

ProX[®] DMP 100

3D Production Printer



User Guide

Original Instructions

Please refer back to <http://infocenter.3dsystems.com/product-library/prox-100#user-guide> for the most up-to-date user guide.

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1 INTRODUCTION

OVERVIEW

The ProX® DMP100 is a high quality direct metal printing (DMP) machine. It brings reliability and repeatability to production-level direct metal printing. The ProX® DMP100 is designed to meet industrial market demands of reliable, high material quality and low maintenance 3D printing machines.

With direct metal printing, parts are built up layer by layer. Using this technique, the most complex parts can be made. Loose metal powder particles are melted together by a high-precision laser. The laser is directed to the powder particles in order to selectively build up thin subsequent horizontal layers. Connecting each new layer to the previous one, it brings a high quality alternative to the traditional manufacturing processes. Since no tools are used and no material is removed, waste is reduced significantly. Parts aren't built by removing material in different steps, but by adding material. Other advantages are the quick set up times and the ability to produce very complex assemblies as a single part.

The ProX® DMP100 has a build platform of 100 x 100 x 80mm which can produce high quality parts in a variety of metals. In order to operate the machine safely and efficiently, please follow the following instructions and warnings. The machine is a Class I Laser System equipped with a Class IV laser that can be potentially dangerous when the machine is operated differently than stated in this manual.

The principal technical characteristics are mentioned on the table :

Fiber Laser	P=50 W – $\lambda=1070$ nm
Layering system	Adjustable
Building volume	100 x 100 x 80 mm
Metal materials	Stainless steel, tool steels, non-ferrous alloys, super alloys...
Ceramic materials	Alumina, cermet, ...
Repeatability	x=20 μ m ; y=20 μ m ; z=20 μ m
Detail size	x=100 μ m ; y=100 μ m ; z=20 μ m
Loading system	Semi-automatic
Recycling system	External option
CAD/CAM software	3DXpert
Control software	PX Control V2
CAD read formats	STL

"Dental" configuration

The ProX® DMP100 system, in its "Dental" configuration, is a solution for the rapid manufacturing by laser sintering to perform directly, without tools, fixed and removable dental prostheses.

"Dental" configuration includes the exclusive use of Cobalt Chrome Molybdenum alloy powder ST2724G certified as a medical device in a standard ProX® DMP100 machine associated with **ProX DMP Dental** CAM software including all non-modifiable manufacturing parameters by the user.

In the case of a different use of the conditions defined by the "Dental" configuration - as the use of another powder in the machine or modification of the manufacturing parameters - the conformity of dental components built with the machine is not guaranteed by the manufacturer anymore. It will be then the responsibility of the user to qualify the manufactured dental elements in compliance with standards and regulatory requirements of each country.

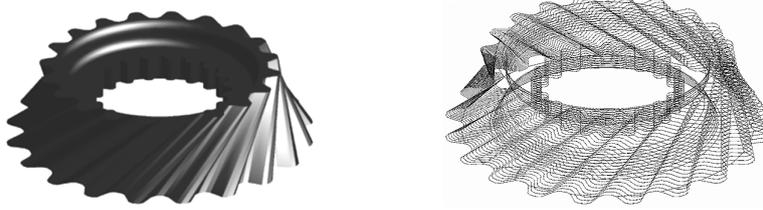
CONTROL SOFTWARE VERSION

All figures and features related to the user interface on this user guide correspond to control software from version V2.1.5.1.

GENERAL MACHINE OPERATION

The manufacturing process takes place as follows:

- Processing of the CAD file with **3DXpert**, all-in-one software solution, in order to slice the part as a series of superimposed cross-sections. Creation of the manufacturing file (*.FAB2, or *.FAB3 files), used by the ProX[®] DMP metal printers.



- Preparation of the machine, loading of the sintering plate and purging the chamber.
- Uploading the *.FAB2 or *.FAB3 file onto the machine.
- Dispensing a powder layer on the sintering plate (Layering cycle).
- Fusing the metal powder into a solid part using a focused laser beam (Sintering cycle).



- Repeated execution of layering and sintering cycles until the part is produced.
- Unloading the part and possible post-processing and finishing in order to obtain the desired characteristics.

INTENDED USE

Laser sintering operations are performed on metal powders only.

Each metal powder should only be used after checking the information provided by the supplier, the material safety data sheet (MSDS) and any applicable regulations.

Limitations relating to the manufacture of 3D objects by laser sintering

Before manufacturing a 3D object, please ensure that none of the following criteria are met :

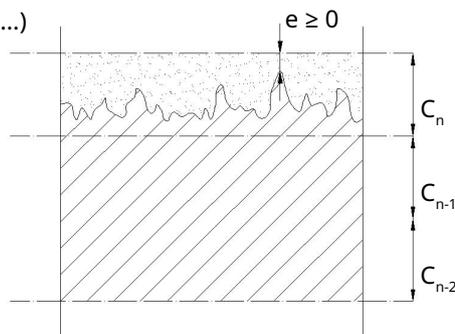
- A 3D object with at least one of the layers covering more than half of the total surface of the sintering plate,
- 3D object with an undercut angle $< 45^\circ$ compared to the horizontal surface of the sintering plate,
- 3D object where its minimum thickness is 5 times smaller than its height,

Without being exhaustive, these criteria represent the majority of cases to be checked before manufacturing a 3D object by laser sintering.

Conditions relating to the Layering

During the manufacturing process, the roller must not disturb any of the previous sintered layers. This is why the correct conditions required for the manufacturing of layers is given in the following diagram.

C : thickness of layers ($c = c_{n-1} = c_{n-2} \dots$)



2 SAFETY GUIDELINES AND INSTRUCTIONS



Read and follow these instructions before operating the machine.

GENERAL GUIDELINES

Before using your Direct Metal Printing (DMP) equipment, your company should have a safety program in place. The safety program should:

- Point out hazardous equipment, materials, and procedures.
- Explain what to do in case of an emergency.
- Provide information about the hazards of the equipment and materials in the form of Safety Data Sheets (SDS). The Safety Data Sheets are provided with all materials supplied by 3D Systems.

All DMP equipment is designed with safety in mind. However, improper use, malfunctions, and excessive exposure could cause injury.

TRAINING AND INSTRUCTIONS

Follow these general safety guidelines when operating any DMP equipment:

- Do not operate any DMP equipment before receiving proper training.
- Read and follow all operating instructions.
- Follow all safety rules in this section and heed all hazard warnings in this guide.
- Do not try to perform any equipment maintenance procedures you were not trained to do.
 - **Operators** are trained to operate the system and perform all the necessary tasks to print a part.
 - **Certified service personnel** are those who have completed the 3D Systems service training package and are certified to perform service tasks. Certification may occur at various levels, and service personnel should only perform tasks they are authorized and certified to complete.

MACHINE HANDLING

- Do not try to access, service, or adjust any components inside any DMP equipment enclosure.
- Do not try to open any panel or door while a machine is running.
- Do not access any area of the machine near the print chamber during printing.
- Take note of all warning labels on the machine.
- Secure electrical cables and coolant hoses to prevent tripping.
- Make a daily inspection of the machine before starting work.
- Never wear a tie, scarf or loose-fitting clothing when operating the machine.
- Make it a rule that only one trained and qualified operator uses the machine at any given moment.
- Make sure that the sintering module is cleared of any obstacles before powering up the machine.
- Laser sintering operations are performed on metal powders only.
- Never place any reflective materials (such as glass, lenses, mirrors, etc.) below the scanner head.

MATERIAL HANDLING

- Do not use any material without first reading the Safety Data Sheet (SDS) for that specific material.
- To prevent injury and equipment damage, be sure to follow all handling guidelines detailed in the appropriate material guide.

LASER

- **Do not** try to access, service, or adjust the laser system in any way.
- **Do not** enter any area displaying posted warning signs during open beam operations. Open beam operations refer to the laser, and they **only** occur during service procedures performed by certified service personnel.

ALARMS AND WARNINGS

- If you see an error, alarm, or warning message on any DMP equipment display, note the state of that machine's stack light. Clear the alarm, error, or warning message before resuming operation.
- Displayed error, alarm, or warning messages can result from unsafe practices, such as opening an enclosure door or panel while the equipment is powered up and running.

SAFETY SYMBOLS AND DEFINITIONS

The following safety labels are posted at various points on the machine to indicate potentially hazardous conditions:



HOT SURFACES HAZARD: There are surfaces and materials in the vicinity that may be hot and could cause severe burns.



LASER RADIATION HAZARD: Invisible laser radiation is accessible in the vicinity of this sign or behind the access panel. Direct and scattered radiation can cause severe burns and blindness. Access panels are for service only and should be opened only by certified service personnel.



ELECTRIC SHOCK HAZARD: High voltage electricity is accessible in the vicinity of this sign or behind the access panel. High voltage can cause severe burns or death. Access panels are for service only and should be opened only by certified service personnel or trained maintenance personnel.



CAUTION: Indicates something may happen that could cause loss of data, damage to equipment, or could cause personal injury.



FIRE HAZARD: Indicates potential fire can occur that could cause damage to equipment or personal injury.



EXPLOSION HAZARD: Indicates potential explosion can occur due to combustible particles inside of unit that could cause damage to equipment or personal injury.



PINCH POINT HAZARD: Keep hands clear.



STATIC HAZARD: Indicates electro-static discharge that can cause damage to the equipment or personal injury.



DUST HAZARD: Indicates dust particles are in the air and a suitable dust mask is required.



Disposable rubber gloves. Heat-resistant gloves such as welding gloves should be used in conjunction with other fire-retardant clothing when there is a potential for fire, such as when performing a filter change in the re-circulating unit.



Safety glasses and/or full face shield required.



Disposable dust mask rated FFP3 or N99 (or better) level protection required.



When working in areas where reactive metal condensates are present, use fire retardant special fabric, rendered conductive, trousers without turn-ups and closed pockets.



Before starting any operation or maintenance on the printer, consult the Technical User Guide.



Antistatic shoes required.



Safety shoes required.

FIRST AID SECTION – WHAT TO DO



In the case of an accident while using any DMP equipment, seek medical attention immediately. Use the following guidelines for specific safety instances.

Burns

This equipment contains high temperatures and burning laser radiation which could cause 2nd degree burns. Do not attempt to remove any protective panels. There are no user serviceable parts inside.

If a burn occurs, seek first aid and immediate medical attention. Pushing the E-stop button will de-energize the equipment components and diffuse the hazardous situation.

Reporting Laser Radiation Exposure

If the injury was determined to be the result of laser radiation overexposure, please send a report to:

Attention: Laser Safety Officer
3D Systems, Inc.
333 Three D Systems Circle
Rock Hill, South Carolina, 29730
USA.

Include the following information in your report:

- Nature of the accident and circumstances surrounding it
- Where the accident occurred
- Model and serial number of the machine
- Number of people involved
- Any other pertinent information

Please send this information to 3D Systems within a day of the accident.

Electrocution

The DMP system contains equipment energized at 400 volts. Do not attempt to remove protective panels. There are no user serviceable parts inside.

If electrocution occurs, seek first aid and medical attention immediately. Pushing the E-stop button will de-energize the equipment components and diffuse the hazardous situation.

Material Inhalation

The material handling process may create a choking or air restriction hazard. If someone has difficulty breathing or a “loss of breath” sensation, transport the person to a well-ventilated room or outside of the facility. If the condition persists, seek immediate medical attention.

Powder ingestion

Quickly wipe material from mouth and rinse with water. Do not induce vomiting. Seek medical attention if symptoms occur or when unsure.

Powder skin contact

Powder contamination of the skin may cause soft tissue irritation and/or an allergic reaction. Remove contaminated clothing and dispose of or properly launder. Brush material off skin, wash affected area with soap and water. Seek medical attention if symptoms persist.

Powder eye contact

Even non toxic powders may cause soft tissue irritation and/or an allergic reaction. If someone gets powder in his/her eyes immediately rinse eyes gently but thoroughly with lukewarm water. Also rinse under upper and lower eyelids, for at least 10 to 20 minutes. Seek medical attention when symptoms persist. Eye wash station must be present in the vicinity of all powder operations.



NOTE: for more specific information regarding first aid in relations to powder, see the applicable SDS sheet.

DMP EQUIPMENT SAFETY FEATURES

A major design goal for all DMP equipment is to provide a safe operating environment. The frame and enclosure designs passively limit hazardous access while the electronics and software actively and automatically sense and react to unsafe conditions when they arise. For example, if the DMP system detects unsafe operating conditions, it will immediately stop operating and, in some cases, shut down completely.



WARNING: IF ANY DMP EQUIPMENT SAFETY FEATURES FAIL, YOUR ACTIONS MAY BE ALL THAT WILL PREVENT POTENTIALLY HAZARDOUS OPERATING CONDITIONS.

Safety Interlocks

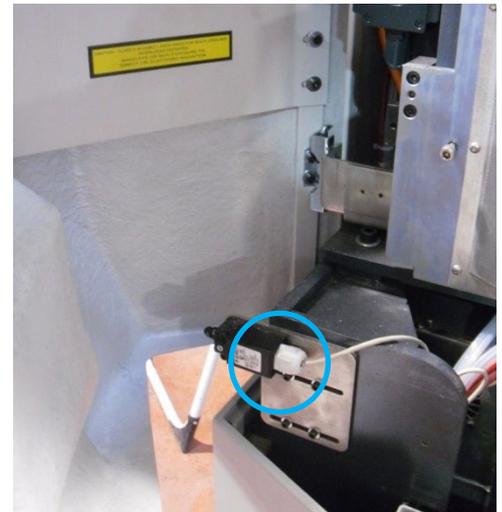
Safety interlock devices on the DMP equipment help prevent accidental laser exposure, electrical shocks, crush injuries, burns, and fires. DMP equipment will not operate unless all safety interlocks are satisfied.



WARNING: NEVER TRY TO DISABLE OR OVERRIDE ANY SAFETY INTERLOCK DEVICE ON ANY DMP EQUIPMENT. OPERATING EQUIPMENT WITHOUT ALL SAFETY INTERLOCKS ENABLED CAN CAUSE EQUIPMENT DAMAGE, INJURY, OR DEATH. IF YOU SUSPECT A SAFETY INTERLOCK DEVICE IS NOT WORKING PROPERLY, DO NOT OPERATE YOUR DMP EQUIPMENT. RATHER, DISCONNECT POWER FROM THE EQUIPMENT AND CONTACT 3D SYSTEMS CUSTOMER SUPPORT FOR ASSISTANCE.



A Safety interlock switch on the left door



B Safety interlock switch on the right door



C Safety interlock switch on the scanner head



D Safety interlock switch on the airlock door



DMP System Response if an Interlock Fails

Safety interlock devices mounted on the DMP system sense the hazardous operating conditions below. The DMP system takes the actions listed when an interlock fails.

SAFETY INTERLOCKED CONDITION	IF THIS INTERLOCK FAILS...
<ul style="list-style-type: none"> For all conditions 	<ul style="list-style-type: none"> No job will start Warning message appears on DMP system display
<ul style="list-style-type: none"> Front doors open Scanner head open 	<ul style="list-style-type: none"> Orange stacklight illuminates Laser interlock activated Supply of the motors is cut off: carriage and feeding
<ul style="list-style-type: none"> Airlock door open 	<ul style="list-style-type: none"> Airlock motion blocked
<ul style="list-style-type: none"> E-Stop 	<ul style="list-style-type: none"> Supply of the motors is cut off Laser power cut off 230V actuators cut off (blower, light, oven, vacuum cleaner recoiler) Red stacklight illuminates
<ul style="list-style-type: none"> Oxygen in process chamber too high 	<ul style="list-style-type: none"> No job will start Warning message appears on DMP system display Blower not operating Process filter valves closed

Limited Access and Barrier Shielding

DMP equipment frame and enclosure designs limit access to the following:

- Service areas**, such as cabinets and enclosures for electrical power and automation controls. This prevents accidental exposure to electrical shock hazards.
- Material areas**, such as material feed hoppers. This prevents:
 - burn hazards by minimizing exposure to heated material
 - slip hazards by preventing material from spilling onto the floor
 - fire hazards by minimizing airborne dust cloud formation and potential ignition. See SDS for complete material hazard details.
- Laser beam optics and scanning areas**, including the fully-enclosed print head—where the laser beam originates—and the interior of the print chamber, into which the beam projects. The scan head and chamber are designed to minimize hazards such as burns, eye injury, and fire in the following ways:
 - The scan head optics and laser beam duct (at the top of the chamber) prevents the laser beam from being aimed outside the print chamber.
 - The fully enclosed chamber blocks laser radiation from escaping to the outside.
 - The material of the chamber window, which conforms to CE EN207, also blocks laser radiation so you can safely observe the part during a print.

Other Active Safety Features

- Software in the DMP system automatically initiates immediate equipment shutdown if certain unsafe conditions are detected during operation,
- Ground fault interrupter and over-current circuit-breaker,
- Locking key on the control display: the machine cannot be switched on unless the key is in the ON position.

Machine Safety

DMP equipment includes following safety features:

- Detection of a drop in air pressure: control indicates a fault if the air feed pressure drops below the required pressure,
- Detection of chamber temperature: inability to open the doors if the temperature is above +50°C (+122°F),
- Protection of the motors: the axis stop if an abnormal temperature is observed,
- Protection of blower: the blower stops if an abnormal temperature is observed,
- Rotate of the airlock (the sas) when airlock door is open,
- Anti-collision system: the HMI (Human Machine Interface) and the various sensors fitted on the ProX® DMP100 make it possible to avoid collisions between moving system components,
- Protection of the Laser: control of the diodes temperature, control of the back-reflexion absorber temperature and control the integrity of the fiber,
- Protection of the scan head: control of the head temperature.
- Lock-out/tag out on the main power switch: when the main power switch is locked in the OFF position, the machine cannot be switched on.

ELECTRICAL SAFETY

3D Systems recommends explosion-proof wiring for the room where the DMP is operating and where the materials are stored.

To prevent electrical shock, DMP equipment will not operate unless all external panels are installed and all electrical safety interlock circuits are closed.



ELECTRICAL HAZARD: Hazardous voltage exists inside the enclosures of all DMP equipment. Injury or death from electrical shock can result if you remove external panels or try to defeat safety interlocks. Panels should only be removed, and interlocks should only be defeated, by 3D Systems certified service personnel.



ELECTRICAL HAZARD: Verify your facility's electrical service ratings before connecting power to any DMP equipment. Power must only be connected by a certified electrician.



ELECTRICAL HAZARD: Do not open the panel behind disconnect switch! Live voltage present. This should only be opened by qualified personnel after power is disconnected from the facility's power circuit/breaker panel.

All DMP equipment is designed to minimize operator exposure to electrical hazards during normal operations. All exposed electrical circuits are inside limited-access cabinets. This is to separate the operator from service and maintenance areas.

When operating any DMP equipment, keep the following electrical safety points in mind:

- Only 3D Systems certified service personnel should operate DMP equipment with access panels or service doors open.
- Heed high voltage warning signs and labels.
- Take common-sense safety precautions when operating any electrical equipment.
- After any change to the electrical wiring, make sure the equipment is properly grounded.

PERSONAL PROTECTIVE EQUIPMENT



Gloves

Wear disposable nitrile gloves when handling powders. Dispose the gloves when the powder handling operation is complete. Do not operate switches or use door handles or other fixtures while still wearing the gloves in order to prevent cross contamination.



Clothing

When working in areas where reactive metal condensates are present, use fire-retardant special fabric, rendered conductive, trousers without turn-ups, closed pockets.



Safety masks

Wear disposable dust mask rated FFP3 level protection (EN149:2001 - Filters at least 99% of airborne particles), N99 (Occupational Safety and Health Administration standard - Filters at least 99% of airborne particles), or equivalent level protection.



Safety goggles

Wear close fitting safety goggles or a full face mask when handling powder. In case of emergency, use an eye shower to remove any particles from the eye(s).



Safety shoes

The use of antistatic safety shoes is mandatory in any area where heavy items are handled. This includes powder vessels and sintering plate. In any area where powder is handled safety shoes with antistatic soles are recommended.

HYGIENE

It is advised to wash your hands, even when wearing gloves, after handling powder. It is also recommended to shower and wash your hair after removing the protective clothing at the end of a day's work.

HAND TOOLS

You must acquire non-sparking, non-magnetic hand tools that are safe for Ex zones where hazardous, flammable or combustible vapors, liquids, dusts or residues may be present:



- Aluminum
- Aluminum-Bronze (AlBr),
- Copper-Beryllium (CuBe₂) alloys).

You must also acquire and use natural fiber brushes and brooms. Work benches must be grounded.

GROUNDING

Grounding personnel and equipment when working with powder is highly recommended. To ensure easy, uncomplicated operation, the following is recommended:



- Dedicated grounding points in each process room
- Antistatic flooring
- Antistatic floor mats

In addition it is recommended to check the grounding itself on a regular basis.

VACUUM CLEANERS

Installations must have a wet separator, explosion proof vacuum cleaner. The RUWAC, NA35 serie explosion proof vacuum is recommended. Certain metal powders will react with water forming hydrogen gas, this process is sped up when the powder to water ratio is higher. It is therefore necessary to refill or replace the liquid of the wet separator regularly as indicated in the vacuum cleaner manual. Please refer to the vacuum cleaner user manual before using it.

FIRE AND EXPLOSION PREVENTION

In no case are smoking, open flames, heat sources or spark sources to be allowed in the vicinity of powders or in rooms where powders are handled. This includes all electronic devices as well as non-ATEX or EX certified equipment. Use non-sparking tools, when working with powder. Likewise activities which generate heat or sparks, such as grinding or welding, should not be performed near combustible powder or in rooms where such powder is manipulated.

The grounding of all personnel is highly recommended. This is especially true for any location where combustible powders are used. As fine powder can remain static in the air for hours after dispersion, it is recommended that all rooms where powder manipulations occur are equipped with grounded conductive or antistatic flooring. Furthermore the personnel entering those rooms must wear safety shoes with antistatic or conductive soles and antistatic or conductive outer garments. If grounding through conductive flooring is impossible, the use of antistatic bracelets, combined with grounding to a work bench or the equipment itself is recommended. Likewise the use of carts or other devices with non-conducting wheels is prohibited.

ROOM VENTILATION

A room ventilation system is required in order to:

- Prevent inert gas (Nitrogen, Argon) accumulation and
- Remove suspended fine powder particles.

Inert gas may be released into the room as a result of opening the machine. Even though Argon or Nitrogen are an inert gas, it still poses a suffocation danger when it is allowed to accumulate. Argon is heavier than air and will "pool" on the floor and in any low points. Therefore the room must be equipped with a system which continuously exchanges the air in the room a minimum of four times per hour.

A room ventilation system is also required to prevent the presence of fine powder particles suspended in the air. This presents both a health and an explosion hazard. Because powder fines can accumulate in filters, the system must either:

- Be a filter free system.
- or --
- The system must be equipped with immersion filtration

Ventilation

If available, use forced ventilation at your work station when handling powder. Set it to the correct strength to ensure maximal removal of air suspended powder, while preventing the ventilation itself from causing agitation of static powder.

MATERIAL SAFETY

All materials certified by 3D Systems are safe during normal operation. However, you should be aware of the following issues:

- Any material, material-like substance, or airborne cloud of material has a remote chance of rapid combustion.
- Breathing some materials may cause certain people to experience respiratory irritation.
- Material safety hazards are minimized by good industrial housekeeping and ventilation practices.
- Spilled material can cause the floor to become very slippery.
- Material should be sifted in a well-ventilated room.

Refer to the SDS's and to 3D Systems material guides for information on specific materials.



WARNING: USING MATERIALS THAT HAVE NOT BEEN CERTIFIED FOR USE IN THE DMP EQUIPMENT MAY CAUSE HEALTH OR SAFETY HAZARDS AND MAY DAMAGE THE EQUIPMENT AND VOID THE WARRANTY.

Material Ignition Information

Powdered materials can be flammable and can be ignited by static electricity in a non-inert environment. Refer to each material's SDS for specific information.

Use only Class D extinguishing agents. Never use water, carbon dioxide, Halon or non-class D foam on fires involving reactive metal powders.



WARNING: THE OPERATOR MUST USE AN APPROVED VACUUM CLEANER TO CLEAN UP EXCESS MATERIAL. 3D SYSTEMS RECOMMENDS AN EXPLOSION-PROOF MODEL. CONTACT 3D SYSTEMS CUSTOMER SERVICE FOR PURCHASING OPTIONS.

Finding Material Safety Information

Use the Material Safety Information table to locate references and contacts for information on important material safety topics. Read the SDS of the material used for the specific precautions to be observed.

Material Safety Information

TOPIC	REFERENCE / CONTACT		
Standard industrial ventilation practices	US: American Conference of Governmental Hygienists, Committee on Industrial Ventilation Europe: Maximale Arbeitsplatz Konzentration, January 1990		
Housecleaning and prevention of accumulation of explosive dust concentrations	US: NFPA 484-2012: standard for combustible metals Europe: directive 99/92/EC risk from explosive atmospheres and directive 2014/34/EU: equipment and protective systems intended for use in potentially explosive atmospheres.		
Material exposure	US: Code of Federal Regulations, 29 CFR, section 1900.1000, available from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 Europe: directive 99/92/EC risk from explosive atmospheres and directive 2014/34/EU: equipment and protective systems intended for use in potentially explosive atmospheres		
Specific materials	Safety Data Sheets (SDS) from 3D Systems, Inc.		
	US/Canada:		Europe:
	Mfgr. Contact:	3D Systems Corporation 333 Three D Systems Circle Rock Hill, SC 29730 USA	3D Systems Parc Européen d'Entreprises Rue Richard Wagner 63200 Riom, France attn: Customer Support
	Information	Phone: 803.326.3900 or Toll-free: 800.739.3669	Phone: (+33) 4.73.33.45.85
Emergency	1.800.262.8200 - Chemtrec	1.703.741.5500 - Chemtrec (U.S.)	

POTENTIALLY HAZARDOUS METAL POWDERS

The risks concerning powder handling can be roughly divided into two large classes: health hazards and combustion and explosion risk. Each specific risk requires suitable precautions when handling powder. Furthermore some powders pose a risk in both classes.

As for health risks, the following metals are known to cause health problems upon prolonged or short term extensive exposure:

- CoCr and other cobalt containing alloys
- Nickel & Nickel alloys

Cobalt and some other metals are known to cause poisoning. Nickel is considered to be allergenic, leading to intolerance after extensive exposure. Other powders, even when they are considered to be non-hazardous or to pose no health risk, should still be handled with care. Even biocompatible powders, such as titanium alloys, are harmful after inhalation or contact with soft tissues, causing irritation of lung tissue and those soft tissues. Furthermore even if no health risks are attributed to a specific powder as to date, there is no guarantee that none will be discovered in the future.

Concerning fire and explosion hazards, the following powders are known to be combustible:

- Titanium and Titanium alloys
- Aluminum and Aluminum alloys
- Magnesium and Magnesium alloys
- Pure non-noble metals

Accumulations of combustible powder can ignite due to elevated temperatures, open flames, sparks or electrostatic discharge. When dispersed finely into the air, they are susceptible to dust explosions. Furthermore fine fractions and condensates of these materials (as you will find in the process filter), are to be considered extremely flammable.

In addition to combustible powders, some materials can react with moisture, generating heat and/or hydrogen gas. Typical examples include pure aluminum, magnesium and magnesium alloys. The combination means that these powders form an immediate fire and explosion risk when exposed to moisture.

The end user is required to review the Safety Data Sheet for each material in your facility. Always assume that any material is both a health and fire hazard.

REACTIVE METAL POWDER STORAGE

To store reactive metal powders in your facility:

- Use closed containers. Closed containers will prevent accidental dust generation and contamination.
- Always use conductive containers or containers lined with conductive material. Containers made from a conductive materials will help dissipate electrostatic charges.
- Store containers on a grounded conductive surface.
- Store separately from other chemicals such as, but not limited to, oxidizers and fuels.
- Store in a fireproof cabinet that is certified for the storage of combustible materials (class 4.1).
- Make certain you have small containers for small quantities of powder. Do not store small quantities of powder in large vessels.
- In the ideal case, large quantities of powders are stored in a suitable separate building, away from the production environment.

Storage in closed containers will prevent accidental dust generation and contamination, while a conductive material will help dissipate electrostatic charges.

It is also recommended to store large quantities of combustible powders in fire retarding cabinets or a specifically designed room. While this will not prevent fire itself, it will prevent powder from igniting immediately by a fire in the vicinity of the powder storage. This will give your personnel additional time to evacuate and will provide emergency services the opportunity to extinguish the external fire before the powder stock ignites. In the ideal case, store large quantities of powders in a suitable separate building, away from the production environment.

You must make certain there is no automatic sprinkler system installed where aluminum, magnesium or magnesium alloys are stored. These materials will react with water to produce hydrogen which will create an explosion hazard.

Material Handling Precautions

Always wear all PPE as specified in the section, "Personal Protective Equipment".

Read the SDS of the material used for the specific precautions you should observe. Use the following table of precautions as a general guide.

Safe Material Handling Guidelines

CATEGORY	PRECAUTION
FIRE/HEAT	<ul style="list-style-type: none">• Never smoke or ignite anything around powdered materials.• Store flammable liquids away from materials.• After removing a part from the print chamber, allow it to cool to room temperature in a well-ventilated area.• Use anti-static mats in front of DMP equipment.
INHALATION	<ul style="list-style-type: none">• Avoid breathing powdered materials. Always wear dust mask rated FFP3 (N99) level protection, or equivalent level protection.• Always provide adequate ventilation.
SHOP SAFETY	<ul style="list-style-type: none">• Train operators in DMP system procedures.• Wear safety glasses.• Use extreme care with all heated materials.• Make sure that the room is well ventilated.
AVOIDING SPILLS	<ul style="list-style-type: none">• Keep containers closed when not in use.• Have a fully-grounded internal non-ignition vacuum cleaner ready to use.• Have any equipment specified in the SDS ready to use.
SDS	<ul style="list-style-type: none">• Give operators access to the SDS's that apply to materials they will be handling and ensure that they read them. If necessary, translate them.• File SDS's in an easily accessible location for immediate reference.• Strictly follow all the conditions in each SDS.

GAS SAFETY

The DMP system use inert gas (Nitrogen, Argon) as a cover gas to create an inert atmosphere in the print chamber. The cover gas inhibits any potential rapid combustion of particulate matter during the DMP process.

The oxygen content of air is approximately 21 percent. Displacement of the normal atmosphere with an inert gas can reduce the oxygen content in a room. In the remote chance that an inert gas leaks into the room during the sintering process, the situation can be hazardous.

3D Systems recommends that you have an oxygen monitor installed in the room containing the DMP system. This monitor will alert you if the oxygen level drops below a designated point.



WARNING: BECAUSE ARGON IS HEAVIER THAN AIR, 3D SYSTEMS RECOMMENDS INSTALLING THE OXYGEN MONITOR CLOSE TO THE FLOOR TO DETECT ARGON POOLING.



WARNING: EXPOSURE TO AN ATMOSPHERE CONTAINING 12 PERCENT OR LESS OXYGEN CAUSES UNCONSCIOUSNESS WITHOUT ANY WARNING SYMPTOMS. THIS HAPPENS SO QUICKLY THAT YOU CANNOT HELP OR PROTECT YOURSELF.

The table of [Oxygen Deprivation Effects and Symptoms](#) explains the potential effects and symptoms that can occur at different concentrations of oxygen in the atmosphere.

When you work in an environment that may become oxygen-deficient, make sure you comply with the following items:

- If, at any time, you feel you are experiencing symptoms of oxygen deprivation, leave the area immediately.
- You have received oxygen safety training.
- The room is well-ventilated; at least 4 air exchanges per hour.
- Self-contained breathing apparatus is available and easily accessible.
- The room oxygen alarm monitor is functioning and audible.
- Leave the DMP system room/area immediately when you hear the oxygen alarm.

Oxygen Deprivation Effects and Symptoms

OXYGEN CONTENT (% BY VOLUME)	EFFECTS AND SYMPTOMS AT ATMOSPHERIC PRESSURE ^a
15 – 19 %	Decreased ability to work strenuously. May impair your coordination or may induce early symptoms in persons with coronary, pulmonary, or circulatory problems.
12 – 14 %	Increases respiration during exertion. Pulse rate goes up. May experience impaired coordination, perception, and judgment.
10 – 12 %	Respiration continues to increase in rate and depth. Lips become blue. May lose consciousness at this point.
8 – 10 %	Mental failure. Fainting and unconsciousness. Face becomes ashen, lips become blue. Nausea and vomiting may occur.
6 – 8 %	100% fatal after 8 minutes of exposure. 50% fatal within 6 minutes. Recovery with treatment within 4 to 5 minutes.
4 – 6 %	Coma within 40 seconds; convulsions, respiration ceases, death occurs.

a. From Safety Bulletin SB-2 - 1983—"1983 by the Compressed Gas Association, Inc. 1235 Jefferson Davis Highway, Arlington, VA 22202

RISK RELATING TO GAS BOTTLES

Whenever necessary, compressed air bottles are to be stored outside the buildings in an enclosed and ventilated shelter. The bottles must be placed vertically in the racks attached to the walls.

Any gas bottles that cannot be attached and that have to be used close to the equipment, must be placed on a suitable support that makes it impossible for them to tip over.

Remember that there is a risk of asphyxia in small, poorly ventilated, rooms.

Furthermore, an excess-flow shut-off valve must be fitted to the regulator output, upstream of the gas pipe. This valve starts to operate when the flow exceeds approx. 10% of the flow value used under normal operating conditions.

CHEMICAL RISK

These risks can have several sources:

Laser – material interaction: in this case, the emission, to a greater or lesser extent, is caused by the vaporization and decomposition of materials during a laser procedure (emission of fumes, aerosols and dust, some of which may be carcinogenic),

Use of gas to control the sintering atmosphere (Argon Ar, Nitrogen N) – inert gas: anoxia.

The printer rejects filtered inert gases (HEPA filters: 99,97 % of particles dimensions higher than 0,3 µm are filtered). A connection or exit towards the outside is only necessary if the flow of the premises is lower than 50 m³/hour (29.43 cfm).

LASER SAFETY

The DMP system contains a fiber laser. The laser itself is designated Class IV. Very brief exposure to a direct—or specularly or diffusely reflected—laser beam can cause significant burns or eye damage. It can also be a fire hazard.

During normal operations of the DMP system, the laser beam path is wholly contained within the machine. This makes the entire machine a Class I Laser System. That means the DMP system does not produce damaging emissions under normal operations.

LASER SAFETY CLASSIFICATIONS

Class I and Class IV are designations established by the U. S. Department of Health and Human Services, Public Health Service, Food and Drug Administration, Center for Devices and Radiological Health (CDRH), and by IEC 60825 (the International Electrotechnical Commission's *Radiation Safety of Laser Products, Equipment Classification Requirements, and User's Guide*). The Class I and Class IV laser designations also comply with DIN VDE 0837/02.86+A1/07.90. You can read more about laser safety and classifications in ANSI Z136.1-1993 (the American National Standards Institute standard for the safe use of lasers).

BIOLOGICAL RISK

The main risk is to the eyes. The laser beam presents a danger in two ways:

- Direct radiation, where the eyes are in the beam axis. Do not look directly into laser during power burn.
- Reflected radiation, where the beam hits a surface that does not fully absorb it, results in partial reflection of the emitted beam.

Specular reflections (due to reflective objects) present exactly the same risk as direct radiation, as not only are they insidious, but they also contain up to 90% or more of the initial energy content.

Effects due to laser radiation depend on the wavelength; in the near infrared range (700 to 1400 nm), the cornea and lens are highly transparent to laser radiation, which thus reaches the retina. If the eye receives a significant energy density, the laser beam may cause small, irreversible lesions with extremely variable consequences depending on the location of the affected area. This can result in the formation of a hole in the retina with no adverse effect on vision, or in a blind area (or black spot) due to damage to the macula or even in almost total loss of vision when the fovea is affected.

The laser safety window conforms to standard CE EN207 allowing operators to observe interaction of laser and material while avoiding the risk of burns and loss of visual acuity.

MECHANICAL RISK

Any machine-tool with digitally-controlled movements are likely to be susceptible to rapid changes in position.

This results from inadvertent movements of the motorized axes:

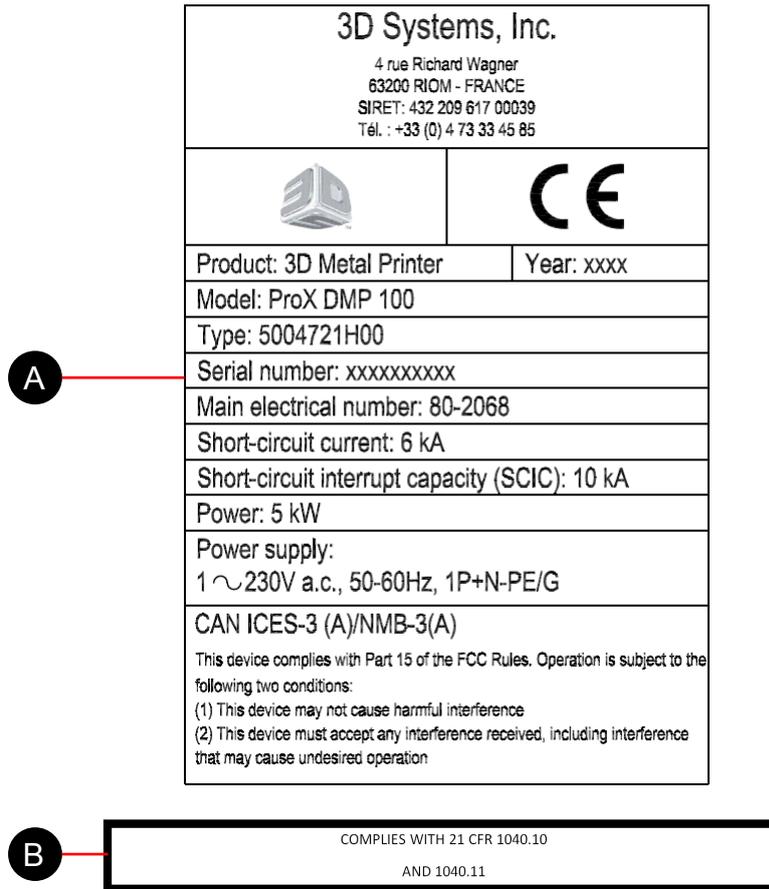
- Sintering axis,
- Supplying axis,
- Layering system.

And from inadvertent movements of actuators:

- Opening/closing of the airlock,
- Scraper.

SAFETY LABELS ON THE DMP SYSTEM

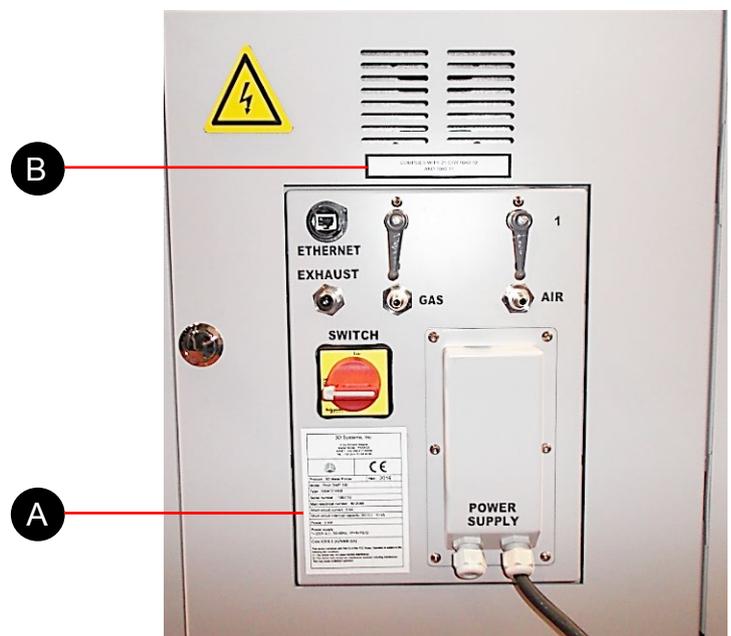
Laser certification / Identification with name plate



A Printer nameplate

B Laser certification statement

Both are located at the right side of the printer.



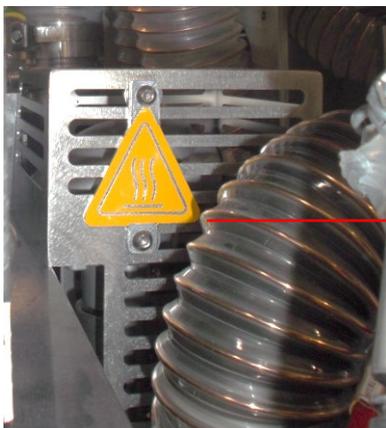
Warning Labels - Airlock door



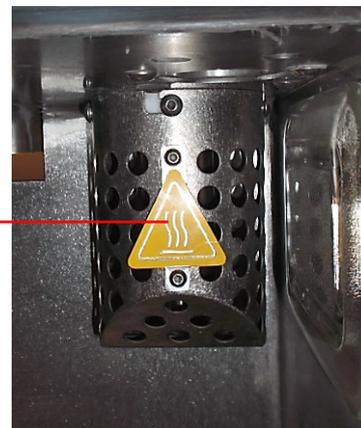
Pinch Hazard Label - Front of the scanner head



Burn Hazard Label - Oxygen sensor

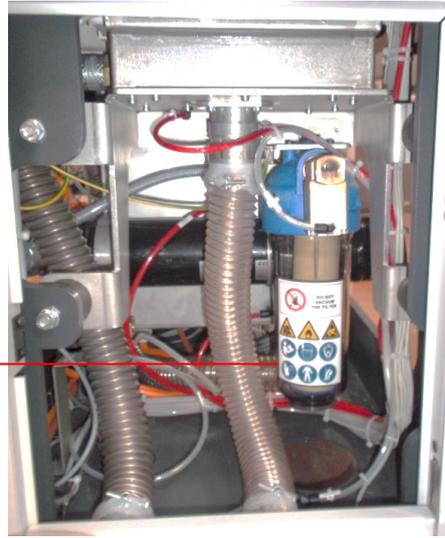


Behind the screen control panel
Above the manufacturing
chamber



Inside the manufacturing
chamber
Adjacent to oxygen sensor

Warning labels - Exhaust filter



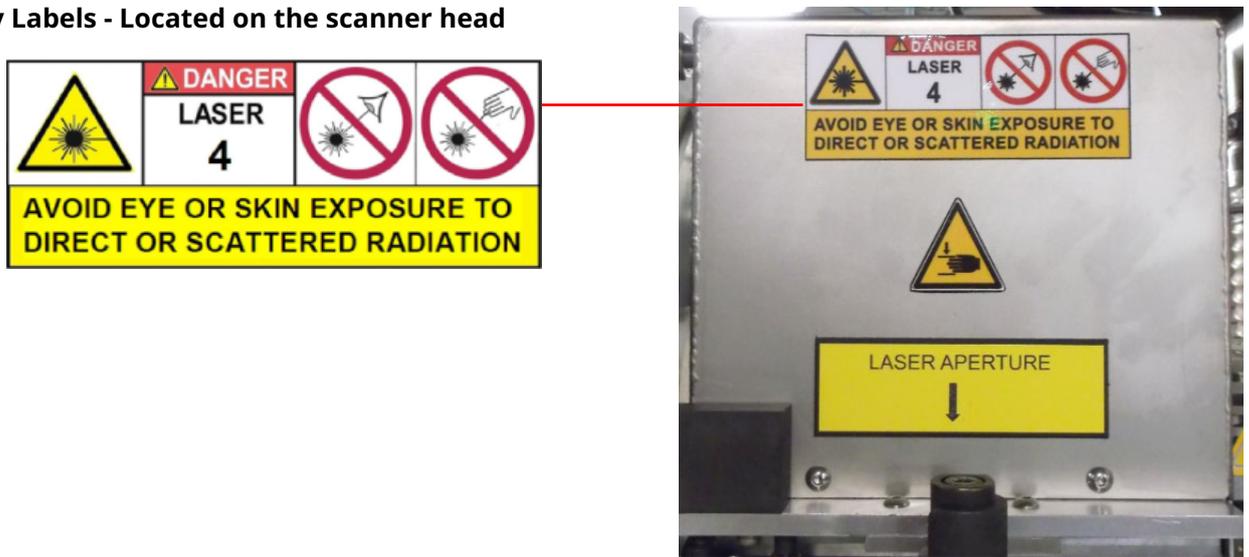
Warning labels - Right side of the printer



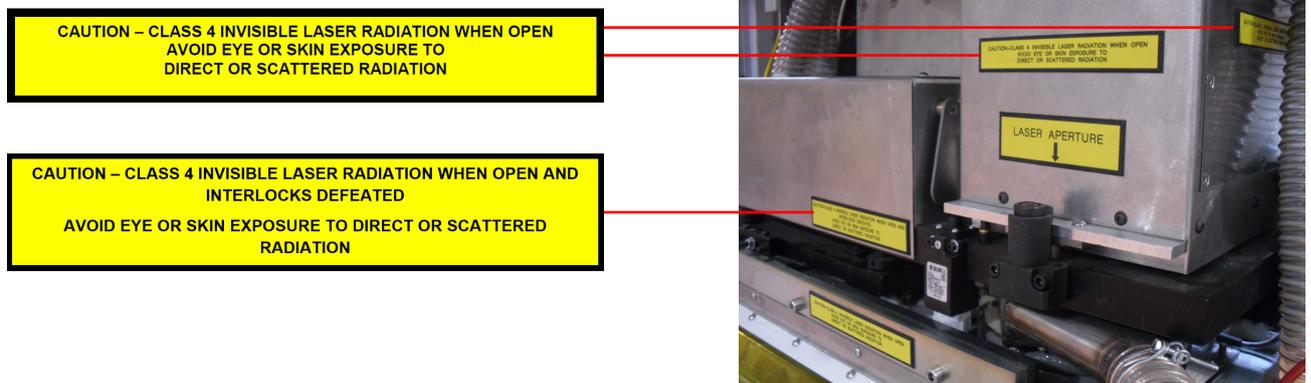
Laser Safety Labels - Located on the scanner head trap door



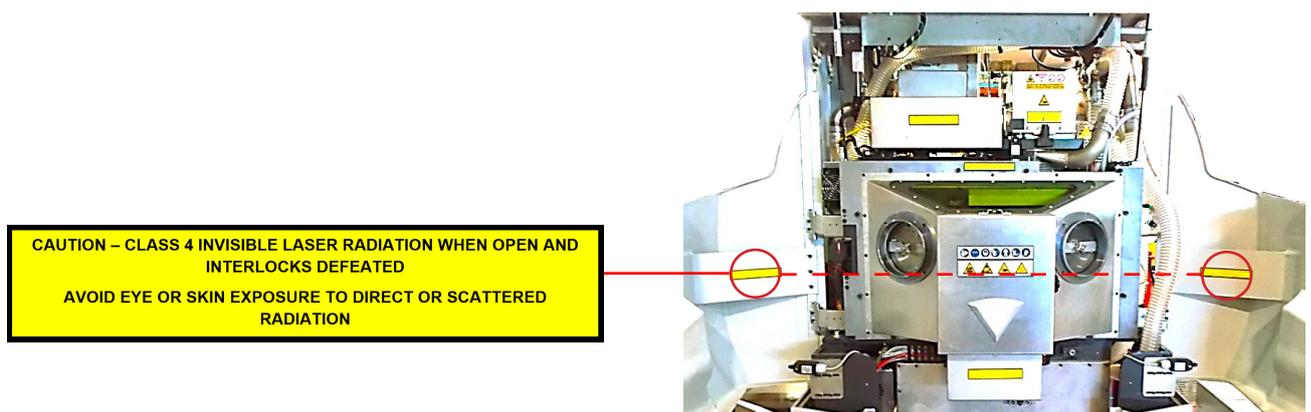
Laser Safety Labels - Located on the scanner head



Laser Safety Labels - Located on the scanner head/beam expander sides

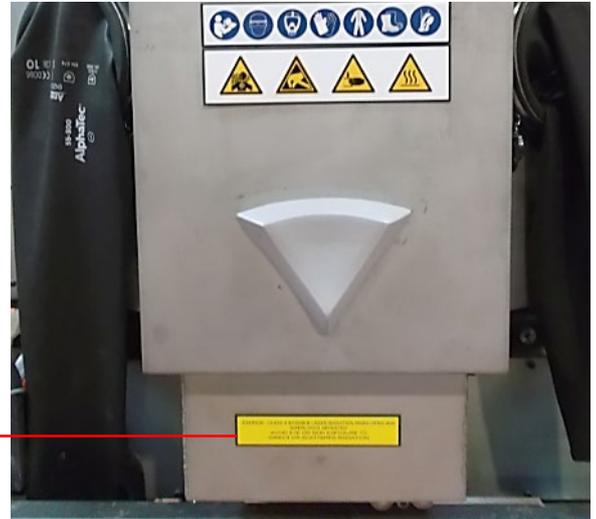


Laser Safety Labels - Located on the front doors



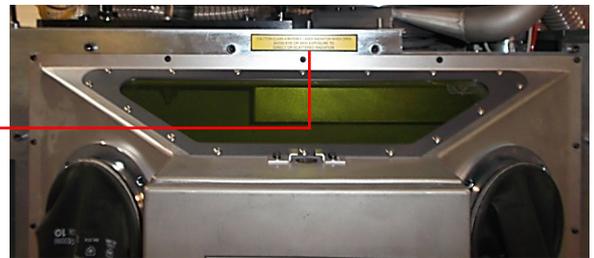
Laser Safety Label - Located under the airlock door

**CAUTION – CLASS 4 INVISIBLE LASER RADIATION WHEN OPEN AND INTERLOCKS DEFEATED
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION**



Laser Safety Label - Located on the manufacturing chamber door

**CAUTION – CLASS 4 INVISIBLE LASER RADIATION WHEN OPEN
AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION**



EUROPEAN DIRECTIVES

European directive 89/686/CE in Europe

For Personal Protective Equipment (PPE), the employer is required to:

- Provide the appropriate PPE,
- Check the correct choice of PPE has been made in relation to the risks involved,
- Ensure that PPE is used effectively,
- Check their conformity,
- Notify the people responsible for their implementation (workshop manager, etc.),
- Make sure that any PPE are in proper working order and are correctly maintained,
- Notify the users about the risks from which they are protected by the PPE and
- Train the users.

Conforming PPE (self-certified or certified by an accredited body) shall be marked both visibly and indelibly with (CE marking for Europe):

- The manufacturer's name and logo,
- PPE trade name or reference,
- Filtration classification with applicable regulation.

PPE must be delivered with a notice as well as a declaration of conformity to applicable regulations (to the main requirements of European directive 89/686/CE in Europe).

Following measures should be practiced, to ensure that PPE provided is properly used :

- PPE must be used in accordance with the instructions provided,
- PPE must be inspected before each use. Damaged equipment should be removed.
- Reasonable care of any PPE must be taken by employees,
- Employees should carry out maintenance to make sure the equipment continues to provide the degree of protection for which it is designed (according to the manufacturer's maintenance).
- Maintenance should include : cleaning, inspection, replacement. Repairs must only be carried out by competent personnel.

3 SYSTEM SPECIFICATION

THE PROX® DMP100 SYSTEM

This section lists all of the equipment that is provided as a part of the ProX® DMP100. For more detail on product specification, please refer to the ProX® DMP100 Facility Guide.

- Main cabinet
- Process filter with its transportation cart

4 PROX® DMP100 AT A GLANCE

PROX® DMP100 SYSTEM COMPONENTS



- A** Front doors (see section "A. Front doors and glove doors" on page 24)
- B** Manufacturing chamber (see section "B. Manufacturing chamber" on page 24)
- C** Laser assembly (see section "C. Laser assembly" on page 26)
- D** Screen and control panel (see section "D. Screen control panel and external control panel" on page 27)
- E** Connection panel (see section "E. Connection panel" on page 28)
- F** Airlock (see section "F. Airlock" on page 29)
- G** Pneumatic data management (see section "G. Pneumatic data management" on page 29)
- H** Process filter assembly (see section "H. Process filter assembly" on page 30)
- I** Process chamber window, part of the manufacturing chamber

A. Front doors and glove doors

The operator accesses the inside of the manufacturing chamber through the two glove ports located behind the front doors of the printer. Sensors on each gloves door block all movements when they are opened, except the airlock position.

Direct access to the manufacturing chamber is only performed to carry out maintenance.



Only qualified personel may operate the machine with the manufacturing chamber door opened.

B. Manufacturing chamber

The direct metal printing takes place in the manufacturing chamber, which is kept under a controlled inert atmosphere during the printing process.

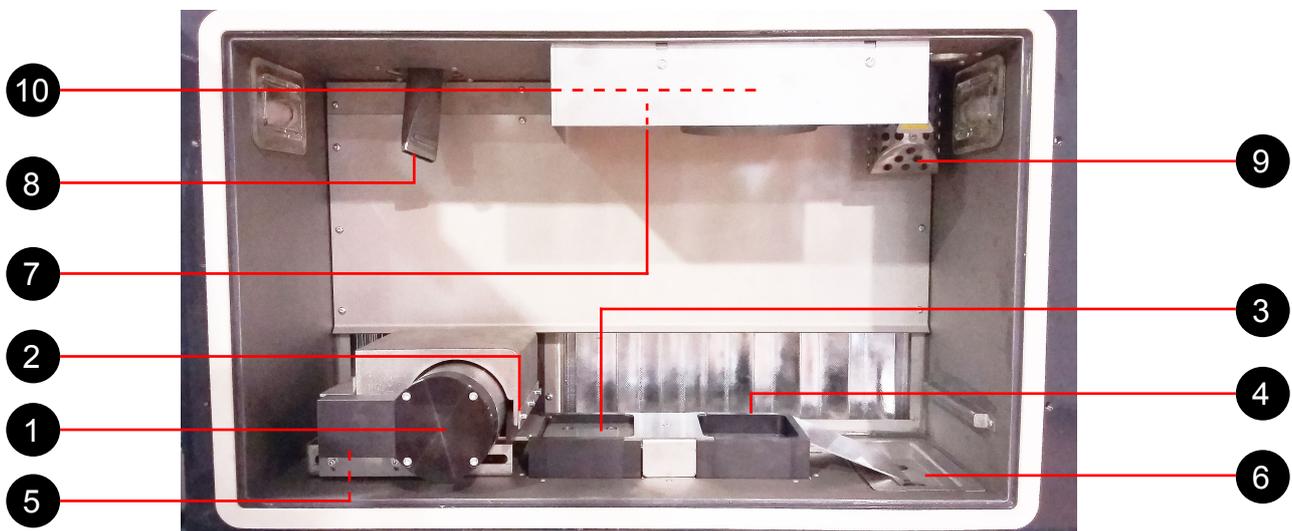
A process chamber window enables the operator to look inside the manufacturing chamber while being protected from the laser.



The manufacturing chamber door is equipped with a laser safety window.

850nm ≤ λ ≤ 1100nm DLB5 - IRLB8 - CE EN207

The manufacturing chamber consists of :



- 1 ROLLER - part of the layering module (see section "1. Layering module" on page 25)
- 2 SCRAPER - part of the layering module (see section "1. Layering module" on page 25)
- 3 FEEDING PISTON - part of the layering module (see section "1. Layering module" on page 25)
- 4 SINTERING PISTON - part of the layering module (see section "1. Layering module" on page 25)
- 5 TAMPING UNIT (see section "1. Layering module" on page 25)
- 6 COLLECTING TANK (see section "2. Collecting tank" on page 25)
- 7 HEATING ELEMENT (see section "3. Heating element" on page 26)
- 8 VACUUM CLEANER HOSE (see section "4. Vacuum cleaner hose" on page 26)
- 9 OXYGEN ANALYSER SENSOR (see section "5. Oxygen analyser sensor" on page 26)
- 10 LENS CLEANER (see section "6. Lens cleaner" on page 26)

1. Layering module

This module consists of :

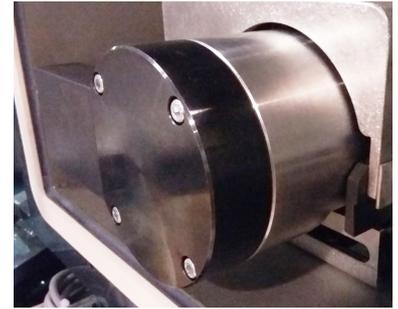
- The roller

The roller can move in a straight line using the carriage :

- Maximum position: 355 mm
- Maximum speed: 200 mm/s
- Accuracy: <1 mm

And rotate :

- Maximum speed: 5 turn per second



The combination of different movements of roller and carriage are adjustable for carrying out actions of layering such as spreading, smoothing and compacting. The layer thickness of powder differs depending on the material properties (particle size, flowability...) and on the desired part characteristics.

- The scraper

Its geometry enables to carry the powder from the feeding piston to the sintering piston.



- Feeding piston

This piston contains the volume of powder that will be used for sintering. Its characteristics are given below:

- Dimensions: 100 x 100 mm
- Powder volume: 2 liters
- Stroke: 200 mm
- Maximum speed: 20 mm/s
- Positioning accuracy: $\pm 5 \mu\text{m}$

- Sintering piston

The parts are manufactured on a sintering plate, located on the sintering piston. Its characteristics are:

- Dimensions of the sintering plate : 100 x 100 mm
- Useful stroke: 80 mm (with a sintering plate of 10 mm thick)
- Maximum speed: 20 mm/s
- Positioning accuracy: $\pm 3 \mu\text{m}$

- Tamping unit

The compacting element translates in order to clog the feeding piston, then, the piston rises to compact the powder.

2. Collecting tank

It recovers all non-sintered powders and residues of sintering that have to be treated within external recycling system.



3. Heating element

The internal chamber temperature can be controlled. This has the following characteristics:

- Max. internal chamber temperature: 70 °C
- Control accuracy: ± 10 °C
- Heating element power rating: 1200 Watts

4. Vacuum cleaner hose

The printer is equipped with a vacuum cleaner hose that can be operated only if connected to an external powder recycling system. The vacuum cleaner can be used to clean the manufacturing area. The vacuum cleaner hose connection is located on the left-hand side of the printer.

5. Oxygen analyser sensor

The printer is equipped with an oxygen analyzer that monitors the level of oxygen continuously (value is expressed in percent till 1% and in ppm below).

6. Lens cleaner

A filtering unit is fitted on the system to avoid particles and fumes from the sintering process being deposited onto the lens. A gas flow sweeps permanently the underside of the lens; this airflow is filtered using a filter cartridge. The particles are stopped by the cartridge membrane and stored in a collector.



Caution : the lens filter must be replaced regularly. Consult the Maintenance section for the recommended maintenance interval and details on how to replace the filter.

C. Laser assembly

The main optical devices are :

- A fiber laser source: continuous operation, single mode, power at the collimator output 50W, wavelength in the short-wave infrared range (approx. 1070 nm),
- A collimator: outlet beam diameter at $1 / e^2$ of 5 mm,
- A beam expander: optical device that expands the laser beam,
- A scanner head,
- A flat field F-Theta lens (420mm focus length).

- 1 COLLIMATOR + BEAM EXPANDER ENCLOSURE
- 2 OPTICAL RAIL
- 3 SCANNER HEAD
- 4 LENS (COULD NOT BE SEEN ON THE FIGURE)



D. Screen control panel and external control panel

Screen control panel

This touch screen provides a human-machine-interface for visualization of the various steps during the manufacturing process.

The touch screen displays all controls, status indicators and positioning information from different parts of the machine.



External control panel

On the right side, an external control is used to manage the main parts & events during a manufacturing cycle:

1 EMERGENCY STOP

This button activates immediate shutdown of the heating element and cuts the power supply to the laser and the motors. It also triggers an emergency software stop. If the printer needs to be stopped in an emergency situation, press this button.

2 MAIN SUPPLY PRESENT

This light indicates when the machine is powered on and started.

3 PUSH BUTTON "ON"

This push button turns the machine on when it is powered up with the "start-up key" switched to "1".

4 STOP

This button instantly stops all currently operating processes (power, heating element, motor, laser, etc.). If the machine is stopped during a sintering operation, manufacturing will be stopped immediately and may not be continued. All processes will have to be reset.

5 CYCLE BREAK

This button interrupts a cycle at its completion and lets the operator choose either to continue the cycle by pressing the button again or to end the process by pressing the stop button (layering or sintering cycles for example).

6 RECOIL OF VACUUM CLEANER

This button is used to recoil the vacuum cleaner hose. When the tip of the vacuum cleaner is correctly engaged, the hose is locked in its housing.

7 UNLOCKING

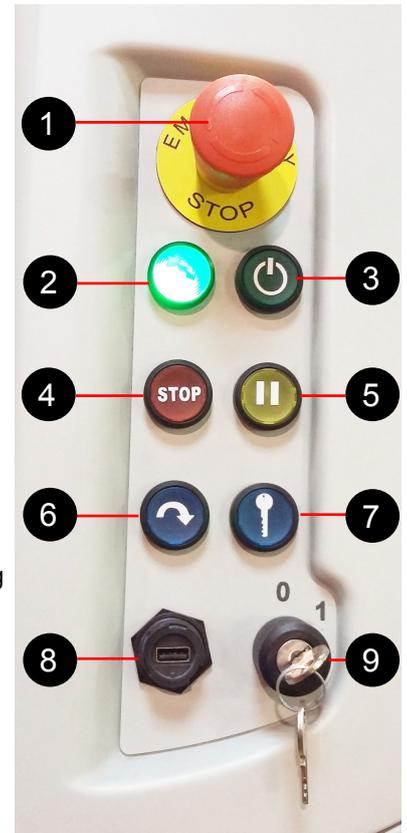
This device deactivates the locking system on the doors to access the airlock and the glove doors.

8 USB PORT

Allows to connect any USB device.

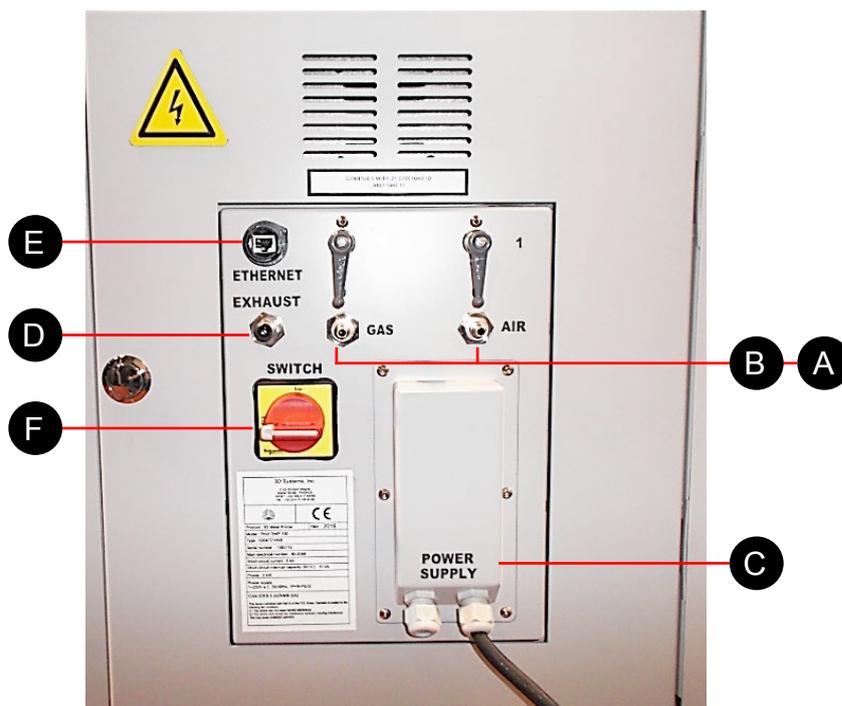
9 START KEY

This key activates/deactivates the machine start command using the "ON" button.



E. Connection panel

The connection panel is located at the right side of the main cabinet. It contains the following connections:



- A Compressed air supply : valve and automatic coupler with 6 mm splined adaptor
- B Gas supply : valve and automatic coupler with 6 mm splined adaptor
- C Electrical power supply
- D 6mm exhaust gas
- E Ethernet socket : RJ45 network cable
- F Main cut-off switch: ON/OFF

F. Airlock

The airlock lets operators load/unload a plate and powder cans without having contact with the inside of the chamber, thus ensuring there is no contamination of the powder and maintaining the inerting process.

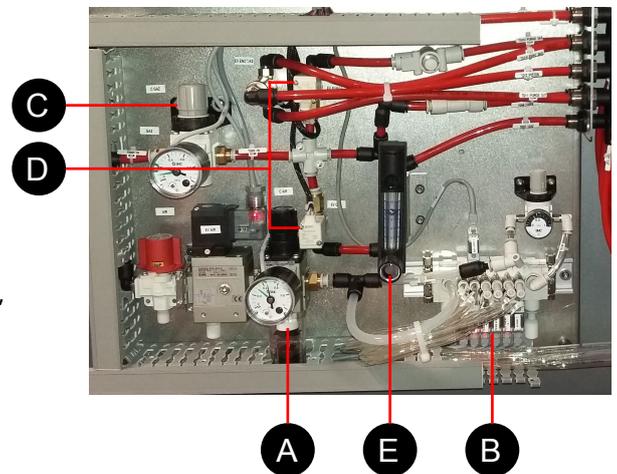
The airlock is located behind the front doors.



G. Pneumatic data management

This unit is located below the front doors of the printer. It contains all the systems required to control input to pneumatic and gas circuits.

- Pneumatic circuit containing:
 - an air treatment unit (manual shut-off valve, solenoid valve, filter, regulator) (A),
 - a pump island (B).
- Gas circuit containing:
 - a pressure regulator (C),
 - two solenoid valves that control operation of the chamber's gas feed and purge system according to the selected case (D),
 - A gas flow regulator to adjust flow rate in control mode (E).



H. Process filter assembly



NOTE: The ProX® DMP100 is equipped with a lens cleaner filtering unit that prevents particles and fumes generated by the sintering process from being deposited on the lens.

The external filter vessel removes particles and fumes generated by the sintering process. The filter cannot be installed in a separate room, and must be installed adjacent to the manufacturing chamber.



1 DISPOSABLE PROCESS FILTER

2 PROCESS FILTER CART

Description

As the gas flow enters the side connection of the vessel (Dirty In), particles and fumes are trapped by the filter inside the vessel. After the gas has gone through the filter media in the vessel, it is pumped back into the machine via the top connection (Clean Out).

The machine monitors continuously the O₂ level. As soon as the O₂ value reaches the safety limit setting, the machine stops the lens cleaner blower, closes the lens trap and the filters vessel valves (up and downstream the vessel).

These two valves are used to isolate the filter from the machine, allowing a quick, easy and safe filter replacement.



Caution : the lens filter must be replaced regularly. Consult the Maintenance section for the recommended maintenance interval and details on how to replace the filter.



WARNING : DO NOT START THE LENS CLEANER BLOWER WHILE THE PROCESS FILTER IS NOT CONNECTED TO THE PRINTER.

LIFTING



Caution: moving the printer may affect settings (alignments, calibration...). Contact your 3D Systems-certified Customer Support Engineer to check the operation of the printer after moving.

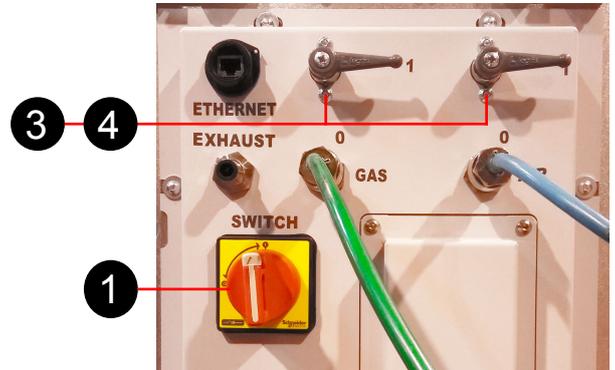
When moving the ProX[®] DMP100 system, follow the instructions outlined below :

- The system must only be lifted by authorized people.
- Make sure entire lifting, rigging and supporting structure has been inspected, and is in a good condition.
- The main cabinet can be moved by using a forklift with a load capacity of at least 1500 kg (3307 lbs), with minimum fork length of 1500 mm (59.05 in.).

5 SYSTEM USE

POWERING UP THE PRINTER

1. Make sure printer is plugged into the facility power.
2. Make sure that the 16A circuit-breaker is engaged upstream of the machine.
3. Turn on the main switch on the connection panel (1).



4. Make sure that all doors are closed and emergency stop is not pushed.
5. Switch the locking key to position "1", on the external control panel (2).
6. Open the compressed air valve (3) and gas valve (4).



7. Start the machine by pressing the start push button, on the external control panel (5).



8. The **PX Control** application will automatically start and be displayed on the screen control panel.

To launch the **PX Control** application manually, double-click on the icon  "PX_Control" from the desktop.



USER INTERFACE

At the start of the printer, the **Operator** level (of **PX Control V2**) is logged by default. Only **Operator** functions are available from the main tool bar (1).



The main tool bar (1) consists of :

Icon	Description
	Access button for Preparation Menu (see section "Preparation menu" on page 34)
	Access button for Manufacturing Menu (see section "Manufacturing menu" on page 42)
	Access button for User Level Selection (see section "User level selection" on page 46)
	Access button for Setting Menu (see section "Setting menu" on page 47)
READY	Access button for the Machine Status page (see section "Machine Status menu" on page 53)
	This button enables chamber lighting. It is always available for use
	Machine off button (see section "Shutting printer down" on page 68)
	Close Application button (see section "Closing / opening PX Control application" on page 68)



NOTE: The text displayed on the **Machine Status** access button indicates the current status of the machine:

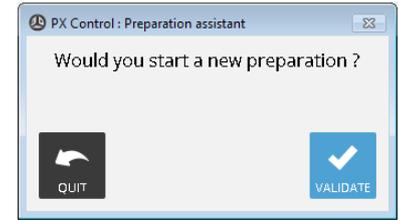
- **INIT** : the machine is initializing (during start-up or after an emergency shutdown),
- **READY** : the machine is operational,
- **UNLOCK** : the machine is in unlocked mode (front doors or sas door opened, or unlocked),
- **RESET** : the machine is reinitializing (after a **STOP** button, or a relock of the doors),
- **MANUF** : the machine is manufacturing,
- **C.B.** : the machine is on a cycling break, during manufacturing,
- **PREPA** : the machine is on a preparation cycling,
- **MAINT** : the machine is in maintenance mode.

Preparation menu



By clicking on the **Preparation Menu** button, the "PX Control : Preparation assistant" window appears.

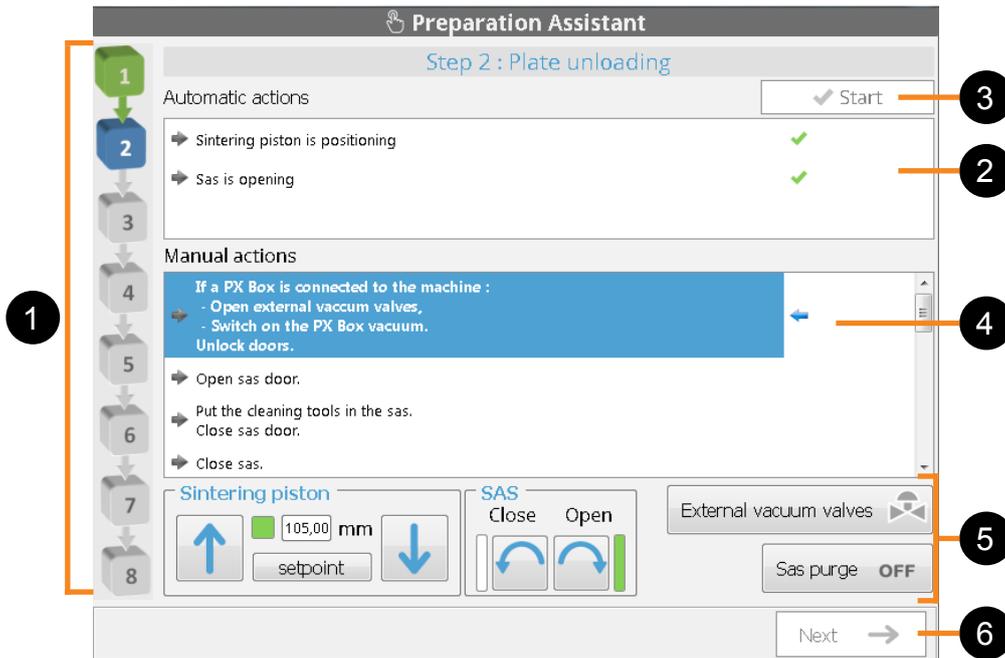
Click "Validate" to confirm, or "Quit" to cancel.



NOTE: this window will appear only if the machine has finished the previous preparation. Otherwise, the application will display the Preparation Assistant window at the current step.

The **Preparation Menu** allows user to prepare the printer to print a job, and to unload the printed part.

This menu is composed by 8 successive steps. Each step shows manual and automatic actions to be performed, and consists of :

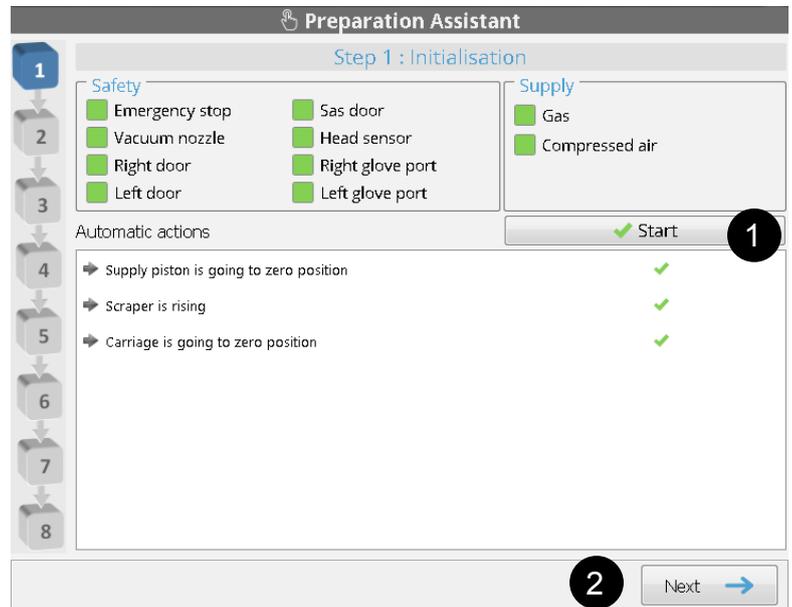


- 1 List of the preparation steps (green: completed, blue: in progress, grey: not performed)
- 2 Actions executed during the automatic cycle
- 3 Button to launch the current cycle
- 4 List of actions of the current step to be performed by the operator
- 5 Available commands of the current step
- 6 Button to navigate to the next step

Step 1 : Initialization

For each new job preparation, the printer must be initialized at first. The **Initialization** step is performed automatically:

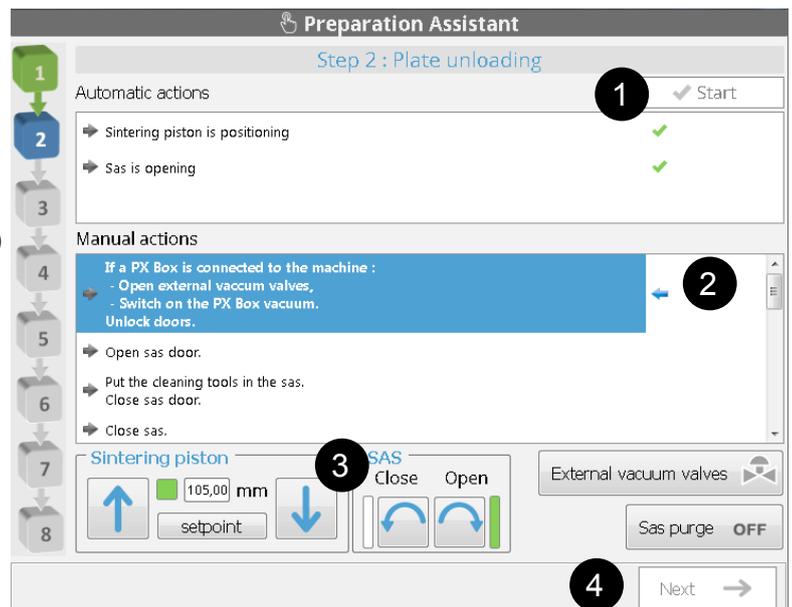
1. Click on the automatic cycle launch button (1).
2. When automatic cycle completed, click on **Next** (2) to go to the next step.



Step 2 : Plate unloading

The **Plate unloading** step includes both automatic and manual actions. When automatic actions have been done, manual actions are required.

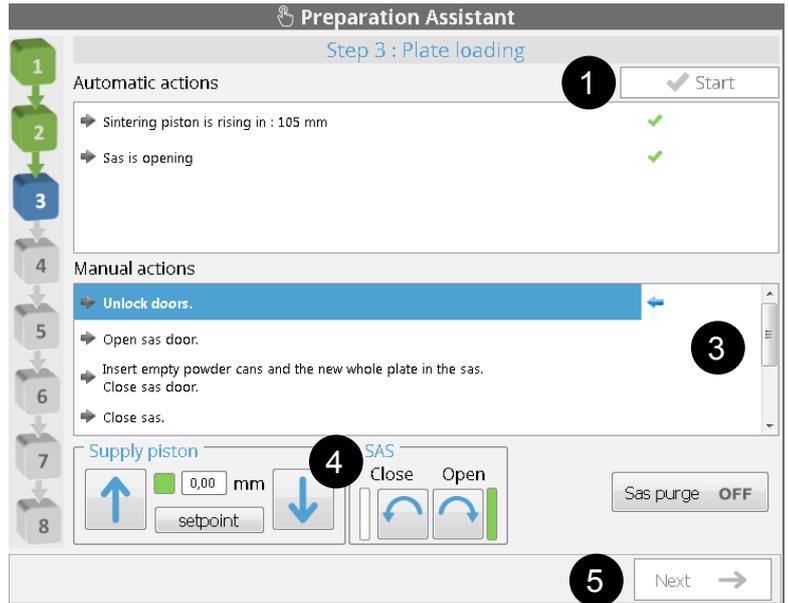
1. Click on the **Start** button (1): this will launch the automatic cycle.
2. When the automatic cycle is completed, then perform the actions (2) by using the available commands (3) and the external control panel. Consult the section "Unloading a plate" on page 64 for details.
3. When manual actions completed, click on **Next** (4) to go to the next step.



Step 3 : Plate loading

The **Plate loading** step includes both automatic and manual actions. When automatic actions done, manual actions is required.

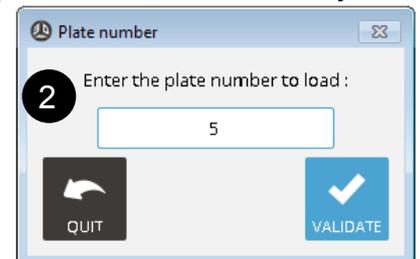
1. Click on the **Start** button (1).



2. Enter a plate number that will be used to identify the plate (2). After validating the plate number, the automatic cycle will be launched.



NOTE: the pre-filled number is the first number plate available. This number will correspond to the sintering plate being loaded on the printer.

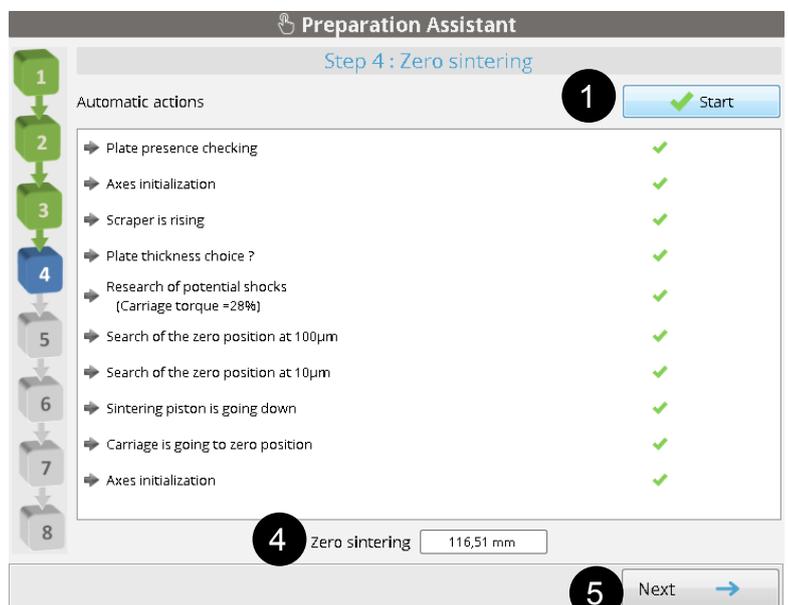


3. Perform the actions (3) by using the available commands (4) and the external control panel. Consult the section "Sintering plate preparation and loading" on page 57 for details.
4. When manual actions completed, click on **Next** (5) to go to the next step.

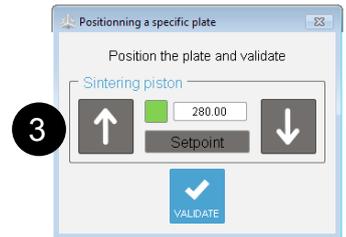
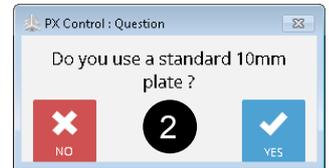
Step 4 : Zero sintering

The **Zero sintering** step will allow the printer to perform a zero sintering. Consult the section "Zero sintering search" on page 58 for details. This step is performed automatically:

1. Click on the **Start** button (1): this will launch the automatic cycle.



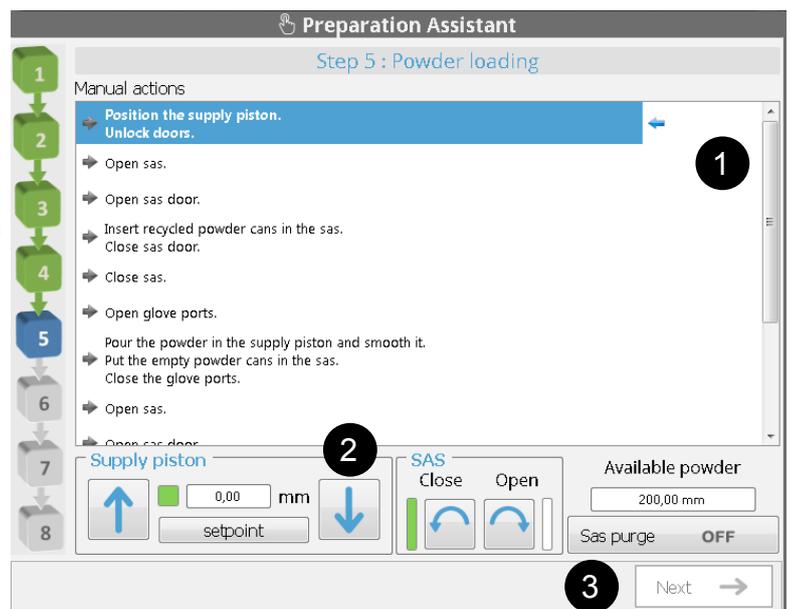
2. During the automatic cycle, the user is prompted to indicate if a standard 10mm plate is used (2):
 - If yes, click "Yes". Then the automatic actions will continue. When completed, click on **Next** (4) to go to the next step.
 - If a different 10mm plate is used, then select "No", and proceed the following step.
3. Position the sintering plate by using the window (3) (with the arrows, or by entering a setpoint), so that the top of the sintering plate is leveled with the sleeve of the sintering piston. Then confirm by clicking on **Validate**. The automatic cycle will then continue.
4. When the automatic cycle is completed, the zero sintering value is displayed (4). Click on **Next** (5) to go to the next step.



Step 5 : Powder loading

The **Powder loading** step is performed manually:

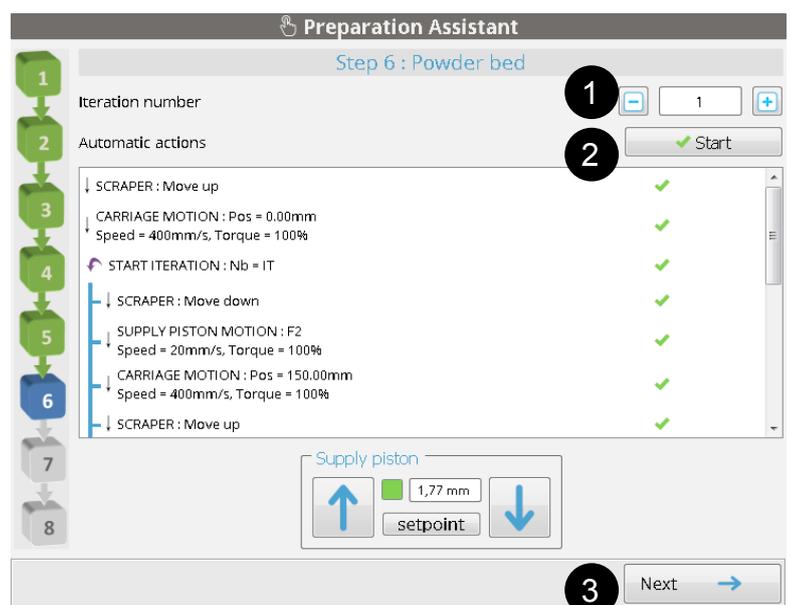
1. Perform the actions (1) by using the available commands (2) and the external control panel. Consult the section "Loading the feeding piston" on page 59 for details.
2. When manual actions completed, click on **Next** (3) to go to the next step.



Step 6 : Powder bed

The **Powder bed** step will allow to create the powder bed: the first powder layer will be deposited on the sintering plate.

1. Enter the iteration number of the powder bed sequence, by using the "-" and "+" buttons (1).
2. Click on the **Start** button (2): this will launch the automatic cycle.
3. Consult the section "Creating the powder bed" on page 60 for details on how to control the well completion of the power bed.
4. When cycle completed, click on **Next** (3) to go to the next step.



Step 7 : Lens cleaning



Caution: to ensure process quality, it is important to clean the lens before each job. Consult the section "Cleaning the laser optic system" on page 61 for details on how to clean the lens.

If no filter replacement required

1. Perform the actions (1). Consult the section "Cleaning the laser optic system" on page 61 for details on how to clean the lens.
2. Click on **Next** (2) to go to the next step.

Preparation Assistant

Step 7 : Lens cleaning

Manual actions

- Switch off the turbine ✓
- Unlock doors. ✓
- Open the laser head. ✓
- Clean the lens. Then close the laser head. ✓
- Lock doors. ✓

Turbine ON

Next

If filter replacement required

1. When the **lens cleaner timer** value has reached 60 days, the interface will at first prompt to change the lens cleaner filter. Perform the actions (1). Consult the **Maintenance** section for details on how to replace the filter.

Preparation Assistant

Step 7 : Lens cleaning

Manual actions

Canister valves

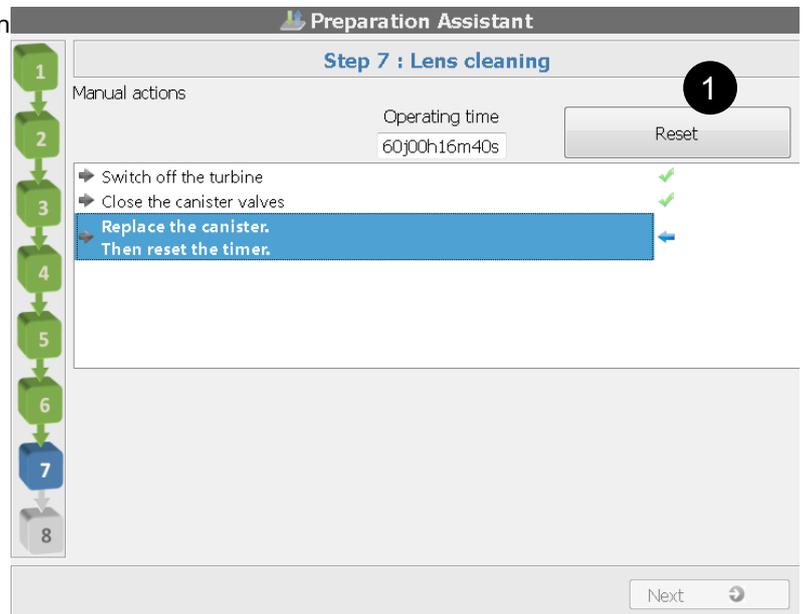
Operating time 60j00h16m40s

- Switch off the turbine
- Close the canister valves
- Replace the canister. Then reset the timer.

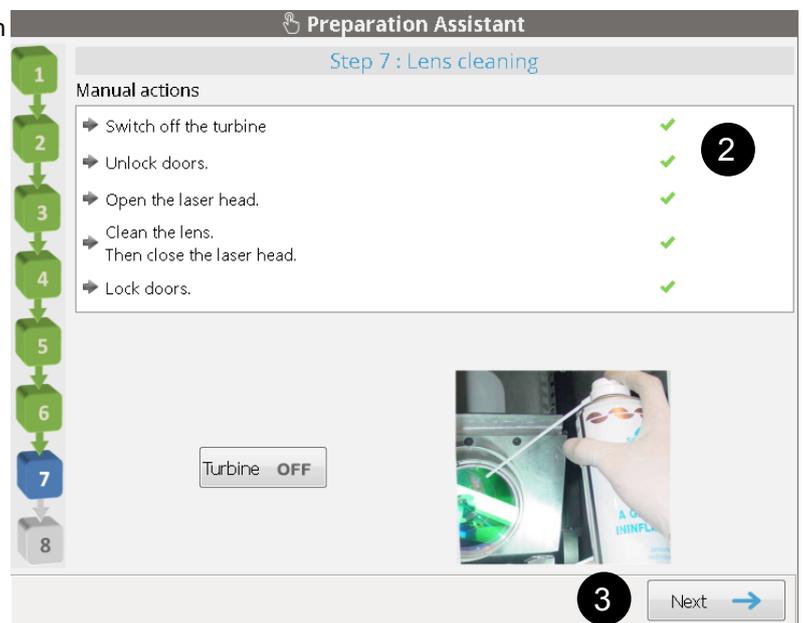
Turbine ON

Next

- When the filter replacement is completed, click on **Reset** (1) to reset the filter timer.



- Then, perform the actions (2) : consult the section "Cleaning the laser optic system" on page 61 for details on how to clean the lens.
- Click on **Next** (3) to go to the next step.



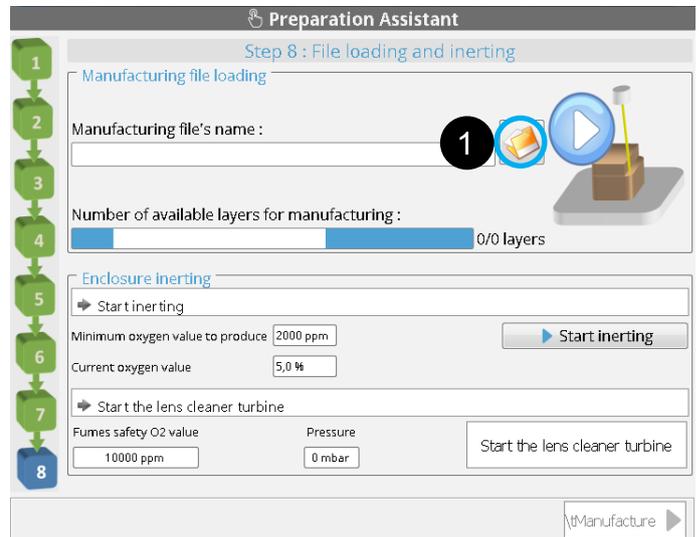
Step 8 : Loading of the manufacturing file and inerting

This step consists of :

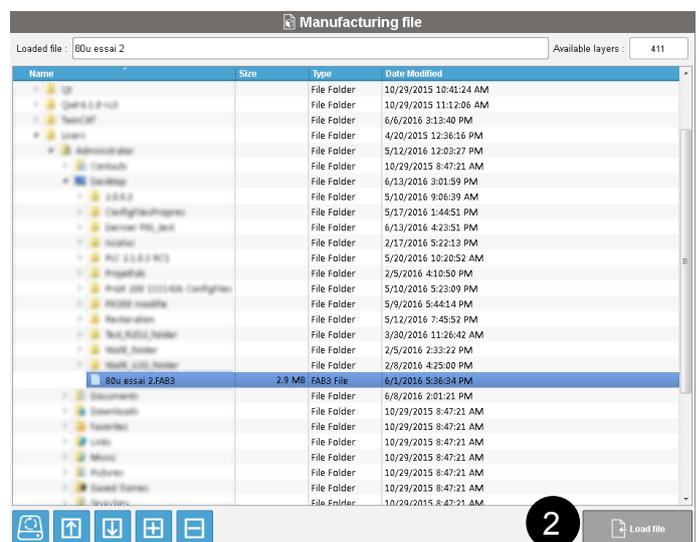
- Selecting the manufacturing file (*.FAB3 format) created with **ProX DMP Manufacturing**, standalone software,
- Inerting the manufacturing chamber and process filter.

Manufacturing file selection

1. Click on the folder icon to launch the file browser (1).



2. Select the manufacturing file and click on **Load file** (2).



The **Preparation Assistant** will then return to the previous page. The inerting phase should then be initiated.

Inerting phases process



The inerting process must follow the 2 phases in this order : manufacturing chamber inerting **at first**, then process filter inerting. Do not activate the lens cleaner turbine if the process filter is not connected to the printer. Make sure the filter is well connected to the printer before starting the inerting process.

1. Click on **Start inerting** (1) : Gas and purge activated – Regulation mode activated – Lens cleaner turbine OFF and external vessel valves closed. This step will only inert the manufacturing chamber.
2. Once the O2 value is lower than the safety limit, **Start lens cleaner turbine** button is enable. Click on it (2) to activate the lens cleaner turbine : the vessel valves will open, allowing the fume vessel inerting.

3. Once the O2 value is lower than the **Minimum Oxygen Value To Produce**, then click on **Produce** (3) to go to the **Manufacturing menu**.



If the O2 level goes higher than the safety limit (during manufacturing or after filter vessel replacement), the lens cleaner turbine will stop automatically (and the external vessel valves close). It will trigger an oxygen error (4). Click on **Validate**, then proceed again to the inerting phases process up to get the O2 level below the safety limit.

Date	Time	Message
17/06/2016	10:51:30	O2 value > O2 fumes safety limit (10000 ppm)

Manufacturing menu

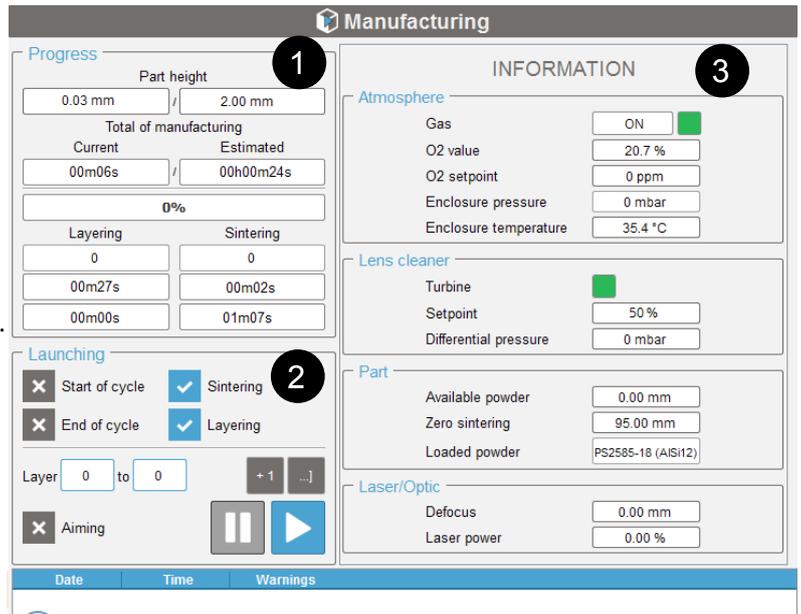


This menu allows the user to start the manufacturing process (layering and sintering), and also to see the progress. It consists of four parts.

Consult the section "Start a manufacturing process" on page 63 for details on basic rules of starting a job.

1 Progress area

- Current / Project part height (mm)
- Current / Estimated manufacturing time (hours),
- Manufacturing progress in %,
- Layering : the current number, the duration of the current layering, and the total layering time,
- Sintering : the current number, the duration of the current sintering, and the total sintering time.

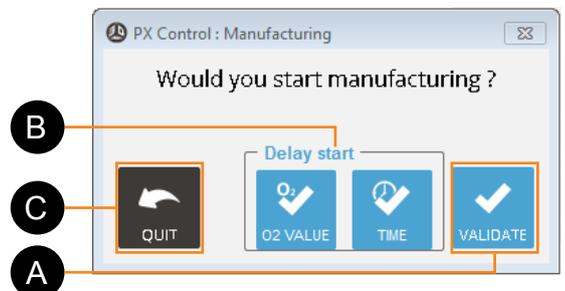


2 Launching area

- Selection of the Start/End cycles:
 - **Start of cycle** : if selected, executes actions of the **Start cycle** sequence (i.e gas ON...) when starting a job.
 - **End of cycle** : if selected, executes actions of the **End cycle** sequence (i.e Blower OFF...) when job is finished.
- Selection of the Layering/Sintering process:
 - **Sintering** : if selected, enables the sintering process, when starting a job.
 - **Layering** : if selected, enables layering, when starting a job.
- Selection of the layers:
 - **Layer "start" to "end"** : the numbers of the first and last layer must be indicated. Click on the corresponding field to complete individually them (a numeric keypad will be displayed).
 - Optional: the button **" +1 "** increases the **_start_** layer by one and duplicate this value for the **_end_** layer (useful when producing the first layers step-by-step). The button **" ...] "** increases the **_start_** layer by one, and automatically fills the **_end_** layer with the last layer value.
- The button **"Aiming"** sets the laser in no-power mode : the laser will sinter (without power) with a red beam.
- The button allows to pause the job (see section "Interrupt a job" on page 44).
- The button allows to start the job (according to the selections **Start/End** cycles and **Layering/Sintering** process). When activated, the confirmation window appears :

To start a job, proceed as following:

1. Select and configure the settings on the *Launching* area,
2. Click on ,
3. Click on either **Validate** (A) to confirm, or on one of the **Delay start** functions (B) or on **Quit** (C) to cancel. Refer to the next paragraph for the delay start functions detail.



If some warning conditions occur, the confirmation window will differ (see section Manufacturing launch warnings on page 44).



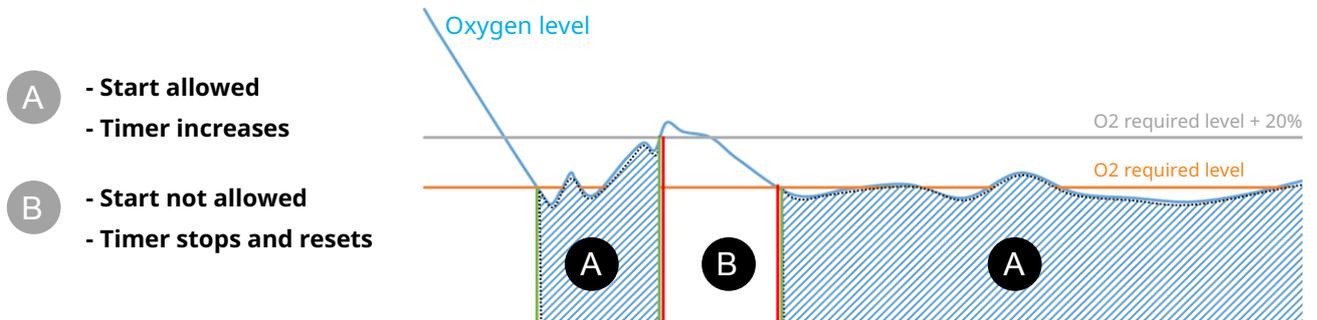
To overcome O2 level variation around the fume safety setting, the job will start only if the oxygen level is lower than 90% of the fume safety setting.

Delay start function

Two delay start functions can be used to start a job at a specific oxygen level or at a specific time:

- **O2 value function**

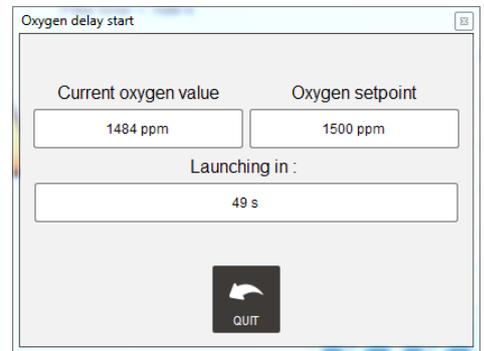
The delay **O2 value** start function offers the possibility to start the selected cycles only when the oxygen level is lower the required value + 20% for more than 1 minute. When the oxygen is lower the required value, a timer starts. If the oxygen level rises above the required value + 20% within the first minute, then the timer stops and resets. As soon as the oxygen level remains below the required level more than 1 minute, then the job will start.



When the printer is on the area A, the "Oxygen delay start" window displays:

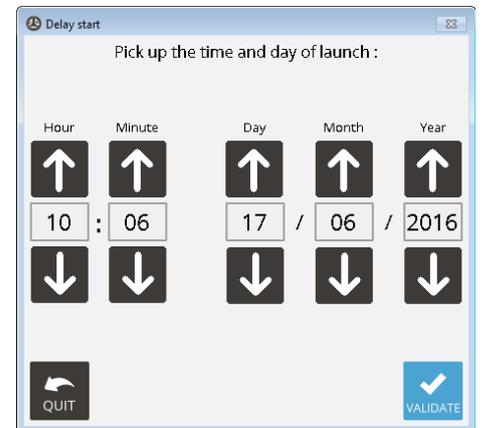
- the current oxygen value and setpoint value
- the remaining time before the start of the job

Click **Quit** to abort the delay start function.



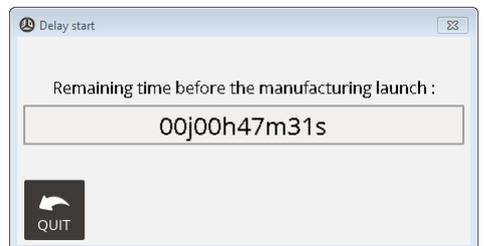
- **Time function**

The delay start function offers the possibility to start the selected cycles at a specific time. If selected, the user can program the next start within the setting window:

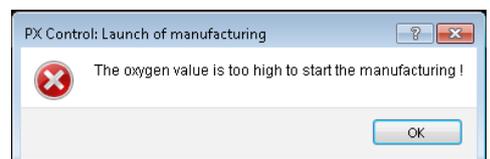


Click on **Validate** to confirm, or on **Quit** to cancel.

When validate, the remaining time before the start will be displayed:

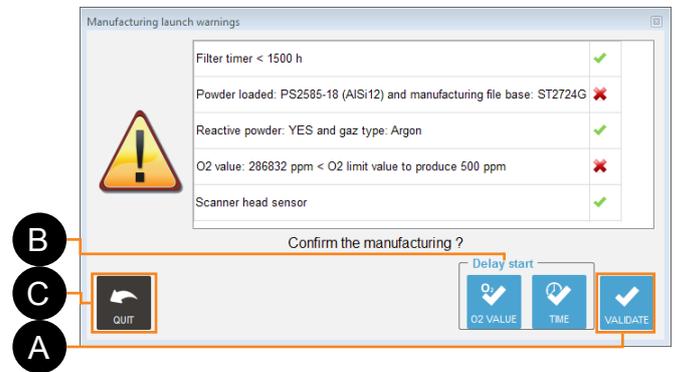


The manufacturing will start at the end of the specified time and if the current oxygen value is under the "Oxygen limit value to produce" setting. If not, the start of the manufacturing will be aborted and a windows error will appear :



Manufacturing launch warnings

After clicking on the  button, if there are some warnings, the "Manufacturing launch warnings" message will appear:



This is a warning information to indicate:

- Lens cleaner filter timer compared to the recommended interval replacement,
- Powder selected on the printer configuration (see section "Configuration" on page 47) compared to the powder defined on the FAB3 manufacturing file.
- Type of powder (reactive or non-reactive) compared to the type of gas, both defined on the printer configuration (see section "Configuration" on page 47).
- Current oxygen value compared to the "Minimum O2 threshold to launch a manufacturing" setting (see "Oxygen tab" paragraph of the section "Configuration" on page 47),
- Scanner head sensor state.

1. Select **Quit** (C), then fix all warnings before continuing.
2. Click on either **Validate** to confirm (A), or on one of the **Delay start** functions (B) (see section "Delay start function" on page 43) or on **Quit** (C) to cancel.



To overcome O2 level variation around the fume safety setting, the job will start only if the O2 level is lower than 90% of the fume safety setting.

Interrupt a job

During the manufacturing, it is possible to interrupt the job by clicking the pause button . When activated:

- The **Cycle interruption message** will be displayed.
- The printer will finish the current layer sintering, will then proceed to the next layering cycle without sintering. The operator will have to:
 - Click on  to continue the job or,
 - Click on  to completely stop the manufacturing.



- ATMOSPHERE
 - **Gas** (mode of the gas supplied): REGUL (regulation around an oxygen target value), DIRECT (continuous injection of gas at a constant rate), OFF (no gas injection),
 - Status of the gas valve indicator : if green, the valve is opened,
 - **O2 value**: current oxygen level value in PPM (particles per million) on the manufacturing chamber,
 - **O2 setpoint**: oxygen level target value,
 - **Enclosure pressure**: current pressure value in the manufacturing chamber,
 - **Enclosure temperature**: current temperature value on the manufacturing chamber.
- LENS CLEANER
 - **Turbine**: state of the lens cleaner blower (turbine). If green/white, the blower is operating/not operating,
 - **Setpoint**: setpoint of the blower operating, in %,
 - **Differential pressure** : [Outlet Pressure – Inlet Pressure] of the external filter.
- PART
 - **Available powder**: the height of the powder available in the feeding piston in mm,
 - **Zero sintering**: the zero position of the sintering piston in mm.
 - **Loaded powder**: name of the powder. Corresponds to the value set in the **Configuration** menu (see section "Configuration" on page 47).
- LASER/OPTIC
 - **Defocus**: defocusing value in mm (relative position of the sintering piston compare to the zero sintering position),
 - **Laser power**: current Laser power, in %.

User level selection

The **User Level Selection** gives access to other more advanced users and/or service tasks, grouped into 5 levels. All user levels (except **Operator** level) are restricted by access code.



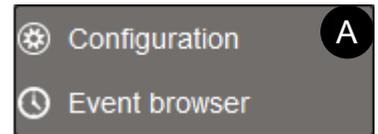
Icon	Description
	Operator level: first user level including a printer preparation wizard, showing the step-by-step instructions on how to prepare/to start a job and to remove the built part when job complete.
	Adjuster level: dedicated to advanced user - no printer preparation wizard. Access to the process settings with read/write and read-only access (see appendix, reference 9000938N00).
	Maintainer level: dedicated to special servicing procedures. Access to Adjuster level menus (with additional features and additional read/write access) + to the maintenance tool
	Expert level: total access to the settings and to the Expert tool
	Administrator level: reserved

Setting menu

The **Setting menu** gives access to 2 sub-menus: **Configuration** (see page 47) and **Event browser** (see page 50).

Proceed the following steps to access to them:

1. Click on the **Setting menu** button.
2. Select the desired sub-menu (A).

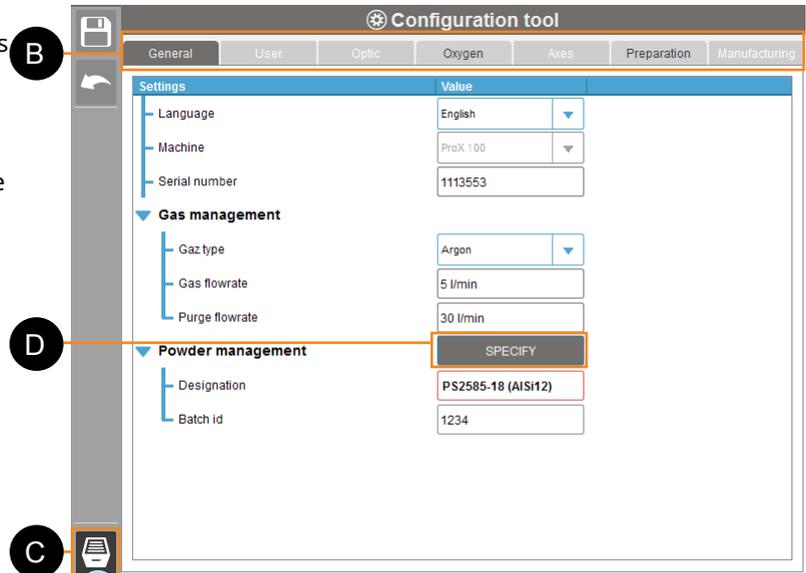


Configuration

The **Configuration** tool includes different parameters grouped in 7 tabs (B).

Only the tabs described further below are unlocked, the access to other tabs require higher user level (see "User level selection" on page 46).

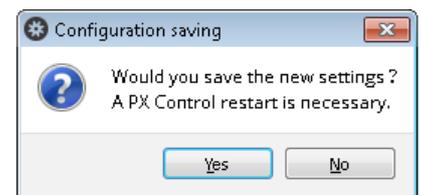
The extracting button (C) exports in one step all files related to specific folders (such as ConfigFiles, Sequences...). This function is intended to create an image of these specific folders, and do not affect the system operation.



Editing value

For each tab, the read-only values are displayed in grey, the editable values are displayed in black with the blue border. To change the settings, proceed as follow:

1. Click on the value.
2. Select or enter the new setting.
3. After modification, the new value is shown in red. Click on  to save the modifications, or  to cancel.
4. Some modifications require the software control to be restarted. Refer to the section "Closing / opening PX Control application" on page 68.



Tabs description

• General tab

This tab summarizes global parameters associated to the machine:

• Settings

Language: select the navigation language of the software (English/French)

Machine: specify the machine model (i.e ProX DMP100)

Serial number: indicate the serial number indicated on the name plate of the printer



The following settings will allow to indicate the gas type and the powder type. These settings will be displayed/retrieved by other menus (Manufacturing menu, manufacturing report...) and be used to calculate gas consumption (on Machine Status menu). Make sure to set them correctly before each printing job.

- **Gas management**

Gas type: choose, from the list, the inert gas used to create the inert atmosphere in the manufacturing chamber.



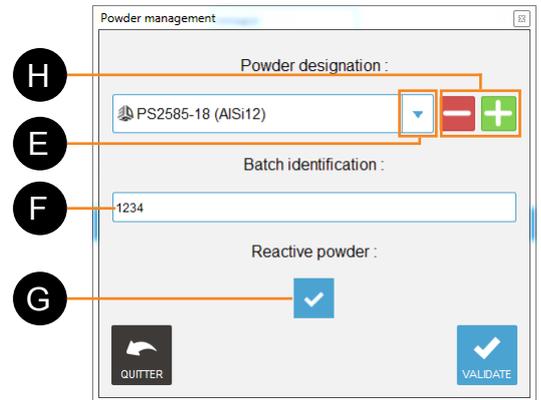
Argon is recommended and is required for all reactive materials such as Titanium and Aluminum. Nitrogen can be used for non-reactive material such as Steel.

Gas / Purge flowrates: indicate the values assigned on the corresponding flow sensors of the printer (see section "Preventive maintenance schedule" on page 78).

- **Powder management**

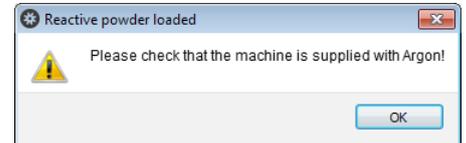
Name: Powder used during the printing job. To edit this field:

1. Click on **Specify** (D),
2. The "Powder Management" window displays (see adjacent figure).
3. Select the powder from the list (E).
4. Type the batch number (F).
5. Tick the *Reactive powder* box if the selected powder is a reactive powder (G).
6. Click **Validate** to confirm, or **Quit** to cancel.

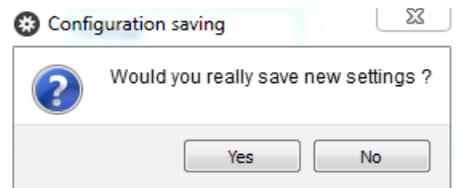


The 3DSystems materials are preceded by the 3DSystems logo.

If the *Reactive powder* box has been selected, the following message will alert to make sure the printer is supplied with required gas. Click OK to confirm.



Any modification on the "Powder Management" window requires a configuration saving.

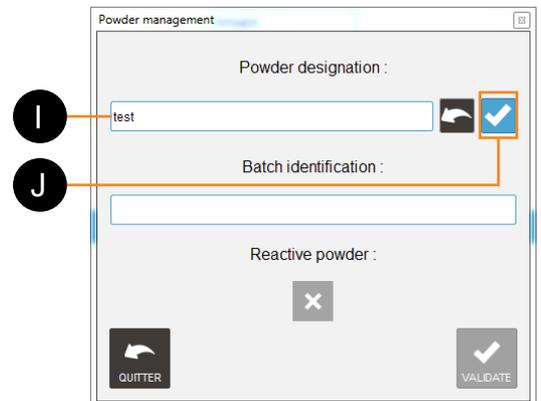


To add a powder on the list:

1. Click on the "+" button (H),
2. Type the name (I),
3. Click on the **Validate** button (J),

To remove a powder from the list:

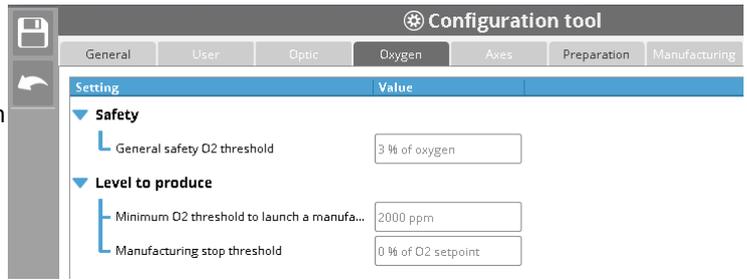
1. Select the powder from the list (E).
2. Click on the "-" button (H).



- **Oxygen tab**

This tab indicates the settings related to the oxygen value:

- **General safety O2 threshold:** this setting value is an absolute percentage of oxygen. The manufacturing will stop immediately if the oxygen value is upper than this setting. If the setting is null, this function is disabled.
- **Minimum O2 threshold to launch a manufacturing:** it defines the minimum value of oxygen to produce. If oxygen value is upper the setting, starting a job is not permitted for **Operator** level and is permitted for other levels (a warning message will be displayed in such case).
- **Manufacturing stop threshold:** this setting value is a percentage relative to the oxygen set point. The manufacturing will stop at the end of the layer if the oxygen value is upper than this setting. If the setting is null, this function is disabled.

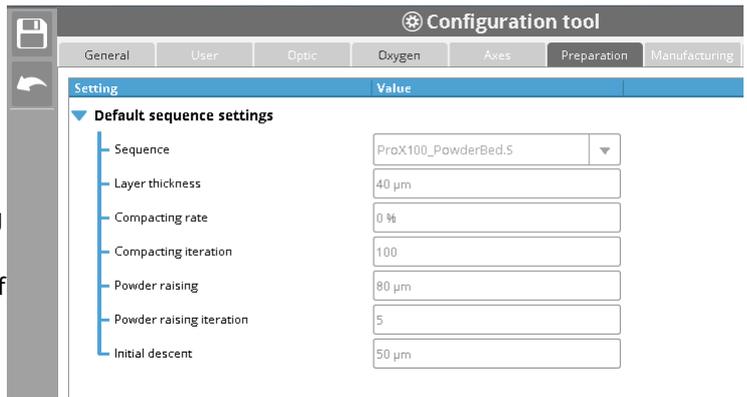


The values are read-only. Editing these values requires higher access privilege (see "User level selection" on page 46).

- **Preparation tab**

This tab shows the default settings related to the layering sequence during the preparation cycle (see section "Creating the powder bed" on page 60):

- **Sequence:** name of the layering sequence used.
- **Layer thickness:** thickness of the layers (in μm).
- **Compacting rate:** percentage of the layer thickness added to the layer thickness.
- **Compacting iteration:** no longer used.
- **Powder raising:** value of the feeding piston rising for each layer (in μm).
- **Powder raising iteration:** number of iterations of the loop in the layering sequence.
- **Initial descent:** value of the first movement (relative position) of the sintering piston. Determine the positions values of the sintering piston for the iteration scraping (in μm).



The values are read-only. Editing these values requires higher access privilege (see "User level selection" on page 46).

Event browser

The **Event browser** tool is composed of 4 tabs:

- **Version tab**

It lists the different software versions and when they have been installed.

Event browser tool				
Version	Manufacturing tracking	Monitoring	Event viewer	
Installation date	PX Control	Driver	PLC	System manager
23/11/2016 11:41 (current)	2.1.2.1	2.0.8.0	2.1.2.1	
09/11/2016 16:50	2.1.2.1	2.0.8.0	2.1.2.1	
04/10/2016 14:25	2.1.2.1	2.0.8.0	2.1.2.1	1.6.2.3.0
30/09/2016 11:58	2.1.2.1	2.0.8.0	2.1.2.1	
14/09/2016 16:39	2.1.2.1	2.0.8.0	2.1.2.1	1.5.2.3.0

- **Manufacturing tracking tab**

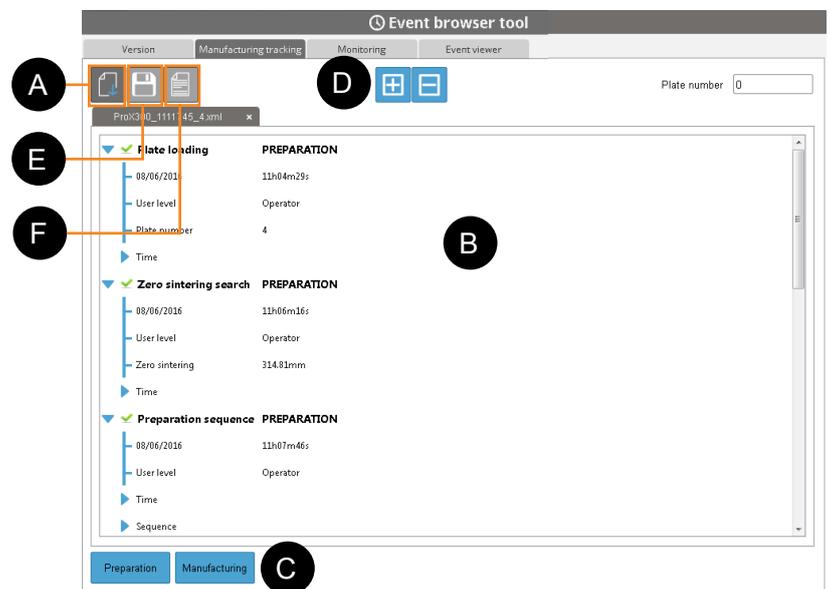
Each event occurred during a preparation or a job is traced and stored on a tracking file. Each time a new sintering plate is loaded into the printer, a tracking file is created. As long as a tracking file is existing on the printer, it can be viewed and exported.

When the plate is unloaded, its tracking plate file will be closed.

The format of the tracking file is ".xml", and is composed by: *PrinterType_SerialNumber_PlateNumber*

- Printer type (e.g ProX DMP100)
- Serial number (e.g 1122333)
- Plate number: the number entered during the plate loading (see section "Step 4 : Zero sintering" on page 36) is linked to the name of the corresponding tracking file

1. Click on the "Open file" button to open a tracking file (A).
2. Select the desired tracking file from the list.
3. All corresponding events will be indicated on the information area (B).
4. Optional: use the "Information filter" (C) to select an event type (Preparation or Manufacturing).
5. Optional: use the "+" or "-" buttons (D) to directly open/close all navigation trees.
6. Export functions (E): to export the tracking file ("csv", "xml" or "pdf" formats).
7. The export button (F) creates a manufacturing report in "pdf" format (see example "Manufacturing report" on page 51).



- Manufacturing report

Manufacturing report
File name :80u essai 2
Plate number : 0

Machine

Type :	ProX100
Serial number :	1111745
Total timer :	125h17m02s

File

Number of objects selected :	17
Database :	ProX100_ST2709B_C03.db
Material :	ST2709B
Estimated volume (mm ³) :	14066

Production

Start date :	04/07/2016 16h13m48s
End date :	04/07/2016 16h22m44s
Start height (mm) :	0
End height (mm) :	0.4
Total duration :	0h08m04s
Layering duration :	
Sintering duration :	

Atmosphere

Oxygen setpoint (ppm) :	1000
Available powder (mm) :	390.40
Gas injection mode :	
Lens cleaner setpoint (%) :	0

Sintering settings

Sequence name :	ProX100_MC_ST2709B_40um_B02.S
Layer thickness (µm) :	40
Powder raising (µm) :	55
Initial descent (µm) :	60

ID	Object	Sintering time	Zmin (mm)	Zmax (mm)	Volume (mm ³)	Done
0	H	00h00m00s	0.00	0.08	0	OK
1	Cube (#1)	00h00m00s	0.00	10.00	2250	OK
2	Cube (#2)	00h00m00s	0.00	10.00	2250	OK
3	Cube (#3)	00h00m00s	0.00	10.00	2250	OK
4	Cube (#4)	00h00m00s	0.00	10.00	2250	OK
5	Cube (#5)	00h00m00s	0.00	10.00	2250	OK
6	Cube (#6)	00h00m00s	0.00	10.00	2250	OK
7	Cube (#7)	00h00m00s	0.00	10.00	2250	OK
8	Cube (#8)	00h00m00s	0.00	10.00	2250	OK
9	Cube (#9)	00h00m00s	0.00	10.00	2250	OK
10	Cube (#10)	00h00m00s	0.00	10.00	2250	OK
11	Cube (#11)	00h00m00s	0.00	10.00	2250	OK
12	Cube (#12)	00h00m00s	0.00	10.00	2250	OK
13	Cube (#13)	00h00m00s	0.00	10.00	2250	OK
14	Cube (#14)	00h00m00s	0.00	10.00	2250	OK
15	1-_A_-_US_1 (repaired)	00h00m00s	5.00	12.36	164	OK
16	1-_A_-_US_1 (repaired)_Grilles Rapides	00h00m00s	0.00	6.05	35	OK
ID	Object	Sintering time	Zmin (mm)	Zmax (mm)	Volume (mm ³)	Done

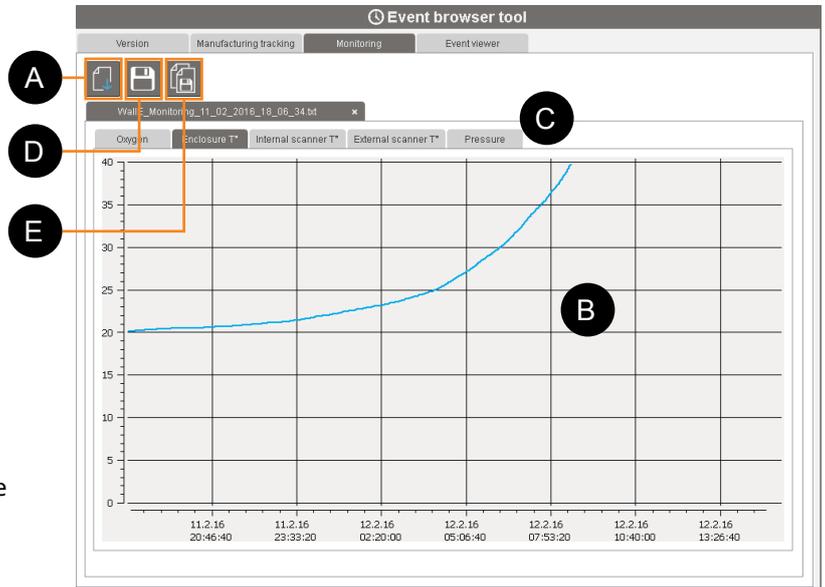
Monitoring tab

Oxygen, enclosure temperature, external scannerhead temperature and enclosure pressure are traced and stored on a tracking file. Each time a new job starts in automatic mode (see section "Manufacturing menu" on page 42), a monitoring file is created. As long as a monitoring file is existing on the printer, it can be viewed and exported.

When the job is complete, its monitoring file is closed.

The format of the monitoring file is ".xml", and is composed by: *NameOfFABFile_Monitoring_Date(Day_Month_Year)_Time(Hour_Minute_Second)*.

1. Click on the "Open file" button to open a monitoring file (A).
2. Select the desired monitoring file from the list.
3. The recordings will be indicated on the information area (B), and grouped within corresponding tab (C).
4. Optional: to export individually each recording ("csv" or "xml" formats), click on the "Export" button (D). The selected tab will then be exported on the location you have specified.
5. Optional: to export all trackings files ("csv" format), click on the "Export" button (E). The tracking files existing on the printer will then be exported on the location you have specified.



When starting a purge, a similar tracking file is automatically created. The name of the corresponding tracking file is similar, apart from the *NameOfFABFile* which is replaced by *Purge*.

Event viewer tab

This tab displays all the operations done on the machine (1), even if there is no plate loaded.

By default, only the events of the current month are displayed. Use the arrows buttons (2) to display the events occure previously.

To lighten the display, use the filters (3) according:

- Event type (Information, Warnings or Errors).
- Operation type (Preparation, Manufacturing, Action).
- Date.

Date	Time	Type	Description
07/11/2016	11h43m35s	PREPARATION	Inerting
07/11/2016	18h58m30s	MANUFACTURING	Warning
07/11/2016	18h58m52s	MANUFACTURING	Warning
07/11/2016	18h59m24s	MANUFACTURING	Step by step
07/11/2016	18h59m50s	ACTION	
07/11/2016	19h00m10s	MANUFACTURING	Warning
07/11/2016	19h00m53s	MANUFACTURING	Step by step
07/11/2016	19h00m58s	MANUFACTURING	Warning
07/11/2016	19h01m11s	MANUFACTURING	Warning
07/11/2016	19h01m49s	MANUFACTURING	Step by step
07/11/2016	19h02m21s	MANUFACTURING	Warning
07/11/2016	19h03m16s	MANUFACTURING	Step by step
08/11/2016	13h43m38s	MANUFACTURING	Step by step
08/11/2016	13h45m07s	MANUFACTURING	Warning

When an event is selected, the corresponding details can be displayed by clicking on the button. Click on "Quit" to close the Event details.

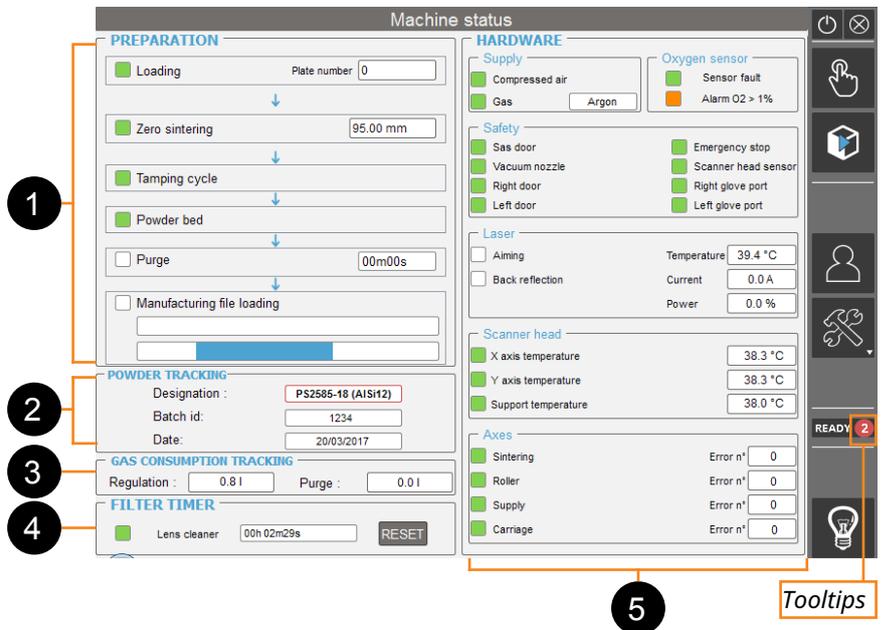
Time	Type	Description
07/11/2016 18h58m52s	MANUFACTURING	Warning
User level	Administrator	
Warning description	Lens cleaner is restarting...	
Time		
Total machine timer	2h00m22s	
Manufacturing duration	0h00m00s	
Environnement		
Oxygen value	3ppm	
Temperature	0°C	

Machine Status menu

READY

This menu displays a global view of the status of the printer. It consists of 5 parts described below.

The access button can also display a warning tooltip 5 (for more detail, please refer on the last paragraph of this section).



1 PREPARATION

Are listed the different operations of the machine preparation. For each operations, it shows if the process is complete (green light) or not (no light), and it indicates the related information when applicable (values will be displayed/will start when the corresponding operation occurs, and will be updated/reset during the next cycle).

2 POWDER TRACKING

Display information relating to the powder management (powder name, batch number). Values are based on settings from the **Configuration** menu (see section "Configuration" on page 47). The field *Date* indicates when the powder management feature has been set.



The border frame color of the powder name will be red if the powder type has been set as a reactive powder.

3 GAS CONSUMPTION TRACKING

Display gas consumption (during building job and purge). The consumption values will be reset during the next building plate loading, and are based on the flowrates set on the **Configuration** menu (see section "Configuration" on page 47).

4 FILTER TIMER

This area indicates the following information for the Process filter:

- Status of the filter operating hours:
 - Green light: operating hours < 90% of the recommended filter replacement
 - Orange light (caution): operating hours > 90% and < 100% of the recommended filter replacement
 - Red light (warning): operating hours > 100% of the recommended filter replacement
- Value of the current operating hours.



The timer must be reset after the Process filter replacement by clicking on the "Reset" button. Please refer to corresponding procedure on the Maintenance section from page 71.

5 HARDWARE

Display the status of components and alarms (green light = OK, yellow light = activated, orange light = caution, red light = fault/warning):

- **Supply:**
 - status of various power supplies of the machine (compressed air supply, gas supply),
 - the gas type (corresponds to the value set in the **Configuration** menu (see section "Configuration" on page 47)).
- **Oxygen sensor:**
 - status of the oxygen sensor,
 - status of the oxygen alarm: orange light if oxygen level measured by the sensor is higher than the required level.
- **Safety:**
 - status of the safety of the machine and interlocks states (open, locked) that can block a movement or a manufacturing start,
- **Laser:**
 - status of the laser (aiming, back reflection) and operating values (temperature, current and power).
- **Scanner head:** state of the thermo-couples, and the temperature values,
- **Axes:** indicates the state of the 4 motors, with the corresponding error code.

Warning tooltip (encircled number)



Displayed only if one of the followings occurs. It indicates the number of:

- orange lights activated of the filter timers: the corresponding number is displayed with orange background.
- red lights activated of the filter timers or any sensor fault: the corresponding total number is displayed with red background.

If both colors occur, the red one is only displayed.

If none of them occur, the tooltip is not displayed.

MACHINE PREPARATION

Introduction

In order to keep an inert atmosphere inside the manufacturing chamber, the operator needs to use the glove doors across the attached gloves for all manipulation inside the manufacturing area. The glove doors are located behind the front doors, as well as the airlock door.



Caution : always use appropriate safety equipment when operating the printer. Personal Protective Equipment (PPE) must be used to protect the user against health or safety risks during working tasks. Wear disposable rubber gloves, anti-static coverall, anti-static safety shoes and safety glass. Wear disposable dust mask rated FFP3 or N99 level protection at minimum ; we recommend the use of powered air-purifying respirator.

• Front doors

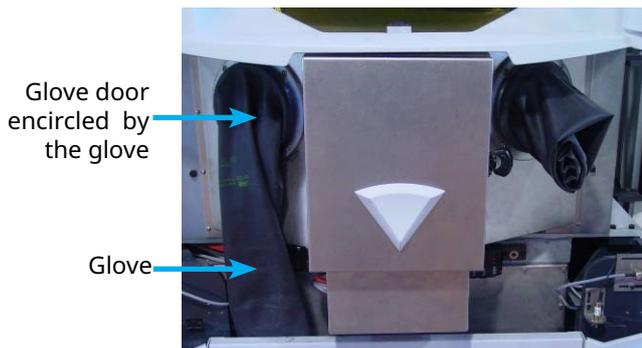
To open the front doors, the operator must at first unlock by pressing the key button from the control panel (see "External control panel" on page 27).



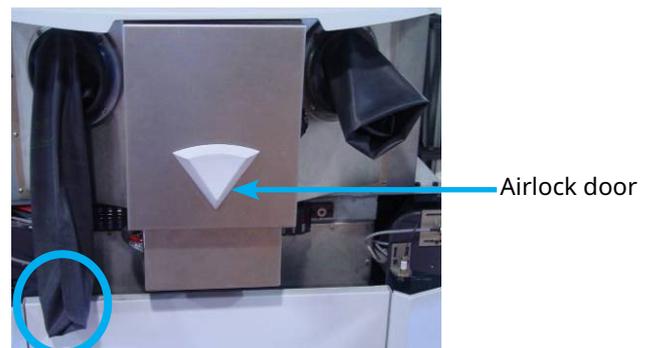
If the sensor does not detect the well closing of the front doors, the printer will be in "UNLOCK" mode (see "User interface" on page 33) as long as the front doors will not be closed. Make sure to close the front doors so that the printer will be in "READY" mode (i.e operational).



Caution: do not close the front doors on the gloves, this may damage the gloves. The gloves must be checked regularly. Consult the Maintenance section for the recommended maintenance interval and details on how to check the gloves.



Good gloves position before front doors closure.



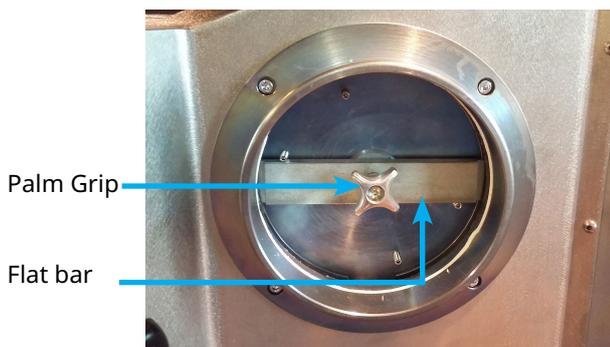
Wrong gloves position before front doors closure.

• Glove doors

To describe the opening/closing mechanism of the glove doors, the gloves have been removed on the following figures.

In normal operation, the opening/closing of the glove doors must be performed **with the gloves**.

- To open the glove door, rotate the Palm Grip in a counterclockwise direction, then rotate the Flat Bar a quarter-turn. The glove doors are opening towards the inside of the chamber. The position of the Flat Bar are used to detect the well closing of the glove doors.

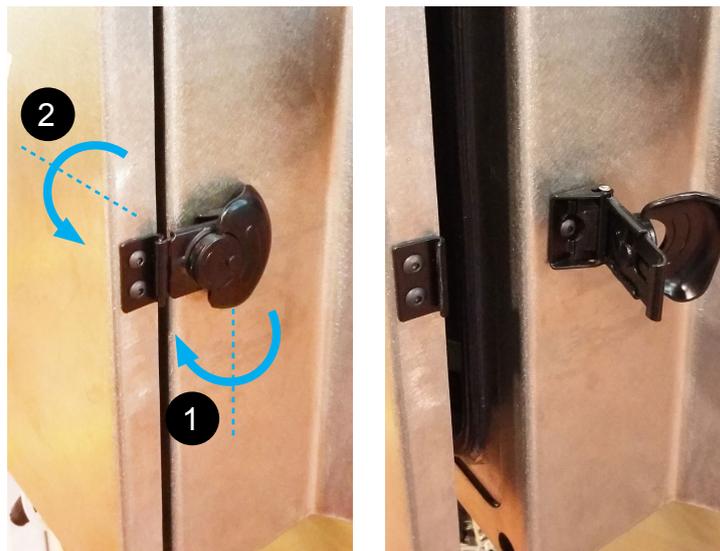


- To close the glove door, make sure the Flat Bar is placed at first vertically. Then fully close the glove door, and place the Flat Bar horizontally (as shown on the left figure). Make sure to tighten securely the Palm Grip while the Flat Bar is placed horizontally.

- **Airlock door**

To access to the airlock door, the front doors must be opened.

The mechanism to open/close the door is a quarter-turn lock system.



Airlock door closed and locked.

Airlock door unlocked and opened.

- **Airlock positions**

The airlock (or sas) is controlled from the screen control panel, as per the following:

OPEN = airlock facing the operator side,
CLOSE = airlock facing the chamber side.

- **Tool required**

- A natural fiber brush for the cleaning process,
- A 4mm hex key wrench,
- 4 socket head screws (M5x12), to fix the sintering plate on the sintering piston.



Sintering plate preparation and loading

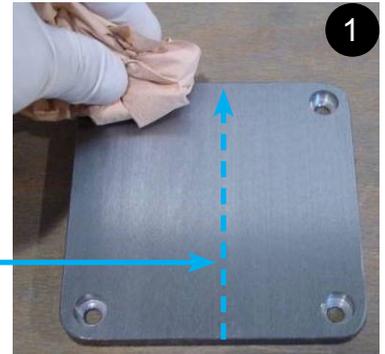
Operations described below complement and follow on from the Preparation Assistant "Step 3 : Plate loading" on page 36.

1. Soak a paper towel with degreaser.
2. Clean both surfaces of the sintering plate with paper towels soaked in degreaser.



To avoid leaving towel residues on the sintering plate, clean it in the grinding lines direction.

Grinding lines

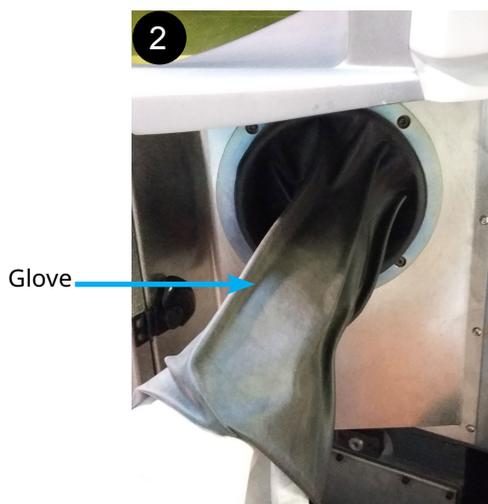


3. Protect the plate against dust by wrapping in paper towel soaked in degreaser.
4. Start the **Plate loading** cycle on the control panel (see "Step 3 : Plate loading" on page 36).



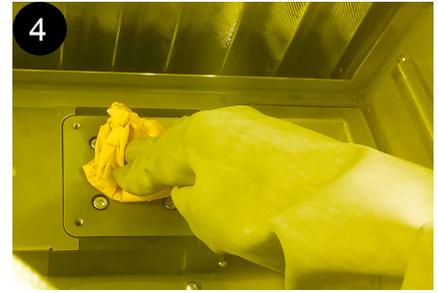
The following steps are displayed on the corresponding cycle.

5. The following automatic cycles are performed:
 - the sintering piston rises,
 - the airlock rotates to OPEN position.
6. Unlock the front doors of the printer and open them (refer to section "Introduction" on page 55).
7. Open the airlock door (refer to section "Introduction" on page 55).
8. Put the sintering plate, the M5x12 screws and the hex key wrench on the airlock.
9. Close the airlock door.
10. Only for powders oxidizable materials, purge the airlock for 5 minutes by using the screen control panel.
11. Rotate the airlock to CLOSE position (refer to section "Introduction" on page 55).
12. Put on gloves (2) and open glove doors (3) (refer to section "Introduction" on page 55).



13. Remove the paper towel (used to protect the sintering plate) from the airlock.

14. Clean the sintering piston head with the paper towel (4).



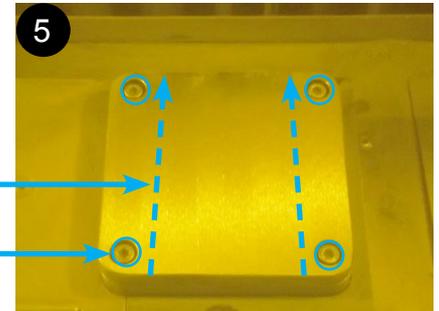
15. Place the sintering plate on the sintering piston (5), and fix it by tightening crosswise the M5x12 screws.



Make sure to position the sintering plate so that the grinding lines are on the same direction than the operator (i.e parallel to the carriage).

Grinding lines

Fixing screw



- 16. Put the hex key wrench and towels on the airlock.
- 17. Close the glove doors and remove hands from the gloves.
- 18. Rotate the airlock to OPEN position.
- 19. Open the airlock door and empty it.
- 20. Close the airlock door.
- 21. Close the front doors.

Zero sintering search

Operations described below complement and follow on from the Preparation Assistant "Step 4 : Zero sintering" on page 36.

The zero research is performed with the roller. Please ensure :



The sintering plate must be clean. No dust must be located on its surface. The roller should not get in touch with any powder during this cycle. Make sure to keep a clean area as described on the section "Unloading a plate" on page 64.

- 1. Check the sintering plate is clean.
- 2. Start the **Zero sintering** cycle on the control panel (see "Step 4 : Zero sintering" on page 36).
- 3. The zero sintering value will then be displayed.

Loading the feeding piston

Operations described below complement and follow on from the Preparation Assistant "Step 5 : Powder loading" on page 37.



WARNING: REACTIVE POWDERS

THE MANUFACTURING CHAMBER MUST BE INERT BEFORE POWDER MANIPULATION (O₂ LEVEL 1% MAXIMUM).

Before the first use of metal powder, ensure absence of humidity in the powder, which would affect its flow. That is why sifting and oven drying are strongly recommended.

Implement the following operations :

- Sieve the fresh powder once,
- Place the fresh powder into a large tray in order to obtain a thin layer (maximum 4cm),
- Place the tray in the oven at 70°C for 24 hours, in order to dry the powder out completely. As a good practice, shake the powder delicately from time to time in order to speed up the process of moisture loss,
- Sieve the powder again.



WARNING: REACTIVE POWDERS

DO NOT HEAT THE POWDER IN CASE THE OVEN IS NOT INERT. FLAMMABLE POWDERS ARE PROVIDED IN SEALED INERT PACKAGING FREE OF HUMIDITY.

1. Start the **Powder loading** cycle on the control panel (see "Step 5 : Powder loading" on page 37).



The following steps are displayed on the corresponding cycle.

2. Position the feeding piston by using the corresponding button from the screen control panel. Make sure there is enough material to complete the job. To get the amount of material needed to have a successful build, use the formula= (Total layers) x (Powder raising during manufacturing). Values are accessible with the Adjuster level, see section "User level selection" on page 46).
3. Unlock the front doors of the printer and open them.
4. Rotate the airlock to OPEN position.
5. Open the airlock door.
6. Put the powder can in the airlock (1).
7. Close the airlock door.
8. Only for powders oxidizable materials, purge the airlock for 5 minutes.
9. Rotate the airlock to "CLOSE" position.
10. Put on gloves and open glove doors.
11. Take the powder can from the airlock, then fill it into the feeding piston (2).



Put half a powder container maximum when filling the feeding piston.



The amount of powder after filling the feeding piston must not exceed the height of the horizontal grooves from the feeding piston liner, to not prevent the implementation of the compacting unit.

12. Close the glove doors and remove hands from the gloves.
13. Rotate the airlock to "OPEN" position.
14. Open the airlock door.
15. Empty the airlock.
16. Close the airlock door.
17. Rotate the airlock to "CLOSE" position.
18. Close the front doors.
19. Start the **Tamping** cycle.
20. When tamping complete, unlock the front doors to fill more powder on the feeding piston (i.e repeat from step 3), or proceed to next step.



For best powder compaction, compact a powder container twice (put half a powder container, run compaction, then put the second half and then run the compaction again).

Creating the powder bed

Operations described below complement and follow on from the Preparation Assistant "Step 6 : Powder bed" on page 37.

1. Start the **Powder bed** cycle on the control panel (see "Step 6 : Powder bed" on page 37).



The following steps are displayed on the corresponding cycle.

2. Check the proper completion of the powder bed sequence (3):
 - Gaps must be filled,
 - Powder must properly cover the area between the two pistons,
 - Powder must be well smoothed on the feeding piston,
 - Plate must be visible in transparency and the screws must be filled with powder, to not disturb the layers during manufacturing.



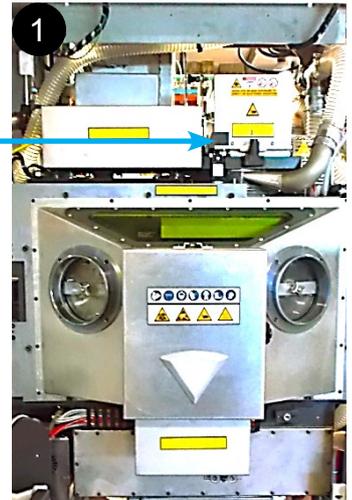
3. If the powder bed is not properly completed, re-run the powder bed cycle. Proceed the next section only if the powder bed cycle is properly completed.

Cleaning the laser optic system

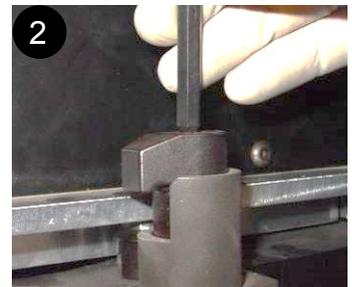
Operations described below complement and follow on from the Preparation Assistant "Step 7 : Lens cleaning" on page 38.

1. Check the lens cleaner blower is OFF.
2. Open the front doors, then lift the top skin up (1).

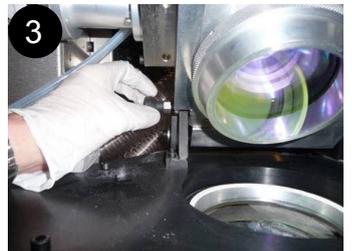
Access to the scan head



3. Unlock the clamp that holds the head in position with the use of Allen key.
4. Rotate the clamp a quarter turn in the anti-clockwise direction (2).



5. Tilt the head back until it locks into position (3).



6. Use the aerosol to clean any large dust particles off the lens (4).



- Hold the aerosol as upright as possible without shaking it.
- Spray the aerosol once into free air in order to clear the gas tube of any dust that could damage the lens.
- Avoid touching the lens with the spray nozzle.



7. Soak slightly an optical paper towel in optical cleaning fluid.

The *Sigma-Aldrich* fluid (producer product number 02856) is recommended.

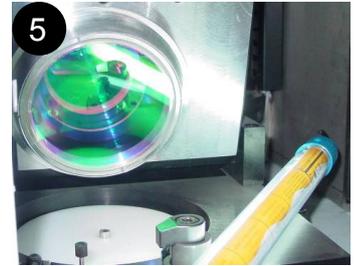
Optical cleaning fluid ingredients:



- **Quality:** absolute ethanol, denaturated with 4.8% isopropanol
- **Grade:** Purum
- **Assay:** $\geq 99.8\%$ (based on denaturant-free substance)

8. Holding the optical paper towel by both ends, wipe the towel over the lens from the top to the bottom.
9. Use the clean air aerosol to blow away any dusts.

10. Use a lamp to observe the lens in order to check for any traces of dirt (5).

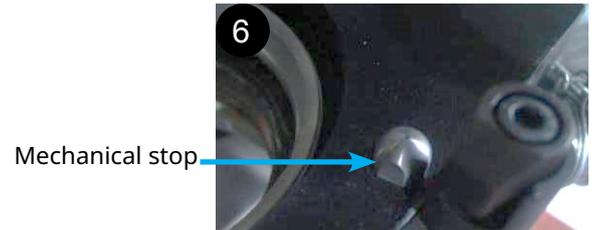


11. Repeat these steps until the lens is clean.

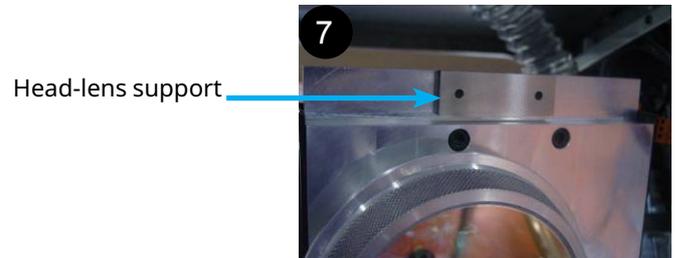


Caution: comply with the following steps in order to ensure the correct positioning of the head after opening.

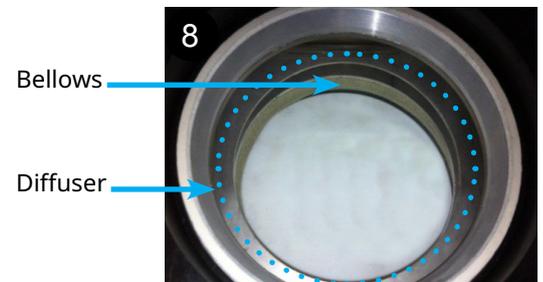
12. Make sure the mechanical stop is clean (6).



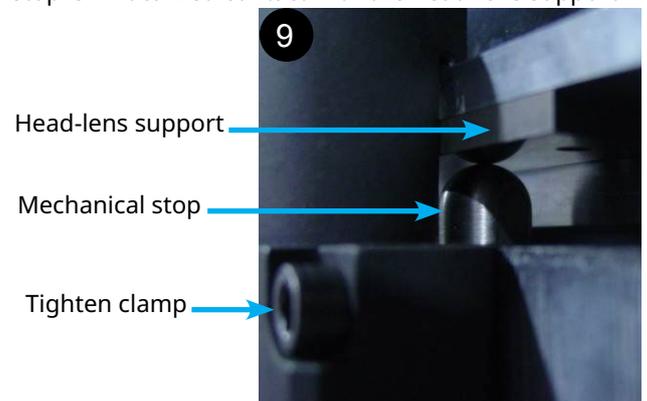
13. Make sure the head-lens support contact is clean (7).



14. Ensure the cleanliness of the bellows and the lens cleaner diffuser (8).



15. Close the head-lens assembly, making sure that the mechanical stop is in localized contact with the head-lens support (9).



16. Tighten the assembly (9).



Excessive tightening could damage the localized contact.

Inerting the manufacturing chamber

The machine needs a gas to create an inert atmosphere in the manufacturing chamber. This cover gas inhibits any potential rapid combustion of particulate matter during the process.

The inerting is required for oxidizable or flammable materials, and for better build quality.



The inerting process must follow the 2 phases in this order: manufacturing chamber inerting at first, then process filter inerting. Do not activate the lens cleaner blower if the process filter is not connected to the printer. Make sure the filter is well connected to the printer before starting the inerting process.

Enclosure inerting

Start inerting

Minimum oxygen value to produce 2000 ppm Start inerting

Current oxygen value 5,0 %

Start the lens cleaner turbine

Fumes safety O2 value 10000 ppm Pressure 0 mbar Start the lens cleaner turbine

To perform the inerting, follow the instructions of the Preparation Assistant "Step 8 : Loading of the manufacturing file and inerting" on page 40.



The start of manufacturing shall be carried out only when the oxygen level is below the required value. Refer to the Adjuster User Level appendix (see "User level selection" on page 46) for details.

START A MANUFACTURING PROCESS



WARNING: THE MANUFACTURING CHAMBER AND PROCESS FILTER MUST BE INERTED BEFORE STARTING ANY JOB. REFER TO SECTION "INERTING THE MANUFACTURING CHAMBER" ON PAGE 63.

Operations described below complement instructions from the "Manufacturing menu" on page 42.

When all the steps of the machine preparation have been completed, the start procedure of a job is as follows:

- Run the sintering of layer #0 (the layering of layer #0 has been established during the step "Creating the powder bed" on page 60).
- Run the layering of layer #1. Repeat this operation if the layer obtained is not correct (lack of powder for example).
- Run the sintering of layer #1.
- Run the layering of layer #2. Repeat this operation if the layer obtained is not correct (lack of powder for example).
- Continue step by step as described above, up to layer #5.
- If all five layers completed successfully on the first try, then start the full manufacturing in automatic mode.



Make sure that during the first 10 layers, there is no short feed.

UNLOADING A PLATE

Introduction



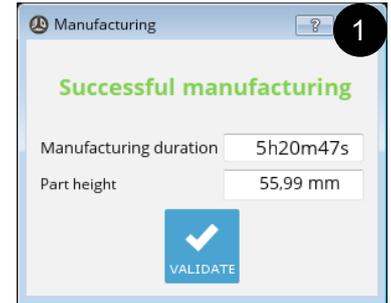
Caution : always use appropriate safety equipment when operating the printer. Personal Protective Equipment (PPE) must be used to protect the user against health or safety risks during working tasks. Wear disposable rubber gloves, anti-static coverall, anti-static safety shoes and safety glass. Wear disposable dust mask rated FFP3 or N99 level protection at minimum ; we recommend the use of powered air-purifying respirator.



WARNING : REACTIVE POWDER

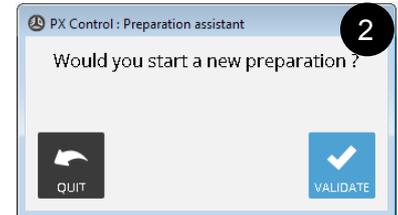
THE MANUFACTURING CHAMBER MUST BE INERT BEFORE POWDER MANIPULATION (O₂ LEVEL 1% MAXIMUM).

1. When a job is complete, the control panel will display the job time and the part height. Proceed as indicated below:
 - Click on **Validate** to quit the end job window (1).



2. The plate unloading is performed through the **Plate Unloading** cycle, corresponding to the step 2 of the **Preparation Assistant**. Proceed as indicated below:

- Click on the **Preparation Menu** button .
- Click on **Validate** to confirm (2).
- Follow the Preparation Assistant up to the step#2 **Plate Unloading**.



3. The plate unloading cycle includes the following phases:

- Sintered plate cleaning.
- Manufacturing chamber cleaning.
- Powder cans removal.

Sintered plate cleaning

Operations described below complement and follow on from the Preparation Assistant "Step 2 : Plate unloading" on page 35.

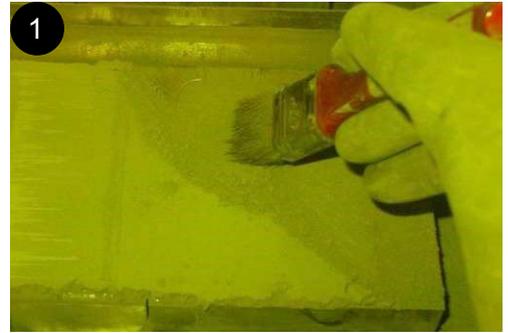
1. Start the **Plate Unloading** cycle (see "Step 2 : Plate unloading" on page 35).



The following steps are displayed on the corresponding cycle.

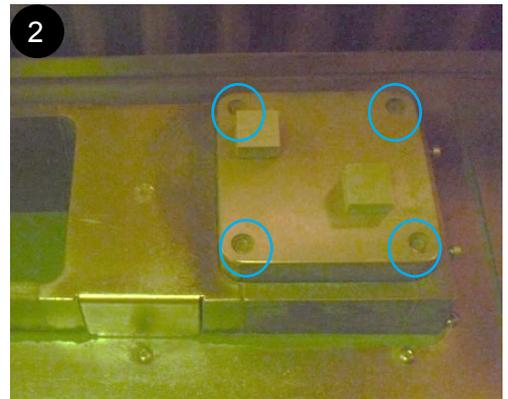
2. Automatic cycles are performed:
 - the sintering piston rises,
 - the airlock rotates to OPEN position.
3. Unlock the doors of the printer and open them.
4. Open the airlock door.
5. Put the natural fiber brush and the hex key wrench on the airlock, and close the airlock door.
6. Only for powders oxidizable materials, purge the airlock for 5 minutes, then stop the purge.
7. Rotate the airlock to CLOSE position.
8. Put the gloves and open the glove doors.

- Using the brush, remove powder between the 2 pistons, and clean the sintering plate by sweeping any unsintered powder from the left to the right (1) towards the collecting cans.



Always scoop slowly from as close as possible to the surface to avoid producing dust from material.

- Put the brush on the airlock.
- Close the glove doors and remove hands from the printer.
- Close the front doors.
- Move up the sintering piston by about 30 mm.
- Open the front doors of the machine.
- Repeat steps from 8 to 14 to continue remove the excess of powder, until the sintering plate reaches its top position.
- When sintering in top position, remove the sintering plate by unscrewing the 4xM5 screws with the use of the hex key wrench (2).

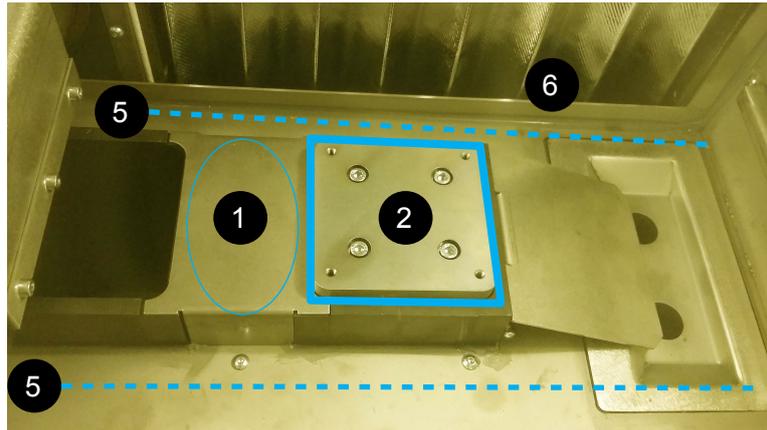


Place each screw on the airlock when removed.

- Put the sintering plate and the key wrench on the airlock.
- Close the glove doors and remove hands from the printer.
- Rotate the airlock in OPEN position.
- Open the airlock door.
- Remove the sintering plate.
- Close the airlock door.
- Proceed to the next section.

Manufacturing chamber cleaning

The aims of these following steps are to brush the unsintered powder into the collecting cans, and to get a manufacturing chamber as clean as possible, as per the following figure:



Always scoop slowly from as close as possible to the surface to avoid producing dust from material.

1. With a brush, clean the zone between the feeding piston and the sintering piston (1) so that the roller does not get dirty when searching the zero of the sintering plate at the next manufacturing run.
2. Clean the sintering piston and area around it.
3. Remove powder from the carriage (3).



4. Move the carriage up to the sintering piston, then clean the left side of the manufacturing chamber (4), sweeping the powder toward the collecting cans.



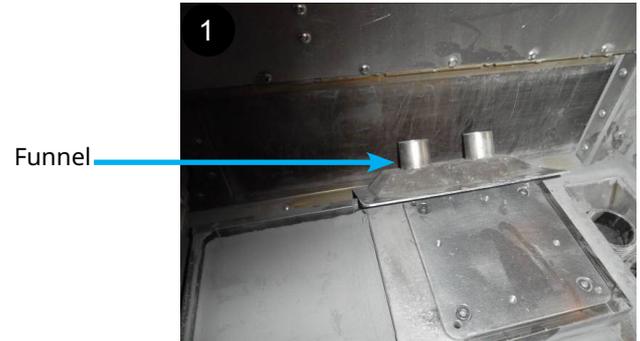
Areas to clean

5. When left side cleaning complete, move back the carriage to the left (position 0).
6. Clean the whole chamber, in front and behind the pistons (5). Brush the unsintered powder into the collecting cans. Make sure not to put powder behind the protection bellow (6).

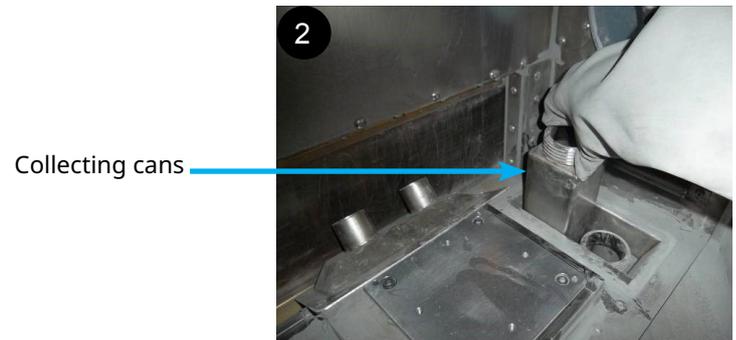
Powder collecting cans removal

The aim of these following steps is to remove the collecting cans.

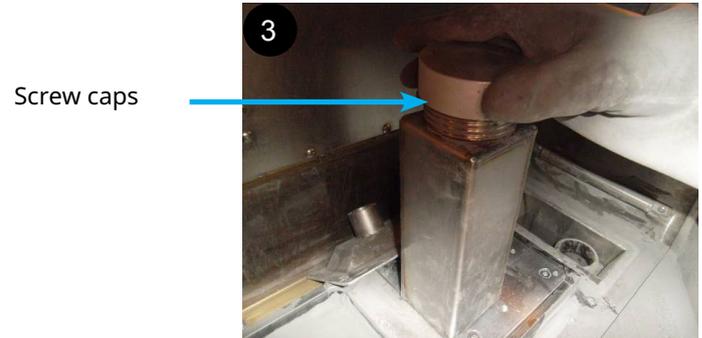
1. Rotate the airlock in OPEN position.
2. Open the front doors.
3. Open the airlock door.
4. Install the screw caps on the airlock.
5. Close the airlock door.
6. Rotate the airlock in CLOSE position.
7. Open the glove doors.
8. Remove the funnel (1) from the collecting cans location.



9. Remove the collecting cans from their location (2).



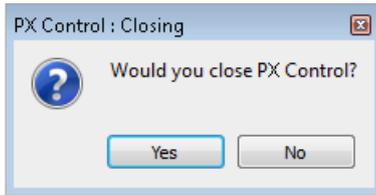
10. Close the collecting cans with their caps (3).



11. Put the collecting cans on the airlock.
12. Close the glove doors.
13. Rotate the airlock in OPEN position.
14. Open the airlock door.
15. Remove the collecting cans from the airlock.
16. Close the airlock door.
17. Close the front doors.
18. Use a sieving system to sift the usable powder for the next job.

CLOSING / OPENING PX CONTROL APPLICATION

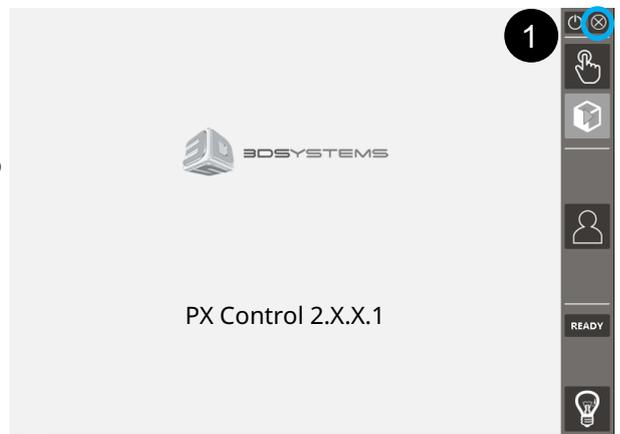
1. Click on the  button (1).
2. Click "Yes" on the "PX Control : Closing" message.



To relaunch the PX Control application, double-click on the icon  "PX_Control", from the desktop.

SHUTTING PRINTER DOWN

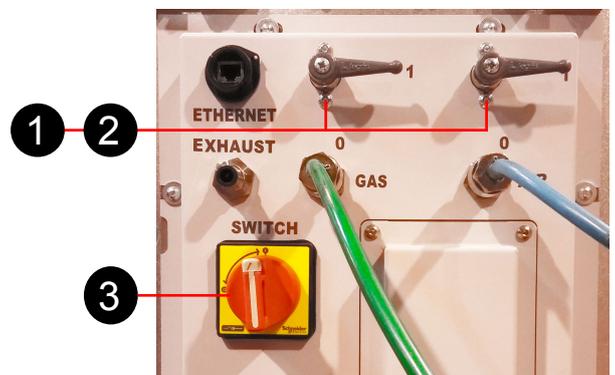
1. Click on the  button (1).
2. Click "Yes" on the "PX Control : Shutdown" message. The complete shutdown of the machine takes about 30 seconds (shutting down the system control). Then push the start button to switch off.



The shutting printer down procedure will only switch off the printer, it will not be de-energized. To de-energize the printer, refer to the section "Powering down the printer" on page 68.

POWERING DOWN THE PRINTER

1. The printer must be at first switched off (see section "Shutting printer down" on page 68).
2. Close the gas valve (1) and compressed air valve (2) located on right side of the printer.
3. Switch the locking key to position "0".
4. Turn off the main switch (3).



REASONABLY FORESEEABLE MISUSE

The DMP machine must not be used for any purposes other than metal powder sintering.

Do not operate the machine outside the limits of operation of the machine (building volume, supply pressure...).

These are typical examples of machine misuse:

CYCLE	DESCRIPTION
Building process	Do not start a job while warning message(s) is (are) still activated (see section "Manufacturing menu" on page 42). Do not start a job without cleaning the lens, or at least, controlling its cleanliness.
At anytime	Do not start the lens cleaner blower while the process filter is not connected to the printer. Do not try to open the front doors without pressing the key button at first (see section "Machine preparation" on page 55). Do not move the carriage while any other object is present in the manufacturing chamber. Do not fill the feeding piston with material without compacting several times. This may result in bad compacting, thus short feeding hazard during the layerings.
Maintenance	Do not confirm the lens filter replacement warning message without actually replacing the filter. The level of filter clogging impacts the quality of the sintering process.

6 USER MAINTENANCE

Described here are the servicing and preventive maintenance procedures that are required in the day to day operation of the ProX® DMP100 printer. The following safety rules are applicable for all procedures.



Caution: the machine is not allowed to run a job during a maintenance.



Caution: perform only tasks you are authorized and certified to complete.



Caution: presence of metal powder. Do not use or manipulate any material without first reading the safety datasheet (SDS) for that specific material.



Caution: Personal Protective Equipment (PPE) must be used to protect the user against health or safety risks during working tasks. Wear disposable rubber gloves (and leather gloves when using a vacuum cleaner), anti-static coverall, anti-static safety shoes and safety glass. Wear disposable dust mask rated FFP3 or N99 level protection at minimum ; we recommend the use of powered air-purifying respirator.



WARNING: FINE METAL DUST IS HIGHLY FLAMMABLE. AVOID USING ANY IGNITION SOURCE NEAR THE MACHINE (OPEN FLAME, SPARKING, ELEVATED TEMPERATURE PARTS).

SERVICING: REPLACEMENT PROCESS FILTER PROCEDURE

ITEM	SPECIFICATION	1500 HOURS
External Filter vessel	Replace	X

Process filter (external filter)

The lens cleaner filter must be changed every 1500 hours (2 months continuous 24/7 operation).

The ProX® DMP100 is equipped with a lens cleaner filtering unit that prevents fumes and dust generated by the sintering process from being deposited on the lens. If this filter becomes clogged, the gas will not flow as efficiently as it should and may result in reduced sintering quality. Moreover, the step-by-step instructions identify the potential filter replacement hazards and must be understood by the trained operators.

This procedure must be followed to ensure efficient sintering during the machine operation and also the operator's safety during maintenance. 3D Systems recommends that you execute this procedure as written and have a Class D extinguisher available when performing this procedure.



WARNING : WEAR PPE DURING HANDLING OPERATIONS (REFER TO MSDS OF MATERIAL). WEAR A NON-ELECTROSTATIC SUIT.



WARNING : RISK OF FIRE AND EXPLOSION.

THIS MAINTENANCE HAS TO BE DONE PROPERLY AND CAREFULLY. IF THIS MAINTENANCE IS NOT PROPERLY DONE, IT CAN CAUSE DAMAGE TO THE MACHINE OR THE USER. USE THE NECESSARY TOOLS AND WEAR THE CORRECT PROTECTION. THIS IS A TWO PERSON JOB.

Centering rings

There are two types of centering ring used on the disposable process filter:

- The first type is a standard centering ring that will be used for the filter replacement. 2 standard centering rings are supplied with the process filter crate, and should be stored for later use (filter replacement).
- The second type is a centering ring with stand-off tube. These rings are already mounted on the filter, one on each port of the filter.



Standard centering ring



Centering ring with stand-off tube

The inlet and outlet ports of the filter are equipped with a spring-loaded valve. When the filter is not connected to the printer, these valves keep the ports normally closed and thereby prevent air from entering the filter. The adjacent figure shows the top of the internal valve in the filter outlet port. When installed, the stand-off of the centering ring is placed directly on the locating pin of the valve.

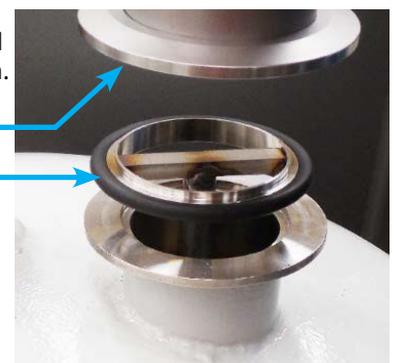
Locating pin



The external pneumatic valve is placed directly on top of the centering ring with stand-off and pressed down until the flanges meet. This creates the seal between the two parts and the centering ring with stand-off holds the spring-loaded valve open for normal operation. The connection is secured with a clamp.

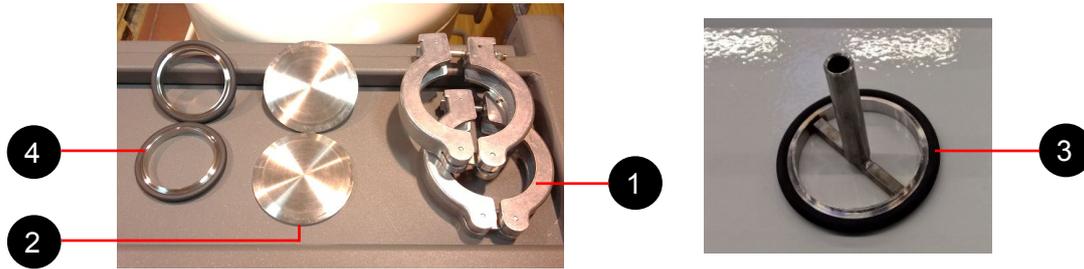
Pneumatic valve

Centering ring with stand-off tube



Parts:

- 1x kit “Disposable Process Filter” (part number : 151605), including :
 - 1x filter vessel in closed state, with closing set mounted on it: 2x clamps (1), 2x cover lids (2), 2x centering rings with stand-off (3)
 - 2x standard centering rings (4)



- ADR stickers (European Agreement concerning the International Carriage of Dangerous Goods by Road). The sticker must be applied on the filter vessel before shipping it to waste management.
 - ADR 4.2: apply when filter is full with Ti fumes
 - ADR 9: apply when filter is full with Ni or Co containing fumes
- 2x cover lids that have been kept aside during the used process filter installation. They will be used to close the filter during the replacement. The procedure will indicate to store it for later use.



Caution: the clean filter vessel is filled with argon to avoid water condensation during transportation.



WARNING: OPEN NEW FILTER VESSEL ONLY AT THE MOMENT OF CONNECTION TO MACHINE. KEEP OPEN TIME TO ABSOLUTE MINIMUM.



WARNING: ALWAYS LEAVE DIRTY FILTER VESSELS FIRMLY CLOSED AND MARK CLEARLY THAT IT CONTAINS EX AND FLAMMABLE SOLIDS AND/OR ENVIRONMENTALLY HAZARDOUS SUBSTANCES USING THE PROVIDED ADR LABELS. STORE DIRTY FILTER VESSELS IN A SAFE LOCATION WITHOUT THE RISK OF BEING DAMAGED OR OPENED BY UNAUTHORIZED PEOPLE.



WARNING: DO NOT START THE LENS CLEANER BLOWER WHILE THE PROCESS FILTER IS NOT CONNECTED TO THE PRINTER.

Tools:

- Permanent marker
- 10mm wrench
- 5mm Allen wrench

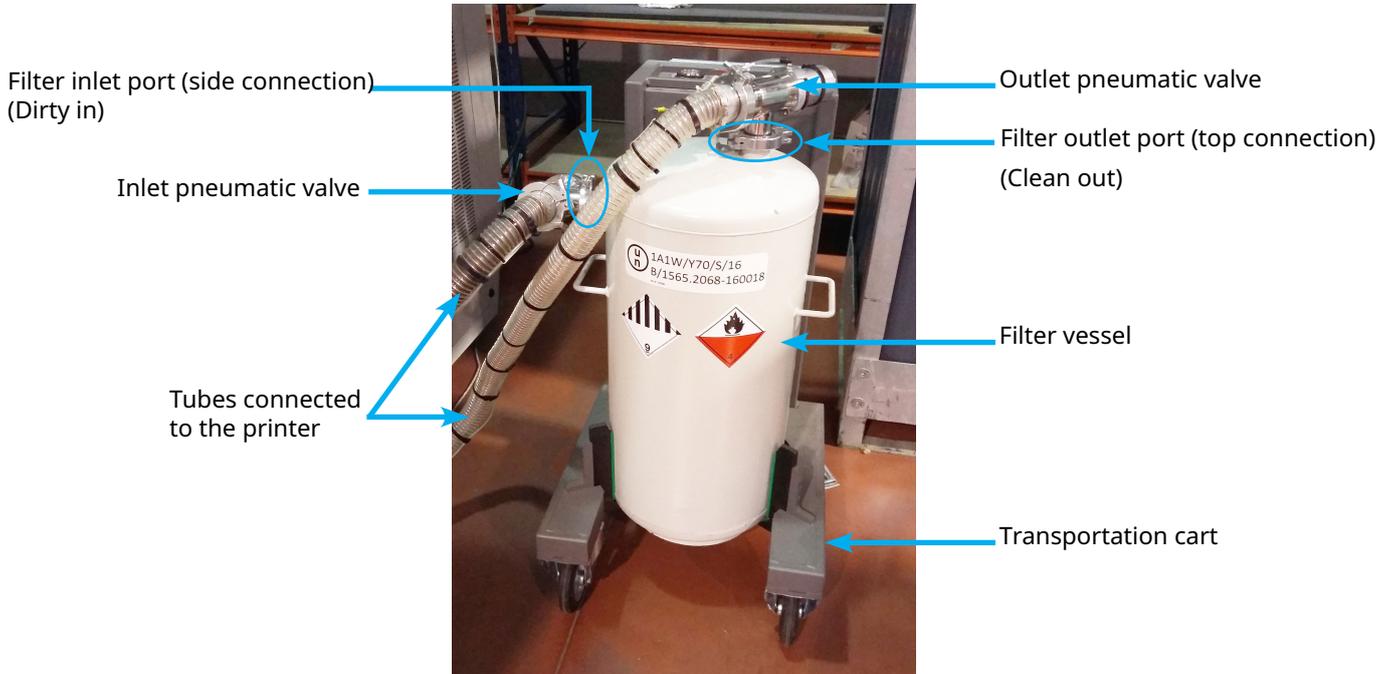
Procedure:



WARNING: MULTI-STAGE MAINTENANCE. YOU MUST READ THE ENTIRE PROCEDURE BEFORE BEGINNING.

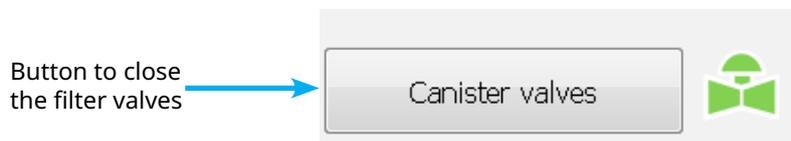


WARNING : IMPROPER OPERATION OR STORAGE MAY CONTRIBUTE TO CONDITIONS IN THE WORK AREA OR FACILITY THAT COULD RESULT IN SEVERE PERSONAL INJURY AND PRODUCT OR PROPERTY DAMAGE. CHECK THAT EQUIPMENT IS PROPERLY INSTALLED AND USED AS INTENDED.



1. Check that the 2 pneumatic filter valves are closed:

- Access Step #7 of the Preparation Assistant,
- The graphic display of the closed filter valves is . If valves are not closed (corresponding graphic ), click on “Canister valves” button on the control panel to close them:



Step 2 is performed to disconnect filter from machine. When changing the filter, leave the pneumatic valves on the tubes. Only open the clamps on the filter vessel (as indicated below), and remove the valves from the vessel.

2. Disconnect filter from machine in this order:



Caution : do not leave the filter vessel unattended after removing the valves and the centering ring with tube. A mechanism inside the vessel will already prevent oxygen getting inside. Nevertheless immediately replace the valves with the closing set (standard centering ring, cover lid and clamp).

- Remove the filter outlet port connection:
 - Disconnect and remove the clamp from filter vessel.
 - Remove immediately the special centering ring with stand-off tube by holding it by its center. The ring may stick slightly to the filter housing. Pry it loose with a plastic tool (such as a scraper).

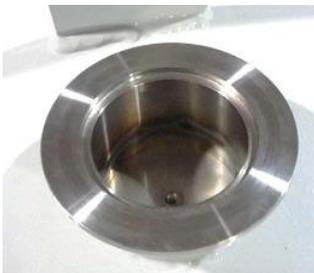


Caution : the filter outlet port must be capped immediately after the outlet pneumatic valve is removed.



There may be a pressure difference when taking off the valve. Do not be disturbed if you hear gas escaped, this is normal.

- Immediately close the filter outlet port with the closing set:
 - step a: install 1x standard centering ring,
 - step b: install 1x cover lid,
 - step c: install 1x clamp (**tightening torque 4Nm +0/+0.5**).



Filter outlet port view



Step a : centering ring positioning



Step b : cover lid positioning

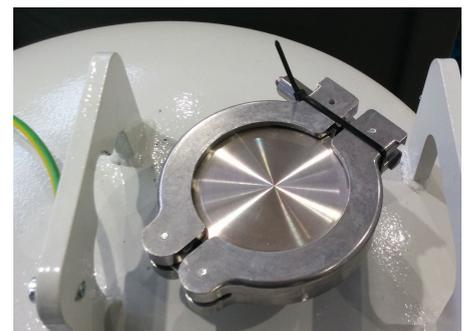


Step c : clamp tightening



Caution : make sure to secure the closing set by tightening the clamping according to the specified torque.

- Place a zip tie around the ends of the clamp and tighten.



- Repeat the step 2 for the filter inlet port connection. When complete, proceed to step3. The filter is completely sealed off and safe to be handled and transported. Move filter cart to unloading area.

3. Identify the filter:

- Apply the applicable ADR label to the side of the used filter: ADR 4.2 flammable solid for Titanium fumes, ADR 9 for Ni and Co containing fumes. These labels are required for storage and transport over road of the used filter.



ADR 4.2 label for pyrophoric substances

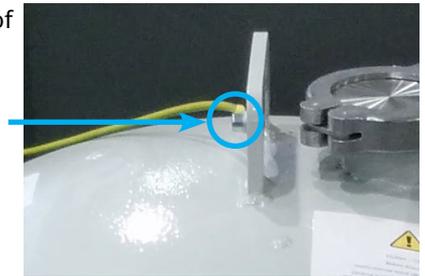


ADR 9 label for miscellaneous hazardous materials

- Use a permanent marker to write on the vessel the date, all materials that are contained in the filter and the operation hours.

4. Unload the filter vessel from the transportation cart:

- Remove the grounding wire between the filter and the filter cart with the use of a 5mm Allen wrench.



- Use appropriate lifting equipment adjusted to the weight of the filter vessel (~70 kg, ~154lbs).

5. Store the sealed vessel in appropriate location, and protect filter from mechanical damage (drop or puncture) and extreme temperatures.

6. Dispose of vessel in accordance with all local/regional/national, state and federal regulations. Have the used filter vessel(s) picked up by hazardous waste transporter company : the filter vessel equipped with the provided closing set has been certified under the UN guidelines for transport of class 4.2 and class 9 hazardous materials up to a total weight (filter + contents) of 70kg for vessels manufactured up to 2016 or 100kg for vessels manufactured after.



The stamping UN number of the vessel indicates the gross weight and the year of production:

1A1W/Y70/S/16...

7. Reload a new clean filter on the transportation cart. Make sure the new filter is installed with the filter inlet and filter outlet ports oriented as shown.

8. Attach the grounding wire to the filter removed previously.

9. Remove the tape seals from the filter inlet and filter outlet ports.



10. Reconnect the filter to machine in this order:

- Remove the closing set of the filter outlet port (top connection):
 - step a: remove the clamp,
 - step b: remove the cover lid,
 - step c: remove immediately the centering ring with stand-off tube.



Step a : clamp removal



Step b : cover lid removal



Step c : centering ring removal



The filter is charged with argon gas. It is normal for some of the argon gas to be expelled from the filter when the centering ring is removed.

- Inspect the internal valve and make certain the valve is closed after the centering ring is removed.



WARNING: DO NOT USE THE FILTER IF THE VALVE WILL NOT CLOSE.

- Install the centering ring with standoff tube in the filter outlet port. The stem of the centering ring must be placed directly on the locating pin of the internal valve.



Caution : make sure to install the special centering ring with stand off tube in the right orientation (tube should point to the filter vessel). The tube will open the closing mechanism inside the vessel. Proceed immediately to the filter outlet port connection, in order to prevent too much air coming into the filter vessel.



Caution : make sure to connect with the outlet pneumatic valve. Do not mix up the valves. The valve at the top of the vessel is the outlet, and the valve at the side of the vessel is the inlet.

- Press the outlet pneumatic valve directly on top of the centering ring.
- The internal valve is spring loaded. Push the outlet pneumatic valve down against the centering ring until the flanges meet.
- Install the clamp to secure the filter outlet connection (tightening torque 4Nm +0/+0.5).



Caution : make sure to secure the closing set by tightening the clamping according to the specified torque.



- Store the cover lid in a safe area. This cover lid will be needed to close the dirty filter on the next replacement (for example, in a closed bag attached to the cart).

- Repeat the step10 for the filter inlet port connection. Make sure to store the second cover lid with the first one. When complete, perform the next step.

11. When filter vessel replacement complete, click on "Reset" button on the machine interface. This will set the filter timer to zero and allow the **Preparation Assistant** to continue to the next step (Step 8: Loading of the manufacturing file and inerting).



12. The machine has to do a purge cycle, in order to fill the filter with inert gas, because during connection of filter to machine, the argon in the filter may be lost. Refer to the section "Step 8 : Loading of the manufacturing file and inerting" on page 40.

PREVENTIVE MAINTENANCE SCHEDULE

Maintenance not listed on this section is only allowed to be performed by 3D Systems-certified Customer Support Engineer.

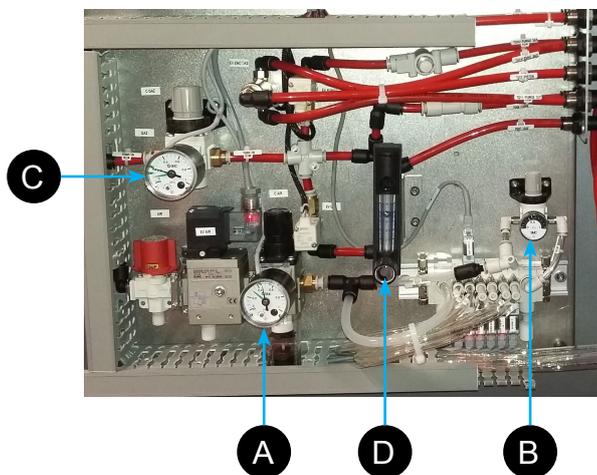
ITEM	SPECIFICATION	ONCE A MONTH	EVERY 3 MONTHS	EVERY 6 MONTHS	EVERY YEAR
Air pressure	Check : 5.5 bar	X			
Pinch valve pressure	Check : $3.5 < X < 4$ bar	X			
Gas pressure	Check : 2 bar	X			
Gas flow	Check : $5 < X < 10$ l/min	X			
Gloves	Check		X		
Front casings	Clean		X		
Back casings	Clean		X		
Exhaust filter	Replace		X		
Gas filter	Replace			X	
Calibration	Check				X

3D Systems recommends having an additional annual printer service performed by 3D Systems-certified Customer Support Engineer. Contact the 3DSystems hotline.

EVERY MONTH MAINTENANCE

The pressure and flowrate controls are performed below the front doors:

- A** Compressed air pressure
- B** Pinch valve pressure
- C** Gas pressure
- D** Gas flow



EVERY 3 MONTHS MAINTENANCE

The following step-by-step procedures must be performed in the provided order.

Procedure to check the glove for damage.

The gloves must be checked at each use of the machine, or at least every 3 months.

Caution: Dust Hazard.



Machine is equipped with rubber gloves to manipulate inside the manufacturing chamber. If rubber gloves become damaged, fine dust can blow out into the environment. Do not operate the machine with damaged glove. If glove ripped or punctured during use, dispose of it immediately, and replace it with new one.

1. Remove the gloves from the machine.
2. Check the presence of defects (cracks, splits, holes, cuts) by visual inspection.
3. Proceed the following steps:
 - Grasp the glove,
 - Stretch to seal close,
 - Roll up the glove by pressing against body,
 - Listen for leaks.
4. If glove damaged, replace them with new one:
 - Glove reference : 1001619U00



Front and Back casings cleaning

Part required :

- Vacuum cleaner equipped with wet separator and be explosion proof
- Natural fiber brush
- Damp cotton cloth



Caution : Personal Protective Equipment (PPE) must be used to protect the user against health or safety risks during working tasks. Wear disposable rubber gloves (and leather gloves when using a vacuum cleaner), anti-static coverall, anti-static safety shoes and safety glass. Wear disposable dust mask rated FFP3 or N99 level protection at minimum ; we recommend the use of powered air purifying respirator.



Caution : perform only tasks you are authorized and certified to complete. This maintenance procedure requires the operator to be trained on the use of the printer through the *Adjuster* level ("User level selection" on page 46).



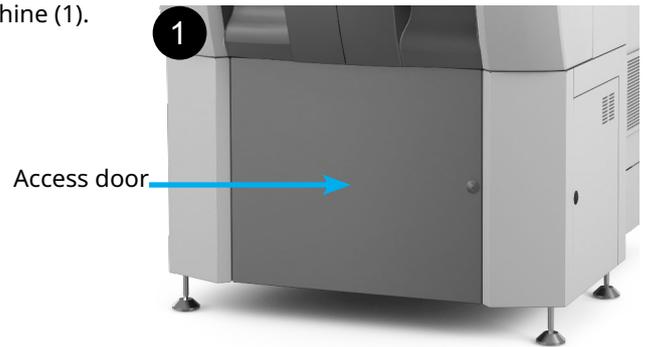
Caution: this maintenance will require to move the feeding piston. Make sure not to perform the maintenance that might result in powder overflow inside the manufacturing chamber.



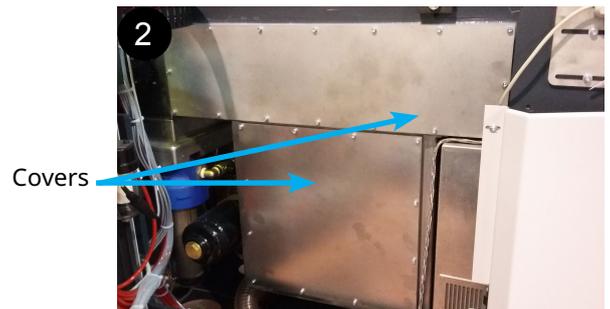
The steps from 1 to 10 are performed to clean the front casings.

Procedure:

1. Move the feeding piston and the sintering piston respectively to the position 100mm and 0mm.
2. Switch off the printer (see section "Shutting printer down" on page 68).
3. Switch the locking key to position "0", remove the key and keep it with you. This will prevent any power up of the printer during the maintenance.
4. Open the access door located below the front doors of the machine (1).



5. Remove the 2 cover panels (2).



WARNING: FIRE AND EXPLOSION HAZARDS. COMBUSTIBLE DUST INSIDE. METAL POWDERS ARE FLAMMABLE AND POTENTIALLY EXPLOSIVE, ESPECIALLY WHEN DISPERSED IN A CLOUD AND EXPOSED TO AN IGNITION SOURCE SUCH AS HEAT OR STATIC ELECTRICITY SPARK. OPERATORS AND SERVICE PERSONAL SHOULD AVOID DISTURBING POWDER (MANIPULATE CAREFULLY TO AVOID AS MUCH AS POSSIBLE SUSPENDING OF FINE PARTICLES).

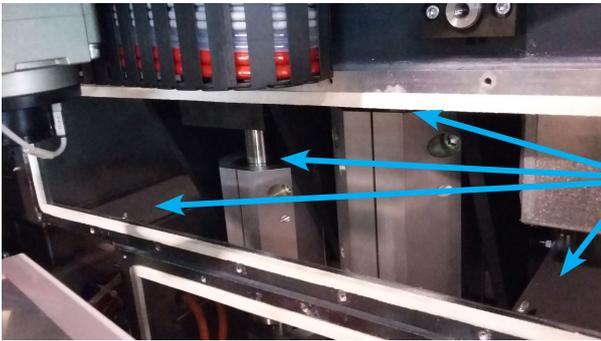


WARNING : FIRE AND EXPLOSION HAZARDS. PRESENCE OF METAL PARTICLE CONDENSATE. HIGHLY COMBUSTIBLE. DO NOT VACUUM, DO NOT BLOW. USE DAMP COTTON CLOTH TO REMOVE THE METAL PARTICLE CONDENSATE.

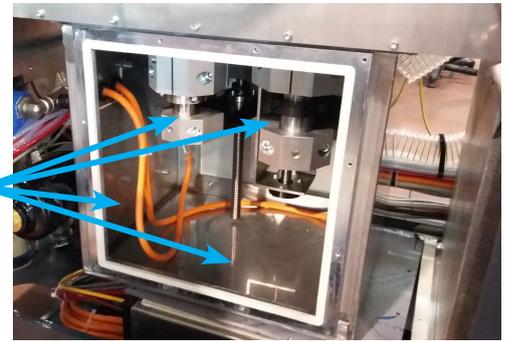


WARNING : STATIC HAZARD. METAL PARTICLE CONDENSATES INSIDE THE PRINTER ARE HIGHLY COMBUSTIBLE AND SHOULD BE KEPT AWAY FROM SOURCES OF POTENTIAL IGNITION. WEAR ANTI-STATIC CLOTHING, ANTI-STATIC SAFETY SHOES, STAND ON GROUNDED ANTI-STATIC FLOOR PAD.

6. Clean the sides of the covers with the use of a damp cotton cloth to neutralize any presence of the condensate (black particle aspect).
7. Clean inside of the enclosures with the use of a damp cotton cloth to neutralize any presence of the condensate (black particle aspect).
8. Then, remove any presence of powder with the use of a vacuum cleaner and a natural fiber brush. Depending on the grain size of the material, some powder may be present on the "cleaning areas", preventing the printer from operating properly.



Cleaning areas



9. Finalize the cleaning with a damp cotton cloth.
10. Put back the cover panels and secure them by tightening the screws.



The next steps are performed to clean the back casings.

11. Open the rear doors of the printer.
12. Remove the cover panel (3) at the rear of the main cabinet, as indicated on the figure.



Caution: injury risk. The cover panel is heavy (25 kg).



To facilitate the cover panel removal, replace at first the 2x M5 screws located on the upper-right corner and upper-left corner (circled in blue on the adjacent figure) with M5x25 set screws. They will support the panel during the other screws removal.



WARNING: FIRE AND EXPLOSION HAZARDS.



COMBUSTIBLE DUST INSIDE. METAL POWDERS ARE FLAMMABLE AND POTENTIALLY EXPLOSIVE, ESPECIALLY WHEN DISPERSED IN A CLOUD AND EXPOSED TO AN IGNITION SOURCE SUCH AS HEAT OR STATIC ELECTRICITY SPARK. OPERATORS AND SERVICE PERSONAL SHOULD AVOID DISTURBING POWDER MANIPULATE CAREFULLY TO AVOID AS MUCH AS POSSIBLE SUSPENDING OF FINE PARTICLES).



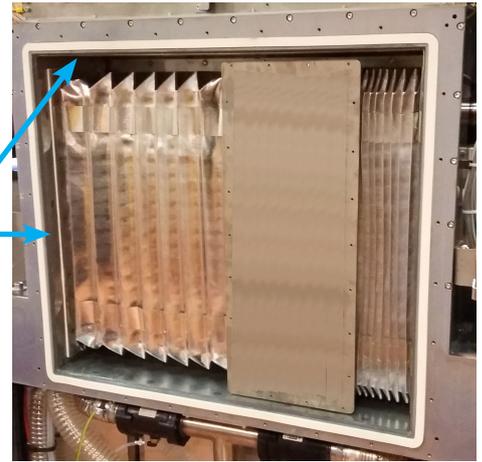
WARNING : FIRE AND EXPLOSION HAZARDS. PRESENCE OF METAL PARTICLE CONDENSATE. HIGHLY COMBUSTIBLE. DO NOT VACUUM, DO NOT BLOW. USE DAMP COTTON CLOTH TO REMOVE THE METAL PARTICLE CONDENSATE.



WARNING : STATIC HAZARD. METAL PARTICLE CONDENSATES INSIDE THE PRINTER ARE HIGHLY COMBUSTIBLE AND SHOULD BE KEPT AWAY FROM SOURCES OF POTENTIAL IGNITION. WEAR ANTI-STATIC CLOTHING, ANTI-STATIC SAFETY SHOES, STAND ON GROUNDED ANTI-STATIC FLOOR PAD.

13. Clean the cover panel (inside and outside) with the use of damp cotton cloth to neutralize any presence of the condensate (black particle aspect).
14. Clean the sides of the enclosure and protection bellow with the use of a damp cotton cloth to neutralize any presence of the condensate (black particle aspect).

Metal particle
condensate
- Highly
combustible



15. Remove any presence of powder on the enclosure and protection bellow with the use of a natural fiber brush and a vacuum cleaner.



Caution: make sure not to damage the protection bellow during cleaning.

16. Put back the cover panel and secure it by tightening the screws.
17. Close the rear doors of the printer.

Exhaust filter replacing

Part required :

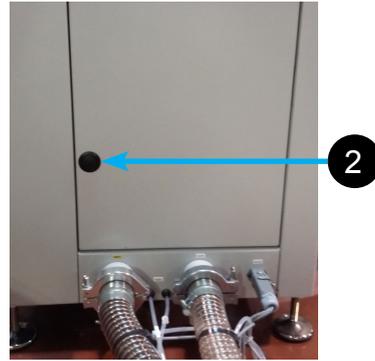
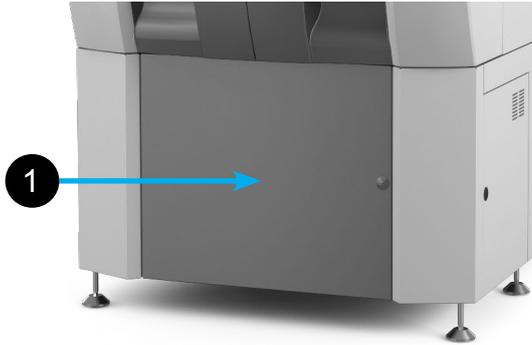
- Filter element : 80-1833



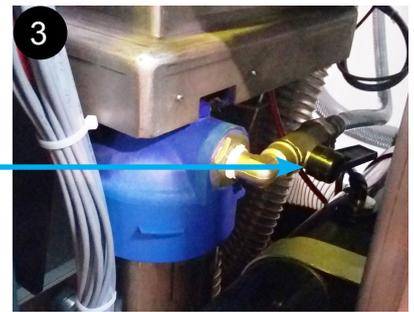
Caution : Personal Protective Equipment (PPE) must be used to protect the user against health or safety risks during working tasks. Wear disposable rubber gloves, anti-static coverall, anti-static safety shoes and safety glass. Wear disposable dust mask rated FFP3 or N99 level protection at minimum ; we recommend the use of powered air purifying respirator.

Procedure:

1. Make sure the gas and purge are not activated.
2. Open the door located below the front doors of the machine (1), and the left side door (2).



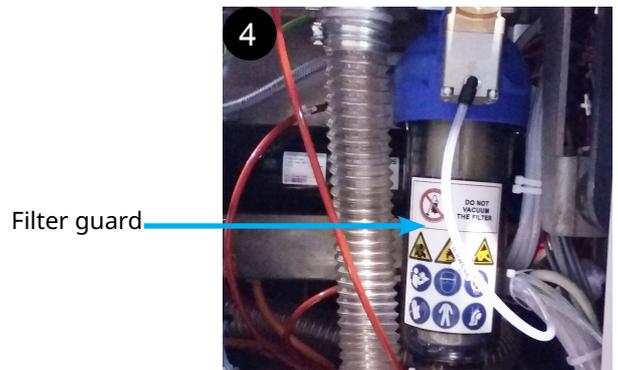
3. Close the input valve (3).



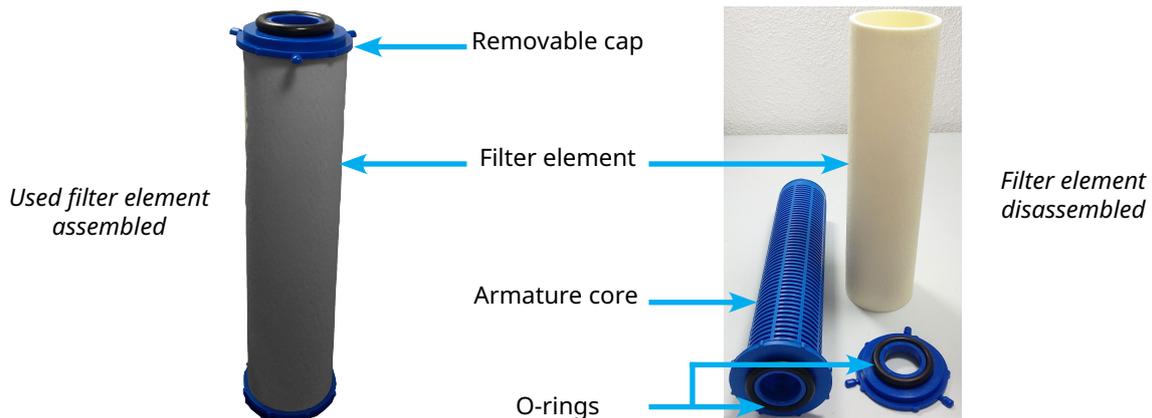
4. Remove the filter guard (4).



Caution : Wear disposable rubber gloves and leather gloves during the filter guard removal.



5. Remove the filter and disassemble the blue armature core (by unscrewing the removable cap) to re-use on the new element.



6. Dispose of the old element in accordance with all local/regional/national/, state and federal regulations.



WARNING : FLAMMABLE POWDERS.

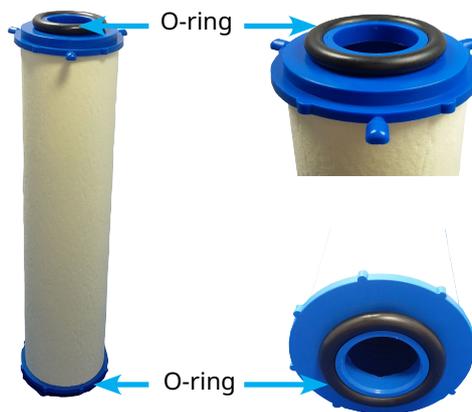
PLACE THE USED FILTER ELEMENT IN A CLOSED METALLIC CONTAINER IN A ROOM WITH FIRE DETECTION.

7. Clean the filter guard with the use of damp cotton cloth.

8. Assemble the new filter element, and replace it with the filter guard on the machine.



Caution : Make sure to re-use the 2 O-rings (on top and bottom).

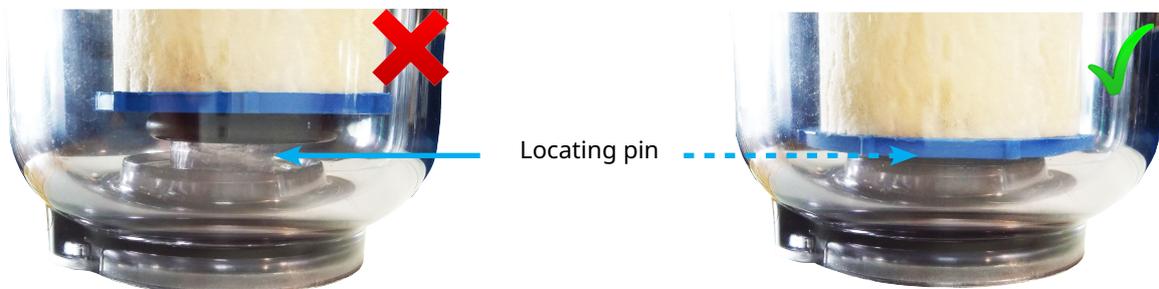


Caution : Make sure to fit the filter element assembly on the correct position as indicated on the following figures (removable cap on the top, and centered on the filter guard) .

Removable cap on the top



Filter element centering: it must be placed on the locating pin of the filter guard.



9. Open the input valve.

10. Close the left side door and the door located below the front doors of the machine.

EVERY 6 MONTHS MAINTENANCE

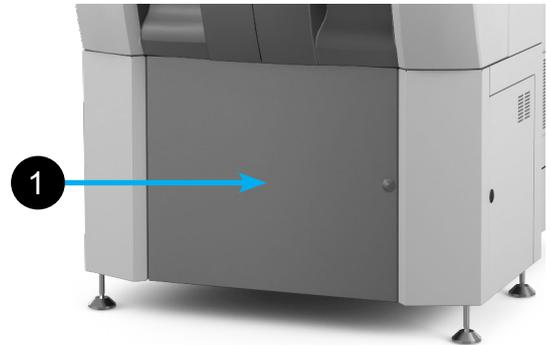
Gas filter replacement

The gas filter must be replaced every 6 months. The gas filter is located under the front doors.

Part required :

- Filter element : 1001884R00.

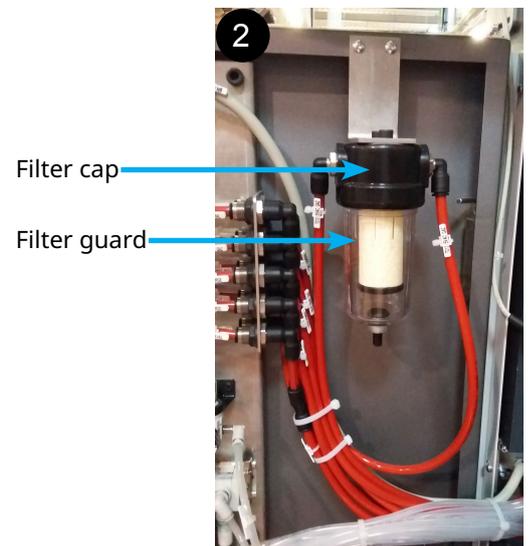
1. Make sure the gas and purge are not activated.
2. Open the access door located below the front doors of the machine (1).



3. Remove the filter guard from the filter cap by unscrewing it (2).



Caution : Wear disposable rubber gloves and leather gloves during the filter guard removal.



4. Remove the filter element. Dispose of it in accordance with all local/regional/national, state and federal regulations.



WARNING : FLAMMABLE POWDERS.

PLACE THE USED FILTER ELEMENT IN A CLOSED METALLIC CONTAINER IN A ROOM WITH FIRE DETECTION.

5. Clean the filter guard with the use of a damp cotton cloth.
6. Install the new filter element.
7. Install the filter guard.
8. Close the access door located below the main cabinet.

EVERY 1 YEAR MAINTENANCE

Calibration

This section gives the printer calibration procedure; to correctly correlate the scanning system's theoretical X/Y print bed coordinates with the actual X/Y print bed coordinates.

The calibration must be controlled once a year. As explained on the procedure, the control of the calibration will require to draw a calibration plate and to retrieve the current printer correction file (*xml* format) that both must be sent to 3D Systems Customer Support for analysis. If required, a new correction file may be loaded to the printer.

Part required

- Calibration plate (p/n 5007183J00): minimum 2 required.
- Specific calibration manufacturing FAB file (if not owned, contact 3D Systems Customer Support).

Instruction

NOTE: before starting the procedure, the followings are required:



- The manufacturing chamber must be cleaned (see section "Manufacturing chamber cleaning" on page 66).

- A new sintering plate has been loaded on the printer (see section "Sintering plate preparation and loading" on page 57).



Caution : perform only tasks you are authorized and certified to complete. This maintenance procedure requires the operator to be trained on the use of the printer through the *Adjuster* level (see "User level selection" on page 46).



Caution : presence of metal powder. Do not use or manipulate any material without first reading the safety datasheet (SDS) for that specific material.



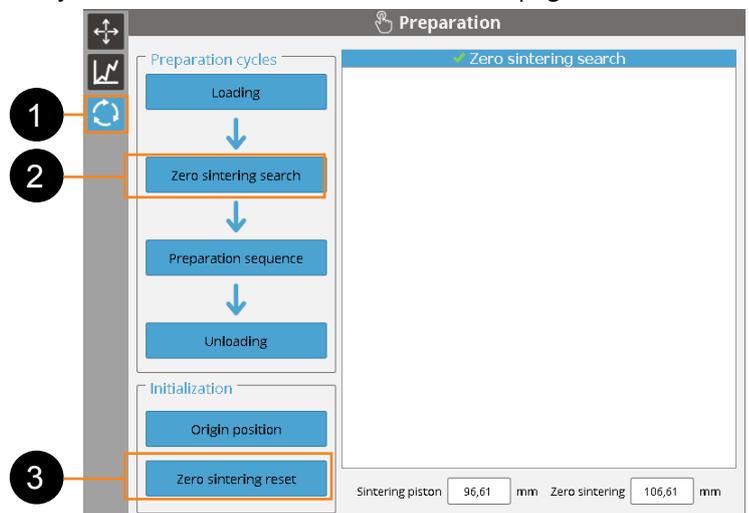
Caution : Personal Protective Equipment (PPE) must be used to protect the user against health or safety risks during working tasks. Wear disposable rubber gloves, anti-static coverall, anti-static safety shoes and safety glass. Wear disposable dust mask rated FFP3 or N99 level protection at minimum ; we recommend the use of powered air-purifying respirator.



WARNING : FINE METAL DUST IS HIGHLY FLAMMABLE. AVOID USING ANY IGNITION SOURCE NEAR THE MACHINE (OPEN FLAME, SPARKING, ELEVATED TEMPERATURE PARTS).

Control of the current calibration

1. Make sure to access to the control software by using the *Adjuster* level (see "User level selection" on page 46).
2. Perform a Zero research:
 - Navigate to the **Preparation** menu.
 - Access to the **Cycles** submenu (1).
 - Click on the **Zero sintering search** button (2): the printer initiates the corresponding cycle.
3. Measure the thickness of the calibration plate.
4. Move the sintering piston to: "zero sintering" value - "thickness" of the calibration plate.
5. Perform a zero sintering reset :
 - Navigate to the **Preparation** menu.
 - Access to the **Cycles** submenu (1).
 - Click on the **Zero sintering reset** button (3): the printer initiates the corresponding cycle.



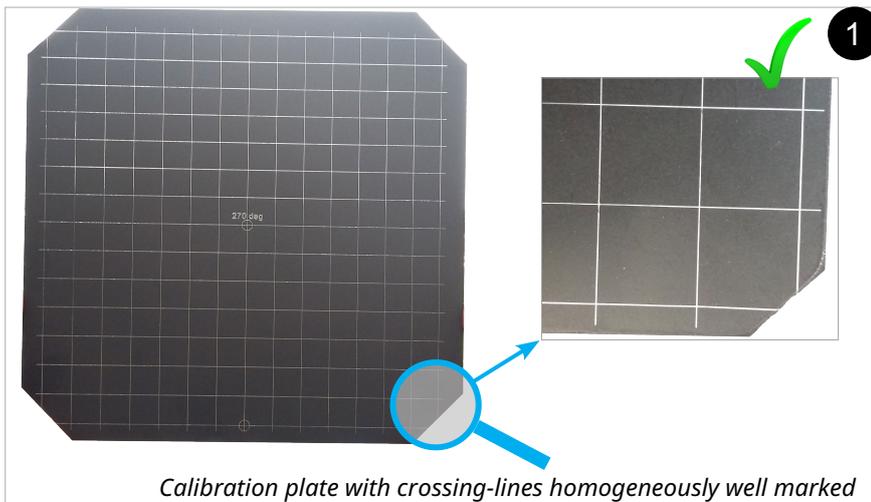
6. Make sure the airlock is in OPEN position, then put the calibration plate on the airlock.
7. Rotate the airlock in CLOSE position.
8. Open the front doors.
9. Put the glove and open the glove doors.
10. Install the sintering plate on the sintering piston.



Make sure the painted surface of the calibration plate is visible when positioning it on the sintering piston, as showed on the adjacent figure.

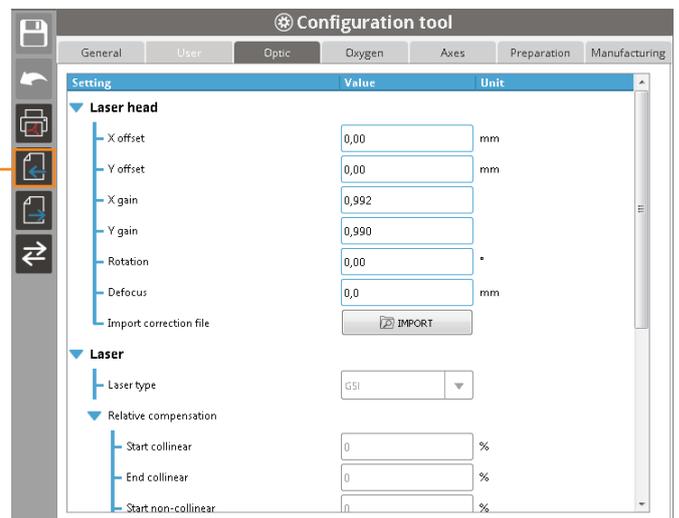


11. Close the glove door.
12. Launch the inerting process up to reach the *fume safety* level.
13. Download the specific manufacturing FAB file on the printer.
14. Start the draw (layer#0) of the calibration plate **with the red point** in order to control its positioning. Adjust the calibration plate if it is necessary.
15. Start the draw (layer#0) of the calibration plate **without the red point**.
16. Repeat the previous step, to be sure the draw will be well marked.
17. Move up the sintering piston about 5-10mm, for easier calibration plate removal.
18. Remove the calibration plate from the printer.
19. Inspect visually the sintered lines are homogeneously well marked over the whole surface of the plate (1). If the result is not correct (2), repeat the draw on a new calibration plate. If the result is still no correct, contact 3D Systems Customer Support.



20. The control of the calibration requires the current correction file. To export this correction file:

- Access to the **Configuration** tool,
- Click on the **Export** button (1),
- Select "Correction file" from the file list, then save the file on a folder from your network or a USB key.



21. Ship the following to 3D Systems Customer Support:

- Calibration plate: use a shock-resistant package that protects the plate from damage. Make sure to indicate the serial number of the corresponding printer on a paper labelled on the back of the calibration plate.
- Current correction file: send an email to hotline.phenix@3dsystems.com by attaching the correction file and indicating the serial number of the corresponding printer.

22. 3D Systems Customer Support will then give the result of the measurement:

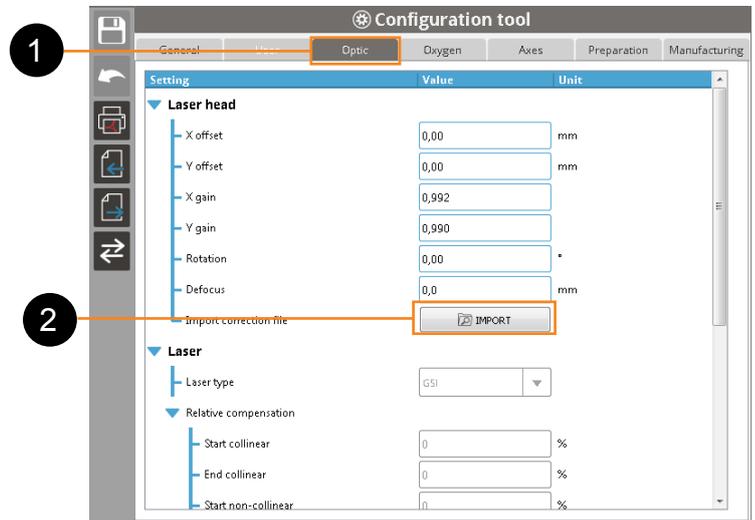
- If the result of the calibration is not correct, 3D Systems Customer Support will supply a new correction file (*xml* format); proceed then to the next section.
- If it is correct, the printer calibration is validated.

Import a new correction file



The following steps must be performed as long as the calibration has not been validated.

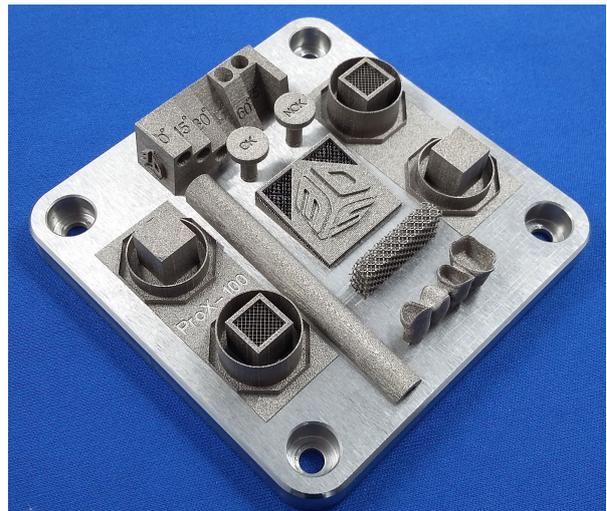
1. Store the new correction file (*xml* format) supplied by 3D Systems Customer Support on a USB key.
2. Install the USB key on the USB port (see "D. Screen control panel and external control panel" on page 27).
3. Make sure to access to the control software by using the *Adjuster* level (see "User level selection" on page 46).
4. Access to the **Configuration** tool.
5. Go to the **Optic** menu (1).
6. Click on the **Import** button (2).
7. Select the new correction file, then validate. The new correction will replace the previous one (confirm the overwriting message if displayed).



8. Draw a new calibration plate (see page 86).
9. To control and validate the new calibration, ship the following to 3D Systems Customer Support:
 - Calibration plate: use a shock-resistant package that protects the plate from damage. Make sure to indicate the serial number of the corresponding printer on a paper labelled on the back of the calibration plate.
 - Current correction file: send an email to hotline.phenix@3dsystems.com by attaching the correction file and indicating the serial number of the corresponding printer.
10. 3D Systems Customer Support will then give the result of the measurement:
 - If the result of the calibration is not correct, 3D Systems Customer Support will supply a new correction file (*xml* format); repeat steps from 1 to 10.
 - If it is correct, the printer calibration is validated.

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