

1061.4. con't.

e. Aspheric optical elements having all of the following characteristics:

1. The largest dimension of the optical-aperture is greater than 400 mm;
2. The surface roughness is less than 1 nm (rms) for sampling lengths equal to or greater than 1 mm; **and**
3. The coefficient of linear thermal expansion's absolute magnitude is less than $3 \times 10^{-6}/K$ at 25° C;

Technical Notes.

1. An 'aspheric optical element' is any element used in an optical system whose imaging surface or surfaces are designed to depart from the shape of an ideal sphere.
2. Manufacturers are not required to measure the surface roughness listed in 6.A.4.e.2. unless the optical element was designed or manufactured with the intent to meet, or exceed, the control parameter.

Note.

1061.a.4.e. does not control aspheric optical elements having any of the following:

- a. A largest optical-aperture dimension less than 1 m and a focal length to aperture ratio equal to or greater than 4.5:1;
- b. A largest optical-aperture dimension equal to greater than 1 m and a focal length to aperture ratio equal to or greater than 7:1;
- c. Being designed as Fresnel, flyeye, stripe, prism or diffractive optical elements;
- d. Being fabricated from borosilicate glass having a coefficient of linear thermal expansion greater than $2.5 \times 10^{-6}/K$ at 25° C; or
- e. Being an x-ray optical element having inner mirror capabilities (e.g. tube-type mirrors).

N.B.

For aspheric optical elements specially designed for lithography equipment, see Item 1061.a.3.b.1.

5. Lasers

"Lasers", components and optical equipment, as follows:

Notes:

1. Pulsed "lasers" include those that run in a continuous wave (CW) mode with pulses superimposed.
2. Pulse-excited "lasers" include those that run in a continuously excited mode with pulse excitation superimposed.
3. The control status of Raman "lasers" is determined by the parameters of the pumping source "lasers". The pumping source "lasers" can be any of the "lasers" described below.

a. Gas "lasers", as follows:

1. Excimer "lasers" having any of the following:
 - a. An output wavelength not exceeding 150 nm and having any of the following:
 1. An output energy exceeding 50 mJ per pulse; **or**
 2. An average or CW output power exceeding 1 W;
 - b. An output wavelength exceeding 150 nm but not exceeding 190 nm and having any of the following:
 1. An output energy exceeding 1.5 J per pulse; **or**
 2. An average or CW output power exceeding 120 W;
 - c. An output wavelength exceeding 190 nm but not exceeding 360 nm and having any of the following:
 1. An output energy exceeding 10 J per pulse; **or**
 2. An average output power exceeding 500 W; **or**
 - d. An output wavelength exceeding 360 nm and having any of the following:
 1. An output energy exceeding 1.5 J per pulse; **or**
 2. An average output power exceeding 30 W;

N.B.:

For excimer "lasers" specially designed for lithography equipment, see 1032.1.

5. a. 2. Metal vapour "lasers", as follows:
 - a. Copper (Cu) "lasers" having an average output power exceeding 20 W;
 - b. Gold (Au) "lasers" having an average output power exceeding 5 W;
 - c. Sodium (Na) "lasers" having an output power exceeding 5 W;
 - d. Barium (Ba) "lasers" having an average output power exceeding 2 W;
3. Carbon monoxide (CO) "lasers" having any of the following:
 - a. An output energy exceeding 2 J per pulse and a pulsed "peak power" exceeding 5 kW; **or**
 - b. An average or CW output power exceeding 5 kW;
4. Carbon dioxide (CO₂) "lasers" having any of the following:
 - a. A CW output power exceeding 15 kW;
 - b. A pulsed output having a "pulse duration" exceeding 10 µs and having any of the following:
 1. An average output power exceeding 10 kW; **or**
 2. A pulsed "peak power" exceeding 100 kW; **or**
 - c. A pulsed output having a "pulse duration" equal to or less than 10 µs and having any of the following:
 1. A pulse energy exceeding 5 J per pulse; **or**
 2. An average output power exceeding 2.5 kW;
5. "Chemical lasers", as follows:
 - a. Hydrogen Fluoride (HF) "lasers";
 - b. Deuterium Fluoride (DF) "lasers";
 - c. "Transfer lasers", as follows:
 1. Oxygen Iodine (O₂-I) "lasers";
 2. Deuterium Fluoride-Carbon dioxide (DF-CO₂) "lasers";
6. Krypton ion or argon ion "lasers", having any of the following:
 - a. An output energy exceeding 1.5 J per pulse and a pulsed "peak power" exceeding 50 W; **or**
 - b. An average or CW output power exceeding 50 W;
7. Other gas "lasers", having any of the following:

Note:
1061.5.a.7. does not control nitrogen "lasers".

 - a. An output wavelength not exceeding 150 nm and having any of the following:
 1. An output energy exceeding 50 mJ per pulse and a pulsed "peak power" exceeding 1 W; **or**
 2. An average or CW output power exceeding 1 W;
 - b. An output wavelength exceeding 150 nm but not exceeding 800 nm and having any of the following:
 1. An output energy exceeding 1.5 J per pulse and a pulsed "peak power" exceeding 30 W; **or**
 2. An average or CW output power exceeding 30 W;
 - c. An output wavelength exceeding 800 nm but not exceeding 1,400 nm and having any of the following:
 1. An output energy exceeding 0.25 J per pulse and a pulsed "peak power" exceeding 10 W; **or**
 2. An average or CW output power exceeding 10 W; **or**
 - d. An output wavelength exceeding 1,400 nm and an average or CW output power exceeding 1 W.
5. b. Semiconductor "lasers", as follows:
 1. Individual single-transverse mode semiconductor "lasers", having any of the following;