OPERATION AND MAINTENANCE MANUAL
For NIL-2.5 inch

The Nanoimprinter

Model: NIL-25-OB-xx-PL-xx
Serial number: 25-06-xxx

P. O. Box 580
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SWEDEN

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Owner Registration:

To ensure Obducat AB supplies you with any necessary hardware or documentation updates, please enter your company details; detach this page and FAX or POST to:

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COMPANY NAME: **ADDRESS:** **CONTACT:**	
FAX: **PHONE:** **EMAIL:**	

Important Notices:

Safety Notices:

Please do not switch on this equipment unless the operation and maintenance manual has been fully read and understood. If there is any difficulty in understanding, please contact the address below:

Information Content:

All efforts have been made to ensure the accuracy of the information in this manual, however the contents of this manual are subject to change without notice.

Obducat AB shall not be liable against any damages or problems arising from the use of options, consumables or spares, other than those supplied or designated by Obducat AB.

Obducat AB can assume no responsibility for any errors in this manual or their consequences.

Sales and Service Address:

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Safety Instructions:

The machine must be placed on a suitable level surface offering the system firm support.

Ensure there is sufficient surrounding clearance for maintenance and cleaning operations.

Do not deposit any object in front or on top of the machine.

Hoses and electrical cables must be laid in a manner to prevent tripping and damage.

General Notes on Safety:

All persons concerned with the installation, commissioning, operation, maintenance and repair of the system and its components must have read the operations and maintenance manual, particularly those on safety.

Prior to commissioning the system, the user must ensure that all safety conditions are met.

Both user Interface and Operations and Maintenance Manuals should be read before attempting to operate the machine.

ONLY authorized personnel to carry out maintenance or adjustments to this machine.

Notes on Safety for Operating Personnel:

All working methods are forbidden, which:

Constitute a danger to the life and limb of the user or third parties,

Are detrimental to the system or others,

Are detrimental to the safety and proper function of the system,

Are not in compliance with the specified notes on safety.

NO safety devices may be removed or rendered inoperative.

Safety devices must be replaced prior to re-connecting mains supplies.

Only those items that can be adjusted or maintained by non-Obducat personnel are to be accessed or adjusted.

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Maintenance and repair may only be undertaken when the unit is switched off and disconnected from the mains input supply.

Hazardous voltages are present in this machine. This machine must be earthed.

Repair work on hydraulic may only be carried out when relevant pressures are zero.

The front door must be closed during normal operation.

When handling Nickel Stampers, protective gloves should be worn.

Care should always be taken when feeding the machine with the stampers and substrates.

Spare Parts:

Use recommended spare parts only. For a list of authorized spare parts please contact Obducat AB.

Terms of Guarantee:

Unauthorized changes or modifications to the system and its components, which are part of the scope of supply by Obducat AB, or the use of the system other than for its intended purpose, will exclude the manufacturer from any liability for damage caused as a result of such use, changes or modifications, and render any warranty or guarantee by the manufacturer invalid.

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Warning Labels:

All the electrical, chemical, thermal and other hazards are identified on the imprinter machine. The used labels are as follows:

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Safety Integration:

a) The NIL-2.5 is constructed to fit its functions, and can be adjusted and maintained without putting person at risk when these operations are carried out under the conditions foreseen by Obducat AB.
b) Obducat AB has taken the following points into account when designing and constructing the NIL-2.5:
   - Eliminate or reduce risk as much as possible.
   - Take the necessary protection measures in relation to risks that cannot be eliminated.
   - Inform users of the residual risk due to any limitations of the protection measures adopted, indicating whether any particular training is required and specify any need to provide personal protective equipment.
   - Obducat AB envisages not only the normal use of the NIL-2.5 but also uses, which could reasonably be expected.
   - Obducat AB supplies its NIL-2.5's with all the essential special equipment and accessories to enable it to be adjusted, maintained and used without risk.
c) Materials and Products: The materials used, in the construction of Obducat AB's NIL-2.5 and products, does not endanger the safety or health of exposed persons'.
d) Handling of the NIL-2.5:
   - The NIL-2.5 is designed to be handled safely,
   - The NIL-2.5 is designed to be packaged and stored safely,
   - The NIL-2.5 and its parts are designed to be safe and easily movable.

Safety and Reliability of Control Systems:

The control systems are designed and constructed to withstand the rigorous of normal use and external factors, and also error in logic does not lead to dangerous situations.

Control Devices:

The system's control devices have been designed to be:

- Clearly visible, and identifiable with appropriate marks.
- Positioned for safe operation without hesitation or ambiguity.
- Are located outside the danger zones.
- Their position do not cause additional risk.
- Made to withstand foreseeable strain.

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Starting:

The NIL-2.5 has a (Main Switch) to power up the system.

Stopping Device:

Normal Stopping:

- The NIL-2.5 has a control whereby the system can be brought safely to a complete stop, using a software interface.
- Each part of the NIL-2.5 has its own stop control either by software or by hardware, e.g. pressing the Down Buttons.

Emergency Stopping:

The NIL-2.5 is fitted with a easily identifiable, clearly visible and quickly accessible emergency stop control to bring the system into stop safely. The switch is located on the front of the machine, and stops all operations except the computer. To resume operation, release the EMO and turn it back to the "ON" position.

Interlock:

The NIL-2.5 is fitted with a partial stop when the door is opened, intentionally or accidentally. This will interrupt the ongoing operations for the Pressure ONLY. To resume operation, close the door.

Failure of Power Supply:

Interruption or fluctuations in whatever manner of the power supply to the NIL-2.5 does not lead to a dangerous situation. In particular:

- The NIL-2.5 does not start unexpectedly.
- The stop will override any command that has previously been given.
- No moving part of the NIL-2.5 or piece held by the NIL-2.5 will fall or be ejected.
- All automatic or manual stopping of the moving parts will be unimpeded.
- The protection devices remain fully effective.

Failure of the Control Circuit:

A fault, failure or damage to the control circuit do not lead to dangerous situations. In particular:

- The NIL-2.5 does not start unexpectedly.
- The stop will override any command that has previously been given.
- No moving part of the NIL-2.5 or piece held by the NIL-2.5 will fall or be ejected.
- All automatic or manual stopping of the moving parts will be unimpeded.
- The protection devices remain fully effective.

Software:

Obducat AB has developed an interactive software interface for communication between the operator and the system. It is fully described in the "User Interface Manual for NIL-2.5".

Stability:

The NIL-2.5 components and fittings are so designed and constructed that they are stable enough, under the foreseen operating conditions for use without risk of overturning, falling or unexpected movement.

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Risk of Break-Up during Operation:

The various parts of the NIL-2.5 and their linkages are able to withstand the stress which they are subject to when used as foreseen by Obducat AB.

Fire:

The NIL-2.5 is designed and constructed to avoid all risk of fire or overheating posed by the NIL-2.5. The circuit boards are rated UL94V-1 or better.

External Radiation:

The external radiation does not affects the NIL-2.5 or its process.

NIL-2.5 Maintenance and Inspection:

Adjustment, lubrication, maintenance points are located outside danger zones:

For example,

- Open back door to look for oil leak.
- Open back door to look for air leak.
- Open front door to look for electric connections and fuses.

Cleaning of Internal Parts:

The NIL-2.5 is designed and constructed in such a way that it is possible to clean internal parts safely.

Marking:

The NIL-2.5 is marked with the following:

- Power Voltage and Frequency.
- Designation of type and series.
- Serial number.

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EQUIPMENT DIAGRAMS

The following pages are photographs of the NIL – 2.5" Machine and a detailed description of its components.

Front Electrical and Electronics Cabin-Top

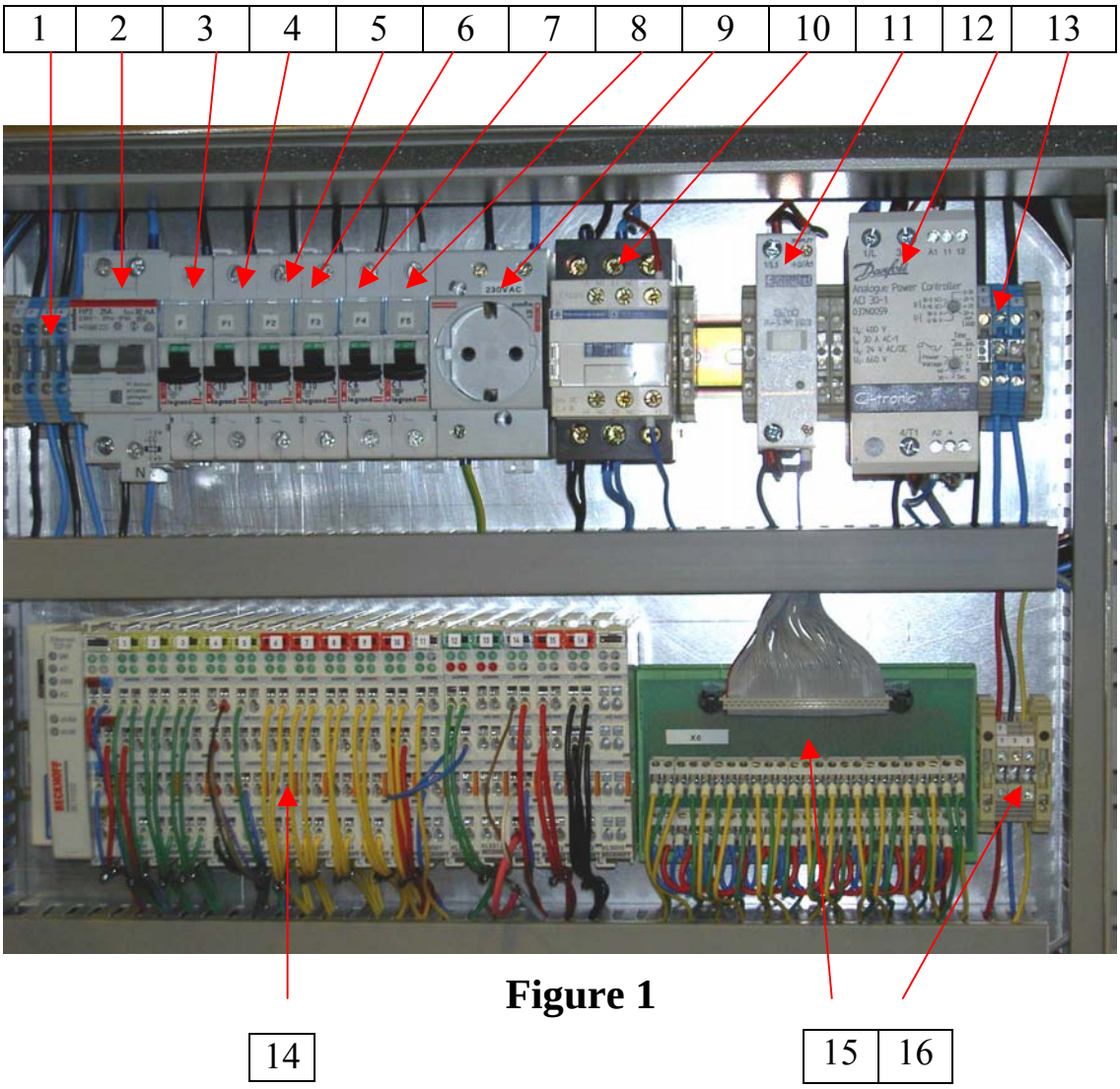

Figure 1

1	Power cable feed to Main switch (X8)	**9**	Service power, 230V
2	Earth Leakage circuit breaker	**10**	Oil-pump contactor
3	Main fuse	**11**	Solid-state relay (Heater)
4	Pump fuse	**12**	Heater regulator ACI 30-1
5	Heater fuse	**13**	Heater connection (X9)
6	Service power fuse (see 9)	**14**	PLC, (Programmable Logic Circuit)
7	24 VDC /5 VDC fuse	**15**	Cable converter to Manual Control Panel (X6)
8	High pressure gas valve fuse	**16**	Connections for Display (X7)

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Front Electrical and Electronics Cabin-Bottom

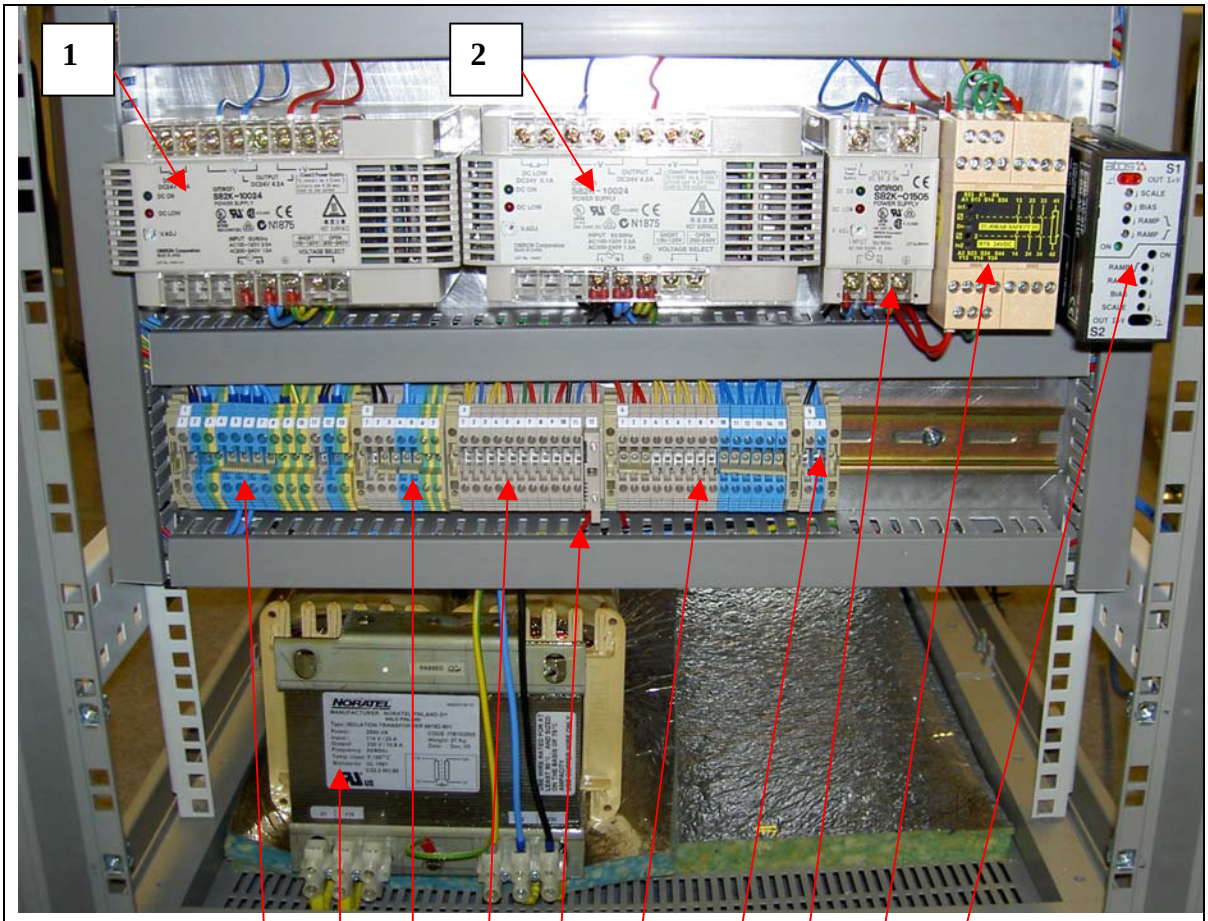

Figure 2

1	Power supply 24 VDC (PLC)	**7**	Fuse for display
2	Power supply 24 VDC to pressure regulator	**8**	Connectors for 24VDC and 0VDC (X4)
3	Main cable feed (X1)	**9**	Connection for fan (X5)
4	Power transformer (115 to 230VAC)	**10**	5VDC power supply (VFD-display)
5	High pressure gas valve cable feed (X2)	**11**	Safety relay (RT6)
6	Pressure sensors, vacuum cable feed (X3)	**12**	Pressure regulator (Motor control unit)

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Control panel and Imprinter safety door

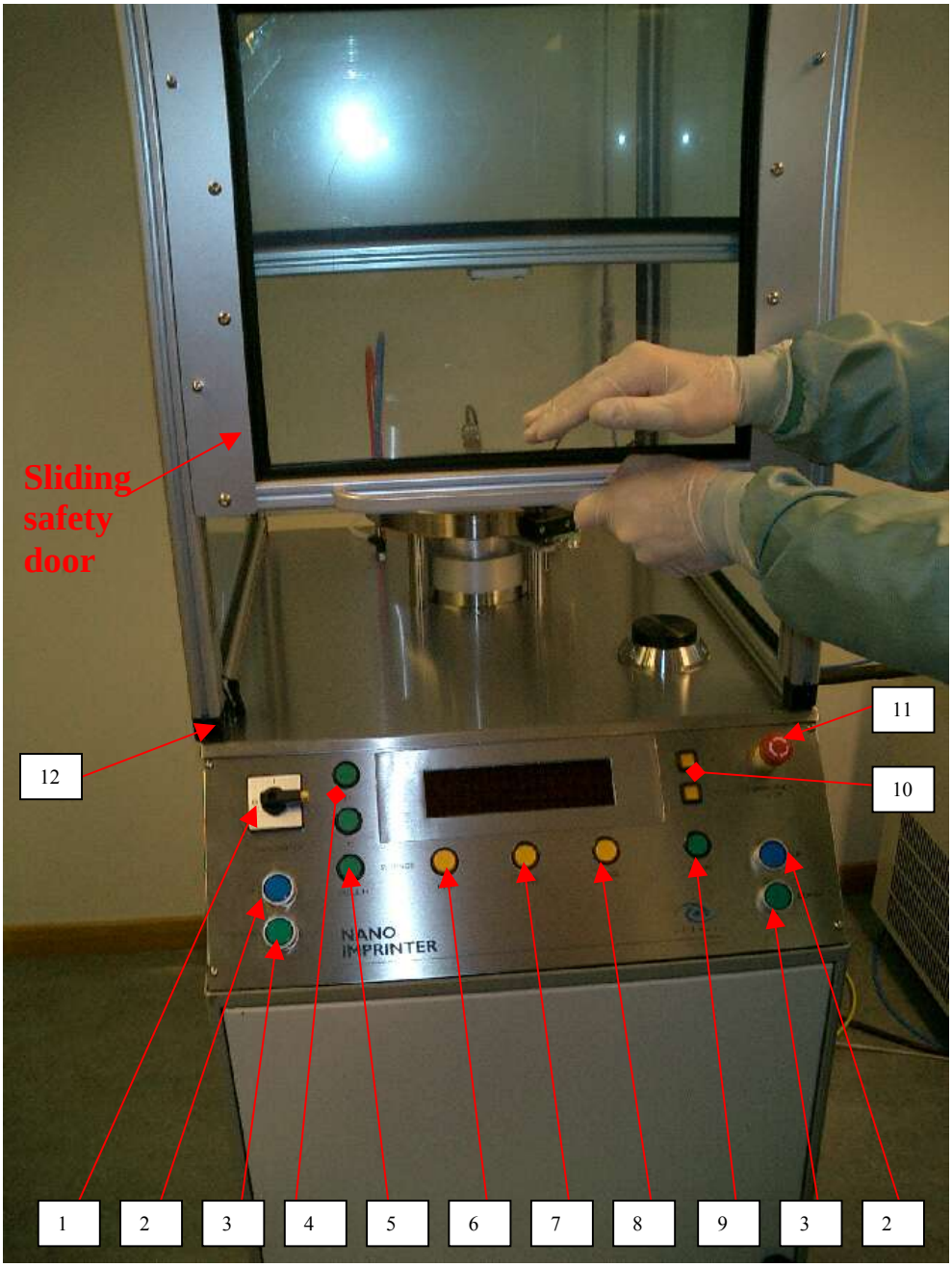

Figure 3

1	Main switch	**7**	Setting Pressure and Time
2	Up button (2 bottoms)	**8**	Setting release Temperature
3	Down button (2 bottoms)	**9**	ESCAPE (Save and leave the programming mode)
4	Insert preset parameters from P1, P2	**10**	Change the parameters (+) or (-)
5	Vacuum ON/OFF	**11**	Emergency stop
6	Setting Temperature	**12**	Safety switch

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Imprinting Chamber, Heater and Loader arm (Front)

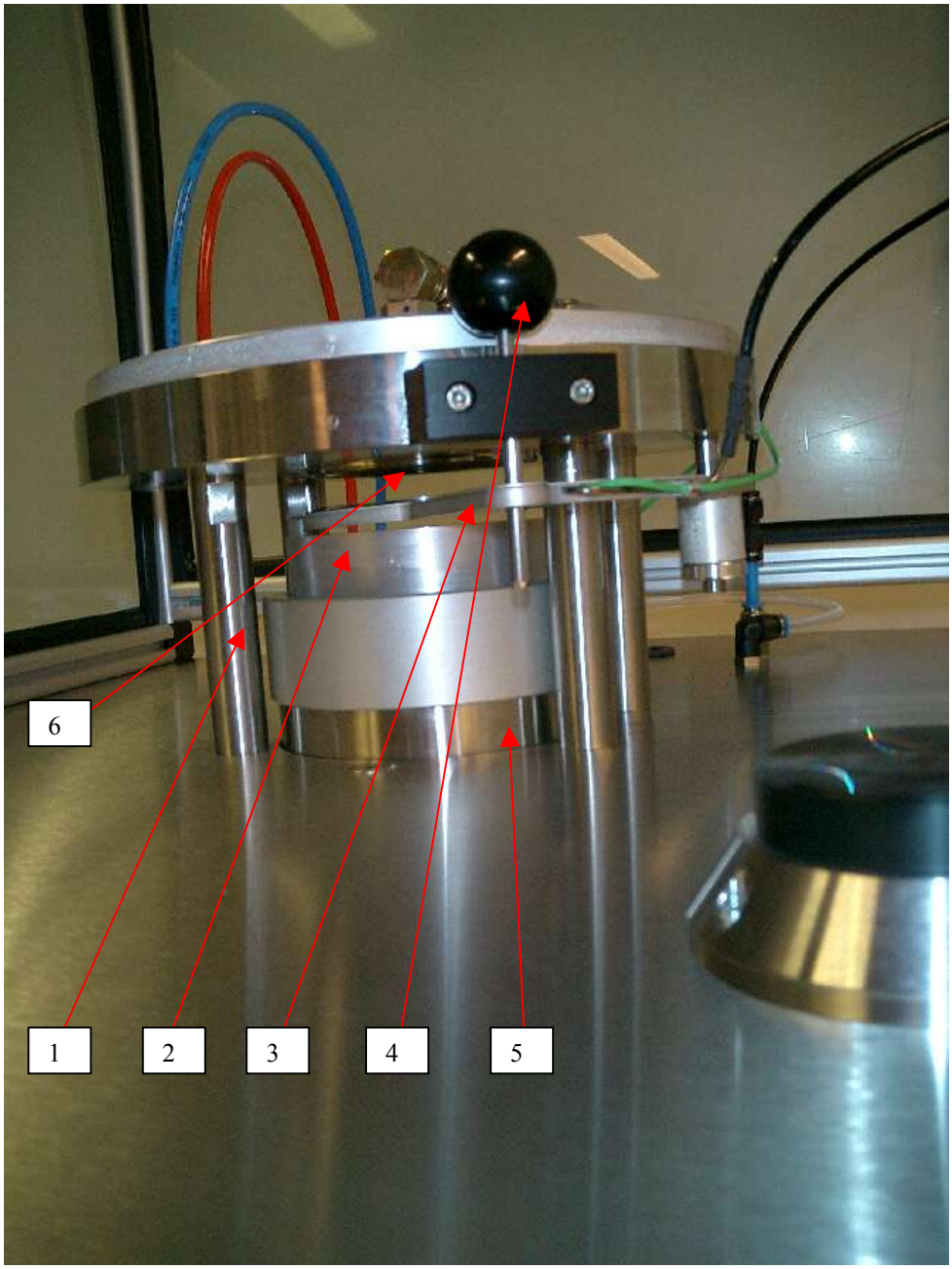

Figure 4

1	Pressure pins	**4**	Loader Arm Lock Pin
2	Heater	**5**	Piston Adapter
3	Loader Arm	**6**	Pressure Chamber

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High pressure Chamber, Loader Arm and Nitrogen inlet

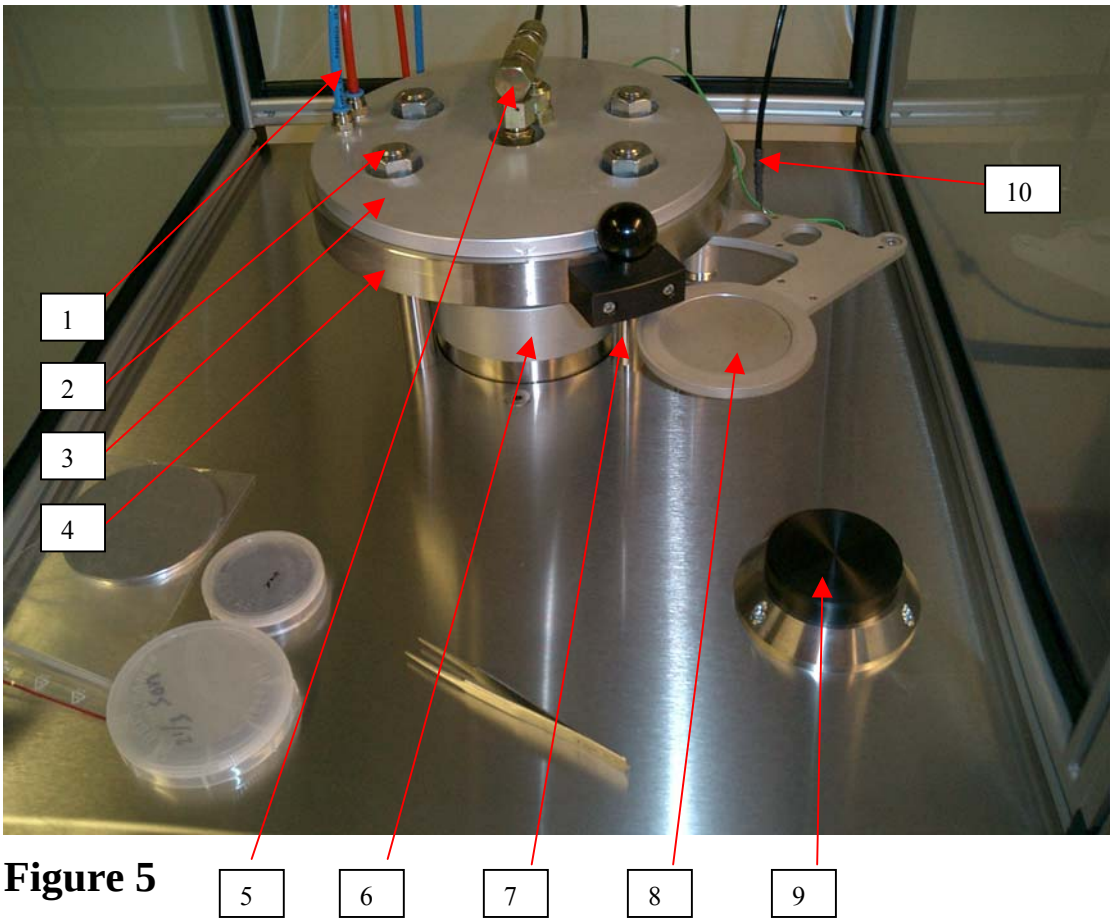

Figure 5

1	Air cooling tubes	**6**	Heater
2	Top pressure block nut	**7**	Loader Arm Lock Pin
3	Cooling plate	**8**	Loader Arm
4	Top pressure block	**9**	Liquid Nitrogen inlett
5	High pressure gas connector	**10**	Vacuum tube

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Hydraulics, Valves and the oil tank

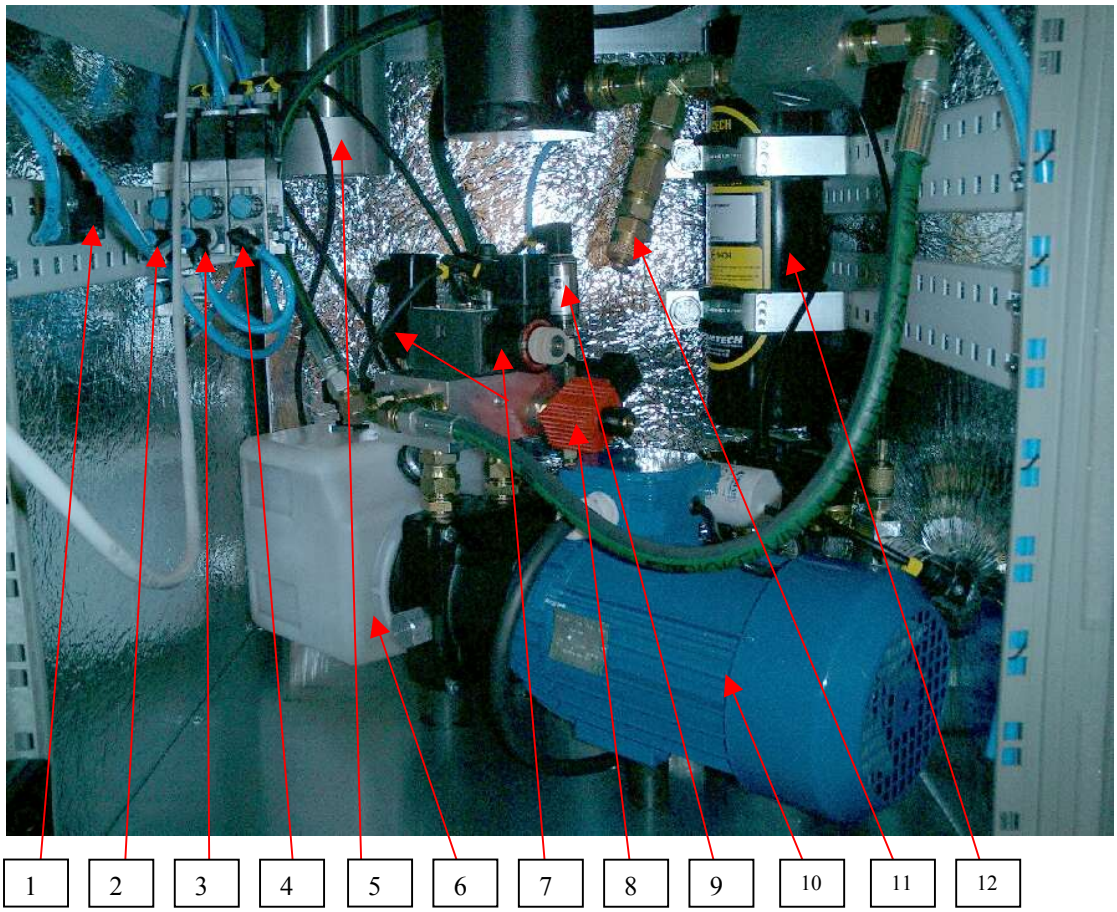

Figure 6

1	Inlet Air pressure regulator	**7**	Up / Down Hydraulics valves for Cylinder
2	Nitrogen (Air) cooling valve for cooling substrate and stamper	**8**	Oil Pressure Regulator
3	Air valve for cooling	**9**	Hydraulics Pressure Sensor
4	Vacuum valve and vacuum (ejector) pump	**10**	Hydraulic pump
5	Liquid nitrogen can	**11**	Service check A
6	Oil tank	**12**	Gas (air) pressure accumulator

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NIL-2.5 System Specifications

System name: NIL – 2.5 Imprinter

Stamper:

- Material: Nickel/Silicon
- Thickness 0,25-0,32 mm (recommended maximum. thickness 0,65 mm)
- Outer diameter 65 mm. Any size smaller then 65 mm in diameter
- Imprinting area: diameter 65 mm Ø

Substrate material:

- Silicon
- Glass
- Polymers

Substrate size:

- 2.5-inch or smaller.

Loading:

- Manual
- Larger substrate or stamper first.

Imprinting:

- One side imprinting.
- Two-sided imprinting.

Alignment:

- NO alignment system on this setup.

Heating:

- Heating of substrate to a max. of 250 ^{0}C with a temperature setting accuracy ±2.0 ^{0} C.
- Temperature differences across active surface is within +/- 0.5% of the temperature.

Substrate cooling capability:

Air-cooling is available.

Pressure:

Max. 70 Bar.

Manual material unload:

Sample is operated manually.

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Configuration options Lab-view controlled:

- Programmable recipe software
- Profile control for temperature
- Sequence: First heat, then press
- Pressure and position vs. time
- Closed feedback loop to ensure accuracy
- PID settings available
- Equipment test and calibration

Environment limitations:

- External temperature: 18 – 32° C
  - Will require additional cooling for keeping ambient constant
- Max. relative humidity: 65 %

Clean room performance:

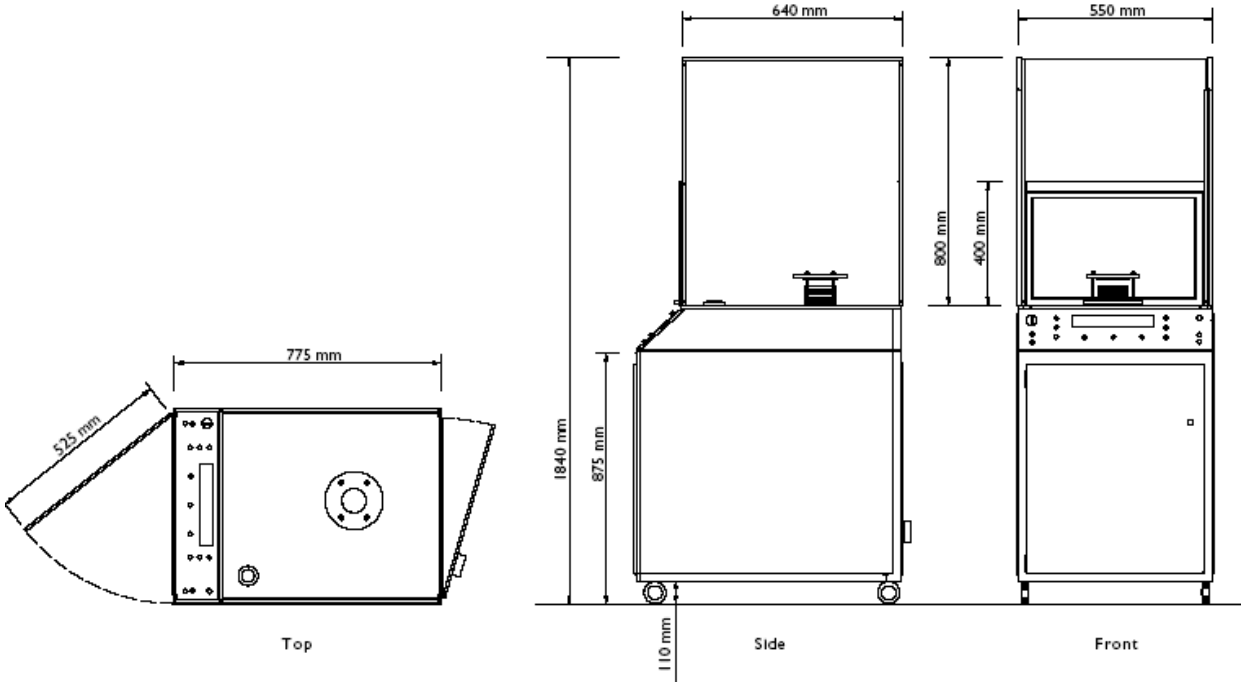
- Class 10 for the press module
- Class 1000 or better for rest of NIL equipment

Mains requirements:

- Frequency: 50/60 Hz
- Voltage: 1 phase, 230 VAC +/- 5%, Optional: 115 VAC

Markings and regulations:

- Interlocked safety covers restricting access to any hazardous energy, including movement
- EMOS



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Preventive Maintenance:

lose

Before each imprint

Check the O-ring. It should be placed well inside the O-ring track. There is a risk, depending on temperature, that the O-ring expand/shrink. As a result, the outer part of the O-ring may get displaced from the track. If so, press the O-ring back into the track using a flat screwdriver.

DAILY

Check the air tubes nearby the top press block.
Check the electrical connectors to the heater elements.

WEEKLY

Look for oil hosts in the rear compartment of the machine cabinet.
Clean with alcohol if necessary.
Check electrical connections.

MONTHLY

Check oil level, Damaged Cables, Hosts, Loose Screws.
Clean with alcohol if necessary.
Change the O-ring

YEARLY

Check oil level. Change the oil if necessary.
Test all functions.
Clean with alcohol.

ONLY authorized personnel is allowed to carry out maintenance or adjustments to this machine.

Maintenance and repair may **ONLY** be undertaken when the unit is switched off, and disconnected from the main input supply.

Repair work on hydraulic system, may **ONLY** be carried out when relevant pressures are at zero.

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Hydraulic Oil Reservoir:

Level Inspection:

If the reservoir oil level in the white tank in figure (9) falls below the mark "Min. level" it is important to check for oil leaks, as this can be the only reason for the oil level falling.

Provided the reason of the fall in oil level is established and the problem rectified, the oil can be topped up.

Level Top Up:

A flexible tube and funnel may be used for refilling the oil reservoir. For this method, only the Top Cap needs to be removed.

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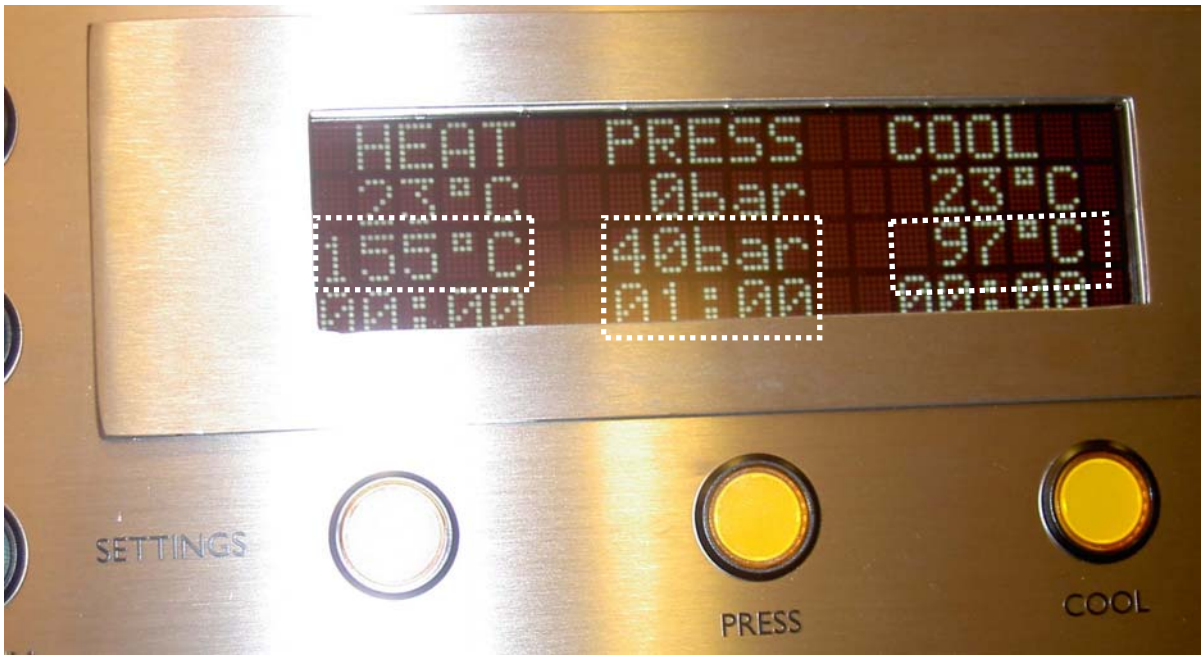
Display and Parameter Settings in Manual mode

The display shows the parameter values.



Adjustable values are indicated in the white-striped boxes.

Parameter Settings

Heat

23°C	Current temperature of Substrate Holder
155°C	**Required temperature (maximum 250°C)**
00:00	Heating time elapsed (mm:ss)

Press

0bar	Current pressure
40bar	**Required pressure (maximum 70 bar)**
01:00	**Required pressing duration (mm:ss)**

Cool

23°C	Current temperature of Substrate
97°C	**Required release temperature**
00:00	Cooling time elapsed (mm:ss)

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Installation:

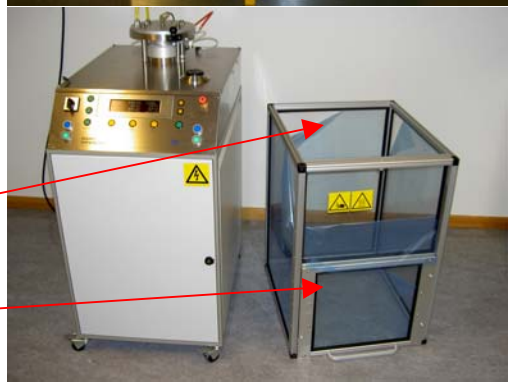
Clean the stainless parts with clean room tablecloth wetted with 2-propanol or ethanol, and/or water.

Note:

- The small cable connector, which shall be connected to the cover cage.
- The nuts at the corners are used to hold the cover cage in position.

Clean the machine part (left) and the cover cage (right). If there is protection plastic at the windows on the cover, carefully remove it.

Protection plastic
Slide front door of the cover cage



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Assembling the cover cage.

1. Place the backside of the cover cage on the machine (be sure that the nuts at the corners are covered) as it is shown in the picture.
2. Flip the cover cage down slowly until the front side is in contact with the top part of the machine.

3. Make sure that the cover cage is sitting well on the nuts and is not sliding.

Open the front door by pulling up the handle. In the up-position the door holds by a magnet. **(Make sure it does!!!).**

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At the left hand side, you will find two cable connectors. One coming through a hole in the top of the main cabinet, the other from the aluminum frame of the hood. Attach the connectors by gently pressing them together. When connected, push the excess cable into the hole to hide the connection under the top plate.	
In order to prevent particles and dust, the machine can be placed under a clean room filter with fan, or in a clean room.	
Pull out the cable.	

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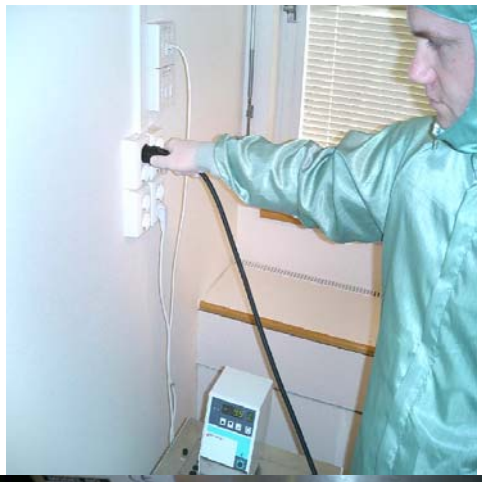
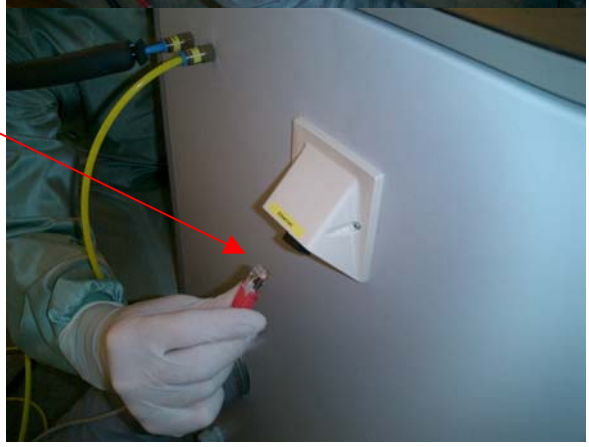
Plug the cable. 230, (10 A Fuse) (USA: 115, 20A fuse)	
Connect the Air connection using a 6 mm tube. Pressure: 6 to 8 bar. Connect the Nitrogen gas using a 6 mm tube. Pressure: 6 to 8 bar.	
Connect the exhaust pipe.	
If your system is equipped with the Lab-view option, connect the Ethernet cable from the PC to the equipment. (Note: Do not connect the equipment directly to the network, thus there is a risk for viruses)	

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Close the front door by holding the door by one hand and pressing (hit) the door down using the other hand. **Be careful, the retaining magnet is very strong.** **Repeat several times to master the closing procedure.** **Watch your hands and fingers!!!**	
Start the machine by turning the main switch to the “On” position. The machine is ready to use. Start to program the imprint parameters.	

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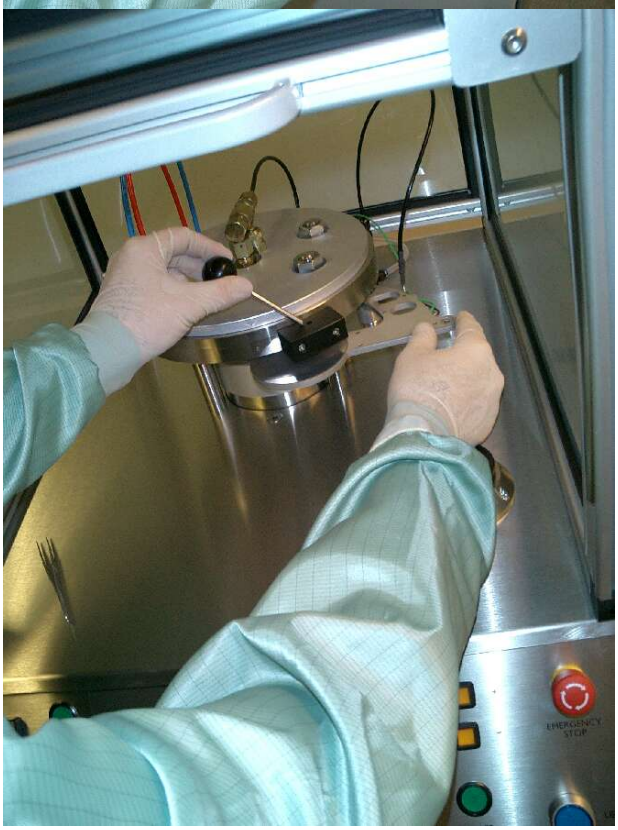
Loading substrate/stamper

Press the two ”DOWN” buttons for a few seconds to release the loader arm. (The elevator will stop when it is ready).	
Open the front door and pull up the loader lock pin to release the loader arm. Pull out the loader arm. Put the loader lock pin back into the hole to prevent the loader arm from swinging back in.	

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Place the stamp (substrate) on the holder Be sure that the stamp (substrate) is placed inside the seal ring of the loader.	
Place the substrate (stamp) on the stamp (substrate) Be sure that the substrate (stamp) is placed within the area of the stamp (substrate).	

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Use two or three aluminum sheets to cover the sandwich. (Approximately a 50 aluminum sheets are delivered with the machine). Be careful so that the aluminum sheet does not dislocate the substrate and stamp from each other. Note: the aluminum sheets can be used many times.	
Place the aluminum sheets over the stamp/substrate stack. The sheets should cover the entire holder part of the loader arm. Push the "VACUUM" button to apply vacuum in the loader. The vacuum is not necessary for the imprint, but it will hold the stamp/substrate in place while moving the loader arm into the pressure chamber.	
Lift the loader lock pin. Move the loader arm into the pressure chamber. Lock the loader arm in place by reinserting the load lock pin into the hole in the loader arm.	

The loading procedure is finished. You can run the imprinting program.
See the Running-instruction.

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Programming

Imprint temperature setting: Press the “TEMP” button once to select the temperature setting. The temperature unit is shown in “°C”. Use “+” or “-“ to change the value. Save and leave the programming mode by pressing the “ESCAPE”	
Pressure setting: Press the “PRESS” button once to set the imprinting time and press the “PRESS” button one more time to set the pressure value. The time unit is second and the pressure unit is bar. Use “+” or “-“ to change the value. Save and leave the programming mode by pressing the “ESCAPE”	
Cooling temperature: Press the “COOL” button to set the cooling temperature. Change the value using the “+” or “-“ buttons. Save and leave the programming mode by pressing the “ESCAPE”	
Alternative Programming: There are two pre-programmed settings. Press P1 or P2 to load the settings.	

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Running-instruction

Press and hold the two “UP” buttons simultaneously. Hold the buttons until an arrow (←)-mark appears on the display near to the HEAT-text.	
When the (←)-mark appears near to the HEAT-text on the display release the buttons. The process is than started automatically.	
When the process is finished the (↓)-mark appears near the COOL-text on the display. Press and hold the two ”DOWN” buttons simultaneously for a few seconds to release the substrate loader. (The elevator will stop when it is ready to take the loader out).	

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The Imprint Process as an example for Silicon and PMMA

(The settings are just an example and should not be taken as a standard)

The substrate, covered with a polymer, is placed on the Substrate Holder. The stamp is placed on top.	**Stamp** **Polymer** **Substrate** 	2" Nickel Structure height ≈ 150 nm 30% coverage PMMA = 50K Thickness ≈ 150 nm Si (2")
The substrate and stamp are heated to required imprint temperature. Recommended temperature range is 50 - 200°C.	**Heating** 	T imprint ≈ 140°C-160°C T max ≈ 200°C
The imprint is effected at high pressure. Recommended pressure is 12 – 50 bar, but pressures up to 70 bar can be applied.	**Imprint** 	Pressure ≈ 30-40bar Time ≈ 30s – 5 min **(5 min for smaller trenches)**
After the imprint is completed, the substrate must be cooled in order to prevent the polymer from being damaged when the stamp is released. Recommended cooling temperature range is 60 - 100°C.	**Cooling** 	T release = 97-100°C
The stamp is released from the substrate when the requested release temperature is reached. The imprint process is now completed.	**Release** 	
The ashing will be performed in another machine.	**Ashing** 	Use oxygen RIE (Reactor Ion Etching) Or Plasmapream Cleaner O_2 @5 mbar, Etchrate<2nm/s

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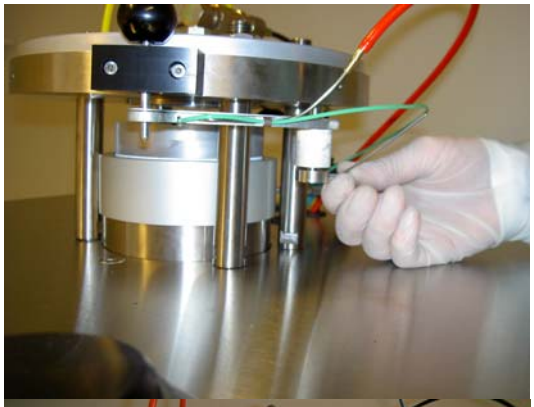
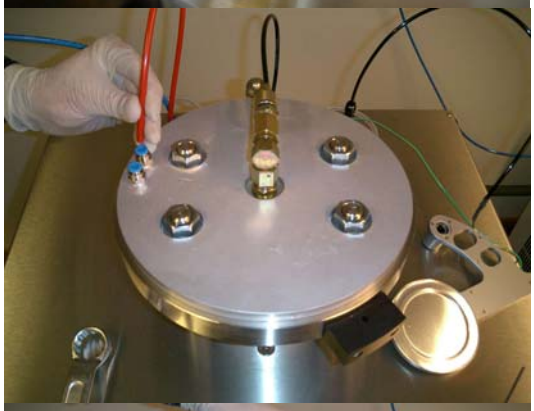
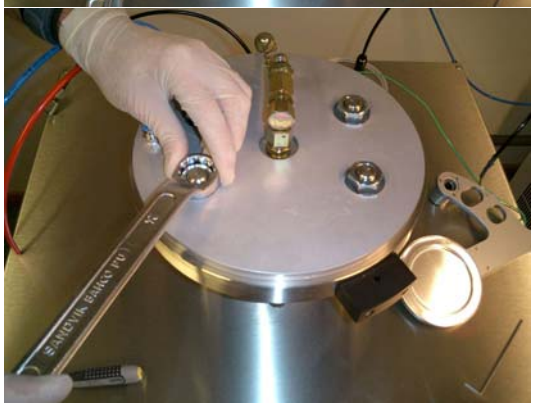
Changing the Sealing Ring

Use an Allen-key to remove the Loader Arm.	
Remove the Air cooling tubes and	
Remove the high-pressure connector.	
Lose the nut from the top pressure plate	

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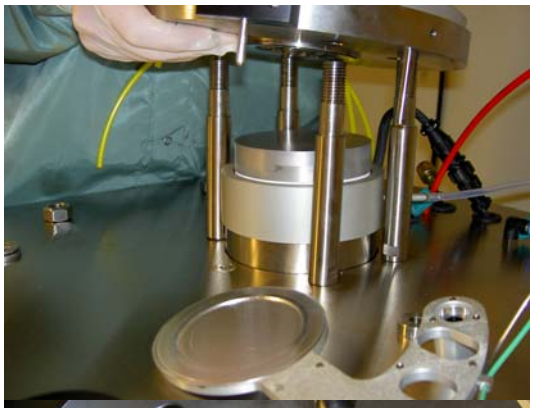
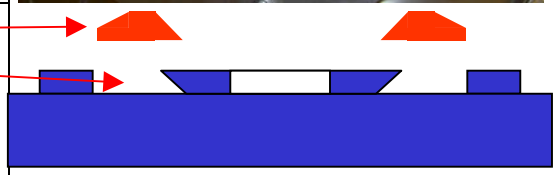
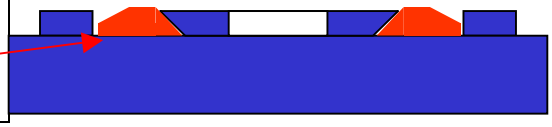
Remove the top pressure plate and place it up and down on the pins	
Remove the old O-ring by pressing from the outside part of the ring using a screwdriver.	
	
O-ring and the O-ring track.	
The O-ring should be install inside the O-ring track in the right side as shown in the drawing.	

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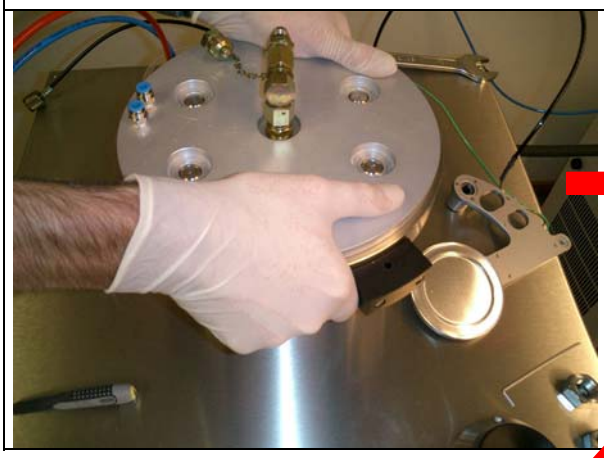
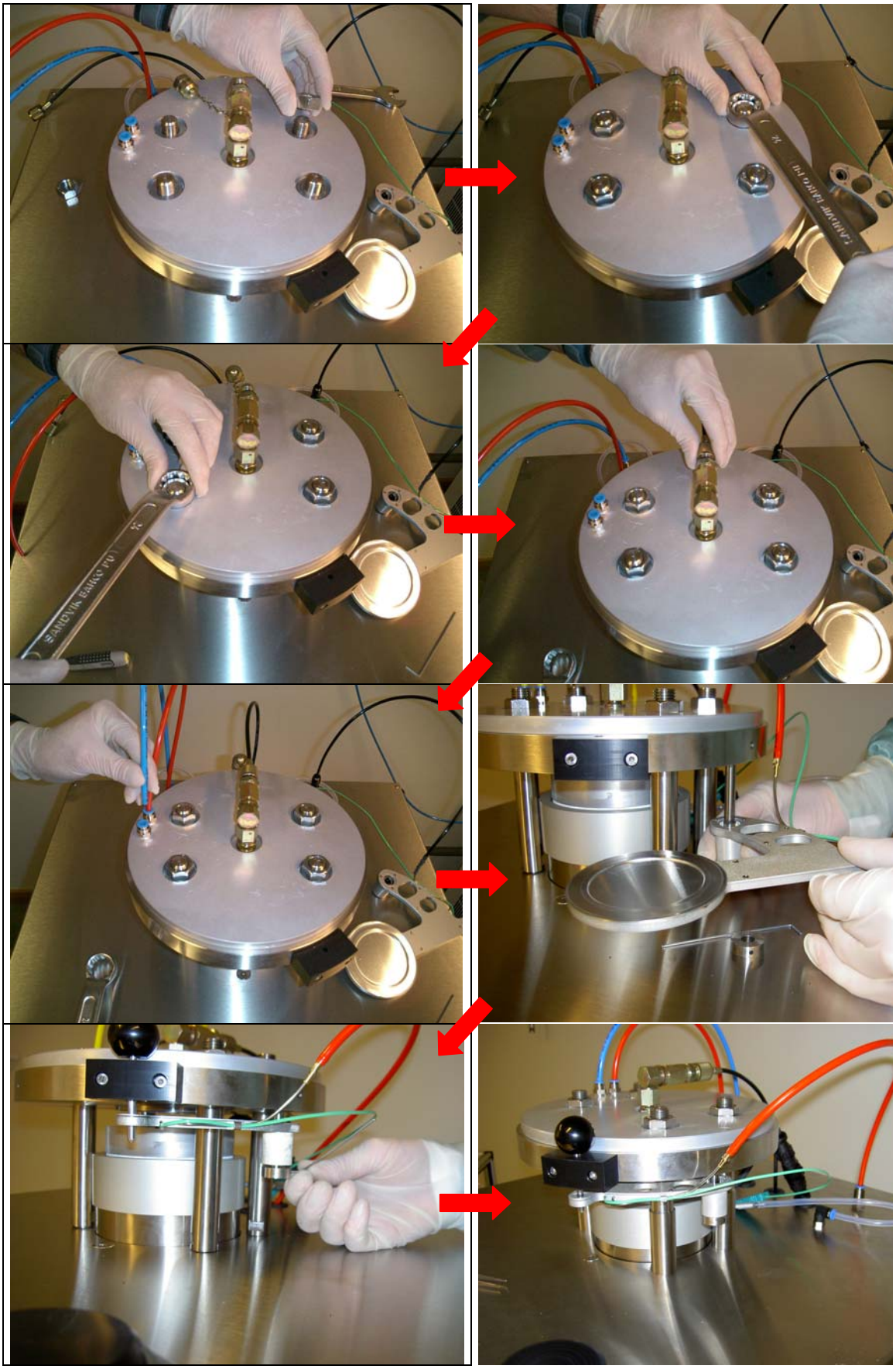
Start from one side and place the O-ring in the track. Be sure to place the inner edge first and then the outer part. (The O-ring is smaller than the track diameter)	
Place the O-ring around by holding and pull the O-ring around the track in same time pressing it inside the track.	
The O-ring will be remaining inside the track when the O-ring is placed completely in the track correctly. Reinstall the top plate and the tubes back according to pictures below.	
	



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Other features

Cooling: It is possible to use liquid nitrogen in order to cool down the sample to a temperature lower then the ambient temperature. The cooling time decreases when using liquid nitrogen. Pour out about 0.5-litter liquid nitrogen directly into the container shown in the picture.	
The “EMERGENCY STOP” button: By pressing the “EMERGENCY STOP” button you will terminate the pressure function and terminates the imprint cycle. You reset this button by turning it clockwise.	
The imprint cycle can be terminated by pressing the two “Down” buttons simultaneously	
When the machine is on idle (no imprinting), you have possibility to check some information on the display. The equipment information will appear on the display by pressing the “ESCAPE” button once. You need to press the “ESCAPE” button one more time to leave this mode.	

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Power breakdown vs. pressure

In the table 1 below you can see the effect on the pressure in the chamber if there is a power breakdown.

Action	***Stand Alone***	***PC-control mode***
1. At rise sequence	No pressure.	No pressure.
2. At pressure lock in	No pressure.	No pressure.
3. At heating process	Still pressure in chamber.	Still pressure in chamber.
4. At pressure build up	Still pressure in chamber.	Still pressure in chamber.
5. At imprint sequence	Still pressure in chamber.	Still pressure in chamber.
6. At imprint sequence/pressure rebuild	Still pressure in chamber.	Still pressure in chamber.
7. At cooling sequence	Still pressure in chamber.	Still pressure in chamber.
8. At cooling sequence/pressure rebuild	Still pressure in chamber.	Still pressure in chamber.
9. At lower sequence	No pressure.	No pressure.

Table 1. Power breakdown vs. pressure

OBS. After turning power on to the imprinter there is still pressure in the chamber. To release the pressure, press simultaneously the two “Down” buttons in Stand Alone mode.

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Emergency stop vs. pressure

In table 2 below you can see what happens with the pressure in the chamber when emergency stop button (EMO) is pressed in different states in software.

Action	***Stand Alone***	***PC-control mode***
1. At rise sequence	No pressure.	No pressure.
2. At pressure lock in	No pressure.	No pressure.
3. At heating process	The imprinter is releasing the pressure.	The imprinter is releasing the pressure.
4. At pressure build up	The imprinter is releasing the pressure.	The imprinter is releasing the pressure.
5. At imprint sequence	The imprinter is releasing the pressure.	The imprinter is not releasing the pressure.
6. At imprint sequence/pressure rebuild	The imprinter is releasing the pressure.	The imprinter is not releasing the pressure.
7. At cooling sequence	The imprinter is releasing the pressure.	The imprinter is not releasing the pressure.
8. At cooling sequence/pressure rebuild	The imprinter is releasing the pressure.	The imprinter is not releasing the pressure.
9. At lower sequence	No pressure.	No pressure.

Table 2. Emergency stop vs. pressure

OBS. To release the pressure after EMO reset, press simultaneously the two “Down” buttons in Stand Alone mode. If there was no pressure when emergency stop button was activated, just reset the EMO and press once on any of the two “Down” buttons to get the imprinter ready for a new imprint.

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Hydraulic oil specification

- Brand: Statoil Hydra Way 46 HVXA 46**.**
- It is a highly refined Mineral oil.
- This is a outdoor oil in order to be more tolerant to temperature differences
- Type: VG 46 oil, in the ISO-standard
- It is possible to blend it with other brands, but it have to be a outdoor mineral oil type VG 46.

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