# Table of Contents

I. Introduction ........................................................................................................................................ 1

II. Lab access and renewal policy ......................................................................................................... 2
  1. Lab Access Procedure .................................................................................................................. 2
  2. Lab Access Renewal Procedure .................................................................................................. 2

III. General Rules & Regulations .......................................................................................................... 3
  1. Lab entry rules ............................................................................................................................. 3
  2. Buddy System ................................................................................................................................ 3
  3. Chemistry Lab rules ...................................................................................................................... 4
  4. Clean room rules .......................................................................................................................... 5
  5. Violation/Offence response .......................................................................................................... 6

IV. Roles & Responsibilities: SO, AU, Operator, Lab-in Charge .............................................................. 7
  1. System Owner (SO) ...................................................................................................................... 7
  2. Authorized User (AU) .................................................................................................................. 7
  3. Operator ....................................................................................................................................... 8
  4. Lab-in-charge (LIC) .................................................................................................................... 8

V. Equipment Usage Policy at IITBNF ........................................................................................................ 9
  1. Process Request ........................................................................................................................... 9
  2. Training Request .......................................................................................................................... 9
  3. Lithography and SEM tools usage .................................................................................................. 10

VI. Anti-Contamination Policy ............................................................................................................ 11
  1. Contamination Categories .......................................................................................................... 11
  2. Miscellaneous Definitions ........................................................................................................... 14
  3. Usage of Glass ............................................................................................................................. 15
  4. Exceptions .................................................................................................................................. 15
  5. Approved process flow charts ...................................................................................................... 16
  6. Ongoing activities to develop Anti-Contamination Policy ........................................................... 20

VII. Violations policy & Disciplinary committee .................................................................................. 21
  1. Principle of Violations policy ....................................................................................................... 21
2. Types of violation
3. Procedure
4. Escalation path for DAC
5. Implication on regular lab running
6. In case of a witness to a violation
7. For violators

VIII. Equipment Up & Down Policy
IX. Lab Shutdown Policy
X. Inventory Policy

Appendix A: Some decisions taken by the faculty oversight committee
Appendix B: Purchase procedure for non-bulk chemicals by the user
I. Introduction

"IIT Bombay Nano Fabrication Facility (IITBNF) is one of the premier research centers catering to a large number of users across the institute as well as across the country, thanks to the INUP (Indian Nano electronics Users Program) program. The research activities at the center cover a wide spectrum of topics, starting from CMOS devices to III-V devices to 2-D materials and more. Catering to a large audience across various disciplines brings with it a slew of challenges. From a user's standpoint, one of the key focuses would be to get the work done at the earliest. This includes allocation of resources in terms of manpower, machine time, and other support systems.

A clear and decisive policy document serves as a guideline to lab members on how to go about their tasks efficiently without any conflicts or confrontations. Being aware of your responsibility as a lab user, can render clarity in execution and implementation of actions in a time bound manner. No policy document is complete and all encompassing. Hence policy making is a collective and continuous activity."

- By Dr. Sandeep S.S., Ex Ph.D. student
II. Lab access and renewal policy

To avail the IITBNF facilities, one needs to go through the lab access procedure and register on the online slot booking module. After that, biometric lab access to various labs can be attained. Lab members need to get renewal done every six months (June/July and December/January).

1. Lab Access Procedure
To attain IITBNF lab access, new members should follow the procedure as given in the link:

http://www.iitbnf.iitb.ac.in/iitbnf/index.php/operation?layout=edit&id=27

2. Lab Access Renewal Procedure
Registration for all lab members expires on 30th June and 31st December every year.

Extension is given every six months when the steps given below are strictly followed:

- For renewal in June/July, seminars on safety and contamination are arranged for lab members. Attendance is mandatory.
- For renewal in December/January, all lab members need to give the safety, contamination, basic clean room tests and clear them all.
- During every extension:
  - Lab members need to meet IT team to check their profile for any modifications/corrections.
  - Lab members need to declare that all the papers/publications associated with work done at IITBNF are uploaded in the repository of IITBNF with the approval by their supervisor.

Note:

- Online tests are conducted for:
  - New user throughout the year
  - Lab members once a year in December
  - Members whose registration expires due to 'not using the lab' continuously for 3 months.

- Lab members who clear the test after 1st October, need not give the test again in December. However, they will have to meet IT team for the extension.
III. General Rules & Regulations

1. Lab entry rules
   For all members/ non-members/ visitors

   ➢ Before entering the labs
     • Remember: The lab is not a meeting place. Enter the lab only if you need to work with instruments, or if you are being given a tour. Nobody is allowed to wait inside the lab without the presence of their mentor or tour instructor.
     • Wearing socks is mandatory – bring your own pair.
     • Persons wearing shorts and/ or sleeveless clothing will not be allowed inside the labs.
     • Pregnant women are advised not to enter the labs.
     • Place your shoes/ sandals in an orderly manner on the shoe rack outside.
     • Leave your bags, notebooks, water bottles in an orderly manner outside.
     • Only cell phones, laptops are permitted to be taken in.
     • Do not hold the main door open and talk to others across the door.
     • Members: Do not use your own biometric access to let in other people who don’t have lab access.

   ➢ After entering the labs
     • Wear lab sandals.
     • Wear hairnet.

2. Buddy System
   ➢ For members/ any usage of laboratories
     • For safety reasons, no one is allowed to work alone in the lab between 8pm and 8am on all days. During weekends and all holidays also buddy system needs to be followed.
     • A buddy refers to any other lab member (need not be an AU) present with you, while working within the lab.
     • Each lab member is individually responsible to ensure that a buddy is ALWAYS present.
     • Buddies may change during lab use.
     • Buddies must communicate with each other regularly (at least every 15 minutes). This ensures the safety and well-being of all lab members during lab use.
     • Usage of any Hazardous Gases (gases stored inside the gas cabinet) between 8pm and 8am/ holidays requires prior intimation & approval from the facility team. Facility team members will ensure/ take care of the service corridor safety.
     • Entry must be made in the ‘Buddy Log Book’ which is placed in every lab.

   ➢ To make buddy system user-friendly, the following labs have been clubbed:
     • Nano lab: Includes Nano yellow room and Nano room.
     • Micro I semi clean lab: Includes chemistry room and semi clean room.
     • Micro I Yellow room: Includes Karl Suss room and Laser Writer room.
     • Micro II lab: Includes HWCVD room and Bio MEMS room.
3. Chemistry Lab rules

Even if you need to use the lab only for a few minutes (for eg: to use acetone), the following rules must be followed.

**IF IN DOUBT, PLEASE ASK.**

➤ **Before going into Chemistry Room:**

- Place regular lab sandals on the shoe rack outside Chemistry Room.
- Wear **covered** lab sandals.
- Wear hair net, chemical resistant apron, facemask, gloves, and goggles.

➤ **In the Chemistry room, before starting your work:**

- Fill up the ‘Chemical Warning Form’ available in the Chemistry Room.
- Check that the mixture of chemicals which you need is a compatible one.
- Label the petri dish/ beaker if you want to leave your sample in it for some time with your name, chemical name, contact no.
- Check that there is space in the ‘Used Chemical’ bottle available for disposing the respective chemical/ mixture after use.

➤ **After completion of work in the Chemistry room:**

- Dispose the hairnet, regular gloves, facemask into the dustbin.
- Place the goggles back into the box provided.
- Remove the chemical resistant apron, place it on the hanger provided outside.
- Place the covered lab sandals back on the rack.
4. Clean room rules

Nano Litho lab: Not more than 6 people are allowed at a time.
Nano lab: Not more than 8 people are allowed at a time.
AMAT lab: Not more than 6 people are allowed at a time.
Nano electronics device fabrication lab: Not more than 11 people are allowed at a time.
NCPRE fab lab: Not more than 8 people are allowed at a time.
NCPRE Characterization lab: more than 8 people are allowed at a time.
MBE labs: Not more than 5 people are allowed at a time.

➢ Before entering the clean rooms:

- Place regular lab sandals on the shoe rack outside Nano lab in an orderly manner.
- Wear the clean room clothing according to the order specified:
  - Wear the hairnet.
  - Wear the facemask.
  - Wear the clean room headgear.
  - Wear the clean room gown.
  - Wear the clean room shoes.
  - Wear the gloves.

➢ While working in the clean rooms:

- Be conscious of your surroundings, no fast movements should be made inside the lab.
- After your work is done, ensure that the instrument & its surrounding area are clean and tidy.

➢ While exiting the clean rooms:

- Remove the clean room clothing according to the order specified:
  - Remove the clean room shoes & place it on its rack in the right manner.
  - Remove the clean room gown & put it up on the hanger.
  - Remove the headgear & put it up on the hanger.
  - Dispose the hairnet, gloves, facemask into the dustbin.

➢ Response to lab rules violations:

- 1st offence without accident - warning
- 2nd offence without accident - lab service
- 3rd offence without accident - report of the offence, determination of the cause recommendation to avoid repeat. FOC review for punishment.
- 1st offence with accident - report of the offence, determination of the cause, recommendation to avoid repeat. FOC review for punishment.
5. Violation/Offence response

- 1st offence without accident - warning.
- 2nd offence without accident - lab service.
- 3rd offence without accident - report of the offence, determination of the cause recommendation to avoid repeat. FOC review for punishment.
- 1st offence with accident - report of the offence, determination of the cause, recommendation to avoid repeat. FOC review for punishment.
IV. Roles & Responsibilities: SO, AU, Operator, Lab-in-Charge

1. System Owner (SO)

- **Tool up-time**
  - To ensure high tool uptime for their respective tools.
  - During troubleshooting, by Equipment maintenance team (EMT) or Service Engineers, SO presence is highly desired but not mandatory.

- **Training**
  - To ensure completion of training requests by uniformly allocating slots in the following order: First to the operator (including M. Tech RAs) & then to other AUs.
  - To conduct authorization tests to qualify users as an AU.
  - Can delegate tasks to AUs (uniformly) if needed.

- **Technical expertise**
  - To advise operators & other AUs when a query comes up, by taking help from respective faculty in-charges if needed, for a non-standard hardware, process or contamination-related issues.
  - To monitor and respond to drifts in baseline process data of equipment’s.

- **Documentation (through IT team)**
  - To take care of modification of SOPs and training policy as & when required.
  - To prepare tool troubleshooting reports, circulate and upload.

2. Authorized User (AU)

- **Tool up-time**
  - AU presence is highly desirable during EMT or Service Engineer tool troubleshooting but it is not mandatory.

- **Tool operating requests**
  - Not obligated to book slots and complete process requests for users in the absence of operator.

- **Training**
  - To complete training requests as delegated by SO.
  - AU will not take authorization tests to qualify a user as an AU.
3. Operator

- **Tool uptime**
  - Operator’s presence is mandatory during troubleshooting / AMC by Service Engineer or EMT.
  - To escalate the issue to EMT and LIC for tool troubleshooting as soon as hardware/process issue is observed.

- **Tool operating requests**
  - Book slots and complete process requests for users.

- **Training**
  - To complete training requests as delegated by SO.
  - To take authorization tests to qualify a user as an AU.

- **Baseline recipe runs**
  - Run baseline recipe at specified frequency, collect data and log it.

- **Communication**
  - To inform all lab users of any status change of tool by sending out mails, lock out/tag out the tool, black out without giving technical details.

4. Lab- in-charge (LIC)

- Check of all equipment in respective labs.
- Coordination with SO & EMT to keep uptime of tool high.
- Monitoring baseline recipe checks taking help from operators.
- Conducting PM schedule of all equipment.
- Coordinating AMC visits for equipment.
- Maintaining troubleshoot logs, tool related documents.
- If any modifications done on SOP - check for implementation & follow up with SO.
- Coordination with IT team for update of equipment information (contamination related, status of equipment etc.).
- Ensure safety, facility readiness, consumables availability, and supervise regular cleanliness of the respective lab.
- Manage operators of respective labs, as operators to report to LIC.
V. Equipment Usage Policy at IITBNF

Submit a request (Process/Training) for equipment online. Go to “www.iitbnf.iitb.ac.in --> For Members --> Online Modules --> Equipment usage Request” to submit a request.

1. Process Request

- SO/ FIC will approve/disapprove the request within 2 days of submission of the request. If not, requester should raise the flag to SO/LIC/Assistant Lab manager within 2 days after the mentioned time period or send a mail to iitbnf@ee.iitb.ac.in.
  
  Note: Slots can be rejected for following reasons - Incomplete or not clear details of sample history, contamination issue, feasibility issue, equipment ‘not working’.

- Requester will receive a mail from SO regarding the approved or rejected mail.

- If the request is approved by SO/FIC, operator will book a slot within one day after SO’s approval as per the requester’s mentioned preferred slot.

- If no preferred dates are given, operator will book slots as per his/her convenience.

- If the ‘preferred dates’ submitted by requester are not convenient for operator, operator needs to coordinate with requester and then book the slots accordingly with mutual consent.

- When a slot is booked, requester will receive a mail about the scheduled slot dates.

- If for some reason, the slot was not used or cancelled, a fresh request needs to be submitted by the requester to book another slot.

- If the request is rejected by SO/FIC, requester should check the ‘comments’ made by the SO for rejection and submit a fresh request accordingly.

2. Training Request

- SO will check the details of the request w.r.t. feasibility and contamination for future usage of the tool by the requester.

  Note: Training can be rejected for following reasons - Incomplete or not clear details of sample history, equipment ‘not working’, usage requirement of requester as an AU.

- If the request is approved by SO/FIC, the lab member should receive a mail from the SO/Operator/AU of that equipment about the schedule of 1st training slot within 7 working days of submitting a training request. If not, member should raise the flag to LIC/Assistant Lab manager within 2 days after the above mentioned time period or email to iitbnf@ee.iitb.ac.in.

- Not more than 3 members should be trained at a time.

- Member needs to be in touch with SO/Operator/AU for taking mutually convenient dates for future training slots.

- After every training slot, it is mandatory for the member to make entries on the online form. [Go to www.iitbnf.iitb.ac.in --> For Members --> Slot Booking. Logon to the module. Click on Management --> Equipment Training].

- When all training slots are completed, the SO/operator conducts a test for the member. The authorization is granted to the member upon passing the test. [While filling this data online, the
member should choose the ‘authorization’ option under 'type of run' for the final slot on the
online training form.

- A formal mail will be received by lab member granting him/her formal authorization for the
equipment. After that, member can book slots on his/her own for the equipment.
Note for SO: Authorization on the slot booking module should be given only after checking that
PROPER 'authorization' entry has been made in the training form.

- A lab member should complete training and authorization test within 20 working days of
submission of a training request [provided the equipment is in a ‘working’ condition]. In case this
does not happen, the member/ SO/ operator should raise the flag to LIC/Assistant Lab Manager.
Note for Trainers/ Trainees: If the training is not happening as per expectations, raise the flag to
LIC/ Assistant Lab Manager or email to iitbnf@ee.iitb.ac.in.

- More than one training run per equipment per day is not recommended. But in emergency, it may
be taken.

- If a lab member does not attend the scheduled training slots without informing the SO/ Operator/
AU, the penalty will be that he/ she will be debarred from submitting any training requests on any
equipment at IITBNF for a period of one month.

- **If the request is rejected by SO/FIC**, requester should check the comments made by the SO for
rejection and if required, submit a fresh request accordingly.

- Lab members should have adequate knowledge of the type of process that is being carried out in
the particular equipment before submitting a training request [Silicon VLSI Technology:
Fundamentals, Practice, and Modeling by James D. Plummer (Author), Michael Deal (Author), &
Griffin].

### 3. Lithography and SEM tools usage

RAITH is a heavily loaded instrument, hence the following policy has been made to share and distribute
the load amongst all three lithography tools - RAITH, EVO SEM and FESEM:

- If samples with film thickness or feature sizes less than 200nm - FESEM to be used.
- If imaging is to be done at an angle other than 45 or 90 degree - FESEM to be used.
- If EVO SEM is down, all SEM requests can be transferred to FESEM.
VI. Anti-Contamination Policy

General Awareness about Contamination Control requirements

CMOS industry is following Moore's law from several decades; currently 7 nm technology node is under research and development. Shrinking device size increases the demand to monitor and control cross contamination among different semiconductor equipment. In the current scenario academia and industry are developing technologies and policies to monitor and control cross contamination in their equipment. IITBNF also considers efforts towards controlling contamination extremely important and required. Developing anti contamination policies is a regular and evolving exercise, which is done keeping mainly two things in mind, first to control cross contamination and second to open the equipment for maximum usage by lab members.

About this Page

This page/document describes the general classifications by which equipment are grouped into which help minimize cross contamination. This page also lists the anti-contamination policy listed in form of allowed flow charts. Some of the exceptions are also listed. There may be alternate methods to allow a certain process flow, depending on the tool, material, and process flow even if it is not possible with allowed policy flow charts. For any questions about contamination concerns, contact System owner / Faculty- incharge/Process committee for the particular tool.

1. Contamination Categories

Equipment at IITBNF is classified in one of the several contamination categories, described below. When defining the process flow, the choice of processing tools which are acceptable will depend on the previous tool and materials used. In general, wafers can be processed in only equipment within the same contamination group or in groups which can take higher contamination risk which is described by the anti-contamination policy flow charts. First let’s understand different contamination categories.

Clean:
Equipment with the lowest tolerance for contamination fall into this group. Other than for photolithography and some approved analytical tools, wafers containing any metals or metal films are strictly prohibited from being processed in this equipment. Wafers that at any point have received processing on any equipment outside of this group cannot be processed on anything listed in this group. Wafers previously undergoing lithography are acceptable for processing (following appropriate photoresist restrictions or resist stripping procedures). Processing in any of the general-purpose wet benches must be done with appropriate dedicated lab ware to prevent cross-contamination. Given the appropriate materials consideration as given in Allowed materials in tools, wafers processed in ‘Clean’ equipment may subsequently be processed in any other category allowed by anti-contamination policy flow charts, listed below:

Clean (for Si)
Same definitions as “Clean”, except that only silicon substrates are allowed.
Clean (III-V compounds)
Same definitions as “Clean”, except that only III-V substrates are allowed.

Clean PV:
Same definition as "Clean" except the samples will be sodium or potassium contaminated. Please see anti-contamination policy flow charts for its allowed usage policy.

Semi - Clean PV:
- Wafers processed in "Clean" and "Clean PV" equipment can be processed in "Semi- Clean PV" equipment.
- The materials allowed in "Semi Clean PV" equipment are: Ag, Al, Ti, Pd, and Pt.
- The materials which are not allowed in "Semi Clean PV" equipment are: Ni, Hf, W, Ta, Cr, Zr, Mo, and Au. Other materials may be allowed after appropriate contamination reviews.
- The samples processed in "Semi Clean PV" equipment are Na and K contaminated. Please see anti-contamination policy flow charts for its allowed usage policy.

Semi-Clean:
Semi-Clean A: Wafers containing standard metals, Aluminum (Al), Tungsten (W), and Titanium (Ti) may be processed in “Semi-Clean A” category equipment. Processing in any of the general-purpose wet benches must be done with appropriately dedicated lab ware to prevent cross-contamination, which means user must have dedicated beaker set for “Semi Clean A” category samples if the samples need to go back to “Semi-Clean A” category equipment. Given the appropriate Allowed materials in tools, wafers processed in “Semi-Clean A” equipment may subsequently be processed in any “Semi-Clean A” or “Semi-Clean B” or Gold-Contaminated tool or other categories as per allowed anti contamination flow charts. For detailed policy which includes integration with other contamination categories such as Litho, Analytical, In Line A/AC/ACT, etc., please see anti-contamination policy flow charts.

- Semi-Clean B: This subclass covers more metals other than previously approved for use in “Semi-Clean A” equipment, except where otherwise noted. These materials are deposited in equipment used for CMOS compatible films. The “Semi-Clean B” materials are: Ni, Co, Pt, Al, Hf, Ta, Mo, W, Ti, Cr, Zr, Pd. Processing in any of the general-purpose wet benches must be done with appropriately dedicated lab ware to prevent cross-contamination, which means user must have dedicated beaker set for “Semi-Clean B” category samples if the sample need to go back to “Semi-Clean B” category equipment. “Semi-Clean B” wafers may be processed in “Semi-Clean A”category equipment EXCEPT FOR the following restrictions:
  - “Semi-Clean B”wafers must be cleaned or wet-etched using dedicated “Semi-Clean B”lab ware at the general purpose wet bench. Do not use metal lab ware such as metal baths, metal tweezers, etc.
  - “Semi-Clean B”wafers may be etched in “Semi-Clean A” plasma etches tools provided the “Semi-Clean B”film is not being etched. Etching other films and stopping on "Semi-Clean B”films is OK. However, dry etching of “Semi-Clean B”films is permitted in “Semi-Clean A” equipment only on a case-by-case basis (contact Process committee).

- Given the appropriate Allowed materials in tools, wafers processed in “Semi-Clean B”equipment may subsequently be processed in other categories as per the anti-contamination flow charts below. For detailed policy which includes integration with other contamination categories such as Litho, Analytical, In Line/off Line analytical, etc., please see anti-contamination policy flow charts.
Gold Contaminated:
Wafers containing other non-standard metals, including gold and copper (see below for Zn), may be processed in this equipment. Please see anti-contamination flow charts for usage policy for this category as well.

- Ordinary metallic Zn is allowed in gold contaminated category equipment BUT evaporation of Zn, or etching of films containing Zn, is conditionally restricted in gold contaminated chambers/equipment, due to high volatility/vapor pressure of Zn.
- Annealing of Zn or its films such as ZnO in furnaces is also conditionally restricted.
- The Zn restriction is introduced in Dec 2014. Conditionally restricted implies, in equipment/chamber where the deposition and etching is already allowed it is still allowed but in equipment [gold contaminated] where deposition and etching of Zn or its films is never done, cannot be assumed to be allowed for these processes. This also includes new chambers/equipment being characterized as gold contaminated.

Please discuss with Process committee if you have any such special requests.
While using wet bench, please ensure that beakers you are using are already allowed to use gold contaminated samples; otherwise you may be contaminating the non-gold contaminated beakers with your samples.

Litho/Analytical:
Because of their general necessity throughout a process flow, all lithography and some analytical category tools processed samples are allowed in most of the categories. Standard resist stripping and equipment-specific, pre-clean procedures designed into the particularly sensitive process modules minimize any potential contamination risk from shared lithography (and other select) tools. Some analytical tools present low risk of cross-contamination; other analytical tools are particularly sensitive to contamination issues or run high risk of transferring contaminants. Consult the materials guidelines for each of these tools, before processing given in the Allowed materials in tools. As always, when in doubt about contamination risks in any step in your process flow, don’t hesitate to contact the Process committee. Please see anti-contamination flow charts for usage policy for this category as well.

We are in process of splitting this category in 2 or more categories such as Litho, In Line A [A for Analytical], off Line A, In Line AC, In line ACT, etc. listed below, hence some of the Litho/Analytical category equipment has already been assigned the new categories, while Litho/Analytical category still exists as well. If you would like to convert Litho/Analytical category to “In Line A/AC/ACT” category please consult with process committee. Please see anti-contamination policy flow charts for its allowed policy.

Litho:
Same as Litho/Analytical category. All photoresist Spinners (both general purpose or dedicated) and mask aligners are categorized as “Litho” category. Please see anti-contamination policy flow charts for its usage policy.

In Line A [A = Analytical]:
Similar to Litho/Analytical category. By definition “In Line” equipment is defined where sample can go back and forth between other processing equipment such as deposition, etch, etc. equipment. This category is defined to identify and segregate critical In Line equipment at IITBNF. Sample processed may go to any other category equipment depending on allowed anti-contamination flow chart. Please see anti-contamination policy flow charts for its allowed policy.

Off Line A [A = Analytical]:
By definition an “Off Line” equipment is defined from which samples cannot go back to critical deposition, etch, etc. equipment in fabrication facility. Outside samples or from NCPRE can be processed in this category. Sample from offline ‘A’ category equipment can go to another off Line ‘A’ category equipment ONLY.

**In Line AC:**
Similar to “In Line A” category with additional allowed usage policy for outside samples. In “In line AC” analytical equipment where ‘C’ stands for a possibility to put different chuck or carrier wafer underneath your sample. You may only process outside samples or from NCPRE or from offline equipment provided you use dedicated chuck or carrier wafer underneath your sample. This is also assuming cross contamination can happen only through chuck, and measurement is done at RT as for high temperature process detailed analysis of the setup is required to comment on cross contamination possibilities.

**In Line ACT:**
Similar to In Line AC category with additional allowed usage policy for outside samples. In “In line ACT” analytical equipment where ‘C’ stands for a possibility to put a different chuck or carrier wafer underneath your sample and “T” stands for a possibility to use a dedicated Tip. You may only process outside samples or from NCPRE or from offline category equipment provided you use dedicated chuck or carrier wafer underneath your sample AND a dedicated Tip. This is also assuming cross contamination can happen only through chuck or from tip, and measurement is done at RT. Currently only AFM falls into this category.

**Table 1:** Table for some of the Equipment with changed categories.

<table>
<thead>
<tr>
<th>In Line A</th>
<th>In Line AC</th>
<th>In Line ACT</th>
<th>Off Line A</th>
<th>Litho</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Probe Automatic</td>
<td>Ellipsometer</td>
<td>AFM</td>
<td>XPS</td>
<td>DSA</td>
</tr>
<tr>
<td>Dektak</td>
<td>Raith</td>
<td>EVO SEM</td>
<td>MJB4</td>
<td></td>
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<tr>
<td>Ambios</td>
<td>XRD</td>
<td>4 Probe Manual</td>
<td>MJB3</td>
<td></td>
</tr>
<tr>
<td>All Microscopes</td>
<td></td>
<td></td>
<td></td>
<td>All PR Spinners</td>
</tr>
</tbody>
</table>

2. **Miscellaneous Definitions**

**IITBNF:** All Labs in New Nano electronics bldg. and old building EE Annexe falls under IITBNF.

**Chuck Contact:** Equipment where sample is in contact only with the chuck of the equipment is considered as chuck contact equipment. No other part of the equipment is in contact with the sample. Ex: Ellipsometer, Microscopes, etc.

**Tip - Chuck Contact:** Equipment where chuck as well as the tip [stylus, etc.] is in contact with the sample is considered as Tip-Chuck contact equipment. Ex: AFM, Dektak Profilo, 4 Probe, etc.

**Inside Sample:** Sample Issued at IITBNF and is never taken out from IITBNF lab premises and hence never processed or opened outside of IITBNF labs is considered an inside sample. NCPRE issues samples, which maintains these criteria are also inside samples.

**Outside Samples:** Samples which are processed or procured outside IITBNF are considered as outside samples. Even if the sample is processed outside the IITBNF labs even once, it is considered an outside sample. If you procure your samples on your own you must open the new wafer box inside IITBNF AND in front of a process staff for it to be considered an inside sample.
Semi-Clean Ambiance: Laboratory where footwear is not allowed and general cleanliness is maintained is considered as having a Semi-Clean ambiance. Micro 1, Micro 2 fall in this ambiance category.

Carrier Wafer: Near all the In Line ‘AC’ and In Line ‘ACT’ category equipment, two carrier wafers one each for NCPRE and outside samples is kept in dedicated wafer boxes. These dedicated wafers are to be used underneath the outside samples or for samples from NCPRE. Please ask equipment operator about these wafers. Carrier wafers are not required underneath if your samples are inside samples.

Allowed materials page on IITBNF Website

This page categorizes equipment into different groups based on contamination control policy. Information of allowed substrates, materials, chemicals, gases and targets for each and every equipment is provided here. Some of the not allowed materials are also listed. Equipment groupings are a very general planning for the tool, as you refine your process flow; make sure to check it against the materials requirements for each individual piece of equipment. If a material is not allowed in the equipment the process flow cannot be allowed even if it is following the anti-contamination policy flow charts. Equipment SOP, allowed materials page and anti-contamination policy flow chart, all must be satisfied to allow a new material or process.

3. Usage of Glass

- Normal Glass cover slips or soda lime or borosilicate glass substrates contains Na and K at percentage levels. Na, K are carrier lifetime killers in MOS devices. Glass cover slips, Soda Lime or Borosilicate glasses are allowed in Litho or Litho/analytical, In Line ‘A’, off line ‘A’, and Au contaminated categories equipment as of now. Glass cover slips are not allowed as a method to generate step in any of the equipment with category “Clean”, “Semi-Clean A”, and “Semi-Clean B”. Please see anti-contamination flow charts for glass usage policy.
- Soda Lime glass cannot be used in any equipment where process goes beyond 500 Deg. C temperatures. Borosilicate glass must be used as Soda Lime melts at above 500 Deg. C.
- Though Quartz is the best choice which is completely free of Na and K, quality Borosilicate (borofloat, schott, BK247) is recommended over soda lime. Future Plan is to shift completely to Quartz or other alkali free borosilicate glass. Process committee is looking for alternate cost viable solution to replace normal glass containing Na and K.

4. Exceptions

- There are a few exceptions in which non-standard equipment sequence may be acceptable- If you have a non-standard process flow requirement, please discuss your project with a member of the Process committee, who should be able to help you design a process flow to accommodate your needs.
- We will consider experimental data in order to allow a non-standard process flow.
- Fig. 7 below lists the anti-contamination exception flow chart based on an experimental data submitted to process committee.
5. Approved process flow charts

**Inside Samples Only [NCPF samples excluded]**

- **Clean** → **Semi-Clean A** ← **Semi-Clean B** → **Gold Contaminated**
  - No metal/metal oxide etch

- **Litho or Litho/Analytical** ← ← **In Line A/AC/ACT or Off Line A**

**Inside samples AND In Line A/AC/ACT processed samples are allowed**

**Fig 1: Anti-contamination Flow Chart 1**

**Inside Samples Only**

- **Clean** → **Clean PV** → **Semi-Clean PV**

**Fig 2: Anti-Contamination Flow Chart 2**
Inside Samples Only

Clean PV or Semi-Clean PV

Clean
Semi-Clean A
Semi-Clean B
Gold Contaminat.
Litho or Litho/Analytical
In Line A

Clean PV or Semi-Clean PV

Off Line A or In Line AC/ACT*

* Using dedicated carrier wafer/chuck-tip for NCPRE samples, as is the case with Raith.

Fig. 3: Anti Contamination Flow Chart 3
Inside & Outside Samples

**Lithography/Analytical Equipment**

- **Litho OR Litho/Analytical OR In Line A**
  - Inside: Allowed#
  - Outside: Not Allowed. Consult Process Committee if you want to.

- **In Line AC OR ACT**
  - Inside: Allowed*
  - Outside: Sample MUST come from semi clean ambiance or better. Restrictions of dedicated chuck/carrier wafer/tip is applicable.

- **Off Line A**
  - Inside OR Outside: Allowed

* NCPRE Samples not allowed

* NCPRE allowed with dedicated wafer/chuck/tip

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**Fig. 4: Anti-contamination Flow chart 4**
Fig. 5: Anti-contamination Flow chart 5

Fig. 6: Anti-contamination Flow chart 6
6. **Ongoing activities to develop Anti-Contamination Policy**

- TXRF Analysis using SR-TXRF, to quantify surface metal contamination, of different equipment to monitor and control cross contamination, and to upgrade anti-contamination policies is in progress.
- CV Shift Analysis for 4TEBE [NCPRE] and PECVD [NCPRE] to quantify surface and embedded Na and K ions introduced by the two equipment is in progress.
- Anti-contamination policy development using carrier lifetime measurement techniques will be explored as well.
VII. Violations policy & Disciplinary committee

1. Principle of Violations policy

- The IITBNF facilities contains hazards that could destroy (in order of priority):
  - Health and Life: safety risks.
  - Property: equipment / facilities risk.
  - Professional career: damage to research quality and productivity.
- These hazards are contained due to:
  - Intelligent and responsive policy definition.
  - Strict adherence to policy by users / staff.
  - Strict implementation of violation policy as deterrence and training.

Zero tolerance for violations with proportional punishment a fair principle to run IITBNF. The core idea is that of deterrence to ensure low violation. 
**Does this compromise creative usage of the lab?**

Nature of Violations

Offence - is violation of expected responsibilities from all stakeholders. The expected responsibilities are as follows:

<table>
<thead>
<tr>
<th>Group</th>
<th>Expectation</th>
<th>Authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users</td>
<td>Stringently abide by user policy</td>
<td>Disciplinary Action Committee</td>
</tr>
<tr>
<td>System Owner</td>
<td>Ensure that the system / tools are Safe from inappropriate use</td>
<td>Process Committee</td>
</tr>
<tr>
<td>Facilities Staff</td>
<td>Ensure that facilities are operational</td>
<td>Facilities Committee</td>
</tr>
</tbody>
</table>
### 2. Types of violation

8 hours days for service, 40 hour weeks.

<table>
<thead>
<tr>
<th>SNo.</th>
<th>Description</th>
<th>Example</th>
<th>Punishment without harm</th>
<th>Punishment with harm</th>
</tr>
</thead>
</table>
| 1    | Impermanent violation - any offence which can be corrected within a few days without harming lab or other users in any way | - entry usage in log book for inventory purposes  
- non-attendance of training session  
- timely disposal of labeled chemical | 3 levels for repeats/extent  
- Warning  
- 1 days of service  
- 3 days of service  
- 7 days of service | NA |
| 2    | Permanent equipment/consumables/facilities/samples safety violation - any offence that could compromise equipment health requiring maintenance/vendor service | - Not following SOP  
- Using lab consumable for non-authorized use  
- Not turning on scrubber, purge gas | 1 month suspension +14 days of service | 2 month suspension +1 month of service |
| 3    | Permanent health safety violation - any action that could put human health in jeopardy | - Leaving un-labeled chemicals  
- Disabling safety equipment without proper procedure/authority | 2 months suspension +1 month service | Permanent removal |

In case of harm, suspension is immediate. Suspension = lab access suspension; Max punishment applies. Punishment can be reduced to minimum of 25% lab service and 25% suspension at the discretion of the competent authority based on extent/repetition of offence.

- If a grace period is given by Disciplinary Committee (max 2 weeks) to start the punishment double the punishment needs to be served by the violator.
- Any offence during the grace period, will lead to strict action by Disciplinary Committee.
3. Procedure

<table>
<thead>
<tr>
<th>Type</th>
<th>Documentation</th>
<th>Competent Authority</th>
<th>Review/ Appeal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Asst. Lab Manager</td>
<td>Lab manager/ relevant committee</td>
<td>FOC</td>
</tr>
<tr>
<td>2</td>
<td>Asst. Lab Manager</td>
<td>3 faculty committee FOC appointed by FOC</td>
<td>FOC</td>
</tr>
<tr>
<td>3</td>
<td>Asst. Lab Manager</td>
<td>6 faculty committee appointed by FOC</td>
<td>FOC</td>
</tr>
</tbody>
</table>

Permanent removal for any offence is always an option but to be exercised by the discretion of a 6 member committee.

**Template: Report prepared by Lab Manager**

- Description of violation c.f. expectation with notes on evidence source/ credibility.
- Potential Impact of violation.
- Actual Impact of violation.
4. Escalation path for DAC

If any user (AU/SO/Staff) identifies any violation

Complaint can be made to LIC, FIC (Faculty In-charge), Asst. LM & FOC

Concerned LIC will send an e-mail (with Violation details) to defaulter keeping in cc - FIC of the tool, Asst. LM & SRC members. If Violation is related to Equipment / Facility, concerned in-charge will also be called for the meeting

Quorum is 3 SRC Members, Asst. LM, and LIC

DAC meeting is planned once in a Month normally (for INUP Users & Safety Violations, DAC will meet asap)

DAC decision will be e mailed by LIC to SRC for consent.

DAC decision will be E-mailed to defaulter and cenfoc, censtaff, censtudent, SRC members by LIC.
5. **Implication on regular lab running**
   - Surveillance by video for entire lab.
   - Active vigilance by SO and Staff.
   - Active vigilance by users.
   - Maintenance of online log of violations.
   - Online complaint system for reporting and tracking complaints.
   - Maybe add a Disciplinary inspection team for weekly inspections reporting to lab manager.

6. **In case of a witness to a violation**
   - Try to inform the potential violator of the proper operating procedure.
   - Lodge a complaint using online Complaint Form.
   - Inform SO or Lab manager if urgent.

7. **For violators**
   - Stop your current activity *safely* for the lab property/person not necessarily for your samples after referring to the SOP.
   - Report your violation.
VIII. Equipment Up & Down Policy

If any user (AU/SO/Operator) faces an issue while using tool

Send “Tool Down” status email to censtudent, censtaff with tool down details

Inform SO and LIC over phone. “System under maintenance” card needs to be placed on the tool

SO to black out the tool on online slot booking module

EMT to take lead taking help from SO / AU / LIC & start troubleshooting

EMT will send email status of the tool to LIC & SO after troubleshooting is done

If tool is “Up”, SO should check the working condition (baseline recipe) of the tool & update the status to LIC and take the approval from ‘Process Technologist’

LIC to send email about “Tool Up” status to censtudent, censtaff
IX. Lab Shutdown Policy

- Shutdown for less than 1 day: 3 days prior notice.
- Shutdown for 1 day & up to 4 days: 2 weeks prior notice.
- Shutdown for more than 4 days: 4 weeks prior notice.
- A prior notice will be sent to lab members for every shutdown.
- FOC approval will be taken only for shutdown of more than 4 days.
- In case of an emergency, a forced shutdown of the lab will be done without any prior notice (only email will be sent).
X. Inventory Policy

Objectives:

To maintain sufficient stock of various consumables like wet chemicals, wafers, photo-resists, gases, targets etc.

- To maintain sufficient stock of various lab consumables like gloves, goggles, tweezers etc.
- To maintain AMCs up to date - Maintained by equipment maintenance team (EMT)
- To keep sufficient stock of essential spares for maintenance of tools.
- It is the goal of this team to ensure that at no point in time, experiments should stop for want of consumables and spares.

Clarification on the items to be maintained by the team

Following is the list of items that are maintained as part of the team. For some of them, stock is not maintained.

1. Spare parts of Equipment:
   - Equipment spares
   - EMT spares – maintained by EMT
   - Air conditioners
2. Dehumidifiers
3. Bulk chemicals
4. Resists
5. Developers
6. Toxic Gases
7. Non-toxic gases
8. Wafers and Mask plates
9. Precious metals – Gold and Platinum

The team would be responsible for maintaining the stock of bulk consumables and spare parts recommended by system owner/tool staff. Bulk consumables are those used by a large number of users and projects. Certain users may want to maintain their own stock of some of the bulk chemicals to take care of special processing needs. In such cases:

- The user should inform the inventory team of this and the quantity of the chemical being stocked.
- The user should maintain his/her own stock including ordering of the chemical. The inventory team would provide all help for ordering the chemical.
- The user should inform the inventory team if he/she is willing to share the chemical with the rest of the lab should the lab stock deplete due to unforeseen circumstances. The use of this chemical by
the user from the lab would be on a reciprocal basis. i.e. if the user is not willing to share it with the lab under crunch situations, the user cannot draw the same chemical from the lab inventory.

Non bulk chemicals are those chemicals that are required by individual users in small quantities. All chemicals NOT LISTED in appendix A can be considered non bulk. These have to be bought by the user him/ herself. The procedure for the purchase of these is given in ‘Appendix B’. A list of non-bulk chemicals purchased by the lab users is given on the web site of the CEN with the name of the user and vendor details. It is the responsibility of the individual user to store the item and maintain a stock of the item. The inventory team would provide guidance and help.

**AMC Policy for Equipment**

- AMC for all equipment at IITBNF are taken care of either by vendors or internally by Equipment Maintenance Team. The facility equipment (like UPS, chillers, AHUs, etc) are also listed under the Equipment.
- The Purchase Order tracking for the AMCs which are given to vendors can be viewed by logging on to:
  - [http://www.cen.iitb.ac.in/inventory/](http://www.cen.iitb.ac.in/inventory/)
  - [http://www.inup.iitb.ac.in/purchase_track/](http://www.inup.iitb.ac.in/purchase_track/)

- If the purchase tracking of AMC for any equipment cannot be located, Purchase Team (Jomon, phone # 4441) needs to be contacted.
- There may be some exceptions regarding AMC availability for some of the tools.

**Steps to be followed for the Renewal of AMCs:**

1. Two months before the expiry of AMC, IT generated mail is received regarding AMC renewal.
2. LIC will get the quote from vendor.
3. EMT head will check the quote: Cost and technical specifications (compare with previous year AMC) and give the approval.
4. Final technical approval from faculty in charge should be taken by LIC.
5. LIC should submit technically approved AMC quote to Purchase Team.
6. Purchase team should get the fund approval from concerned authority.
7. PO of AMC processing should be started by Purchase team.
8. Once PO is generated, purchase team must send the copy of PO to EMT head.
9. EMT head will upload the scanned copy of PO in the AMC module.
10. When the first advance payment is done, EMT head should be intimated.

11. EMT head will then communicate with vendor regarding scheduling of AMC (in coordination with LIC and SO).

12. LIC will make all arrangements for the AMC schedule.

13. Once AMC is completed, service report should be uploaded on the AMC module by EMT head

14. SO & LIC should take care that SOP is modified if necessary and equipment must be released for usage after the baseline check is made.

15. Before the final (2nd installment) payment is released, Purchase team should check with EMT head for completion of the AMC visits.

**Note:**
- Whenever Purchase team communicates with vendor, EMT head should be copied in all mails.
- Every three months, an IT reminder mail will be received by SO, LIC, EMT head, faculty in charge of tool, inventory faculty in charges, to schedule an AMC visit.
- Whenever an IT mail regarding AMC visit or renewal is received, EMT head must reply to ‘all’ about the plan of execution of AMC/ PM for the particular tool.
- The AMC and PM for facility equipment are completely taken care of by Facility team head in coordination with LICs.

➢ **Roles of the team members:**
- Faculty in-charges: Overall guidance.
- Asst. Lab manager: Supervision of the activities and personnel in this team and communication of related policies to all lab members.
- Materials management in-charge: Organization and maintenance of stocks and relevant registries, triggering of purchase of bulk items. Communication of stock situation to other members of the team and also to the lab, adding data and documents on the AMC module.
- Supporting staff members: Stock Management for chemicals and gases online updation. Purchase of items/material for the running of the lab on a day-to-day basis.
- CENIT: Updation of the CEN website with purchase policies and relevant documentation.
Appendix A: Some decisions taken by the faculty oversight committee

Only 4 wafers are issued at a time for 2"
Only 8 wafers are issued at a time for 4"

1. Breakage of wafers or damage of samples during processing of samples is an accident for which the lab has no insurance. Replacement of wafers will not be done by IITBNF. New wafers can be issued to the project account of the user. - **FOC decision on 13 June 2014**

2. Requisition of wafers in large numbers (more than 4 for 2 inch Si wafers and 8 for 4 inch Si wafers) will be considered only if the stock of the wafer being requested does not fall below 8 months upon the issue of the requested number of wafers. Broken & damaged wafers costing to be taken by common pool. - **FOC decision on 4th Oct 2013**

3. Research groups that want to get more than the standard issue size (4 of 2” and 8 of 4”) should project their requirements well in advance. Otherwise they would be issued only the standard numbers. Any group/any faculty who has any specific requirements over and above the standard issue size can send the request to the inventory team and it will be ordered and included in the stock. - **FOC decision on 29th June 2012**
Appendix B: Purchase procedure for non-bulk chemicals by the user

1. If the item was already used in the lab, one can contact vendor and procure it him/herself. In case the item is already available in the lab, the user may contact the person who has purchased the item. Please check the link [http://www.cen.iitb.ac.in/cen/chemical.html](http://www.cen.iitb.ac.in/cen/chemical.html) for a list of bulk and non-bulk chemicals.

2. If it is a new chemical, the user has to download chemical procurement form [http://www.cen.iitb.ac.in/cen/msds/cpf.pdf](http://www.cen.iitb.ac.in/cen/msds/cpf.pdf)

3. Submit the duly filled form, MSDS of chemical, prepare 2/3 ppt. slides highlighting storage, precautions while handling, and disposal of chemical to Chemical Safety Team. The user should start procurement procedure with the following information: project code to bill the purchase to be obtained from the supervisor, hard copy of the quotation. If the chemical is available from Sigma Aldrich, it can be bought without a PO as IIT has rate contract with Sigma Aldrich.

4. For industry users, if a chemical needs to be purchased from their own funds, IITBNF will help procuring the chemical. The chemical can be labeled & stored in the lab. It is up-to the industry representative to manage their own inventory.

5. For procurement of consumables, kindly send an e-mail to consumables.cen@gmail.com.