LASER INJURY GUIDEBOOK

The purpose of this guidebook is to provide guidelines and instructions for a deployed flight surgeon working in field conditions for evaluation and management of laser eye injuries and suspected laser incidents. This document will eventually migrate to an AFI. The field kit (Attachment 1) contents are in flux. Not every location will have every item. However, the information and procedures in this document are valuable to hold pending final package contents.

1. REFERENCES:

a. AFI 48-123, Medical Examination and Standards
b. AFOSH Standard 48-10, 1 Aug 99
c. ASCC Air Standard 61/115/14A Initial Investigation and Intermediate Management of Laser Eye Damage in Aircrew
d. The Evaluation and Management of Laser Injuries NATO-AGARD AGARDOGRAPH AR-354
e. Headquarters, Dept. of the Army FM8-50, Prevention and Medical Management of Laser Injuries
f. USAFSAM-TR-88-2, Oct 1988, Medical Management of Combat Eye Injuries

2. GENERAL

2.1 In modern expeditionary Air Force medical operations, there is a proliferation of laser devices that are an injury threat to deployed personnel in the air and on the ground. Therefore, there is an increasing likelihood of laser eye injuries due to hostile or friendly ("buddy-lasing") sources that can have a severe flying mission impact. An asymmetric threat exists due to readily accessible and inexpensive laser devices worldwide, in addition to civilian commercial use in light shows and advertising. Flight medical force protection/prevention in the operational units should include training and awareness of the threat through direct flight surgeon involvement in the Flying Safety and recurrent aircrew training programs. For example, education that many lasers (e.g. Class 2 and 3A pointers) cause no more than a momentary dazzle may help defeat fear and anxiety concerns. On the other hand, more powerful lasers, to include laser pointers rated class 3B, are potentially dangerous. Aircrew need to be educated as to the entire threat spectrum and appropriate steps to be taken should they be exposed. However, any laser is potentially capable of producing temporary or permanent bioeffects if used improperly or abused.

2.2 The key to evaluating and managing any laser injury and suspected laser exposure is the early involvement of the flight surgeon. The flight surgeon should be notified as soon as possible and will be responsible for coordinating and determining the appropriate care and action to be taken on a crewmember. The flight surgeon should always approach a suspected laser eye injury as being little different from a conventional injury caused by a bullet or shrapnel. The only difference is that in a laser injury the "bullet" is a

concentration or quantum of light. Personnel exposed or suspected to have been exposed to a laser should be worked up, evaluated, and managed in accordance with standard Air Force Instructions as determined by the flight surgeon. Reference materials listed above provide additional guidance. Consultation with laser eye injury specialists is readily available at USAFSAM: (210) 536-3241/DSN 240-3241 and AFRL/HEDO : 1-800-473-3549 and (210) 536-4784/DSN 240-4784.

3. STEPS TO BE TAKEN WHEN THE FLIGHT SURGEON ENVALUATES THE CREWMEMBER.

3.1. Obtain a detailed operational/medical history with respect to the nature and characteristics of the exposure including details such as intensity, color, constant or flicker light source, duration of exposure, location, range, did it track, airborne or ground environment, any immediate or delayed symptoms, and glare, pain or photophobia. It is important to remember that some lasers are invisible to the human eye (i.e., UV and IR) and may present with sudden visual symptoms without a history of visible light exposure. Be sure to note what types of personal protective equipment or viewing devices were being used, if any. Past ocular and family eye histories should be included. A laser eye injury questionnaire (see attachment 2) may be helpful, and this information should be coordinated with Wing Intelligence. Notifications should be made from the deployed location as soon as possible. These are outlined in AFOSH Standard 48-1, 2.6.2.1, but from the field level notification should focus on the Air Expeditionary Wing Commander, Joint Task Force and MAJCOM level. Attachment 3, Laser Injury, may be used as an education tool for aircrew with suspected exposures.

3.2 Always test both eyes independently (attachment 4). Assess vision using the Aidman screener and Amsler Grid (See attachment 5). Each eye should be tested separately while the other eye is covered. Document all details in the medical record, especially the best corrected visual acuity in each eye and the conditions and appropriate ranges or devices used to determine this.

3.3 Determine distant visual acuity using the 10-foot chart. Ensure accuracy of the testing procedure, because near vision can be greatly affected depending on the patient age and the actual distance that they hold the chart. Generally, near and distant visual acuity correspond, but there can be wide variation. If distant visual acuity tests worse than 20/30, or if corrective eyewear is not available, then administer a pinhole acuity test to assess distant visual acuity. Ensure documentation of best-corrected distant visual acuity in each eye and how it was determined.

3.4 The Amsler Grid should be administered monocularly at 12 inches using adequate illumination and corrective eyewear as required. Have the crewmember sketch out any abnormalities on the Amsler Grid. A positive Amsler Grid test result would indicate that the central 10 degrees of the visual field has been affected and provide information on the condition of the macula and perimacular region of the retina within the vascular arcade. The test is capable of detecting scotomas and lesions as small as 50 microns and may note retinal damage not visible to the examiner Not all laser eye injuries have an associated visible retinal lesion, and some visible retinal injuries may still have a normal

Amsler Grid test. It is critical to follow and document any changes related to a laser injury. For example, edema may progress and cause symptoms to worsen. In any suspected laser eye injury, the patient should be re-examined as clinically indicated, but at least within 72 hours.

3.5 Perform an external examination of the skin and adnexa looking for burns or evidence of thermal trauma.

3.6 Examine the pupils for anisocoria, fixed pupil, or other abnormalities external abnormalities. Use the pupil gauge on the Aidman screener to measure both pupil sizes in dim and bright light using a distant fixation target. Perform such examinations before dilating drops are administered. If visual acuity is normal or near normal, then perform a depth perception test, such as a Randot Stereopsis test, before dilation. This should done on all crewmembers since stereo vision is key to their performance. It is unlikely that stereopsis would be affected without other symptoms, but should be checked before returning aircrew to flying duty if possible. Remember, dilation may degrade stereopsis, so always perform the test before administering any mydriatic medications. Drug effects of mydriatics may persist – Homotropine may last 2 – 5 days while atropine may last 3 weeks.

3.7 Color vision. Although it is unlikely that color vision will be affected in association with an acute event without other macular damage, it is possible that subtle affects may only be picked up with color vision testing. If available, color testing should be performed monocularly. The vision field kit screens for red/green deficits, and red/green along with blue yellow should be done if available. It should be noted what type of illumination was used. The tests are designed for a special illumination called Illumination C or equivalent, but indirect natural daylight or fluorescent illumination will may be of limited value since subtle acquired color deficits may not be picked up or miscategorized.

3.8 If available perform a slit lamp exam on the anterior segment, cornea, anterior chamber, iris and lens. Apply a sodium fluorescein strip to the tear film in the inferior conjunctival cul-de-sac to examine for any corneal abrasions or burns. If a slit lamp is unavailable use a Woods lamp as the instrument to examine the anterior portion of the eye. Describe and diagram any lesions identified.

3.9 Dilate both eyes even if only monocular symptom present. Proparacaine, Tropicamide 1% and Phenylephrine 2.5% should be used as they last only 4 – 6 hours. Other agents may have much longer effects. Using the direct ophthalmoscope describe any abnormal lesions. Use the fundus identification chart as needed. In difficult diagnostic scenarios, a hand-held digital non-mydriatic retinal camera at the supporting expeditionary medical facility can be used. Retinal lesions can be photographed and digitally sent to the telemedical consultant ophthalmologist for evaluation and recommendations.

3.10 An inability to focus on the retina could be a sign of vitreal debris or hemorrhage. Patients who are suspected of having vitreoretinal hemorrhage should be maintained at bed rest, with their head elevated to facilitate blood settling down and away from the macula. They should be re-examined within 72 hours by an ophthalmologist to evaluate

for other associated retinal pathology and be evacuated for more definitive care immediately. This injury requires an urgent medical airevacuation.

3.11 Chorioretinal Burns. The classic hallmark of a significant laser eye injury is a chorioretinal burn. Any chorioretinal burn can also cause inflammation throughout the eye, especially in surrounding tissue. Any chorioretinal burn can cause inflammation of the eye. Usually this inflammation is not effectively treated with use of topical steroid drops because of poor penetration and access to retinal tissue. Therefore oral or IV steroids are generally more effective in reducing intraocular inflammation. Periocular, retrobulbar, or subconjuntival injections should only be given by an ophthalmologist, as the eye can be easily perforated with standard needles. The flight surgeon may consult with an ophthalmologist and administer IV or oral steroids if preservation of vision is thought to benefit from such therapy. If laser eye injury is strongly suspected the use of systemic steroids to facilitate preservation or recovery of vision should be considered. This should be decided on a case-by-case basis.

4. TRAINING FOR FLIGHT SURGEONS

4.1 All flight surgeons who are likely to be deployed and utilize the flight surgeon vision field kit should be proficient on the use of all the equipment and performance of the proper tests. This will initially be taught in the Aerospace Medicine Primary Course for Flight Surgeons and yearly refresher training accomplished at the unit level. Initial and recurrent training of flight surgeons and technicians already operational will be the responsibility of the unit Chief of Aeromedical Services. It will be obtained by coordinating training with the optometry/ophthalmology element at the unit or Command level as necessary. It is recommended that this be done at least once per year. In addition, this training with the field evaluation kit will be incorporated into the Residency in Aerospace Medicine.

4.2 Ophthalmology/Optometry clinics will provide all necessary initial and recurrent training to flight surgeons for field evaluation of suspected laser eye injuries.

Flight Surgeon Vision Field Kit

- ❑ Aidman Vision Screener
- ❑ Medical Laser Debrief Sheet
- ❑ 10 foot Snellen Chart
- ❑ Sodium Fluorescein Strips
- ❑ Artificial Tears
- ❑ Proparacaine
- ❑ Tropicamide 1%
- ❑ Phenylephrine 2.5%
- ❑ 2% Homatropine
- ❑ Methylprednisolone (Solu Medrol)
- ❑ Oral Prednisone
- ❑ Topical Ophthalmic steroid drops
- ❑ Pinhole Occluder
- ❑ Penlight
- ❑ Randot Stereopis Chart with Poloroid Lenses
- ❑ Armed Forces Color Plates
- ❑ Ophthalmoscope with blue light
- ❑ Hand Held Retinal Camera (optional)
- ❑ Hand Held Slit Lamp with 90D lens / Woods Lamp
- ❑ Fundus Identification Chart
- ❑ Hand Held Tonopen

Expeditionary Medical Squadron Support Equipment

- ❑ Slit Lamp
- ❑ Digital Non-Mydriatic Fundal Camera

Debriefing For Suspected Laser Incidents

CIRCUMSTANCES

1. Did you see a bright light? How bright was it like the sun, a full moon, or automobile headlights at night? Were there other light sources on the platform (such as running lights or navigation lights) and were they brighter or dimmer?

2. What was the color(s) of the light? Was it uniform in color? Did the color(s) change during the exposure?

3. Did the light come on suddenly, and did it become brighter as you approached it?

4. Was the light continuous or did it seem to flicker? If it flickered, how rapidly and regularly?

5. For how long was the light on?

6. From what did the light emanate? Was it from an airplane, helicopter, tank, etc.?

7. How would you describe the brightness of the light? Was it equally bright in all areas or was it brighter in one area?

8. How far away was the light source? Was it moving?

9. At what time of the day did the incident occur?

10. What was the visibility? What were the atmospheric conditions- clear, overcast, rainy, foggy, hazy, sunny?

11. What was between the light source and your eyes – windscreen, glasses, head-up display, lenses, binoculars, filters, visors, or goggles? Describe them in great detail (for example, 2X binoculars, standard issue sun visor, prescription glasses, hazy windscreen). Were any of these things damaged or caused to malfunction by the light?

12. Did you try to move out of the light beam? What evasive maneuvers did you attempt? Did the beam follow you as you tried to move away? How successful were you in avoiding it?

13. Was the light coming directly from its source or did it appear to be reflected of other surfaces? Did you notice multiple sources of light?

14. Did the light fill your cockpit or compartment? How wide was the beam at its source? How wide was the beam once it reached you?

POSSIBLE EFFECTS

15. How long did you look into the light beam? Did you look straight into the light beam or off to the side?

16. What tasks were you doing when the exposure occurred? Did the light prevent or hamper you from doing those tasks, or was the light more of an annoyance?

17. Were both eyes exposed? If not, describe the difference between the light exposure (for example, one eye was shielded or closed, or on the side away from the light beam). Describe any difference in the affect on either eye.

18. Were you startled or disorientated when the light appeared?

19. Was the light so bright that you had to blink or squint, close your eyes, or look away? Was the light painful? Describe the pain. For how long did the pain persist after the light exposure?

20. Was you vision affected while the light was on? How much of your visual field was affected? What types of things could you see or not see? Did you notice the color of instruments or targets change? Did the changes to your vision remain constant or vary during the exposure? If the light source was mounted on a platform (aircraft, ground vehicle or building), how much of the platform was obscured?)

21. Did your vision remain affected after the light was extinguished? If so, for how long and how did you estimate the time? How much of your visual field was affected? What types of things could you see or not see (watch, hand, altimeter, map, et.)? Did you notice afterimages ("spats before you eyes")? If so, how long did the last, what did they look like, and what were their size, shape and position in your visual field.? Describe how your vision was affected 10 seconds after the light exposure ended, 30 seconds afterward, 1 minute, 2 minutes, etc.?

22. Were there any lingering (hours or days) visual affects? If so, were the effects continuos or intermittent? Did you have problems reading or seeing in low-light conditions? How long until you were able to see normally again?

23. Did you notice any reddening, warming, or burns to your skin?

24. Describe the condition of your vision before the incident? Do you wear glasses? Are you taking any medications?

25. Did you seek medical attention following the incident? Were and when were you examined? Who performed the examination? Was the examiner an ophthalmologist or optometrist: What were the clinical findings.

LASER Injuries

If you have been involved in a laser incident, then naturally you are concerned about what affect the laser might have had on your eyes and vision. The best way for you to get a quick evaluation of your vision is to use the Laser Incident Vision Sreen. Ideally you would have checked your vision with the card to determine a baseline. If you can read line 32, 25, or 20 and there is no distortion on the Foveal Grid Test, then it is unlikely that the laser did any significant damage. In fact, it may have done none at all.

Laser injuries can have a wide range of effects including flashblindness, dazzle, dark spots, hazy vision, floaters, burns, retinal bleeding, etc. Luckily, the part of the eye responsible for most of our central vision is about the size of a pinhead. It is possible, that this area could be damaged by a laser, but only if a person happened to be looking directly at the light. A laser injury even a few millimeters away from this area, will probably not significantly affect the central vision. The central vision is what you use to read, watch TV, and drive with.

Most people after encountering a laser incident quite naturally start to become overly conscious about how their eye feels and sometimes begin to rub their eyes. This has caused some people to erroneously conclude that their eye was injured. Furthermore, rubbing of the eyes can produce small scratches on the cornea. This of course makes the eyes irritable, to which people have falsely attributed to the laser incident. The important point is that if your vision and eyes seem normal after completing the Laser Incident Vision Screen, there is probably no significant damage to your eyes due to the laser.

LASER INCIDENT

VISION SCREEN

Following a suspected LASER incident, any exposed or potentially exposed person should perform visual screening using these instructions and the Aidman Vision Screener. THIS SCREENING IS TO BE DONE ONLY WHEN THE MISSION ALLOWS. The results should be reported to the flight surgeon and intelligence personnel. All personnel who suspect laser exposure or injury should be evaluated by a flight surgeon.

Step 1. Near Visual Acuity

Hold the card approximately 2 card lengths away in good light.

- use a flashlight to illuminate the card if necessary
- if you wear glasses to read, wear them for the test

Cover your left eye with the palm of your left hand.

- do not press on the eyeball

Using the letter chart on the left side of the card, record the line number of the smallest line where you can identify 7 out of 10 letters (ie., 40, 32, 25, etc.)

Repeat procedure for the other eye.

The smallest line the right eye could see at least 7 out of 10 was _____

The smallest line the left eye could see at least 7 out of 10 was _____

Note: The tumbling "C" chart can also be used for this test by identifying if the "C" is oriented left, right, up, or down. Also, disregard Laser Exposure Evacuation Criteria

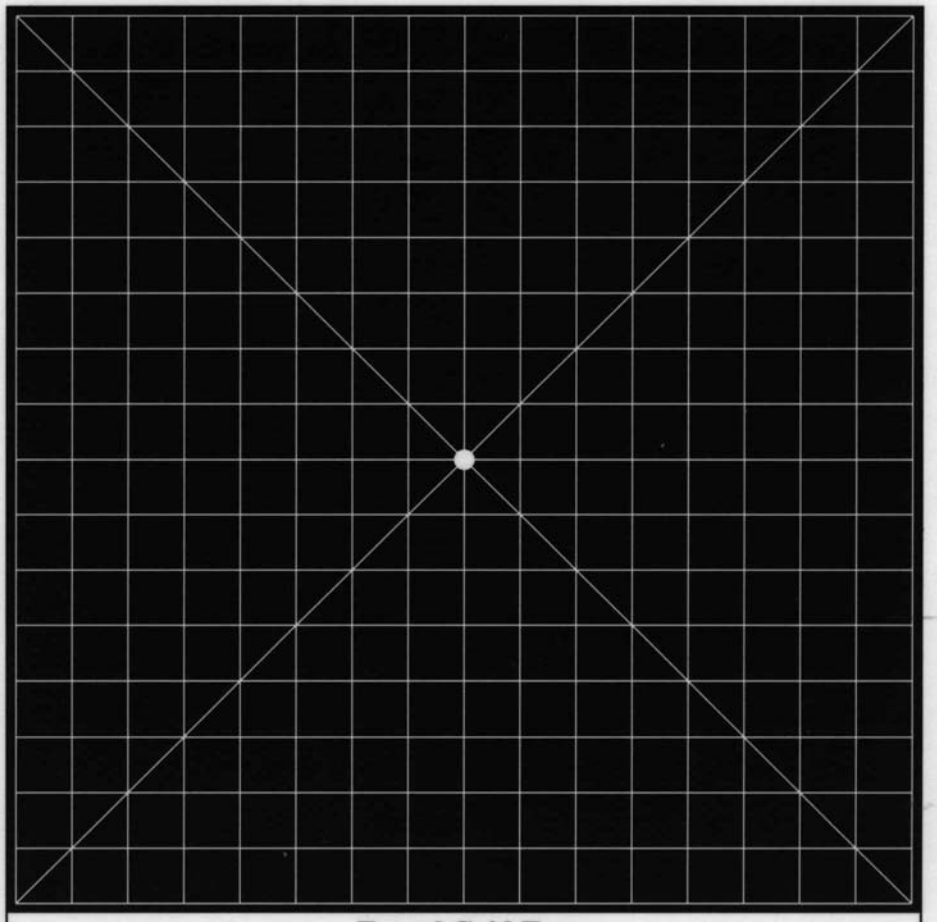
Step 2. Foveal Grid Test

Follow the instructions on the back of the card. Remember to do the test for each eye individually.

The foveal grid test resulted in a (circle one) normal/ minor defect/ major defect of the right/ left eye.

Step 3. Review

Review the Debriefing for Suspected Laser Incidents when time permits.



Foveal Grid Test

Instructions: Provide Amsler Record Chart pad for soldier to draw any irregularities. Test each eye separately in good light, reading the following:

1. Cover your left [right] eye.
2. Hold the card about 40 centimeters or two card-lengths from your eye.
3. Focus on the dot in the center of the grid.
4. While continuing to focus on the center dot, do you notice any dark or hazy areas anywhere on the grid? [If the answer is YES, provide a pen or pencil and say: Please draw in the areas that appear dark or hazy to you.]
5. While still looking at the center dot, do you see all of the horizontal lines? Do these all appear straight? [If the answer to either question is NO, provide a pen or pencil and say: Draw the straight lines where you think they should be.]
6. While still looking at the center dot, do you see all of the vertical lines? Do these all appear straight? [If the answer to either question is NO, provide a pen or pencil and say: Draw the straight lines where you think they should be.]

Interpreting the Results:

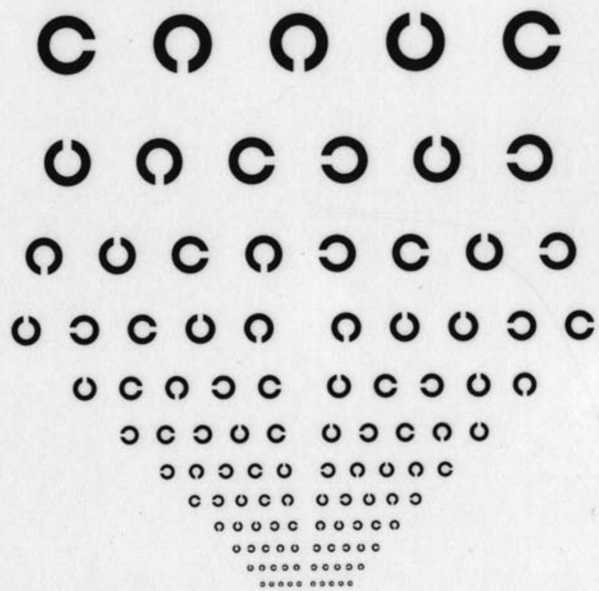
Normal - No dark or hazy areas are seen. All lines are seen and are straight.
Minor defect - Dark or hazy area (or abnormal lines) which is less than 4 boxes long.
Major defect - Dark or hazy area (or abnormal lines) which is 4 or more boxes long or the affected area includes the center dot.

Attachment 5

USAMRD-WRAIR
7914 A Drive
Brooks AFB, TX 78235-5138
(210) 536-4642

AIDMAN VISION SCREENER

Letters	Acuity
Z V S K R	250
V O Z D K R	200
C N D V O Z H S	160
D V K R S K R C N V	125
Z H R K R C N D V O	100
S D K H N O R C N D	80
N D V O K H R Z R C	63
Z H R Z R C N D S O	50
K R C N D O D V K R	40
O R C N D S D K H N	32
Z R C N D V O K H R	25
K R C N D V O Z H R	20



Laser Exposure Evacuation Criteria: For soldiers who report being exposed to a potential laser source, perform the above test and the test on the reverse side of the card. Use the following table to determine whether the soldier should be evacuated or returned to duty.

Visual Acuity	Foveal Grid Result: Normal	Minor Defect	Major Defect
20/63 or worse in one/both eyes	Evacuate	Evacuate	Evacuate
20/50 or better in both eyes	Return to Duty	Reevaluate in 15 minutes*	Evacuate

* Based on reevaluation findings, return to duty if no worse, or evacuate if condition worsens.

Instruction for testing Visual Acuity: Hold card in good light 40 centimeters, approx. 2 card lengths, from eye. Test each eye individually. If the soldier normally wears glasses, these should be worn during the test. Record acuity of the smallest line for which the soldier can identify the letter or direction of 7 out of 10 characters correctly.

Pupil Gauge (mm)