-site at least two hours prior to the mission. The Lead Biologist onboard one survey vessel will assess the overall suitability of the mission site based on environmental conditions (sea state) and presence or absence of marine mammal indicators. This information will be communicated to Tower Control and relayed to the Safety Officer in CCF.

(b) One and One-Half Hours Prior to Mission – Commence Pre-Mission Surveys

Vessel-based surveys will begin approximately one and one-half hours prior to live weapon deployment. Surface vessel observers will survey the ZOI and relay all marine species and indicator sightings, including the time of sighting, GPS location, and direction of travel, if known, to the Lead Biologist. The Lead Biologist will document all sighting information on report forms to be submitted to Eglin Natural Resources after each mission. Surveys will continue for approximately one hour or until the entire ZOI has been adequately surveyed, whichever comes first. During this time, Air Force personnel in the mission area will also observe for marine species as feasible. If marine mammals or indicators are observed within the ZOI, the range will be declared "fouled," a term that signifies to mission personnel that conditions are such that a live ordnance drop cannot occur (e.g., protected species or civilian vessels are in the mission area). If no marine mammals or indicators are observed, the range will be declared clear of protected species.

(c) One-Half Hour Prior to Mission

At approximately 30 minutes to 1 hour prior to live weapon deployment, marine species observers will be instructed to leave the mission site and remain outside the safety zone, which on average will be 15 miles from the detonation point. The actual size is determined by weapon NEW and method of delivery. The survey team will continue to monitor for protected species while leaving the area. As the survey vessels leave the area, marine species monitoring of the immediate target areas will continue at CCF through the live video feed received from the high definition cameras on the GRATV. Once the survey vessels have arrived at the perimeter of the safety zone (approximately 30 minutes after being instructed to leave, depending on actual travel time) the range will be declared "green" and mission will be allowed to proceed, assuming all non-participating vessels have left the safety zone as well.

(d) Execution of Mission

Immediately prior to live weapon drop, the Test Director and Safety Officer will communicate to confirm the results of marine mammal surveys and the appropriateness of proceeding with the mission. The Safety Officer will have final authority to proceed with, postpone, or cancel the mission. The mission would be postponed if:

1. Any marine mammal is visually detected within the ZOI. Postponement would continue until the animal(s) that caused the postponement is either:

    a. Confirmed to be outside of the ZOI on a heading away from the targets.

  b. Not seen again for 30 minutes and presumed to be outside the Level A PTS ZOI due to the animal swimming out of the range.

2. Large schools of fish or large flocks of birds feeding at the surface are observed within the ZOI. Postponement would continue until these potential indicators are confirmed to be outside the ZOI.
3. Any technical or mechanical issues related to the aircraft or target boats.
4. Non-participating vessels enter the human safety zone prior to weapon release.

In the event of a postponement, protected species monitoring would continue from CCF through the live video feed.

(e) Completion of the Mission – Commence Post-Mission Surveys

Post-detonation monitoring surveys will commence once the mission has ended or, if required, as soon as EOD personnel declare the mission area safe. Vessels will move into the survey area from outside the safety zone and monitor for at least 30 minutes, concentrating on the area downcurrent of the test site. If boat targets have been struck by weapons, this area is easily identifiable because of the floating debris in the water from the impacted targets. Up to 10 Air Force support vessels will clean debris and collect damaged targets from this area, thus spending many hours in the area once the mission is completed. All vessels will be instructed to report any dead or injured marine mammals to the Lead Biologist.

11.5 MITIGATION EFFECTIVENESS

The effectiveness of the mitigation and monitoring measures described above depends largely on the ability to visually locate marine mammals at or near the water surface (visual observation is the primary measure used) and the elapsed time between the completion of surveys and the actual detonation(s). Aerial surveys are used during some missions but are not feasible for all missions due to airspace and mission complexity. In these instances, observation will occur primarily from vessels and video cameras, when available. Eglin AFB has implemented all monitoring options described in Section 11.2 for previous Air Force actions in the EGTTR. The following qualitative analysis for mitigation effectiveness is largely based on the success of all Eglin air-to-surface mission activity in the EGTTR over the last five years.

Since 2010, Eglin AFB has conducted 37 gunnery missions (as of July 2015) in the EGTTR. Each year, Eglin Natural Resources submits an Annual Report to NMFS summarizing these activities and survey results. Monitoring procedures that have been employed are the same as those described in Section 11.2.2, under *AC-130 and CV-22 Gunship Procedures.* To date, no marine mammals have been impacted from gunnery operations. Instrumentation on the AC-130 and CV-22 has been proven effective in clearing a potential mission site of protected species prior to commencement of firing live gunnery rounds. Figure 11-6 depicts an unclassified image of three sharks captured from an AC-130 conducting a 3-mile (5-km) orbit at a 15,000-ft altitude using the Raytheon Multispectral Targeting System (MTS™)-A electro-optical/infrared sensor. Monitoring altitudes during pre-mission surveys for both the AC-130 and CV-22 are much lower than 15,000

ft (see Table 11-2), and employing an infrared system for monitoring should make it easier to identify warm-blooded marine mammals.

Figure 11-6. Image of Sharks Captured on AC-130 Gunship Using Raytheon MTS-A Sensors at 15,000-foot Altitude

Since 2012, 13 live ordnance missions have been conducted under either the Maritime Strike Operations or Maritime WSEP Operational Testing activities. NMFS issued Eglin AFB an IHA on August 13, 2013, for Maritime Strike Operations missions and an IHA for Maritime WSEP Operation Testing missions on February 5, 2015. These two programs were similar in that they both involved the release of varying live munitions against small, fast-moving boat targets in the EGTTR. Monitoring procedures incorporated a combination of vessel-based surveys and live video monitoring from CCF. Due to changing acoustic criteria and thresholds for marine mammals in between these actions, the approach used to determine survey areas for these missions were not the same. Even though Maritime Strike had more and larger weapons than Maritime WSEP, Eglin AFB was required to survey a larger area for Maritime WSEP based on discussions revolving around accumulated energy impacts from multiple detonations. For both sets of missions, Eglin conducted monitoring activities based on the descriptions in Sections 11.2.1 and 11.2.3. While marine mammals were observed during pre-mission surveys on multiple mission days, proper measures were taken (delay of missions while waiting on marine mammals to clear the area) to ensure no marine mammals were in the area during the mission. As a result, no marine mammal takes occurred during any of the Maritime Strike and Maritime WSEP missions. The increase in survey area for Maritime WSEP missions did not appear to provide an added benefit to marine mammals over what was accomplished during Maritime Strike; observers detected no more marine mammals among the search areas, respectively. The overall effectiveness of these measures in reducing take levels has not been quantified; however, the high numbers of documented sightings during the pre-mission surveys indicate a significant level of success in executing the survey plans and identifying protected species in the area. Furthermore, there were no observed impacts to any protected species during post-mission surveys, and none were identified in the days immediately following the end of all Maritime Strike and Maritime WSEP missions. Therefore, Eglin believes

the proposed mitigations will provide protection to marine mammals from potential acoustic impacts while enabling the military mission to proceed.

11.6 MONITORING OPTIONS AVAILABLE TO KNOWN PROPONENTS AND MISSIONS

The following table lists known proponents (based on mission descriptions provided in Section 2) and the monitoring platforms that may be employed for marine mammal monitoring before, during, and after live air-to-surface missions. As stated above, coordination with proponents before live missions will ensure these options are still available, as well as any changes to assets or mission capabilities for new proponents that would fall under this authorization. Eglin Natural Resources will ensure all practical measures will be implemented to the maximum extent possible to comply with the mitigation and monitoring requirements while meeting mission objectives.

Table 11-3. Monitoring Options Available for Live Air-to-Surface Mission Proponents Operating in the EGTTR

Mission[1]	Monitoring Platform		
	Vessel	Aerial	Video
86 FWS Maritime Weapons System Evaluation Program (WSEP)	●		●
Air Force Special Operations Command (AFSOC) Training			
Air-to-Surface Gunnery		●	
Small Diameter Bomb/Griffin Missile Training		●	
CV-22 Training		●	
413th Flight Test Squadron (FLTS)			
AC-130J Precision Strike Package Testing		●	
AC-130J Stand-Off Precision Guided Munitions Testing		●	
780th Test Squadron			
Precision Strike Weapon	●	●	
Longbow Littoral Testing	●		

86 FWS = 86th Fighter Weapons Squadron
1. See Section 2 for a complete description.

12. MINIMIZATION OF ADVERSE EFFECTS ON SUBSISTENCE USE

Based on the discussion provided in Section 8, there will be no impacts on the availability of species or stocks for subsistence use.

13. MONITORING AND REPORTING MEASURES

For air-to-surface missions using live ordnance, prospective mission sites will be monitored for marine mammal presence prior to commencement of activities. Pre-mission monitoring will be conducted from one or a combination of vessels, video cameras, and aircraft, depending on the mission type. In some cases, after survey vessels (when applicable) have exited the safety footprint, a trained marine species observer located in the CCF will continue to monitor the immediate target area through live video feed for the duration of the mission. Post-mission surveys will also be carried out in most cases. If any marine mammals are detected during pre-mission surveys or the live video feed, activities will be immediately halted until the area is clear of all marine mammals. Refer to Section 11 for a more detailed explanation of monitoring requirements for each type of mission.

In addition to monitoring for marine species before and (in most cases) after missions, the following monitoring and reporting measures will be required.

- Within a year before the planned missions, all protected species observers will receive the Marine Species Observer Training Course developed by Eglin in cooperation with NMFS.
- Eglin Natural Resources will track use of the EGTTR and protected species observation results through the use of protected species observer report forms.
- A summary annual report of marine mammal observations and mission activities will be submitted to the NMFS Southeast Regional Office and the NMFS Office of Protected Resources. This annual report must include the following information:
    - Date and time of each exercise
    - A complete description of the pre-exercise and post-exercise activities related to mitigating and monitoring the effects of mission activities on marine mammal populations
    - Results of the monitoring program, including numbers by species/stock of any marine mammals noted injured or killed as a result of the missions, and number of marine mammals (by species if possible) that may have been harassed due to presence within the activity zone
- If any dead or injured marine mammals are observed or detected prior to mission activities, or injured or killed during mission activities, a report must be made to NMFS by the following business day.

- Any dead or injured marine mammals must be immediately reported to the respective stranding network representative.

14. RESEARCH

Although Eglin AFB does not currently conduct independent marine mammal research, Eglin Natural Resources participates in marine animal tagging and monitoring programs lead by other agencies. Additionally, Eglin Natural Resources has also supported participation with NMFS in annual surveys of marine mammals in the Gulf of Mexico. From 1999 to 2002, Eglin participated in summer cetacean monitoring and research efforts through a contractor. The contractor participated in visual surveys for cetaceans in 1999 in the Gulf of Mexico, as a visual observer during the 2000 Sperm Whale Pilot Study, and as member of the behavioral team for the 2001 and 2002 Sperm Whale Seismic Study (SWSS) research cruises. In addition, Eglin Natural Resources has obtained Department of Defense funding for two marine mammal habitat modeling projects. The most recent project (Garrison, 2008) included funding for and extensive involvement of NMFS personnel so that recent aerial survey data could be utilized for habitat modeling and protected species density estimates in the northeastern Gulf of Mexico, including portions of the EGTTR.

Eglin conducts other research efforts that utilize marine mammal stranding information as a potential means of detecting the effectiveness of mitigation techniques. Stranding data are collected and maintained for the Florida panhandle area as well as for the entire Gulf of Mexico. This task is undertaken through the establishment and maintenance of contacts with local, state, and regional stranding networks. Eglin AFB assists with stranding data collection by maintaining its own team of permitted stranding personnel. In addition to simply collecting stranding data, various analyses are performed. Stranding events are tracked by year, season, and NMFS statistical zone, both in the Gulf of Mexico and on the coastline in proximity to Eglin AFB. Stranding data may be analyzed in relation to records of EGTTR mission activity in each water range and possible correlations examined. In addition to being used as a possible measure of the effectiveness of mitigations, stranding data can yield insight into the species composition of cetaceans in the region.

Eglin Natural Resources is actively exploring funding mechanisms through the Air Force Civil Engineering Center (AFCEC) to conduct acoustic monitoring studies in the EGTTR that will enhance the knowledge base on impacts to marine resources from underwater detonations. Two concepts are being developed to focus these monitoring efforts: 1.) Documenting and assessing source levels and received levels of in-water detonations during live missions in the EGTTR 2.) Conducting passive acoustic monitoring for marine mammal vocalizations before, during, and after live missions in the EGTTR. Once funding for these efforts is secured, Eglin Natural Resources will work closely with NMFS to develop a research plan that will meet mutually agreeable objectives.

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APPENDIX A

ACOUSTIC MODELING METHODOLOGY

Eglin Air Force Base

Eglin Gulf Test and Training Range (EGTTR)
MMPA and ESA
Acoustic Impact Modeling:
Modeling Appendix

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APPENDIX A
MMPA AND ESA ACOUSTIC IMPACT MODELING

A.1 BACKGROUND AND OVERVIEW

A.1.1 Federal Regulations Affecting Marine Animals

All marine mammals are protected under the Marine Mammal Protection Act (MMPA). The MMPA prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

The Endangered Species Act of 1973 (ESA) provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range, and the conservation of their ecosystems. A "species" is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species within the foreseeable future. Some marine mammals, already protected under MMPA, are also listed as either endangered or threatened under ESA, and are afforded special protections. In addition, all sea turtles are protected under the ESA.

Actions involving sound in the water may have the potential to harass marine animals in the surrounding waters. Demonstration of compliance with the MMPA and ESA, using best available science, has been assessed using criteria and thresholds accepted or negotiated, and described here.

Sections of the MMPA (16 USC 1361 et seq.) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity, other than commercial fishing, within a specified geographical region. Through a specific process, if certain findings are made and regulations are issued or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings may be granted if National Marine Fisheries Service (NMFS) finds that the taking will have no more than a negligible impact on the species or stock(s), will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses, and that the permissible methods of taking, and requirements pertaining to the mitigation, monitoring and reporting of such taking are set forth.

NMFS has defined negligible impact in 50 CFR 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

Subsection 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. The National Defense Authorization Act of 2004 (NDAA) (Public Law

108-136) removed the small numbers limitation and amended the definition of "harassment" as it applies to a military readiness activity to read as follows:

> (i) *any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild [Level A Harassment]; or*
>
> (ii) *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 [Level B Harassment]*.

The primary potential impact to marine mammals from underwater acoustics is Level A and Level B harassment, as defined by the MMPA from noise. Potential impacts to sea turtles from underwater acoustic exposure are primarily behavioral responses and impairment, with some potential for injury, and a very small potential for mortality.

A.1.2 Development of Animal Impact Criteria

A.1.2.1 Marine Mammals

For explosions of ordnance planned for use in the EGTTR area, in the absence of any mitigation or monitoring measures, there is a chance that a marine mammal could be injured or killed when exposed to the energy generated from an explosive force. Analysis of noise impacts is based on criteria and thresholds initially presented in U.S. Navy Environmental Impact Statements for ship shock trials of the Seawolf submarine and the Winston Churchill (DDG 81), and subsequently adopted by NMFS.

<u>Mortality</u>

Lethal impact determinations currently incorporate species-specific thresholds that are based on the level of impact that would cause extensive lung injury from which one percent of exposed animals would not recover (Finneran and Jenkins, 2012). The threshold represents the expected onset of mortality, where 99 percent of exposed animals would be expected to survive. The lethal exposure level of blast noise, associated with the positive impulse pressure of the blast, is expressed as Pascal-seconds (Pa·s) and is determined using the Goertner (1982) modified positive impulse equation. This equation incorporates sound propagation, source/animal depths, and the mass of a newborn calf of the affected species. The Goertner equation used in the acoustic model to develop mortality impact analysis, is as follows:

$$I_M(M,D) = 91.4M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$$

$I_M(M,D)$	mortality threshold, expressed in terms of acoustic impulse (Pa·s)
M	Animal mass (Table D-1)
D	Water depth (m)

Level A Harassment

Non-lethal injurious impacts (Level A Harassment) are defined in those documents as onset of slight lung injury, gastro-intestinal (GI) tract damage, and permanent (auditory) threshold shift (PTS).

The criteria for onset of slight lung injury were established using partial impulse because the impulse of an underwater blast wave was the parameter that governed damage during a study using mammals, not peak pressure or energy (Yelverton, 1981). Goertner (1982) determined a way to calculate impulse values for injury at greater depths, known as the Goertner "modified" impulse pressure. Those values are valid only near the surface because as hydrostatic pressure increases with depth, organs like the lung, filled with air, compress. Therefore the "modified" impulse pressure thresholds vary from the shallow depth starting point as a function of depth.

The shallow depth starting points for calculation of the "modified" impulse pressures are mass-dependent values derived from empirical data for underwater blast injury (Yelverton, 1981). During the calculations, the lowest impulse and body mass for which slight, and then extensive, lung injury found during a previous study (Yelverton et al, 1973) were used to determine the positive impulse that may cause lung injury. The Goertner model is sensitive to mammal weight such that smaller masses have lower thresholds for positive impulse so injury and harassment will be predicted at greater distances from the source for them. The equation used for determination of slight lung injury is:

$$I_S(M,D) = 39.1M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2},$$

where M is animal mass (kg), D is animal depth (m), and the units of I_s are Pa-s. Following Finneran and Jenkins (2012), the representative mass for each species is taken to be that of an average newborn calf or pup for that species.

The criterion for slight injury to the GI tract was found to be a limit on peak pressure and independent of the animal's size (Goertner, 1982). A threshold of 103 psi (237 dB re 1 µPa) is

used for all marine mammals. This level at which slight contusions to the GI tract were reported from small charge tests (Richmond *et al.*, 1973).

Two thresholds are used for PTS, one based on cumulative sound exposure level (SEL) and the other on the peak sound pressure level of an underwater blast. Thresholds follow the approach of NMFS 2016 Technical Guidance. The threshold producing either the largest Zone of Influence (ZOI) or higher exposure levels is then used as the more protective of the dual thresholds. In previous assessments Type I and Type II weighting functions (Finneran and Jenkins, 2012) have been applied for each functional hearing group as appropriate. Following recent guidance from NMFS (NMFS, 2016), the newer TAP Phase 3 weighting functions are utilized within this assessment. PTS thresholds for mid-frequency (MF) cetaceans are 185 dB re 1 μPa^2·s SEL (Phase 3 weighted) and 230 dB re 1 μPa Peak SPL (unweighted).

<u>Level B Harassment</u>

Level B (non-injurious) Harassment includes temporary (auditory) threshold shift (TTS), a slight, recoverable loss of hearing sensitivity. Similar to PTS, the 2016 NMFS Guidance details two criteria to be evaluated for TTS exposure, the cumulative sound exposure level (SEL, weighted), and the peak sound pressure level (SPL, unweighted). NMFS applies the more conservative of these two. For species where no data exist, TTS thresholds are based on the most closely related species for which data are available. The TTS thresholds for MF cetaceans are 170 dB re 1 μPa^2·s SEL (Phase 3 weighted) and 224 dB re 1 μPa Peak SPL (unweighted).

<u>Level B Behavioral Harassment</u>

For multiple successive explosions, the acoustic criterion for non-TTS behavioral disturbance is used to account for behavioral effects significant enough to be judged as harassment, but occurring at lower sound energy levels than those that may cause TTS. The threshold for behavioral disturbance is set 5 dB below the Phase 3 weighted total SEL-based TTS threshold, or 165 dB re 1 μPa^2-s. This is based on observations of behavioral reactions in captive dolphins and belugas occurring at exposure levels approximately 5 dB below those causing TTS after exposure to pure tones (Schlundt et al., 2000). The behavioral impacts threshold for MF mammals exposed to multiple, successive detonations is 165 dB re 1 μPa^2·s SEL (Phase 3 weighted).

Table A-1 summarizes the current threshold levels for marine mammals used to analyze explosives identified for use in the EGTTR area. The two mammal species of interest, Atlantic spotted dolphins and bottlenose dolphins , both are in the mid frequency (MF) functional hearing group.

Table A-1. Explosive Criteria and Thresholds Used for Impact Analyses

Mortality*	Level A Harassment			Level B Harassment	
	Slight Lung Injury[1]	GI Tract Injury	PTS	TTS	Behavioral
$91.4M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$	$39.1M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}$	Unweighted SPL: 237 dB re 1 μPa	Weighted SEL: 185 dB re 1 μPa^2·s	Weighted SEL: 170 dB re 1 μPa^2·s	Weighted SEL: 165 dB re 1 μPa^2·s

M = Animal mass based on species (kilograms); *D* = water depth (meters); dB re 1 µPa = decibels referenced to 1 micropascal; dB re 1 µPa^2·s = decibels reference to 1 micropascal-squared – seconds; *M* = animal mass based on species (kilograms); psi = pounds per square inch; PTS = permanent threshold shift; TTS = temporary threshold shift; SEL = sound exposure level; SPL = sound pressure level. 1. Expressed in terms of acoustic impulse (Pacsal – seconds [Pa·s]

A.2 EXPLOSIVE ACOUSTIC SOURCES

A.2.1 Acoustic Characteristics of Explosive Sources

The acoustic sources employed at the EGTTR study area are categorized as broadband explosives. Broadband explosives produce significant acoustic energy across several frequency decades of bandwidth. Propagation loss is sufficiently sensitive to frequency as to require model estimates at several frequencies over such a wide band.

Explosives are impulsive sources that produce a shock wave that dictates additional pressure-related metrics (peak pressure and positive impulse). Detailed descriptions of the sources in the EGTTR study area are provided in this subsection.

Explosives detonated underwater introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: the weight of the explosive material, the type of explosive material, and the detonation depth. The net explosive weight (or NEW) accounts for the first two parameters. The NEW of an explosive is the weight of TNT required to produce an equivalent explosive power.

The detonation depth of an explosive is particularly important due to a propagation effect known as surface-image interference. For sources located near the sea surface, a distinct interference pattern arises from the coherent sum of the two paths that differ only by a single reflection from the pressure-release surface. As the source depth and/or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface-reflection scattering loss).

A.2.2 Animal Harassment Effects of Explosive Sources

The harassments expected to result from these sources are computed on a per-event basis, where an event lasts for 24 hours and takes into account multiple explosives that would detonate within that time period. Within that 24-hour time period it is assumed that the animal population remains constant, or in other words, animals exposed to sounds at the beginning of the 24-hour period would also be exposed to any sounds occurring at the end of the period. A new animal population is assumed for each consecutive 24-hour period. In some cases this can be a more conservative approach than assuming each detonation, or burst of detonations, is received by a new population of animals. It is important to note that only energy metrics are affected by the accumulation of energy over a 24-hour period. Pressure metrics (e.g., peak pressure and positive impulse) do not accumulate. Rather, a maximum is taken over all of the detonations specified within the 24-hour period. A more detailed description of pressure and energy considerations resulting from munition bursts is provided in Section A.2.3 below.

Explosives are modeled as detonating at depths ranging from the water surface to 10 feet below the surface, as provided by Government-Furnished Information. Impacts from above surface detonations were considered negligible and not modeled.

For sources that are detonated at shallow depths, it is frequently the case that the explosion may breach the surface with some of the acoustic energy escaping the water column. We model surface detonations as occurring one foot below the water surface. The source levels have not been adjusted for possible venting nor does the subsequent analysis attempt to take this into account.

A.2.3 Zone of Influence: Per-Detonation Versus Net Explosive Weight Combination

It may be considered why and when it is appropriate to treat rounds within a burst as separate events, rather than combining the NEW of all rounds and treating it as a single, larger event. The basic information necessary to address this issue is provided below.

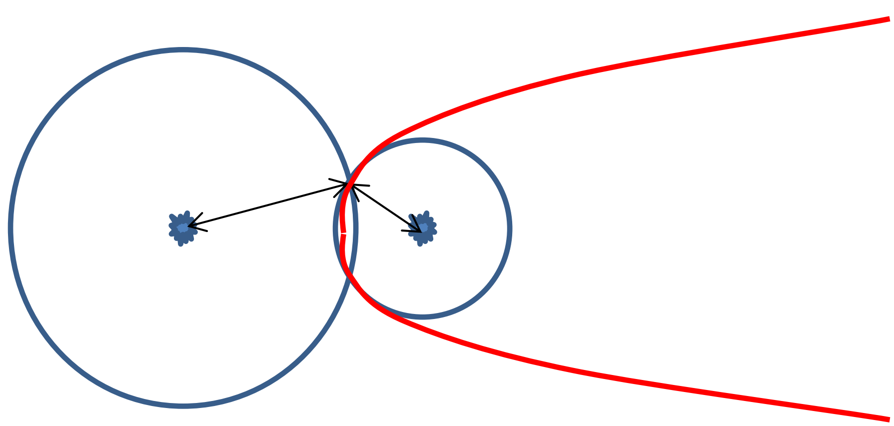
Peak Pressure and Positive Impulse

Peak pressures add if two (or more) impulses reach the same point at the same time. Since explosive rounds go off at different times and locations, this will only be true for a small set of points. This problem is mathematically the same as the passive sonar problem of localizing a sound source based on the time difference of arrival (TDOA) of a signal reaching two receivers. The red curve in the figure (half of a hyperbola) represents the set of all point where

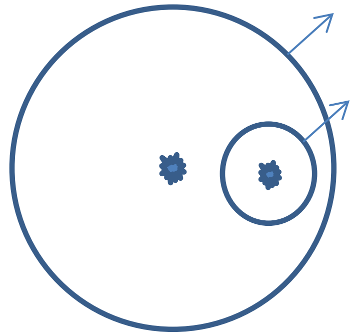
$R1 - R2 = c*(T2 - T1)$, for

c = the speed of sound in water, and

T1 and T2 being the detonation times of the two rounds:



Such a curve can only be drawn when c*(T2-T1) is less than the distance between the two explosions. If, for instance, 30 rounds/second are fired (and the difference in impact time is assumed to be roughly the distance in firing time), then the peak impact pressure from the first round will have traveled 1,500 m/s * 1/30 sec = 50 m. If the second round hits less than 50 m from the first round, the impact wave from the second round will never catch the impact wave from the first.



In the first case (loose grouping), the pressures will only add along a curve with very narrow width and negligible volume. The pressure on this curve less than twice the pressure of the closest round, as it will be the pressure at R2 and at (R2+c*dT). In the second case (tight grouping), the pressures will never add.

If this logic is extended to a many-shot burst, the logic becomes even more persuasive. For the impulse peak from a third shot to interact with the peaks from the first two using the 30 round/sec assumption, it would have to impact the water more than 100 m away from the impact of the first round and more than 50 m away from the impact of the second round. Even in that case, there would be at most two places in the ocean where the curve from the 1st and 3rd impacts would meet the curve from 2nd and 3rd explosions (and the travel distances would have to be 50 m longer for one and 100 m longer for the other). In summary:

- There would be 0 to 4 directions where a curve (a hyperbola approaches an asymptotic line far from the source) of negligible thickness, and volume would have less than two times the pressure from the closest source
- There would be 0 to 2 very small points with no extent in range or bearing where one would see less than three times the pressure from the closest source
- In every other part of the zone of influence (ZOI), the impulse from each round would be received separately by any animal present

For the 4th round and any subsequent round, another curve could be added, if it was far enough away from the previous shots so that their peak had not already passed the impact point. However, this new curve would intersect with the previous 2 curves at a different location than where the first two curves intersected. No matter how many rounds are fired, there would not be any point in the ocean where more than 3 peaks arrive at the same time. These points would have almost no volumetric extent and required range increases from the closest source of N*dt*c, where N is the difference in shot number and dt is the time between shots.

If the rate of fire is increased, there is a decrease in the additional required separation in order to have any coherent increase in pressure or positive impulse. However, the end result is that almost all of the ocean experiences only one pressure peak at a time.

If the rounds are far enough apart in space and close enough in time, there will be curves where sequential rounds add coherently; however,

- They will not occupy any significant volume, and

- They will be less than a factor of 2 above the pressure or positive impulse of the nearest source.

Contrast this with the alternative assumption that pressures from separate rounds be added. This models the event as if all rounds went of exactly at the same place and exactly at the same time. That is the only way that travelling pressure peaks from separate rounds would go through space together and add pressures at all points. This is not realistic and would over-estimate pressure and positive impulse metrics by a factor equal to the number of rounds in the burst, which could be 10 or 20 dB in pressure levels.

Energy Metrics

Energy metrics accumulate the integral of the power density of each explosion over the duration of the impulse. Thus, even though the peaks from separate explosions arrive at different times, the energy from all of their arrivals will be added. If you fire a number of rounds close together in a burst (N_{burst}), the energy from all of the rounds will add and the sound exposure level will be 10*log10(N_{burst}) higher than if a single shot had been fired. The area affected, A_{burst}, would be larger than the area affected by a single shot (A_1), because additional transmission loss would be needed to reduce the larger energy level to a given threshold.

Following guidance from NMFS, 20 mission scenarios have been defined, with each scenario capturing the munitions expected to be dropped within a 24-hour period. Energy metrics such as Total Energy are accumulated over this period while peak level metrics are maximized over the set of munitions in order to capture those with the largest peak amplitudes.

A.3 ENVIRONMENTAL CHARACTERIZATION

A.3.1 Important Environmental Parameters for Estimating Animal Harassment

Propagation loss ultimately determines the extent of the Zone of Influence (ZOI) for a particular source activity. In turn, propagation loss as a function of range depends on a number of environmental parameters including:

- Water depth;
- Sound speed variability throughout the water column;
- Bottom geo-acoustic properties; and
- Surface roughness, as determined by wind speed.

Due to the importance that propagation loss plays in Anti-Submarine Warfare, the Navy has, over the last four to five decades, invested heavily in measuring and modeling these environmental parameters. The result of this effort is the following collection of global databases containing these environmental parameters, which are accepted as standards for Navy modeling efforts. Table A-4 contains the version of the databases used in the modeling for this report.

Table A-4. Navy Standard Databases Used in Modeling

Parameter	Database	Version
Water Depth	Digital Bathymetry Data Base Variable Resolution	DBDBV 6.0
Ocean Sediment	Re-packed Bottom Sediment Type	BST 2.0
Wind Speed	Surface Marine Gridded Climatology Database	SMGC 2.0
Temperature/Salinity Profiles	Generalized Digital Environment Model	GDEM 3.0

The sound speed profile directs the sound propagation in the water column. The spatial variability of the sound speed field is generally small over operating areas of typical size. The presence of a strong oceanographic front is a noteworthy exception to this rule. To a lesser extent, variability in the depth and strength of a surface duct can be of some importance. If the sound speed minimum occurs within the water column, more sound energy can travel further without suffering as much loss (ducted propagation). But if the sound speed minimum occurs at the surface or bottom, the propagating sound interacts more with these boundaries and may become attenuated more quickly. In the mid-latitudes, seasonal variation often provides the most significant variation in the sound speed field. For this reason, both summer and winter profiles are modeled to demonstrate the extent of the difference, but only the winter was used for this analysis.

Losses of propagating sound energy occur at the boundaries. The water-sediment boundary defined by the bathymetry can vary by a large amount. In a deep water environment, the interaction with the bottom may matter very little. In a shallow water environment the opposite is true and the properties of the sediment become very important. The sound propagates through the sediment, as well as being reflected by the interface. Soft (low density) sediment behaves more like water for lower frequencies and the sound has relatively more transmission and relatively less reflection than a hard (high density) bottom or thin sediment.

The roughness of the boundary at the water surface depends on the wind speed. Average wind speed can vary seasonally, but could also be the result of local weather. A rough surface scatters the sound energy and increases the transmission loss. Boundary losses affect higher frequency sound energy much more than lower frequencies.

A.3.2 Characterizing the Acoustic Marine Environment

The environment for modeling impact value is characterized by a frequency-dependent bottom definition, range-dependent bathymetry and sound velocity profiles (SVP), and seasonally varying wind speeds and SVPs. The bathymetry database is on a grid of variable resolution.

The SVP database has a fixed spatial resolution storing temperature and salinity as a function of time and location. The low frequency bottom loss is characterized by standard definition of geo-acoustic parameters for then given sediment type of sand. The high frequency bottom loss class is fixed to match expected loss for the sediment type. The area of interest can be characterized by the appropriate sound speed profiles, set of low frequency bottom loss parameters, high frequency bottom loss class, and High Frequency Environmental Acoustic Algorithms (HFEVA) very-high frequency sediment type for modeled frequencies in excess of 10 kHz.

Generally seasonal variation is sampled by looking at summer and winter cases that tend to capture extreme in both the environmental variability as well as animal populations. Ordnance usage for all mission groups was assumed to be spread equally between summer and winter environments.

Impact volumes in the operating area are then computed using propagation loss estimates and the explosives model derived for the representative environment. The longest radial within the impact volumes were then used to calculate the area of impact.

A.3.3 Description of the Eglin Gulf Test and Training Range Area Environment

The EGTTR Study Area is located off the coast of Florida in the Gulf of Mexico. It is an area that slopes from shallow waters near the coast to deeper waters offshore. The bottom is characterized as sandy sediment according to the Bottom Sediments Type Database. Environmental values were extracted from unclassified Navy standard databases in a radius of 50 km around the center point at

N 30° 08.5' W 86° 28'

The Navy standard database for bathymetry has a resolution of 0.05 minutes in the Gulf of Mexico; see Figure A-1. Mean and median depths from DBDBV in the extracted area are 47 and 112 meters, respectively.

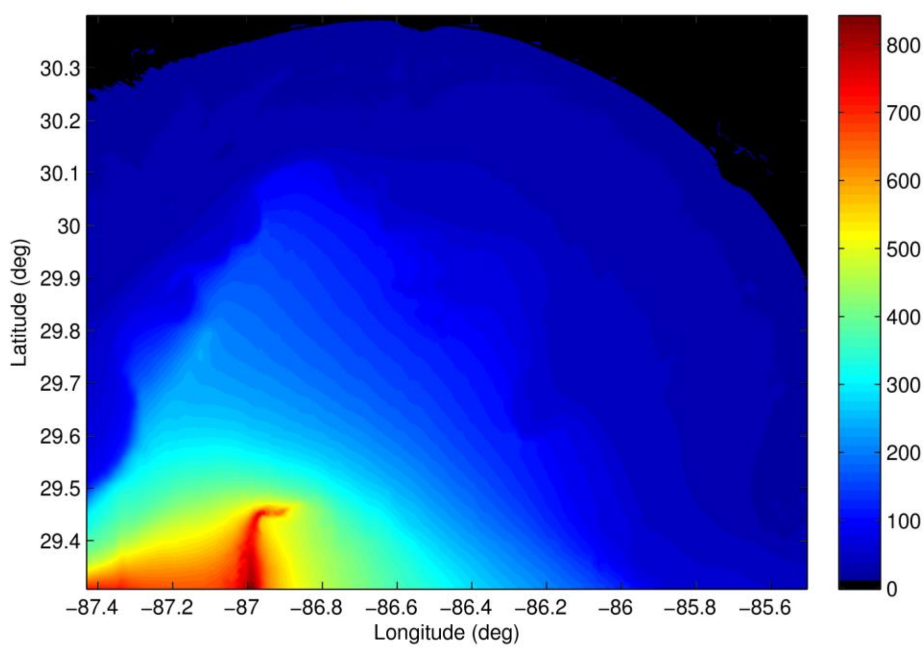


Figure A-1. Bathymetry (in meters) for the EGTTR Study Area Representative Environment

The seasonal variability in wind speed was modeled as 8.6 knots in the summer and 13.02 knots in the winter.

Example input of range-dependent bathymetry is depicted in Figure A-2 for the due-north bearing.

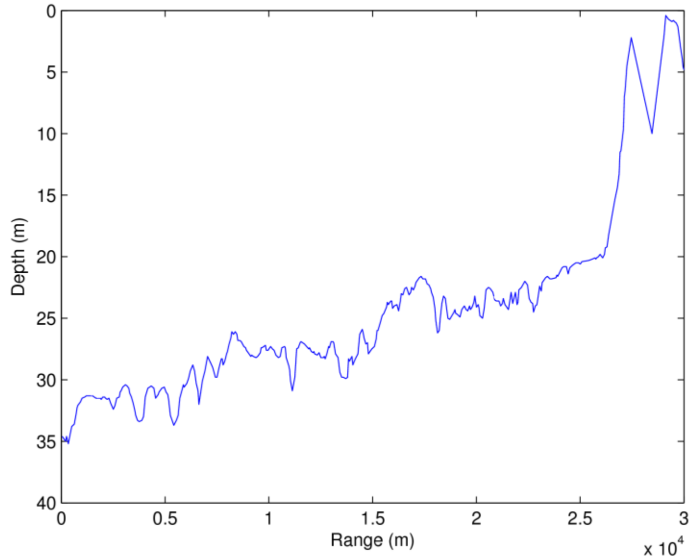


Figure A-2. Bathymetry due-North of the EGTTR Study Area Center Point

The seasonal variability in wind speed was modeled as 8.6 knots in the summer and 13 knots in the winter.

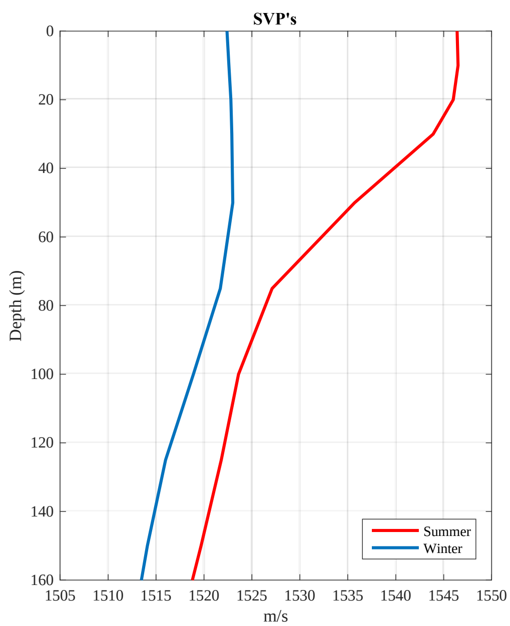


Figure A-3. Seasonal sound speed profiles shown for deepest portion of the exercise area. Upper portion of the profiles does not vary significantly going into shallower water.

A.4 MODELING IMPACT ON MARINE ANIMALS

Many underwater actions include the potential to injure or harass marine animals in the neighboring waters through noise emissions. The number of animals exposed to potential harassment in any such action is dictated by the propagation field and the characteristics of the noise source.

Estimating the number of animals that may be injured or otherwise harassed in a particular environment entails the following steps.

- For the relevant environmental acoustic parameters, transmission loss (TL) estimates are computed, sampling the water column over the appropriate depth and range intervals. TL calculations are also made over disjoint one-third octave bands for a wide range of frequencies with dependence in range, depth, and azimuth for bathymetry and sound speed. TL computations were sampled with 20 degree spacing in azimuth.
- The weighted total accumulated energy within the waters where the source detonates is sampled over a volumetric grid. At each grid point, the received energy from each source emission is modeled as the effective energy source level reduced by the appropriate propagation loss from the location of the source at the time of the emission to that grid point and summed. For the peak pressure or positive impulse, the appropriate metric is similarly modeled for each emission. The maximum value of that metric over all frequencies and emissions, is stored at each grid point.
- Finally, the number of harassments is estimated. The maximum range at which sound energy still exceeds threshold is taken to be the radius of a circle defining a zone of influence.

This section describes in detail the process of computing impact volumes.

A.4.1 Calculating Transmission Loss

Transmission loss (TL) was pre-computed for both seasons for thirty non-overlapping frequency bands. The 30 bands had one-third octave spacing around center frequencies from 50 Hz to approximately 40.637 kHz. At the request of NMFS, a normal mode model was used instead of the Navy Standard CASS/GRAB (v4.3) model that is typically used. In this case, the normal mode model KRAKEN (Porter, 1985) was integrated into the software Leidos has developed for estimating marine mammal acoustic impacts. To accommodate the strong variability in bathymetry, the acoustic pressure fields were computed using a coupled mode calculation. While normal mode models are ideally suited to waveguide propagation similar that found in the EGTTR area, these models are not typically used at the upper frequency ranges of interest here so care had to be taken in setting up step sizes within the model to maintain accuracy.

The TL results were interpolated onto a variable range grid with logarithmic spacing. The increased spatial resolution near the source provided greater fidelity for estimating impact volumes and ranges.

The TL was calculated from the source depth to an array of output depths. The output depths were the mid-points of depth intervals matching GDEM's depth sampling. For water depths from surface to 10 m depth, the depth interval was 2 m. Between 10 m and 100 m water depth, the depth interval was 5 m. For waters greater than 100 m, the depth interval was 10 m. For the EGTTR study area environment, there were thirty depth bins spanning 0 to 160 m. The depth grid is used to make the surface image interference correction and to capture the depth-dependence of the positive impulse threshold. Because of the sloping bathymetry within the area, only a few radials actually reached 160 meters of water depth

In shallow water areas such as the EGTTR, the environmental parameters with the greatest influence on the acoustic propagation are those having to do with the seafloor properties. This is particularly true when sound speed profiles bend energy down towards the bottom. Standard modeling practice is to rely on environmental properties found in databases. Bottom properties, however, are highly site-dependent and can deviate significantly from what is in the database. A literature search was conducted to see if better information on bottom acoustic properties was available. As it turns out, the Sediment Acoustics Experiment-99 (SAX99) was conducted not far from the EGTTR area, in roughly 20 meters of water over a sandy bottom. Bottom sound speed and attenuation were measured and modeled over a wide range of frequencies, making this an ideal dataset (Thorsos, 2001 and Zhou, 2009). Geoacoustic properties consistent with both Biot-Stoll theory as well as the measured SAX99 data were derived for the frequency band 50 Hz – 40 kHz and then used in the propagation model.

A.4.2 Computing Impact Volumes

This section and the next provide a detailed description of the approach taken to compute impact areas for explosives. The impact area associated with a particular activity is defined as the area of water in which some acoustic metric exceeds a specified threshold. The product of this impact area and animal density yields the expected value of the number of animals exposed to that acoustic metric at a level that exceeds the threshold. The acoustic metric can either be an energy term (weighted or un-weighted cumulative SEL, either in a limited frequency band or across the full band) or a pressure term (such as peak pressure or positive impulse). The thresholds associated with each of these metrics define the levels at which half of the animals exposed will experience some degree of harassment (ranging from behavioral change to mortality).

Impact area is particularly relevant when trying to estimate the effect of repeated source emissions separated in either time or space. Impact range, which is defined as the maximum range at which a particular threshold is exceeded for a single source emission or accumulation of source emissions over a 24-hour period, defines the range to which marine mammal activity is monitored in order to meet mitigation requirements. Based on the latest guidance, this impact range is used to provide conservative two-dimensional calculations of the exposure estimates simply by multiplying the impact area by the animal density and the total number of events proposed each year. Refer to Section A.5.3 below. This two-dimensional, maximum-range approach conservatively assumes all ranges and depths, out to the maximum range, are above threshold. In deep water environments with near-surface sources, this is a particularly conservative approach as it does not consider shadow zones where sound levels are greatly diminished due to vertical gradients in the speed of sound within the water column.

The effective energy source level is modeled directly for the sources to be used at the BT-9 target area. The energy source level is comparable to the model used for other explosives (Arons, 1954; Weston, 1960; McGrath, 1971; Urick, 1983; Christian and Gaspin, 1974). The energy source level over a one-third octave band with a center frequency of *f* for a source with a net explosive weight of *w* pounds is given by:

$$ESL = 10 \log_{10} (0.26 f) + 10 \log_{10} (2\, p_{max}^2 / [1/\theta^2 + 4 \pi^2 f^2]) + 197 \text{ dB}$$

where the peak pressure for the shock wave at 1 meter is defined as

$$p_{max} = 21600 \, (w^{1/3} / 3.28)^{1.13} \text{ psi} \qquad \text{(B-1)}$$

and the time constant is defined as:

$$\theta = [(0.058)\, (w^{1/3})\, (3.28 / w^{1/3})^{0.22}] / 1000 \text{ sec} \qquad \text{(B-2)}$$

For each explosive source, the amount of acoustic energy injected into the water column is calculated, conservatively assuming that all explosive energy is converted into acoustic energy. The propagation loss for each frequency, expressed as a pressure term, modulates the sound energy found at each point along the range (logarithmic spacing). If a threshold is exceeded at a point, the impact volume of that annular sector is added to the total impact volume. The impact area is calculated as the area of a circle with the radius equal to the maximum range across all depth bins and azimuths for each threshold and criteria.

A.4.3 Effects of Metrics on Impact Areas

The impact of explosive sources on marine wildlife is measured by three different metrics, each with its own thresholds. The energy metric, the peak pressure metric, and the "modified" positive impulse metric are discussed in this section. The energy metric, using the TAP Phase 3 weighting functions as shown in the NMFS Technical Guidance (NMFS 2016), is accumulated after the explosive detonation. The other two metrics, peak pressure and positive impulse, are not accumulated but rather the maximum levels are taken.

Energy Metric

The energy flux density (EFD) is sampled at several frequencies in one-third-octave bands. The total weighted energy flux at each range/depth combination is obtained by summing the product of the TAP Phase 3 frequency weighting function, $W_{II}(f)$, and the EFD at each frequency. The Phase 3 weighting function in dB is given by:

$$W(f) = C + 10log\left\{\frac{\left(f/_{f_1}\right)^{2a}}{\left[1+\left(f/_{f_1}\right)^{a}\right]^{2}\left[1+\left(f/_{f_2}\right)^{2}\right]^{b}}\right\}$$

where *W(f)* is the weighting function in dB for a given frequency *f*.

The component lower cutoff frequency f_1, upper frequency f_2, low- and high- frequency exponents *a* and *b*, and weighting function gain *C*, are given in Table A-5.

Table A-5. TAP Phase 3 Weighting Parameters used for MF Cetaceans

Functional Hearing Group	C(dB)	f_1(kHz)	f_2(kHz)	a	b
MF cetaceans	1.20	8.8	110	1.6	2

Note that because the weightings are in dB, we will actually weight each frequency's EFD by $10^{(W(f)/10)}$, sum the EFDs over frequency and then convert the weighted total energy back to dB, with level = 10 $\log_{10}$(total weighted EFD). Note that accumulating the EFD across frequency is equivalent to summing the energy in time over the pulse duration, both of which lead to the cumulative SEL metric with units of μPa^2-s. Single-impulse SEL levels are then accumulated over a pre-determined set of munition detonations that are likely to occur within a single 24-hour period.

Peak Pressure Metric

The peak pressure metric is a simple, straightforward calculation at each range/animal depth combination. First, the transmission pressure ratio, modified by the source level in a one-third-octave band, is summed across frequency. This averaged transmission ratio is normalized by the total broadband source level. Peak pressure at that range/animal depth combination is then simply the product of:

- The square root of the normalized transmission ratio of the peak arrival,
- The peak pressure at a range of 1 meter (given by equation B-1), and
- The similitude correction (given by $r^{-0.13}$, where r is the slant range).

If the peak pressure for a given grid point is greater than the specified threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

"Modified" Positive Impulse Metric

The modeling of positive impulse follows the work of Goertner (Goertner, 1982). The Goertner model defines a "partial" impulse as

where $p(t)$ is the pressure wave from the explosive as a function of time t, defined so that $p(t) = 0$ for $t < 0$. This similitude pressure wave is modeled as

$$I = \int_0^{T_{min}} p(t)dt \, ,$$

where $p(t)$ is the pressure wave from the explosive as a function of time t, defined so that $p(t) = 0$ for $t < 0$. This similitude pressure wave is modeled as

$$p(t) = p_{max}\, e^{-t/\theta}$$

where p_{max} is the peak pressure at 1 meter (see, equation B-1), and θ is the time constant defined in equation A-2.

The upper limit of the "partial" impulse integral is

$$T_{min} = \min \{T_{cut}, T_{osc}\}$$

where T_{cut} is the time to cutoff and T_{osc} is a function of the animal lung oscillation period. When the upper limit is T_{cut}, the integral is the definition of positive impulse. When the upper limit is defined by T_{osc}, the integral is smaller than the positive impulse and thus is just a "partial" impulse. Switching the integral limit from T_{cut} to T_{osc} accounts for the diminished impact of the positive impulse upon the animals lungs that compress with increasing depth and leads to what is sometimes call a "modified" positive impulse metric.

The time to cutoff is modeled as the difference in travel time between the direct path and the surface-reflected path in an isovelocity environment. At a range of r, the time to cutoff for a source depth z_s and an animal depth z_a is

$$T_{cut} = 1/c \ \{ \ [r^2 + (z_a + z_s)^2]^{1/2} - [r^2 + (z_a - z_s)^2]^{1/2} \ \}$$

where c is the speed of sound.

The animal lung oscillation period is a function of animal mass M and depth z_a and is modeled as

$$T_{osc} = 1.17 \ M^{1/3} \ (1 + z_a/33)^{-5/6}$$

where M is the animal mass (in kg) and z_a is the animal depth (in feet).

The modified positive impulse threshold is unique among the various injury and harassment metrics in that it is a function of depth and the animal weight. So instead of the user specifying the threshold, it is computed as $K\ (M)^{1/3}\ (1 + z_a/33)^{1/2}$. The coefficient K depends upon the level of exposure. For the onset of slight lung injury, K is 39.1; for the onset of extensive lung hemorrhaging (1% mortality), K is 91.4.

Although the thresholds are a function of depth and animal weight, sometimes they are summarized as their value at the sea surface for a typical dolphin calf (with an average mass of 12.2 kg). For the onset of slight lung injury, the threshold at the surface is approximately 13 psi-msec; for the onset of extensive lung hemorrhaging (1% mortality), the threshold at the surface is approximately 31 psi-msec.

As with peak pressure, the "modified" positive impulse at each grid point is compared to the derived threshold. If the impulse is greater than that threshold, then the incremental volume for the grid point is added to the impact volume for that depth layer.

A.5 ESTIMATING ANIMAL HARASSMENT

A.5.1 "Two-Dimensional" Harassment Estimates

The conservative approach to estimating harassment is to compute only a two-dimensional impact. In this approach, the impact volume is essentially a cylinder extending from the surface to the seafloor, centered at the sound source and with a radius set equal to the maximum range, Rmax, across all depths and azimuths at which the particular metric level is still above threshold. The number of animals impacted is computed simply by multiplying the area of a circle with radius Rmax, by the original animal density given in animals per square kilometer. Impacts computed in this manner will always exceed or equal impacts based on depth-dependent animal distributions.

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