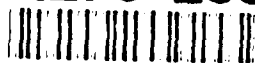


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LASER SAFETY MANUAL FOR DREO

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by

N. Brousseau

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TECHNICAL NOTE 93-36

Canada

November 1993
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LASER SAFETY MANUAL FOR DREO

by

N. Brousseau

*Communications Electronic Warfare Section
Electronic Warfare Division*

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ABSTRACT

This document contains the information and regulations needed to establish a safe working environment in research laboratories where laser radiation is used. It is based on the American National Standard for the Safe Use of Lasers (ANSI Z136.1-1986) and it contains additional provisions for medical surveillance to protect the Department of National Defence from damage claims.

RÉSUMÉ

Ce document contient l'information et les règlements nécessaires au maintien d'un milieu de travail sécuritaire dans les laboratoires de recherche utilisant de la radiation laser. L'"American National Standard for the Safe Use of Lasers (ANSI Z136.1-1986)" est la base de ce document qui contient des clauses additionnelles de surveillance médicale pour protéger le Ministère de la défense nationale de poursuites légales.

EXECUTIVE SUMMARY

Laser beams are currently used for some R&D activities at DREO. As laser radiation constitutes a potential hazard, appropriate laser safety precautions have to be taken to avoid the occurrence of accidents. The primary goal of the DREO Laser Safety Manual is to provide DREO laser users with the information, guidance, and regulations that they need to establish and maintain a safe working environment in their laboratories. A secondary goal is to protect DND from damage claims that could be associated with negligent use of laser light or inappropriate or insufficient laser safety precautions.

The DREO Laser Safety Manual is based on the American National Standard for the Safe Use of Laser, ANSI Z136-1.1986, the DND document Medical Surveillance of Personnel Occupationally Exposed to Hazardous Laser Devices (FCMO 27-13), and some additional provisions about the laser safety program designed specifically for DREO according to ANSI Z136-1.1986. The medical surveillance program proposed in ANSI Z136.1-1986 is not considered adequate because it fails, in some respects, to legally protect DND. Consequently, the medical surveillance program defined in FCMO 27-13 (Attachment B) shall be used at DREO. Hence the DREO Laser Safety Manual contains all the mandatory elements of ANSI Z136.1-1986 plus supplementary regulations that shall ensure the legal protection of DND.

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LIST OF ABBREVIATIONS

ANSI	American National Standard Institute
CFMO	Canadian Forces Memorandum of Understanding
CW	Continuous Wave
DND	Department of National Defence
DREO	Defence Research Establishment Ottawa
LSO	Laser Safety Officer

1.0 INTRODUCTION

Pulsed and continuous-wave (CW) lasers are currently used for some R&D activities at the Defence Research Establishment Ottawa (DREO). As laser radiation constitutes a potential hazard, appropriate laser safety precautions have to be taken to avoid the occurrence of accidents.

The primary goal of the DREO Laser Safety Manual is to provide DREO laser users with the information, guidance and regulations that they need to establish and maintain a safe working environment in their laboratories.

A secondary goal is to protect Department of National Defence (DND) from damage claims that could be associated with negligent use of laser light or inappropriate or insufficient laser safety precautions.

2.0 DREO APPROACH TO LASER SAFETY

The American National Standard for the Safe Use of Lasers (ANSI Z136.1-1986, Attachment A) is the main component of the DREO Laser Safety Manual. ANSI Z126.1-1986 is a comprehensive document that contains integrated analysis and recommendations on all aspects of laser safety. It includes hazards, the mathematical equations and procedures necessary to calculate laser exposure, and the engineering and administrative laser control measures required to achieve safe work environment. Also included is the definition of the organization of laser safety programs, the labelling of lasers and facilities, the handling of laser ancillary hazards, and the training requirements for the personnel using lasers and/or active in the laser safety program.

The DREO Laser Safety Manual is based on ANSI Z136-1.1986, the DND document Medical Surveillance of Personnel Occupationally Exposed to Hazardous Laser Devices (CFMO 27-13), and some additional provisions about the laser safety program designed specifically for DREO according to ANSI Z136-1.1986. It uses the same terminology as found in ANSI Z136.1-1986. CFMO 27-13 can be found in Appendix A. The DREO Laser Safety Manual contains the organization chart of personnel responsible for laser safety at DREO and the position, in terms of the laser safety hierarchy, of the staff working with lasers. It also includes the definition of DREO laser safety training and the DREO medical surveillance program for laser workers.

The only discrepancy, which is an important one, between the ANSI Z136.1-1986 and the DREO Laser Safety Manual is the medical surveillance program that is more developed in the DREO Safety Manual. The medical surveillance program proposed in ANSI Z136.1-1986 is not considered adequate because it fails, in some respects, to legally protect DND. Consequently, the medical surveillance program defined in CFMO 27-13 shall be used at DREO. The DREO Laser Safety Manual therefore contains all the mandatory elements of ANSI Z136.1-1986 plus supplementary regulations that shall ensure the legal protection of DND.

3.0 ORGANIZATION OF LASER SAFETY AT DREO

The management of laser safety at DREO is organized according to the requirements of ANSI Z136.1-1986. Laser safety responsibilities shall be shared by the Laser Safety Officer (LSO), the Deputy Laser Safety Officer, and the Supervisor of Laser Safety in the Laboratories. The duties of this people are defined in ANSI Z136.1-1986. The list and organization chart of the people involved in laser safety at DREO follows:

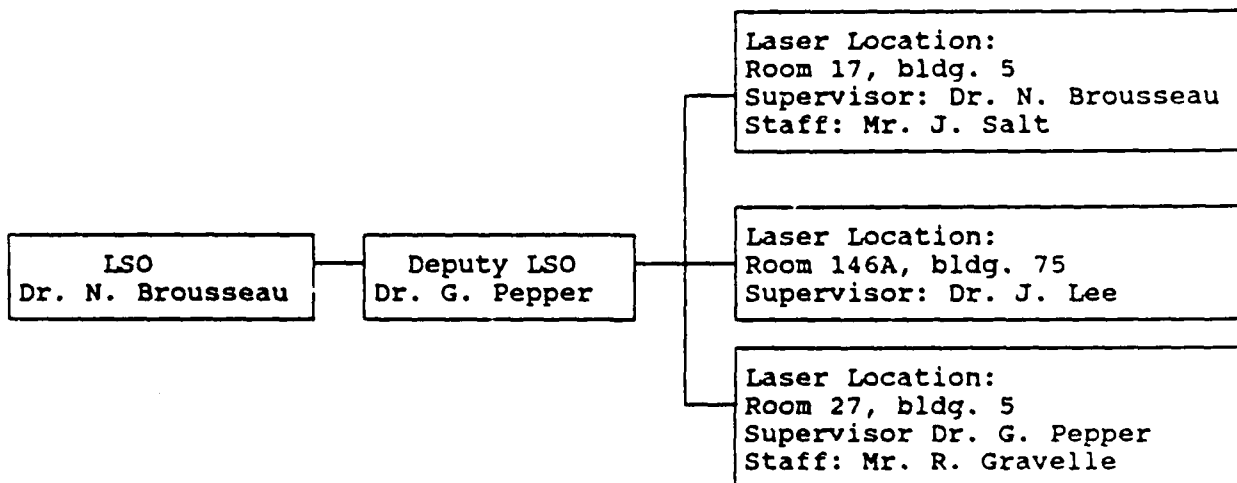


FIGURE 1: ORGANIZATION OF THE PEOPLE INVOLVED IN LASER SAFETY AT DREO

Records of all documents related to the DREO Laser Safety Program shall be kept in the DREO Registry in the file open for that purpose.

4.0 DREO MEDICAL SURVEILLANCE FOR LASER WORKERS

A medical eye examination before assignment to laser work is the only examination required by ANSI Z136.1-1986. This is not sufficient to protect DND against unwarranted claims for damage that might have occurred after employees have stopped working with lasers for DND. Consequently the medical surveillance of laser eye damage at DREO shall be in accordance with the DND document MEDICAL SURVEILLANCE OF PERSONNEL OCCUPATIONALLY EXPOSED TO HAZARDOUS LASER DEVICE, CFMO 27-13, where medical eye examinations before and after assignment to laser work are mandatory. Medical eye examinations are also required when there is an accident, or a presumption of accident, by the employee or management. These eye examinations for laser induced eye injury are made at the National Defence Medical Centre according to the prescriptions of CFMO 27-13.

5.0 DREO LASER SAFETY TRAINING POLICY

ANSI Z136.1-1986 outlines the training requirements for personnel working with lasers. The following rules define explicitly how DREO applies the ANSI Z136.1-1986 for laser safety training.

- 1) All permanent DREO personnel using a class 3 or 4 laser shall successfully complete a course on laser safety. A suitable course is the correspondence course "Safety Course for Laser Personnel" from Engineering Technology Institute (ETI). It includes a written examination which will be marked by ETI. Any equivalent course is acceptable. If a large number of new laser users is expected, a computer based course could be an interesting alternative.
- 2) All personnel using class 1, 2, or 3 lasers shall receive appropriate training from the Laser Safety Officer or the Deputy Laser Safety Officer.
- 3) Summer and co-op students having to work with lasers shall be given the laser safety training appropriate to their function by the Supervisor of the laboratory in which they are working.

6.0 CONCLUSIONS

The Laser Safety Manual for DREO describes the laser safety precautions that must be taken to avoid the occurrence of accidents in laboratories using laser radiation for R&D activities. Also included are the DREO medical surveillance program for laser workers, the DREO laser safety training policy, and a description of the organization of laser safety at DREO.

7.0 REFERENCES

- [1] "American National Standards for the Safe Use of Lasers", ANSI Z136.1-1986, American National Standards Institute Inc., 1430 Broadway, New York 10018, United States.

8.0 ACKNOWLEDGEMENTS

The author would like to thank Mr. J. Salt and Dr. G. Pepper for reviewing this document and for their useful suggestions.

APPENDIX A

MEDICAL SURVEILLANCE OF PERSONNEL
OCCUPATIONALLY EXPOSED TO HAZARDOUS LASER DEVICES,
CFMO 27-13

MEDICAL SURVEILLANCE OF PERSONNEL OCCUPATIONALLY EXPOSED TO HAZARDOUS LASER DEVICES

Purpose

1. This order outlines the medical surveillance program for military and DND civilian personnel who are occupationally exposed to LASER devices.

General

2. "LASER" is an acronym for "Light Amplification by Stimulated Emission of Radiation" and lasers are a family of devices which generate coherent electromagnetic radiation within the ultra-violet, visible and infra-red regions of the spectrum. The light from a laser device can cause retinal and skin burns, therefore, safety precautions as described in CFAO 66-4, must be strictly observed.

3. The target organ of greatest importance in laser-caused burns is the eye. Burns in the peripheral retina, if small, may not be noticeable by the victim, whereas any damage to the fovea, which is only about 1 mm in diameter, can result in serious impairment of vision. When one looks directly into a laser beam, the energy is concentrated onto the fovea which is very susceptible to damage from laser light. Needless exposure to the retina should be avoided.

Classification of Laser Devices

4. Four classes of laser devices, defined by their relative hazards, are detailed in CFTO C-06-040-004/AG-000. For purposes of this order, a brief description of the relative hazards produced by the four classes follows:

- a. Class I device, no radiation hazards;
- b. Class II device, no significant retinal hazard if reasonable precautions are taken and the length of a work day (eight hours) prevents longer exposures;
- c. Class III device, significant retinal and skin hazard from direct beams; flammable material may be ignited and protective materials begin to lose protective characteristics at Class III upper limits; and

SURVEILLANCE MÉDICALE DU PERSONNEL EXPOSÉ DANS LE CADRE DE SES FONCTIONS AUX DANGERS INHÉRENTS À L'USAGE D'APPAREILS À LASER

But

1. Le présent ordre décrit le programme de surveillance médicale à l'intention des militaires et du personnel civil du MDN qui, dans le cadre des fonctions qu'ils exercent, sont exposés aux appareils à LASER.

Généralités

2. "LASER" est un acronyme anglo-saxon qui signifie "Light Amplification by Stimulated Emission of Radiation" et les lasers constituent une famille d'appareils qui engendrent des radiations électromagnétiques cohérentes dans les régions ultraviolettes, visible et infrarouges du spectre. La lumière émise par un appareil à laser peut provoquer des brûlures de la rétine et de la peau. Les mesures de précaution décrites dans l'OAFC 66-4 doivent donc être strictement observées.

3. L'œil est l'organe le plus exposé à subir des brûlures causées par des lasers. Si elles sont petites, les brûlures de la rétine périphérique peuvent passer inaperçues, tandis que tout dommage à la fovéa, qui n'a qu'un millimètre, peut provoquer une sérieuse diminution de la vue. Lorsqu'on regarde directement dans un rayon laser, l'énergie se concentre sur la fovéa, laquelle peut être très facilement endommagée par la lumière du laser. Il faut éviter d'exposer inutilement la rétine.

Classification des appareils à laser

4. Quatre catégories d'appareils à laser, définies en fonction du danger relatif qu'elles représentent sont décrites de façon détaillée dans l'ITFC C-06-040-004/AG-000. Aux fins du présent ordre, voici une brève description du degré variable de danger que représente chacune des quatre catégories:

- a. Appareils de catégorie I, aucun danger de radiation;
- b. Appareils de catégorie II, pas de danger sérieux pour la rétine si de bonnes précautions sont prises et que la durée d'une journée de travail n'excède pas huit heures, empêchant ainsi une exposition plus prolongée,
- c. Appareils de catégorie III, danger sérieux pour la rétine et la peau, s'il y a exposition directe aux rayons, des matériaux inflammables peuvent prendre feu et les matériaux protecteurs commencent à perdre leurs caractéristiques protectrices dans les limites supérieures des appareils de la catégorie III; et

- d. Class IV highly significant retinal and skin hazard from direct or reflected beams; protective materials may be ineffective.

Surveillance Procedures

5. Surveillance of occupationally exposed personnel, as defined in paras 11 and 12, shall be maintained by means of three types of individual examinations; these are:

- a. Pre-employment examinations;
- b. Special examinations; and
- c. Post-employment examinations.

6. Visitors to a laser facility who are adequately protected from the laser beam by protective devices or other suitable means need not be included in the surveillance program.

Pre-Employment Examination

7. A pre-employment examination will be carried out on personnel prior to employment associated with Class II, III or IV laser devices. This examination will normally be performed by a non-specialist medical officer (MO) and will include:

- a. Ocular and relevant general medical history;
- b. Assessment of near and far visual acuity, with or without correction, if worn;
- c. Test of colour vision; and
- d. Examination of the fundus with use of a mydriatic agent.

8. Should the pre-employment examination reveal any fundus abnormality, the individual will be referred to an ophthalmologist for further examination. Any fundus, corneal or lens abnormality, whether or not it is believed due to the effects of radiation, will be visually recorded, preferably by colour photography.

- d. Appareils de catégorie IV, danger très sérieux pour la rétine et la peau s'il y a exposition directe ou exposition par réflexion à des rayons, les matériaux protecteurs peuvent s'avérer inefficaces.

Mesures de surveillance

5. La surveillance du personnel qui est exposé dans l'exercice de ses fonctions aux appareils à laser, telle que définie aux paragraphes 11 et 12, doit être exercée en procédant aux trois types d'exams individuels suivants:

- a. Les exams avant l'emploi;
- b. Les exams spéciaux; et
- c. Les exams après l'emploi.

6. Il n'est pas nécessaire d'inclure dans le programme de surveillance les visiteurs d'une installation où l'on utilise des lasers, s'ils sont protégés d'une manière convenable contre les rayons laser par des appareils protecteurs ou autres moyens efficaces.

Examen avant l'emploi

7. Avant d'occuper un poste où il est fait usage des appareils à laser des catégories II, III ou IV, le personnel devra subir un examen préalable. En règle générale, cet examen sera donné par un médecin militaire généraliste et comprendra:

- a. Un rapport sur les antécédents médicaux de l'employé afférents à ses yeux et d'autres questions médicales pertinentes d'ordre général;
- b. Une évaluation de son acuité visuelle à proximité et à distance, avec ou sans verres correcteurs, si l'employé en porte;
- c. Des tests de discernement des couleurs; et
- d. Un examen du fond de l'oeil avec l'utilisation d'un agent mydriatique.

8. Au cas où l'examen avant l'emploi révélerait une anomalie quelconque du fond de l'oeil, la personne doit être dirigée chez un ophtalmologiste aux fins d'un examen plus approfondi. Toute anomalie du fond de l'oeil, de la cornée ou de la lentille, qu'on soupçonne être causée ou non par les effets de radiations, doit être enregistrée par moyens visuels, de préférence en ayant recours à la photographie en couleurs.

Post-Exposure Examination

9. A post-exposure examination will be carried out on all personnel occupationally associated with Class II, III or IV laser devices who have good reason to believe they have been accidentally exposed to hazardous laser radiation. The examinations listed in subparas 7a to d will be carried out, as required, by a non-specialist MO, who will refer the individual to an ophthalmologist for further examination should evidence of an ocular change be found.

Post-Employment Examination

10. A post-employment examination will be carried out on personnel who have ceased employment or association with Class II, III or IV laser devices. These examinations will normally be performed by a non-specialist MO immediately after termination of the laser-associated duties. The examinations listed in subparas 7a to d are required. Detection of any ocular change occurring since the most recent examination indicates a requirement for referral to an ophthalmologist.

Personnel Requiring Examination

11. Military personnel whose duties entail significant risk of retinal exposure to Class II, III or IV laser device beams shall have the medical examinations outlined in paras 5 to 10. Common sense must be applied in determining personnel who are at significant risk of retinal exposure since it is neither possible nor necessary to provide routine examinations to all personnel occupationally associated with Class III or IV laser devices.

12. DND civilian personnel whose duties entail significant risk of retinal exposure to Class II, III or IV laser device beams shall have the same medical examinations as specified for military personnel in para 11 above.

Responsibilities

13. The responsibilities of commanding officers to the medical surveillance program are outlined in CFAO 66-4.

14. The Canadian Forces Medical Services (CFMS) is responsible for providing the examinations described in this order and for recording and reporting findings as detailed in paras 16 and 17.

Examen après exposition aux radiations

9. Toutes les personnes qui, en raison des fonctions qu'elles exercent, sont en contact avec des appareils à laser des catégories II, III ou IV et qui ont de bonnes raisons de croire qu'elles ont été accidentellement exposées à des radiations laser doivent subir un examen de ce genre. Un médecin militaire généraliste procédera, au besoin, aux examens énumérés aux alinéas a. à d. du paragraphe 7 et dirigera la personne concernée chez un ophtalmologiste aux fins d'un examen plus approfondi dans le cas où il observerait un changement oculaire quelconque.

Examen après l'emploi

10. Le personnel qui cesse d'être en contact ou de travailler avec des appareils à laser des catégories II, III ou IV doit subir un examen après leur emploi. En règle générale, un médecin militaire généraliste procédera à ces examens immédiatement après que l'employé cesse de s'acquitter des tâches liées à l'usage de lasers. Les examens requis sont ceux énumérés aux alinéas a. à d. du paragraphe 7. La découverte de tout changement oculaire survenu depuis l'examen le plus récent signifie que la personne concernée doit consulter un ophtalmologiste.

Personnel nécessitant un examen

11. Les militaires dont les tâches comportent de sérieux risques d'exposition de la rétine à des rayons laser des catégories II, III ou IV doivent subir les examens médicaux énumérés aux paragraphes 5 à 10 ci-dessus. Il faut faire preuve de bon sens en procédant à l'identification des militaires qui risquent de subir une exposition de la rétine, étant donné qu'il n'est ni possible, ni nécessaire de procéder à des examens périodiques de tous les militaires appelés par leurs fonctions à être en contact avec des appareils à laser des catégories III ou IV.

12. Le personnel civil du MDN dont les tâches comportent un risque sérieux d'exposition de la rétine aux rayons d'appareils à laser des catégories II, III ou IV doit subir les mêmes examens médicaux que ceux prévus pour les militaires au paragraphe 11 ci-dessus.

Responsabilités

13. Les responsabilités des commandants relativement au programme de surveillance médicale sont décrites dans l'OAF 66-4.

14. Le Service de santé des Forces canadiennes est chargé d'assurer les services d'examen décrits dans le présent ordre et de consigner et présenter sous forme de rapport les résultats de la façon précisée aux paragraphes 16 et 17.

15. The requirement for notification of DND civilian employees as to the purpose and requirements of the medical surveillance program, and of the individual's responsibility to request of the base surgeon the required examinations at the prescribed times, is described in CFAO 66-4.

Reporting and Recording

16. Results of medical surveillance examinations will be recorded on the appropriate parts of form CF 2033, Record of Medical Examination or form CF 2007, Canadian Forces Ophthalmology Case Record. All records of surveillance program examinations must be of the highest possible quality and completeness.

17. Form CF 98, Report on Injuries, will be initiated in all cases of significant accidental exposure of military personnel to laser beams.

18. Workmen's Compensation Board forms should be prepared for civilian employees as described in Chap 5 of the Administrative and Accounting Manual - Civilian Personnel, in cases of significant accidental exposure of DND civilian personnel to laser beams.

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15. L'OAF 66-4 donne des précisions concernant l'obligation d'avertir les employés civils du MDN au sujet du but et des exigences du programme de surveillance médicale et souligne que c'est à l'individu qu'il incombe de demander au médecin-chef de la base de lui faire subir les examens obligatoires aux intervalles prescrits.

Établissement des rapports et des dossiers

16. Les résultats des examens de surveillance médicale doivent être inscrits dans les parties appropriées de la formule CF 2033, Dossier d'examen médical, et (ou) de la formule CF 2007, Ophtalmologie - Dossier du cas. Tous les dossiers des examens du programme de surveillance doivent être d'excellente qualité et aussi complets que possible.

17. On doit remplir une formule CF 98, Rapport en cas de blessures, dans tous les cas d'exposition accidentelle sérieuse de militaires à des rayons laser.

18. Il faut remplir les formules de la Commission des accidents du travail de la façon décrite au chapitre 5 du Manuel d'administration et de comptabilité du personnel civil, dans les cas où des membres du personnel civil du MDN ont été sérieusement exposés de façon accidentelle aux effets des rayons laser.

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(U) This document contains the information and regulations needed to establish a safe working environment in research laboratories where laser radiation is used. It is based on the American National Standard for the Safe Use of Lasers (ANSI Z136.1-1986) and it contains additional provisions for medical surveillance to protect Department of National Defence from damage claims.

14. **KEYWORDS, DESCRIPTORS or IDENTIFIERS** (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus. e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

LASER SAFETY
MEDICAL SURVEILLANCE FOR LASER SAFETY
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