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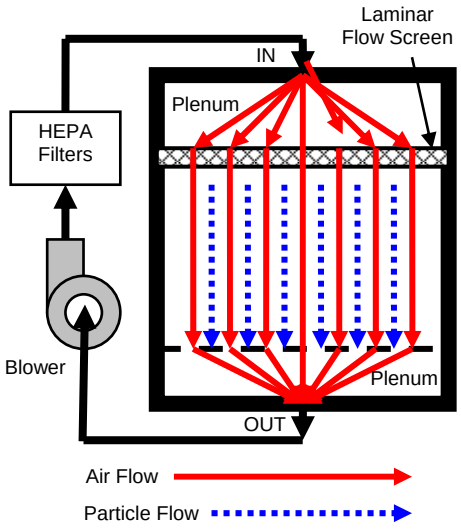
Laser and Resistance Welding in a Clean Room Environment
By David Steinmeier

Introduction
A clean room is a controlled environment where products are manufactured. These specially designed rooms control the concentration of airborne particles within specified limits. Sub-micron particles generated by people, processes, facilities, and equipment must be continuously removed from the air. The only way to control particle contamination is to control the total environment, which includes controlling air flow rates and direction, pressurization, humidity, and the cleaning processes used to maintain the clean room[1].

The diagram below shows how the use of laminar air flow carries particles in a "top to bottom" direction within the clean room. Air flow turbulence or deflection of the laminar flow is very undesirable and results in the deposition of unwanted particles on manufacturing part surfaces. HEPA (High Efficiency Particulate Air Filters) can capture particles as small as 0.3-micronis with 99.97% efficiency[1].



Federal Standard 209E establishes standard classes of air cleanliness for airborne particulate levels in clean rooms. "Class" represents the number of 0.5-micron or larger particles per one cubic foot. The lower the "Class Number", the fewer the permitted particles per cubic foot[1]. Medical device clean rooms are predominately Class-10,000, although a limited number of Class-1,000 clean rooms exist. Molecular contamination requirements are captured in MIL-STD-1246.

Key Concept
Clean room contamination comes from what you as the user of the clean room bring into the clean room. This microTip will only deal with particle contamination from welding equipment. Many excellent sources exist that describe clean room cleaning and maintenance procedures in general.

Pre-clean Room Preparation
Both laser and resistance welding equipment contain electronic or electro-mechanical modules that require forced air cooling. In the normal factory environment, dust and dirt will accumulate on all surfaces exposed to the forced air flow.

New laser or resistance welding power supplies do not have a build up of internal dust, but will have an unknown quantity of skin flakes with body oil and lower quantities of hair and lint from clothing. It is NOT necessary to remove these items by a fluid wash for Class-10,000 operation. For power supplies that are not new and may have a layer of dust on the internal modules, blow out the dust using an anti-static air nozzle before performing external surface cleaning. Before taking any welding power equipment into the clean room, turn on the power supply for 15 minutes to blow any loose particles out of the power supply.

Next, move the power supply and supporting equipment into the gowning room. Clean all accessible surfaces, including any wheels, with isopropyl alcohol and a lint free wipe made just for clean room use. Use a stroking motion with some overlap on each new stroke. Use a new portion of the wipe for each stroke. Do NOT employ a back-and-forth scrubbing motion as this action will just push the particles around on the surface.

Clean Room Preparation
After bringing your "clean" equipment into the clean room, install the welding equipment, turn on, and then measure the air particle count at specific locations within the clean room as required by your clean room particle count validation procedure.

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Laser Welding Equipment Decontamination
A complete laser system is comprised of the power supply, detachable control pendant, optional chiller, fiber optic cables, a glove box for conducting the welding process, and a computer for controlling the motion control system. The glove box contains the focusing head, computer controlled motion system and fixtures, argon cover gas nozzles, and an exhaust system for removing welding particles.

Follow the *Pre-clean Room Preparation* and *Clean Room Preparation* procedures described on the first page. The chiller should be installed outside of the clean room to provide the best heat dissipation, noise reduction, and service access. Feed the cooling pipes through bulkhead seals in the clean room wall.

For Class-10,000 installations, the glove box exhaust system for removing welding particles can be implemented using a filtered exhaust fan which vents into the clean room. CAUTION – The exhaust filter must be replaced on a regular basis.

For Class-1,000 installations, the exhaust system should vent outside of the clean room. CAUTION - Replace all standard factory applied lubricants on any motion control parts with clean room approved greases or lubricants that have controlled particle count and vapor control before bringing these parts into the clean room.

Resistance Welding Equipment Decontamination
A complete resistance welding system is comprised of the power supply, weld head, weld cables, electrodes, manual or motion controlled fixture, particle exhaust system, optional microscope, and optional argon cover gas flow system. If the power supply and weld head are placed on a laminar flow workbench, then there is no need for a separate particle exhaust system. The laminar flow workbench will remove operator created particles as well as particles created by the welding process.

The weld head, electrodes, and parts are the largest source of non-biological particles. In addition, some parts of the weld head, such as the force tube, are usually impregnated with a coating such as molybdenum disulfide to minimize friction and provide long life. Cleaning the force tube with isopropyl alcohol may be harmful to the special coating and could affect the inertial follow up capability of the weld head.

Air actuated weld heads must have air cylinder or air solenoid exhaust filters to minimize spreading particles when actuating and de-actuating the weld head. Mounting the weld head on a laminar flow workbench also helps to reduce contamination from air exhaust filters.

Follow the *Pre-clean Room Preparation* and *Clean Room Preparation* procedures described on the first page. In addition, clean new electrodes and electrode tip cleaning tools in isopropyl alcohol. Dry on a lint free wipe and then use gloves to transfer the clean electrodes into a lint free plastic bag for transfer into the clean room.

Once inside the clean room, mount the weld head on the laminar flow work bench. If holes must be drilled through wood, then the hole must be sealed with the appropriate sealant to prevent the bolts from dislodging wood particles when passing the bolts through the mounting holes.

For Class-10,000 installations, use a filtered exhaust system to capture welding particles. Better – Perform all work on a laminar flow workbench. As electrode tips wear and become impregnated with particles and oxides, clean the electrode tip surfaces using a ceramic polishing disk in the same manner as wiping down the external equipment surfaces. The ceramic polishing disk traps particles and oxides. These polishing disks can be kept in a closed isopropyl alcohol container. Discard used disks by placing in a lint free plastic bag and remove from the clean room.

For Class-1,000 installations, do all welding on a laminar flow workbench. Replace used electrodes with clean, resurfaced electrodes. Place used electrodes in a lint free plastic bag and remove from the clean room. Resurface electrode tips outside of the clean room.

Conclusion
With proper particle control, it is possible to laser and resistance weld in Class-1000 and Class-10,000 clean rooms.

References:
1. "A Basic Introduction to Clean Rooms", Roger McFadden, Technical Director, Coastwide Laboratories, http://www.coastwidelabs.com/Technical%20Articles/Cleaning%20the%20Cleanroom.htm