

## Procedure for Laser Eye Exams

v1, August 4, 2020

### I. Scope

This procedure applies to all individuals directly involved with the use of Class 3b and 4 lasers in MIT facilities. Incidental laser workers (e.g. custodial, clerical) are excluded from the eye exam requirements.

This Procedure is issued collaboratively by MIT Medical and the Radiation Protection Program of Environment, Health, and Safety.

### II. Purpose

To establish a Procedure for pre-assignment eye exams, periodic eye exams, termination eye exams, and incident-related eye exams related to laser use. These requirements reflect those stated in ANSI Z136.1-2014, Appendix E, Medical Surveillance [see Addendum to this Procedure] and those of DoD as it pertains to MIT Lincoln Laboratory. Principle investigators and supervisors of laser installations are requested to publicize this procedure and are responsible that these requirements are met.

### III. Requirements

- Pre-assignment Medical Exams - The pre-assignment medical exam (commonly referred to as baseline laser eye exam) as stated in ANSI Z136.1-2014 is **not required** for users of class 3b and 4 lasers on MIT Campus. If it is determined by the LSO, facility supervisor, and the laser worker or by facility requirements (i.e., MITLL) that a baseline eye exam is required; the following applies.

The baseline exam is used to establish a baseline against which ocular damage may be measured. Ocular histories, visual acuity measurement and selected examination protocols may be required dependent on the specific laser radiation wavelength. These examinations shall be performed by, or under the supervision of, an ophthalmologist, optometrist or other qualified physician as specified in ANSI Z136.1. This exam shall include those procedures specified in the latest version of ANSI Z136.1. In Lieu of the Amsler Grid as specified in ANSI Z136.1, Spectral Domain Optical Coherence Tomography (Spectral Domain OCT) should be performed as the preferred method as this provides in part, a physical record of the exam. Records of these results shall be maintained in the individual's medical file.

- Periodic Eye Examination - Periodic eye examinations are not required. No chronic health problems have been associated with laser work.
- Termination Eye Examination - Termination eye examinations are not required for all users of class 3b and 4 lasers. If it is determined by the LSO, facility supervisor and the laser worker that a termination eye exam eye exam is required, the exam shall include those procedures specified in the latest version of ANSI Z136.1. Records of these results shall be maintained in the individual's medical file.

- Incident-Related Eye Exams - In the event of any accidental or suspected eye exposure to laser radiation, a thorough eye examination shall be conducted as specified by the ophthalmologist, optometrist or other qualified physician as specified in ANSI Z136.1 as soon as possible following the incident/exposure. For Incident related eye exams, it is important that immediate care be administered promptly and as such, the most immediate care should be sought.

Supervisory injury report is required for any injury or suspected exposure

The MIT Radiation Protection program will review the incident.

- Administration of Eye Exams – Eye Exams are normally conducted at MIT Medical, however other care providers may administer the Eye Exam, provided they follow the guidance and meet the qualifications for administering the eye exam as set forth within the most current version of ANSI Z136.1.

For eye exams conducted using care providers other than MIT Medical, a copy of the requirements and administration of the eye exam shall be provided to the examiner by the examinee. Providing a copy of these requirements is not necessary for incident base eye injury care provided by outsider providers.

#### IV. Examination Protocol

The laser worker is provided a Laser Eye Examination Approval Form from Radiation Protection typically during Laser Safety training but can be requested at any time from the Radiation Protection program when a laser eye exam is required. The Laser Eye Examination Form will be signed by the optometrist or ophthalmologist performing the examination. The laser worker then returns the completed form to MIT EHS whereupon the date of completion is entered into the training system and the form filed. Note that this is not required for incidents and immediate care should be sought.

Eye Examinations performed by providers other than MIT shall have the results transmitted to MIT Medical for review and in particular for any deviations that may warrant further consultations and evaluations.

Examinations should include the following elements:


- **Ocular History:** The past eye history and family histories 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. Use of photosensitizing medications, such as phenothiazines and psolarens, lower the threshold for biological effects in the skin, cornea, lens and retina of experimental animals exposed to ultraviolet and near ultraviolet radiation. Aphakic individuals would be subject to additional retinal exposure from near ultraviolet and ultraviolet radiation. Unless chronic viewing of these wavelengths is required, there should be no reason to deny employment to these individuals.

- **Visual Acuity:** Visual acuity for far and near vision should be measured with some standardized and reproducible method.
- **Macular Function:** A Spectral Domain OCT or in absence of such, an amsler grid or similar pattern is to be used to test macular function for distortions and scotomas.
- **Dilated Examination of the Ocular Fundus:** Points to be covered are the presence or absence of opacities in the cornea; media; the sharpness of outline of the optic disc; the color of the optic disc; the presence or absence of a well-defined macular and any retinal pathology (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. The use of Spectral Domain OCT provides documentation and is the preferred means for doing so.

*Addendum A:*

*MIT Medical Eye Service to authorize and document performance [not findings] of exam*

*Contact Radiation Protection for current form and authorization*

|   |  |   |              |               |
|---|--|---|--------------|---------------|
|  <b>MIT EHS</b><br><small>ENVIRONMENT · HEALTH · SAFETY</small>  |  | <b>Laser Eye Examination</b>  |              |               |
| <b>Radiation Protection Program</b>   |  | <input type="checkbox"/> MIT Campus <input type="checkbox"/> MIT Lincoln Laboratory |              |               |
| <b>SECTION I. Information</b>   |  |   |              |               |
| <b>Laser Worker</b>   |  | <input type="checkbox"/> MIT Campus <input type="checkbox"/> MIT Lincoln Laboratory |              |               |
| Last, First name _____  |  | Kerberos ID/LL Badge # _____  |              | Phone # _____ |
| Department/Group _____  |  | PI/Project _____  |              |               |
| Supervisor/Group Leader _____   |  | Last, First name _____  |              |               |
| RP Approval (last, first name) _____  |  | Signature _____   |              | Date _____    |
| <b>SECTION II. Instruction</b>  |  |   |              |               |
| <p>The ANSI Standard (ANSI Z136.1) has made baseline and termination eye exams optional. Eye Exams are required for incidents or for cause conditions. MIT does encourage baseline Eye Examinations for open beam class 4 laser systems.</p> <p><b>Eye Exams administered by the MIT Medical Department (E23)</b></p> <ol style="list-style-type: none"> <li>Contact the MIT Eye Clinic at 617-258-9788 to schedule an appointment for the Laser Eye Examination.</li> <li>Bring this form with you to your eye examination appointment.</li> <li>Obtain the Examiner's signature for verification.</li> <li>Return this form, <b>signed by the Examiner</b>, to the Radiation Protection Program within EHS.</li> </ol> <p><b>Eye Exams administered by an external provider</b></p> <ol style="list-style-type: none"> <li>Provide a copy of the laser eye exam procedure and evidence of the eye exam. (available for download on the EHS Radiation Protection Websites)</li> <li>Bring this form with you to your eye examination appointment.</li> <li>Obtain the Examiner's signature for verification.</li> <li>Return this form, signed by the Examiner, to the Radiation Protection Program within EHS.</li> </ol> <p>Upon termination of work with Class 3B and/or Class 4 laser systems, you may also obtain a <b>Termination Eye Examination</b> by completing this form.</p> <p><b>NOTE:</b><br/>         In the event of any accidental or suspected eye exposure to laser radiation, seek Medical Attention immediately. This form is not required for this. Have your supervisor initiate the supervisory injury process. MIT Medical Department may follow-up if initial care is not provided at MIT Medical Department. Notify the Radiation Protection Program for a review of the incident.</p> |  |   |              |               |
| <b>Eye Exam Type:</b> <input type="checkbox"/> Baseline <input type="checkbox"/> Termination <input type="checkbox"/> Incident  |  |   |              |               |
| <b>TO BE COMPLETED BY EXAMINER</b>  |  |   |              |               |
| <input type="checkbox"/> <b>MIT Medical</b>   |  |   |              |               |
| Examiner (Print Name) _____   |  | Signature _____   |              | Date _____    |
| <input type="checkbox"/> <b>External Provider:</b>  |  |   |              |               |
| Company/Provider Organization Name _____  |  |   |              |               |
| Address: _____  |  |   | Phone: _____ |               |
| Examiner (Print Name) _____   |  | Signature _____   |              | Date _____    |
| <small>RP-L-FRM007<br/>Rev2.0</small>   |  |   |              |               |

## Addendum B

Excerpts from ANSI National Standard Z136.1-2014

## **6. Medical Examinations**

### **6.1 Examinations Following a Suspected or Actual Laser-Induced Injury.**

Medical examinations shall be performed as soon as practical (usually within 48 hours) when a suspected injury or adverse effect from a laser exposure occurs. In addition to the acute symptoms, consideration shall be given to the exposure wavelength, emission characteristics and exposure situation to ensure appropriate medical referral. See Appendix F for recommended examination protocol commensurate with the observed symptoms and laser system. For injury to the eye from lasers operating in the retinal hazard region, examinations shall be performed by an ophthalmologist.

### **6.2 Rationale for Other Medical Examinations.**

The rationale for providing a medical surveillance program for personnel working in a laser environment and specific information of value to examining or attending physicians are included in Appendix F. Medical surveillance should be considered for those who are clearly known to be at risk from particular kinds of laser radiation. Medical surveillance is not recommended for personnel using Class 1, Class 1M, Class 2, Class 2M or Class 3R lasers and laser systems as defined in 3.3, but should be considered for personnel exposed to Class 3B and Class 4 lasers and laser systems. Further information is provided in Appendix F3.1.

## **Appendix F**

### **Medical Examinations**

#### **F1. Medical Referral Following Suspected or Known Laser Injury**

Any employee with an actual or suspected laser-induced injury should be evaluated by a medical professional as soon as possible after the exposure (usually within 48 hours). Referral for medical examinations shall be consistent with the medical symptoms and the anticipated biological effect (see Appendix H) based upon the laser system in use at the time of the incident. For laser-induced injury to the retina, the medical evaluation shall be performed by an ophthalmologist. Employees with skin injuries should be seen by a physician.

**F1.1. Examination Protocols.** Recommended medical examinations for actual or suspected exposure include but are not limited to those listed below.

**F1.1.2 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 that might produce ocular problems with regard to the performance cited in 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. Aphakic individuals would be subject to additional retinal exposure from blue light, near ultraviolet and ultraviolet radiation. Unless chronic viewing of these wavelengths is required, there should be no reason to deny employment to these individuals.

**F1.1.3 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 near vision, a more extensive examination is indicated as defined in F1.1.6.

**F1.1.4 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.

**F1.1.5 Color Vision.** Color vision discrimination can be documented by Ishihara or similar color vision tests.

**F1.1.6 Examination of the Ocular Fundus with an Ophthalmoscope or Appropriate Fundus Lens at a Slit Lamp.** This portion of the examination is to be administered to individuals whose ocular function in any of subsections F.1.1.2 through F.1.1.5 is not normal. The points to be covered are:

- a) the presence or absence of opacities in the media;
- b) the sharpness of outline of the optic disc;
- c) the color of the optic disc;
- d) the depth of the physiological cup, if present;
- e) 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 fovea reflex; and

f) 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.

**F1.2 Skin Examination.** While not required for pre-placement of laser workers, skin examinations are recommended for employees with a history of photosensitivity or working with lasers emitting accessible ultraviolet radiation. 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 that are potentially photosensitizing.

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

**F1.3 Other Examinations.** Further examinations should be done as deemed necessary by the examiner.

## **F2. Medical Examinations**

**F2.1 Rationale for Examinations.** Past experience has shown that pre-incident examinations would normally not be as extensive as a post incident examination. Therefore, the medical-legal value of pre-examination has been shown to be of limited value with litigation tending to be driven by biophysical measurements of the accident site and the exposure geometry. Individual institutions may provide pre-exposure screening and even continuing surveillance; however, that surveillance is not deemed to be a requirement for safe laser usage.

**F2.1.1 Preassignment Medical Examinations.** One purpose for the use of a preassignment medical examination 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 F1.1). Examinations should be performed by, or under the supervision of, an ophthalmologist, optometrist or other qualified physician. Certain examination protocols may be performed by other qualified practitioners or technicians under the supervision of a physician. Although skin damage from chronic exposure to 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 indicate whether they are needed or not.

**F2.1.2 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 biological 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.



**F2.1.3 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.

### **F3. Medical Surveillance Examinations**

**F3.1 Rationale for Surveillance Examinations.** 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 biological 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 (e.g., toxic gases, noise, ionizing radiation) 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 biological 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 implemented 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 30 years and the excellent safety records with laser devices do not provide support to this argument.

### **F4. 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.

### **F5. 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 F4 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. All records must be managed in accordance with the Health Insurance Portability and Accountability Act (HIPAA).

## F6. 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 295 nm to 450 nm range and are also theoretically possible from 750 nm to 1400 nm.

Photochemical retinitis appears to be inducible by exposure to 350 nm to 500 nm 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.

## F7. References

Department of the Army Field Manual 8-50, *Prevention and Medical Management of Laser Injuries*, Headquarters, Department of the Army, Washington, D.C. August 1990.

<http://www.adtdl.army.mil/cgi-bin/atdl.dll/fm/8-50/toc.htm>

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Hathaway, J. A., "The need for medical surveillance of laser and microwave workers," *Current Concepts in Ergophthalmology, Societas Ergophthalmologica Internationalis*, Sweden, pp. 139-160, 1978.

Hathaway, J. A., Stern, N., Soles, E. M., Leighton, E., "Ocular medical surveillance on microwave and laser workers," *J. Occup Med.*, vol. 19, pp. 683-688, 1977.

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Wolbarsht, M. L., and Landers, M. B., "Testing visual capabilities for medical surveillance or to ensure job fitness," *J. Occup Med.*, vol. 27, pp. 897-901, 1985.

USAFSAM-TR-88-21, *Medical Management of Combat Laser Eye Injuries*, Green, R.P., Cartledge, R.M., Cheney, F. E., Menendez, A. R., Brooks Air Force Base, TX. October 1988