

Figure A1. Example of Danger Label (for Repetitive-Pulse Gallium-Arsenide Laser).

Sample SOP

Mandatory Procedures for Laser Atmospheric Testing

(This SOP is a sample only. Actual testing may require alternate or additional controls.)

The following procedures shall be mandatory prior to, during, and immediately after any and all atmospheric testing using laser systems (Zenith mode only). Modifications to these procedures will be effective only upon receipt of a written notice. If there are any difficulties encountered with strict compliance of the following procedures, they should be brought to the immediate attention of the Radiation Safety Officer or the current chairperson of the local Nonionizing Radiation Committee (names and phone #'s).

1. Call the relevant Base of Operations and give the following information:

(a) building location.

(b) anticipated time when the atmospheric testing will commence and the duration of the test (e.g., "At approximately 0900 hours we will commence laser atmospheric testing and the tests will last for approximately 3 hours until 1200 hours.").

(c) emergency phone number and points of contact (e.g., "In the event of an emergency, you can call me at 555-1234 to notify us and we will immediately shut down the laser.").

(d) any additional information if requested by the Base of Operations personnel (e.g., type of laser, wavelength, divergence, NOHD, etc).

2. Advise the nearest Federal Aviation Administration (FAA) Approach Control a minimum of 2 hours before, and again, at 15 minutes prior to the actual operation each day and immediately upon termination of the actual operations each day.

3. As an added precaution, you are required to contact the nearest Automated Flight Service Station, and Air Traffic Control (ATC) Facility, to speak to a manager. This call is to be instigated a minimum of 6 hours before the operation, to request the issuance of a NOTAM (Notice to Airmen). The text of the NOTAM will be given to the Flight Service personnel upon initial contact. Then it should be stated that the wording of the NOTAM will remain the same for all future tests until further advised, the exception being the time of operation. A sample of the text is as follows:

"A laser operation with a light beam hazardous to direct visual observation will be conducted at (place of operations) within ½ nautical mile of: (latitude and longitude coordinates; date/time/duration). Strong caution is advised. Laser light beam may be injurious to pilots/passenger eyes within all altitudes of the beam."

4. Ensure that at least one visual observer is monitoring the airspace. This observer(s) shall be located outside and have adequate means to contact the authorized laser operator for emergency shutdown when aircraft are on course to intercept or cross the laser beam NHZ or flight hazard zone.

5. At the completion of the test, call the Base of Operations, relevant FAA, ATC, and Flight Service Station, and state that the operations have ceased (e.g., "This is (your name) of (Project Office). As of 1400 hours (time) the laser testing commenced at building (your building) has terminated."

Instructions For Completing Form**Notice Of Proposed Outdoor Laser Operation(s)****(modified from FAA Advisory Circular 70-1, Outdoor Laser Operations)**

(This form was current at the time of printing. Actual forms required by the FAA may be different.)

The information on this form will be used by the FAA Regional Office to perform an aeronautical study to evaluate the safety of a proposed laser operation. Provide all information that may be needed to perform the study. If additional details are necessary, list these in the "ATTACHMENTS" section of this form.

1. GENERAL INFORMATION – In 1.(a), enter the name, address, telephone, and fax numbers of the FAA Regional Office Air Traffic Division responsible for the area that includes the laser operation site. In 1.(b), enter the proponent's name, address, telephone, fax, and E-mail information. This is the party primarily responsible for the laser safety of this operation. When the proponent is a manufacturer or a governmental agency (e.g., NASA), and the laser is located at a different site, list the proponent here. In 1.(c), enter the event name (for temporary shows) or the facility name (for permanent installations). In 1.(d), enter the date the report is prepared or sent to FAA. It is not the date of the laser operation. - If the laser user is different than the proponent, fill in section 1.(e) Customer; if not, enter "Same as proponent." In 1.(f) enter the site address.

2. DATE(S) AND TIME(S) OF LASER OPERATION – Enter the dates and times of testing alignment procedures, and operation.

3. BRIEF DESCRIPTION OF OPERATION – The description should be a general overview of the operation. If necessary, attach additional pages.

4. ON-SITE OPERATION INFORMATION – List names and/or titles of operators. There should be at least one working, direct telephone link to the operator, or equivalent way of quickly reaching the operator (e.g., telephoning a central station that reaches operator via radio). Two telephone numbers are requested on the form; the number in 2.(c) should be used as an alternate or backup.

5. FDA/CDRH LASER LIGHT SHOW VARIANCE – List the variance number, accession number, and variance date if the operation uses or is a "demonstration laser" (generally, a laser light show) and therefore, is regulated by the Food and Drug Administration's Center for Devices and Radiological Health.

6. BRIEF DESCRIPTION OF CONTROL MEASURES – Describe the method(s) used to protect airspace; for example, termination on a building (where the beam path is not accessible by aircraft including helicopters), use of observers, use of radar and imaging equipment, physical methods of limiting the beam path, etc. The more the operation relies on the control measures to ensure safety, the more detailed the description should be.

7. ATTACHMENTS – In 7.(a) list the number of "Laser Configurations" you are submitting with this notice. If a particular setup operates with more than one laser, with different beam characteristics (power settings, pulse modes, divergence, etc.) or has multiple output devices (example: projector heads), then each should be analyzed as a separate laser configuration. In 7.(b) list all additional attachments that are included to assist the FAA in sufficiently evaluating the proposal, such as maps, diagrams and details of control measures.

8. DESIGNATED CONTACT PERSON – Specify the person with whom the FAA will communicate if additional information is needed. This should be the person most knowledgeable about laser safety of this operation. However, the person could also be the laser operation central contact that interfaces with the FAA. The designated contact person should work for or represent the proponent listed in 1.(b).

9. STATEMENT OF ACCURACY – The person having the authority to bind the proponent should sign the form.


10. WORKSHEET INSTRUCTIONS – See AC 70-1, Outdoor Laser Operations.

11. PAPERWORK REDUCTION ACT STATEMENT – The FAA intends to maintain a high level of safety between laser operations and aircraft operations. The FAA is requesting that laser operators submit information on a voluntary basis using the form listed. It will take the proponent approximately 10 hours to provide the necessary information for the initial system analysis. The time should decrease with subsequent submissions for the use of the same laser system by the same respondent. A person is not required to respond to an information collection request unless it displays a currently valid Office of Management and Budget (OMB) number. The OMB control number assigned this request is 2120-0662.

Sample of Form Submitted to FAA for Outdoor Laser Operations

Please Type or Print on This Form

Form Approved OMB No. 2120-0662

| | | | | | |
|---|--|--|-----------------------|-------------------------|--|
|  | | Failure To Provide All Requested Information May Delay Processing of Your Notice | | FOR FAA USE ONLY | |
| U.S. Department of Transportation Federal Aviation Administration | | NOTICE OF PROPOSED OUTDOOR LASER OPERATION(S) | | | |
| 1. GENERAL INFORMATION | | | | | |
| (a) To: (FAA Regional Office) | | | (b) From: (Proponent) | | |
| (c) Event or facility | | | (d) Report Date: | | |
| (e) Customer | | | (f) Site address | | |
| 2. DATE(S) AND TIMES(S) OF LASER OPERATION | | | | | |
| (a) Testing and alignment | | | (b) Operation | | |
| 3. BRIEF DESCRIPTION OF OPERATION | | | | | |
| | | | | | |
| 4. ON-SITE OPERATION INFORMATION | | | | | |
| (a) Operator(s) | | | | | |
| (b) On-site phone #1 | | | (c) On-site phone #2 | | |
| 5. FDA CDRH LASER LIGHT SHOW VARIANCE (if applicable) | | | | | |
| (a) Variance # | | (b) Accession # | | (c) Expiration date | |
| 6. BRIEF DESCRIPTION OF CONTROL MEASURES | | | | | |
| | | | | | |
| 7. ATTACHMENTS | | | | | |
| (a) Number of laser configurations [fill out one copy of page 2 of this notice ("Laser Configurations Worksheet") for each configuration] | | | | | |
| (b) List additional attachments (including maps, diagrams, and details of control measures) | | | | | |
| | | | | | |
| 8. DESIGNATED CONTACT PERSON (if further information is needed) | | | | | |
| (a) Name | | | (b) Position | | |
| (c) Phone | | (d) Fax | | (e) E-mail | |
| 9. STATEMENT OF ACCURACY | | | | | |
| To the best of my knowledge, the information provided in this Notice and attached worksheet(s) is accurate and correct. | | | | | |
| (a) Name (if different from contact person) | | | (b) Position | | |
| (c) Signature | | | (d) Date | | |

FAA Form 7140-1 (4-01)

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032500.III

Instructions for Completing Laser Configuration Worksheet**(modified from FAA Advisory Circular 70-1, Outdoor Laser Operations)**

(This form was current at the time of printing. Actual forms required by the FAA may be different.)

A single outdoor operation may have a number of lasers or “laser configurations” – power settings, wavelength, pulse modes, divergence, etc. In section 7.(a), of the Notice of Proposed Outdoor Laser Operations form, enter the number of different laser configurations for the outdoor operation. Then, complete one Laser Configuration Worksheet (page 2) for each different configuration.

Data sources: This form requires calculations based on data concerning the laser beam’s characteristics. The data can be obtained from direct measurement, manufacturer specifications, or specialized instruments. Also, data may be derived by making reasonable, conservative assumptions (e.g., that a certain value makes the beam more hazardous than it would be in reality). All data should err on the side of safety. In borderline situations where data accuracy is crucial to compliance, provide additional information on measurement techniques, data sources, and assumptions.

1. CONFIGURATION INFORMATION – In 1.(a), enter the number of the specific configuration and the total number of configurations. In 1.(b), enter the name of the event or facility. In 1.(c), enter the date the worksheet is prepared or sent to the FAA. In 1.(d), describe the beam projecting or directing system. Include a description of the site layout. Attach additional sheets if more space is required.

2. GEOGRAPHIC LOCATION – In 2.(a), enter the elevation of the site in feet above Mean Sea Level (MSL). In 2.(b), enter the height of the laser above the site elevation. This value should reflect the total height including any tall structure or building on which the laser may be located. In 2.(c), enter the total height of the laser above MSL (site elevation + height above site elevation). For aircraft or spacecraft operations, attach additional information on the flight locations and altitudes. In 2.(d) and (e), enter the latitude and longitude in degrees, minutes and seconds. Some maps or devices may give this information in “Degrees Decimal” form; convert this value into degrees, minutes, and seconds. In 2.(f), enter the method used to determine the latitude and longitude. In 2.(g), enter the horizontal datum used to determine the latitude and longitude. In 2.(h), enter the vertical datum used to determine the site elevation.

3. BEAM CHARACTERISTICS AND CALCULATIONS – Determine the mode of operation for this configuration: single pulse, continuous wave, or repetitively pulsed. Check the appropriate column and fill out only the beam characteristics, MPE calculations, and visual effect calculations applicable to that column.

4. BEAM DIRECTION(S) – Enter the maximum and minimum elevation angles. Also, provide the pointing directions and elevation angles (minimum and maximum) of the beam projections for this configuration only: If the beam is moved horizontally during the operation, enter the movement range under “Azimuth.” For example, “20° to 50°.” Make sure you give the range going clockwise, otherwise your data will be interpreted as directing the beam everywhere but where you intend. Specify if azimuth is in true or magnetic readings. Provide the magnetic variation for the location if this is known (necessary if you mark the “Magnetic” check box or if you are using a compass as part of your control measures).


For some configurations, additional information concerning the beam direction may be needed. For example: lasers that are very widely separated at the geographic location, or a laser used on an aircraft or spacecraft that is moving and/or shoots downward.

5. CALCULATED DISTANCES – There are four distances that are important in evaluating the safety of outdoor operations: For some visible pulsed lasers, the sensitive exposure distance, the critical exposure distance, or the laser-free exposure distance may be calculated to be less (shorter distance) than the NOHD. If this is the case, for safety reasons do not enter the distance numbers in the applicable block. Instead, enter that the distance is “less than NOHD.”

Sample of Form Submitted to FAA for Outdoor Laser Operations

Please Type or Print on This Form

Form Approved OMB No. 2120-0662

| | | | |
|--|---------------------------------------|--|--|
|  Failure To Provide All Requested Information May Delay Processing of Your Notice | | FOR FAA USE ONLY | |
| U.S. Department of Transportation Federal Aviation Administration | | | |
| LASER CONFIGURATION WORKSHEET | | | |
| 1. CONFIGURATION INFORMATION | | (b) Name of event/facility: | (c) Report date: |
| (a) Configuration number _____ of _____ | | | |
| (d) Brief Description of Configuration: | | | |
| | | | |
| 2. GEOGRAPHIC LOCATION | | (d) Latitude _____° (deg.) _____' (min.) _____" (sec.) | |
| (a) Site Elevation (ft. above Mean Sea Level) | | (e) Longitude _____° (deg.) _____' (min.) _____" (sec.) | |
| (b) Laser Height Above Site Elevation (ft.) | | (f) Determined by: <input type="checkbox"/> GPS <input type="checkbox"/> Map (Quad) <input type="checkbox"/> Other _____ | |
| (c) Overall Laser Elevation (a + b) | | (g) Horizontal Datum: <input type="checkbox"/> NAD 27 <input type="checkbox"/> NAD 88 | |
| | | (h) Vertical Datum: <input type="checkbox"/> NGVD 29 <input type="checkbox"/> NAVD 88 | |
| 3. BEAM CHARACTERISTICS AND CALCULATIONS (check one Mode of Operation only, and fill in only that column) | | | |
| Mode of Operation | <input type="checkbox"/> SINGLE PULSE | <input type="checkbox"/> CONTINUOUS WAVE | <input type="checkbox"/> REPETITIVELY PULSED |
| Laser Type (lasing medium) | (not applicable) | | |
| Power Watts (W) | | maximum power | average power |
| Pulse Energy Joules (J) | | (not applicable) | |
| Pulse Width Seconds (s) | (not applicable) | (not applicable) | |
| Pulse Repetition Frequency Hertz (Hz) | | (not applicable) | |
| Beam Diameter @ 1/e points Centimeters (cm) | | | |
| Beam Divergency 1/e @ full Angle Milliradians (mrad) | | | |
| Wavelength(s) Nanometers (nm) | | | |
| (a) MAXIMUM PERMISSIBLE EXPOSURE (MPE) CALCULATIONS (will be used to calculate NOHD). | | | |
| MPE W/cm^2 | (not applicable) | | |
| MPE per pulse J/cm^2 | | (not applicable) | |
| (b) VISUAL EFFECT CALCULATIONS (will be used only for visible lasers [400-700 nm] to calculate SZED, CZED, and LFED) | | | |
| Pre-Corrected Power (PCP) Watts (W) | Pulse Energy (J) x 4 | Maximum Power (from above) | Pulse Energy (J) x PRF (Hz) OR Average Power |
| Visual Correction Factor (VCF) (Enter "1.0" or use Table 5) | | | |
| Visually corrected Power PCP x VCF | | | |
| 4. BEAM DIRECTION(S) | | Magnetic variation (degrees) | |
| Maximum elevation angle (degrees) | | Azimuth <input type="checkbox"/> True <input type="checkbox"/> Magnetic | |
| Minimum elevation angle (degrees, where horizontal = 0°) | | (degrees) _____ | |
| 5. CALCULATED DISTANCES (fill in all three columns) | SLANT RANGE (ft.) | HORIZONTAL DISTANCE (ft.) | VERTICAL DISTANCE (ft.) |
| NOHD (based on MPE) | | | |
| *SZED (for 100 $\mu W/cm^2$ level) | | | |
| *CZED (for 5 $\mu W/cm^2$ level) | | | |
| *LFED (for 50 n W/cm^2 level) | | | |
| *If the laser has no wavelengths in the visible range (400-700 nm), enter "N/A (non-visible laser)" in all blocks. For visible lasers, if the calculated SZED, CZED, and/or LFED is less than the NOHD, enter "less than NOHD." than NOHD." | | | |
| 6. CALCULATION METHOD <input type="checkbox"/> Commercial software (print product name) | | | |
| <input type="checkbox"/> Other [(describe method (spreadsheet, calculator, etc.)] | | | |

FAA Form 7140-1 (4-01)

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Sample of Form Submitted to FAA for Outdoor Laser Operations

Suspected Laser Beam Incident Report

This form may be used by local ATC or airline authorities to report a suspected laser beam exposure. When completed, the report should be forwarded to the competent authority as soon as possible for further investigation. Additionally, an anonymous report of a safety issue can be completed and submitted to the Aviation Safety Reporting System – website: <http://asrs.arc.nasa.gov>.

Name _____ Age _____

Position (pilot, co-pilot, controller, etc.) _____ Phone _____

Type of vision correction worn at time of incident (spectacles/contact lenses) _____

Type of aircraft _____

Aircraft ID or call _____

Date and time of incident (UTC) _____

Date and time report is being completed (UTC) _____

Environmental factors:

Weather conditions _____

VMC/IMC _____

Ambient light level (day, night, sunlight, dawn, dusk, starlight, moonlight, etc.) _____

Location of incident:

Near (aerodrome/city/NAVAID) _____

Radial and distance _____

Phase of flight _____

Type/name of approach or departure procedure _____

Heading/approximate heading if in turn _____

Altitude (AGL) _____ (MSL) _____

Aircraft bank and pitch angles _____

Angle of incidence:

Did the light hit your eye(s) directly or from the side? _____

Light description:

Color _____

Nature of beam (constant/flicker/pulsed) _____

Light source (stationary or moving) _____

Do you feel you were intentionally tracked? _____

Relative intensity (flashbulb, headlight, sunlight) _____

Duration of exposure (seconds) _____

Was the beam visible prior to the incident? _____

Position of light source (relative to geographical feature or aircraft) _____

Circle the window where the light entered the cockpit:

Left left-front center right-front right other _____

Elevation of the beam from horizontal (degrees) _____

Effect on individual:

Describe visual*/psychological/physical effects _____

Duration of visual effects (seconds/minutes/hours/days) _____

Do you intend to seek medical attention? _____

Note. - This is recommended if even minor symptoms were experienced.

Effect on operational or cockpit procedures: _____

*Examples of common visual effects:

afterimage. A transient image left in the visual field after an exposure to a bright light.

blindspot. A temporary or permanent loss of vision of part of the visual field.

flashblindness. A visual interference effect that persists after the source of illumination has been removed.

disability glare. Obscuration of an object in a person's field of vision due to a bright light source located near the same line-of-sight. Glare lasts only as long as the bright light is actually present within the individual's field of vision.

Suspected Laser Beam Exposure Questionnaire

This questionnaire may be filled out by the competent authority during interviews with persons exposed to laser beams. This information will be used to aid in any subsequent investigation and provide important medical and statistical data for the review of regulatory and enforcement issues associated with new laser beam applications and threats to aviation safety. The completed form should be forwarded to the appropriate aviation authority as soon as possible.

1. Did anyone else see the light beam? _____
2. What was the color(s) of the light? _____

Did the color(s) change during the exposure? _____
3. Did the light come on suddenly, and did it become brighter as you approached it? _____

4. Was the light continuous or did it seem to flicker? _____

If it flickered, how rapidly and regularly? _____
5. Did the light fill your cockpit or compartment? _____
6. How would you describe the brightness of the light? _____

Was it equally bright in all areas or was it brighter in one area? _____
7. Did you attempt an evasive maneuver? _____

If so, did the beam follow you as you tried to move away? _____

How successful were you in avoiding it? _____
8. Do you know the source of the light emission? _____
9. Can you estimate how far away the light source was from your location? _____

Was the source moving? _____
10. What was between the light source and your eyes - windscreen, glasses, contact lenses, etc.? _____

Did any of these sustain damage by the light? _____
11. Was the light coming directly from its source or did it appear to be reflected off other surfaces? _____

Were there multiple sources of light? _____
12. Did you look straight into the light beam or off to the side? _____

13. How long was the exposure? _____

Did the light seem to track your path or was there incidental contact? _____

14. At what time of the day did the incident occur? _____

15. What was the visibility? _____

What were the atmospheric conditions - clear, overcast, rainy, foggy, hazy, sunny? _____

16. What tasks were you performing when the exposure occurred? _____

Did the light prevent or hamper you from doing those tasks, or was the light more of an annoyance? _____

17. What were the visual effects you experienced (after-image, blind spot, flash-blindness, glare*)? _____

18. How long did any symptoms you experienced from the exposure last? _____

Are any symptoms (tearing, light sensitivity, headaches, etc.) still present? _____

19. Did you touch or rub your eyes at the time of the incident? _____

20. Did you have your eyes examined after the incident? _____

If so, when and by whom? _____

What were the results of this visit? _____

21. Did you report the incident? _____

If so, to whom (ATC, medical personnel, safety officer, etc.) and when?

*Examples of common visual effects:

afterimage. A transient image left in the visual field after an exposure to a bright light.

blindspot. A temporary or permanent loss of vision of part of the visual field.

flashblindness. A visual interference effect that persists after the source of illumination has been removed.

disability glare. Obscuration of an object in a person's field of vision due to a bright light source located near the same line-of-sight. Glare lasts only as long as the bright light is actually present within the individual's field of vision.

Sample Notification Letter to FDA/CDRH

(This letter is an example of a notification letter to the FDA/CDRH once a variance has been granted. All names and places are intended to be fictitious, and any similarities are purely coincidental.)

Date: 1/1/99

Office of Compliance (HFZ-342)
Center for Devices and Radiological Health
2098 Gaither Rd.
Rockville, MD 20850

Ref: FDA/CDRH Docket No. 000-0000
Accession No. 0000000-0000

This is a notice of the following laser light show:

| | |
|---|---|
| EVENT: | Fourth of July Festivities |
| VENUE: | Seattle Fairgrounds |
| TIME(S) AND DATE(S): | 7/4/99 - 8:00 p.m. to 10:00 p.m. |
| EFFECT(S) UTILIZED: | Beams into sky |
| DESCRIPTION OF SHOW: | Beams in an outdoor environment |
| EQUIPMENT UTILIZED: | Laser Model XXX 20 W System |
| LASER OPERATOR(S) IN CHARGE OF SHOW: | John Doe |
| AGENCIES NOTIFIED: | FDA/CDRH and FAA |
| DESCRIPTION OF SAFETY FACTORS: | All pertinent safety factors will be adhered to: three meter rule, barriers, beam blocks, and use of certified laser projector. |

MISCELLANEOUS COMMENTS:

If you have any further questions or comments, please don't hesitate to call me at (000) 555-0000.

Sincerely,

John Doe
Office Manager