

## **Cleanroom rules and regulations**



**NanoLabTUE**  
**[www.tue.nl/nanolab](http://www.tue.nl/nanolab)**

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## Introduction to the cleanroom

Welcome as a user of the cleanroom in the Spectrum building of TU/e. The cleanroom has three levels. The normal cleanroom working environment is situated on level 1 of the building. Level 2 is above the ceiling and not accessible. This level contains the filter fan units that are responsible for the laminar down flow through the working environment on level 1. The ground level is called subfab. This area is reserved for auxiliary equipment like vacuum pumps, exhaust ventilation channels and gas lines. It is also used for storage of components and materials.

The air flow inside the cleanroom is from top to bottom and is recirculated 20-30 times per hour. Each time the air passes through a filter fan unit, the HEPA filter will filter any particle larger than 0.5  $\mu\text{m}$ . This system will guarantee an ISO 6 cleanroom (class 1000), together with the behaviour of the users.

To ensure a clean, healthy, and safe work environment it is mandatory to follow the rules of this document. In addition all users have to follow the generic TU/e safety and behaviour rules (see Annex B).

## Authorisation for access

After requesting for access the new user will receive the following documents:

- Cleanroom rules and regulations (this document).
- Registration form by which user declares to know the rules and also to specify the appointed mentor for the cleanroom work (typically a colleague in your group).
- External users will receive emails from TU/e to (1) preregister, (2) upload passport and hospitality declaration, (3) pick up the TU badge.

All new users should request for the course **Cleanroom Safety Introduction & General Intake** via the NIS (NanoLabNL Information System). After the intake the user receives a name tag for the CR clothing and must apply for a user box (see below). Finally, Nanolab will inform TU/e security for authorising the TU/e badge for access to the cleanroom door.

## Opening hours and entry rules

The cleanroom is only accessible with an authorised TU/e badge from Monday till Sunday between 07:00 and 23:00. These opening hours are for the Spectrum building too. This means it is not possible to leave the building between 23:00 and 07:00. Make sure you leave the cleanroom in time to prevent to get locked in. There can be exceptions for this time frame, e.g. for external parties working in shifts.

To open the door to the cleanroom you must hold your TU/e badge against the badge reader. The door will get unlocked and your name will appear on the registration display. Your presence in the cleanroom will be registered for safety and hour registration reasons. It is mandatory to register with your TU/e badge, also when you enter the cleanroom with someone else. You are also obligated to use your TU/e badge when leaving the cleanroom. Do not leave the cleanroom doors open for an extended time and make sure the door is closed completely when entering or leaving the cleanroom.

The cleanroom is equipped with surveillance cameras. Registration information will be kept for a maximum of six months, camera footage is kept one week.

Each authorised user can take 5 visitors into the cleanroom after approval by the Nanolab staff. The user is responsible that visitors do not touch anything and must guide them to the safety exits in case of an evacuation.

It is not allowed to be alone in the cleanroom. Outside business hours and during the weekend it is mandatory to enter with at least one other authorised person and to organize this upfront. Please check the monitor above the exit door to be sure that nobody stays inside alone.

There are special rules when working outside normal business hours (between 08:30 and 16:30 hours) due to delayed response times by a safety assistance team in case of an accident. The following activities are in principle **not allowed outside business hours**:

1. Changing MO's or gas bottles
2. Mixing of chemicals\*
3. Use of high-risk chemicals:
  - a. concentrated fuming nitric acid ( $\text{HNO}_3$ )
  - b. concentrated piranha ( $\text{H}_2\text{SO}_4/\text{H}_2\text{O}_2$ ) (*diluted Pyranha is allowed*)
  - c. HF (in any concentration) \*

*\* Exception to this rule: HF and mixing are allowed in the off-hours in presence of a certified BHV user or in presence of another authorized, yearly trained user.*

## Personal belongings

Contamination of the cleanroom must be prevented as much as possible. This starts with keeping most particle generated materials outside the gowning. Coats, jackets, sweaters umbrellas, bags and backpacks must be left outside the gowning in the coat rack outside. Use of this coat rack is at your own risk. NanoLabTUE is not responsible for theft or loss of personal belongings.

There are lockers available to store personal belongings and valuables. These lockers can be used with your TU badge. In case of malfunction, please contact the reception of FLUX.

## Cleanroom dressing procedure

Entrance to the cleanroom is only allowed when wearing the appropriate cleanroom clothes. It is mandatory to wear a cleanroom cap, cleanroom suit, overshoes, gloves and name card in the proper way. It is not allowed to wear open shoes. All personal clothing must be completely covered. Make sure no (loose) hair sticks out. Special beard covers are mandatory for those who have a beard and/or moustache. Not following the cleanroom dressing procedure will lead to an increased number of particles inside the cleanroom and an increased risk in contamination of your samples and materials. See also Annex E for the dressing procedure.

Nitrile gloves are also mandatory. These provide a first protection against possible contaminated objects like door handles and are a first barrier for chemicals. Be aware these nitrile gloves are not chemical resistant. In case of suspicion of contamination please dispose them and take a new pair. All gloves are to be disposed in the designated grey waste bins.

After leaving the cleanroom and entering the dressing area deposit your mouth mask (in case you wear one) in the designated bin marked TU/e. It is mandatory to leave your cleanroom suit and hood at one of the hangers when leaving the cleanroom. Take off the grey gloves and put them in the designated waste bin. It is advised to replace your cleanroom suit once a week. When not using the cleanroom for a longer period please put your cleanroom suit in the laundry bin. Each Thursday freshly washed cleanroom clothing will be supplied.

## Contamination control

In order to keep the cleanroom clean the following behaviour rules apply.

1. It is prohibited to take dust-generating materials like (uncoated) wood, paper, cardboard of rusted materials inside the cleanroom. Styrene foam is not allowed either.
2. Do not eat or drink inside the cleanroom. Chewing gum is also not allowed,
3. Also do not smoke just before entering the cleanroom; wait at least twenty minutes before entering,
4. Only use special cleanroom paper,
5. It is not allowed to run inside the cleanroom. Always move calm and in a controlled manner,
6. Use the decontamination room to transport consumables or large materials, and clean materials before bringing them inside the cleanroom,
7. Always keep your workspace clean. Store samples or other materials in the user box.
8. When entering or leaving the cleanroom close the outer door completely and take care that the outer and inner door are not open at the same time.

## User box and samples

You will be provided with a user box when cleanroom authorisation is granted. This box must stay inside the cleanroom and must be used for storing samples and the materials you are working on. Students do not need to buy a user box and they can use the box of their cleanroom supervisor.

The cleanroom box contains a timer, safety goggles and a set of tweezers. The user box is NOT meant for storing chemicals and resists. The cleanroom box is personal, and you are responsible for this box at all times. A deposit of € 100 must be paid by bank transfer. For this purpose a mandate form is available. After finishing the project or at the end of the position the box should be returned to NanoLabTU/e. For returning the deposit the request of payment form can be found at the TU/e website.

New substrate materials which are not standard can only be used after approval by the Nanolab staff. Standard materials are Si, GaAs, InP, quartz and glass. On the homepage of NIS a list of allowed material can be found.

## Hearing protection / headphones

The machines in the cleanroom produce a lot of noise. Measurements have been done to determine the exact noise pressure which is approximately 76 dB(A). This is a safe environment to work without hearing protection. Nevertheless, the noise levels and its frequency can be troublesome at times. It is possible to get personal hearing protection specially made to fit in your ears. Please refer to the safety technician of your group for ordering. See link in Annex B. It is not allowed to use music systems and headphones in the cleanroom.

In the subfab hearing protection is mandatory. An earplug dispenser is available at the entrance doors.

## Safety Goggles

In principle you can enter the cleanroom without wearing safety goggles. Nevertheless, it is mandatory to wear safety goggles in designated areas. These areas are the Yellow Room, the area surrounding the wet chemical benches in the ballroom (behind the yellow/black lines on the floor), the grinding/polishing room and the chemical preparation areas in the MBE/MOVPE modules. Use of safety goggles in those areas is also obligated when you are not working with chemicals. A personal safety goggles is provided with the user box. Safety goggles are also available in two special boxes that are located next to the wet chemical area and next to the cleanroom entrance.

*Remember: spectacles are NOT safety goggles. You need to wear safety goggles over your own spectacles.*

## Use of equipment

Use of cleanroom equipment is only allowed after an extensive training. The training courses are to be requested by directly contacting the responsible equipment owners who eventually will authorise you for using a tool. Please send your request for training shortly before you start with the actual work. For EBL, DUV scanner and wet-chemical training a minimum stay period of 7 months applies.

All equipment is provided with a status card that shows if it's UP or DOWN and can also be viewed in the NIS reservation system (NanoLabNL Information System). Name and phone number of the equipment owners to contact can be found in the reservation system. The actual list with all equipment and equipment owners can be found on the NanoLabTUE website too.

1. It is not allowed to use equipment if you are not instructed and permitted to operate the equipment
2. It is not allowed to use the equipment without a reservation in NIS
3. Changing of process recipes is not allowed, unless this is explicitly approval by the equipment owner
4. Only materials that are in the *allowed materials lists* (see NIS) are allowed. If you have a new material please send a request to one of the NanoLabTUE staff members.
5. It is not allowed to make hardware or software modifications in any way

6. It is not allowed to bring your own USB stick into the CR (some computers do not have up-to-date virus protection)
7. It is not allowed to use the equipment when it is not in the status UP in the Living Database, or with the status card reading DOWN
8. Fill in the equipment logbooks in NIS (depends on the tool)
9. Keep the equipment and working area clean (for next users)
10. Report any faults or defects to the responsible equipment owner immediately
11. Misuse of equipment and unauthorised use of equipment will result in a penalty
12. After not using a tool for more than one year your access rights will expire and you need to ask the equipment owner for re-training.

## Wet chemical processing

It is not allowed to use wet chemical processing without a proper introduction and instruction by a staff member. A request for the chemicals can be found in Annex C. After training your authorisation will be filed in NIS and you will receive personal cards for each approved chemical.

All wet chemical processing must be performed inside the designated wet bench. It is not allowed to work with more than 2 persons in the same wet bench. For sake of your own safety and exhaust capacity please keep the windows in the downward position as much as possible, and anyhow close them after finishing your work. Safety goggles are mandatory in all chemical areas. Chemical resistant gloves for inorganic processing (i.e. all acids and alkalines) are highly recommended, especially for inexperienced users. They can be found in the wet-bench area. In addition aprons and face shields are available.

Walking from one place to another with (open) chemicals is strictly forbidden. However, there are two exceptions. Ultra-Pure Water (UPW) is the only chemical that can be transferred as an open system. The second exception is spray bottles with acetone or isopropanol that can be used outside fume hoods or wet benches. But be aware that these liquids, especially acetone, are highly flammable! Please be aware that these organic solvents can be risky if used close to electrical systems in terms of creating a fire.

Dispose your own chemicals in the designated waste container when ready. Notify the Nanolab staff if chemicals are running out. Full waste bottles replacement should be done by the user.

Many types of chemicals are being used inside the cleanroom. Before working with chemicals, you need to be aware of the risks and possible health issues. Material Safety Data Sheets (MSDS) are available for every chemical that can be found inside the cleanroom. Refer to the Cleanroom Safety Committee if chemical processing not described in one of the procedures. In case of a new wet-chemical process first a proper process description and safety inquiry must be made. It is prohibited to take chemicals inside or outside the cleanroom. Introduction of new chemicals is only allowed after assessment and approval by the Nanolab staff.

Extra care must be given to carcinogenic, mutagenic and reprotoxic materials (CMR materials). Exposure to carcinogenic agents can increase the possibility to induce cancer. Exposure to mutagenic agents can cause a

permanent change in the genetic materials inside cells (mutations). Exposure to reprotoxic agents can have an adverse effect on sexual function and fertility in both males and females. Please refer to the latest updated list of these materials via the link on the website mentioned in Annex B. Cleanroom users that have a child wish or already are pregnant need to be extra careful and prevent possible contact with CMR materials. Please refer to the TU/e policy *“Pregnancy & Employment”*. Anyhow, it is advised to refrain from resist coating activities (see Annex B). In case you will be working with heavy metals or nanomaterials that can become airborne special precautions need to be made and it is advised to first visit the

## In case of an emergency

The cleanroom is a high-risk environment. Different chemicals are being used and quite a few very dangerous gasses are present in the subfab and cleanroom. Many precautions are taken to make working inside the cleanroom as safe as possible. Even so, there is always a risk something happens. The cleanroom is provided with smoke detection, high sensitivity particle detection and gas detection. All these systems are fully automatic and will give an early warning signal when something goes wrong. This can be a visual alarm or an evacuation alarm. The gas systems of the cleanroom will go into safe state automatically when an alarm occurs and if the exhaust ventilation fails.

### Evacuation alarm

The evacuation alarm is a slow-whoop signal with a spoken message. You must leave the cleanroom in an orderly manner by taking the nearest emergency exit. In all four corners of the cleanroom emergency exits are located. Make sure you leave your workspace behind safely to prevent a possible second emergency. Do not use the elevators during an evacuation. Take any visitors with you. During incidents the cleanroom door will be blocked with the warning belt and it is forbidden to enter.

### Visual alarm

A visual alarm means something is wrong, but the situation is not yet dangerous. It is NOT necessary to leave the cleanroom without further notice. Ask the NanoLab staff if you have questions or doubts about the visual alarm. Sometimes a visual alarm will go together with a local alarm signal. This is not an evacuation signal. A visual alarm can be a prelude to an evacuation alarm.

### Chemical accidents

Before you start using chemicals, always make sure you know where to find the emergency rinsing agents, the emergency shower and eye wash shower. This also holds for the Sub-Fab in case unknown liquid is dripping from above !

Cry for help to get assistance from your colleagues. If someone next to you has a chemical accident, please assist him or her. Be take care of your own safety. Always (ask someone to) call the emergency number (040 247) **2222** to report the accident, even if it seems to be insignificant. Also report the incident to one of the NanoLab staff members. In case of a chemical accident you have rinse yourself excessively with water for at least 20 minutes, or as long as possible. Use one of the eye wash showers or emergency showers. When your clothing is contaminated, remove all clothing while rinsing with water.



Besides water, there are two special rinsing agents available: Diphoterine and Hexafluorine.

Diphoterine is a neutralizing agent for most acidic and alkaline burns, and it is available as an eye wash bottle and a spray can. They can be found in the orange boxes.

Hexafluorine is a special rinsing agent for HF burns. It is provided in an eye wash bottle and in bottles with rinsing liquid. Calcium gluconate ointment for HF burns can also be found in the hexafluorine kit. Use excessively after rinsing with hexafluorine. Both are present in the black boxes.

### **Other accidents**

Other accidents also need to be reported to the NanoLabTUE staff. In case of a severe accident like cutting yourself or injuries due to falling, always (ask someone to) call the emergency number (040 247) 2222 to report the accident. If necessary, TU/e personal will arrive to give assistance of emergency help. If you encounter a potentially dangerous situation, please do not hesitate to contact the NanoLabTUE staff immediately.

### **Manual evacuation alarm**

It is possible to activate a manual evacuation alarm by pressing one of the fire alarm buttons or one of the gas detection buttons.

### **Cleanroom plan**

A schematic floor plan of the cleanroom and subfab with the locations of all emergency exits and safety aids is provided in Annex D.

## **Penalty in case of breaking the cleanroom rules**

Not obeying the cleanroom rules is a serious offence. Misbehaviour might affect the cleanroom conditions or lead to unsafe situations for other cleanroom users. The number of repeated violations will affect the severity of the penalty.

All NanoLabTUE staff members are obliged to report all violations including names to the Cleanroom Safety Committee. Orders by the NanoLab support staff always have to be obeyed. The cleanroom Director (or his representative in time of absence) will give the official warning and exclude people from access to the cleanroom for a time period. Also, the supervisor of the person involved will receive a copy.

### **After the first violation**

An official warning is given and possible cleanroom exclusion for the rest of the day

### **After the second violation**

A second official warning is given and two weeks of cleanroom exclusion

### **After the third violation**

Permanent cleanroom exclusion

## Appendices

### A. NanolabTUE staff

Director:	Frank Dirne
Process Engineers:	Patrick Bax Jeroen Bolk Beatriz Barcones Campo Erik Jan Geluk Barathi Krishnamoorthy Stacey Martina René van Veldhoven Tjibbe de Vries
Technicians:	Martijn Dijkstra Herman Leijssen Marissa Vlemminx- Roijen Jeroen Jansen
Logistics and support:	Alwin Maas

## B. Useful links

- NanoLabTUE website  
<http://www.tue.nl/nanolab>
- NanoLabNL Information system (NIS)  
<https://nis.nanolabnl.nl/login>
- General TU/e safety and behaviour rules  
<https://www.tue.nl/en/our-university/about-the-university/support-services/human-resources-management/occupational-health-safety-environment-and-radiation-protection-ohser/department-ohse-radiation-protection-ohse/ohse/safety-tue-instruction-videos/>
- Chemical Safety Cards (MSDS) online  
<https://jr.chemwatch.net/chemwatch.web/home>
- CMR materials (Dutch)  
<http://www.rivm.nl/rvs/Gevaarsindeling/CMR>  
<https://zoek.officielebekendmakingen.nl/stcrt-2018-21.html>
- Request form hearing protection (Dutch)  
<https://intranet.tue.nl/en/university/services/service-for-personnel-and-organization/working-environment/occupational-health-safety-environment-radiation-protection/occupational-health-safety-environment-ohse/ppes-personal-protection-equipment/hearing-protection/>
- Pregnant employees & prospective parents  
<https://intranet.tue.nl/en/university/services/service-for-personnel-and-organization/working-environment/occupational-health-safety-environment-radiation-protection/occupational-health-safety-environment-ohse/special-categories-of-employees/pregnant-employees-prospective-parents/>
- Working with heavy metals
- Working with nano-materials
- Slow whoop evacuation sound example  
<https://www.youtube.com/watch?v=QQ4YOBMrkhl>
- Use of Diphoterine / Hexafluorine  
<https://www.youtube.com/watch?v=huaEwKWx41I>

### C. Request for of wet chemical process Cards

Name :

Date :

Which chemicals will you be using:

Acetone	<input type="checkbox"/>	HNO <sub>3</sub> conc.	<input type="checkbox"/>	Isopropanol (IPA)	<input type="checkbox"/>	MIBK / IPA rinse for ZEP
Acetone for Lift-off	<input type="checkbox"/>	(NH <sub>4</sub> ) <sub>2</sub> Sx / H <sub>2</sub> O	<input type="checkbox"/>	Isobutyl methyl ketone	<input type="checkbox"/>	MIF-826 Dev (TMAH)
AZ 400K Dev (KOH)	<input type="checkbox"/>	H <sub>2</sub> SO <sub>4</sub>	<input type="checkbox"/>	IPA/MIBK Dev for PMMA	<input type="checkbox"/>	MIF-826 for Silicon etching
AZ-Dev	<input type="checkbox"/>	H <sub>2</sub> SO <sub>4</sub> /H <sub>2</sub> O <sub>2</sub>	<input type="checkbox"/>	KI/I <sub>2</sub> solution	<input type="checkbox"/>	n-Amylacetate dev for ZEP
Buffered HF 7:1	<input type="checkbox"/>	H <sub>3</sub> PO <sub>4</sub> diluted	<input type="checkbox"/>	KOH (33% by weight)	<input type="checkbox"/>	NMP
Buffered HF 30:1		<p style="text-align: center; color: red; font-weight: bold;">Example Only:</p> <p style="text-align: center; color: red;">For more information on requesting chemical card please read the Wetbench Wet Chemistry reader which can be found at the course in NIS</p>				H diluted
Chromium etchant						H/H <sub>2</sub> O <sub>2</sub> /H <sub>2</sub> O RCA1
Citric acid in solution						262 Dev (TMAH)
Citric Acid regrowth						Dev
Citric acid/H <sub>2</sub> O <sub>2</sub>						OR
Copper polishing etch						1D
Chromium etchant						000
Ethanol						plution
(NH <sub>4</sub> ) <sub>2</sub> HPO <sub>4</sub> Titanium etch	<input type="checkbox"/>	HF (1%)	<input type="checkbox"/>	Ma-D 532s Dev	<input type="checkbox"/>	UPW for rinsing
H <sub>2</sub> O/H <sub>2</sub> SO <sub>4</sub> /H <sub>2</sub> O <sub>2</sub>	<input type="checkbox"/>	HSQ 6% resist	<input type="checkbox"/>	Methanol/Br <sub>2</sub>	<input type="checkbox"/>	
H <sub>2</sub> O/NH <sub>4</sub> OH/H <sub>2</sub> O <sub>2</sub>	<input type="checkbox"/>	IPA Rinse for PMMA	<input type="checkbox"/>	Mesitylene	<input type="checkbox"/>	
	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	

It is prohibited to use wet chemicals without authorisation.

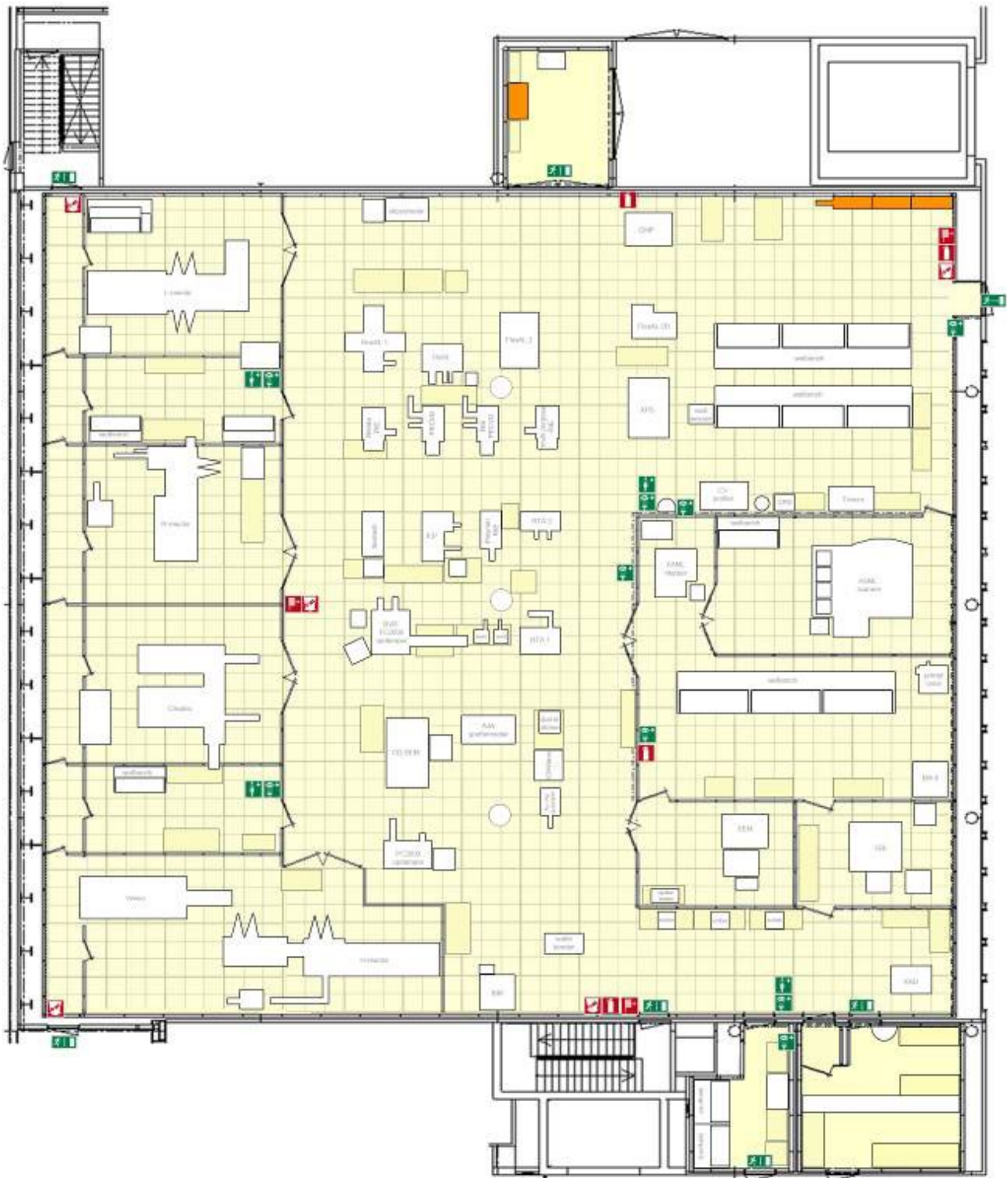
Authorisation can only be given by Patrick Bax (or in absence by Frank Dirne).

After filling in the form send the document to [p.p.p.bax@tue.nl](mailto:p.p.p.bax@tue.nl).

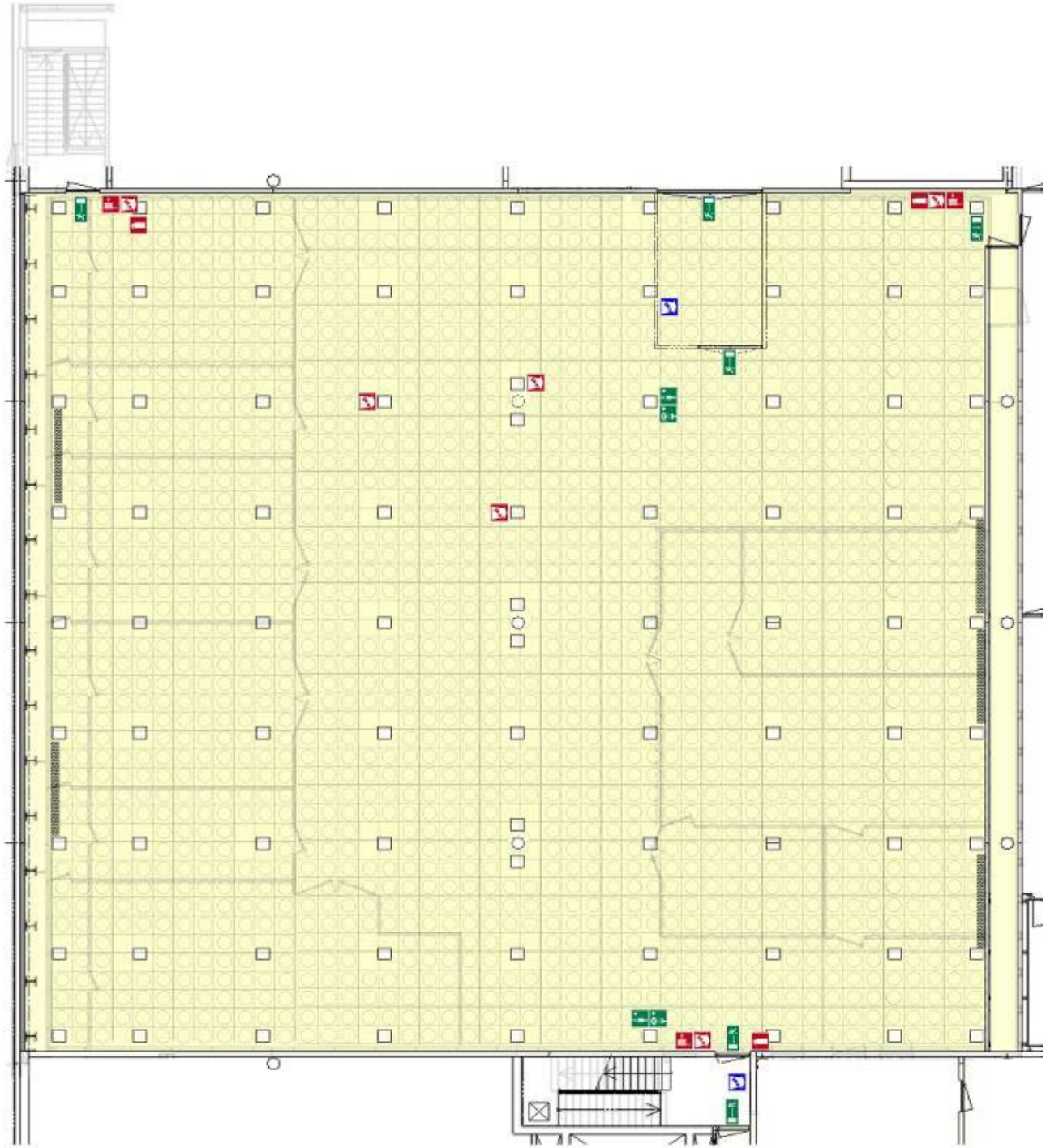
After accordance we will prepare the individual cards and provide them to you.

For more information please refer to the document "*Cleanroom Rules and Regulations*".

## D. Cleanroom Map – Spectrum 1<sup>st</sup> floor



Cleanroom Subfab (SP0.28) – Spectrum ground floor





## E. Dressing procedure

