HRP Job Aid

Lasers

Description	ECCN
Alexandrite lasers	6A005.c.2.b
Argon ion lasers	6A005.a or 6A005.b
Atomic transition solid-state lasers	6A005.b
Barium metal vapor lasers	6A005.b
Carbon dioxide (CO_2) lasers	6A005.d.3
Carbon monoxide (CO) lasers	6A005.d.2
Chemical lasers	6A005.d.5
Color center lasers	6A005.c.1, c.2, or c.3
Copper metal vapor lasers	6A005.b
Deuterium fluoride–carbon dioxide (DF-CO_2) lasers	6A005.d.5
Deuterium fluoride lasers	6A005.d.5
Dye lasers	6A005.c or 6A205
Excimer lasers	6A005.d.4
Gas discharge and ion lasers	6A005.a
Gas lasers	6A005.a
Gold metal vapor lasers	6A005.b
Hydrogen fluoride lasers	6A005.d.5.a
Ion lasers	6A005.a
Laser-pointing devices for use on firearms	0A504.f
Lasers	6A005, 6A205, or 6A995
Liquid lasers	6A005.c
Metal vapor lasers	6A005.b
Neodymium lasers	6A005.d.6 or 6A205.f
Nontunable continuous wave lasers	6A005.a or 6A995.e
Nontunable pulsed lasers	6A005.b or 6A995.d
Nontunable solid-state lasers	6A005.a, 6A005.b, or 6A995.f
Optical components for lasers	6A004.b or 6A005.e
Pulse excited Q-switched neodymium-doped lasers	6A205.f
Q-switched lasers	6A005.a, 6A005.b, or 6A205.f
Raman shift lasers	6A205.e
Ruby lasers	6A995.c
Semiconductor lasers	6A005.d.1

Description	ECCN
Sodium metal vapor lasers	6A005.b
Solid-state lasers, tunable	6A005.c
Thulium-YAG (Tm:YAG) lasers	6A005.c.1, c.2, or c.3
Thulium-YSGG (Tm:YSGG) lasers	6A005.c.1, c.2, or c.3
Titanium-sapphire (Ti:Al_2O_3) lasers	6A005.c.1, c.2, or c.3
Tunable lasers	6A005.c
Tunable lasers, solid-state	6A005.c.1, c.2, or c.3

Key Points

Terminology

- LASER is an acronym for **light amplification by stimulated emission of radiation**
- Light produced by conventional sources such as lamps radiates in all directions and in various wavelengths that reinforce or cancel each other. Light from a laser source is highly coherent, highly directional, and a specific *wavelength* (measured in nanometers [nm])
- Some lasers are export controlled based only on their (average) output power and wavelength, whereas others also have specifications on pulse duration, repetition rate (i.e., rate at which pulses are emitted), or bandwidth
- A laser "system" consists of a laser and its power supply

Classes of Lasers

- Lasers are classified into different groups called *classes* based on the hazard they present. The higher the class, the more powerful the laser is and the greater potential it poses for serious injury (if used improperly)
- In the United States, classes are I, II, IIIa, IIIb, and IV
- In Europe, classes are 1, 2, 3R, 3B, and 4
- Outside of "catch-all" controls, **only certain Class IIIa, IIIb, and Class IV lasers are export controlled**

Laser Products in the Different Classes

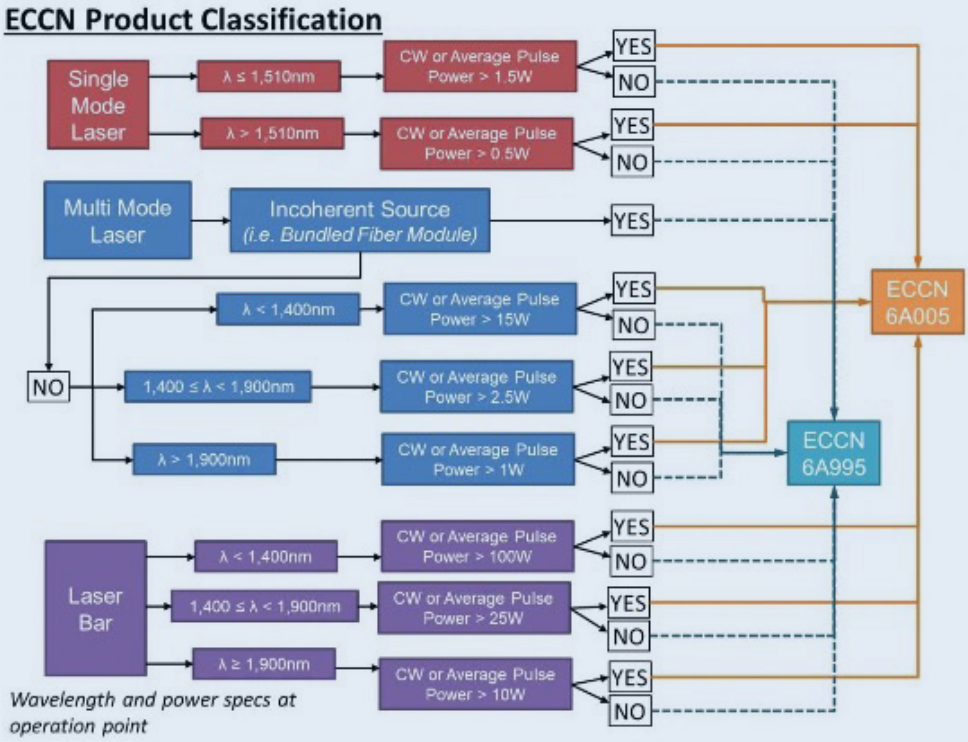
- **Class I:** Laser printers, CD players, DVD players
- **Class II:** Barcode scanners, regular laser pointers
- **Class IIIa:** Surveying, leveling, and alignment lasers used in agriculture and in the construction industry; stronger laser pointers

Laser Products in the Different Classes Continued

- **Class IIIb:** Laser light show projectors, industrial lasers, research lasers, therapeutic lasers, acupuncture lasers, bio-stimulation lasers, military laser range finders and designators
- **Class IV:** Uranium enrichment processes (e.g., atomic vapor laser isotope separation [AVLIS]/ molecular laser isotope separation [MLIS]), laser light show projectors; industrial lasers (e.g., drilling, cutting, welding), research lasers, medical device lasers (e.g., eye surgery or skin treatments)

Technical Assistance

Recognition of a laser is rather straightforward. However, technical specifications associated with lasers are tedious and complex. Interpretation by a subject matter expert is encouraged to determine the appropriate ECCN for a laser or laser system. For example, one laser manufacturer's website provides the following decision tree to evaluate ECCN 6A005 vs. ECCN 6A995:



Applications of Export-Controlled Lasers

- Uranium enrichment processes (i.e., AVLIS/MLIS)
- Materials processing, including cutting, welding, marking, micromachining, and microablating metals and non-metals
- Medical devices, including lasers for imaging and surgery
- Military range finders
- Laser light shows

Note: *The average academic or research spectroscopy laboratory will typically* ***not*** *need lasers as high-powered as these applications.*

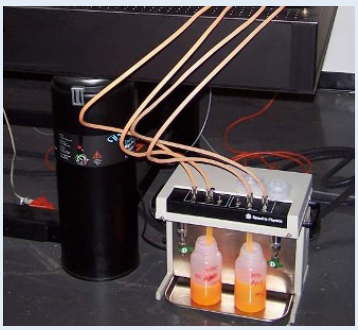
Types of Lasers and Export Controlled Examples

Laser light can be produced in four types of "lasing" mediums:

Nd:YVO_4 laser head with power supply. ECCN 6A205.f.

1. Solid-state lasers use laser crystals to generate light

- More compact than gas or liquid lasers
- Export-controlled solid-state lasers include neodymium-doped lasers (Nd:YAG, Nd:YLF, Nd:YVO_4, etc.), alexandrite lasers, and fiber lasers



Dye laser head with tubing for dye solution. ECCN 6A005.c.

2. Liquid lasers generate light from fluorescent dyes and are "optically pumped" with other lasers

- Look for tubing (plastic or metal) or attachments for tubing to the laser head; liquid pumps may be present

Excimer laser with gas connections and pressure gauges. ECCN 6A005.d.4.

Industrial copper vapor laser. ECCN 6A005.b.

3. Gas lasers operate with a gas flow system or a sealed gas "ion" tube

- The largest of the laser types
- Look for gas connections, gauges, and other related features; gas cylinders may also be present
- Export-controlled solid-state lasers include copper vapor lasers, argon ion lasers, carbon dioxide (CO_2) lasers, and excimer lasers
- Copper vapor lasers are especially significant for uranium enrichment applications (e.g., AVLIS) and are becoming more popular for industrial and medical applications

A simple and low power metal enclosed laser diode. Not controlled.

4. Semiconductor lasers generate light by flowing an electric current to a semiconductor (i.e., gallium arsenide)

- Also called *diode lasers*
- Most are inexpensive and very compact—about the same size as (and work in a similar way to) an ordinary LED
- The most widespread lasers in the world (used in barcode readers, DVD players, laser printers, etc.)

Industrial Lasers

Material Processing Lasers

- Industrial lasers are used for laser cutting and welding and are typically the most powerful commercially available lasers
- Three main types of lasers are used in laser cutting:
  - CO_2 lasers can be used for cutting, boring, and engraving
  - Neodymium lasers are used for boring
  - Nd-YAG lasers can be used for boring, engraving, and welding
- The most popular industrial lasers are called *fiber lasers*, which have the following characteristics:
  - Use an optical fiber cable made of silica glass to guide the light
  - More precise beam than other types of lasers
  - Typically operate at 1,100 nm wavelength
  - Small footprint
  - Are considered solid-state lasers

Industrial Laser Diode Modules

Note cooling fins for extra passive heat dissipation.

ECCN 6A005

- Class IIIa
- Wavelength: 532 nm (green light)
- Dimensions: 60 mm length × 20 mm diameter
- Applications:
  - Spectroscopy
  - Interferometry
  - Particle measurement
  - Medical tissue analysis
  - Positioning

ECCN 6A005

- Class IIIa
- Wavelength: 650 nm (red light)
- Dimensions: 71 mm length × 16.65 mm diameter
- Applications:
  - Metal forming
  - Drilling
  - Punch presses
  - Heavy-duty saws
  - Welding
  - Alignment
  - Targeting
  - Positioning
  - Riveting

ECCN 6A005.d.1.b.1

- Fiber-coupled semiconductor laser module
- Class IV (400 W output power)
- Wavelength: 915 nm
- Dimensions: 58 mm W × 125 mm L × 17 mm H
- Applications:
  - Industrial fiber lasers
  - Fiber laser amplifiers
  - Microfabrication
  - Defense applications

Laser Aiming Devices or Laser Illuminators

Nightstick Compact Tactical Weapon Lights

- ECCN 0A504.f
- Class IIIa
- Wavelength: 532 nm (green light)

Steiner Dual-Beam Aiming Laser, Infrared (IR) Illuminator

- ECCN 0A504.f
- Class IIIa
- Wavelength: 532 nm (visible green laser)
- Wavelength: 835 nm (IR laser and IR illuminator)

Laser heads.

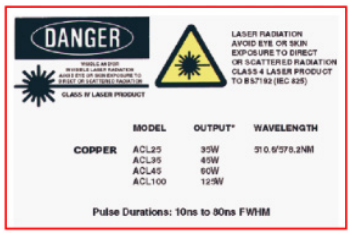
Identifying Features and Appearance

- The size and weight of lasers can vary greatly, depending on the particular laser design and power output
- A key part of a laser system is the *laser head*, which produces the laser light
- Aiming devices and illuminators are usually housed in metal rectangular or cylindrical boxes with the following features:
  - Apertures for light to escape. Look for arrows pointing to the apertures
  - Electrical connections for power and control. Often there will be a prominent multipin connector for the main "umbilical" cable
  - Connections for a coolant (e.g., chilled water for high-power lasers)
  - Leveling feet for mounting on a table
- Other components needed to operate the laser are a power supply, control panel, heat exchanger or chiller, and special cables for connecting the head to the power supply

Typical Packaging for New or Unused Equipment

- The laser head will be highly protected by its packaging
  - Wooden crates filled with molded Styrofoam padding
  - "Shock-impact" labels are likely to be placed on the laser head crate
  - Crates usually marked *fragile* and *laser*
- Electrical and optical components are usually sealed in plastic bags to protect them from dust
- The laser head, power supply, and other components will be packaged separately, unless the components are integrated

Identifying Features and Appearance



Labels

Classes II–IV lasers must include a warning symbol and label indicating its hazard classification, output power/energy, and lasing material or wavelength.

Laser Head

Laser heads should have prominent warning labels because of serious hazards associated with laser light and the presence of apertures (openings) for light to escape. The most obvious clue identifying a laser is the "sunburst" symbol, shown either in a yellow triangle or in red on danger labels.

System Electronics

Look for indicators or controls with labels like *interlock* (for preventing laser from operating if the head is open), *radiation* or *emission*, or *shutter*.

Power Supply

Laser power supplies are usually key operated as an additional safety measure to prevent unauthorized laser operation.

DOE/NNSA High Risk Property

https://hrp.doe.gov

https://ecap.doe.gov

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