



Laser Safety Disclosure

Everyone in Laser Controlled Area* Must Read and Observe




Laser safety is of utmost importance and requires diligent attention. It is the responsibility of the employer or purchaser to ensure proper safety measures are implemented and adhered to at all times. 1987 Machinery, Inc. does not assume responsibility for user safety or safety training associated with the use of our laser powered products. Furthermore, 1987 Machinery cannot be held liable for any injuries or damages resulting from the use or misuse of our products. It is imperative that the employer/purchaser provides all users adequate safety training and PPE. Any party not in agreement with these conditions should not purchase or use any laser product offered by 1987 Machinery.

Recommended Personal Protection Equipment

The recommended Personal Protection Equipment (PPE) for all individuals operating a Laser Welding or Cleaning Device or in a Laser Controlled Area (LCA) where a Laser Welding or Cleaning Device is in use is a Laser Safety Welding Helmet with appropriate filters and face shield, Laser Safety Glasses, Laser-Resistant and Heat-Resistant Protective Gloves, Suit, and Apron.

The recommended Personal Protection Equipment (PPE) for all individuals operating a Laser Cutting Device or in a Laser Controlled Area (LCA) where a Laser Cutting Device is in use is Laser Safety Glasses and Laser-Resistant and Heat-Resistant Gloves.

	<p>Laser Radiation</p> <p>Exposure to laser light can result in severe retina and/or cornea injuries, leading to permanent eye damage, and may cause skin damage. It is important to note that some laser light, including the laser beam is invisible. Safety protocols must be followed to prevent accidental exposure to invisible, direct, and reflected beams. The system must only be operated in a Laser Controlled Area.</p>
	<p>Eye Damage</p> <p>All individuals in the Laser Controlled Area must wear all recommended personal protective equipment (PPE), to protect against eye damage from any reflected or scattered laser beams as well as intense light, ultraviolet (UV) light, heat, and sparks. If any PPE becomes damaged or compromised while using the laser device, discontinue using the laser device immediately and replace damaged PPE. Before using a pair of laser safety glasses, all personnel must check for any cracking, discoloration, coating damage, pitting, and crazing. Also check the mechanical integrity of the frame.</p>
	<p>Skin Hazard</p> <p>Exposure to infrared (IR) and UV light radiation can cause serious injury to the skin. Operators and all personnel working within the Laser Controlled Area must wear all recommended personal protective equipment (PPE). Sleeves and collars should always be secured. Depending on the intensity of the IR light, skin injuries may also include thermal burns or excessive dryness. Exposure to UV light may cause sunburn and can increase the risk of skin cancer and accelerated signs of skin aging. Sparks generated during laser operations may also cause burns. Laser beams can penetrate through metal parts to objects or persons on the other side. Never hold parts for processing in a position where laser penetration of the material may result in a hazard.</p>

	<p>Reflected Beam Hazard</p> <p>Highly reflective metals such as aluminum and copper may cause the reflection of laser energy away from the target area to the laser source or surrounding environment, posing a hazard to all individuals in the Laser Controlled Area. All individuals in the Laser Controlled Area must wear all recommended PPE. Spectators should never attempt to view the process or processed part from the opposite side of the laser device's source. Spectators should only attempt to view the process or processed parts from behind the operator of the device, and only when wearing all recommended PPE.</p>
	<p>Fume Hazards</p> <p>Fumes resulting from the interaction of the laser beam with target materials can consist of very fine particles that may damage the lungs, heart, kidneys, and central nervous system. During use, always keep your head away from fumes. It is essential to use a laser in an area with adequate ventilation and utilize a fume extraction system to eliminate vapors, particles, and hazardous debris from the laser processing area.</p>
	<p>Other Hazards</p> <p>Heat, sparks, and reflected laser beams can start a fire, or cause an explosion in combustible or flammable materials in the laser processing area. Laser operations should only be performed in an area free of combustible or flammable materials. Never direct a laser towards containers that contain flammable or combustible material. If the contents of a container are unknown, you should assume that they are flammable or combustible. Gas cylinders must be stored only in areas where they cannot be struck by laser beams, sparks, or laser beam deflections. Adequate regulators for proper storage and pressure regulation of any gases are required. All hoses and fittings must also be suitable for the gas types and pressures used in the laser application.</p>

*All 1987 Machinery Laser Machines should be assumed to be Class 4 Laser Radiation Machines unless stated otherwise

⚠ DANGER



Class 4 Laser Radiation

Severe and permanent eye damage from reflected or scattered radiation.










Precautions:

- ▶ Protective laser eyewear must be worn inside the laser area if the system can be active (Keyswitch turned ON).











Signal Words Used in this Safety Guide

Signal Word ¹	Explanation
⚠ DANGER	<ul style="list-style-type: none"> This signal word indicates an immediate danger. If this danger is not avoided, this will lead to death or severe injuries.
⚠ WARNING	<ul style="list-style-type: none"> This signal word indicates a possible danger. If this danger is not avoided, this could lead to death or severe injuries.
⚠ CAUTION	<ul style="list-style-type: none"> This signal word indicates a possible dangerous situation. If this dangerous situation is not avoided, this could lead to light or moderate injuries.
NOTICE	<ul style="list-style-type: none"> If this notice is not needed, there is a risk of damage to the product, or other property damage or environmental damage.
IMPORTANT	<ul style="list-style-type: none"> This signal word indicates important information or recommendations concerning the subject under discussion) not hazard related). Do not overlook this information.

Signal Words Used in this Safety Guide

Symbols	Explanation
	<p>ELECTRICAL HAZARD</p> <p>Indicates presence of dangerous voltages that may be sufficient magnitude to constitute a risk of electric shock in certain conditions.</p>
	<p>LASER RADIATION HAZARD</p> <p>Indicates a danger of exposure to hazardous invisible and visible laser radiation.</p>
	<p>CAUTION HAZARD SYMBOL</p> <p>General purpose hazard symbol to call our attention to a particular hazard.</p>
	<p>LASER CONTROLLED AREA</p> <p>Laser Device Operation should only be done within a laser-controlled area (or room) with safety interlocks implemented. Laser devices within this controlled area protect personnel outside (who are not wearing PPE) from hazardous exposure. The interlocks would automatically shut down the laser emission if someone unexpectedly enters.</p>
	<p>DIRECT AND REFLECTED LASER BEAM HAZARD</p> <p>Symbol indicates a potential eye or skin hazard due to direct or reflected laser beams during use. Personnel must wear protective equipment and clothing.</p>
	<p>DIRECT BEAM POINTING IS PROHIBITED</p> <p>Symbol warns users to never look directly into the output laser head or point the laser head at others. This is extremely dangerous, even when wearing full eye protection.</p>
	<p>LASER AREA PERSONNEL LASER RADIATION HAZARD</p> <p>All personnel that are working in the laser use area must wear proper Personal Protective Equipment to prevent exposure to reflected beams generated.</p>
	<p>FIRE HAZARD</p> <p>Symbol indicates a possible fire hazard. Operators must take precautions to avoid causing a fire by igniting flammable material.</p>
	<p>HOT SURFACE HAZARD</p> <p>Symbol indicates hot surface. To avoid possible burns protective gloves and clothing should be worn.</p>

Signal Words Used in this Safety Guide

Symbols	Explanation
	<p>GAS CYLINDER HAZARD</p> <p>Symbol indicates exploding pressurized cylinder. The gas cylinder must be protected from high temperatures, sparks, and flames. The cylinder should be secured to prevent it from tipping over.</p>
	<p>FUME INHALATION HAZARD</p> <p>Symbol indicates an inhalation health hazard.</p>
	<p>HEAVY WEIGHT HAZARD</p> <p>Symbol warns that physical injuries are possible when attempting to carry a laser source unit alone.</p>
	<p>NOTICE SYMBOL</p> <p>Symbol is used in conjunction with the notice signal word. Notices are related to various kinds of property damage. Ensure you do not overlook this information.</p>
	<p>WEAR LASER PROTECTIVE EYEWEAR</p> <p>Symbol indicates that personnel must wear laser safety eyewear (PPE) to protect against laser radiation hazards.</p>
	<p>WEAR LASER SAFETY HELMET AND SHEILD</p> <p>This symbol indicates that personnel must wear a laser safety helmet and sheild to protect their eyes and head. There may be hot flying particles, intense light and UV radiation from laser activity.</p>
	<p>WEAR PROTECTIVE GLOVES</p> <p>Symbol indicates that personnel must wear laser-resistant and heat-resistant protective gloves.</p>
	<p>WEAR PROTECTIVE CLOTHING</p> <p>Symbol indicates that personnel must wear laser-resistant and heat-resistant protective clothing.</p>
	<p>WEAR PROTECTIVE APRON</p> <p>Symbol indicates that personnel must wear laser-resistant and heat-resistant protective apron.</p>
	<p>READ USER GUIDE INSTRUCTIONS</p> <p>Symbol indicates that personnel must read safety and operational instructions in this user guide.</p>

*All 1987 Machinery Laser Machines should be assumed to be Class 4 Laser Radiation Machines, unless stated otherwise

Governmental standards require that all lasers be classified according to their output power or energy and the laser wavelength. Assume that all 1987 Machinery laser devices are a high-power class IV laser instrument under 21 CFR, Subchapter J, part II, 1040.10(d) and Class 4 per IEC 60825-1, unless stated otherwise.

Please refer to the product specification for the specific performance characteristics of your device. Class 4 high power lasers present the most serious of all laser hazards. Take precautions to prevent accidental exposure to both direct and reflected beams. Class 4 laser beams are also a potential skin hazard and fire hazard as well.

⚠ DANGER



Class 4 Invisible Laser Radiation

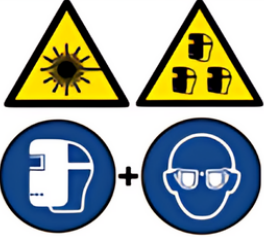
Severe and permanent eye damage from reflected or scattered radiation.

Precautions:

- ▶ Protective laser eyewear must be worn inside the laser area if the system can be active: (Keyswitch turned ON).
-

Class 4 Laser Safety (cont.)

WARNING



Eye Hazards During Operation of a Laser Device

Risk of permanent eye damage and vision impairment from invisible reflected and scattered Class 4 Laser beams. Also, the risk of eye damage as a result of exposure to UV light, heat and sparks produced during the laser process.

Precautions:

- ▶ Operators and persons in the vicinity must use all recommended Personal Protection Equipment. Laser safety glasses are sufficient eye protection when laser cutting devices are in use.
- ▶ Laser Safety glasses alone do not provide sufficient eye protection when laser welding or cleaning devices are in use.
- ▶ Laser Safety Glasses must have an optical density greater than 4 at a nominal laser wavelength of 1070 nm or lower.
- ▶ The laser safety helmet and laser safety face shield must be capable of withstanding a specular laser reflection of full power and nominal working distance for a time duration long enough to avoid injury while a laser welding or cleaning device is in use.

WARNING



- ▶ Use of controls, adjustments, or performance of procedures other than those set forth in this User Guide may result in exposure to hazardous radiation.

WARNING



Class 4 Invisible Laser Radiation - Eye and Skin Hazards

This level of light may cause severe damage to the eyes and skin. Diffuse and specular beam reflections can inflict severe retina and/or cornea injuries leading to permanent eye damage.

Precautions:



- ▶ Due to these risks a qualified laser safety officer should be present to ensure a safe working environment.
- ▶ Appropriate laser safety protection, guards and procedures shall be in place at all times while the laser is operational.
- ▶ When operating the laser device or in the vicinity of the laser device while in operation, all personnel must wear all recommended PPE. All recommended PPE should be inspected by a qualified laser safety officer before use.
- ▶ Additional PPE to protect against skin hazards includes laser-resistant and heat-resistant protective gloves, suit, and apron.

Class 4 Laser Safety (cont.)

⚠ DANGER



Class 4 Invisible Laser Radiation!

Severe and permanent eye damage from reflected or scattered laser radiation.

Precautions:



- ▶ Protective laser eyewear must be worn by all personnel working inside the Laser Controlled Area if the system can be active (Keyswitch turned ON).

⚠ DANGER



Incorrect or Damaged Laser Safety Glasses!

Severe and permanent eye damage and vision impairment can occur.

Precautions:

- ▶ Laser Safety Glasses must have an optical density greater than 4 at a nominal laser wavelength of 1070 nm or less.
- ▶ Before using a pair of laser safety glasses, all personnel must check the labeling on the glasses and confirm that they meet the requirements specified above.
- ▶ Prior to use, the laser safety glasses should be inspected to check for any cracking, discoloration, coating damage, pitting, and crazing. Also check the mechanical integrity of the frame.
- ▶ If the condition of the laser safety glasses is suspect that pair should be discarded and replaced.

PPE Responsibility

Whether the laser is used in a new installation or to retrofit an existing system, the end user is solely responsible for determining the suitability of all personal protective equipment.

Important

Laser safety eyewear must conform to US and international safety standards, including 9 CFR 1926.102(b)(2), ANSI Z136.1 (US) and EN207/EN208 (Europe). The regulations in force will depend on the location of the laser installation.

Class 4 Laser Safety (cont.)

Secondary Radiation Hazard

Personnel who are exposed to invisible UV light without proper protection can suffer permanent eye damage. Even brief exposure to invisible UV light during operation can cause blurred vision, burning, tearing, eye pain and irritation (feeling of sand in your eye)

WARNING



Visible and Invisible Light Radiation Produced During Operation

- ▶ The interaction between high power laser beams and target materials coming in contact may create plasmas that produce UV emissions and “blue light” which may cause conjunctivitis, photochemical damage to the retina and/or sunburn-like reaction to the skin.

Protective Eyewear for Use of Laser Device

For laser welding or cleaning, it is not sufficient to wear PPE that only protects against the laser’s IR wavelength. The selection of PPE should also take into account the secondary radiation hazards.

WARNING



Eye Hazards While Laser Device is in Use

Risk of permanent eye damage and vision impairment from invisible reflected and scattered Class 4 laser beams. Also risk of eye damage as a result of exposure to UV light, heat and sparks produced while the laser is in use.

Precautions:



- ▶ While in a laser controlled area all recommended PPE must be worn.
- ▶ Laser safety glasses can protect you from eye damage while using a laser cutting device. A combination of (1) laser safety glasses and (2) laser safety helmet can protect the user from eye damage, hot splatter, metal particulates and sparks, while using a laser welding or cleaning device.
- ▶ All personnel working near the laser area must wear all recommended PPE

Class 4 Laser Safety (cont.)

⚠ WARNING



Laser Device in Use - UV radiation

Damage to eyes or skin from exposure to UV-radiation produced by the laser process.

Precautions:



- ▶ All recommended Personal Protection Equipment (PPE) must be worn while laser device is in use.

⚠ WARNING



Laser Device In Use - High Temperature

Severe skin burn from contact to hot surface or exposure to thermal radiation or hot particles.

Precautions:



- ▶ All recommended Personal Protection Equipment (PPE) must be worn while laser device is in use.
- ▶ Required PPE for laser welding or cleaning devices includes: (1) laser safety helmet over specified laser safety glasses, (2) laser and heat resistant gloves, (3) laser and heat resistant clothing, and (4) laser and heat resistant apron.
- ▶ Avoid touching the laser head nozzle tip and/or tube, with unprotected skin, immediately and shortly after laser emission.

Skin Hazard

Exposure to UV light may cause skin burns that are similar to sunburns and will increase a user's risk of skin cancer and accelerated signs of skin aging. Depending on the intensity of the IR light, skin injuries may include thermal burns or excessive dry skin. Laser sparks may also cause burns. Laser material processing can transfer a significant amount of energy into a part. Parts may be extremely hot even after the laser process is complete. Parts of the laser head can become hot during use. Ensure that the proper PPE is used to protect against potential burns. Take precautions to prevent skin damage by wearing protective clothing such as laser-resistant and heat-resistant gloves, caps, leather apron and other laser-resistant and heat-resistant clothing. Sleeves and collars should be buttoned.

Class 4 Laser Safety (cont.)

WARNING



Use of Laser Device can generate a fire or explosion.

The heat and sparks produced while the laser is in use are capable of starting a fire or causing an explosion.

Precautions:

- ▶ Laser devices should only be used if the area is free of combustible materials.
- ▶ Never use a laser device on containers that have flammable or combustible material.
- ▶ If the container contents are unknown, you should assume they are flammable or combustible.
- ▶ Fire extinguishers should be nearby and accessible and personnel should be trained in their usage.

Reflected Beam Hazard During Welding

Often there can be numerous secondary laser beams produced at various angles near the laser output aperture. These beams are called “Specular Reflections” and are produced when the laser light reflects off a surface where the primary beam is incident. Laser systems may create specular reflections due to the interaction of the laser beam and the parts being processed. Although these secondary beams can be less powerful than the total power emitted from the laser, the intensity can be great enough to cause damage to the eyes and skin as well as materials surrounding the laser.

WARNING



- ▶ Highly reflective metals such as aluminum and copper may cause some portion of the beam energy to be reflected from the target site and require additional precautions.
- ▶ Specular reflections may also present a hazard to the operator if any portion of the beam is reflected from multiple surfaces.
- ▶ Take precautions to understand the expected cone of specular reflection for each processed part and do not attempt to view the part or place any part of the body within the expected specular reflection cone.



Operators and observers must also be aware of reflections at all times. More reflections are likely to occur if laser parameters are not set correctly to achieve melting of the target part.

- ▶▶ Fumes and “smoke” can be comprised of very fine particles and gases. Laser fumes and gases come from a combination of the material being heated or any filler material used, shielding gases used, paints, coatings, chemical reactions, and air contaminants.
- ▶▶ Fumes can adversely affect the lungs, hear, kidneys and central nervous system.
- ▶▶ When the laser interacts with target materials such as plastics, metals, composites, the target material may start to vaporize. Often the fumes and mists cannot be seen but are very toxic and pose a serious health hazard.
- ▶▶ Using a laser device in a poorly ventilated confined space is extremely dangerous. Dangerous concentrations of toxic fumes and gases can build up very quickly causing unconsciousness or death from suffocation.
- ▶▶ UV emissions given off during the laser process can react with the oxygen and nitrogen in the air to form ozone and nitrogen oxides which at high concentrations can be deadly.
- ▶▶ Shielding gases used with laser device can displace the air and cause injury or death.
- ▶▶ Conduct routine air monitoring to determine the levels of hazardous fumes in the laser area.

WARNING



Laser Process – Fumes and Particles

Damage to body tissues or organs from exposure to fumes and other by-products produce while the laser is in use.

Precautions:

- ✗ Measures must be taken b the user depending on the material of the workpiece.
- ✗ During use of a laser device keep your head away from the fumes.
- ✗ Always use a laser device in an area with adequate ventilation
- ✗ Hazardous fumes, vapors and particles need to be captured and exhausted from the laser processing area.

NOTICE



Risk Assessment for Laser Fumes, Particles, and Dust

System owner minimum requirement before starting the laser process is to:

Precautions:

- ▶ Be familiar with the material to be processed, know what by-products may result, assess their risk to health and determine what precautions are necessary;
- ▶ Read and obey the safety data sheets and warning labels for all laser materials used;

- ▶ Employ appropriate measures to prevent or control the risk, such measures will normally require positive exhaust of fumes from the process zone and adequate purification before exhaust gases are returned to the atmosphere away from personnel;
- ▶ Inform, instruct and train operators about the risks, and precaution to be taken;
- ▶ Where necessary, monitor the exposure of operators and carry out an appropriate form of surveillance of their health in compliance with local regulations;
- ▶ Consult a pertinent authority to find out what national, state and/or local regulations must be satisfied before exhaust gases are returned to the atmosphere.

Specular Reflections

Often there can be numerous secondary laser beams produced at various angles near the laser output aperture. These beams are called “Specular Reflections” and are produced when the laser light reflects off a surface where the primary beam is incident. Although these secondary beams can be less powerful than the total power emitted from the laser, the intensity can be great enough to cause damage to the eyes and skin as well as materials surrounding the laser.

Establish a Laser Controlled Area

IMPORTANT



For more information on setting up a laser-controlled area, the site Laser Safety Officer or safety officer should refer to the most recent revision of:

- ▶ American National Standards Institute publication ANSI Z136.1 (US) or,
- ▶ IEC 60825-4 Safety of Laser Products – Part 4: Laser Guards (Europe).

- ▶ In many jurisdictions, laser safety regulations require the appointment of a site Laser Safety Officer (LSO). Work with your site LSO to establish a laser-controlled area (LCA) to protect all personnel working in the area from being directly or indirectly exposed to the laser beam. The LSO is responsible for conformance and enforcement of laser safety regulations. In addition, the LSO ensures that laser protective eyewear, clothing and shields are available and being used.
- ▶ Ensure that all personal protective equipment (PPE) is suitable for the output power and wavelength range listed on the laser safety labels affixed to the product. Any PPE must also be suitable for any secondary radiation.
- ▶ Use the laser only in a laser-controlled area with access controlled by door interlocks.
- ▶ Provide suitable barriers to secure a laser safe work area and to prevent the beam from escaping the area. Any barriers used in the LCA should be made of a laser-safe material that can withstand direct and diffusely scattered beams.
- ▶ Post warning signs outside the LCA when the laser is in use. Appropriate warning signs should be posted throughout the controlled area, especially at any entrances to and from the area. For example, a sign warning of potential eye hazard should be placed outside the entrance to the enclosed controlled area.
- ▶ Restrict access into the LCA to only those individuals who are trained in laser safety while operating the laser. Post a sign with the names of all persons authorized to work within the laser work area.