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LASER RANGE EVALUATION FOR THE AVON PARK RANGE, MACDILL AIR FORCE BASE, FLORIDA

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At the request of the 6th Medical Group Bioenvironmental, TASC, Incorporated personnel (through a contract let by the Armstrong Laboratory) performed a laser range evaluation at the Avon Park Range, FL, on 25-29 September 1994. Subjects covered included lasers used on the range and the various missions to be conducted on the ranges. Recommendations and footprint evaluations were made to provide effective use of the Foxtrot and Echo complexes. Laser range procedures and laser goggle data were detailed, as well as required medical surveillance requirements for range personnel. Range assessment consisted of on-site (laser target) visit, review of range procedures, and an evaluation as detailed in checklists from MIL-HDBK-828 and Range Commanders' Council Document 306-91 (see Appendix I of report).

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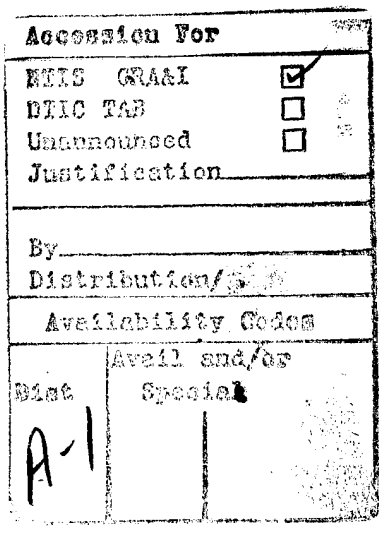

LASER RANGE EVALUATION FOR THE AVON PARK RANGE
MacDill AFB, Florida

INTRODUCTION

The Avon Park, FL, laser range evaluation was performed at the request of SSgt Villegas, Bioenvironmental Engineering Services, MacDill AFB, FL, on 25-29 September 1994. The hazard analysis, range evaluation, and recommendations were accomplished in accordance with AFOSH Std 161-10, MIL-HDBK-828, and USAFOEHL Report 87-091RC0111GLA for the purpose of ensuring range laser safety (see Appendix H).

Previous range surveys were conducted by Capt Brewer and Capt Speer from Brooks AFB (USAFOEHL) on 25 November 1986; and by Mr. Pfoutz and Mr. Shawn Sparks of US Army Environmental Health Agency, Aberdeen Proving Ground, MD, on 15-17 November 1993.

The primary objectives of this range visit were:

1. To evaluate laser target footprints for more efficient range use during air-to-ground operations. Presently, the total range is closed during airborne lasing.

2. To provide laser goggle optical density (OD) requirements for the operational laser weapons that are being used on the range. The present goggles are OD 14 and 30, which are too dark to permit the operators to function effectively and safely.

3. To investigate the concern expressed over the potential effect of lasers on animals. The range is inhabited by deer, wild pigs, alligators, cattle, many types of birds, and several endangered species of rodents.

4. To provide laser information which may assist the rewriting of Avon Park Range laser procedures.

RANGE ASSESSMENT

Laser Systems

Laser systems used on Avon Park Range are for ranging and target designation purposes for both air-to-ground and ground-to-ground.

The laser most frequently used on Avon Park Range is the Low-Altitude Navigation and Targeting Infrared for Night (LANTIRN) system mounted on the F-16 and F-15 aircraft. Other systems such as the air-to-ground Air Force Pave Spike, Pave Tack, and F-117 lasers, as well as other Army and Navy systems are being considered. Tables A-1, A-2, and A-3 (Appendix A) list all the air-to-ground laser rangers and target designators that are used by the US Air Force, US Army, and US Navy, respectively. Tables A-4 through A-7 (Appendix A) list all the ground-to-

ground laser rangers and target designators currently used by the US Armed Forces. These lists include all pertinent and available information for the range evaluation and laser hazard calculations such as the wavelength, the laser classification, the Nominal Ocular Hazard Distance (NOHD), the required OD, the buffer angle, etc. Appendix B contains a brief description of the USAF air-to-ground laser systems as well as their platforms and their laser hazard evaluations. Appendix B also contains the same information for the other services' laser systems when available.

Laser Eye Protection (LEP)

The eye protection that was being used by the range personnel was OD 14 and 30 at 1064 nm and had darkened since their purchase (a document in one box indicated purchase in 1977). The eye protection was so dark that users could not function effectively on the range. For example, the eye protection was not safe for personnel if movement was required to accomplish their duties.

The Range

Avon Park Range, FL, is 106,110 acres of mixed forest and rangeland. Approximately 82,800 acres are open to public access on a regular basis for hiking, hunting, fishing, camping, and other related activities. The bulk of the installation is classified as a Wildlife Management Area through a cooperative agreement with the Florida Game and Fresh Water Fish Commission. This allows them to provide law enforcement and technical assistance for wildlife problems; however, the Air Force administers all recreational activities. Access is limited as military activities permit. On rare occasions the entire installation is closed due to military exercises.

Military operating areas (MOAs) are located north and south of the Avon Park Range allowing aircraft space to acquire a run-in heading prior to entering the range. Military airspace above the range is restricted and useable from the ground to 18,000 feet.

Appendix C contains the range maps. Map C-1 shows the entire Avon Park Range. Laser hazard zones based on worst-case Pave Tack profiles around the targets for the North and South range complexes are also annotated. These maps include geographic items and the location of present and proposed laser targets.

The laser targets are shown with more detail on maps C-2 for the North (Foxtrot Range) and C-3 South (Echo Range) complexes. Kissimmee Road is a distinct landmark and control access that divides the range into fairly even parts to allow operations on the North or South complexes.

Avon Park Range does not have radar control to monitor the lasing aircraft position. Therefore, the direct communications between ground control and the airborne aircrew are the primary means of assuring the proper laser targets are being used.

Avon Park Range personnel have not had formal laser range safety training.

Avon Park is inhabited by many kinds of wild and domestic animals, some of which are endangered species. The environmental organizations and farmers have been interested in the effects of lasers on the many range creatures.

The present procedure for scheduling use of Avon Park Range is difficult due to the requirement for processing through MacDill AFB. This procedure does not include direct contact with range control personnel. It could provide sources of errors in flight profiles and control points. Also, to conduct safe range operations, a considerable amount of scheduling is required to notify and monitor farmers, hunters, the Forest Service, and recreationists. Up until now, procedures have been adequate to protect users of the range.

Avon Park Personnel are in the process of updating their range procedures. They requested source material to assure range operations are safe and to consider the new weapon systems that might be requesting use of the range facilities. Present procedures do not consider "buddy lasing" or show laser flight profiles or laser footprints (see Appendix I).

The Targets

Many different types of targets are used on Avon Park Ranges; all are static. Targets on the tactical ranges consist mostly of old vehicles, aircraft, conex containers, legos (large concrete blocks), missiles, large antennas, and revetted areas. Most of the Avon Park Range targets are rusty and therefore do not provide reflective surfaces. Range personnel have been very effective in ensuring that the targets are free of specular reflectors by painting or removing mirror-like surfaces and using canisters or legos to avoid hazardous reflections.

The laser targets are identified with a circle and numbers on maps C-2 and C-3. Table 1 lists targets for Foxtrot and Echo Tactical Ranges, as well as target type, coordinates, and elevations. Foxtrot Range has four laser targets at the South end of a simulated runway. Target #22 consists of six vehicles, target #23 is a 10x10 foot building, target #27 is a radar van, and target #19 is a 10x20 foot concrete complex of legos supporting radar reflector. The targets in Echo Range are target #22 (an aircraft), target #29 (an ammo storage bunker), and target #16 (a radar van).

At the time of our visit there was considerable standing water near the targets.

Target No.	Type	Coordinates	Elevation (feet)
	FOXTROT TACTICAL RANGE		
19	Radar Van (Legos)	N2742.056 W8117.739	114
22	Support Vehicle	N2742.083 W8117.167	130
23	HQ Building	N2742.269 W8117.266	129
27	SA-3 Site	N2742.294 W8117.971	101
	ECHO TACTICAL RANGE		
16	Van SA-2 Site	N2736.063 W8114.205	76
22	Aircraft	N2735.600 W8113.983	69
29	Ammo Storage (Legos)	N2735.148 W8113.826	63

Table 1. Avon Park AF Range, FL, Targets.

The Flight Profiles

Airborne laser flights should avoid overflight of populated areas of Avon Park City and MacDill AFB Auxiliary Field. Popular recreational areas such as Lake Arbuckle should also be avoided. Therefore, an inbound heading of 050° clockwise to 130° magnetic should be avoided. Approaches using the MOAs would be the most logical and safest.

F-16 and F-15 LANTIRN profiles will use the laser at approximately 4 miles during low (500 feet pop-up-AGL) approaches and could plan to use the laser 15 nautical miles prior to the target on medium altitude approaches up to an altitude of 25,000 feet (MSL). Flight organizations should coordinate their flight profiles with range/laser safety officer prior to flying any missions on the range.

The Laser Surface Danger Zone (LSDZ)

The footprint calculations at Appendix E show the worst case or largest footprints for various delivery profiles. They are summarized here in Tables 2-4.

Laser System	Forward	Footprint Aft	Width
LANTIRN	4420 ft 1340m	3420 ft 1040 m	127 ft 39 m
Pave Tack	6500 ft 1980 m	4550 ft 1390 m	176 ft 54 m
Pave Spike	3730 ft 1140 m	4250 ft 1290 m	163 ft 50 m

Table 2. Loft Delivery Footprints

Laser System	Forward	Footprint Aft	Width
LANTIRN	51 ft 16 m	51 ft 16 m	58 ft 18 m
Pave Tack	71 ft 22 m	71 ft 22 m	81 ft 25 m
Pave Spike	66 ft 20 m	66 ft 20 m	75 ft 23 m

Table 3. Medium-Altitude Delivery Footprints

Laser System	Forward	Footprint Aft	Width
LANTIRN	650 ft 198 m	587 ft 179 m	51 ft 15 m
Pave Tack	921 ft 281 m	800 ft 244 m	70 ft 21 m
Pave Spike	845 ft 258 m	742 ft 226 m	65 ft 20 m

Table 4. "Buddy Lasing" Delivery Footprints

Therefore, one can see from the data given in Tables 2-4 that the largest footprint is the one for the Loft Delivery Profile using the Pave Tack laser (Footprint: Forward = 6500 ft, Aft = 4550 ft, Width = 176 ft).

We did some preliminary hazard evaluations on some of the Navy's air-to-ground laser systems (see Appendix E). However, we do not have enough information on the beam divergence and buffer angles to make reasonable footprint calculations. We had to use some very

large values (worst-case) for both divergence and buffer angles; consequently, the preliminary results are overly restrictive.

CONCLUSIONS/RECOMMENDATIONS

The Avon Park Range personnel need to be commended for their efforts and awareness of laser safety on their range. Their use of information from previous inspections and from their own research have resulted in a very clean range.

The range personnel are very competent, as most have had relevant military experience and understand range operations. They have very positive control of the range and work smoothly with the aircrews during range operations.

The LSDZs for the targets considered fit safely on the Avon Park Range. The minimum distance between a range boundary and an LSDZ is over three kilometers.

Avon Park Range can easily be divided into two sections for laser operations. Kissimmee Road is a natural boundary for monitoring and control of ground parties, while providing space for aircraft to maneuver.

Range Control

Positive aircraft monitoring and control will be required when dividing the range into North and South complexes for lasing operations. This can be accomplished with the laser safety officer communicating "Cleared to Lase" **AFTER** the pilot or crew member calls "Target Acquired" passing initial point (IP). Definite landmarks make good IPs. Local examples are Smith Road or the road to Hard Luck Hammock for southbound flights to Echo Range and Kissimmee Road for northbound flights to Foxtrot Range targets. Night flights require a system of lights at the IPs along a given flight path. Smoky Hill Range, KS, has such a nighttime system. The crew member must also make calls of "Laser ON" and "Laser OFF" to assure the laser is maintained in the LSDZ.

Close communications with the aircrews, in addition to aircrew briefings are highly recommended, since Avon Park Range does not have radar tracking to monitor positive aircraft position.

Laser Footprint

Laser footprint information (Appendix E) was provided at the time of the visit and is also included in this report (see The Laser Surface Danger Zone (LSDZ) section). The information was designed for level terrain, which readily applies to Avon Park Range.

Map C-1 depicts the laser target and LSDZs/Nominal Hazard Zone (NHZ) for Avon Park Range MOA entry and on-range approach profiles. A laser hazard footprint from the worst-case, Pave Tack loft profiles (see Table 2), is shown by solid line arcs. The solid line circles on Maps

C-1, C-2, and C-3 are extensions of the "forward" laser hazard zone (6500-foot radius to a full circle). This allows maneuvering headings within the Avon Park Range, as required for "buddy lasing." Overlapping circles depict the use of laser footprints for more than one target. All other airborne systems listed in the tables will fall in these safety footprints.

Scheduling

A primary factor for laser operations range control is scheduling with all the range users. The aircraft crew members must be briefed on control landmarks, flight profiles, laser footprints, and communication requirements for their particular missions. The aircrew must be notified of the locations of any ground parties they could be flying over. All ground personnel must also know flight profiles over their location and times of laser operations. Avon Park laser range controllers are key players in coordinating and scheduling with aircrews, environmentalists, Forest Service, farmers, hunters, and recreationists. All laser missions actually flown on the range should be recorded in a "Laser Mission Log." This will be very beneficial during investigations or legal actions.

Water Reflection

The laser safety officer and aircrew members must also understand that laser beams can be reflected from standing water. The condition of smooth standing water requires consideration of aircraft potentially flying in areas of reflected laser beams. As a guide use a minimum of 1/2 of the nominal ocular hazard distance (NOHD) beyond the target for a hazard reflection distance. As an example, for LANTIRN with an NOHD of 22,700 meters, the beam could extend 11,350 meters beyond the water surface at an angle equal to the aircraft true lasing attitude angle. With low flat approaches the reflected beam could extend beyond range boundaries and into the MOA.

Laser Training

Laser training is highly recommended for aircrew and personnel controlling laser operations, writing laser procedures, and representing ranges at meetings or conferences. Range controllers and managers are directly responsible for implementing safe laser procedures and protecting all the range users. They should be fully qualified in the range operations. This training is the responsibility of the Range Safety Officer and the support Public Health Officer. The assigned flight surgeon and bioenvironmental engineering services can assist in parts of this training. Training should be conducted and properly documented. Training material can be obtained from AL/OEO (SSgt Limburg), DSN 240-4785, at Brooks AFB.

LEP

LEP with an OD of 4 has been recommended by Brooks AFB (AL/OEO) for a neodymium:yttrium-aluminum-garnet (Nd:YAG) laser of 1064 nm. It is highly recommended that the old eyewear be replaced with new and more useable protection. Assure that the wavelength (1064 nm) and the OD is printed on the glasses. Eyewear should be stored in containers in a dry location to reduce deteriorating effects of moisture. Laser eyewear can be procured using Federal

Stock Number 4240-00-620-0054 from Glendale Protective Technologies or several other companies listed in Appendix G.

Environmental Impact

One of the range visit objectives was to consider the effects of lasers on the domestic and wild animals. Contacts with Mr. Terry Lyon and Mr. Wes Marshall from the US Army Environmental Health Agency, Mr. Tony Sliwa from Naval Systems Warfare Command, and Brooks AFB has not revealed information of open range injury to animals. Ms. Cheyrl Weiss of China Lake Naval Air Warfare Center is involved with studies of animals on military ranges. The study might be a year or two before completion.

Procedures

Copies of the general laser procedures and footprint data were given to Avon Park Range personnel to assist them in starting their range procedure rewriting. Additional laser safety information can be found in MIL-HDBK-828, April 1993, "Military Handbook Laser Range Safety" or ANSI Z136.1-1993 "American National Standard for the Safe Use of Lasers." AFOSH 161-10 is being redesignated as AFI 48-10 and should be published in 1995. We would also review your procedures if you desire our assistance.

Medical Records

Medical records were not reviewed during this visit; however, current documentation for eye examination requirements are included for range managers' guidance (see Appendixes F&J).

If any questions should arise contact Lt Pat Hoisington (DSN 240-4784) or SSgt Jerry Limburg (DSN 240-4785/4779) at Brooks AFB, TX

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APPENDIX A

Air-to-Ground Laser Systems and Ground-to-Ground Laser Systems

TABLE A-1. USAF AIR-TO-GROUND LASER SYSTEMS

Device	Wavelength (nm)	ANSI Class	NOHD (km)	NOHD-0 (km)	OD	OD-0	Buffer Angle (mrad)	Beam Divergence (mrad)
Pave Spike (AN/ASQ-153)	1064	4	10.4	73.5	4.02	5.71	2.5	0.35
Pave Tack (AN/AVQ-26)	1064	4	2.3	16.1	5.55	7.24	2	1.8
Pave Knife (AN/ALQ-10)	1064	4	5.6	---	3.7	---	5	---
Pave Spectre (AN/AVQ-19)	1064	4	8.89	63	3.7	5.4	5	0.33
LANTIRN operational training	1064 1540	4 3b	22.7 0	157 0	4.15 0	5.84 0	2 N/A	0.18 0.18

Notes: NOHD-0 - NOHD with optical instruments (7 x 50)
OD-0 - OD needed for optical instruments (7 x 50)
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-2. U.S. ARMY AIR-TO-GROUND LASER SYSTEMS

Device	Wavelength (nm)	ANSI Class	NOHD (km)	NOHD-0 (km)	OD	OD-0	Buffer Angle (mrad)	Beam Divergence (mrad)
TADS (AAH) (Apache)	1064	4	20	45	4.0	5.5	5	---
OH-58D	1064	4	35	56	4.1	5.3	5	---

Notes: NOHD-0 - NOHD with optical instruments (7 x 50)
OD-0 - OD needed for optical instruments (7 x 50)
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-3. USN & USMC AIR-TO-GROUND LASER SYSTEMS

Device	Wavelength (nm)	ANSI Class	NOHD (km)	NOHD-0 (km)	OD	OD-0	Buffer Angle (mrad)
LAAT (AH1S) (MC)	1064	4	5	15	3.5	4.8	5
AN/AAS-33A (A6E TRAM)	1064	4	14.6	___	4.6	5.8	5
AN/AAS-37 (OV-10D NOS)	1064	4	11.2	45	5.2	5.6	5
AN/AAS-38A (F18)	1064	4	17	50	4.3	5.4	5
Nite Eagle (MC-Cobra) UH-1N	1064	4	15	45	4.1	5.2	5
AIM-1/MLR	800	3b	.085	.68	1.7	1.7	10
AIM-1/EXL	850	3b	.085	.68	1.7	1.7	10

Notes: NOHD-0 - NOHD with optical instruments (7 x 50)
OD-0 - OD needed for optical instruments (7 x 50)
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-4. GROUND-TO-GROUND LASER SYSTEMS

(Tank Mounted)

Device	ANSI Class	NOHD (km)	NOHD-0 (km)	t (m)	s (m)	Buffer Angle (mrad)	
						Static	Moving
AN/VVG-1	4	10	80	10	60	2	Not Permitted
AN/VVS-1	4	10	80	10	100	5	10
AN/VVG-2	4	10	80	10	60	2	5
red filter (29db)		.300	3.1	0	Target	2	5
green filter (55db)		0	0	0	0	N/A	N/A
AN/VVG-3	4	7	35	0	60	2	5

Notes: NOHD - Multiple-pulse NOHD
NOHD-0 - NOHD with optical instruments (7 x 50)
t - diffuse reflection hazard distance
s - a predetermined (by the using service) distance around the target which must be cleared of specular reflective surfaces
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-5. GROUND-TO-GROUND LASER SYSTEMS

(Tank Mounted)

Device	Wavelength (nm)	Built-in OD	Required OD
AN/VVG-1	694.3	Clip-on > 5	5.8
AN/VVS-1	694.3	Clip-on > 5	5.8
AN/VVG-2	694.3	Clip-on > 5	5.8
AN/VVG-3	1064	> 5	4.7

TABLE A-6. GROUND-TO-GROUND LASER SYSTEMS

(Man Portable)

Device	ANSI Class	NOHD (km)	NOHD-0 (km)	t (m)	s (m)	Buffer Angle (mrad) Static	Moving
AN/GVT-1	1	0	0	0	0	N/A	N/A
LLTD	---	7	---	0	200	10	N/A
AN/GVS-5 (handheld)	4	2.7	20.6	0	200	10	N/A
red filter (19db)		.29	1.8	0	200	10	N/A
yellow filter (29db)		.056	.55	0	200	10	N/A
AN/PAQ-1 (handheld) target designator	4	7.7	33	0	200	10	N/A
CLD	---	9.7	---	0	200	10	N/A
AN/TVQ-2							
Rangefinder w/	4	8	40	0	60	2 on tripod	N/A
yellow filter (8.5db)		2.5	23	0	100	5 on vehicle	N/A
Designator	4	25	80	0	60	2 on tripod	N/A
					100	5 on vehicle	N/A

TABLE A-6 (continued)

Device	ANSI Class	NOHD (km)	NOHD-0 (km)	t (m)	s (m)	Buffer Angle (mrad) Static	Moving
AN/PAQ-3 (mule)							
Rangefinder	4	6.5	35	0	60	2 on tripod	N/A
					200	10 on vehicle	N/A
Designator	4	20	79	0	60	2 on tripod	N/A
					200	10 on vehicle	N/A
AN/GAQ-TI	---	12.5	---	0	200	5	N/A
AN/PVS-X Rangefinder	---	3 single pulse	16	0	200	90	degrees
TD-100	---	0.1	---	0	30	10	10
LPL-30	---	.095	.68	0	20	10	10

Notes: NOHD - Multiple-pulse NOHD
NOHD-0 - NOHD with optical instruments (7 x 50)
t - diffuse reflection hazard distance
s - a predetermined (by the using service) distance around the target which must be cleared of specular reflective surfaces
(7 x 50: 7x magnifying power, 50-mm aperture)

TABLE A-7. GROUND-TO-GROUND LASER SYSTEMS

(Man Portable)

Device	Wavelength (nm)	Built-in OD	Required OD
AN/GVT-1	1064	N/A	0
AN/GVS-5	1064	5	3.7
AN/PAQ-1	1064	4	4.2
AN/TVQ-2	1064	yes	3.8
AN/PAQ-3	1064	> 5	3.9
AN/GAQ-T1	1064	yes	4.6
LLTD	1064	---	4.0
CLD	1064	5	4.5
LPL-30	800-850	1.7	1.7

Notes: The built-in OD only protects against the wavelength of the laser in which it is installed.

APPENDIX B

Description and Hazard Evaluation of the Laser Systems

Description of Fielded Laser Systems

a. AN/VVS-1: Laser Range Finder mounted on the M60A2 tank.

b. AN/VVG-1: Laser Range Finder mounted on the M551A1 Sheridan vehicles.

c. AN/VVG-2: Laser Range Finder mounted on the M60A3 tank. Used with two filters, the green Eye Safe Simulated Laser Range Finder (ESSLR) filter and the red ESSLR filter. The green ESSLR is eye safe, the red ESSLR is less hazardous than the system without filters.

d. AN/VVG-3: M1 tank laser rangefinder used with one eyesafe filter.

e. AN/GVS-5: Laser Range Finder Infrared Observation Set (Handheld).

f. AN/PAQ-1: (LTD) Laser Target Designator. This is a lightweight, handheld, battery operated laser device. Forward observers use it to designate targets.

g. AN/TVQ-2: (G/VLLD) Ground/Vehicle Laser Locator Designator. This is a ranging and laser designating device used by Army artillery forward observers with laser energy homing munitions. It is capable of designating stationary or moving vehicular targets and may be used in a stationary, vehicle mounted, or tripod supported dismounted mode. The primary vehicle mount is the Fire Support Team Vehicle (FISTV).

h. AN/PAQ-3: (MULE) Modular Universal Laser Equipment. This is a Marine Corps laser designator used with laser energy homing munitions. The MULE is man portable and is used only in a dismounted mode.

i. Laser Augmented Airborne TOW (LAAT) mounted in the AH-1S COBRA Helicopter. The LAAT system consists of a laser range finder and receiver that is incorporated into the M65 tube launched, optically tracked, wire guided (TOW) telescopic sight unit.

j. Target Acquisition and Designation System with Pilot Night Vision Sight (TADS/PNVS) mounted in the Apache Advanced Attack Helicopter.

k. Mast Mounted Sight on the OH-58D that, in addition to thermal and optical sensors and imaging instrumentation, incorporates a laser rangefinder and/or designator.

l. AN/AAS-37: Laser Range Finder Designator mounted on the Marine Corps OV-10 Observation Aircraft.

m. AN/AAS-33A: Target Recognition Attach Multisensor (TRAM) laser system. This system is mounted on the A6-E Aircraft and has a laser target designator and forward looking infrared (FLIR).

n. LANTIRN System: Low Altitude Navigation and Targeting Infrared System for Night. A two-pod system containing a terrain following radar (TFR), two forward looking infrared (FLIR) sensors, a laser designator/ranger, and later, a target recognition system. This system is designed to be flown on the F-15, F-16, and A-10. The laser operates at 1064 nm and has a training modification to allow operation at 1540 nm which is "eye safe."

o. PAVE SPECTRE (AN/AVQ-19): Laser tracker and designator used on C-130 gunships.

p. PAVE SPIKE (AN/AVQ-12): Laser tracker and designator pod fitted on F-4 and F-111 aircraft.

q. PAVE TACK (AN/AVQ-26): Advanced optronics pod containing stabilized turret with FLIR, laser designator and tracker used on the F-4, RF-4, and F-111F aircraft.

r. COMPACT LASER DESIGNATOR (CLD): A small, lightweight laser designator and/or rangefinder used by the Navy for target designation.

s. TD-100: A day/night aiming laser. For daytime use this device uses a class 2 helium neon visible laser and for nighttime it uses a class 3b infrared laser diode. Night vision goggles will provide adequate nighttime protection for anyone viewing the infrared laser.

t. AIM-1: A class 3b infrared diode aiming laser for use with night vision goggles. The AIM/MLR is mounted on USAF and Marine Corps 50 caliber helicopter gun mounts. The AIM/EXL version is hard mounted on the AH-1 turret.

u. LPL-30: A class 3b infrared diode aiming laser used by command to indicate targets of choice to attacking forces equipped with the night vision goggles.

LASER HAZARD EVALUATION

LANTIRN 1064 nm

A. A hazard evaluation was accomplished for a laser with the following operational characteristics:

Wavelength = 1064.00 nm
Energy/pulse = 1.70E-01 Joules/pulse
Pulsewidth = 15.00 nsec
PRF = 2.00E+01 Hz
Beam Diameter = 3.38 cm at 1/e point
Divergence = 0.18 mradians at 1/e point

B. This is an ANSI Class 4 Laser and should be operated in accordance with the safety measures outlined in AFOSH Std 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without adverse biological effects.

Single Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE
Ocular point source	1.50E-08	5.00E-06 J/cm2
Ocular extended source	1.50E-08	1.23E-01 J/cm2/sr
Skin	1.50E-08	1.00E-01 J/cm2

Multiple Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE/pulse
Ocular point source	2.50E-01	3.34E-06 J/cm2
Ocular point source	1.00E+01	1.33E-06 J/cm2
Ocular point source	3.00E+04	1.80E-07 J/cm2
Ocular extended source	2.50E-01	6.30E+00 J/cm2/sr
Ocular extended source	1.00E+01	5.38E-01 J/cm2/sr
Ocular extended source	1.00E+04	1.60E-01 J/cm2/sr
Skin	2.50E-01	1.00E-01 J/cm2
Skin	1.00E+01	4.89E-02 J/cm2
Skin	3.00E+04	5.00E-02 J/cm2

D. The Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The NOHD is defined as the distance from the laser where the radiant exposure is equal to the MPE.

NOHD

Type of NOHD	Exposure Duration (s)	(m)	(ft)
Ocular point	1.50E-08	1.16E+04	3.82E+04
Ocular point	2.50E-01	1.43E+04	4.68E+04
Ocular point	1.00E+01	2.27E+04	7.46E+04
Ocular point	3.00E+04	6.22E+04	2.04E+05
Diffuse reflection	1.50E-08	0.00E+00	0.00E+00
Diffuse reflection	2.50E-01	0.00E+00	0.00E+00
Diffuse reflection	1.00E+01	0.00E+00	0.00E+00
Diffuse reflection	3.00E+04	0.00E+00	0.00E+00
Skin	1.50E-08	0.00E+00	0.00E+00
Skin	2.50E-01	0.00E+00	0.00E+00
Skin	1.00E+01	0.00E+00	0.00E+00
Skin	3.00E+04	0.00E+00	0.00E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	1.50E-08	3.58	0.00
1064.0	2.50E-01	3.75	0.00
1064.0	1.00E+01	4.15	0.00
1064.0	3.00E+04	5.02	0.00

OD Required at 100 meters from the Laser

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	1.50E-08	3.21	0.00
1064.0	2.50E-01	3.39	0.00
1064.0	1.00E+01	3.79	0.00
1064.0	3.00E+04	4.66	0.00

LASER HAZARD EVALUATION

LANTIRN 1540 nm

A. A hazard evaluation was accomplished for a laser with the following operational characteristics.

Wavelength = 1540.00 nm
Energy/pulse = 2.20E-02 Joules/pulse
Pulsewidth = 17.00 nsec
PRF = 1.00E+00 Hz
Beam Diameter = 3.38 cm at 1/e point
Divergence = 0.18 mradians at 1/e point

B. This is an ANSI Class 3b Laser and should be operated in accordance with the safety measures outlined in AFOSH Std 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without adverse biological effects.

Single Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE
Ocular or Skin	1.70E-08	1.00E+00 J/cm2

Multiple Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE/pulse
Ocular or Skin	2.50E-01	1.41E+00 J/cm2
Ocular or Skin	1.00E+01	5.62E-01 J/cm2
Ocular or Skin	3.00E+04	7.60E-02 J/cm2

D. The Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The NOHD is defined as the distance from the laser where the radiant exposure is equal to the MPE.

NOHD

Type of NOHD	Exposure Duration (s)	(m)	(ft)
Ocular or Skin	1.70E-08	0.00E+00	0.00E+00
Ocular or Skin	2.50E-01	0.00E+00	0.00E+00
Ocular or Skin	1.00E+01	0.00E+00	0.00E+00
Ocular or Skin	3.00E+04	0.00E+00	0.00E+00
Diffuse reflection	1.70E-08	0.00E+00	0.00E+00
Diffuse reflection	2.50E-01	0.00E+00	0.00E+00
Diffuse reflection	1.00E+01	0.00E+00	0.00E+00
Diffuse reflection	3.00E+04	0.00E+00	0.00E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1540.0	1.70E-08	0.00	0.00
1540.0	2.50E-01	0.00	0.00
1540.0	1.00E+01	0.00	0.00
1540.0	3.00E+04	0.00	0.00

OD Required at 100 meters from the Laser

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1540.0	1.70E-08	0.00	0.00
1540.0	2.50E-01	0.00	0.00
1540.0	1.00E+01	0.00	0.00
1540.0	3.00E+04	0.00	0.00

The 1540-nm training mode is also "eye safe" when using optics of up to 20X magnification.

LASER HAZARD EVALUATION

PAVE SPECTRE AN/AVQ-19

A. A hazard evaluation was accomplished for a laser with the following operational characteristics:

Wavelength = 1064.00 nm
Energy/pulse = 1.10E-01 Joules/pulse
Pulsewidth = 18.00 nsec
PRF = 1.00E+01 Hz
Beam Diameter = 4.18 cm at 1/e point
Divergence = 0.33 mradians at 1/e point

B. This is an ANSI Class 4 Laser and should be operated in accordance with the safety measures outlined in AFOSH Std 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without adverse biological effects.

Single Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE
Ocular point source	1.80E-08	5.00E-06 J/cm2
Ocular extended source	1.80E-08	1.31E-01 J/cm2/sr
Skin	1.80E-08	1.00E-01 J/cm2

Multiple Pulse MPEs

Type of MPE	Exposure Duration (s)	MPE/pulse
Ocular point source	2.50E-01	3.98E-06 J/cm2
Ocular point source	1.00E+01	1.58E-06 J/cm2
Ocular point source	3.00E+04	2.14E-07 J/cm2
Ocular extended source	2.50E-01	1.26E+01 J/cm2/sr
Ocular extended source	1.00E+01	1.08E+00 J/cm2/sr
Ocular extended source	3.00E+04	3.20E-01 J/cm2/sr
Skin	2.50E-01	1.00E-01 J/cm2
Skin	1.00E+01	9.78E-02 J/cm2
Skin	3.00E+04	1.00E-01 J/cm2

D. The Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The NOHD is defined as the distance from the laser where the radiant exposure is equal to the MPE.

NOHD

Type of NOHD	Exposure Duration (s)	(m)	(ft)
Ocular point	1.80E-08	4.95E+03	1.62E+04
Ocular point	2.50E-01	5.56E+03	1.82E+04
Ocular point	1.00E+01	8.89E+03	2.92E+04
Ocular point	3.00E+04	2.44E+04	8.01E+04
Diffuse reflection	1.80E-08	0.00E+00	0.00E+00
Diffuse reflection	2.50E-01	0.00E+00	0.00E+00
Diffuse reflection	1.00E+01	0.00E+00	0.00E+00
Diffuse reflection	3.00E+04	0.00E+00	0.00E+00
Skin	1.80E-08	0.00E+00	0.00E+00
Skin	2.50E-01	0.00E+00	0.00E+00
Skin	1.00E+01	0.00E+00	0.00E+00
Skin	3.00E+04	0.00E+00	0.00E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	1.80E-08	3.20	0.00
1064.0	2.50E-01	3.30	0.00
1064.0	1.00E+01	3.70	0.00
1064.0	3.00E+04	4.57	0.00

LASER HAZARD EVALUATION

LHAZ VER 2.0

PAVE SPIKE

A. A hazard evaluation was accomplished for a laser with the following operational characteristics:

Wavelength = 1064.00 nm
Multiple Pulse Laser
Energy = 1.68E-01 Joules/pulse
Pulsewidth = 1.50E-08 sec
PRF = 1.00E+01 Hz
Beam diameter = 3.59E+00 cm at 1/e point
Divergence = 3.50E-04 radians at 1/e point

B. This is an ANSI Class 4 Laser and should be operated in accordance with the safety measures outlined in AFOSH Std 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without biological effects.

Type of MPE	Exposure Duration (s)	MPE
Ocular point source	Single Pulse	5.00E-06 J/cm2
Ocular point source	0.25	9.94E-06 J/cm2
Ocular point source	10.0	1.58E-04 J/cm2
Ocular point source	30,000	6.41E-02 J/cm2
Ocular point source	1.000	2.81E-05 J/cm2
Ocular extended source	Single Pulse	1.23E-01 J/cm2/sr
Ocular extended source	0.25	3.08E-01 J/cm2/sr
Ocular extended source	10.0	1.23E+01 J/cm2/sr
Ocular extended source	30,000	9.60E+04 J/cm2/sr
Ocular extended source	1.000	1.23E+00 J/cm2/sr
Skin	Single Pulse	1.00E-01 J/cm2
Skin	0.25	2.50E-01 J/cm2
Skin	10.0	1.00E+01 J/cm2
Skin	30,000	3.00E+04 J/cm2
Skin	1.000	1.00E+00 J/cm2

D. The Safe Exposure Distance (SED)/Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The SED is defined as the distance from an operating laser at which the radiant exposure is equal to the MPE.

SED/NOHD

Type of SED/NOHD	Exposure Duration (s)	(m)
Ocular point	Single Pulse	5.81E+03
Ocular point	0.25	6.52E+03
Ocular point	10.0	1.04E+04
Ocular point	30,000	2.85E+04
Ocular point	1.000	7.78E+03
Diffuse reflection	Single Pulse	0.00E+00
Diffuse reflection	0.25	0.00E+00
Diffuse reflection	10.0	0.00E+00
Diffuse reflection	30,000	0.00E+00
Diffuse reflection	1.000	0.00E+00
Skin	Single Pulse	0.00E+00
Skin	0.25	0.00E+00
Skin	10.0	0.00E+00
Skin	30,000	0.00E+00
Skin	1.000	0.00E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	3.52	0.00
1064.0	0.25	3.62	0.00
1064.0	10.0	4.02	0.00
1064.0	30,000	4.89	0.00
1064.0	1.000	3.77	0.00

OD Required at 1.0 km

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	1.46	0.00
1064.0	0.25	1.56	0.00
1064.0	10.0	1.96	0.00
1064.0	30,000	2.83	0.00
1064.0	1.000	1.71	0.00

OD Required at 5.0 km

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	0.13	0.00
1064.0	0.25	0.23	0.00
1064.0	10.0	0.63	0.00
1064.0	30,000	1.50	0.00

LASER HAZARD EVALUATION

LHAZ VER 2.0

PAVE TACK

A. A hazard evaluation was accomplished for a laser with the following operational characteristics:

Wavelength = 1064.00 nm
Multiple Pulse Laser
Energy = 1.80E-01 Joules/pulse
Pulsewidth = 2.50E-08 sec
PRF = 2.00E+01 Hz
Beam diameter = 4.50E-01 cm at 1/e point
Divergence = 1.80E-03 radians at 1/e point

B. This is an ANSI Class 4 Laser and should be operated in accordance with the safety measures outlined in AFOSH 161-10 along with such other safety procedures required by the responsible safety officer.

C. The Maximum Permissible Exposure (MPE) limits are listed below. The MPE is defined as the radiant exposure which personnel may receive without biological effects.

Type of MPE	Exposure Duration (s)	MPE
Ocular point source	Single Pulse	5.00E-06 J/cm2
Ocular point source	0.25	1.67E-05 J/cm2
Ocular point source	10.0	2.66E-04 J/cm2
Ocular point source	30,000	1.08E-01 J/cm2
Ocular point source	1.000	4.73E-05 J/cm2
Ocular extended source	Single Pulse	1.46E-01 J/cm2/sr
Ocular extended source	0.25	7.31E-01 J/cm2/sr
Ocular extended source	10.0	2.92E+01 J/cm2/sr
Ocular extended source	30,000	9.60E+04 J/cm2/sr
Ocular extended source	1.000	2.92E+00 J/cm2/sr
Skin	Single Pulse	1.00E-01 J/cm2
Skin	0.25	5.00E-01 J/cm2
Skin	10.0	1.00E+01 J/cm2
Skin	30,000	3.00E+04 J/cm2
Skin	1.000	2.00E+00 J/cm2

D. The Safe Exposure Distance (SED)/Nominal Ocular Hazard Distance (NOHD) for various exposure conditions is listed below. The SED is defined as the distance from an operating laser at which the radiant exposure is equal to the MPE.

SED/NOHD

Type of SED/NOHD	Exposure Duration (s)	(m)
Ocular point	Single Pulse	1.19E+03
Ocular point	0.25	1.45E+03
Ocular point	10.0	2.30E+03
Ocular point	30,000	6.27E+03
Ocular point	1.000	1.73E+03
Diffuse reflection	Single Pulse	1.07E+00
Diffuse reflection	0.25	1.31E+00
Diffuse reflection	10.0	2.08E+00
Diffuse reflection	30,000	5.65E+00
Diffuse reflection	1.000	1.56E+00
Skin	Single Pulse	5.91E+00
Skin	0.25	5.91E+00
Skin	10.0	9.39E+00
Skin	30,000	9.39E+00
Skin	1.000	5.91E+00

E. The optical density (OD) is a measure of the opacity to radiation expressed in logarithmic units. The following are OD values required at the distances listed.

OD Required at the Laser Aperture

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	4.97	1.05
1064.0	0.25	5.15	1.05
1064.0	10.0	5.55	1.35
1064.0	30,000	6.42	1.35
1064.0	1.000	5.30	1.05

OD Required at 1.0 km

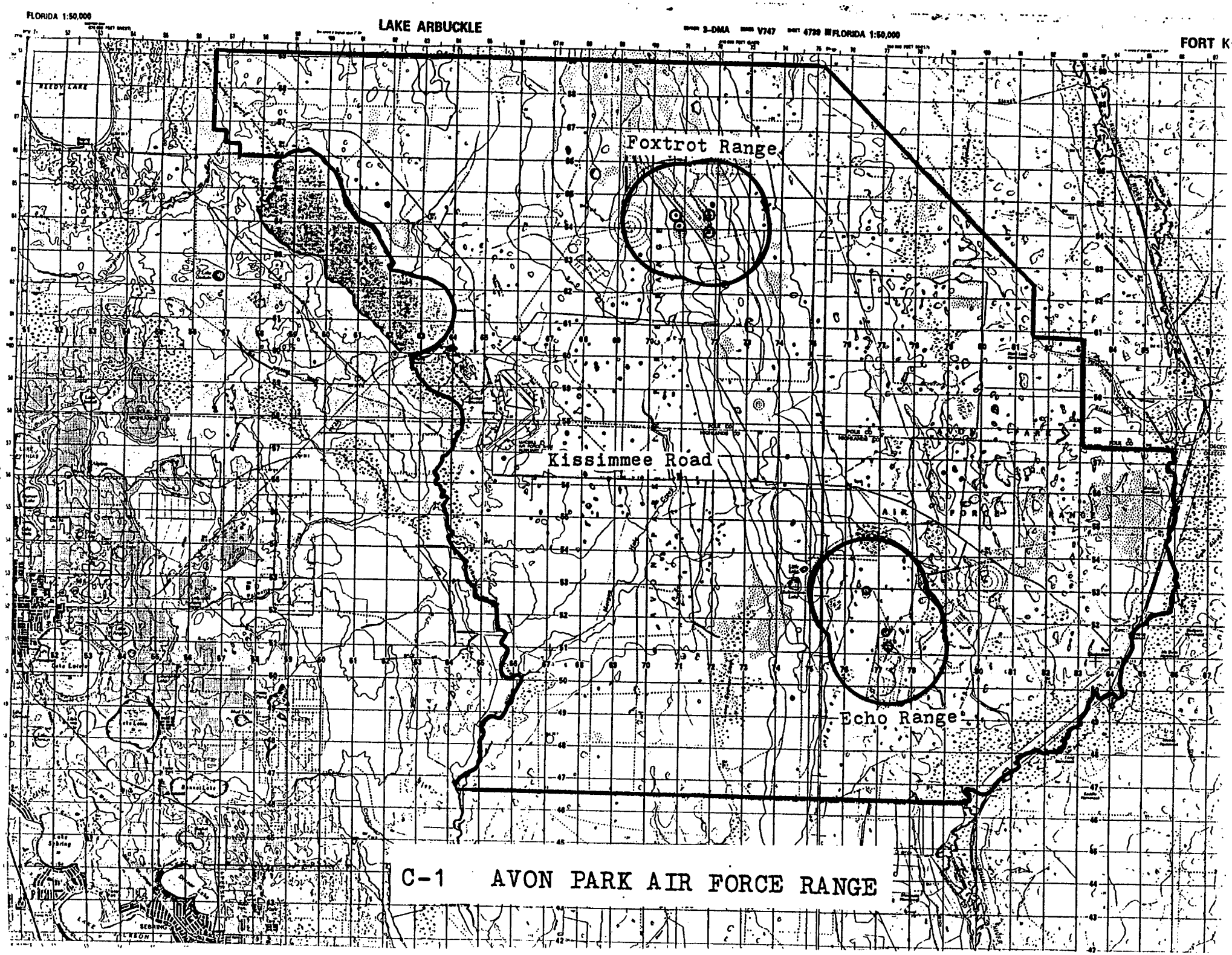
Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	0.15	0.00
1064.0	0.25	0.32	0.00
1064.0	10.0	0.72	0.00
1064.0	30,000	1.59	0.00
1064.0	1.000	0.47	0.00

OD Required at 5.0 km

Wavelength (nm)	Exposure Time (s)	Ocular OD	Skin OD
1064.0	Single Pulse	0.00	0.00
1064.0	0.25	0.00	0.00
1064.0	10.0	0.00	0.00
1064.0	30,000	0.20	0.00

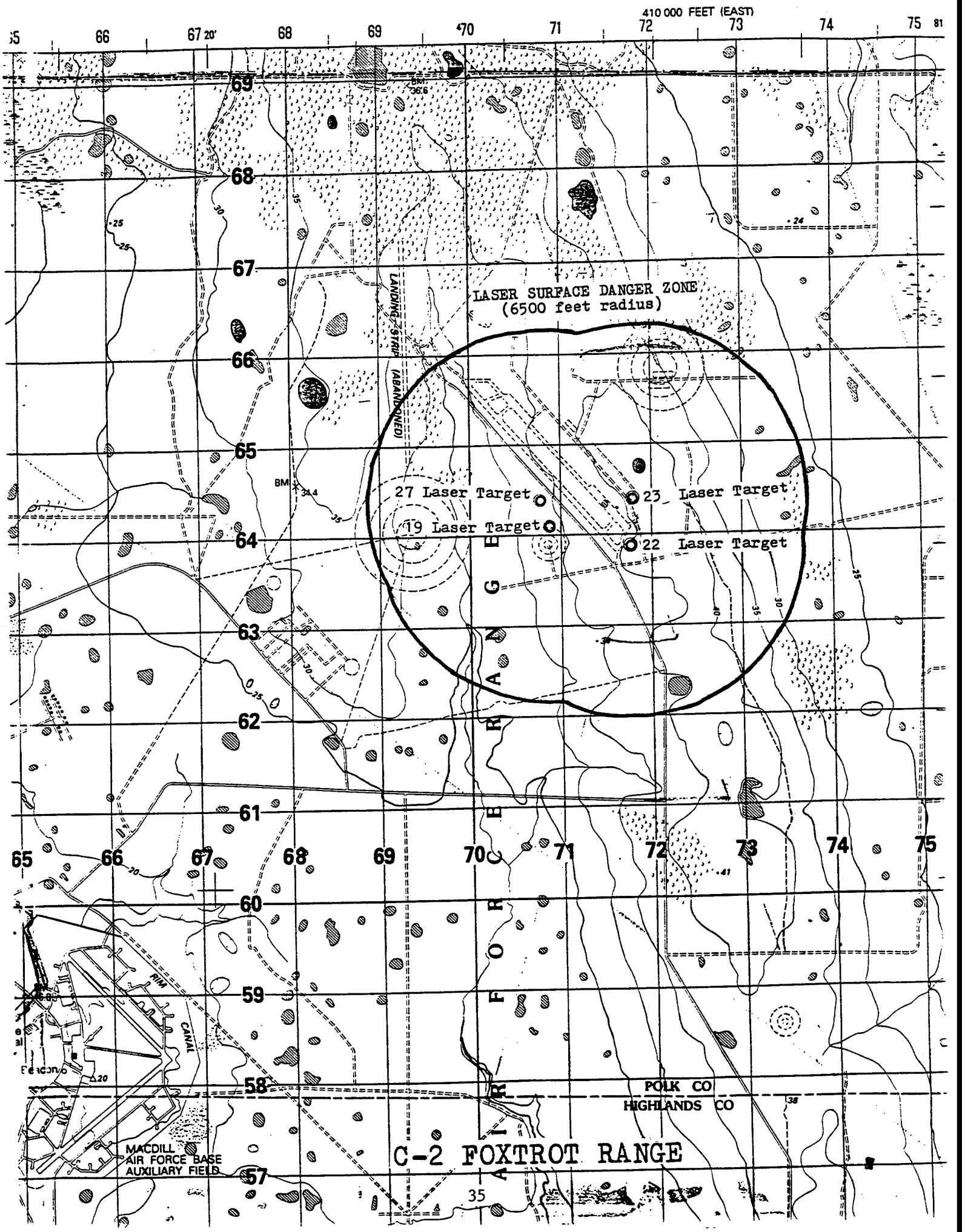
APPENDIX C

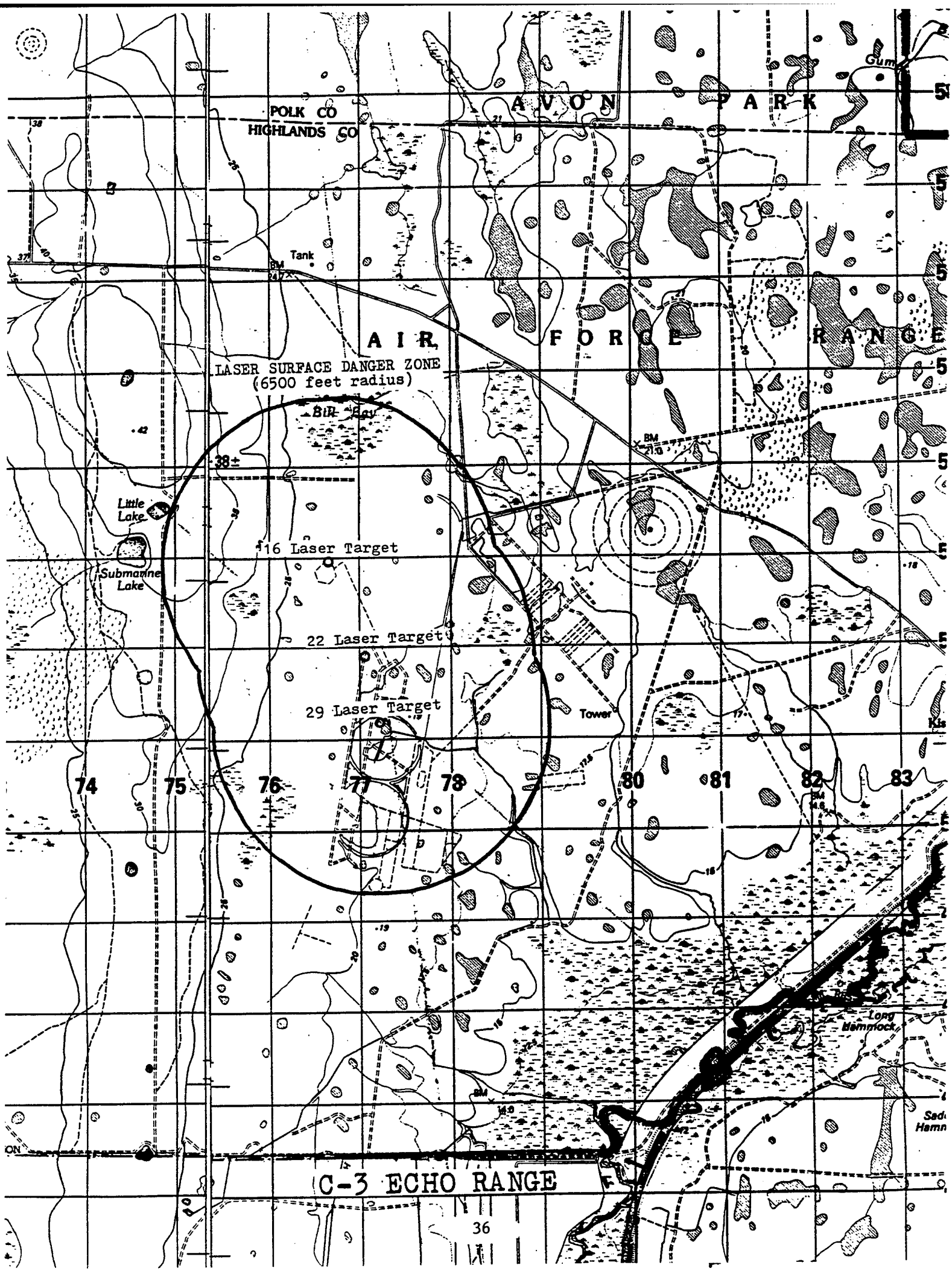
Range Maps



C-1 AVON PARK AIR FORCE RANGE

EDITION 3-DMA SERIES V747 SHEET 4739 III

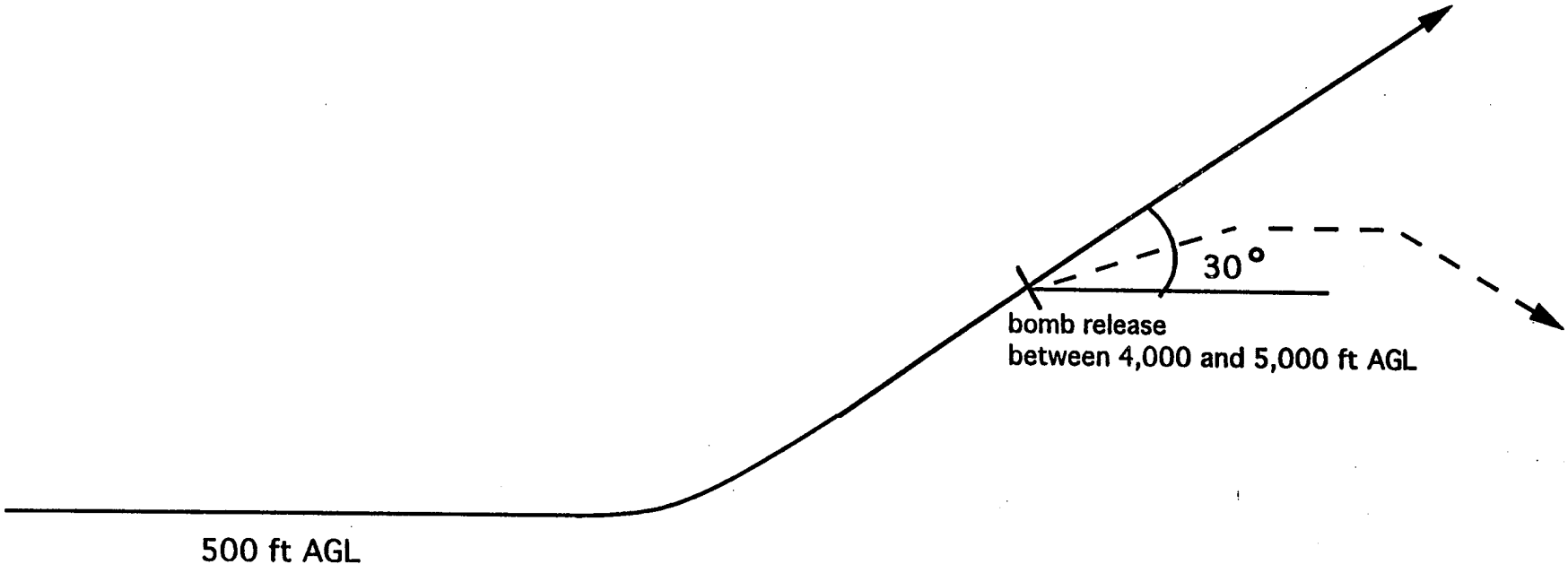



POLK CO
HIGHLANDS CO
AVON PARK
Gum
Tank
AIR FORCE RANGE
LASER SURFACE DANGER ZONE
(6500 feet radius)
Bit Pit
38±
Little Lake
16 Laser Target
Submarine Lake
22 Laser Target
29 Laser Target
Tower
74
75
76
77
78
80
81
82
83
Long Hammock
C-3 ECHO RANGE

APPENDIX D

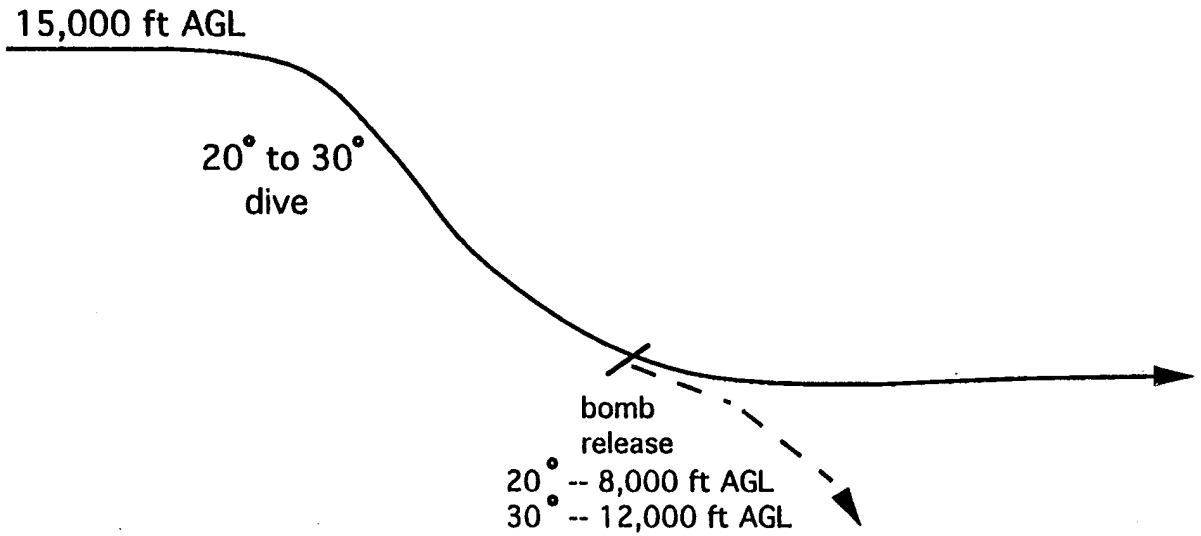
Delivery Profiles

LOFT DELIVERY PROFILE



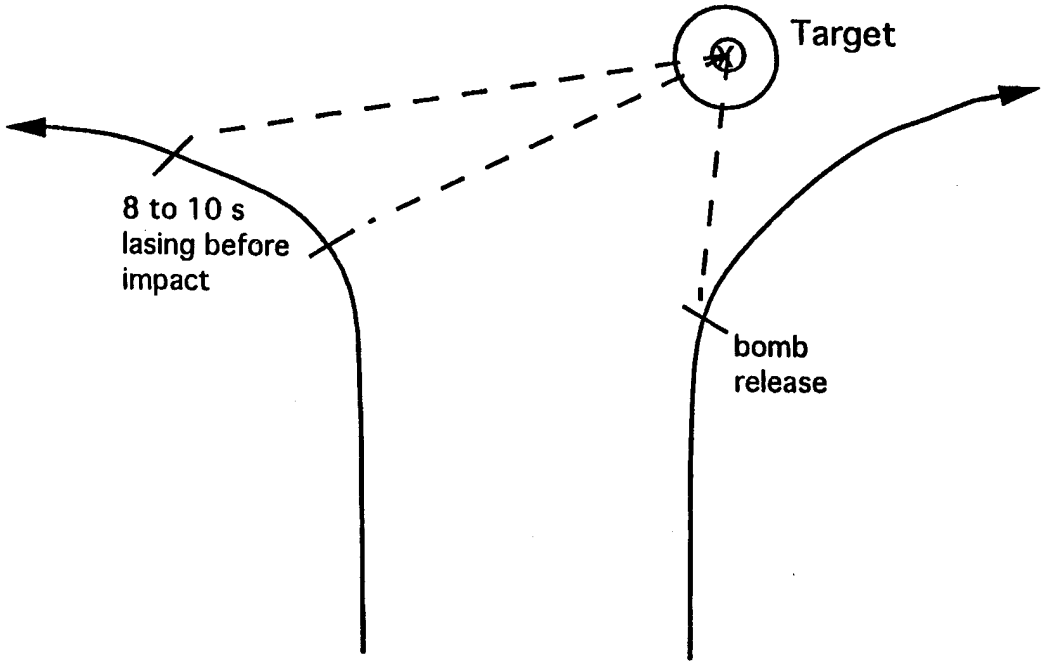
(Side View)

MEDIUM ALTITUDE PROFILE



(Side View)

"BUDDY LASE" PROFILE



(Top View)

APPENDIX E

Footprint Calculations

LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m
500	FORWARD	650 ft	1030 ft	1500 ft	2070 ft	2750 ft	3530 ft
		198 m	314 m	458 m	632 m	838 m	1080 m
	AFT	587 ft	907 ft	1290 ft	1740 ft	2240 ft	2800 ft
		179 m	276 m	393 m	529 m	683 m	855 m
1000	FORWARD	317 ft	498 ft	722 ft	989 ft	1300 ft	1660 ft
		97 m	152 m	220 m	301 m	396 m	505 m
	AFT	301 ft	467 ft	669 ft	905 ft	1170 ft	1480 ft
		92 m	142 m	204 m	276 m	358 m	451 m
1500	FORWARD	209 ft	328 ft	475 ft	649 ft	852 ft	1080 ft
		64 m	100 m	145 m	198 m	260 m	330 m
	AFT	202 ft	315 ft	452 ft	612 ft	796 ft	1000 ft
		62 m	96 m	138 m	187 m	243 m	306 m
2000	FORWARD	156 ft	245 ft	354 ft	483 ft	633 ft	804 ft
		48 m	75 m	108 m	147 m	193 m	245 m
	AFT	152 ft	237 ft	341 ft	462 ft	602 ft	760 ft
		46 m	72 m	104 m	141 m	184 m	232 m
2500	FORWARD	125 ft	195 ft	282 ft	385 ft	504 ft	640 ft
		38 m	60 m	86 m	117 m	154 m	195 m
	AFT	122 ft	191 ft	274 ft	372 ft	484 ft	611 ft
		37 m	58 m	83 m	113 m	148 m	186 m
3000	FORWARD	104 ft	162 ft	234 ft	320 ft	419 ft	531 ft
		32 m	50 m	71 m	97 m	128 m	162 m
	AFT	102 ft	159 ft	229 ft	311 ft	405 ft	511 ft
		31 m	48 m	70 m	95 m	123 m	156 m
3500	FORWARD	89 ft	139 ft	201 ft	273 ft	358 ft	454 ft
		27 m	42 m	61 m	83 m	109 m	138 m

	AFT	88 ft	137 ft	196 ft	267 ft	348 ft	439 ft
		27 m	42 m	60 m	81 m	106 m	134 m
4000	FORWARD	78 ft	121 ft	175 ft	239 ft	313 ft	396 ft
		24 m	37 m	53 m	73 m	95 m	121 m
	AFT	77 ft	120 ft	172 ft	234 ft	305 ft	385 ft
		23 m	36 m	52 m	71 m	93 m	117 m
4500	FORWARD	69 ft	108 ft	156 ft	212 ft	277 ft	352 ft
		21 m	33 m	47 m	65 m	85 m	107 m
	AFT	68 ft	106 ft	153 ft	208 ft	271 ft	343 ft
		21 m	32 m	47 m	63 m	83 m	105 m
5000	FORWARD	62 ft	97 ft	140 ft	191 ft	249 ft	316 ft
		19 m	30 m	43 m	58 m	76 m	96 m
	AFT	61 ft	96 ft	138 ft	187 ft	244 ft	309 ft
		19 m	29 m	42 m	57 m	75 m	94 m
	WIDTH	51 ft	63 ft	76 ft	89 ft	102 ft	114 ft
		15 m	19 m	23 m	27 m	31 m	35 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m
5000	FORWARD	62 ft 19 m	97 ft 30 m	140 ft 43 m	191 ft 58 m	249 ft 76 m	316 ft 96 m
	AFT	61 ft 19 m	96 ft 29 m	138 ft 42 m	187 ft 57 m	244 ft 75 m	309 ft 94 m
5500	FORWARD	56 ft 17 m	88 ft 27 m	127 ft 39 m	173 ft 53 m	227 ft 69 m	287 ft 87 m
	AFT	56 ft 17 m	87 ft 27 m	125 ft 38 m	171 ft 52 m	222 ft 68 m	281 ft 86 m
6000	FORWARD	52 ft 16 m	81 ft 25 m	116 ft 35 m	159 ft 48 m	207 ft 63 m	263 ft 80 m
	AFT	51 ft 16 m	80 ft 24 m	115 ft 35 m	156 ft 48 m	204 ft 62 m	258 ft 79 m
	WIDTH	51 ft 15 m	63 ft 19 m	76 ft 23 m	89 ft 27 m	102 ft 31 m	114 ft 35 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	3530 ft 1080 m	4420 ft 1350 m
	AFT	2800 ft 855 m	3420 ft 1040 m
1000	FORWARD	1660 ft 505 m	2060 ft 628 m
	AFT	1480 ft 451 m	1810 ft 553 m
1500	FORWARD	1080 ft 330 m	1340 ft 409 m
	AFT	1000 ft 306 m	1230 ft 376 m
2000	FORWARD	804 ft 245 m	996 ft 304 m
	AFT	760 ft 232 m	935 ft 285 m
2500	FORWARD	640 ft 195 m	792 ft 241 m
	AFT	611 ft 186 m	753 ft 229 m
3000	FORWARD	531 ft 162 m	657 ft 200 m
	AFT	511 ft 156 m	630 ft 192 m
3500	FORWARD	454 ft 138 m	561 ft 171 m

	AFT	439 ft	541 ft
		134 m	165 m
4000	FORWARD	396 ft	490 ft
		121 m	149 m
	AFT	385 ft	475 ft
		117 m	145 m
4500	FORWARD	352 ft	435 ft
		107 m	133 m
	AFT	343 ft	423 ft
		105 m	129 m
5000	FORWARD	316 ft	391 ft
		96 m	119 m
	AFT	309 ft	381 ft
		94 m	116 m
	WIDTH	114 ft	127 ft
		35 m	39 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
5000	FORWARD	316 ft 96 m	391 ft 119 m
	AFT	309 ft 94 m	381 ft 116 m
5500	FORWARD	287 ft 87 m	355 ft 108 m
	AFT	281 ft 86 m	347 ft 106 m
6000	FORWARD	263 ft 80 m	325 ft 99 m
	AFT	258 ft 79 m	318 ft 97 m
	WIDTH	114 ft 35 m	127 ft 39 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	22 ft	28 ft	35 ft	43 ft	51 ft
		-99	7 m	9 m	11 m	13 m	16 m
	AFT	-99	22 ft	28 ft	35 ft	42 ft	51 ft
		-99	7 m	8 m	11 m	13 m	16 m
9000	FORWARD	-99	19 ft	25 ft	31 ft	38 ft	45 ft
		-99	6 m	8 m	9 m	12 m	14 m
	AFT	-99	19 ft	25 ft	31 ft	38 ft	45 ft
		-99	6 m	8 m	9 m	11 m	14 m
10000	FORWARD	-99	-99	22 ft	28 ft	34 ft	41 ft
		-99	-99	7 m	9 m	10 m	12 m
	AFT	-99	-99	22 ft	28 ft	34 ft	41 ft
		-99	-99	7 m	8 m	10 m	12 m
11000	FORWARD	-99	-99	-99	25 ft	31 ft	37 ft
		-99	-99	-99	8 m	9 m	11 m
	AFT	-99	-99	-99	25 ft	31 ft	37 ft
		-99	-99	-99	8 m	9 m	11 m
12000	FORWARD	-99	-99	-99	-99	28 ft	34 ft
		-99	-99	-99	-99	9 m	10 m
	AFT	-99	-99	-99	-99	28 ft	34 ft
		-99	-99	-99	-99	9 m	10 m
13000	FORWARD	-99	-99	-99	-99	-99	31 ft
		-99	-99	-99	-99	-99	10 m
	AFT	-99	-99	-99	-99	-99	31 ft
		-99	-99	-99	-99	-99	10 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99	38 ft	43 ft	48 ft	53 ft	58 ft
		-99	12 m	13 m	15 m	16 m	18 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	101 ft 31 m	158 ft 48 m	229 ft 70 m	314 ft 96 m	412 ft 126 m	524 ft 160 m	650 ft 198 m
	AFT	97 ft 30 m	151 ft 46 m	216 ft 66 m	292 ft 89 m	380 ft 116 m	478 ft 146 m	587 ft 179 m
1000	FORWARD	50 ft 15 m	78 ft 24 m	113 ft 34 m	154 ft 47 m	202 ft 61 m	256 ft 78 m	317 ft 97 m
	AFT	49 ft 15 m	76 ft 23 m	109 ft 33 m	149 ft 45 m	194 ft 59 m	244 ft 75 m	301 ft 92 m
1500	FORWARD	33 ft 10 m	52 ft 16 m	75 ft 23 m	102 ft 31 m	133 ft 41 m	169 ft 52 m	209 ft 64 m
	AFT	33 ft 10 m	51 ft 16 m	73 ft 22 m	100 ft 30 m	130 ft 40 m	164 ft 50 m	202 ft 62 m
2000	FORWARD	25 ft 8 m	39 ft 12 m	56 ft 17 m	76 ft 23 m	100 ft 30 m	126 ft 39 m	156 ft 48 m
	AFT	25 ft 7 m	38 ft 12 m	55 ft 17 m	75 ft 23 m	98 ft 30 m	124 ft 38 m	152 ft 46 m
2500	FORWARD	20 ft 6 m	31 ft 9 m	45 ft 14 m	61 ft 19 m	80 ft 24 m	101 ft 31 m	125 ft 38 m
	AFT	20 ft 6 m	31 ft 9 m	44 ft 13 m	60 ft 18 m	78 ft 24 m	99 ft 30 m	122 ft 37 m
3000	FORWARD	17 ft 5 m	26 ft 8 m	37 ft 11 m	51 ft 15 m	66 ft 20 m	84 ft 26 m	104 ft 32 m
	AFT	16 ft 5 m	26 ft 8 m	37 ft 11 m	50 ft 15 m	65 ft 20 m	83 ft 25 m	102 ft 31 m
3500	FORWARD	14 ft 4 m	22 ft 7 m	32 ft 10 m	43 ft 13 m	57 ft 17 m	72 ft 22 m	89 ft 27 m

	AFT	14 ft	22 ft	32 ft	43 ft	56 ft	71 ft	88 ft
		4 m	7 m	10 m	13 m	17 m	22 m	27 m
4000	FORWARD	12 ft	19 ft	28 ft	38 ft	50 ft	63 ft	78 ft
		4 m	6 m	8 m	12 m	15 m	19 m	24 m
	AFT	12 ft	19 ft	28 ft	38 ft	49 ft	62 ft	77 ft
		4 m	6 m	8 m	11 m	15 m	19 m	23 m
4500	FORWARD	11 ft	17 ft	25 ft	34 ft	44 ft	56 ft	69 ft
		3 m	5 m	8 m	10 m	13 m	17 m	21 m
	AFT	11 ft	17 ft	25 ft	33 ft	44 ft	55 ft	68 ft
		3 m	5 m	8 m	10 m	13 m	17 m	21 m
5000	FORWARD	-99	15 ft	22 ft	30 ft	40 ft	50 ft	62 ft
		-99	5 m	7 m	9 m	12 m	15 m	19 m
	AFT	-99	15 ft	22 ft	30 ft	39 ft	50 ft	61 ft
		-99	5 m	7 m	9 m	12 m	15 m	19 m
	WIDTH	20 ft	25 ft	30 ft	36 ft	41 ft	46 ft	51 ft
		6 m	8 m	9 m	11 m	12 m	14 m	15 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
5500	FORWARD	-99	14 ft	20 ft	28 ft	36 ft	46 ft	56 ft
		-99	4 m	6 m	8 m	11 m	14 m	17 m
	AFT	-99	14 ft	20 ft	27 ft	36 ft	45 ft	56 ft
		-99	4 m	6 m	8 m	11 m	14 m	17 m
6000	FORWARD	-99	13 ft	19 ft	25 ft	33 ft	42 ft	52 ft
		-99	4 m	6 m	8 m	10 m	13 m	16 m
	AFT	-99	13 ft	18 ft	25 ft	33 ft	42 ft	51 ft
		-99	4 m	6 m	8 m	10 m	13 m	16 m
6500	FORWARD	-99	-99	17 ft	23 ft	30 ft	39 ft	48 ft
		-99	-99	5 m	7 m	9 m	12 m	15 m
	AFT	-99	-99	17 ft	23 ft	30 ft	38 ft	47 ft
		-99	-99	5 m	7 m	9 m	12 m	14 m
7000	FORWARD	-99	-99	16 ft	22 ft	28 ft	36 ft	44 ft
		-99	-99	5 m	7 m	9 m	11 m	13 m
	AFT	-99	-99	16 ft	22 ft	28 ft	36 ft	44 ft
		-99	-99	5 m	7 m	9 m	11 m	13 m
7500	FORWARD	-99	-99	-99	20 ft	26 ft	33 ft	41 ft
		-99	-99	-99	6 m	8 m	10 m	13 m
	AFT	-99	-99	-99	20 ft	26 ft	33 ft	41 ft
		-99	-99	-99	6 m	8 m	10 m	13 m
8000	FORWARD	-99	-99	-99	19 ft	25 ft	31 ft	39 ft
		-99	-99	-99	6 m	8 m	10 m	12 m
	AFT	-99	-99	-99	19 ft	25 ft	31 ft	38 ft
		-99	-99	-99	6 m	8 m	10 m	12 m
8500	FORWARD	-99	-99	-99	18 ft	23 ft	29 ft	36 ft
		-99	-99	-99	5 m	7 m	9 m	11 m

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	46 ft	51 ft
		-99	-99	-99	-99	-99	14 m	15 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: LANTIRN
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= .18 mrad
NOHD= 22700 meters (74456 feet or 12.3 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
10500	FORWARD	-99	-99	-99	-99	-99	24 ft	29 ft
		-99	-99	-99	-99	-99	7 m	9 m
	AFT	-99	-99	-99	-99	-99	24 ft	29 ft
		-99	-99	-99	-99	-99	7 m	9 m
11000	FORWARD	-99	-99	-99	-99	-99	-99	28 ft
		-99	-99	-99	-99	-99	-99	9 m
	AFT	-99	-99	-99	-99	-99	-99	28 ft
		-99	-99	-99	-99	-99	-99	9 m
11500	FORWARD	-99	-99	-99	-99	-99	-99	27 ft
		-99	-99	-99	-99	-99	-99	8 m
	AFT	-99	-99	-99	-99	-99	-99	27 ft
		-99	-99	-99	-99	-99	-99	8 m
12000	FORWARD	-99	-99	-99	-99	-99	-99	26 ft
		-99	-99	-99	-99	-99	-99	8 m
	AFT	-99	-99	-99	-99	-99	-99	26 ft
		-99	-99	-99	-99	-99	-99	8 m
12500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	46 ft	51 ft
		-99	-99	-99	-99	-99	14 m	15 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: LANTIRN
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Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
15500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
20000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	921 ft 281 m	1470 ft 447 m	2150 ft 657 m	2990 ft 912 m	3990 ft 1220 m	5150 ft 1570 m	6500 ft 1980 m
	AFT	800 ft 244 m	1230 ft 375 m	1740 ft 531 m	2340 ft 712 m	3000 ft 915 m	3740 ft 1140 m	4550 ft 1390 m
1000	FORWARD	444 ft 135 m	700 ft 213 m	1020 ft 310 m	1400 ft 426 m	1840 ft 562 m	2350 ft 718 m	2940 ft 895 m
	AFT	414 ft 126 m	641 ft 195 m	915 ft 279 m	1240 ft 377 m	1600 ft 488 m	2010 ft 612 m	2460 ft 750 m
1500	FORWARD	292 ft 89 m	460 ft 140 m	666 ft 203 m	912 ft 278 m	1200 ft 365 m	1530 ft 465 m	1900 ft 578 m
	AFT	279 ft 85 m	433 ft 132 m	621 ft 189 m	840 ft 256 m	1090 ft 332 m	1370 ft 418 m	1690 ft 514 m
2000	FORWARD	218 ft 66 m	342 ft 104 m	495 ft 151 m	677 ft 206 m	888 ft 271 m	1130 ft 344 m	1400 ft 427 m
	AFT	210 ft 64 m	327 ft 100 m	469 ft 143 m	636 ft 194 m	827 ft 252 m	1040 ft 318 m	1280 ft 391 m
2500	FORWARD	174 ft 53 m	272 ft 83 m	394 ft 120 m	538 ft 164 m	705 ft 215 m	896 ft 273 m	1110 ft 338 m
	AFT	169 ft 52 m	263 ft 80 m	378 ft 115 m	512 ft 156 m	667 ft 203 m	841 ft 256 m	1030 ft 315 m
3000	FORWARD	144 ft 44 m	226 ft 69 m	327 ft 100 m	446 ft 136 m	585 ft 178 m	742 ft 226 m	919 ft 280 m
	AFT	141 ft 43 m	220 ft 67 m	316 ft 96 m	428 ft 131 m	558 ft 170 m	704 ft 215 m	867 ft 264 m
3500	FORWARD	124 ft 38 m	194 ft 59 m	279 ft 85 m	381 ft 116 m	499 ft 152 m	634 ft 193 m	784 ft 239 m

	AFT	121 ft 37 m	189 ft 58 m	271 ft 83 m	368 ft 112 m	480 ft 146 m	606 ft 185 m	746 ft 227 m
4000	FORWARD	108 ft 33 m	169 ft 52 m	244 ft 74 m	333 ft 101 m	436 ft 133 m	553 ft 169 m	684 ft 209 m
	AFT	106 ft 32 m	166 ft 50 m	238 ft 72 m	323 ft 98 m	421 ft 128 m	532 ft 162 m	655 ft 200 m
4500	FORWARD	96 ft 29 m	150 ft 46 m	217 ft 66 m	295 ft 90 m	387 ft 118 m	490 ft 149 m	607 ft 185 m
	AFT	94 ft 29 m	147 ft 45 m	212 ft 65 m	288 ft 88 m	375 ft 114 m	474 ft 144 m	584 ft 178 m
5000	FORWARD	86 ft 26 m	135 ft 41 m	195 ft 59 m	265 ft 81 m	347 ft 106 m	440 ft 134 m	545 ft 166 m
	AFT	85 ft 26 m	133 ft 40 m	191 ft 58 m	259 ft 79 m	338 ft 103 m	427 ft 130 m	526 ft 160 m
	WIDTH	70 ft 21 m	88 ft 27 m	106 ft 32 m	123 ft 38 m	141 ft 43 m	159 ft 48 m	176 ft 54 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
5000	FORWARD	86 ft 26 m	135 ft 41 m	195 ft 59 m	265 ft 81 m	347 ft 106 m	440 ft 134 m	545 ft 166 m
	AFT	85 ft 26 m	133 ft 40 m	191 ft 58 m	259 ft 79 m	338 ft 103 m	427 ft 130 m	526 ft 160 m
5500	FORWARD	78 ft 24 m	123 ft 37 m	177 ft 54 m	241 ft 73 m	315 ft 96 m	400 ft 122 m	494 ft 151 m
	AFT	77 ft 24 m	121 ft 37 m	174 ft 53 m	236 ft 72 m	308 ft 94 m	389 ft 118 m	479 ft 146 m
6000	FORWARD	72 ft 22 m	112 ft 34 m	162 ft 49 m	221 ft 67 m	289 ft 88 m	366 ft 112 m	453 ft 138 m
	AFT	71 ft 22 m	111 ft 34 m	159 ft 49 m	216 ft 66 m	282 ft 86 m	357 ft 109 m	440 ft 134 m
	WIDTH	70 ft 21 m	88 ft 27 m	106 ft 32 m	123 ft 38 m	141 ft 43 m	159 ft 48 m	176 ft 54 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)					
		1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	30 ft	39 ft	48 ft	59 ft	71 ft
		-99	9 m	12 m	15 m	18 m	22 m
	AFT	-99	30 ft	39 ft	48 ft	59 ft	71 ft
		-99	9 m	12 m	15 m	18 m	21 m
9000	FORWARD	-99	27 ft	34 ft	43 ft	53 ft	63 ft
		-99	8 m	10 m	13 m	16 m	19 m
	AFT	-99	27 ft	34 ft	43 ft	52 ft	63 ft
		-99	8 m	10 m	13 m	16 m	19 m
10000	FORWARD	-99	-99	31 ft	39 ft	47 ft	57 ft
		-99	-99	9 m	12 m	14 m	17 m
	AFT	-99	-99	31 ft	39 ft	47 ft	56 ft
		-99	-99	9 m	12 m	14 m	17 m
11000	FORWARD	-99	-99	-99	35 ft	43 ft	52 ft
		-99	-99	-99	11 m	13 m	16 m
	AFT	-99	-99	-99	35 ft	43 ft	51 ft
		-99	-99	-99	11 m	13 m	16 m
12000	FORWARD	-99	-99	-99	-99	39 ft	47 ft
		-99	-99	-99	-99	12 m	14 m
	AFT	-99	-99	-99	-99	39 ft	47 ft
		-99	-99	-99	-99	12 m	14 m
13000	FORWARD	-99	-99	-99	-99	-99	44 ft
		-99	-99	-99	-99	-99	13 m
	AFT	-99	-99	-99	-99	-99	44 ft
		-99	-99	-99	-99	-99	13 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99					
		-99	53 ft 16 m	60 ft 18 m	67 ft 20 m	74 ft 23 m	81 ft 25 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	141 ft	222 ft	322 ft	441 ft	581 ft	741 ft	921 ft
		43 m	68 m	98 m	135 m	177 m	226 m	281 m
	AFT	133 ft	207 ft	296 ft	400 ft	519 ft	652 ft	800 ft
		41 m	63 m	90 m	122 m	158 m	199 m	244 m
1000	FORWARD	69 ft	109 ft	157 ft	215 ft	282 ft	358 ft	444 ft
		21 m	33 m	48 m	66 m	86 m	109 m	135 m
	AFT	68 ft	105 ft	151 ft	205 ft	267 ft	336 ft	414 ft
		21 m	32 m	46 m	62 m	81 m	102 m	126 m
1500	FORWARD	46 ft	72 ft	104 ft	142 ft	186 ft	236 ft	292 ft
		14 m	22 m	32 m	43 m	57 m	72 m	89 m
	AFT	45 ft	71 ft	101 ft	138 ft	179 ft	227 ft	279 ft
		14 m	22 m	31 m	42 m	55 m	69 m	85 m
2000	FORWARD	34 ft	54 ft	78 ft	106 ft	139 ft	176 ft	218 ft
		11 m	16 m	24 m	32 m	42 m	54 m	66 m
	AFT	34 ft	53 ft	76 ft	104 ft	135 ft	171 ft	210 ft
		10 m	16 m	23 m	32 m	41 m	52 m	64 m
2500	FORWARD	28 ft	43 ft	62 ft	85 ft	111 ft	140 ft	174 ft
		8 m	13 m	19 m	26 m	34 m	43 m	53 m
	AFT	27 ft	43 ft	61 ft	83 ft	108 ft	137 ft	169 ft
		8 m	13 m	19 m	25 m	33 m	42 m	52 m
3000	FORWARD	23 ft	36 ft	52 ft	70 ft	92 ft	117 ft	144 ft
		7 m	11 m	16 m	21 m	28 m	36 m	44 m
	AFT	23 ft	36 ft	51 ft	69 ft	91 ft	114 ft	141 ft
		7 m	11 m	16 m	21 m	28 m	35 m	43 m
3500	FORWARD	20 ft	31 ft	44 ft	60 ft	79 ft	100 ft	124 ft
		6 m	9 m	13 m	18 m	24 m	30 m	38 m

	AFT	20 ft 6 m	30 ft 9 m	44 ft 13 m	60 ft 18 m	78 ft 24 m	98 ft 30 m	121 ft 37 m
4000	FORWARD	17 ft 5 m	27 ft 8 m	39 ft 12 m	53 ft 16 m	69 ft 21 m	87 ft 27 m	108 ft 33 m
	AFT	17 ft 5 m	27 ft 8 m	38 ft 12 m	52 ft 16 m	68 ft 21 m	86 ft 26 m	106 ft 32 m
4500	FORWARD	15 ft 5 m	24 ft 7 m	34 ft 10 m	47 ft 14 m	61 ft 19 m	78 ft 24 m	96 ft 29 m
	AFT	15 ft 5 m	24 ft 7 m	34 ft 10 m	46 ft 14 m	61 ft 18 m	77 ft 23 m	94 ft 29 m
5000	FORWARD	-99 -99	21 ft 7 m	31 ft 9 m	42 ft 13 m	55 ft 17 m	70 ft 21 m	86 ft 26 m
	AFT	-99 -99	21 ft 7 m	31 ft 9 m	42 ft 13 m	55 ft 17 m	69 ft 21 m	85 ft 26 m
	WIDTH	28 ft 9 m	35 ft 11 m	42 ft 13 m	49 ft 15 m	56 ft 17 m	63 ft 19 m	70 ft 21 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
5500	FORWARD	-99	19 ft	28 ft	38 ft	50 ft	63 ft	78 ft
		-99	6 m	9 m	12 m	15 m	19 m	24 m
	AFT	-99	19 ft	28 ft	38 ft	50 ft	63 ft	77 ft
		-99	6 m	9 m	12 m	15 m	19 m	24 m
6000	FORWARD	-99	18 ft	26 ft	35 ft	46 ft	58 ft	72 ft
		-99	5 m	8 m	11 m	14 m	18 m	22 m
	AFT	-99	18 ft	26 ft	35 ft	46 ft	58 ft	71 ft
		-99	5 m	8 m	11 m	14 m	18 m	22 m
6500	FORWARD	-99	-99	24 ft	32 ft	42 ft	54 ft	66 ft
		-99	-99	7 m	10 m	13 m	16 m	20 m
	AFT	-99	-99	24 ft	32 ft	42 ft	53 ft	66 ft
		-99	-99	7 m	10 m	13 m	16 m	20 m
7000	FORWARD	-99	-99	22 ft	30 ft	39 ft	50 ft	61 ft
		-99	-99	7 m	9 m	12 m	15 m	19 m
	AFT	-99	-99	22 ft	30 ft	39 ft	49 ft	61 ft
		-99	-99	7 m	9 m	12 m	15 m	19 m
7500	FORWARD	-99	-99	-99	28 ft	37 ft	46 ft	57 ft
		-99	-99	-99	9 m	11 m	14 m	17 m
	AFT	-99	-99	-99	28 ft	36 ft	46 ft	57 ft
		-99	-99	-99	9 m	11 m	14 m	17 m
8000	FORWARD	-99	-99	-99	26 ft	34 ft	43 ft	54 ft
		-99	-99	-99	8 m	10 m	13 m	16 m
	AFT	-99	-99	-99	26 ft	34 ft	43 ft	53 ft
		-99	-99	-99	8 m	10 m	13 m	16 m
8500	FORWARD	-99	-99	-99	25 ft	32 ft	41 ft	51 ft
		-99	-99	-99	8 m	10 m	12 m	15 m

	AFT	-99	-99	-99	25 ft	32 ft	41 ft	'50 ft
		-99	-99	-99	8 m	10 m	12 m	15 m
9000	FORWARD	-99	-99	-99	-99	30 ft	39 ft	48 ft
		-99	-99	-99	-99	9 m	12 m	15 m
	AFT	-99	-99	-99	-99	30 ft	38 ft	47 ft
		-99	-99	-99	-99	9 m	12 m	14 m
9500	FORWARD	-99	-99	-99	-99	29 ft	37 ft	45 ft
		-99	-99	-99	-99	9 m	11 m	14 m
	AFT	-99	-99	-99	-99	29 ft	36 ft	45 ft
		-99	-99	-99	-99	9 m	11 m	14 m
10000	FORWARD	-99	-99	-99	-99	-99	35 ft	43 ft
		-99	-99	-99	-99	-99	11 m	13 m
	AFT	-99	-99	-99	-99	-99	35 ft	43 ft
		-99	-99	-99	-99	-99	11 m	13 m
	WIDTH	-99	35 ft	42 ft	49 ft	56 ft	63 ft	70 ft
		-99	11 m	13 m	15 m	17 m	19 m	21 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
10500	FORWARD	-99	-99	-99	-99	-99	33 ft	41 ft
		-99	-99	-99	-99	-99	10 m	12 m
	AFT	-99	-99	-99	-99	-99	33 ft	41 ft
		-99	-99	-99	-99	-99	10 m	12 m
11000	FORWARD	-99	-99	-99	-99	-99	-99	39 ft
		-99	-99	-99	-99	-99	-99	12 m
	AFT	-99	-99	-99	-99	-99	-99	39 ft
		-99	-99	-99	-99	-99	-99	12 m
11500	FORWARD	-99	-99	-99	-99	-99	-99	37 ft
		-99	-99	-99	-99	-99	-99	11 m
	AFT	-99	-99	-99	-99	-99	-99	37 ft
		-99	-99	-99	-99	-99	-99	11 m
12000	FORWARD	-99	-99	-99	-99	-99	-99	36 ft
		-99	-99	-99	-99	-99	-99	11 m
	AFT	-99	-99	-99	-99	-99	-99	36 ft
		-99	-99	-99	-99	-99	-99	11 m
12500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	63 ft	70 ft
		-99	-99	-99	-99	-99	19 m	21 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE TACK
Table based on: Flat terrain, Buffer= 2 mrad, Divergence= 1.8 mrad
NOHD= 26600 meters (87248 feet or 14.4 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
15500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
20000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	845 ft	1340 ft	1970 ft	2730 ft	3630 ft	4680 ft	3730 ft
		258 m	410 m	600 m	832 m	1110 m	1430 m	1140 m
	AFT	742 ft	1140 ft	1620 ft	2170 ft	2800 ft	3490 ft	4250 ft
		226 m	348 m	494 m	662 m	852 m	1060 m	1290 m
1000	FORWARD	408 ft	643 ft	934 ft	1280 ft	1690 ft	2160 ft	2690 ft
		124 m	196 m	285 m	391 m	515 m	658 m	819 m
	AFT	383 ft	593 ft	848 ft	1140 ft	1480 ft	1860 ft	2280 ft
		117 m	181 m	258 m	349 m	452 m	568 m	696 m
1500	FORWARD	269 ft	423 ft	612 ft	838 ft	1100 ft	1400 ft	1740 ft
		82 m	129 m	187 m	255 m	336 m	427 m	530 m
	AFT	258 ft	401 ft	574 ft	777 ft	1010 ft	1270 ft	1560 ft
		79 m	122 m	175 m	237 m	308 m	388 m	476 m
2000	FORWARD	201 ft	315 ft	455 ft	623 ft	817 ft	1040 ft	1290 ft
		61 m	96 m	139 m	190 m	249 m	316 m	392 m
	AFT	194 ft	303 ft	434 ft	588 ft	765 ft	965 ft	1190 ft
		59 m	92 m	132 m	179 m	233 m	294 m	362 m
2500	FORWARD	160 ft	251 ft	363 ft	495 ft	649 ft	824 ft	1020 ft
		49 m	76 m	111 m	151 m	198 m	251 m	311 m
	AFT	156 ft	243 ft	349 ft	473 ft	616 ft	777 ft	957 ft
		48 m	74 m	106 m	144 m	188 m	237 m	292 m
3000	FORWARD	133 ft	209 ft	301 ft	411 ft	538 ft	683 ft	846 ft
		41 m	64 m	92 m	125 m	164 m	208 m	258 m
	AFT	130 ft	203 ft	292 ft	396 ft	516 ft	651 ft	801 ft
		40 m	62 m	89 m	121 m	157 m	198 m	244 m
3500	FORWARD	114 ft	178 ft	257 ft	351 ft	460 ft	583 ft	722 ft
		35 m	54 m	78 m	107 m	140 m	178 m	220 m

	AFT	112 ft 34 m	174 ft 53 m	251 ft 76 m	340 ft 104 m	443 ft 135 m	560 ft 171 m	690 ft 210 m
4000	FORWARD	100 ft 30 m	156 ft 47 m	225 ft 69 m	307 ft 93 m	401 ft 122 m	509 ft 155 m	630 ft 192 m
	AFT	98 ft 30 m	153 ft 47 m	220 ft 67 m	298 ft 91 m	389 ft 119 m	491 ft 150 m	605 ft 184 m
4500	FORWARD	88 ft 27 m	138 ft 42 m	200 ft 61 m	272 ft 83 m	356 ft 109 m	452 ft 138 m	559 ft 170 m
	AFT	87 ft 27 m	136 ft 41 m	195 ft 60 m	266 ft 81 m	346 ft 106 m	437 ft 133 m	539 ft 164 m
5000	FORWARD	79 ft 24 m	124 ft 38 m	179 ft 55 m	245 ft 75 m	320 ft 98 m	406 ft 124 m	502 ft 153 m
	AFT	79 ft 24 m	123 ft 37 m	176 ft 54 m	239 ft 73 m	312 ft 95 m	394 ft 120 m	486 ft 148 m
	WIDTH	65 ft 20 m	81 ft 25 m	98 ft 30 m	114 ft 35 m	130 ft 40 m	146 ft 45 m	163 ft 50 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
5000	FORWARD	79 ft	124 ft	179 ft	245 ft	320 ft	406 ft	502 ft
		24 m	38 m	55 m	75 m	98 m	124 m	153 m
	AFT	79 ft	123 ft	176 ft	239 ft	312 ft	394 ft	486 ft
		24 m	37 m	54 m	73 m	95 m	120 m	148 m
5500	FORWARD	72 ft	113 ft	163 ft	222 ft	291 ft	368 ft	456 ft
		22 m	34 m	50 m	68 m	89 m	112 m	139 m
	AFT	71 ft	111 ft	160 ft	218 ft	284 ft	359 ft	442 ft
		22 m	34 m	49 m	66 m	87 m	109 m	135 m
6000	FORWARD	66 ft	104 ft	149 ft	203 ft	266 ft	337 ft	417 ft
		20 m	32 m	46 m	62 m	81 m	103 m	127 m
	AFT	66 ft	102 ft	147 ft	200 ft	261 ft	329 ft	406 ft
		20 m	31 m	45 m	61 m	79 m	100 m	124 m
	WIDTH	65 ft	81 ft	98 ft	114 ft	130 ft	146 ft	.163 ft
		20 m	25 m	30 m	35 m	40 m	45 m	50 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	28 ft	36 ft	45 ft	55 ft	66 ft
		-99	8 m	11 m	14 m	17 m	20 m
	AFT	-99	28 ft	36 ft	44 ft	54 ft	65 ft
		-99	8 m	11 m	14 m	17 m	20 m
9000	FORWARD	-99	25 ft	32 ft	40 ft	49 ft	58 ft
		-99	8 m	10 m	12 m	15 m	18 m
	AFT	-99	25 ft	32 ft	40 ft	48 ft	58 ft
		-99	8 m	10 m	12 m	15 m	18 m
10000	FORWARD	-99	-99	29 ft	36 ft	44 ft	52 ft
		-99	-99	9 m	11 m	13 m	16 m
	AFT	-99	-99	29 ft	36 ft	43 ft	52 ft
		-99	-99	9 m	11 m	13 m	16 m
11000	FORWARD	-99	-99	-99	32 ft	40 ft	48 ft
		-99	-99	-99	10 m	12 m	15 m
	AFT	-99	-99	-99	32 ft	40 ft	47 ft
		-99	-99	-99	10 m	12 m	14 m
12000	FORWARD	-99	-99	-99	-99	36 ft	44 ft
		-99	-99	-99	-99	11 m	13 m
	AFT	-99	-99	-99	-99	36 ft	43 ft
		-99	-99	-99	-99	11 m	13 m
13000	FORWARD	-99	-99	-99	-99	-99	40 ft
		-99	-99	-99	-99	-99	12 m
	AFT	-99	-99	-99	-99	-99	40 ft
		-99	-99	-99	-99	-99	12 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99	49 ft	55 ft	62 ft	68 ft	75 ft
		-99	15 m	17 m	19 m	21 m	23 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	130 ft	204 ft	296 ft	406 ft	533 ft	680 ft	845 ft
		40 m	62 m	90 m	124 m	163 m	207 m	258 m
	AFT	123 ft	191 ft	274 ft	370 ft	481 ft	605 ft	742 ft
		38 m	58 m	83 m	113 m	147 m	184 m	226 m
1000	FORWARD	64 ft	100 ft	145 ft	198 ft	260 ft	330 ft	408 ft
		20 m	31 m	44 m	60 m	79 m	100 m	124 m
	AFT	62 ft	97 ft	140 ft	189 ft	246 ft	311 ft	383 ft
		19 m	30 m	43 m	58 m	75 m	95 m	117 m
1500	FORWARD	42 ft	67 ft	96 ft	131 ft	171 ft	218 ft	269 ft
		13 m	20 m	29 m	40 m	52 m	66 m	82 m
	AFT	42 ft	65 ft	94 ft	127 ft	166 ft	209 ft	258 ft
		13 m	20 m	29 m	39 m	51 m	64 m	79 m
2000	FORWARD	32 ft	50 ft	72 ft	98 ft	128 ft	162 ft	201 ft
		10 m	15 m	22 m	30 m	39 m	49 m	61 m
	AFT	31 ft	49 ft	70 ft	96 ft	125 ft	158 ft	194 ft
		10 m	15 m	21 m	29 m	38 m	48 m	59 m
2500	FORWARD	25 ft	40 ft	57 ft	78 ft	102 ft	129 ft	160 ft
		8 m	12 m	17 m	24 m	31 m	39 m	49 m
	AFT	25 ft	39 ft	56 ft	77 ft	100 ft	127 ft	156 ft
		8 m	12 m	17 m	23 m	31 m	39 m	48 m
3000	FORWARD	21 ft	33 ft	48 ft	65 ft	85 ft	108 ft	133 ft
		6 m	10 m	15 m	20 m	26 m	33 m	41 m
	AFT	21 ft	33 ft	47 ft	64 ft	84 ft	106 ft	130 ft
		6 m	10 m	14 m	20 m	25 m	32 m	40 m
3500	FORWARD	18 ft	28 ft	41 ft	56 ft	73 ft	92 ft	114 ft
		6 m	9 m	12 m	17 m	22 m	28 m	35 m

	AFT	18 ft	28 ft	40 ft	55 ft	72 ft	91 ft	112 ft
		5 m	9 m	12 m	17 m	22 m	28 m	34 m
4000	FORWARD	16 ft	25 ft	36 ft	49 ft	64 ft	81 ft	100 ft
		5 m	8 m	11 m	15 m	19 m	25 m	30 m
	AFT	16 ft	25 ft	35 ft	48 ft	63 ft	79 ft	98 ft
		5 m	8 m	11 m	15 m	19 m	24 m	30 m
4500	FORWARD	14 ft	22 ft	32 ft	43 ft	56 ft	72 ft	88 ft
		4 m	7 m	10 m	13 m	17 m	22 m	27 m
	AFT	14 ft	22 ft	31 ft	43 ft	56 ft	71 ft	87 ft
		4 m	7 m	10 m	13 m	17 m	22 m	27 m
5000	FORWARD	-99	20 ft	29 ft	39 ft	51 ft	64 ft	79 ft
		-99	6 m	9 m	12 m	15 m	20 m	24 m
	AFT	-99	20 ft	28 ft	39 ft	50 ft	64 ft	79 ft
		-99	6 m	9 m	12 m	15 m	19 m	24 m
	WIDTH	26 ft	33 ft	39 ft	46 ft	52 ft	59 ft	65 ft
		8 m	10 m	12 m	14 m	16 m	18 m	20 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters)						
		0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
5500	FORWARD	-99	18 ft	26 ft	35 ft	46 ft	58 ft	72 ft
		-99	5 m	8 m	11 m	14 m	18 m	22 m
	AFT	-99	18 ft	26 ft	35 ft	46 ft	58 ft	71 ft
		-99	5 m	8 m	11 m	14 m	18 m	22 m
6000	FORWARD	-99	16 ft	24 ft	32 ft	42 ft	54 ft	66 ft
		-99	5 m	7 m	10 m	13 m	16 m	20 m
	AFT	-99	16 ft	24 ft	32 ft	42 ft	53 ft	66 ft
		-99	5 m	7 m	10 m	13 m	16 m	20 m
6500	FORWARD	-99	-99	22 ft	30 ft	39 ft	49 ft	61 ft
		-99	-99	7 m	9 m	12 m	15 m	19 m
	AFT	-99	-99	22 ft	30 ft	39 ft	49 ft	61 ft
		-99	-99	7 m	9 m	12 m	15 m	18 m
7000	FORWARD	-99	-99	20 ft	28 ft	36 ft	46 ft	57 ft
		-99	-99	6 m	8 m	11 m	14 m	17 m
	AFT	-99	-99	20 ft	28 ft	36 ft	46 ft	56 ft
		-99	-99	6 m	8 m	11 m	14 m	17 m
7500	FORWARD	-99	-99	-99	26 ft	34 ft	43 ft	53 ft
		-99	-99	-99	8 m	10 m	13 m	16 m
	AFT	-99	-99	-99	26 ft	34 ft	43 ft	52 ft
		-99	-99	-99	8 m	10 m	13 m	16 m
8000	FORWARD	-99	-99	-99	24 ft	32 ft	40 ft	50 ft
		-99	-99	-99	7 m	10 m	12 m	15 m
	AFT	-99	-99	-99	24 ft	32 ft	40 ft	49 ft
		-99	-99	-99	7 m	10 m	12 m	15 m
8500	FORWARD	-99	-99	-99	23 ft	30 ft	38 ft	47 ft
		-99	-99	-99	7 m	9 m	11 m	14 m

	AFT	-99	-99	-99	23 ft	30 ft	38 ft	46 ft
		-99	-99	-99	7 m	9 m	11 m	14 m
9000	FORWARD	-99	-99	-99	-99	28 ft	36 ft	44 ft
		-99	-99	-99	-99	9 m	11 m	13 m
	AFT	-99	-99	-99	-99	28 ft	35 ft	44 ft
		-99	-99	-99	-99	9 m	11 m	13 m
9500	FORWARD	-99	-99	-99	-99	27 ft	34 ft	42 ft
		-99	-99	-99	-99	8 m	10 m	13 m
	AFT	-99	-99	-99	-99	27 ft	34 ft	41 ft
		-99	-99	-99	-99	8 m	10 m	13 m
10000	FORWARD	-99	-99	-99	-99	-99	32 ft	40 ft
		-99	-99	-99	-99	-99	10 m	12 m
	AFT	-99	-99	-99	-99	-99	32 ft	39 ft
		-99	-99	-99	-99	-99	10 m	12 m
	WIDTH	-99	33 ft	39 ft	46 ft	52 ft	59 ft	65 ft
		-99	10 m	12 m	14 m	16 m	18 m	20 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
10500	FORWARD	-99	-99	-99	-99	-99	30 ft	38 ft
		-99	-99	-99	-99	-99	9 m	11 m
	AFT	-99	-99	-99	-99	-99	30 ft	38 ft
		-99	-99	-99	-99	-99	9 m	11 m
11000	FORWARD	-99	-99	-99	-99	-99	-99	36 ft
		-99	-99	-99	-99	-99	-99	11 m
	AFT	-99	-99	-99	-99	-99	-99	36 ft
		-99	-99	-99	-99	-99	-99	11 m
11500	FORWARD	-99	-99	-99	-99	-99	-99	34 ft
		-99	-99	-99	-99	-99	-99	10 m
	AFT	-99	-99	-99	-99	-99	-99	34 ft
		-99	-99	-99	-99	-99	-99	10 m
12000	FORWARD	-99	-99	-99	-99	-99	-99	33 ft
		-99	-99	-99	-99	-99	-99	10 m
	AFT	-99	-99	-99	-99	-99	-99	33 ft
		-99	-99	-99	-99	-99	-99	10 m
12500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
13500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
14500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	59 ft	65 ft
		-99	-99	-99	-99	-99	18 m	20 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: PAVE SPIKE
Table based on: Flat terrain, Buffer= 2.5 mrad, Divergence= .35 mrad
NOHD= 10400 meters (34112 feet or 5.6 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
15500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
16500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
17500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
18500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
19500	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
20000	FORWARD	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99
	WIDTH	-99	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99	-99

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: F18 LASER
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 17000 meters (55760 feet or 9.2 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	1700 ft 518 m	2750 ft 839 m	4110 ft 1250 m	5820 ft 1770 m	7910 ft 2410 m	10400 ft 3180 m	13400 ft 4100 m
	AFT	1330 ft 405 m	2020 ft 616 m	2830 ft 864 m	3760 ft 1150 m	4790 ft 1460 m	5920 ft 1800 m	7130 ft 2170 m
1000	FORWARD	794 ft 242 m	1260 ft 385 m	1850 ft 563 m	2560 ft 780 m	3400 ft 1040 m	4380 ft 1330 m	5510 ft 1680 m
	AFT	703 ft 214 m	1080 ft 330 m	1540 ft 468 m	2060 ft 629 m	2660 ft 810 m	3320 ft 1010 m	4040 ft 1230 m
1500	FORWARD	518 ft 158 m	819 ft 249 m	1190 ft 363 m	1640 ft 500 m	2170 ft 660 m	2770 ft 845 m	3460 ft 1050 m
	AFT	478 ft 146 m	739 ft 225 m	1050 ft 321 m	1420 ft 433 m	1840 ft 560 m	2310 ft 703 m	2820 ft 859 m
2000	FORWARD	385 ft 117 m	606 ft 185 m	879 ft 268 m	1210 ft 368 m	1590 ft 484 m	2030 ft 618 m	2520 ft 769 m
	AFT	362 ft 110 m	561 ft 171 m	802 ft 245 m	1080 ft 330 m	1410 ft 428 m	1770 ft 538 m	2160 ft 660 m
2500	FORWARD	306 ft 93 m	481 ft 147 m	697 ft 212 m	954 ft 291 m	1250 ft 382 m	1600 ft 487 m	1990 ft 605 m
	AFT	291 ft 89 m	452 ft 138 m	648 ft 197 m	876 ft 267 m	1140 ft 347 m	1430 ft 436 m	1760 ft 536 m
3000	FORWARD	254 ft 77 m	398 ft 121 m	577 ft 176 m	789 ft 241 m	1040 ft 316 m	1320 ft 402 m	1640 ft 499 m
	AFT	244 ft 74 m	379 ft 115 m	543 ft 165 m	735 ft 224 m	956 ft 291 m	1200 ft 367 m	1480 ft 451 m
3500	FORWARD	217 ft 66 m	340 ft 104 m	492 ft 150 m	673 ft 205 m	883 ft 269 m	1120 ft 342 m	1390 ft 424 m

	AFT	210 ft 64 m	326 ft 99 m	467 ft 142 m	633 ft 193 m	824 ft 251 m	1040 ft 316 m	1280 ft 389 m
4000	FORWARD	189 ft 58 m	297 ft 90 m	429 ft 131 m	586 ft 179 m	769 ft 234 m	977 ft 298 m	1210 ft 369 m
	AFT	184 ft 56 m	286 ft 87 m	410 ft 125 m	556 ft 170 m	724 ft 221 m	913 ft 278 m	1120 ft 342 m
4500	FORWARD	168 ft 51 m	263 ft 80 m	380 ft 116 m	520 ft 158 m	681 ft 208 m	865 ft 264 m	1070 ft 327 m
	AFT	164 ft 50 m	255 ft 78 m	366 ft 111 m	496 ft 151 m	646 ft 197 m	814 ft 248 m	1000 ft 305 m
5000	FORWARD	151 ft 46 m	236 ft 72 m	342 ft 104 m	467 ft 142 m	611 ft 186 m	776 ft 237 m	961 ft 293 m
	AFT	148 ft 45 m	230 ft 70 m	330 ft 101 m	447 ft 136 m	583 ft 178 m	735 ft 224 m	905 ft 276 m
	WIDTH	123 ft 37 m	153 ft 47 m	184 ft 56 m	215 ft 65 m	245 ft 75 m	276 ft 84 m	307 ft 94 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: F18 LASER
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 17000 meters (55760 feet or 9.2 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	53 ft	68 ft	85 ft	103 ft	124 ft
		-99	16 m	21 m	26 m	32 m	38 m
	AFT	-99	52 ft	67 ft	84 ft	102 ft	122 ft
		-99	16 m	20 m	26 m	31 m	37 m
9000	FORWARD	-99	47 ft	60 ft	75 ft	93 ft	110 ft
		-99	14 m	18 m	23 m	28 m	34 m
	AFT	-99	47 ft	60 ft	74 ft	91 ft	109 ft
		-99	14 m	18 m	23 m	28 m	33 m
10000	FORWARD	-99	-99	54 ft	68 ft	83 ft	99 ft
		-99	-99	16 m	21 m	25 m	30 m
	AFT	-99	-99	54 ft	67 ft	82 ft	98 ft
		-99	-99	16 m	20 m	25 m	30 m
11000	FORWARD	-99	-99	-99	61 ft	75 ft	90 ft
		-99	-99	-99	19 m	23 m	27 m
	AFT	-99	-99	-99	61 ft	75 ft	89 ft
		-99	-99	-99	19 m	23 m	27 m
12000	FORWARD	-99	-99	-99	-99	69 ft	82 ft
		-99	-99	-99	-99	21 m	25 m
	AFT	-99	-99	-99	-99	68 ft	82 ft
		-99	-99	-99	-99	21 m	25 m
13000	FORWARD	-99	-99	-99	-99	-99	76 ft
		-99	-99	-99	-99	-99	23 m
	AFT	-99	-99	-99	-99	-99	76 ft
		-99	-99	-99	-99	-99	23 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99	92 ft	104 ft	117 ft	129 ft	141 ft
		-99	28 m	32 m	36 m	39 m	43 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: F18 LASER
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 17000 meters (55760 feet or 9.2 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	251 ft 76 m	397 ft 121 m	580 ft 177 m	799 ft 244 m	1060 ft 323 m	1360 ft 414 m	1700 ft 518 m
	AFT	228 ft 69 m	351 ft 107 m	500 ft 152 m	673 ft 205 m	869 ft 265 m	1090 ft 332 m	1330 ft 405 m
1000	FORWARD	122 ft 37 m	192 ft 59 m	279 ft 85 m	382 ft 116 m	502 ft 153 m	639 ft 195 m	794 ft 242 m
	AFT	117 ft 36 m	181 ft 55 m	259 ft 79 m	350 ft 107 m	455 ft 139 m	573 ft 175 m	703 ft 214 m
1500	FORWARD	81 ft 25 m	127 ft 39 m	183 ft 56 m	251 ft 76 m	329 ft 100 m	418 ft 127 m	518 ft 158 m
	AFT	78 ft 24 m	122 ft 37 m	175 ft 53 m	237 ft 72 m	308 ft 94 m	389 ft 118 m	478 ft 146 m
2000	FORWARD	60 ft 18 m	95 ft 29 m	137 ft 42 m	187 ft 57 m	245 ft 75 m	310 ft 95 m	385 ft 117 m
	AFT	59 ft 18 m	92 ft 28 m	132 ft 40 m	179 ft 55 m	233 ft 71 m	294 ft 90 m	362 ft 110 m
2500	FORWARD	48 ft 15 m	75 ft 23 m	109 ft 33 m	149 ft 45 m	195 ft 59 m	247 ft 75 m	306 ft 93 m
	AFT	47 ft 14 m	74 ft 22 m	106 ft 32 m	144 ft 44 m	187 ft 57 m	237 ft 72 m	291 ft 89 m
3000	FORWARD	40 ft 12 m	63 ft 19 m	91 ft 28 m	123 ft 38 m	162 ft 49 m	205 ft 62 m	254 ft 77 m
	AFT	40 ft 12 m	62 ft 19 m	89 ft 27 m	120 ft 37 m	157 ft 48 m	198 ft 60 m	244 ft 74 m
3500	FORWARD	34 ft 10 m	54 ft 16 m	77 ft 24 m	106 ft 32 m	138 ft 42 m	175 ft 53 m	217 ft 66 m

	AFT	34 ft	53 ft	76 ft	103 ft	135 ft	170 ft	210 ft
		10 m	16 m	23 m	31 m	41 m	52 m	64 m
4000	FORWARD	30 ft	47 ft	68 ft	92 ft	121 ft	153 ft	189 ft
		9 m	14 m	21 m	28 m	37 m	47 m	58 m
	AFT	30 ft	46 ft	67 ft	90 ft	118 ft	149 ft	184 ft
		9 m	14 m	20 m	28 m	36 m	45 m	56 m
4500	FORWARD	27 ft	42 ft	60 ft	82 ft	107 ft	136 ft	168 ft
		8 m	13 m	18 m	25 m	33 m	41 m	51 m
	AFT	26 ft	41 ft	59 ft	81 ft	105 ft	133 ft	164 ft
		8 m	13 m	18 m	25 m	32 m	40 m	50 m
5000	FORWARD	-99	37 ft	54 ft	74 ft	96 ft	122 ft	151 ft
		-99	11 m	16 m	22 m	29 m	37 m	46 m
	AFT	-99	37 ft	53 ft	73 ft	95 ft	120 ft	148 ft
		-99	11 m	16 m	22 m	29 m	36 m	45 m
	WIDTH	49 ft	61 ft	74 ft	86 ft	98 ft	110 ft	123 ft
		15 m	19 m	22 m	26 m	30 m	34 m	37 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: TRAM
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 14600 meters (47888 feet or 7.9 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 2.0 NM 12200 ft 3700 m	2.5 NM 15200 ft 4630 m	3.0 NM 18200 ft 5560 m	3.5 NM 21300 ft 6480 m	4.0 NM 24300 ft 7410 m	4.5 NM 27300 ft 8330 m	5.0 NM 30400 ft 9260 m
500	FORWARD	1700 ft 518 m	2750 ft 839 m	4110 ft 1250 m	5820 ft 1770 m	7910 ft 2410 m	10400 ft 3180 m	13400 ft. 4100 m
	AFT	1330 ft 405 m	2020 ft 616 m	2830 ft 864 m	3760 ft 1150 m	4790 ft 1460 m	5920 ft 1800 m	7130 ft 2170 m
1000	FORWARD	794 ft 242 m	1260 ft 385 m	1850 ft 563 m	2560 ft 780 m	3400 ft 1040 m	4380 ft 1330 m	5510 ft 1680 m
	AFT	703 ft 214 m	1080 ft 330 m	1540 ft 468 m	2060 ft 629 m	2660 ft 810 m	3320 ft 1010 m	4040 ft 1230 m
1500	FORWARD	518 ft 158 m	819 ft 249 m	1190 ft 363 m	1640 ft 500 m	2170 ft 660 m	2770 ft 845 m	3460 ft 1050 m
	AFT	478 ft 146 m	739 ft 225 m	1050 ft 321 m	1420 ft 433 m	1840 ft 560 m	2310 ft 703 m	2820 ft 859 m
2000	FORWARD	385 ft 117 m	606 ft 185 m	879 ft 268 m	1210 ft 368 m	1590 ft 484 m	2030 ft 618 m	2520 ft 769 m
	AFT	362 ft 110 m	561 ft 171 m	802 ft 245 m	1080 ft 330 m	1410 ft 428 m	1770 ft 538 m	2160 ft 660 m
2500	FORWARD	306 ft 93 m	481 ft 147 m	697 ft 212 m	954 ft 291 m	1250 ft 382 m	1600 ft 487 m	1990 ft 605 m
	AFT	291 ft 89 m	452 ft 138 m	648 ft 197 m	876 ft 267 m	1140 ft 347 m	1430 ft 436 m	1760 ft 536 m
3000	FORWARD	254 ft 77 m	398 ft 121 m	577 ft 176 m	789 ft 241 m	1040 ft 316 m	1320 ft 402 m	1640 ft 499 m
	AFT	244 ft 74 m	379 ft 115 m	543 ft 165 m	735 ft 224 m	956 ft 291 m	1200 ft 367 m	1480 ft 451 m
3500	FORWARD	217 ft 66 m	340 ft 104 m	492 ft 150 m	673 ft 205 m	883 ft 269 m	1120 ft 342 m	1390 ft 424 m

	AFT	210 ft 64 m	326 ft 99 m	467 ft 142 m	633 ft 193 m	824 ft 251 m	1040 ft 316 m	1280 ft 389 m
4000	FORWARD	189 ft 58 m	297 ft 90 m	429 ft 131 m	586 ft 179 m	769 ft 234 m	977 ft 298 m	1210 ft 369 m
	AFT	184 ft 56 m	286 ft 87 m	410 ft 125 m	556 ft 170 m	724 ft 221 m	913 ft 278 m	1120 ft 342 m
4500	FORWARD	168 ft 51 m	263 ft 80 m	380 ft 116 m	520 ft 158 m	681 ft 208 m	865 ft 264 m	1070 ft 327 m
	AFT	164 ft 50 m	255 ft 78 m	366 ft 111 m	496 ft 151 m	646 ft 197 m	814 ft 248 m	1000 ft 305 m
5000	FORWARD	151 ft 46 m	236 ft 72 m	342 ft 104 m	467 ft 142 m	611 ft 186 m	776 ft 237 m	961 ft 293 m
	AFT	148 ft 45 m	230 ft 70 m	330 ft 101 m	447 ft 136 m	583 ft 178 m	735 ft 224 m	905 ft 276 m
	WIDTH	123 ft 37 m	153 ft 47 m	184 ft 56 m	215 ft 65 m	245 ft 75 m	276 ft 84 m	307 ft 94 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: TRAM
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 14600 meters (47888 feet or 7.9 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 1.3 NM 7900 ft 2410 m	1.5 NM 9110 ft 2780 m	1.7 NM 10300 ft 3150 m	1.9 NM 11500 ft 3520 m	2.1 NM 12800 ft 3890 m	2.3 NM 14000 ft 4260 m
8000	FORWARD	-99	53 ft	68 ft	85 ft	103 ft	124 ft
		-99	16 m	21 m	26 m	32 m	38 m
	AFT	-99	52 ft	67 ft	84 ft	102 ft	122 ft
		-99	16 m	20 m	26 m	31 m	37 m
9000	FORWARD	-99	47 ft	60 ft	75 ft	92 ft	110 ft
		-99	14 m	18 m	23 m	28 m	34 m
	AFT	-99	47 ft	60 ft	74 ft	91 ft	109 ft
		-99	14 m	18 m	23 m	28 m	33 m
10000	FORWARD	-99	-99	54 ft	68 ft	83 ft	99 ft
		-99	-99	16 m	21 m	25 m	30 m
	AFT	-99	-99	54 ft	67 ft	82 ft	98 ft
		-99	-99	16 m	20 m	25 m	30 m
11000	FORWARD	-99	-99	-99	61 ft	75 ft	90 ft
		-99	-99	-99	19 m	23 m	27 m
	AFT	-99	-99	-99	61 ft	75 ft	89 ft
		-99	-99	-99	19 m	23 m	27 m
12000	FORWARD	-99	-99	-99	-99	69 ft	82 ft
		-99	-99	-99	-99	21 m	25 m
	AFT	-99	-99	-99	-99	68 ft	82 ft
		-99	-99	-99	-99	21 m	25 m
13000	FORWARD	-99	-99	-99	-99	-99	76 ft
		-99	-99	-99	-99	-99	23 m
	AFT	-99	-99	-99	-99	-99	76 ft
		-99	-99	-99	-99	-99	23 m
14000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99

	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
15000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
16000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
17000	FORWARD	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	AFT	-99	-99	-99	-99	-99	-99
		-99	-99	-99	-99	-99	-99
	WIDTH	-99	92 ft	104 ft	117 ft	129 ft	141 ft
		-99	28 m	32 m	36 m	39 m	43 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

LASER FOOTPRINT TABLE for: TRAM
Table based on: Flat terrain, Buffer= 5 mrad, Divergence= .1 mrad
NOHD= 14600 meters (47888 feet or 7.9 nautical miles)

Table values are FOOTPRINT dimensions(feet and meters)

ALTITUDE (feet)	FOOTPRINT	SLANT RANGE (nautical miles, feet, and meters) 0.8 NM 4860 ft 1480 m	1.0 NM 6080 ft 1850 m	1.2 NM 7290 ft 2220 m	1.4 NM 8510 ft 2590 m	1.6 NM 9720 ft 2960 m	1.8 NM 10900 ft 3330 m	2.0 NM 12200 ft 3700 m
500	FORWARD	251 ft	397 ft	580 ft	799 ft	1060 ft	1360 ft	1700 ft
		76 m	121 m	177 m	244 m	323 m	414 m	518 m
	AFT	228 ft	351 ft	500 ft	673 ft	869 ft	1090 ft	1330 ft
		69 m	107 m	152 m	205 m	265 m	332 m	405 m
1000	FORWARD	122 ft	192 ft	279 ft	382 ft	502 ft	639 ft	794 ft
		37 m	59 m	85 m	116 m	153 m	195 m	242 m
	AFT	117 ft	181 ft	259 ft	350 ft	455 ft	573 ft	703 ft
		36 m	55 m	79 m	107 m	139 m	175 m	214 m
1500	FORWARD	81 ft	127 ft	183 ft	251 ft	329 ft	418 ft	518 ft
		25 m	39 m	56 m	76 m	100 m	127 m	158 m
	AFT	78 ft	122 ft	175 ft	237 ft	308 ft	389 ft	478 ft
		24 m	37 m	53 m	72 m	94 m	118 m	146 m
2000	FORWARD	60 ft	95 ft	137 ft	187 ft	245 ft	310 ft	385 ft
		18 m	29 m	42 m	57 m	75 m	95 m	117 m
	AFT	59 ft	92 ft	132 ft	179 ft	233 ft	294 ft	362 ft
		18 m	28 m	40 m	55 m	71 m	90 m	110 m
2500	FORWARD	48 ft	75 ft	109 ft	149 ft	195 ft	247 ft	306 ft
		15 m	23 m	33 m	45 m	59 m	75 m	93 m
	AFT	47 ft	74 ft	106 ft	144 ft	187 ft	237 ft	291 ft
		14 m	22 m	32 m	44 m	57 m	72 m	89 m
3000	FORWARD	40 ft	63 ft	91 ft	123 ft	162 ft	205 ft	254 ft
		12 m	19 m	28 m	38 m	49 m	62 m	77 m
	AFT	40 ft	62 ft	89 ft	120 ft	157 ft	198 ft	244 ft
		12 m	19 m	27 m	37 m	48 m	60 m	74 m
3500	FORWARD	34 ft	54 ft	77 ft	106 ft	138 ft	175 ft	217 ft
		10 m	16 m	24 m	32 m	42 m	53 m	66 m

	AFT	34 ft 10 m	53 ft 16 m	76 ft 23 m	103 ft 31 m	135 ft 41 m	170 ft 52 m	210 ft 64 m
4000	FORWARD	30 ft 9 m	47 ft 14 m	68 ft 21 m	92 ft 28 m	121 ft 37 m	153 ft 47 m	189 ft 58 m
	AFT	30 ft 9 m	46 ft 14 m	67 ft 20 m	90 ft 28 m	118 ft 36 m	149 ft 45 m	184 ft 56 m
4500	FORWARD	27 ft 8 m	42 ft 13 m	60 ft 18 m	82 ft 25 m	107 ft 33 m	136 ft 41 m	168 ft 51 m
	AFT	26 ft 8 m	41 ft 13 m	59 ft 18 m	81 ft 25 m	105 ft 32 m	133 ft 40 m	164 ft 50 m
5000	FORWARD	-99 -99	37 ft 11 m	54 ft 16 m	74 ft 22 m	96 ft 29 m	122 ft 37 m	151 ft 46 m
	AFT	-99 -99	37 ft 11 m	53 ft 16 m	73 ft 22 m	95 ft 29 m	120 ft 36 m	148 ft 45 m
	WIDTH	49 ft 15 m	61 ft 19 m	74 ft 22 m	86 ft 26 m	98 ft 30 m	110 ft 34 m	123 ft 37 m

FOOTPRINT FORWARD- distance beyond target.
FOOTPRINT AFT- distance from target toward aircraft.
FOOTPRINT WIDTH- total width at target.
NOTE: -99 indicates an impossible alt./range combination

APPENDIX F

General Safety Criteria

GENERAL SAFETY CRITERIA

The following general recommendations are made to ensure safe laser air-to-ground operations:

Lasers should only be fired at targets for ranging or designating purposes.

Laser operations must be stopped immediately if personnel are observed in the LSDZ, equipment malfunction is observed, target is lost in field of view, or anytime laser safety cannot be assured.

The LSDZs must be free of specular reflectors such as shiny metals, glass, and other mirror-like surfaces to the maximum extent possible. During periodic maintenance of the range, the LSDZs must be policed for specular reflectors.

Make sure that the targets are positioned so that the LSDZs do not extend outside the military range or reservation.

When the laser hazard zones are within a designated weapons and gunnery range, laser warning signs are not required on perimeter fences; however, "access" controls to these laser hazard zones are needed.

Laser safety training is essential for both aircrews and ground personnel. This training is the responsibility of the Range Safety Officer and the support Military Public Health Officer. The assigned flight surgeon and Bioenvironmental Engineering Services can assist in parts of this training. Initial and annual training should be conducted and properly documented. Training material can be obtained from AL/OEOE (SSgt Limburg), DSN 240-4785, at Brooks AFB.

No laser should be fired above the horizon or backstop (i.e., hills, trees, or large targets).

On ranges where ground personnel are present during bombing, strafing, and lasing operations, one must take the following additional precautions to ensure their safety from lasers.

Aircrews must call "Target Acquired" and "Laser ON/OFF" to range control personnel each time they fire the laser.

In the event that the laser beam were allowed to go beyond the LSDZ, the range control tower might be illuminated by the laser; therefore, the tower personnel must be equipped with laser eye protection. The required OD for unaided viewing (meaning bare eyes, no optics used such as binoculars, telescope, etc.) for airborne lasers is 4 for λ=1064 nm. The ODs listed in Table A-1 of Appendix A are for exposure at the laser aperture, and

thus 4 is a quite adequate value (even Pave Tack requires only 2.7 OD at 100-m range per our calculations).

On ranges which are not being controlled, there are usually no personnel present on the ground during flying operations. However, it is possible that certain maintenance projects may be performed on a part of the range while flying and lasing operations occur on another part of the range, so that aircrew training time is reduced as little as possible. In that case, the following precautions must be observed:

1. Aircrews must be warned of the presence and location of the ground personnel.

2. Ground personnel must not be in the LSDZ of the targets that aircrews are training on.

3. Ground personnel on a range, who might be overflown, must be equipped with laser protective eyewear with an OD of 4 for the 1064-nm wavelength, and must absolutely avoid using any type of magnifying optics such as binoculars, telescopes, etc., during laser operations.

The following recommendations concern the use of air-to-ground laser systems:

1. When using LANTIRN in the combat or operational mode (λ=1064 nm), and due to the secondary beam, a distance of 150 ft between aircraft must be maintained to ensure the safety of the aircrews while lasing.

2. From the tactics that are used, there should not be a need for aircrews to wear laser eye protection as long as aircrafts remain 150 ft from each other, aircrews only lase the targets, and "buddy lasing" is used only in the manner that was described to us (i.e., there is no chance that the bombing aircraft will pass in the beam from the lasing aircraft).

The following recommendations concern the use of ground-to-ground laser systems. However, since we do not have any details at this time on how and where the lasers would possibly be used, we are only including general guidelines.

1. Ground-to-ground laser target designators and range finders are classified as either ANSI Class 3 or 4. The procedure to determine the LSDZ is about the same as for air-to-ground lasers. However, the ground-to-ground laser system operator can be closer to the target than an air-to-ground laser system because the ground system can be offset from the aircraft flight path and out of the weapons and laser footprints. Therefore, in addition to specular reflection, one needs to be more concerned with diffuse reflections and skin hazards. Buffer angles also need to be determined differently (see MIL-HDBK-828 or AFOSH 161-10).

2. If the laser is fired from an elevated platform, the LSDZ should be evaluated using the same procedures as for air-to-ground lasers.

3. If the surrounding terrain is flat or falls off in the distance without backstop, the LSDZ is a cone, consisting of the beam plus the buffer angle, extending out to the NOHD that covers the target area and surrounding areas within the buffer angles.

4. If the terrain contains backstops (natural or man-made) which terminate the laser beam within the NOHD, then the LSDZ is contained in that area provided the backstop is high enough to include the beam and the buffer angle. It is therefore a good idea to site the targets in front of backstops.

As far as medical surveillance requirements are concerned, one must consider two different categories of employees: laser personnel and incidental personnel. Laser personnel are defined as working routinely with lasers while incidental personnel are those whose work makes it possible but unlikely that they will be exposed to laser energy sufficient to damage their eyes or skin. All personnel working on laser ranges (i.e., the aircrews and the ground personnel) fall in the category of incidental personnel. For this type of personnel, the medical examination requirements are:

1. Required examinations shall be performed prior to participation in laser work, following any suspected laser injury, and after laser employment is completed. Periodic examinations are not required. Please note that medical surveillance is not required for personnel using ANSI Class 1, 2, 2a, or 3a lasers but is required for users of Class 3b and 4 lasers (see Appendix B for laser classifications).

2. Only visual acuity measurement is required. This examination should be performed by, or under the supervision of, an ophthalmologist, optometrist, or other qualified physician. Visual acuity for far and near vision should be measured with some standardized and reproducible method. Refraction corrections should be made if required for both distant and near test targets. If refractive corrections are not sufficient to change acuity to 20/20 (6/6) for distance, and Jaeger 1+ for near, a more extensive examination is indicated.

3. These medical surveillance requirements are those prescribed by the ANSI Std Z136.1-1993 with an additional post-laser employment medical examination required by the Air Force. The current AFOSH Std 161-10, dated 30 May 1980, contains different requirements, but the new Air Force policy is going to endorse the ANSI Std Z136.1-1993 requirements on the topic of medical surveillance and only requires a laser work termination medical examination in addition. This new policy on laser medical surveillance will soon be made official in a policy letter from HQ AFMOA/SGPA and also by the revised AFOSH Std 161-10 (which will be published as AFI 48-10).

Because all Air Force military personnel receive this type of visual acuity examination when they enter the Air Force, this should be documented in their medical records, and there is no need to give them this examination again. In the case of Air Force civilian personnel there is a need to give them this eye examination if they have not had one

during their Air Force employment, and if they are in activities where they could potentially be exposed to lasers.

APPENDIX G

Laser Goggle Procurement Information

GLENDALE PRODUCTS MEET U.S. AND INTERNATIONAL STANDARDS

Glendale laser eye protection devices are certified to exceed the requirements of both ANSI Z136 and Canadian Z386 standards for protection against both direct or reflected beam impact.

Further, all basic filters are regularly tested by the Federal Physical-Technical-Institute, West Germany and have received DIN and European EN207 approvals. For a product to receive this approval both the frame and lens are subjected to a direct beam hit of 10 seconds from a continuous wave laser, or 100 pulses from a corresponding pulse laser, and must still maintain specific protection factors. Glendale filters certified under this test program are marked with their respective test results.

In the event a filter should receive direct beam impact, the filter will absorb the radiation for a period of time long enough to allow wearers to remove themselves from the beam path without sustaining eye injuries. The Audio Visual Alert System (AVAS) designed into all filters warns wearers that they are being lased.

All products are permanently marked with the optical density (OD) and laser wavelength(s) against which a filter is designed to protect, a requirement of ANSI Z136.3.

Laser-Gard green CO_2 and Nd-YAG filters provide protection against secondary harmful radiation created by welding and cutting. Clear or other tinted plastic filters and clear glass do not.

KEEPING PACE WITH THE NEW APPLICATIONS OF LASERS

As new applications emerge, Glendale is usually one step ahead working on laser absorbers that will protect against the wavelengths and other characteristics of the new lasers. In industry, diode-equipped Nd-YAG, high power diode, excimer and copper vapor can offer capabilities to create new processes and improve old ones. In medicine, laser diode arrays will be joining Nd-YAG, holmium, excimer and erbium lasers as effective surgical devices. Glendale is constantly expanding the base library of its absorber technology to custom design protective filters for new single line and combination multi-wavelength laser systems.

GLENDALE LIGHT MANIPULATION SYSTEMS MAKE LIGHT WORK FOR YOU

The applications of light manipulation technology can enhance products and equipment in many areas: commercial, medical and military. Infrared absorptive technology can be used to address manufacturing requirements—to speed processing and improve quality.

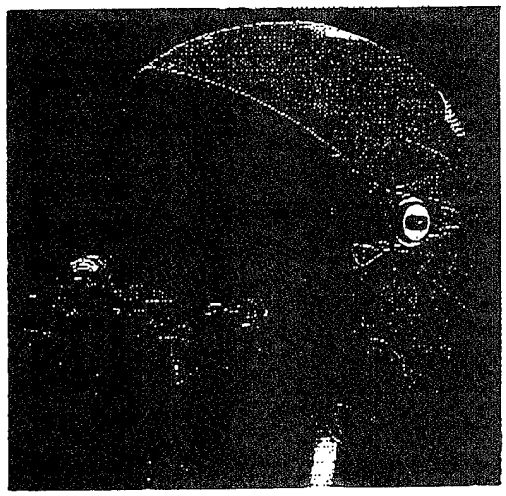
Some of the special light manipulation filters available from Glendale include:

• Visibly Opaque-IR Transparent Filters (Various cut-on wavelengths) • ANVIS Compatible Filters for Infrared Supression • Secure Lighting Filters • Specialty Electro-Optic Filters for Automotive and Other Uses • IR Marking Systems • IR Lithography • High Quality Sunglass Filters.

LASER PROTECTION FOR MILITARY PERSONNEL

Glendale is a leader in designing both single and multi-wavelength laser eye protection filters for military personnel. The company provided the first laser filter to the military in 1968 and has continued since then to develop enhanced filters to meet the more sophisticated modern day battle field needs for both daytime and nighttime operations.

The laser absorbers can be processed in various polymers to meet special design needs. When processed in polycarbonate the filters meet military ballistic and pilot ejection wind blast requirements. The same filters can be used on vehicles such as tank viewing ports to protect personnel and sensitive equipment inside.



Glendale laser specialists can help you.
For assistance call toll-free 1-800-500-4739

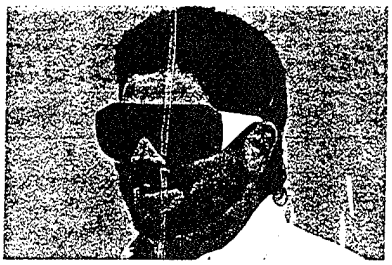
GP Glendale Protective Technologies
By the Bilsom Group

BILSOM GROUP

5300 Region Court, Lakeland, FL 33801 TOLL-FREE: 800-500-4739/813-687-7266/FAX: 813-687-0431

LPS Laser Plastic Spectacle
Stylish, Adjustable Eyewear
DVO™ (diffuse viewing only) laser eyewear from **uvex** provides excellent protection against stray light from today's most common lasers. It is available in 3 attractive frame styles. The LPS (laser plastic spectacle) features adjustable temples and an inclination system for a customized fit. Wrap-around styling with a wide unilens design provides panoramic vision. All models feature **uvex**'s exclusive **optidura 4C Plus** coating. This permanently bonded anti-fog, anti-scratch coating provides clear vision even in humid environments.

Circle 245

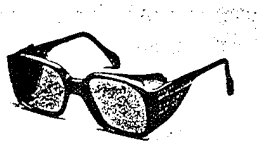


L2001 OTG Spectacle
Over-The-Glass Spectacle
Introducing the **L2001**, the industry's first **OTG** (over the glass) laser spectacle.This lightweight, impact resistant polycarbonate eyewear can be worn comfortably over your prescription glasses, or as a stand alone spectacle. It is ideal for visitors or for people who dislike goggles - a truly universal product. The **L2001**, (as well as all other **DVO laser eyewear** from **uvex**) is laser inscribed with the name of the laser, the wavelength, and the optical density on the front of the lens for easy identification.

Circle 246

LPG Laser Plastic Goggle
Comfortable, Fog Free Goggles
The **DVO LPG** (laser plastic goggle) features a soft, flexible PVC body that fits comfortably over Rx glasses. The sportstyle sealing flange and "accordion pleat" nasal area assure longwearing comfort. **uvex**'s exclusive **optidura 4C Plus** coating, combined with a unique indirect venting system, offer a cool fit. All **DVO** lenses have the laser absorptive dye uniformly dispersed throughout the lens which consists of 100% impact resistant polycarbonate and meets ANSI Z136.1-93, and ANSI Z87.1-89

Circle 247



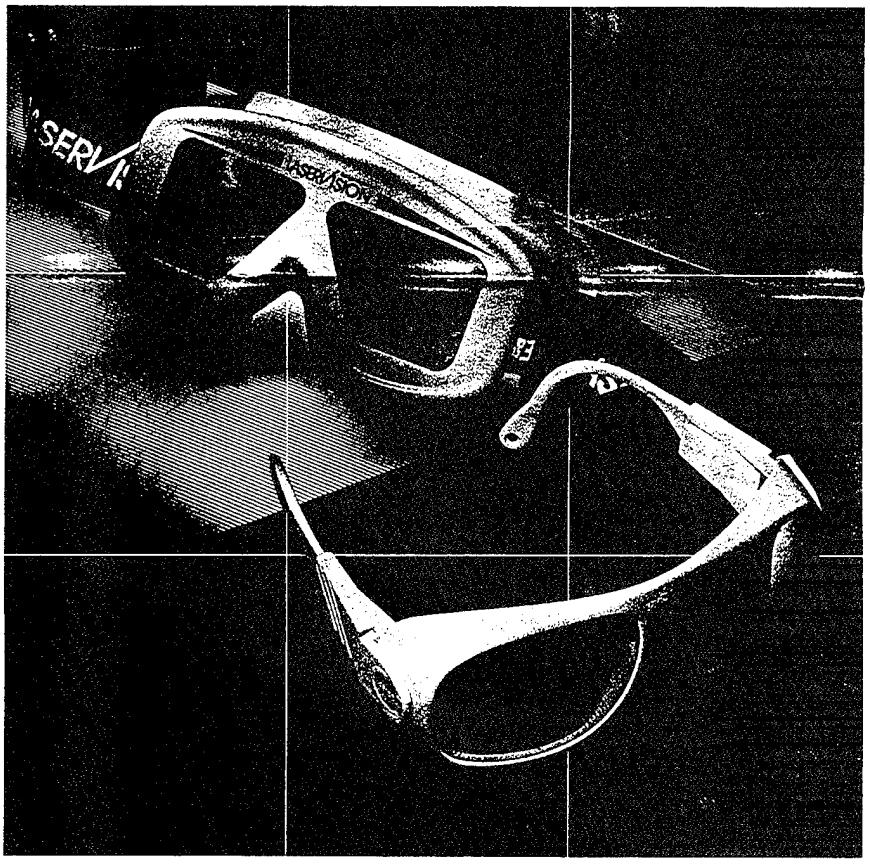
LO2 Series
The Industry Standard
The **LO2** spectacle is our most popular LGT design. The lightweight, comfortable frame is equipped with wire core temples for complete adaptability.The option of inserting prescription lenses makes this model universally applicable. We offer more than 50 off-the-shelf filter types for virtually any application. Custom-made filters are available upon request.

Circle 248

LO3 Goggle
Long-Lasting OTG Comfort
This flexible, reliable goggle is fitted with strategically located head straps and with soft face foam to provide long lasting comfort. Grooves inside the goggles allow you to wear this model over prescription glasses with a pressure-free fit. All of our LGT models are clearly laser inscribed with optical density and corresponding wavelength for easy identification.

Circle 249

uvex LGT laser eyewear: Clearly Superior



uvex laservision introduces a completely redesigned line of laser glass technology (LGT) eyewear, focusing on your concerns for improved comfort, fit, and visibility. Our filters optimize visible light transmission by tailoring the optical densities to your specific applications.

All **uvex** laser lenses are designed to meet ANSI Z136.1. **uvex laservision** LGT lenses also meet the stringent European norms that calculate optical density using direct laser radiation.

The **LO5 series** spectacle features a large curved glass lens in a wrap-around frame.This panoramic design is enhanced with adjustable temples and an inclination system for a customized fit.

Our new **LO6** goggle is fog-free due to its unique air flow design. The new clip-on strap facilitates donning of the goggle. Personalized adjustment pads maximize comfort and are easily cleaned or sterilized.

uvex laservision, helping you see clearly and safely into the 21st century and beyond.

LASERVISION Eye-protection

DAIMLERSTR. 26
D-91301 FORCHHEIM
GERMANY
PHONE: +49-9191-2061
FAX: +49-9191-66913

UVEX SAFETY,LLC
10 Thurber Blvd.
Smithfield, RI 02917
(401)232-1200
(800)343-3411
fax (401)232-1830

uvex®

LIST OF LASER PROTECTION EYEWEAR MANUFACTURERS OR VENDORS

American Optical Company
Safety Products Group
14 Mechanics Street
Southbridge, MA 01550
Telephone: 508-765-9711

Ealing Electro-Optics, Inc.
New Englander Industrial Park
Holliston, MA 01746
Telephone: 508-429-8370

Edmund Scientific
Edmund Building
Publications Department
Barrington, NJ 08007
Telephone: 609-547-3488

Energy Technology, Inc.
P.O. Box 1038
San Luis Obispo, CA 93406
Telephone: 805-544-7770

Fish - Schurman Corporation
P.O. Box 319
New Rochelle, NY 10802
Telephone: 914-636-1300

General Scientific Equipment Co.
525 Spring Garden
Philadelphia, PA 19123
Telephone: 215-922-5710

Glendale Protective Technologies
130 Crossways Park Drive
Woodbury, NY 11797
Telephone: 516-921-5800

Omicron Eye Safety Corporation
73 Main Street
Brattleboro, VT 05301
Telephone: 802-257-7363

Phase-R Company
Box G-2
New Durham, NH 03855
Telephone: 603-859-3800

Fred Reed Optical
P.O. Box 27010
Albuquerque, NM 87125-7010
Telephone: 505-265-3531

Rockwell Associates, Inc.
P.O. Box 43018
Cincinnati, OH 45243
Telephone: 513-271-1568

U.S. Laser Corp.
P.O. Box 609
825 Windham Ct. N.
Wychoff, NJ 07481
Telephone: 201-848-9200

U.V.P., Inc.
P.O. Box 1501
San Gabriel, CA 91778
Telephone: 818-285-3123

UVEX Winter Optical, Inc.
10 Thurber Blvd.
Smithfield, RI 02917
Telephone: 401-232-1200

APPENDIX H

DoD Laser Range Survey Checklist

DOD LASER RANGE SURVEY

PRESURVEY CHECKLIST

RANGE/AREA NAME: AVON PARK AF RANGE, FLORIDA
DATE: 26-29 Sept 1994
LOCATION (GRID COORDINATES): _____
ADDRESS: _____ PLANNED SURVEY:
DATE: _____

LAST SURVEY DATE: 26 Nov 86
PERFORMED BY: USAFOEHL

PHONE: DSN: 968-7138
COMM: (813) 452-4138
RANGE POC: Mr. Jim Onoprienko
USER POC'S: Mr. Al Byrne and Mr. Ken Beers

DATA COLLECTION

DOCUMENTS
RANGE SOP yes RANGE LASER yes
DIRECTIVES _____
OLD SURVEY REPORT yes

MAPS OF
RANGE BOUNDARIES yes TOPOGRAPHY yes
RESTRICTED AIR SPACE _____ TGT LOCATIONS yes
LASER OPERATING LOCATIONS yes

TYPES OF LASER OPERATIONS
AIRBORNE LASER OPERATIONS Yes
GROUND BASED LASER OPERATIONS planned
SHIP MOUNTED LASER OPERATIONS No

SYSTEMS TO BE USED ON RANGE
TRAM _____ LTD Yes MULE _____ LANTIRN Yes NOS _____

LD-82 _____ GVLLD Yes M60A2 _____ PAVE TACK Yes GVS-5 Yes

M60A3 _____ M1A1 _____ M551A1 _____ PAVE SPIKE Yes MILES Yes

TADS _____ LAAT _____ CLD _____ PAVE KNIFE _____ F/A-18 _____

MMS _____

OTHERS (LIST)
F-117

	TARGET NAME	GRID COORDINATES	
1.	Foxtrot-19 Radar Van	N2742.056 W8117.739	EL...114
2.	-22 Vehicles	N2742.083 W8117.167	130
3.	-23 Building	N2742.269 W8117.266	129
4.	-27 SA-3	N2742.294 W8117.971	101
5.			
6.			
7.	Echo -16 Radar Van	N2736.063 W8114.205	76
8.	-22 Aircraft	N2735.600 W8113.983	69
9.	-29 Ammo Storage	N2735.148 W8113.826	63
10.			

	LASER OPERATOR/FIRING POSITIONS FOR TARGET #?	GRID COORDINATES
1.	N/A	
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

	FORWARD OBSERVER POSITIONS FOR TARGET #?/LASER #?	GRID COORDINATES
1.	N/A	
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

A. Does the range have established run in headings for aircraft?

Yes XX No _____

If Yes, what are they?
Foxtrot 300-340
Echo 135-200

B. Will more targets be added? Yes _____ No _____ Possibly

If yes, where? grid coordinates
Echo Range

Are there manned positions on the range? Yes XX No _____

If so, where? grid coordinates
South Echo Range

D. Are there any conditions off the range that need to be addressed?

Yes _____ No XX

If yes, what? _____

E. Any other changes North and South ranges can be divided.

F. Comments _____

ON-SITE CHECKLIST

1. **Laser Safety Officer**
   Mr. Ken Beers

   Address

   Phone (DSN)

2. **Is there a Laser Safety Officer on range during laser operations?**

   Yes XXX **No** _____

3. **Have all of the range personnel involved with laser operations had laser safety training?**

   Yes _____ **No** XX

4. **Is there a medical surveillance program in place?**

   Yes _____ **No** _____ Somewhat

5. **Have all of the lasers being used on the range been evaluated by the specific service agency in Chapt 1 para A1a?**

   Yes _____ **No** XX

6. **Is the range adequately fenced to prevent unauthorized entry?**

   Yes _____ **No** _____ Range Boundaries

7. **Are laser warning signs posted at the range boundaries and at the entrance?**

   Yes _____ **No** _____ On Access Roads

8. **Are there barricades with laser warning signs?**

   Yes XX **No** _____

9. **If necessary, are the laser warning signs multilingual?**

   Yes _____ **No** XX

10. Are the targets made of a non-reflecting material for the laser wavelengths being used on the ranges?

Yes XX No _____

11. Are the target and target areas free of specular reflectors?

Yes XX No _____

12. Is there a protective eyewear training, inspection and replacement program in place?

Yes _____ No X Eyewear old, being replaced

13. Are all of the personnel who must be on the range during laser operations equipped with the proper eye protection?

Yes XX No _____

14. Is a laser operations log or schedule containing the date, time and heading of all laser operations being kept?

Yes _____ No _____not in detail

15. Is there two-way communication between the range laser safety officer, laser system operators and range personnel?

Yes XX No _____

16. Describe the surveillance of the range.

By communications
With proper eyewear, some visual

REVIEW OF RANGE SOP AND/OR LASER SAFETY INSTRUCTION

Does SOP or Laser Safety Instruction specify:

(a) **Permissible aircraft flight profiles and run-in headings for specified targets or target areas.**

Yes _____ **No** _____ Being developed, Text version only.

(b) **Permissible ships headings and safe firing zones for specified targets or target areas.**

Yes _____ **No** _____ N/A

(c) **Permissible ground-based laser operating positions and/or areas for specified targets or target areas.**

Yes _____ **No** _____ Surveyed By Army Nov. 1993.

(d) **Hazard areas to be cleared of non-operating personnel (roadblocks if required).**

Yes XX **No** _____ By scheduling and communications

(e) **Operating personnel locations (indicating those requiring eye protection).**

Yes XX **No** _____ Range control tower (Echo Range).

(f) **Types of surveillance to be used to ensure a clear range.**

Yes _____ **No** _____ Scheduling and communications

(g) **Radio frequencies for communication where appropriate.**

UHF 292.2 VHF 150.225 or 126.15

(h) **Firing log/schedule is kept by the range officer in accordance with DOD safety and health record keeping regulations.**

Yes _____ **No** _____ Partially

(i) **Laser systems will not be activated until the target has been positively identified.**

Yes XX **No** _____ New procedure.(with range identification locations-IP)

RANGE SURVEY REPORT

Note: This report may require sign-off by the respective Service Laser Safety Authority.

A. RANGE/AREA NAME: AVON PARK AF RANGE, FLORIDA

B. SURVEY SUMMARY: _____

Date survey was completed: _____

Applicable regulations: _____

Range controlled by: _____

Survey completed by (name/organization): B. Barker

_____

Dates of operations for which survey is valid: _____

Other pertinent information: _____

_____

C. SURVEY RESULTS:

1. Degree of compliance with applicable regulations

Regulations being rewritten

Copies of suggested improvements given to range

2. Safety deficiencies that must be corrected before approving range for laser use

Eyewear

Range laser footprints

D. RECOMMENDED ACTIONS:

1. Corrective actions for existing deficiencies

Replace eyewear with new items, proper OD (5)

Provided laser footprint information

2. **Ground Laser Restrictions**

Description of Laser Surface Danger Zones (LSDZ)
Army provided

3. **Aircraft Mounted Lasers**

Description of Laser Surface Danger Zones (LSDZ)
Provided data at time of visit

4. **Recommended operating procedures/range regulations**
Reccommend closer communications with aircrew during laser missions to assure positive location when the laser is activated; also assure target is acquired prior to laser activation.
Recommend that AL/OEO at Brooks AFB review the final updated procedures.

5. **Recommended laser eye protection**
Recommend use of tables in MIL HNDB 828 for the system been flown. RCC Doc 316-91 can also be used.

6. **Controls for protection from reflected laser beams**
Range is well cleared
For water, caution aircrews of condition and remind them of the NOHD for the system, could reflect beyond target at least half of NOHD.

7. **Recommended training**

Recommend use of support medical group or bio-environmental units.
Contact Brooks AFB AL/OEO for support.

8. **Recommended prebriefs for**

(1) laser users

Recommend on-site visits for laser range users to assure positive knowledge of land marks, flight patterns, headings and laser footprints.

(2) laser range personnel

Recommend training for lasers

Commend for the effective use of the range and the definite concern for safe procedures and operations on their range.

APPENDIX I

Avon Park Laser Operations

LASER OPERATIONS

Section A - GENERAL:

1. SCHEDULING. Units will inform 56 OSS/OSO and 56 SS/DO of missions employing lasers four weeks in advance. Coordinate laser mission changes to the daily schedule (range time, target, etc.) NLT 1200 hours the day prior to the scheduled mission.

2. SAFETY. Because range personnel can be exposed to potentially hazardous laser radiation, crews must exercise extreme caution upon activating any laser system. The following restrictions apply:

a. Contact 56 SS/DO for current laser target. No other targets or range area may be lased without written approval.

b. Prior to lasing any target on the Avon Park AF Range complex, advise Avon Operations on 292.2 that the flight is on range and the target number.

3. LASER TARGET PREPARATION AND MAINTENANCE. Remove specular reflectors from targets before integration into the target complex. Cover specular devices or surfaces which cannot be removed with a permanent matte finish protective coating.

Section B - AIRBORNE LASER SYSTEM PROCEDURES:

1. GENERAL. Operate only approved Nd YAG lasers, operating at 1.064 microns wavelength.

2. RANGE OPERATIONS. All targets listed in AFR 50-46, Macd Sup 1, are approved for laser operations.

a. Do not activate the laser until the target is positively identified.

b. Do not lase a target if a specular reflective object such as standing water is observed within the five milliradian Laser Surface Danger Zone centered on the target.

c. Scanning from one target to another is not authorized.

d. The lasing of wildlife is strictly prohibited.

3. SCHEDULE. When laser operations are scheduled, annotate the words "Laser Operations" and target number in the remarks section of the weekly and daily schedule.

4. PRECAUTIONS FOR GROUND PERSONNEL.

a. To prevent inadvertent laser exposure, personnel located in the vicinity of Bravo/Foxtrot or Charlie/Delta/Echo are encouraged to use one of the following precautions when those ranges are scheduled for laser operations:

(1) Remain in an area where no direct or reflected laser energy can enter.

(2) If located in open areas, wear approved laser protective eyewear with a minimum optical density (OD) of 5.8 at 1.064 microns wavelength.

b. Ground personnel should not use magnifying optics such as binoculars, view-finder type cameras with telephoto lenses, optical sighting equipment, or telescopes unless the device incorporates either:

(1) A filter with an OD of 7.8 at 1.064 microns wavelength, which protects for 10-power magnification optics.

(2) A filter with an OD of 8.5 at 1.064 microns wavelength, which protects for 20-power magnification optics. Magnifying optics systems used with a television display (indirect viewing) may be used without filters.

Section C - GROUND LASER SYSTEM PROCEDURES:

1. GENERAL. Operate only approved Nd YAG lasers operating at 1.064 microns wavelength. Target designation is authorized when specular reflectors lie clear of a laser safe target as follows:

a. Hand-held laser: The beam plus a 15-milliradian buffer.

b. Stabilized lasers: The beam plus five times the beam divergence at the I/E point or five milliradians, whichever is less.

2. LASER POSITIONS. Non-scan lasing is authorized from the south fence of Echo range.

Section D - LASER SYSTEMS:

Laser systems authorized for laser ranging and designation operations on the Avon Park AF Ranges are listed below. Direct specific laser questions to 56 SS/DO.

a. AN/GVS-5 Laser Range Finder Infrared Observation Set (hand-held)

b. AN/PAQ-1 Laser Target Designator (LTD)

c. AN/TVQ-2 Ground/Vehicle Laser Locator Designator (G/VLLD) (LRF only)

d. Multiple Integrated Laser Engagement System (MILES)

e. This list is not all inclusive. Direct specific laser types to the Coordination Center.

APPENDIX J

Medical Examination Requirements

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE

FROM: HQ USAF/SG
170 Luke Avenue, Suite 400
Bolling AFB DC 20332-5113

15 SEP 1993

SUBJ: Medical Examination Requirements for Personnel Potentially Exposed to Laser Radiation (93-016)

TO: ALMAJCOM/SG HQ AFIA/SG HQ AFMPC/DPMM AFMSA/CC
HQ AFRES/SG HQ AFIC/SG HQ USAF/REM NGB/SG

1. This policy letter implements new laser medical examination requirements based on recommendations in American National Standards Institute (ANSI) publication Z136.1-1993, "American National Standard for the Safe Use of Lasers." This ANSI document supersedes ANSI's 1986 version of this standard, and will ultimately be adopted, with a few exceptions, by the Air Force in a forthcoming revision of AFOSH Standard 161-10 expected to be published in early 1994.

2. The current AFOSH Standard specifies medical examination requirements which include a funduscopic examination under mydriasis. The 1986 ANSI Standard deleted this recommendation, and instead recommended individuals having abnormal visual acuity, Amsler Grid or ophthalmoscopic examination of the optic nerve and macula be referred to an ophthalmologist. The 1993 ANSI Standard further refines the 1986 recommendations, deletes the requirement for an ophthalmology examination, and adds a test for color vision.

3. Effective with the publication of this policy letter, Air Force medical activities conducting laser medical examinations will accomplish the following:

a. General. Medical examination requirements are limited to those that are clearly indicated and are based on known risks of a particular kind of laser radiation. Military Public Health (MPH) is responsible for medical surveillance of personnel who work with Class 3b and 4 laser systems. Personnel working with Class 1 through 3a lasers do not require medical surveillance. Individuals under laser medical surveillance will fall into one of the two personnel categories defined below. MPH will determine each employee's category.

(1) Laser Personnel are those who work routinely in laser environments. These individuals are normally fully protected by engineering controls and/or administrative procedures.

(2) Incidental Personnel are those whose work makes it possible, but unlikely, that they will be exposed to laser energy sufficient to damage their eyes or skin, e.g., custodial, military personnel on maneuvers, clerical, and supervisory personnel not working routinely in a laser environment.

b. Frequency of Medical Examinations. For both laser and incidental personnel, pre and post-placement medical examinations will be performed. Periodic examinations are not required. Following any suspected laser injury, the pertinent examinations, as determined by an ophthalmologist, will be performed.

c. Surveillance Procedures. Complete details are given in Appendix E of ANSI Std 136.1-1993 which is attached. The following minimum surveillance procedures will be adhered to:

(1) Laser Personnel:

(a) An ocular history will be obtained (E2.2.1).

(b) An ocular examination will be accomplished and include a check of visual acuity (E2.2.2), Amsler Grid (E2.2.3) and color vision (E2.2.4). The test for color vision will be for purposes of determining a baseline and an individual's ability to work safely in a laser environment.

(c) If the ocular history shows no problems and visual acuity is found to be 20/20 (6/6 in each eye for far, and Jaeger 1+ for near) with corrections (whether worn or not), and Amsler Grid is normal, and color vision tests are acceptable (see 1.b. above), no further examination is required. Laser personnel with medical conditions noted in the ocular history should be evaluated carefully with respect to the potential for chronic exposure to laser radiation. Any deviations from acceptable performance will require an identification of the underlying pathology either by a funduscopic examination (E2.2.5) or other tests, as determined appropriate by the responsible medical or optometric examiner.

(2) Incidental Personnel will have an eye examination for visual acuity.

4. Please disseminate this letter to all ophthalmology, optometry, bioenvironmental engineering, flight medicine and military public health units in your command. Point of contact is Major Don W. Jordan, HQ AFMOA/SGPA, 170 Luke Avenue, Suite 400, Bolling AFB DC 20332-5113, DSN 297-0621.

ROBERT A. BUETHE, JR.
Major General, USAF, MC
Director, Medical Programs and Resources
Office of the Surgeon General

1 Atch
Appendix E, ANSI Std 136.1-1993

cc: HQ USEUCOM/ECMD
HSC/CC
USCENTCOM/CCSG

Appendix E

Medical Surveillance

E1. Purpose of Medical Surveillance

The basic reasons for performing medical surveillance of personnel working in a laser environment are the same as for other potential health hazards. Medical surveillance examinations may include assessment of physical fitness to safely perform assigned duties, biological monitoring of exposure to a specific agent, and early detection of biologic damage or effect.

Physical fitness assessments are used to determine whether an employee would be at increased or unusual risk in a particular environment. For workers using laser devices, the need for this type of assessment is most likely to be determined by factors other than laser radiation per se. Specific information on medical surveillance requirements that might exist because of other potential exposures, such as toxic gases, noise, ionizing radiation, etc, are outside the scope of this appendix.

Direct biological monitoring of laser radiation is impossible, and practical indirect monitoring through the use of personal dosimeters is not available.

Early detection of biologic change or damage presupposes that chronic or subacute effects may result from exposure to a particular agent at levels below that required to produce acute injury. Active intervention must then be possible to arrest further biological damage or to allow recovery from biological effects. Although chronic injury from laser radiation in the ultraviolet, near ultraviolet, blue portion of the visible, and near infrared regions appears to be theoretically possible, risks to workers using laser devices are primarily from accidental acute injuries. Based on risks involved with current uses of laser devices, medical surveillance requirements that should be incorporated into a formal standard appear to be minimal.

Other arguments in favor of performing extensive medical surveillance have been based on the fear that repeated accidents might occur and the workers would not report minimal acute injuries. The limited number of laser injuries that have been reported in the past 20 years and the excellent safety records with laser devices do not provide support to this argument.

E2. Medical Examinations

E2.1 Rationale for Examinations

E2.1.1 Preassignment Medical Examinations. Except for examination following suspected injury, these are the only examinations required by this standard. One purpose is to establish a baseline against which damage (primarily ocular) can be measured in the event of an accidental injury. A second purpose is to identify certain workers who might be at special risk from chronic exposure to selected continuous-wave lasers. For incidental workers (e.g., custodial, military personnel on maneuvers, clerical and supervisory personnel not working directly with lasers) only visual acuity measurement is required. For laser workers' medical histories, visual acuity measurement, and selected examination protocols are required. The wavelength of laser radiation is the determinant of which specific protocols are required (see E2.2). Examinations should be performed by, or under the supervision of, an ophthalmologist or optometrist or other qualified physician. Certain of the examination protocols may be performed by other qualified practitioners or technicians under the supervision of a physician. Although chronic skin damage from laser radiation has not been reported, and indeed seems unlikely, this area has not been adequately studied. Limited skin examinations are suggested to serve as a baseline until future epidemiologic studies indicates whether they are needed or not.

E2.1.2 Periodic Medical Examinations. Periodic examinations are not required by this standard. At present no chronic health problems have been linked to working with lasers. Also, most uses of lasers do not result in chronic exposure of employees even to low levels of radiation. A large number of these examinations have been performed in the past, and no indication of any detectable biologic change was noted. Employers may wish to offer their employees periodic eye examinations or other medical examinations as a health benefit; however, there does not appear to be any valid reason to require such examinations as part of a medical surveillance program.

E2.1.3 Termination Medical Examinations. The primary purpose of termination examinations is for the legal protection of the employer against unwarranted claims for damage that might occur after an employee leaves a particular job. The decision on whether to offer or require such examinations is left to individual employers.

E2.2 Examination Protocols

E2.2.1 Ocular History. The past eye history and family history are reviewed. Any current complaints concerned with the eyes are noted. Inquiry should be made into the general health status with a special emphasis upon systemic diseases which might produce ocular problems in regard to the performance cited in Section 6.1. The current refraction prescription and the date of the most recent examination should be recorded.

Certain medical conditions may cause the laser worker to be at an increased risk for chronic exposure. Use of photosensitizing medications, such as phenothiazines and psoralens, lower the threshold for biological effects in the skin, cornea, lens and retina of experimental animals exposed to ultraviolet and near ultraviolet radiation. (See Table E1 for a representative list of photosensitizing agents.) Aphakic individuals would be subject to additional retinal exposure from blue light and near ultraviolet and ultraviolet radiation. Unless chronic viewing of these wavelengths is required, there should be no reason to deny employment to these individuals.

E2.2.2 Visual Acuity. Visual acuity for far and near vision should be measured with some standardized and reproducible method. Refraction corrections should be made if required for both distant and near test targets. If refractive corrections are not sufficient to change acuity to 20/20 (6/6) for distance, and Jaeger 1+ for near, a more extensive examination is indicated as defined in 6.3.

E2.2.3 Macular Function. An Amsler grid or similar pattern is used to test macular function for distortions and scotomas. The test should be administered in a fashion to minimize malingering and false negatives. If any distortions or missing portions of the grid pattern are present, the test is not normal.

E2.2.4 Color Vision Color vision discrimination can be documented by Ishihara or similar color vision tests.

E2.2.5 Examination of the Ocular Fundus with an Ophthalmoscope This portion of the examination is to be administered to individuals whose ocular function in any of Sections E.2.2.1 through E.2.2.4 is not normal. The points to be covered are: the presence or absence of opacities in the media; the sharpness of outline of the optic disc; the color of the optic disc; the depth of the physiological cup, if present; the ratio of the size of the retinal veins to that of the retinal arteries; the presence or absence of a well-defined macula and the presence or absence of a foveal reflex; and any retinal pathology that can be seen with an ophthalmoscope (hyper-pigmentation, depigmentation, retinal degeneration, exudate, as well as any induced pathology associated with changes in macular function). Even small deviations from normal should be described and carefully localized. Dilation of the pupil is required.

E2.2.6 Skin Examination. Not required for preplacement examinations of laser workers; however, suggested for employees with history of photosensitivity or working with ultraviolet lasers. Any previous dermatological abnormalities and family history are reviewed. Any current complaints concerned with the skin are noted as well as the history of medication usage, particularly concentrating on those drugs which are potentially photosensitizing.

Further examination should be based on the type of laser radiation, above the appropriate MPE levels, present in the individual's work environment.

E2.2.7 Other Examinations. Further examinations should be done as deemed necessary by the examiner.

E3. Medical Referral Following Suspected or Known Laser Injury

Any employee with a suspected eye injury should be referred to an ophthalmologist. Employees with skin injuries should be seen by a physician.

E4. Records and Record Retention

Complete and accurate records of all medical examinations (including specific test results) should be maintained for all personnel included in the medical surveillance program. Records should be retained for at least 30 years.

Table E1

Representative List of Photosensitizing Agents

	Agent	Reaction
1	Sulfanomide	Phototoxic Photoallergic
2	Sulfonylurea	Phototoxic
3	Chlorthiazides	Papular and Edematous Eruptions Plaques
4	Phenothiazines	Exaggerates Sunburn Uriticaria Gray-Blue Hyperpigmentation
5	Antibiotics, e.g., Tetracycline	Exaggerates Sunburn Phototoxic
6	Griseofulvin	Exaggerates Sunburn Phototoxic Photoallergic
7	Nalidixin Acid	Erythema Bullae
8	Furocoumarins (Psoralen)	Erythema Bullea Hyperpigmentation
9	Estrogens/Progesterones	Melasma Phototoxic
10	Chlordiazepoxide (Librium)	Eczema
11	Triazetyldiphenolisatin (Laxative)	Eczematious Photoallergic Reaction
12	Cyclamates	Phototoxic Photoallergic
13	Porphyrins (Porphyria)	Phototoxic
14	Retin-A (Retinoic Acid)	Exaggerates Sunburn Photoallergic

E5. Access To Records

The results of medical surveillance examinations should be discussed with the employee.

All non-personally identifiable records of the medical surveillance examinations acquired in Section E.4 of these guidelines should be made available on written request to authorized physicians and medical consultants for epidemiological purposes. The record of individuals will, as is usual, be furnished upon request to their private physician.

E6. Epidemiologic Studies

Past use of lasers has generally been stringently controlled. Actual exposure of laser workers has been minimal or even nonexistent. It is not surprising that acute accidental injury has been rare and that the few reports of repeated eye examinations have not noted any chronic eye changes. For these reasons, the examination requirements of this standard are minimal. However, animal experiments with both laser and narrow-band radiation indicate the potential for chronic damage from both subacute and chronic exposure to radiation at certain wavelengths. Lens opacities have been produced by radiation in the 0.295 to 0.45 μm range and are also theoretically possible from 0.75 to 1.4 μm.

Photochemical retinitis appears to be inducible by exposure to 0.35 to 0.5 μm radiation. If laser systems are developed that require chronic exposure of laser workers to even low levels of radiation at these wavelengths, it is recommended that such workers be included in the long-term epidemiologic studies and have periodic examinations of the appropriate eye structures.

Epidemiologic studies of workers with chronic skin exposure to laser radiation (particularly ultraviolet) are suggested.

E7. References

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