



INDUSTRIAL LASER COMPLIANCE GUIDE

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Michigan Department of Energy, Labor & Economic Growth
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STATE OF MICHIGAN

MIOSHA CET DIVISION

SAMPLE

(Insert company name)

INDUSTRIAL LASER SAFETY
WRITTEN PROGRAM

SCOPE

This document provides for the safe use of high powered lasers in industrial applications (e.g. where woods, metals, aggregates and plastics are cut or shaped using a class 3B or 4 lasers) and for employee protection related to the use of these lasers. The intent of this program is to provide safe guidelines for our facility, the Laser Safety Officer (LSO) and any other "Authorized" employee user of Class 3B and 4 lasers.

LASER SAFETY OFFICER (LSO)

The LSO for this facility is _____.

LSO SPECIFIC DUTIES

The LSO has the authority to monitor and enforce the control of laser hazards and effect the knowledgeable evaluation and control of laser hazards. The LSO administers the overall laser safety program where the duties include, but are not limited to: confirming the classification of lasers, conducting a hazard evaluation (e.g. Nominal Hazard Zone (NHZ) evaluation), assuring proper control measures are in place, approving substitute controls, approving Standard Operating Procedures (SOP's), recommending and/or approving protective eyewear and other protective equipment, assuring appropriate signage and labels, approving overall facility controls, assuring adequate laser safety training for affected personnel (e.g. maintenance and operators), and determining personnel categories requiring medical surveillance if appropriate.

Classification of Lasers

The LSO shall classify or verify the classifications of lasers or laser systems. The laser hazard class is based on the laser's capability of injuring personnel. Any laser or laser system shall be classified according to its accessible radiation during operation (**Note:** Class 1 systems containing imbedded Class 3B or 4 lasers, where employees have access to the laser, would be included in this program. For example, maintenance or alignment activities associated with a Class 3B or 4 imbedded laser).

Our site laser inventory is shown in the table below (**Complete with site specific information. A sample entry has been provided**).

Laser Inventory Table

Class	Type	Manf. And Model #	Serial #	Power (W)	Hazard Analysis Completed and on-file? (Y/N)	SOP(s) has been developed? (Y/N/NA)	Affected employees trained? (Y/N)
4	CO2	Mazak XYZ	11000	2000	Y	Y	Y

Hazard Evaluation

The LSO shall assure that hazard evaluations are conducted for the lasers used. The hazard evaluation process shall consider the laser or laser system's ability to injure personnel, the environment in which the laser is used (including the beam path) and any personnel who may be directly or indirectly exposed to laser radiation; such as maintenance or operators.

Hazard evaluations will be conducted for all of our Class 3B and 4 lasers (**See *Laser Hazard Evaluation form included in the compliance guide***).

Standard Operating Procedures (SOPs) Procedure Approvals

A SOP is a written description of the safety procedures and administrative controls to be followed when performing a specific task; such as alignment. Any SOPs or laser procedures developed shall be approved by the LSO or his/her authorized designee. The SOPs shall address both beam and non-beam hazards.

The SOPs developed for this facility can be found attached to this program (*Attach site specific laser related SOPs. A sample SOP is attached*).

Personal Protective Equipment (PPE)

Hazard analyses conducted by the LSO will determine what PPE is required (e.g. laser eyewear, skin protection, natural fiber/non-flammable clothing, etc.). The LSO will assure that any optical density (OD) calculated during a hazard analysis is rounded up to the next highest number when selecting eyewear. As an example, if the calculated OD = 5.2, eyewear rated with an OD=6 shall be selected. OD information may be found in the Laser manufacturer's manual.

Signs and Labels

The LSO shall assure any applicable area signage and equipment labels are in place and legible. The purpose of a laser area warning sign is to convey a rapid visual hazard-alerting message. The three types of signs are DANGER, CAUTION and NOTICE. DANGER signs and labels shall be used for Class 3R, 3B and 4 lasers. CAUTION signs and labels shall be used for Class 2 and 2M lasers. A NOTICE sign is to be used for facility area control (e.g. an outside temporary laser controlled area during periods of service).

Equipment labels for Class 3B lasers and laser systems shall say, "Laser Radiation – Avoid Direct Exposure to Beam". Equipment labels for Class 4 lasers and laser systems shall say, "Laser Radiation – Avoid Eye or Skin Exposure to Direct or Scattered Radiation".

Signage and labels shall be displayed in locations where they best serve to warn onlookers.

Equipment

The LSO shall approve the purchase of new laser equipment, regardless of class. The LSO shall review the modification, installation and facilities associated with laser equipment, *prior* to use.

The use of protective barrier curtains and screens to protect against laser exposure will be approved by the LSO to assure they are appropriate. Standard "welding curtains" have not been rated to serve as a means of laser beam protection.

Training

Education may be provided to users of Class 1M, Class 2, Class 2M or Class 3R lasers. Laser safety training must be provided to users of Class 3B or Class 4 lasers.

Laser Safety Officer (LSO) training is required for the facility LSO and will be documented. The LSO should have a comprehensive understanding of the key laser safety issues associated with the lasers they manage.

The LSO shall be trained on the following:

1. **Operational laser characteristics** (e.g. operation, definitions, applications, manufacturers requirements)
2. **Laser hazards** (e.g. hazard assessment, eye and skin hazards)
3. **Laser safety standards** (e.g. OSHA Pub 8-1, ANSI Z136.1)
4. **Laser controls** (e.g. Engineering, Administrative and Procedural)
5. **Safety Methods and Procedures** (e.g. alignments, barriers, warning signs and labels, control of unauthorized personnel, audits and laser worker training)

Maintenance Personnel

The LSO shall insure that all employees assigned to service, maintain, install, adjust, and operate laser equipment be qualified and trained. The training program should be designed appropriate to the class of laser and radiation accessible during the performance of required task(s). Laser area supervisors shall maintain the names of all persons trained and date of training and inform the LSO of training completions and requirements.

Operator Training

Training will include all of the following as appropriate:

- (a) Capabilities of equipment and attachments or fixtures.
- (b) Purpose, use, and limitation of controls & safeguards.
- (c) How to make daily visual inspections of all safety devices.
- (d) Practice in operating assigned equipment through its functions necessary to perform the required job tasks.
- (e) A review of applicable state standards.

Training shall be provided for employees working with Class 3B and Class 4 lasers (e.g. including operators, maintenance personnel, service persons, technical support staff, technicians, etc.) The training will provide a complete understanding of the requirements of a safe laser environment and include discussion of the hazards, safety devices required, procedures related to operating the equipment, warning sign requirements and description of any applicable medical surveillance practices. Emphasis should be placed on practical, safe laser techniques and procedures as well as safety devices that provide an overall safe environment.

The content of the laser safety training should be tailored to each different group that uses lasers. Often the type of laser(s) and locations will impact the content of the training program. For example, the hazards and controls recommended for far-infrared CO₂ lasers may be different than those for a near-infrared Nd:YAG laser or a visible Argon Ion laser.

Training records should be reviewed periodically to assure that training is up to date and potentially exposed personnel have been trained.

Unauthorized Personnel

No unauthorized personnel may enter an identified laser area, when a laser is in operation, unless accompanied by an authorized user. All visitors must be briefed on proper safety protocol and wear appropriate laser safety eyewear.

Medical Surveillance

A medical exam will be performed as soon as practical (usually within 48 hours) of when a suspected injury or adverse effect from a laser exposure occurs. A baseline ocular exam may be useful to have to compare to a post incident ocular exam. Also, a baseline ocular exam may identify certain workers who might be at special risk from chronic exposure to selected lasers.

Audits

An annual laser equipment audit is recommended to assure that effective safeguards and controls are still appropriate and in place.

Accidents

Notifications or incidents (e.g. near miss, recordable injury and/or equipment damage) of actual or suspected exposure, to potentially harmful laser radiation, should be reported to management. **At this site, the contact person to report such an incident is _____.** Employees are encouraged to report laser related incidents. Incidents will be investigated to determine the root cause and appropriate corrective actions to be taken.

The Michigan Public Health Code P. A. 368 of 1978 requires reporting of laser injuries on the MIOSHA Form MTSD 51 attached in this compliance guide.

Attachments

Laser Hazard Analysis Form
MIOSHA Form MTSD 51

SAMPLE SOP

This standard operating procedure (SOP) applies to beam alignment for Laser #2 (See equipment manual specifics associated with beam alignment procedure). Only trained and authorized employees are permitted to perform alignment activities.

1. System Description.

Model 1000 Nd:YAG laser marker system manufactured by the XYZ Company. This is a class 1 laser system with an embedded class 4 laser.

Wavelength: 1.064 μ m

Pulse Duration: 100 ns

Pulse Repetition Rate: 5,000-20,000 Hz

Average Power: 30 W

Beam Diameter: 4 mm

Beam Divergence: 2 mrad

2. Hazards.

- Eye hazard from direct, reflected or scattered beam.
- Skin hazard and fire hazard.
- Electrical hazard inside power supply.
- Laser Generated Air Contaminants (LGACs).

3. Control Measures.

- Exclude unnecessary personnel from the laser area.
- Establish a Laser Controlled Area using laser barrier screens and warning signs.
- Personnel in the laser controlled area shall wear approved laser safety eyewear with O. D. 5.0 @ 1064nm and protective clothing.
- Use a low power visible laser for path simulation of higher power invisible lasers.
- Use the lowest possible power level while performing alignment tasks.
- When aligning invisible laser beams, use beam display devices such as image converter viewers or phosphor cards to locate beams.
- Utilize diffuse reflecting beam blocks under these conditions:
 - At source when not needed
 - To terminate beams down range
 - Where alignment beams could stray
 - To terminate beams that might miss mirrors
- Locate and block stray reflections before proceeding to the next optical component or section.
- Be sure all beams and reflections are properly terminated before high-power operation.
- Keep all combustibles, tool, and reflective surfaces away from the beam path. Make sure you know where the beam is and stay clear.
- Work involving access to the power supply normally will be conducted with the system locked out. Access to the energized power supply must be done only by qualified personnel using the "buddy" system. Workers are directed to review the electrical safety and power supply sections of the manual before any activities involving access to high voltage.
- Assure the exhaust system is on to remove LGACs, even with the protective housing open.

LASER INSPECTION TIPS

1. Is there a designated Laser Safety Officer (LSO)?

Is the LSO trained?

- Required for Class 3B and Class 4
- Application dependent for Class 1M and Class 2M

2. Does the operator utilize protective eyewear?

Does the eyewear match the laser manufacturer's requirements?

- Required for Class 4
- Recommended for Class 3B

3. Are reflective objects in or near the beam path of the laser kept to a minimum?

- Required for Class 3B and Class 4

4. Is egress clear of obstructions?

- Required for all laser classes

5. Are the warning signs and labels legible and adequately located?

- Required for Class 3B and Class 4
- Recommended for Class 3R, Class 2M and Class 2

6. Are the interlocks intact and functioning?

- For Class 3B and Class 4, including enclosed Class 3B and Class 4, interlocks are required for protective housings and service access panels

7. For fully open and limited open beam paths: Does the beam appear to be as close to the work piece as possible?

Is the beam above or below eye level? (These Lasers cannot operate at eye level)

- Required for Class 3B and Class 4

8. Did the person in charge of the area authorize the presence of all personnel in the area?

- Required for Class 3B and Class 4

9. Is the area well lit?

- Required for all laser classes

10. Alignment/Adjustment procedures

- *Beam off*- is the power on. Do additional safeguards appear adequate? (contact with live parts)
- *Beam off*- the power is not on. Do additional safeguards appear adequate?
- *Beam on*- Service function as delineated in product manual
- Required for Class 3B and Class 4, including enclosed Class 3B and Class 4

SHALL AND REQUIRED
From OSHA Instruction PUB 8-1.7

PROCEDURAL and ADMINISTRATIVE CONTROLS

The LSO shall have the authority and responsibility to monitor and enforce the control of laser hazards, and to effect the knowledgeable evaluation and control of laser hazards.

This shall be done at each location or administrative area where Class 3 or 4 laser or laser systems are used or manufactured.

If service is performed on a laser product having an embedded Class 3A, 3B or 4, there shall be a designated LSO.

Employees who service, maintain, install, adjust and operate laser equipment shall be trained.

An alignment SOP is required for all Class 2, 3A, 3B and 4 lasers.

The Nominal Hazard Zone (NHZ) associated with Class 3B and 4 lasers shall also be determined.

Control measures shall be devised to reduce the possibility of exposure to the eye and skin to hazardous laser radiation and to other hazards associated with the operation of lasers and laser systems.

Access during operations must require authorization of the person responsible for the area. In conditions where the beam path is not completely enclosed, access shall be limited.

Designs for lasers, laser systems and the associated work areas shall be predicated upon the classification of the laser or laser system used.

The beams shall not, under any circumstances, be transmitted from an indoor laser controlled area unless for specific purposes (such as testing).

The LSO shall be notified of the purchase of any laser regardless of class.

No attempt shall be made to place any shiny or glossy object into the laser beam other than that for which the equipment is specifically designed.

Eye protection devices designed for protection against radiation from a specific laser system shall be used when engineering controls are inadequate to eliminate the possibility of potentially hazardous eye exposure.

All laser protective eyewear shall be clearly labeled with optical density values and wavelengths for which protection is afforded.

SHALL AND REQUIRED
From OSHA Instruction PUB 8-1.7

PROCEDURAL and ADMINISTRATIVE CONTROLS

Class 3B Lasers:

Laser beams shall be contained whenever possible.

When uncontained beams are used, the following precautions shall be taken:

1. A Class 3B warning sign shall be placed at the entrances to the area when the laser beam is operating and access must require authorization by persons responsible for the area.
2. The laser beam shall be terminated at the limit of its useful distance.
3. Specularly reflecting surfaces in or around the beam path shall be minimized.
4. The area shall be well lighted to restrict pupils.
5. The laser shall be positioned and the beam contained such that the beam does not exit the immediate area of use.

Class 4 Lasers:

In addition to the requirements for Class 3B lasers the following are required:

1. A total hazards review shall be conducted before a high-powered laser is used.
2. Devices shall be located in an area designated specifically for laser operations.
3. An entryway control shall be used. Control measures shall permit rapid egress and admittance to the area under emergency conditions.
4. A control disconnect switch or equivalent shall be available near the exit for deactivating the laser.
5. The beam shall be terminated by a highly absorbent beam trap of fire resistant material.
6. For infrared lasers, areas which are exposed to reflections of the beam shall be protected by fully enclosing the beam and target area
7. Ultra violet laser beam radiation shall require a beam shield.
8. A countdown procedure shall be used to signify the firing of single pulse laser types (Q-switch).

SHALL AND REQUIRED
From OSHA Instruction PUB 8-1.7

ENGINEERING CONTROLS

Protective Housing- Shall be provided for all classes of laser.

Housing Interlocks- Shall be provided for both Class 3A,3B and 4.

Beam enclosures:

1. Enclosed Beam Path- When properly labeled and safeguarded with a protective housing, the laser may be operated with no additional controls for the operator.
2. Limited Open Beam Path - Enclosure surrounding the laser focusing optics and immediate area of the workstation almost completely, procedural controls will be sufficient for both Class 3B and 4.
3. Totally Unenclosed Beam Path - Complete Hazard Analysis and NHZ assessment is required. Additional controls which may be required are: PPE, barriers, and entryway interlock for both Class 3B and 4.
4. When the entire beam path from a Class 3B or 4 laser is not sufficiently enclosed and/or baffled such that access to radiation above the MPE is possible, a laser-controlled area is required.

Beam Shutter or Attenuator - Should for Class 3B, Shall for Class 4

Remote Interlock Connector - Should for Class 3B, Shall for Class 4

Key Switch Master Control - Should for Class 3B, Shall for Class 4

Viewing Optics and Windows - Shall for both Class 3B and 4

When viewing optics and windows are utilized in the laser, optical filter interlocks are required.

Service Panels - Shall for both Class 3B and 4, be interlocked or require a tool for removal.

Warning System - Should for Class 3B, Shall for Class 4

Controlled Areas:

1. Indoor - Shall for both Class 3B and 4
2. Outdoor - Shall for both Class 3B and 4

Laser Related Websites

MIOSHA

www.michigan.gov/miosha

State of Michigan - Consultation – Education – Training (CET)

Michigan Occupational Safety & Health Administration

Several links to current MIOSHA standards, publications, sample written programs, the MIOSHA Training Institute (MTI) and current MIOSHA initiatives.

Laser-Professionals

www.laser-professionals.com

Sample Micro Laser Safety training course, speakers notes, SOP template and example, laser related DVDs (show 2 free 5 min video clips), EASY- Haz free laser hazard calculator.

ANSI electronic Standards Store

www.webstore.ansi.org

The American National Standards Institute (ANSI) coordinates development and use of voluntary consensus standards in the United States.

Rockwell Laser Industries (RLI)

www.rli.com

Rockwell Laser Industries pledges to continue its heritage of delivering outstanding quality, service and support to the worldwide community of laser users.

Laser Institute of America (LIA)

www.laserinstitute.org

Federal OSHA and LIA have an Alliance that focuses on providing the organization's members and others, including small businesses with information, guidance, and access to training resources that will help them protect employees' health and safety, particularly in reducing and preventing exposure to laser beam and non-beam hazards in industrial and medical workplaces.

Federal OSHA

www.osha.gov

STD 01-05-001 - PUB 8-1.7 - Guidelines for Laser Safety and Hazard Assessment

This publication is free to download, is over 100 pages, and covers use of lasers, laser hazards, and laser training.

STATE OF MICHIGAN
CONSULTATION EDUCATION & TRAINING
LASER HAZARD EVALUATION FORM

EMPLOYER NAME		LASER SYSTEM LOCATION		NAME OF LASER SAFETY OFFICER (LSO)	
LASER TYPE	LASER MANUFACTURER		MODEL NO.	SERIAL NO.	
WAVE LENGTH (S) (NM)	AVERAGE POWER (W)	PULSED YES <input type="checkbox"/> NO <input type="checkbox"/>	PULSE RATE (HZ)	PULSE DURATION (S)	PULSE POWER(J)
BEAM DIAMETER OR DIMENSIONS AT THE APERTURE (mm)			BEAM DIVERGENCE, FULL ANGLE (mrad)		

LASER HAZARD ANALYSIS

WAVELENGTH (S) (nm)		EXPOSURE DURATION (s)			
OCULAR MPE		SKIN MPE			
MINIMUM BEAM OD (INTRABEAM)	MINIMUM OD (DIFUSE VIEWING @ 50 cm)	INTRABEAM NOHD (m)	DIFFUSE REFLECTION NHZ(m)		
FOCAL LENGTH (mm)	SINGLE MODE (um) MODE FIELD DIAMETER	LENS ON LASER NOHD(m)	FIBER OPTIC NOHD(m)	MULTI MODE NUMERICAL APERTURE	
CHEMICAL HAZARDS		OPTICAL HAZARDS		LASER GENERATED HAZARDS	
COOLANTS <input type="checkbox"/> SOLVENTS <input type="checkbox"/> GASES <input type="checkbox"/> OTHER _____		DISCHARGE TUBES <input type="checkbox"/> UV / WELDING <input type="checkbox"/> VISIBLE <input type="checkbox"/> IR - A <input type="checkbox"/> OTHER _____		AIR CONTAMINANTS <input type="checkbox"/> CHEMICAL FUMES <input type="checkbox"/> METALLIC FUMES <input type="checkbox"/> METALLIC DUSTS <input type="checkbox"/> OTHER _____	
VENTILATION PROVIDED		NOISE ISSUES		FIRE HAZARDS	
TYPE _____ CFMS _____ OTHER _____		YES <input type="checkbox"/> NO <input type="checkbox"/> dBA IF KNOWN _____		IMPROPER BEAM ENCLOSURES <input type="checkbox"/> COMBUSTIBLE MATERIALS <input type="checkbox"/> GAS / VAPOR IGNITION <input type="checkbox"/> ELECTRICAL CIRCUITS <input type="checkbox"/>	
ELECTRICAL HAZARDS		IS LOCKOUT REQUIRED		COMPRESSED GAS CYLINDERS	
POWER SOURCES <input type="checkbox"/> EXPOSED WIRING <input type="checkbox"/> MISSING COVERS <input type="checkbox"/> STORED ENERGY <input type="checkbox"/>		YES <input type="checkbox"/> NO <input type="checkbox"/> PROCEDURES ESTABLISHED YES <input type="checkbox"/> NO <input type="checkbox"/>		PROPERLY STORED <input type="checkbox"/> RESTRAINED <input type="checkbox"/> REQUIRED SIGNAGE <input type="checkbox"/> NO MISSING CAPS <input type="checkbox"/>	

LASER HAZARD CONTROL MEASURES

SIGNAGE REQUIRED	PROTECTIVE DEVICES FOR STRAY BEAMS OR REFLECTIONS	LASERS IN AREA	EYE PROTECTION	OTHER PPE
DANGER <input type="checkbox"/> CAUTION <input type="checkbox"/> NOTICE <input type="checkbox"/>	BEAM BLOCKS <input type="checkbox"/> PATH COVERS <input type="checkbox"/> BARRIERS <input type="checkbox"/> CURTAINS <input type="checkbox"/>	ONE <input type="checkbox"/> TWO <input type="checkbox"/> THREE <input type="checkbox"/>	OD RATING _____	
TRAINING PROVIDED	ALIGNMENT PROCEDURES ESTABLISHED	STANDARD OPERATING PROCEDURES ESTABLISHED	LAST TIME LASER INSPECTED	
LSO <input type="checkbox"/> OPERATOR <input type="checkbox"/> MAINTENANCE <input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>	YES <input type="checkbox"/> NO <input type="checkbox"/>		

FORM COMPLETED
BY: _____

DATE: _____

Known or Suspected Occupational Disease Report

(Information will be held confidential as prescribed in Act.)

EMPLOYEE AFFECTED

Name (Last, First, Middle)	Age	Sex M F	Race: <input type="radio"/> White <input type="radio"/> Black <input type="radio"/> Hispanic <input type="radio"/> Other
Street	City	State	Zip
Home Phone Number	Social Security Number		

CURRENT EMPLOYER

Current Employer Name	Worksite County		
Worksite Address	City	State	Zip
Business Phone	If Known, Indicate Business Type (products manufactured or work done)		
Number of Employees <input type="radio"/> < 25 <input type="radio"/> 25-100 <input type="radio"/> 100-500 <input type="radio"/> > 500			
Employee's Work Unit/Department	Dates of Employment From: _____ To: _____ Mo Day Year Mo Day Year		
Employee's Job Title or Description of Work			

ILLNESS INFORMATION

Nature of Illness or Health Condition (Examples: Headache, Nausea, Difficulty Breathing, Cough, etc.)	Date of Diagnosis _____ Mo Day Year	
Suspected Causative Agents (Chemicals, Physical Agents, Conditions)	Did Employee Die? Yes <input type="radio"/> No <input type="radio"/>	If Yes, Date of Death _____ Mo Day Year
If Physician, Indicate Clinical Impression for Suspected Occupational Disease, or Diagnosis of Confirmed Occupational Disease		

ADDITIONAL COMMENTS

_____ _____

REPORT SUBMITTED BY

If Report Submitted by Non-Physician, Did Employee See a Physician? <i>If yes, record information below.</i>	Yes <input type="radio"/> No <input type="radio"/> Don't Know <input type="radio"/>
Physician's Name	Phone
Office Address	City State Zip
Name of Person Submitting Report	Physician <input type="radio"/> Non-Physician <input type="radio"/>
Address	City State Zip
Signature	Phone Date

The Michigan Department of Labor and Economic Growth is an equal opportunity, affirmative action employer, service provider and buyer.

Return completed form to:

Michigan Department of Labor and Economic Growth
Michigan Occupational Safety and Health Administration
Management and Technical Services Division
7150 Harris Drive, P.O. Box 30649
Lansing, MI 48909-8149

Authority: P.A. 368 of 1978
 Completion: Required
 Penalty: Misdemeanor