MAINTENANCE PROCEDURES FOR ENGINEERED LASER SAFETY SYSTEMS

This procedure shall be used for routine preventive maintenance and repair of the engineered laser safety systems designed and installed on laser facilities by Engineering Services Group.

Comments and questions regarding this procedure should be directed to the Laser Contact Person listed below:

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Sign-off Record:

Approved by: John Hjortshoj Date: 4-20-04
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Program/Department

Approved by: Date: 4/21/04
Laser Safety Officer

Reviewed by: Date: 4/22/04
Environment, Safety, Health & Assurance

Approved by: Date: 4/22/04
Division Director

1.0 Revision/Review Log

This document will be reviewed once every 3 years as a minimum.

Revision Number	Effective Date	Contact Person	Pages Affected	Description of Revision
0	06/01/95	B. Thomas	All	Initial issue
1	06/01/97	B. Thomas	All	Change in procedure
2	10/01/99	G. Sleege	All	General update
3	11/11/99	G. Sleege	All	Change in procedure
4	12/09/99	J. Hjortshoj	All	Change in procedure
5	12/20/02	J. Hjortshoj	2	Updated revision/review log
6	03/31/04	J. Hjortshoj	All	Reference Revision Description Summary PROC462_006REV6desc.doc

2.0 Purpose and Scope

This procedure shall be used to direct the inspection, preventive maintenance and/or repair activities for the engineered laser safety systems which have been installed on laser facilities located in Ames Laboratory spaces or owned by Ames Laboratory Programs in ISU spaces as identified by the Readiness Review process. The engineered laser safety system consists of laser interlock hardware and software specifically designed by ESG-Electronics to provide protected operating environments, possessing particular features designed to guard all personnel from exposure to the laser beam. As a safety system, these interlocks require routine preventive maintenance checks and/or repair as needed to assure their operational integrity. Scheduled preventive maintenance shall routinely occur on an *annual basis* for those laser interlock devices in Ames Laboratory spaces or owned by Ames Laboratory Programs in ISU spaces.

3.0 Prerequisite Actions and Requirements

3.1 Definitions

Designated escort
An individual assigned by the facility group to accompany and remain with the preventive maintenance technician while working in the area to safeguard ESG personnel if hazards are present.

ESG
Engineering Services Group, Technical & Administrative Services Division, Ames Laboratory

ISU
Iowa State University

IPRT
Institute for Physical Research and Technology

Laser Interlock
An electrical or mechanical system that prevents the device from emitting hazardous energy into the workspace when the protective barriers are open.

LSO
Laser Safety Officer

NRTL
Nationally Recognized Testing Laboratory

PROM
Programmable Read Only Memory

3.2 Authorized Maintenance Personnel

Only ESG and/or the certified manufacturer utilizing NRTL equipment shall inspect, repair, or perform maintenance on laser systems. **Inspection and preventive maintenance checks and/or repair of laser interlock and shutter safety systems shall be performed only by trained ESG-Electronics personnel. Engineered safety systems or factory installed safety systems, particularly those designed for personnel protection may not be modified or otherwise tampered with without specific approval of the Program Directors or the Laboratory Administration. Failure to recognize and adhere to these rules seriously jeopardizes the lives and/or safety of personnel using such systems, in addition to exposing Ames Laboratory to serious liability.**

3.3 Assignment of Designated Escort to Laser Facility

Each laser facility shall assign a designated escort **to be present** whenever ESG-Electronics personnel perform preventive maintenance checks and/or repair on the engineered laser safety system within the laser facility.

3.4 Group Training/Administrative Controls

Upon installation of the engineered laser safety system or reactivation of an otherwise dormant laser activity, the designated laser facility escort will receive initial safety training from ESG-Electronics personnel using lesson plan AL-052 on the operation of the system. It will then become the group's responsibility to train all other effected personnel within their group. In addition, each group must develop appropriate administrative controls to prevent unauthorized access, misuse, or modification of the engineered safety system. Appropriate lockout/tagout measures will be used whenever repair is needed.

3.5 ESG-Electronics Personnel Training

All technicians and engineers within ESG-Electronics prior to performing this procedure are Qualified Electrical Workers (reference Ames Laboratory Electrical Safety Manual 46200.001) and will have completed the AL-070 training module, Laser Safety Training. Additionally, technicians will receive hands-on training utilizing the performance steps in item 4.0 Performance of this procedure.

4.0 Performance (Annual)

4.1 Typical room layout of a Laser Interlock Safety System.

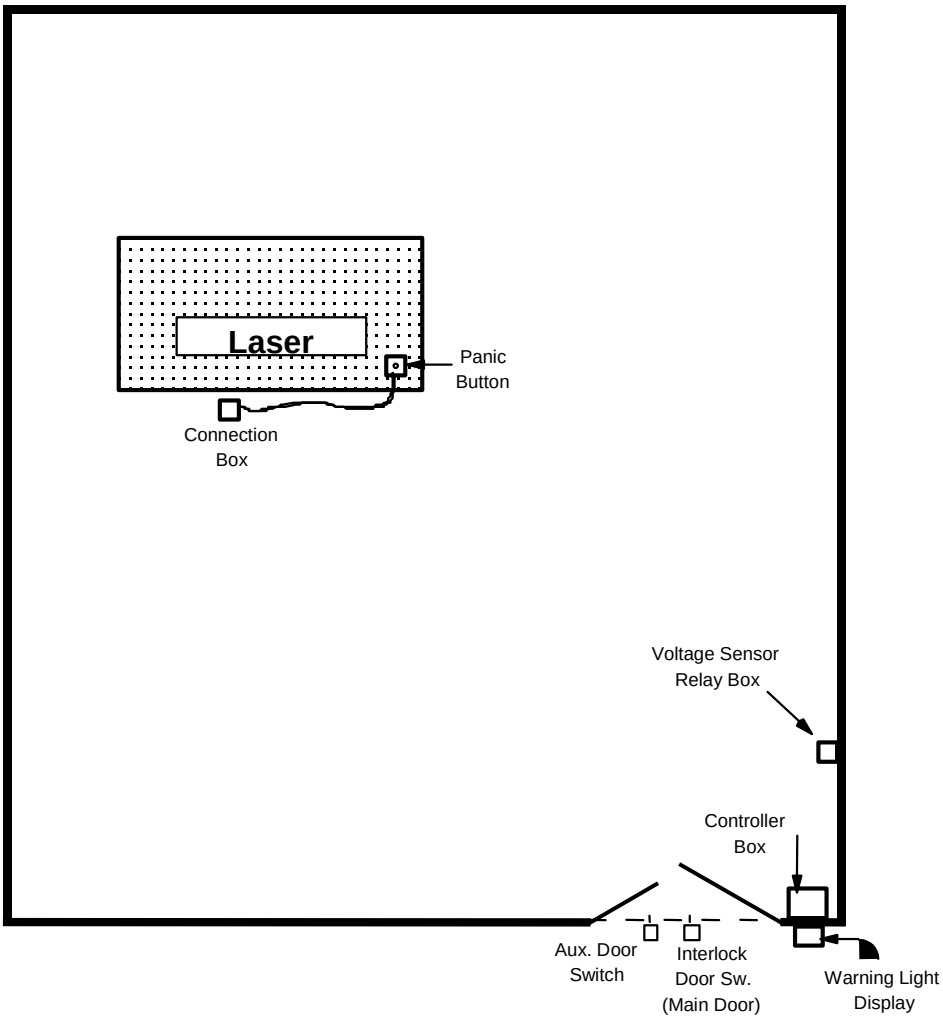
On the drawing of the typical room layout (4.2), you can see the general locations of each of the components of the laser safety system.

The programmable controller is mounted in a standard 12”x10”x6” electrical knock-out box. It is mounted on stand-offs to allow the wiring through the back of the box and to clear the box mounting hardware. This allows ample space for the controller, the bypass switch, the two indicator lights and for the wiring. The controller box should be mounted close to the main door so that the bypass button is easy to reach and the beam-on light is easy to see. The controller box is mounted as close as possible to the location of the display panel outside the room to make wiring through the wall fairly easy. The 110VAC has been wired through a combination fuse/disconnect or electrical interlock switch to allow local shut-down during troubleshooting, programming, etc.

The voltage sense relay is mounted in an electrical box along with a transformer (depending on laser voltage and relay coil voltage). The relay box is usually mounted close to or attached to the laser’s power disconnect box. Depending on the room layout, it’s often possible to use the sense relay box as the connection box for the interlock wiring.

The connection box, whether separate or as a part of the sense relay box, should be close to the laser. We have found it convenient to use a single four conductor cable from the connection box to the laser and install a four pin connector on the laser for the keyswitch contacts and the interlock enable. The four pin connector can be installed in-place-of the existing interlock connector and often the laser's interlock connector will have unused pins which can be pressed into service. The panic button is wired to the connection box with enough cable length to reach the work area.

4.2 Drawing of Typical Room Layout



Typical Room Layout

1/1/95 L. Harker

4.3 Preventive Maintenance Actions

Responsibility

Inspection, preventive maintenance and/or repair activities will be performed by ESG-Electronics personnel utilizing the specified training identified in Item 3.5 of this procedure. The interval between inspections shall not exceed twelve months. The Preventive Maintenance Activity Checklist for Laser Interlock, Form 46200.015 will be utilized to document the results of Actions 1-18. For new or reactivated systems follow the Laser Interlock Safety System User Orientation Outline AL-052. ESG will obtain the current inventory list of Engineered Laser Safety Systems from the Laser Safety Officer before starting inspections.

Action

1) Contact the group Safety Coordinator, Safety Representative, or user to arrange for a designated escort and a date and time for the preventive maintenance activity.

2) With help from the escort, perform a safety hazard awareness survey of the location prior to initiation of the inspection and maintenance work. If hazards are different than covered by ESG Activity 46200.007, Testing/Repair, then document this action on the ESG Hazard Awareness Form 46200.047.

3) With an escort present, make a visual inspection of the laser interlock system noting the condition of interlock hardware, cables, shutter mounting and panic box location.

4) Replace all incandescent bulbs. The lamp/bulb indicator test is performed by exchanging the system prom with a test prom in the controller. The program will blink all indicator lamps on/off at one second intervals. Replace any defective bulbs.

5) While the lamp test program is operating, confirm that the lights stop blinking when:

    i) the by-pass switch is activated;

    ii) the main door interlock is activated; or

    iii) when one of the laser key switches is activated.

6) Replace test prom with the prom module designated for the given system.

7) De-energize all laser power disconnects to verify that the green indicator lamps light. Energize each laser power disconnect (on then off) and verify that the amber lamps begin blinking to indicate a caution condition. If de-energizing the laser power disconnect will cause damage to the laser or will require an extended start up time, the green indicator lamps may be tested with the test PROM.

8) With a laser power disconnect energized (amber light blinking), activate each laser key switch (on then off) individually and verify that the red indicators start blinking.

9) With one of the laser key switches on (red lights blinking), open the by-pass or auxiliary doors and verify this action closes the laser shutter or shuts down the laser unit's power supply. Closing the door allows an operator to restart the laser. For a laser that can be damaged by emergency shutdown the function can be tested with the laser power off and the laser interlock in the shutdown state. Verify the laser will not start up.

10) With one of the laser key switches on (red lights blinking), test the by-pass condition by first using the escort's key (key lock on hallway display box) and then the push button in the laser room on the controller box. Either switch activation will allow access or exit through the primary entrance without shut-down for a period of twenty seconds.

11) In testing systems equipped with beam shutters, the laser key is mounted on the shutter control box and the beam shutter is closed rather than turning off the laser power supply.

12) Confirm that the panic button either closes the beam shutter or causes the laser power supply to de-energize. When laser deactivation occurs, (shutter or power supply) manual re-activation is required. For a laser that can be damaged by emergency shutdown the function can be tested with the laser power off and the laser interlock in the shutdown state. Verify the laser will not start up.

13) Ensure the danger warning sticker (see example 6.3) is on the interlock box. If the interlock box does not have a sticker, or if sticker is damaged, contact ESH&A.

14) Affix a dated and signed inspection sticker (see example 6.4) on the controller box.

15) Return the laser units to their original condition.

16) Complete all documentation needed on the "Preventive Maintenance Activity Checklist for Laser Interlocks," Form 46200.015. All deficiencies shall be documented on this form. Original forms are kept on file in the ESG-Electronics Tech Shop.

17) Complete the "Laser Interlock Preventive Maintenance Schedule," Form 46200.017, and provide a copy to the ESG-Electronics Tech Shop Supervisor.

18) For quality assurance purposes, the supervisor will review the completed "Laser Interlock Preventive Maintenance Schedule," and randomly select four laser interlock locations and perform a visual audit. The supervisor will then document these visual audits by initialing and dating the "Laser Interlock Preventive Maintenance Schedule."

5.0 Post Performance Activity

5.1 Repairs (other then normally Scheduled Preventive Maintenance)

Laser facility group personnel suspecting any malfunction of the engineered laser safety system should call ESG-Electronics Tech Shop, 4-4823 or factory representative for immediate repair. The cognizant group should initiate lockout/tagout of the laser facility until repairs can be scheduled and completed by ESG-Electronics or factory representative.

5.2 Documentation of Laser Interlock Devices

The location and preventive maintenance schedule of all installed engineered laser safety systems shall be documented by ESG-Electronics personnel by completing the following.

5.2.1 Complete AL-052, "Laser Interlock Safety System User Orientation Outline," for new or reactivated systems.

5.2.2 Follow and perform the "Preventive Maintenance Activity Checklist for Laser Interlocks," Form 46200.015. This checklist will be kept on file in the ESG-Electronics Tech Shop as long as the equipment is property of Ames Laboratory/IPRT.

5.2.3 Date and sign inspection sticker, Form 46200.013, and affix to the controller box.

5.2.4 Complete the "Laser Interlock Preventive Maintenance Schedule," Form 46200.017 and provide a copy to the ESG-Electronics Tech Shop Supervisor. The original form is to be kept on file in the ESG-Electronics Tech Shop.

5.2.5 For quality assurance purposes, the supervisor will review the completed "Laser Interlock Preventive Maintenance Schedule," and randomly select four laser interlock locations and perform a visual audit. The supervisor will then document these visual audits by initialing and dating the schedule. The supervisor will provide copies to ESH&A and ESG-Administrative office.

6.0 Materials Required for Maintenance Activity

6.1 AL-052, "Laser Interlock Safety System User Orientation Outline."

6.2 Form 46200.015, Rev. 1, 3/31/04, "Preventive Maintenance Activity Checklist for Laser Interlocks," and a typical room layout.

6.3 Danger Label (example)

6.4 Inspection Sticker (example)

Ames Laboratory Laser Interlock
Inspection & Preventative Maintenance
LAST INSPECTION
(Y/M/D) _____
BY _____

Form 46200.013 Rev. 0 1/1/95

6.5 Form 46200.017, Rev. 3, 3/31/04, "Laser Interlock Preventive Maintenance Schedule."

6.6 Form 46200.047, Rev. 3, 3/31/04, "Hazard Awareness Form for ESG In-house or Out-of-area Service Tasks."

Laser Interlock Safety System User Orientation Outline
AL - 052

Date: _____ Laser Location: _____
(Building, Room and Unit Number)

Instructor: _____ Recipient: _____
(Name and Employee number)

1) Purpose of the Laser Interlock Safety System:

Laser interlock and warning systems are engineered safety systems consisting of entry door interlocks and outside the room indication. These items are specifically designed and selected by ESG-Electronics to limit exposure of laser beams to unauthorized personnel entering the laser operating environment.

2) Laser Beam Control:

a) A positive action by the operator to apply power to the laser unit. A positive action by the operator to turn on the laser unit. A positive action by the operator to open the laser beam shutter. A positive action by the operator to re-start the laser unit or to re-open the beam shutter after an interlock violation.

b) Laser deactivation (interlock control and panic button):

Control outputs 5-7 are the contacts supplied to enable a laser. These contacts are connected to the laser's interlock connector and are in series with a normally closed "PANIC" button. Some lasers do not have a convenient means for interlocking and may need modification. Although outputs 5-7 all activate simultaneously, separate outputs are used to avoid electrical interaction between lasers. When the interlock on the laser is opened, the laser will only restart with human intervention such as turning the key off and on again.

c) Shutter Control:

Some lasers may be damaged or tube life shortened by an uncontrolled shutdown as may be caused with a safety system such as this. In these cases it may be necessary or desirable to control a beam shutter instead of controlling the laser's power supply. Some lasers have a shutter control as part of the power supply whereas some shutters must be opened by a separate piece of equipment. This laser safety system can be used in these circumstances with some different wiring arrangements. The inputs from the power sense relay would remain the same. The input intended for the laser keyswitch would be connected to the shutter control circuit that opens the shutter. The line which normally enables the laser interlock would be used to enable or disable the shutter opening circuit. It is important that the shutter controller not allow the shutter to re-open without human intervention after being closed by the laser safety system.

3) Indicator Lights:

The green, amber, and red indicators are mounted on a panel outside the room containing the laser and they indicate the laser's status. The green light is illuminated when the laser safety system is on but none of the lasers in the room have power supplied to them. The amber indicator flashes when the a.c. power has been supplied to any of the lasers through their respective power panels. When a laser has had power supplied and the laser key has been switched on, the red indicator will flash. Realize that, if a room has multiple safety controlled lasers, one laser may have power supplied and a different laser might have its key turned and this condition would result in a red light flashing.

4) Override Function:

The override indicators consist of two amber lights wired in parallel. One of them is mounted under the controller box and one is mounted on the indicator panel outside the room. These lights come on when the bypass timer is activated indicating that the door may be opened without disabling the laser.

The beam-on light illuminates during the time that the red lights are flashing outside the room. It is also red and mounted on the side of the controller box closest the door as a reminder to not open the door without pressing the bypass switch lest you shut down a laser inadvertently.

5) Maintenance:

Inspection and preventive maintenance checks and/or repair shall be performed only by trained ESG-Electronics personnel. Engineered safety systems, particularly those designed for personnel protection may not be modified or otherwise tampered with without specific approval of the program directors or the laboratory administration. Failure to recognize and adhere to these rules seriously jeopardizes the lives and/or safety of personnel using such systems, in addition to exposing Ames Laboratory to serious liability.

Reference *Maintenance Procedures for Engineered Laser Interlock Safety Systems*, 46200.006.

6) Assignment of designated escort at location of laser equipment:

Each group having interlocked laser equipment shall assign a designated escort to be present whenever ESG-Electronics personnel perform inspection and preventive maintenance checks and/or repair on the engineered laser interlock safety systems.

7) This completed form shall be given to the ESG-Electronics Tech Shop Supervisor who will deliver it to the Training Office, 125 Spedding Hall.

PREVENTIVE MAINTENANCE ACTIVITY CHECKLIST FOR LASER INTERLOCK

USER GROUP: _____ LOCATION: _____
(Building and Room #)

DESIGNATED ESCORT: _____

DATE: _____ PM PERFORMED BY: _____

PERFORMANCE CHECKLIST: S - Satisfactory; U - Unsatisfactory

1) Visual inspection:

a) display panels	**S** ☐	**U** ☐
b) door interlock switches	**S** ☐	**U** ☐
c) panic button box location	**S** ☐	**U** ☐
d) wiring/cable condition	**S** ☐	**U** ☐
e) danger sticker in place	**S** ☐	**U** ☐

Corrective actions needed: _____
_____

Corrective actions taken: _____
_____

2) Test operation of warning lamps and door interlock switches using interlock switches: **S** ☐ **U** ☐

Corrective actions needed: _____
_____

Corrective actions taken: _____
_____

3) With the interlock system in an activated state, entry door opening closes the beam shutter or drops voltage to the laser: **S** ☐ **U** ☐

Corrective actions needed: _____
_____

Corrective actions taken: _____
_____

4) In the override mode, entry door opening does not close the beam shutter or drop voltage to the laser: **S** ☐ **U** ☐

Corrective actions needed: _____
_____

Corrective actions taken: _____
_____

5) Verify that all operable laser units within the enclosed area exhibit results stated in items 3 & 4.
S ☐ U ☐

Corrective actions needed: _____
_____

Corrective actions taken: _____
_____

6) ☐ Affix a dated and signed inspection sticker (Form 46200.013) to the controller box.

7) ☐ Return all laser units to normal conditions.

8) ☐ Complete Laser Interlock Preventive Maintenance Schedule (Form 46200.017).

Laser Interlock Preventive Maintenance Schedule

Building & Room #	Group Leader	Contact Person & Phone #	Date of PM	PM Performed by	Audit Performed by	Date of Audit

Hazard Awareness Form for ESG In-house or Out-of-area Service Tasks

DIRECTIONS: FOR SERVICE REPAIR AND TROUBLESHOOTING TASKS, THE SUPERVISOR OR ASSIGNED WORKER WITH THE HELP OF THE REQUESTER, SHALL PERFORM A SAFETY ASSESSMENT AND COMPLETE THE ITEMS BELOW FOR THE EQUIPMENT/WORK AREA BEFORE WORK BEGINS. THE WORKER SHALL NOT PERFORM THE REPAIR UNTIL CONCERNS ARE ADDRESSED AND NEEDED SAFETY PRECAUTIONS ARE TAKEN. PLEASE COMMENT ON PRECAUTIONS NEEDED FOR ANY 'YES' ANSWERS. IF ANY OF THE ANSWERS BELOW ARE MARKED 'YES' SEND A COPY OF THIS SHEET TO ESH&A.

1) Work Area Concerns:

a. Confined space/limited egress	Yes/No
b. Temperature/humidity extremes	Yes/No
c. Other	Yes/No

2) Electrical Concerns:

a. High Voltage	Yes/No
b. Exposed wiring	Yes/No
c. LOTO needed	Yes/No
d. Non-NRTL equipment	Yes/No
e. PPE needed	Yes/No
f. Other	Yes/No

3) Chemical, Biological, & Radiation Concerns:

a. Suspected carcinogens/biological agents	Yes/No
b. MSDS needed & available	Yes/No
c. Radioactive matrl./sources (laser/x-ray)	Yes/No
d. PPE needed	Yes/No
e. Other	Yes/No

4) Mechanical Concerns:

a. Rotating parts or pinch points	Yes/No
b. Stored energy systems	Yes/No
c. LOTO needed	Yes/No
d. Pressurized system/pressure vessel	Yes/No
e. PPE needed	Yes/No
f. Other	Yes/No

Hazard assessment performed by (please print): _____ **Date (m/d/y):**_____

Item #_____ **Comments:**_____

Item #_____ **Comments:**_____

Item #_____ **Comments:**_____