A6.2 Sample Letter of Objection from FAA

NOTE—This letter is an example. All names and places are intended to be fictitious and any similarities are purely coincidental.

Mr. John Doe
Laser Coordinator
John Doe Laser Co.
0000 North St.
Seattle, WA 00000

Dear Mr. Doe:

This letter is in response to your proposals for a laser show scheduled for July 4, 2000 at Seattle Fairgrounds, in Seattle, WA. An aeronautical study has been performed by this office regarding your request dated September 1, 1998 for a proposed laser light show at the Seattle Arena. Limitations on laser beam propagation into navigable airspace are necessary in order to integrate your show into the National Airspace System. The proposed site would be too close to the nearby Seattle Airport. That area is directly within the "laser-free zone" described in FAA Order 7400.2.

Therefore, the proposals are objectionable.

If you need further assistance, please contact me at (000) 555-0000.

Sincerely,

Tom Smith
Airspace and Procedures Manager

A6.3 Sample Non-Objection Letter from FAA for Scientific Application

System Operations Services
800 Independence Avenue, SW.
Washington, DC 20591

U.S. Department of Transportation
Federal Aviation Administration
[Date]
Mr. John Doe
[ADDRESS]

Dear Mr. Doe:

This is in response to your Notice of Proposed Outdoor Laser Operation(s) dated October 10, 2007, on the use of the [laser title] system at the [location] located in [any town], USA.

Specifically, the project involves using the [control] system to range the [object to be studied], using short pulse, low power laser energy. The system uses a Laser Hazard Reduction System (LHRS) radar, which is slaved to the telescope mount to ensure the laser is deactivated if an aircraft approaches.

The [name] has six instruments onboard to collect detailed information on the environment. The focus of the [name] mission is the [system]. The [name] will provide [scientific data] through laser altimetry.

Your request indicates the [object to be studied] will be visible from the earth for approximately 1 hour during its 2 hour orbit around the moon. However, the planned use of the system is intermittent, with possible operations happening 24 hours a day, 7 days a week.

This site is located in an area where a high volume of aircraft operations are conducted. It encroaches upon the Critical Flight Zones of 23 airports and the Laser Free Zones of 4 airports. Additionally, the irradiance levels calculated for the Nominal Ocular Hazard Distance associated with this mission are hazardous to aviation. Propagation of the [name] laser into the navigable airspace as described in your correspondence requires safety measures that will ensure aircraft are not illuminated during this operation.

Federal Aviation Administration personnel personally viewed the capabilities of the LHRS and its multiple fail-safe features and feel [agency name] has proven the efficacy of its radar detection safety system. We have reviewed your request in accordance with FAA Order JO 7400.2G, Procedures for Handling Airspace Matters, and do not object to the above-requested operations through April 30, 2010, contingent upon strict compliance with the following conditions:

1. The LHRS is designed to detect aircraft within a 26-statute-mile radius of the laser transmitter. To protect aircraft operations to 60,000 feet mean sea level, the minimum laser beam elevation angle should be at or above 20 degrees above the horizon. Beam characteristics below 10 degrees in elevation will require the use of a 5.4 Optical Density Filter. Visual observers are also required for the operation and should be positioned at adequate distances to effectively observe possible air traffic penetrations.

2. Laser irradiance levels that exceed the minimum exposure levels within the Laser Free, Critical Flight, and Sensitive Flight Zones, will be controlled to maintain authorized levels. If penetration of the laser beam is possible, the laser shall be shuttered or terminated until the area is clear.
3. As an additional precaution against any adverse effects to local aviation, you are required to contact the [FAA location] at (XXX) XXX-XXXX at least 2 hours before, upon commencement, and upon conclusion of any laser operation.
4. Additionally, at least 7 days in advance of the laser operation, you are required to contact the System Operations Support Center at (XXX) XXX-XXXX and request the issuance of a Notice to Airmen stating the following:

   SPECIAL NOTICE... EFFECTIVE 0906..... UTC UNTIL 1006.._.. UTC.

   SCIENTIFIC AND RESEARCH LASER OPERATIONS WILL BE CONDUCTED AT THE [LOCATION] IN [ANYTOWN], [USA], LOCATED AT XXXXXXN/XXXXXW. THE SYSTEM IS INTERMITTENT, WITH POSSIBLE OPERATIONS HAPPENING 24 HOURS A DAY, 7 DAYS A WEEK. THE LASER BEAM MAY BE INJURIOUS TO PILOTS/AIRCREWS AND PASSENGERS EYES FOR A DISTANCE OF XX,XXX FEET ABOVE GROUND LEVEL. HOWEVER, THIS SYSTEM USES A LASER HAZARD REDUCTION SYSTEM RADAR THAT IS SLAVED TO THE TELESCOPE MOUNT TO ENSURE THE LASER IS DEACTIVATED IN THE EVENT AN AIRCRAFT APPROACHES. THE AREA WILL ALSO BE MONITORED BY OBSERVERS AND THE LASER BEAM WILL BE TERMINATED IF NONPARTICIPATING AIRCRAFT ARE DETECTED. LASER IRRADIANCE LEVELS WILL NOT EXCEED THE MAXIMUM PERMISSIBLE EXPOSURE LEVELS WITHIN THE LASER FREE, CRITICAL FLIGHT, AND SENSITIVE FLIGHT ZONES. OTHER VISUAL EFFECTS, E.G., FLASH BLINDNESS, AFTERIMAGE, GLARE, AND DISTRACTION MAY OCCUR AT GREATER DISTANCES. THE [FAA LOCATION], AT XXX-XXX-XXXX, IS THE FAA COORDINATION FACILITY.

5. [Agency] personnel shall comply with any notification or coordination required by air traffic control (ATC). The [organization] Operations Specialist agrees to terminate any projections immediately upon the request of the ATC facility or the NCRCC in the interest of aviation safety. The direct phone lines to the [name] system are (XXX) XXX-XXXX and (XXX) XXX-XXXX.
6. All personnel associated with the [name] mission will be briefed on and have a complete understanding of the conditions and limitations contained herein in advance of the operation.

This letter does not relieve [agency name] or any other personnel associated with the operation from the requirements of title 14, Code of Federal Regulations, Section 91.11, Prohibition on interference with crewmembers. [Agency name] will assume complete liability for any interference with any crewmember(s) performing duties aboard an aircraft caused by any laser beam emission associated with conducting the [name] operation.

Furthermore, this letter does not relieve [agency name], other [name] laser operators, or maintenance personnel from compliance responsibilities related to the laws, ordinances, or regulations of any Federal, State, or local government agency.

If we can be of further assistance, please contact [name], Manager, Airspace and Rules Group, at (XXX) XXX-XXXX.

Sincerely,

Signature
[Name]
Vice President, System Operations Services

A6.4 Sample Request for Laser Clearinghouse Predictive Avoidance Support

```
Classification:                 Unclassified
File Name:                      PRM_ABC_1.07um_123W_123urad_20090224.txt
Message Purpose:                Request for Predictive Avoidance Support
Message Date/Time (UTC):        2009 Feb 25 (056) 21:20:00
Type Windows Requested:         Open
Point of Contact:               xxxxxxxxxxxxx
                                (Voice) 123-456-7899
                                (Fax) 987-654-3210
                                (E-mail) xxxxxxxxxxxx@xxxxxx.xxx
Emergency Phone #
at Operations Site:             123-456-7899
Remarks:                        None

MISSION INFORMATION
---------------------------
Owner/Operator:                 ABC Laser Program
Mission Name/Number:            ABC_1.07um_123W_123urad
Target Type:                    Fixed Field of View
Location:                       XXXXXXXXXXXXXXXXXXXXX
Start Date/Time (UTC):          2009 Feb 26 (057) 00:00:00
End Date/Time (UTC):            2009 Feb 26 (057) 02:00:00
Duration (HH:MM:SS):            02:00:00

LASER INFORMATION
---------------------------
Laser:                          ABC_1.07um_123W_123urad

SOURCE INFORMATION
-----------------------------------
Method:                         Fixed Point
Latitude:                       01.000 degrees N
Longitude:                      010.0000 degrees W
Altitude:                       1.000 km

TARGET INFORMATION
-----------------------------------
Method:                         Fixed Field of View
Azimuth Range:                  63.2 to 66.9 degrees
Elevation Range:                17.2 to 23.2 degrees
```

```
Method:                         Fixed Field of View
Azimuth Range:                  62.3 to 65.8 degrees
Elevation Range:                22.2 to 28.4 degrees

Method:                         Fixed Field of View
Azimuth Range:                  339.0 to 6.1 degrees
Elevation Range:                11.0 to 19.6 degrees

END OF FILE
```

A6.5 Sample Laser Clearinghouse Predictive Avoidance Findings

Classification: UNCLASSIFIED

UNITED STATES STRATEGIC COMMAND LASER CLEARINGHOUSE (LCH) TIME WINDOWS REPORT

Date: 2009 Feb 25 22:07:02
From: JFCC-SPACE/J95 (LCH)
To: XXXXXXXXXXXXXXX
Subject: LCH Authorized Shoot (Open) Windows

1. The attached information contains the coordinated and approved spatial parameters

(a) Authorized Shoot (Open) Windows

During Authorized Shoot Windows, the laser owner-operator (O/O) is authorized to operate the approved system laser in accordance with the Source/Target geometry definitions contained in this report.

2. The laser O/O may perform Hybrid Predictive Avoidance (HPA) during Authorized Shoot Windows, if previously certified in writing by USSTRATCOM to do so.

3. Any deviation from this authorization must be immediately reported to the Laser Clearinghouse at: Commercial 805-605-6565,6578,6546 (Manned 24/7). DSN=275-(xxxx).

4. See below for comments specific to this mission.

5. If you have any questions, please don't hesitate to contact LCH at the above listed phone numbers.

JFCC SPACE/J95 (LCH)
747 NEBRASKA AVE RM B209
VAFB, CA 93437

Mission ID:	ABC_1.07um_123W_123urad_09061171310_P
Laser Owner/Operator:	XXXXXXXXXXXXXXXXXXXXX
Report Date/Time (UTC):	2009 Feb 25 22:07:02
Mission Name:	ABC_1.07um_123W_123urad
Mission Start Date/Time (UTC):	2009 Feb 26 00:00:00

```
Mission Stop  Date/Time (UTC):   2009 Feb 26 02:00:00
Mission Duration   (HH:MM:SS):   02:00:00
Type of Windows in this report:  Authorized Shoot (Open) Windows
Comment:                         None
Number of Targets:               3

YYYY MMM dd (DDD) HHMM SS    YYYY MMM dd (DDD) HHMM SS      MM:SS
-------------------------    -------------------------    -------
2009 Feb 26 (057) 0000 00    2009 Feb 26 (057) 0003 46    0003:46
2009 Feb 26 (057) 0004 23    2009 Feb 26 (057) 0007 13    0002:50
2009 Feb 26 (057) 0007 48    2009 Feb 26 (057) 0023 34    0015:46
2009 Feb 26 (057) 0024 02    2009 Feb 26 (057) 0126 01    0061:59
2009 Feb 26 (057) 0126 53    2009 Feb 26 (057) 0132 45    0005:52

Percent = 90.53%
Source Geometry: (WGS-84)
---------------
Method: Fixed Point
Latitude:  01.000 degrees N
Longitude: 010.000 degrees W
Altitude:  1.000 km

Target Geometry: (WGS-84)
---------------
Method: Fixed Field of View
Azimuth Range:   63.2 to 66.9 degrees
Elevation Range: 17.2 to 23.2 degrees

YYYY MMM dd (DDD) HHMM SS    YYYY MMM dd (DDD) HHMM SS      MM:SS
-------------------------    -------------------------    -------
2009 Feb 26 (057) 0000 00    2009 Feb 26 (057) 0000 28    0000:28
2009 Feb 26 (057) 0001 14    2009 Feb 26 (057) 0003 49    0002:35
2009 Feb 26 (057) 0004 19    2009 Feb 26 (057) 0006 45    0002:26
2009 Feb 26 (057) 0007 05    2009 Feb 26 (057) 0007 18    0000:13
2009 Feb 26 (057) 0007 50    2009 Feb 26 (057) 0023 15    0015:25
2009 Feb 26 (057) 0023 53    2009 Feb 26 (057) 0125 41    0061:48
2009 Feb 26 (057) 0144 32    2009 Feb 26 (057) 0200 00    0015:28

Percent = 85.76%
Source Geometry: (WGS-84)
---------------
```

```
Method: Fixed Point
Latitude:  01.000 degrees N
Longitude: 010.000 degrees W
Altitude:  1.000 km

Target Geometry: (WGS-84)
---------------
Method: Fixed Field of View
Azimuth Range:   62.3 to 65.8 degrees
Elevation Range: 22.2 to 28.4 degrees

YYYY MMM dd (DDD) HHMM SS    YYYY MMM dd (DDD) HHMM SS      MM:SS
-------------------------    -------------------------    -------
2009 Feb 26 (057) 0000 00    2009 Feb 26 (057) 0004 18    0004:18
2009 Feb 26 (057) 0006 28    2009 Feb 26 (057) 0007 08    0000:40
2009 Feb 26 (057) 0010 41    2009 Feb 26 (057) 0013 15    0002:34
2009 Feb 26 (057) 0016 44    2009 Feb 26 (057) 0028 32    0011:48
2009 Feb 26 (057) 0030 00    2009 Feb 26 (057) 0038 22    0008:22
2009 Feb 26 (057) 0138 55    2009 Feb 26 (057) 0139 27    0000:32
2009 Feb 26 (057) 0140 56    2009 Feb 26 (057) 0144 01    0003:05
2009 Feb 26 (057) 0148 21    2009 Feb 26 (057) 0200 00    0011:39

Percent = 72.35%
Source Geometry: (WGS-84)
---------------
Method: Fixed Point
Latitude:  01.000 degrees N
Longitude: 010.000 degrees W
Altitude:  1.000 km

Target Geometry: (WGS-84)
---------------
Method: Fixed Field of View
Azimuth Range:   339.0 to 6.1 degrees
Elevation Range: 11.0 to 19.6 degrees
```

Appendix B
Examples of Calculations, Hazard Evaluation, and Control Measures Implementation

B1. General

Calculations and measurements are necessary for a hazard evaluation of outdoor laser systems. Each section of this appendix uses one set of laser parameters and several examples to illustrate various safety issues. The hazard evaluation techniques described in this appendix are designed to provide a reasonably conservative estimate of the laser hazards. Differing techniques will produce results that may vary by few percent.

B2. Symbols

The following symbols are used in the formulas of this appendix:

a = Diameter of emergent laser beam (cm)

d_e = Diameter of pupil of eye (cm)

D_c = Diameter of collecting aperture of an optical system (cm)

D_m = Diameter of a measurement aperture or aperture used for calculations (cm)

D_f = Diameter of limiting aperture (cm)

D_L = Diameter of laser beam (cm)

D_e = Diameter of the exit pupil of an optical system (cm)

D_{fp} = Beam diameter at the focal point of a lens (cm)

D_0 = Diameter of objective lens of optical aid (cm)

D_ρ = Diameter of beam on a target (cm)

D_W = Diameter of beam waist (cm)

E = Irradiance ($W \cdot cm^{-2}$)

f = Geometric focal length of a lens (cm)

G = Gain of an optical system

G_f = Effective gain of an optical system

H = Radiant exposure ($J \cdot cm^{-2}$)

L_e = Radiance of an extended source ($W \cdot cm^{-2} \cdot sr^{-1}$)

M = Magnifying power of an optical instrument

MPE = Maximum permissible exposure value

MPL = Maximum permissible level ($W \cdot cm^{-2}$); may represent any interference level

NOHD = Nominal ocular hazard distance (cm)

NOHD-M = Nominal ocular hazard distance when magnifying optics are used (cm)

NSHD = Nominal skin hazard distance (cm)

$D(\lambda)$ = Optical density at a particular wavelength

PRF = Pulse repetition frequency (Hz)

Q_0 = Energy per pulse from a pulsed laser (J)

Q_d = Energy per pulse transmitted by an aperture (J)

Q_{MPE} = Safe limit for energy per pulse transmitted by an aperture as used for hazard evaluation (J)

Φ_0 = Radiant power emitted from a laser (W)

Φ_d = Power transmitted by an aperture (W)

Φ_{MPE} = Safe limit for power transmitted by a limiting aperture as used for hazard evaluation (W)

r = Range from laser exit port (cm)

r_0 = Range from laser exit port to an external beam waist (cm)

r_w = Range from the beam waist (cm).

r_1 = Range from a target to viewer (cm)

s = Distance from an object to a focusing lens (cm)

s' = Distance from a focusing lens to an image (cm)

t = Width of an individual pulse (s)

T_{max} = Maximum exposure duration (s)

α = Angular subtense of a laser source (rad)

α_{min} = Angle defining a point source (rad) (equal to 1.5 mrad)

α_{max} = Angle beyond which hazards are related to radiance or integrated radiance (rad)

Δ = Edge inaccuracy of an optical flat (cm)

ϕ = Emergent beam divergence (rad)

ϕ_d = Contribution to divergence of a reflected beam due to diffraction (rad)

ϕ_r = Divergence of a reflected beam (rad)

ϕ_s = Contribution to divergence of a reflected beam due to surface quality (rad)

ϕ_0 = Contribution to divergence of a reflected beam due to emergent beam divergence of beam striking a target (rad)

λ = Wavelength of optical radiation (nm)

ρ_λ = Reflection coefficient from a surface at a particular wavelength

τ_λ = Transmission of an optical device at a specific wavelength

θ_v = Viewing angle measured from normal (perpendicular) to a reflecting surface (rad)

ω = Beam radius at $1/e^2$ of peak irradiance points (cm)

NOTE—For all calculations, values need to be converted to the basic units listed in the above definitions (e.g., cm, rad, W and J); however, these values are often referenced with modified units (e.g., m, mm, km, mrad, mW or mJ). A subscript of 0 (zero) indicates the total or initial value of that parameter. The abbreviation for nautical miles is NM in this document to distinguish nautical miles (NM) from nanometers (nm).