Laser Plumes – Health Care Fact Sheets



WHAT IS A SURGICAL (LASER) PLUME?

Lasers, electrocautery devices, and similar equipment are used for surgery, ablation (removal of tissues), or cauterization to vaporize, coagulate, and cut tissue. The by-products of these procedures include vapours, smoke, and particulate debris, which are collectively called plume.

What is the content of a plume?

Plumes may contain bioaerosols, viruses, blood fragments, cellular debris, and bacteria depending on the type of the procedure.

They also contain carbon monoxide, polyaromatic hydrocarbons, and various toxic gases and vapours. Plume may also contain chemicals that form from gases, dyes, and coolants. Plumes may contain chemicals such as formaldehyde, hydrogen cyanide, acrolein, phenol, butane, and benzene.

Plume may also contain blood (plasma and blood cells or pieces of cells), and related blood-borne pathogens including viruses such as human papillomavirus (HPV) or human immunodeficiency virus (HIV), or bacteria such as Bacillus subtilis, Escherichia coli or Staphylococcus aureus.

Are there any health hazards associated with plume?

Health symptoms resulting from plume exposure include eye, nose, throat and respiratory irritation. Other health symptoms may include headaches, nausea, and muscle weakness.

Some components may have long term mutagenic or carcinogenic effects. As with any biomedical waste, there is also the concern of infections.

Safety concerns when operating include eye and respiratory irritation, which may lower the operator’s ability to perform the work appropriately.

Who is at risk of exposure to plume?

Medical and operating room staff and patients in hospitals and clinics can be at risk from exposure to plumes. Others who may be exposed include cleaning staff, and equipment maintenance or repair personnel. When lasers are used in dental clinics, veterinary clinics, laboratories, cosmetic treatment clinics, and others, risk of exposure may occur.

The level of risk will depend on:

- the procedure and equipment used
- presence and amount of any chemicals, dyes, or coolants (and any by-products)
- the health of the patient, the level of exposure (e.g., concentration in the air)
- the effectiveness of controls used

How can the plume be controlled?

Workplaces should conduct a hazard identification and risk assessment to determine how workers are exposed to plume, and what control measures are needed.

Contaminants generated by lasers and electrosurgical units can be controlled by:

- Elimination (e.g., determine if there are other ways to perform the procedure that does not produce plume)
- Engineering controls, such as ventilation and plume scavenging systems (local exhaust)
- Administrative controls, such as safe work practices, education, and training
- Personal protective equipment, including respirators, gloves, eye and face protection, gowns, etc.

These controls would be used along with routine practices and other infection control procedures.

Other controls may be required for protection from the laser and equipment itself.

Please see table below for more information.

Table 1: Plume Content

Plume Contents, Sources, Potential Health and Safety Hazards, & Control Measures			
Plume Content	**Source**	**Potential Health and Safety Hazard**	**Controls**
Dust	Procedures using CO_2 lasers	– Lung damage	– Appropriate respirators – Plume scavenging systems (PSS)
Toxic chemicals*	Laser beam contact with human or animal tissues, plastics, perfluoro-polyethylene polymer (e.g., Teflon), coated products	– Fire – Irritation – Carcinogenic, mutagenic and teratogenic potential	– Respiratory protection suitable for plume composition – Plume scavenging systems (PSS)
Biological Agents	Laser beam contact with tumours, HIV, culture medium, bacteria, warts, treated skin	– Infection	– Respiratory protection suitable for plume composition – Protective clothing and gloves – Plume scavenging systems (PSS)

Smoke (general)	Laser beam vaporization, incision, CO_2 laser beam contact with skin	– Respiratory damage – Eye damage – Irritation – Obstruction of workers' field of vision	– Scavenging of smoke near the source – Suitable eye and respiratory protection

* Toxic Chemicals can include: benzene, formaldehyde, acrolein, aldehydes, polycyclic aromatic hydrocarbons, cyanides, and methane hydrogen cyanide.

How can the plume be controlled by ventilation?

General room ventilation (dilution ventilation) is not sufficient to remove air contaminants.

Plume scavenging system (PSS) is the term used for a device that captures and neutralizes plume. Plume scavenging systems are also known as smoke evacuators, laser plume evacuators, plume scavengers, and local exhaust ventilators. Guidance on the operation requirements for a PSS is provided in the CSA Standard Z305.13-13 (R2020) "Plume scavenging in surgical, diagnostic, therapeutic, and aesthetic settings".

PSSs generally consist of a filter system with activated carbon for trapping gases, an ultra-low particulate (ULPA) filter for particulates, and an intake that can be placed close to the source of the plume. When the exhaust system used by a PSS is a permanent part of the building, it shall not be combined with other utility systems within the building. The suitable airflow speed of the PSS for controlling the airborne fumes will depend on the rate of plume generation and the exact system used.

The air suction ability of filters is significantly reduced when the filter has reached its capacity. Each PSS should have the capability to detect (e.g., pressure drop or a filter change indicator) if a filter is getting overload, or have a preventative maintenance plan based on filter service life and a change-out plan.

When a PSS is used, those workers involved should be appropriately trained on the use, servicing, and maintenance of the PSS (e.g., positioning of the intake, verification of flow settings, filter replacements, etc.),

In addition to the PSS, other equipment may be required during the procedures, such as appropriate equipment for aspirating fluids.

What types of personal protection should workers wear?

Medical personnel should wear appropriate respirators, eye protection, and gloves during laser surgery and when employing electrosurgical units.

Respirators should be used to provide additional protection and not as a substitute for an air exhaust system. Surgical masks do not eliminate the risk of infection or other hazards from inhaling viruses, germs, chemical vapours, tiny dust particles, aerosols, or cellular debris in laser plumes. If engineering controls do not provide sufficient protection then a properly fitting respirator suitable for the contaminants staff are exposed to should be used as protection against airborne contaminants.

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