PILOT PROJECT ON SAFE LABORATORY PRACTICES AND LABORATORY WASTE DISPOSAL

Report Submitted to

Department of Science and Technology (DST)

Ministry of Science and Technology

Government of India, New Delhi

Project Sponsored by

Indian National Academy of Engineering (INAE)

New Delhi

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EXECUTIVE SUMMARY

Indian National Academy of Engineering (INAE) was tasked by the Department of Science and Technology (DST), Government of India, to create a plan of action to enhance the awareness of health and safety issues as well as safe disposal of chemicals and solvents in chemical and biological laboratories in Indian universities, research institutes and colleges. Accordingly, a project entitled, "Pilot Project on Safe Laboratory Practices and Laboratory Waste Disposal." was undertaken funded by INAE, New Delhi. The objective of this project was to create an implementable plan of action along with budgetary estimates for rolling out the plan in selected institutions to enhance the awareness of health and safety issues in chemical laboratories as well establish best practices for the disposal of chemical and hazardous wastes in the chemical and biological laboratories of universities, colleges and research institutions in India. The following institutions were identified for base-line study for the project:

1. Savitribai Phule Pune University (SPPU), Pune
2. Institute of Chemical Technology (ICT), Mumbai
3. Indian Institute of Science Education and Research (IISER), Kolkata.

In order to collect base-line information, a comprehensive checklist was developed. Coordinators/champions were identified at the selected institutions to coordinate and act as a bridge between the institution and the project team for the collection of data and information. The collected information was analyzed and fitted into a "Five-Level" laboratory safety matrix, specifically designed for this project. The objective of defining this matrix was to assess where the institutions are currently placed in this framework and suggest a plan for elevating them, at least, one level up in a time-bound manner.

Based on an analysis of base-line information collected from each of the institutions, SPPU, Pune was placed at Level 1, ICT, Mumbai at Level 2 and IISER, Kolkata at Level 3.

Having defined the current levels of each of the identified institution, the team defined the infrastructure upgradation required to move each institution one-level up. The needs were listed

in considerable details and the cost estimates needed for upgradation were estimated. A summary of budgetary estimates for upgradation of laboratory safety is given below:

Sr. No.	Key Requirements	SPPU, Pune INR (Lakh) **Level 1 to 2**	ICT, Mumbai INR (Lakh) **Level 2 to 3**	IISER, Kolkata INR (Lakh) **Level 3 to 4**
1.	Bulk storage of solvents, chemicals and gases	54	85	94
2.	Fire safety	3	36	3
3.	Ventilation	30	45	5
4.	Electrical safety	30	50	40
5.	Lab accessories	28	42	53
6.	Documentation and training	3	7	5
7.	Waste management system	2	35	-
	TOTAL, INR (Lakh)	**150**	**300**	**200**

We recommend implementation of this project at two levels. One, creation of physical facilities, including buildings, laboratory modifications, equipping laboratories with fume hoods and ventilation systems, where necessary, and procurement of safety accessories, personal protection equipment and the like. The second will be to set up a system of training and education for all the personnel, creation of content and resources for training, drawing up SoPs and institutionalizing safety management practices in chosen institutions. A programme for "training the trainers" needs to be put in place, so that institutions can undertake continuing education and training on their own subsequently.

We, further, reiterate that all institutions must put in place a robust system of collecting all waste and used solvents and chemicals, segregating them at the point of origin and disposing them off in a manner consistent with, both, safety as well as the stipulated norms of the Pollution Control Boards. Care must be taken to ensure that used chemicals are not washed down the sinks.

We also strongly recommend creating a “Safety Science Curriculum” and an associated textbook or workbook, specifically designed for Indian universities and research institutions. Such a course must be made compulsory for every student of science or engineering, both at undergraduate and postgraduate levels. Safety is, in the ultimate, a culture and an attitude, which has to be inculcated early in the life of a student. Only then it will have a lasting and sustainable impact.

PROJECT TEAM:

Dr. S. Sivaram, FNAE, INSA Senior Scientist and Honorary Professor, Indian Institute of Science Education and Research, Pune, PI and Team Leader,

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SAFE LABORATORY PRACTICES AND LABORATORY WASTE DISPOSAL

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1. INTRODUCTION AND BACKGROUND

Indian National Academy of Engineering (INAE) was tasked by the Department of Science and Technology (DST), Government of India, to create a plan of action to enhance the awareness of health and safety issues in chemical and biological laboratories in Indian universities, research institutes and colleges. The purpose is to provide these institutions with the requisite knowledge, tools and resources to ensure that best standards of safety and personal protection are followed. DST also mandated INAE to create a plan of action for the disposal of chemical laboratory wastes from educational institutes and R & D laboratories.

As a first step, INAE convened a Consultative Meeting of about 45 selected stakeholders from universities, colleges, research institutes and industry to deliberate on the issues, define best practices, take stock of the current practices, identify resource constraints and to define an agenda for future action that could be rolled out in a project mode in a phased manner across institutions in India. A report of the deliberations and recommendations was submitted to President, INAE.

2. OBJECTIVES OF THE STUDY AND METHODOLOGY

As a follow up on the recommendations of the consultative committee and as suggested by DST, a pilot project was proposed entitled, "Pilot Project on Safe Laboratory Practices and Laboratory Waste Disposal." The project was funded by INAE, New Delhi. The objective of this project is to create an implementable plan of action along with budgetary estimates for rolling out the plan in selected institutions to enhance the awareness of health and safety issues in chemical laboratories as well establish best practices for the disposal of chemical and hazardous wastes in the chemical and biological laboratories of universities, colleges and research institutions in India. This will include creating a minimum infrastructure to practice safety in teaching and research laboratories and address issues concerning safe disposal of waste chemicals (liquids, solids and gases) keeping in view the prevailing laws and regulations.

The suggested sites for implementation of the project were:

1. Savitribai Phule Pune University (SPPU), Pune

2. Institute of Chemical Technology (ICT), Mumbai
3. Indian Institute of Science Education and Research (IISER), Kolkata.

In order to collect baseline information about the existing state of infrastructure, facilities and practices being followed for safety in the laboratory as well as the storage and disposal of chemicals, a comprehensive checklist was developed. Coordinators/champions were identified from the selected three institutions to coordinate and act as a bridge between the institutions and the project team for the collection of data and information.

3. FIVE LEVELS OF LABORATORY SAFETY: A DEFINITION AND ITS ATTRIBUTES

The design and implementation of safe handling, as well as disposal of chemicals and adherence to safe laboratory practices, is dependent on several factors. These include, the state of infrastructure including the age of laboratory buildings, number of students that the laboratories cater to for both education and research, the nature and intensity of research performed by the students and faculty, the prevalent culture and awareness of safety and the level of engagement of the leadership of the department/institution in defining safety policies and following it up with their implementation. It is recognized that safety in academic laboratories must be viewed as a "Social Construct" which is defined as an idea that has been created and accepted by the people in the society. For safety to operate effectively as a Social Construct within a university campus, an individual's concept of ` safety ` as a constructed object (knowledge) must fit into our communal model. Likewise to shift culture, society must value the change. Because campuses are communities of diverse (and often compartmentalized) activities, creating a common structure of safety is as important as it is complex. This requires elevating safety to discipline status and focus consideration of the health and wellbeing of people and the environment into decision-making using the principles of risk assessment to understand hazards. At the highest levels of practice, safety planning must be embedded in experimental design, which is potentially most effective in preventing accidents. Prevention through design can be considered as anticipating and designing out hazards in tools, equipment, processes, materials, structures and

the organization of work to prevent occupational injury, illnesses or fatalities. The hierarchy of control in safety management is shown in **Figure 1**.

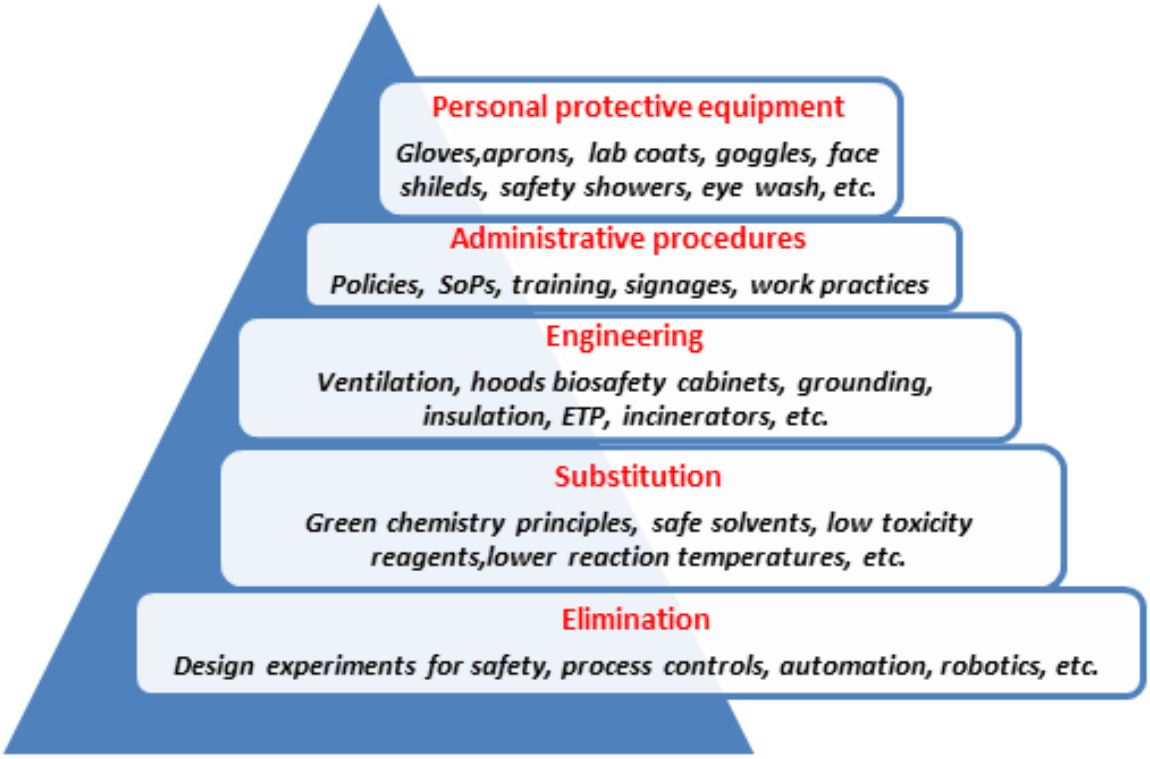

Figure 1: Hierarchy of controls in safety management (*adapted from Cell Press, Reviews, Trends in Chemistry, 2019, 1(3), 275-278)*

In laboratories that are old and have aged facilities, upgrading physical infrastructure requires financial resources. In resource-starved environment where most Indian institutions find themselves, in spite of their best intentions, to find money / allocate budgets for upgradation of laboratories to contemporary standards of safety is a significant challenge to administrators.

Keeping in view this reality, we recommend that improvements must be implemented in a phased manner and incrementally. It is unrealistic to expect that such upgradation and inculcation of safety culture and change of mindset can be accomplished in a short and quick manner.

To provide a framework for accomplishing this goal, we recommend adopting a "Five-Level" laboratory safety matrix (**Figure 2**). The objective of defining the levels is to assess where the institution is currently placed in this framework and strive for climbing, at least, one level up in a time-bound manner. These levels, roughly, parallel the five-level hierarchies of controls shown in **Figure 1** above.

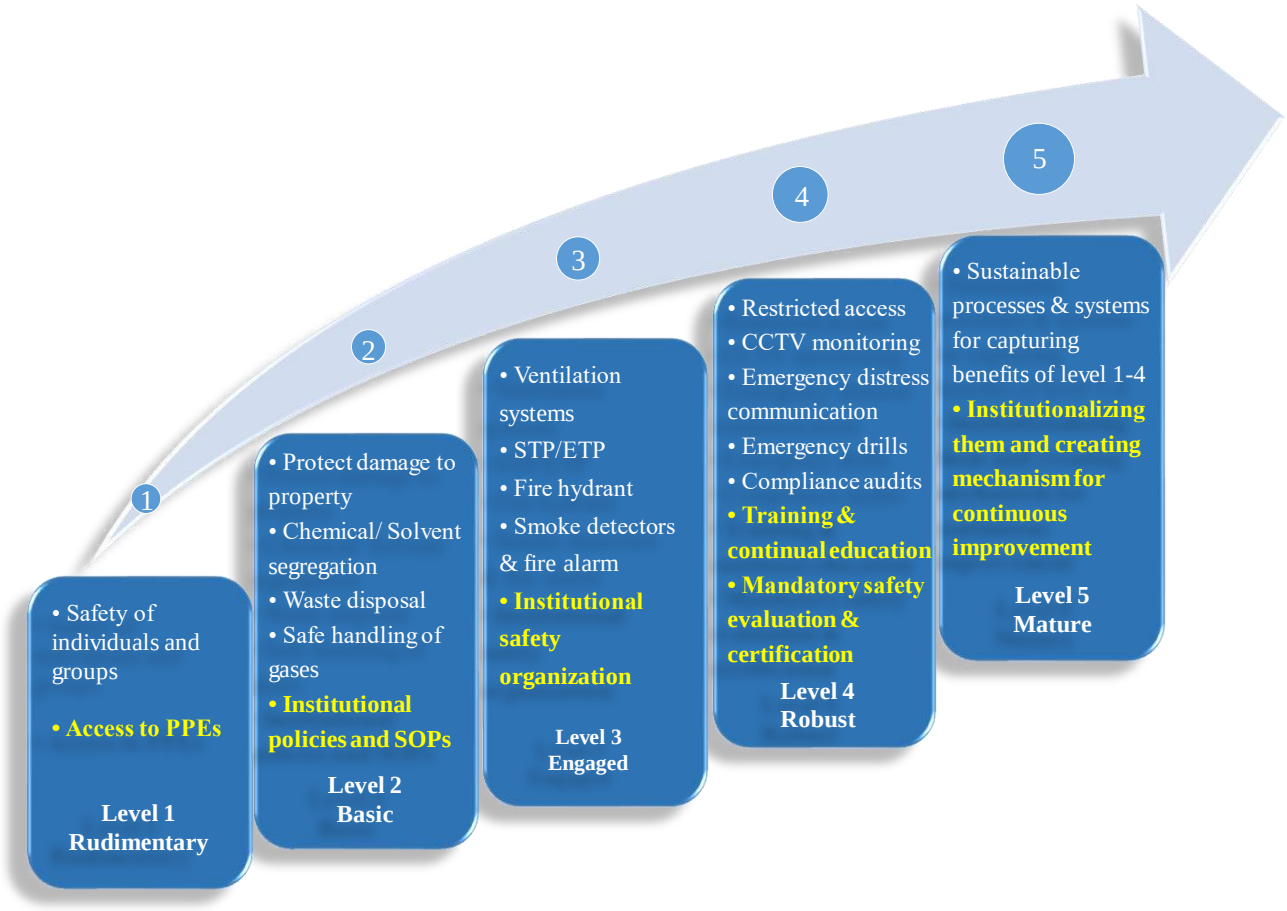

Figure 2: Five–levels of laboratory safety

The attributes that define each level are shown in **Table A**

Table A: Five-levels of laboratory safety and their attributes

LEVEL	DEFINITION	ATTRIBUTES
1	Rudimentary	The focus is on the personal safety of individuals and groups of individuals. The emphasis is on access to and use of personal protection equipment and practice of rudimentary safety practices. Key goal is to prevent damage to life and livelihood
2	Basic	Institutional policies, defining roles and responsibilities, leadership affirmation, written and documented Sops for all operations, minimum measures to protect damage to property, solvent storage, waste chemical and solvent segregation, collection and disposal facilities, practices for safe handling of compressed gases, local fire safety systems, and minimum Laboratory Ventilation Design Level (LVDL) between 0 and 1 (ASHRAE Standards), Electrical wiring, grounding and insulation according to prevalent standards; periodic safety awareness education and training
3	Engaged	Design and installation of ventilation systems confirming to LVDL between 1 to 2 (ASHRAE Standards), STP with pre-treatment for laboratory-related effluents, emergency exits, Fire hydrant lines and associated systems, smoke detector and fire alarm/ siren systems; creating an institutional safety organization
4	Robust	Safety-related access control, CCTV monitoring, emergency distress communication systems; Training, continuing education, emergency drills and periodic compliance audits; mandatory and periodic computer-based

		evaluation and certification
5	Mature	Creating sustainable processes and systems for capturing the benefit of levels 1-4, institutionalizing them and creating a mechanism for continuous improvements; a culture of design for safety and increasing use of laboratory automation, wherever possible.

4. DATA COLLECTION AND ANALYSIS

4.1 Institute I: Savitribai Phule Pune University (SPPU), Pune

SPPU is a Public University devoted to undergraduate and postgraduate education in all disciplines of knowledge. The Campus in Pune is devoted to postgraduate education while the affiliated colleges provide undergraduate and in some cases postgraduate education. The Pune campus houses 46 academic departments with 25 departments under the Science and Technology division and out of which 9 are pure science departments comprising of Physics, Chemistry, Botany, Zoology, Biotechnology, Microbiology, Geography, Geology and Environmental Sciences. The chemistry department has about 350 students (250 MSc students and about 100 MPhil and Ph.D. research students), 4 big teaching laboratories for MSc students and about 20 research laboratories, out of which 15 are, wet labs and 5 are dry labs.

A meeting was held in the office of Vice Chancellor SPPU along with the HODs of Chemistry, Physics & EVS departments, to explain the project details and seek his concurrence to carry out the data collection for the project. The VC of Pune directed the HOD Physics & EVS department to act as a nodal faculty for communication on this subject. This was followed by another meeting, convened with all HODs and representatives of other departments in SPPU to explain the project details and methodology being followed. The checklist was explained and shared with all.

Subsequently, several visits were made to the Departments of Chemistry, Biotechnology, Physics and Environmental Sciences, Botany, Zoology and Geology at SPPU, to assist the coordinators in collecting the baseline data and for an on the spot assessment of the situation. Following these interactions it was felt that we focus only on the Department of Chemistry since it was felt that other departments handle insignificant quantities of hazardous chemicals. The filled checklist was also obtained from the Department of Biotechnology.

The information and the data obtained from the Department of Chemistry and Department of Biotechnology are provided in Annexure 1 and Table 1A and 1B. Further, in order to assess the quality of wastewater/effluents emanating from the Department of Chemistry, points of discharge were identified and samples were taken and analyzed by an external agency.

Based on the perusal of data and information gathered during discussions with stakeholders, the Committee believes that the Department of Chemistry, SPPU can be classified **Level: 1**.The prevalent laboratory safety infrastructure is the bare minimum and requires significant upgradation. The facilities of storage of chemicals, solvents, gases and ventilation systems also need major improvement. All waste chemicals and solvents are discharged into laboratory sinks for disposal. This is an unsafe practice The Department also has minimal emergency response systems. There is a need to put in place a formal laboratory safety management system along with continuing education and training in matters related to safety in the laboratory

4.2 Institute II: Institute of Chemical Technology (ICT), Mumbai

ICT has over 2200 students (about 1100 UG, 500 PG and 600 Ph.D. students). The campus has close to 40 small to medium size laboratories, most of which are occupied daily for more than 15 hours by PG and Ph.D. students for their research work. Almost all the departments of ICT (chemistry, pharmacy, food technology, dyestuff technology, plastics and polymer technology, textile technology, chemical technology and engineering), in some way or other deal with chemicals and hazardous reactions. Data were collected by the champions at ICT and subsequently during five visits. The information and data collected are shown in Annexure 2 and Table 2A and Table 2B. As anticipated, it is observed that the newly refurbished laboratories are

better equipped and, hence, follow better laboratory practices. To assess the quality of wastewater coming out of the laboratory, samples were collected and analyzed from the sump outside 18 laboratories as a representative of all 40 laboratories and analyzed.

Based on the perusal of data and information gathered during discussions with stakeholders, the Committee believes that the Laboratories of ICT, Mumbai can be classified as **Level: 2**. ICT Mumbai has most of the basic safety facilities. However, it is observed that aged laboratories have been progressively refurbished and many await refurbishment. Facilities for the storage of chemicals, solvents and gases as well ventilation systems need upgradation. ICT has a system of segregation and collection of waste solvents and chemicals and their disposal through a designated and approved external agency. The emergency response system and infrastructure require improvement. Laboratory safety management systems, as well as safety education and training require to be implemented uniformly across all departments and laboratories, with a deeper engagement of all HoDs.

4.3 Institute III: Indian Institute of Science, Education and Research (IISER-K), Kolkata

IISER-Kolkata is an institution that commenced operation in 2006. Most of the laboratory facilities for Chemistry were created around 2009-10. Thus, the design of laboratory and associated facilities are somewhat more recent and modern. The chemistry department caters to about 400 undergraduate and Master's students, about 50 integrated Ph.D. students, about 160 Ph.D. students, has 6 teaching laboratories and more than 30 research laboratories. Data was collected from 9 Laboratories in the Chemistry department (as representative cases) and extrapolated to the entire department. The information and the data so obtained are provided in Annexure 3 and Table 3.

Based on the perusal of data and information gathered during discussions with stakeholders, the Committee believes that the laboratories of IISER-K can be classified as **Level: 3**. It is observed that the laboratory has good and modern infrastructure and facilities that are functional. The risk of exposure is minimal as all the labs are centrally air controlled and have good ventilation systems. Good work practices include the collection and segregation of waste chemicals and

solvents that are sent for disposal to a PCB approved external agency. The infrastructure to respond to an emergency is reasonable and functional. The institute lacks storage facilities for bulk solvents, gases and chemicals. It was observed that large quantities of solvents and gas cylinders are stored within the laboratories, which constitute a potential risk. The laboratory has basic safety management system. Better compliance for the use of PPE and regular safety education, training and audits are, however, required.

5.0 BUDGETARY REQUIREMENTS

Budgetary requirements for upgradation, in a summary form, for the three institutions one-level up, are shown in **Table B**. The detailed facilities proposed for each of the institutions and their itemized estimated cost is provided in Annexures

Table B: Summary of budgetary estimates for laboratory safety upgradation

Sr. No.	Key Requirements	SPPU, Pune INR (Lakh) [a] **Level 1 to 2**	ICT, Mumbai INR (Lakh) [b] **Level 2 to 3**	IISER, Kolkata INR (Lakh)[c] **Level 3 to 4**
1.	Bulk storage of solvents, chemicals and gases	54	85	94
2.	Fire safety	3	36	3
3.	Ventilation	30	45	5
4.	Electrical safety	30	50	40
5.	Lab accessories	28	42	53
6.	Documentation and training	3	7	5
7.	Waste management system	2	35	-
	TOTAL, INR (Lakh)	**150**	**300**	**200**

[a] Estimates predominantly based on the needs of the department of chemistry and partly for the department of biotechnology

[b] Estimates for the whole Institute and all the teaching and research departments

[c] Estimates based on the needs of the departments of chemistry and life sciences

Note: The budgetary estimate is based on student strength of the department and with some allowance made for expansion

6.0 RECOMMENDED IMPLEMENTATION STRATEGY

We believe that the implementation of this project will occur at two levels. One, creation of physical facilities, including buildings, laboratory modifications, equipping labs with fume hoods and ventilation systems, where necessary, and procurement of safety accessories, personal protection equipment and the like. The second will be to set up a system of training and education for all the personnel, creation of contents / resources for training, drawing up SoPs and institutionalizing safety management practices in chosen institutions. A programme for "training the trainers" will also be put in place, so that institutions can undertake continuing education and training on their own subsequently. We reiterate that all institutions must put in place a robust system of collecting all waste and used solvents and chemicals, segregating them at the point of origin and disposing them off in a manner consistent with, both, safety as well as the stipulated norms of the Pollution Control Boards. Care must be taken to ensure that used chemicals are not washed down the sinks. We also strongly recommend creating a "Safety Science Curriculum" and an associated textbook or workbook, specifically designed for Indian universities and research institutions. Such a course must be made compulsory for every student of science or engineering, both at undergraduate and postgraduate levels. The course can be web-based with a combination of self-learning and classroom learning modules with a few lectures delivered through NPTEL. Assessment and certification can also be web based. Safety is, in the ultimate, a culture and an attitude, which has to be inculcated early in the life of a student. Only then it will have a lasting and sustainable impact

Annexure 1

Data collection, analysis and brief findings at Savitribai Phule Pune University (SPPU)

Savitribai Phule Pune University is one of the finest and most popular educational centers in the city. It offers excellent programs in various areas including Science, Commerce, Arts, Languages and Management Studies. The university houses 46 academic departments with 25 departments under the Science and Technology division and out of which 9 as pure science departments of, Physics, Chemistry, Botany, Zoology, Biotechnology, Microbiology, Geography, Geology and Environmental Sciences.

A survey of the laboratory facilities was undertaken for on the spot assessment of the infrastructure, facilities available and the laboratory practices being followed. Several visits made at the Departments of Chemistry, Biotechnology, Physics and Environmental Sciences, Botany, Zoology and Geology of the SPPU, to assist the coordinators in collecting the baseline data and for an on the spot assessment of the situation. Data as per the checklist have been collected and reported mainly for the chemistry department of the SPPU, as other departments in the science faculty, handle and use quite insignificant quantities of nonhazardous chemicals. A filled checklist was also obtained from the Department of Biotechnology. Discussions were also held with the staff and HOD of the department of Environmental sciences. It was informed that other science departments use chemicals in negligible quantities.

For the purpose of laboratory safety, storage, handling and disposal of chemicals, it was felt to concentrate on the chemistry department as this would account for more than 95% of the chemicals being used in the whole of Pune University.

The chemistry department was established in 1950 and offers programs leading to M.Sc., M.Phil. and Ph.D. degrees. It has a C shaped building with G+1 structure. On the side wings, both on the GF and FF, it has big laboratory halls ~ 80 FT X 40FT (3200 SQFT) for postgraduate students, while the front portion has offices and laboratories ~20FT X 20 FT, (400SQFT) for Ph.D. researchers. In addition, there is a big lecture hall on the GF while the FF has a smaller lecture hall.

About 15 years ago, one building (G+1) was built to accommodate organic chemistry laboratories and is named as Garware Research Centre.

Very recently a four storied building has come up to house all the sophisticated instruments of the department as a central facility and the FF is proposed to be occupied as office by the faculty members.

The chemistry department has over 350 students (250 MSc students and about 100 MPhil and Ph.D. researchers students) and has 4 big laboratory halls for MSc students and over 20 laboratories, out of which 15 no are wet labs, 5 no are dry labs (i.e. either computer rooms or sitting rooms).

A survey of the laboratory facilities was undertaken for on the spot assessment of the infrastructure, facilities available and the laboratory practices being followed. The filled in inspection checklist is attached as Table 1A and Table 1B for reference. Major observations are as under:

1. Lab space and occupancy: Almost all labs are about 400 SQFT, and on an average 5 students work in each lab. The number could at times be more when M.Sc. project students also come over to do their project work. A small cabin with a partition is occupied by PI for his office. All laboratories have only one door for entrance and exit.
2. Light and Ventilation: The laboratories do not get adequate natural light due to the presence of heavy foliage trees on one side and a covered corridor on the other. The light from the tube lights in the labs is considered inadequate. All laboratories have windows that are partially closed. A few rooms have exhaust fans that are used as required. At least one fume hood is provided in most laboratories; however, it is an old wooden structure either with an exhaust or a blower. But, invariably this is not in operation and the hood is conveniently used as a storage space for acids, reagent bottles, heating mantles or an oil bath etc. 2-3 laboratories have metal fume hood with proper blower for ventilation.
3. Procurement, Storage of chemicals and solvents: There is no centralized facility for procurement of chemicals, solvents, reagents or gases in the chemistry department of SPPU. All PIs order directly to, from a panel of vendors, for their own requirements. Although the

materials are received in the office and entered in appropriate registers for record and audit purposes.

Bulk solvent storage: About 15-20 nos. of 200L drums of common solvents like acetone, methanol, ethyl acetate, hexane and DCM etc are kept in a shed (formerly a civil storage area) in an open space within the chemistry department (while a few more drums are kept outside the shed in open). This place, although under a tree, is generally open to heat and rain, stores about 25-30 drums at a given time.

In general, the chemicals and reagents are stored in the labs itself either in cupboards under the working benches or on open shelves along the walls. The solvents in bottles are similarly placed in cupboards or on the working bench itself. 4/5 solvent drums (20L capacity) and about 10-15 reagent bottles (2.5L capacity), that are required routinely, are normally kept on the floor within the labs.

4. Gas cylinders: Nitrogen is the commonly used gas in several laboratories. The cylinder is kept within the lab and is chained in one lab only. Hydrogen is also used in one of the labs for hydrogenation reactions under pressure in a Parr reactor. The gas cylinders are moved in trolleys. However, it is manually lifted to the first floor through stairs.
5. Disposal of chemicals and solvent wastes: Unfortunately, there is no system of collection and proper disposal of chemical and solvents wastes arising out of the R & D work in laboratories. All such materials is let out is laboratory sink and drains. These drains meet the common drainage facility.
6. Systems of Fire and personal safety:

   Fire Hydrants: The department does not have a fire hydrant system for fire extinguishing.

   Portable Fire Extinguishers: Although several portable fire extinguishers have been kept in different locations, but have not been serviced for long and many of these seem to be outdated. There are no fire hydrants. No fire alarm and detection system have been installed.

   Personal safety: Use of an apron (lab coat), safety goggles, and closed toes shoes are considered as essential components of a laboratory dress and work. Practically, all MSc students wear an apron while doing their experiments, while Ph.D. research scholars wear it occasionally. However, the use of safety goggles, closed toes shoes and other personal protection equipments like hand gloves and masks, etc is negligible.
7. Emergency response and procedures:

Eyewash fountain and safety showers: One combined eyewash and a safety shower has been provided on each floor of the main building and is in working condition. The Garware block does not have any safety shower or an eyewash fountain.

First aid box: First aid box is available in all labs and has been recently procured and given to all faculty members.

Sign boards and exit signs: None

8. Electrical safety and appliances: Although the wiring in the main building is old and concealed, at several points it is observed that due to new instruments or appliances, extension switch boards have been fixed on the wall. The grounding (earthing) has been provided, although, in some rooms, it is a temporary arrangement with hanging wires that run across corridors. All laboratories have at least one refrigerator (normal domestic type) that is loaded with chemicals, solvents and other reagents. There is a need to provide electrical wiring E & MCBs and switches insulation, non-sparking, covered industrial fittings in all chemical labs. Additionally, there is a need to provide flame & explosion proof Furnaces & Ovens, Heating mantles, magnetic stirrers, Refrigerators, etc.
9. Laboratory wastes and Effluents: The drainage from all labs are connected through a common drain pipe within labs and it was let out at the end of each section into a common drainage chamber on the GF. There are about 6 such chambers around the building. Several efforts were made to collect samples from these drain chambers to ascertain the quality of water. However, due to departmental holidays, when the attendance was thin, this had to be postponed. However, by July end, when the university had reopened for the new session, samples were obtained from 3 chambers and analyzed for pH, biological oxygen demand (BOD), chemical oxygen demand (COD). The results are given below.

The characterization of wastewater from laboratory outlet sumps in SPPU

Sr. No.	Sample details	pH	BOD (mg/L)	COD (mg/L)	BOD/COD ratio
1	Chemistry Lab drain	4.42	520	1440	0.36
2	Biochemistry Lab drain	7.65	62	154	0.4
3	Garware Research Lab drain	6.34	3500	10240	0.34

It can be observed that all the samples have shown low BOD/COD ratio depicting their non-biodegradable nature. Since this wastewater gets mixed with other wastewater from academic building, the concentration of BOD and COD is expected to decrease. This will also increase the biodegradability of wastewater and a STP with pre-processing may treat the combined wastewater. Further, it was estimated that approximately 5000 L / day of water is used in the chemistry department.

10. Teaching labs: The four teaching labs for the students have One fume hood with an exhaust fan, one common LPG cylinder with a manifold for burners at all benches. The acids and other reagents are kept in a bay at the end of the laboratory.
11. Safety Education and Training: The chemistry department organizes a safety orientation program for new entrants once a year. However, there is no periodic inspection of the labs, its conditions, or the practices being followed by lab mates.

Annexure 2

Data collection, analysis and brief findings at Institute of chemical technology (ICT), Mumbai

ICT has about 40 different laboratories, where students perform their research work. These labs were visited with few student volunteers and information is collected on the status of these laboratories in terms of safety and waste disposal. Different types of waste generated and the quantity of this waste is also estimated. Detailed information on existing and required facilities is collected. The filled inspection checklists are attached as Table 2A and Table 2B in appendices. Brief details of the findings are given below.

1. Lab space and occupancy:

ICT has Laboratories of different sizes ranging from 300 to 13000 Sq. Ft. Considering a large number of students, laboratories are crowded and this necessitates to follow more safety practices to avoid any accidents. Most of the laboratories have only one door for entrance and exit.

2. Light and Ventilation:

On an average laboratories have good lighting except for laboratories in the basement. Most of the laboratories have old fumehoods and ventilation system which needs to be upgraded. At multiple places, the fume hood is not in working condition and used as storage space for chemicals.

3. Procurement, Storage of chemicals and solvents: There is a computerized central facility for procurement of chemicals, solvents, reagents. Through an online system, students can place the order, after approval from respective project investigator (project guide/faculty), and store department. For things such as gases, appropriate registers are maintained for record and audit purposes.

Bulk solvent storage: Solvents are stored in respective laboratories. The used solvents are also being collected in the lab. There is no centralized facility for the storage of waste solvent.

4. Gas cylinders: Different types of gases such as acetylene, oxygen, nitrogen, hydrogen, carbon dioxide, argon are used in different laboratories. Recently, after an initiative by Chemical Engineering department HOD, all labs in the chemical engineering department have shifted their gas cylinders outside the laboratories by creating small gas banks and connections are given to

the laboratories. Still few laboratories in the institute have cylinders inside the laboratory and need to be shifted outside. Institute also has a common gas bank where cylinders required for practical work of undergraduate students are stored. The gas cylinders are moved in trolleys. In few laboratories, it is manually lifted to the first and second floor through stairs.

5. Disposal of chemicals and solvent wastes:

There is a designated centralized place for the storage of chemical waste. However, there is no segregation at the storage place. The collected waste is occasionally given to the authorized vendor for disposal. There is a need to design the place for centralized storage of the chemical waste with proper segregation. The approximate volume of waste generated in ICT is 365 kg per month. Except for a few hazardous chemicals, the segregation of chemical waste is not done in individual laboratories. There is a need to keep different color-coded bins for disposal of different types of waste. The laboratories in the Energy and Bioscience department follow segregation and disposal of waste. The chemical waste arising out of the R&D work in laboratories is let out in laboratory sink and drains. These drains further meet the common drainage facility.

6. Systems of Fire and personal safety:

Fire Extinguishers: Several portable fire extinguishers have been kept in different locations of the institute. There are no fire alarms and detection systems.

Personal safety: Practically, all undergraduate students wear an apron while doing their experiments, while Masters and Ph.D. research scholars found to wear it occasionally while performing their research work. After an initiative by the chemical engineering department, students in the chemical engineering department are using the personal protection equipments (PPEs) while performing their research work. The same needs to be implemented uniformly across all departments in the institutes.

7. Emergency response and procedures:

Eyewash fountain and safety showers:

Laboratories do not have enough eyewash and safety shower. There is a need to provide these things on each floor of the building.

8. Electrical safety and appliances:

The grounding (earthing) has been provided to all buildings. All laboratories have at least one refrigerator (normal domestic type) that is loaded with chemicals, solvents and other reagents.

There is a need to provide electrical wiring E & MCBs and switches insulation, non-sparking, covered industrial fittings in all chemical labs. Additionally, there is need to provide flame & explosion proof Furnaces & Ovens, Heating mantles, magnetic stirrers, Refrigerators, etc.

9. Laboratory wastes and Effluents:

The laboratory wastewater involves the wastewater produced during different activities performed in the laboratories such as rinsing and cleaning of glassware and equipment. This wastewater further combines with wastewater coming from non-academic buildings. The total wastewater finally flows out of campus to the municipal sewer. Even though wastewater produced from individual laboratories has a high concentration of contaminants, the dilution with other wastewater (washroom and toilets) from academic buildings reduces the concentration of the harmful contaminants.

The total volume of wastewater produced by different laboratories present in different buildings is measured using the volume of overhead tanks on the academic buildings and recording the frequency of filling of these overhead tanks. The total volume of wastewater generated is about 150 m^3/day. In order to know the concentration of contaminants, the wastewater samples were collected from the sump outside the laboratories. The composition of wastewater from two laboratories (before it gets mixed with other wastewater) is shown below.

The characterization of wastewater from two laboratory outlet sumps in ICT

Sr. No.	Sample details	pH	BOD (mg/L)	COD (mg/L)	BOD/COD ratio
1	Oils Building Sump	6.62	180	524	0.34
2	Department of Biotechnology (DBT) Building Sump	6.67	160	492	0.33

The low BOD/COD ratio indicates the non-biodegradable nature of compounds. Further, the laboratory wastewater from 18 different laboratory sumps (before it gets mixed with other wastewater from academic buildings) is collected and analyzed for total organic carbon (TOC) and total nitrogen (TN) and presented in following Figure 2A and Figure 2B.

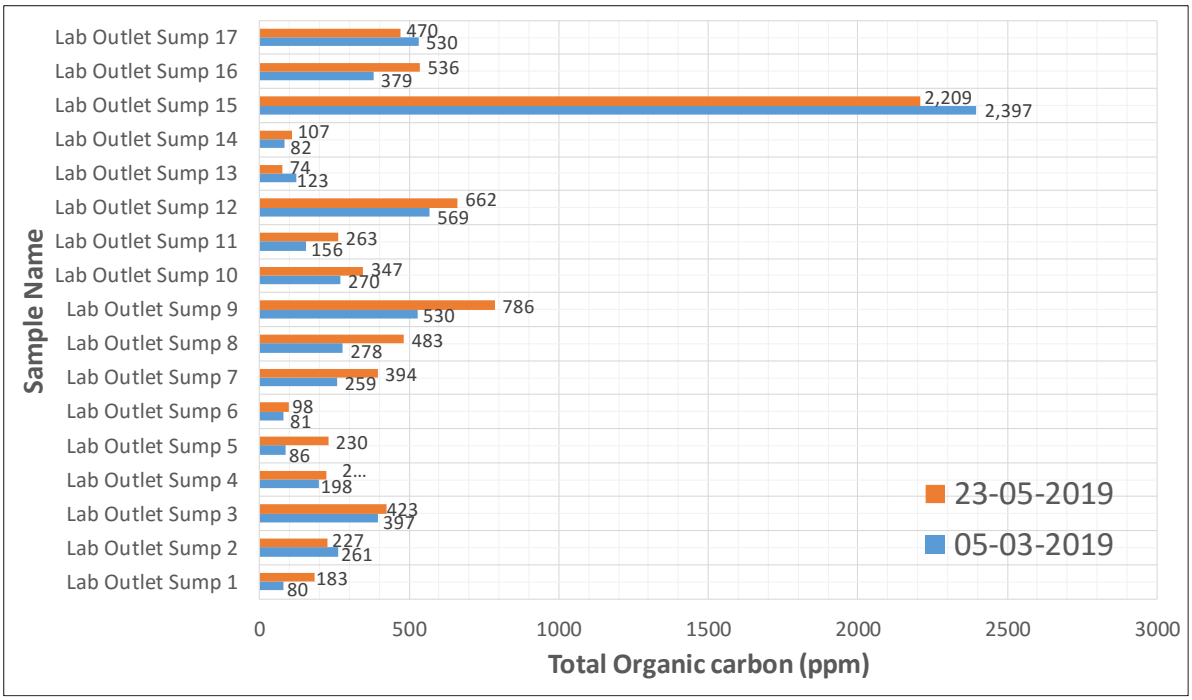

Figure 2A. Total organic carbon (TOC) of the wastewater samples collected from different laboratory sumps in ICT

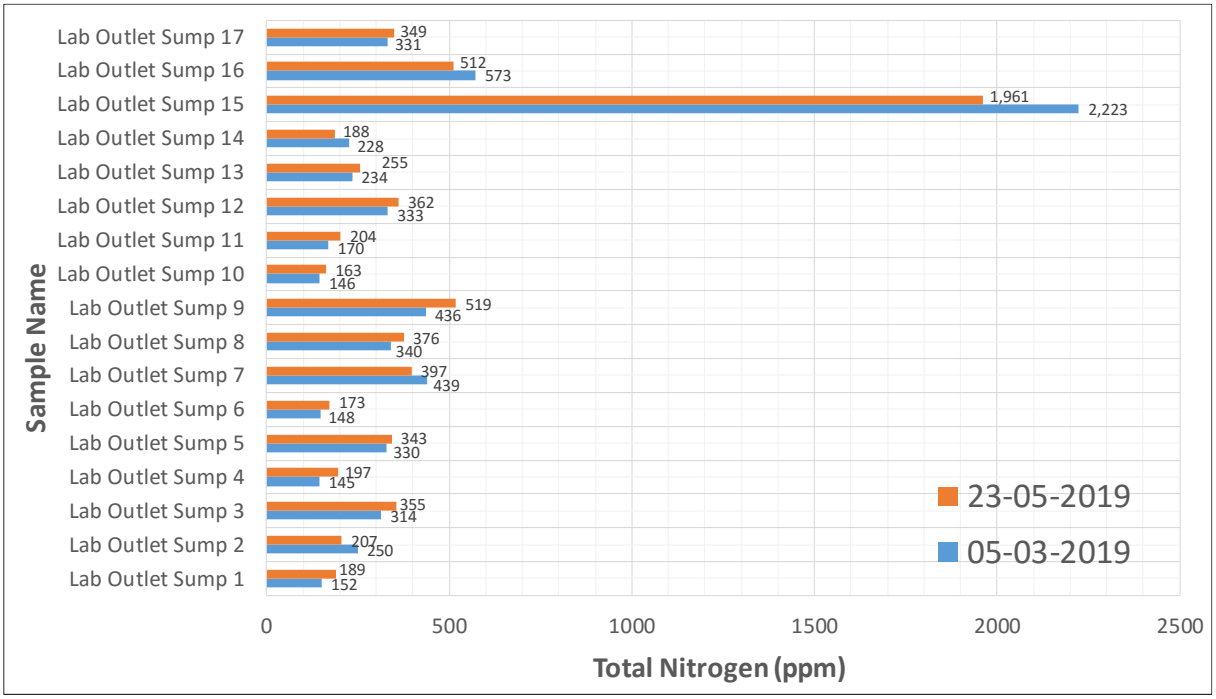

Figure 2B. Total nitrogen (TN) of the wastewater samples collected from different laboratory sumps in ICT

It can be observed from Figure 2A that the TOC in laboratory wastewater varies in the range of 80 – 786 mg/L except for one sample that varied in the range of 2,209 – 2,397 mg/L. As seen in Figure 2B, the total nitrogen content varied from 145 – 573 mg/L except for one sample, which has shown nitrogen content in the range of 1961 – 2223 mg/L. The sample, which has shown a high concentration of TOC and TN, is from the sump where wastewater from 4-5 laboratories from chemistry and chemical engineering department is accumulated.

As discussed earlier, this wastewater will be further combined with other wastewater (mostly washrooms and toilets), and after dilution, it is expected to decrease the level of contaminants and also expected to increase the biodegradable nature of the wastewater.

It is recommended to design STP with the pre-processing unit to adjust pH and BOD/COD ratio (if required). It is also recommended to have an oxidation unit (advanced oxidation processes (AOPs)) as a part of the pre-processing unit.

10. Teaching labs:
Workbench with one hood, exhaust fan, common LPG cylinder with a manifold for burners at all benches. Chemical engineering department practical labs have different demo experimental set-ups.

11. Safety Education and Training: Institute organizes lectures on safety from industry experts.
There is no formal mechanism for periodic inspection of the labs for its conditions and the practices being followed by lab mates. Recently, the Chemical Engineering Department has taken an initiative and formed a committee that inspects labs periodically. Also one safety champion is identified from each lab. The committee periodically holds the meetings and discuss issues related to safety.

Annexure 3

Data collection, analysis and brief findings at IISER Kolkata

Indian Institute of Science Education and Research, Kolkata was visited for a week during early 2019.

A survey of the laboratory facilities was undertaken for an on the spot assessment of the infrastructure, facilities available and the laboratory practices being followed in the Department of Life Sciences, Earth Sciences, Physics and Chemistry. IISER Kolkata has modern laboratories with state of the art facilities including fume hoods, chemical storage space, two doors, and HVAC systems for good ventilation etc for all labs.

The filled in inspection checklist for 9 laboratory rooms in the chemistry department, that was got filled by the champions at IISER-K is attached as Table 3 in Appendices. Although the data is available for 9 laboratories, it can be safely extrapolated to other labs as well.

For the purpose of laboratory safety, storage, handling and disposal of chemicals, it was felt to concentrate on the chemistry department as this would account for more than 95% of the chemicals being used in the whole of IISER Kolkata.

The chemistry department has 36 faculty members, with about 23 faculties doing experimental wet chemistry while the rest are theoretical. All labs have a good and modern infrastructure with built in fume hoods, chemical storage etc. About 18 to 20 labs are functional, while a few labs are being made ready for occupation. Furniture and other facilities (fume hoods, ventilation systems) are being set up.

1. Lab space and occupancy: Almost all labs are about 750 SQFT, and on an average 8 students work in each lab. All laboratories have two doors for entrance and exit and the second door is unobstructed. Generally, the PI has a separate office, but a few also have their office carved out within the labs itself.
2. Light and Ventilation: The laboratories get adequate natural light. All laboratories have windows that are kept closed. The Research complex is fully HVAC controlled and is managed by intelligent systems to take care of fluctuations in air volume etc. On an average, 4 fume hoods have been installed in each laboratory, which are considered adequate. The hoods are in good working condition.

3. Procurement, Storage of chemicals and solvents: There is no centralized facility for procurement of chemicals, solvents, reagents or gases in the IISER (K) chemistry department. All PIs order directly to, from a panel of vendors, for their own requirements. Although the materials are received in the central stores and entered in appropriate registers for record and audit purposes.

IISER-K does not yet have a common bulk solvent storage facility. The chemicals and reagents are stored in the labs itself either in cupboards under the working benches or on the working bench itself. Solvents like EtOAc, Hexane, DCM, Methanol, Toluene, etc are commonly used in the labs. It is observed that a large number of 25 L capacity drum solvents (4 to 20 Nos) and 4L glass bottles (10 to 30 Nos) are stored in the labs. The solvents in bottles are generally kept in cupboards or on the working bench itself, while 25L drums containing solvents are normally kept on the floor within the labs.

4. Gas cylinders: Nitrogen is the commonly used gas in several laboratories. Some labs also use oxygen and ammonia. The cylinders are kept within the lab and are generally kept chained. In a few labs, the cylinders were found to be not chained. The gas cylinders are moved in trolleys and in lifts for movement to higher floors.

It was observed that the color coding of the gas cylinders was not as per standards. One of the gas cylinders was red in color but in fact contained oxygen (PRAXAIR).

The gas cylinders delivered by the vendor are kept in then utility building, without being chained or secured to a wall. Since there is no labeling, there is also a mix-up of empty and filled cylinders. This place may eventually become a centralized store.

5. Disposal of chemicals and solvent wastes: The waste segregation system, hazardous and solvent waste disposal and biohazard waste disposal system are live and functional. On an average ~2000 kg per month of liquid solvent waste is generated and sent for disposal at regular intervals. No solid waste is generated. Hazardous waste solvents are generally segregated (halogenated and non-halogenated). All such wastes including the hazardous wastes and solvents are picked up, on call, by a WB PCB approved vendor for disposal.

The institute has 2 STP plants that are functional.

6. Systems of Fire and personal safety:

Fire Extinguishers: Appropriate portable fire extinguishers have been placed at convenient distances in all corridors of the campus. A fire hydrant system complete with water reservoirs

has been installed all over the campus. This is fully supported by energized water tanks for supply of water.

Addressable fire detection and alarm system has been installed in all buildings on the campus. To mitigate the fire, water sprinkler system has also been installed that is coupled with the fire alarm system.

In several other newly occupied buildings, although the fire detection and alarm system, although functional but yet has not been switched on. (Observed in Officiating Registrars office and lecture rooms). Trained manpower is available to handle a fire, in case of an emergency. The security section also has two volunteers in each shift to assist for chemical incidents in labs.

7. Personal safety: Use of an apron (lab coat), safety goggles, and closed toes shoes are considered as essential components of a laboratory dress and work. Lab coats (aprons) are used by almost all researchers although, the quality is poor and is generally half sleeves, The use of safety goggles, closed toes shoes and other personal protection equipments like hand gloves and masks etc in wet labs is unsatisfactory.

8. Emergency response and procedures:

Eyewash fountain and safety showers: One combined eyewash and a safety shower has been provided on each floor of the main building and is in working condition.

First aid box: First aid box is available in all labs.

Trained manpower is available to handle a fire, in case of an emergency.

9. Electrical safety and appliances:

Being a relatively new building with quality work, the electrical wiring is good. The grounding (earthing) is properly done. All laboratories have at least one refrigerator (normal domestic type) that is loaded with chemicals, solvents and other reagents.

Electrical substation with 33KVA power supply, 3 X 1010 KV generators for total power back up that is integrated with BMC systems for actual demand and supply.

10. Laboratory wastes and Effluents: IISER (K) has a very good system for the segregation and collection of laboratory wastes.

The general waste is segregation into five categories and kept in different colored bins. a). Red- solid chemical waste, b) Yellow- Non biodegradable (plastic, bottles, caps, etc), c) Blue- Metallic waste (syringe, aluminum foil, metal cans, etc), d) Green - Biodegradable waste (food, paper, etc) and e) Black – Wet waste

Such wastes are collected on a weekly basis for further disposal. Waste solvents from the labs are collected in different containers (halogenated and non- halogenated). Similarly solid wastes from the laboratory (mainly silica gel, alumina and sodium sulphate, etc) are also collected. Likewise in biodegradable wastes in Life science labs, wastes are collected as per guidelines.

All such wastes including the hazardous wastes and solvents are picked up, on call, by a WB PCB approved vendor for disposal. (IR Chemicals). Although this process has started very recently and the first lot of solvents and other materials lying for years sent in December 2018.

The general effluents from all IISER are sent to two nos of STP for treatment. The composition of samples after STP is given below.

The characterization of wastewater from treated effluent after STP at IISER

Sr. No.	Sample details	pH	BOD (mg/L)	COD (mg/L)
1	STP outlet	6.6	6.6	36
2	Limit as per environmental protection Act, for effluent discharge into inland surface water	5.5 – 9.0	< 30 (Max)	< 250 (Max)

It can be seen that the STP is capable of maintaining the contaminant level below the limit of the environmental protection act required for discharge into inland surface water.

11 Safety education and training

The institute has been provided with the most advanced set of facilities and infrastructure. However, the practice of science in these labs is still governed by the old fashioned mindset of not following the best safety practices. The regular laboratory safety training and orientation as an institute is not visible. The institute still does not have an institute's safety policy and a safety manual. Although, the life sciences department has a written policy and also conducts a safety orientation for new entrants twice a year followed by a quiz. The safety inspection of the labs, its conditions, or the practices being followed by lab mates is also not regular.

Annexure 4

A list of Maharashtra Pollution Control Board (MPCB) authorized vendors for processing spent solvents

List of authorised spent solvent recyclers having consent from MPCB as on 15/12/2015

Sr. No.	Name and address of industry	Products/activity	Consented Quantity
1	Nilchem Industries, Plot No. F-20, MIDC, Badlapur, Dist. Thane	Solvent Distillation	100 MT/M
2	Ritik Chem Pvt. Ltd., Plot No. N-32, Additional Ambernath Area MIDC, Ambernath, Thane	Distillation of solvents	5 -MT/D
3	Square Chemicals, Plot No. A-61, MIDC, Badlapur, Dist. Thane	Distillation of solvents	50 MT/M
4	Sagar Organics, Plot No. K-37, Additional, MIDC Ambarnath, Dist. Thane	Distillation of Solvents	2400 KL/Annum
5	Maharashtra Esters & Ketones Pvt. Ltd., B-52/1 & 2, MIDC Lote, Khed, Ratnagiri	1) Toulene 2) Mix Xylene 3) Heavy Solvents 4) Resins 5) Distillation of Solvents	1) 300 MT/M 2) 250 MT/M 3) 275 MT/M
6	Sahastra Chemicals Pvt. Ltd., (Formerly Momin Chemicals), Plot No. B-17, MIDC Lote, Parshuram, Khed, Ratnagiri	1) Industrial Solvents & Spent Solvent Distillation 2) DMAHCL	1) 500 MT/M 2) 300 MT/M
7	Sulaki Chemicals Pvt. Ltd., C-33 & 34, MIDC Lote, Khed, Ratnagiri	1) Distillation Solvents	295 KL/Day
8	Ganesh Chemicals, Plot No. 80, 81, MIDC Area, Lote Parshuram, Tal. Khed, Ratnagiri	Distillation of Spent Solvents	500 MT/M

9	Ashonuj Chem Pvt. Ltd., Plot No. A-672, MIDC, TTC, Thane	Solvent Distillation / Purification	40 MT/M
10	Sagarkala Chemicals Pvt. Ltd., Plot No. 56, MIDC Taloja, Panvel, Dist. Raigad	1) Paint Thinner 2) Distilled recovered Solvents	1) 180 KL/A 2) 480 KL/A
11	Sujan Chemoplast Pvt.Ltd. Plot No. A-697, MIDC, Mahape, TTC, Navi Mumbai	Textile Auxiliaries, Resins, Solvent Distillation	458 Ton/M
12	Shri Gajanan Industries, Plot No. W-299, MIDC, TTC, Thane	Solvent Distillation / Purification	15 MT/M
13	Om Pharmaceuticals & Chemicals, Plot No. R-69, MIDC, Rabale, TTC, Thane	Distillation of solvents	550 MT/M
14	Praktan Industries, Plot No. W-298, TTC Indl., Area, Rabale, Navi Mumbai	Distilled solvents	80 MT/M
15	Romel Holdings Pvt. Ltd. Plot No. W-292, TTC Indl., Area, MIDC Rabale, Navi Mumbai	Distilled solvents	350 MT/M
16	Sumitra Chemical Industries, Plot No. W-278, MIDC, Rabale, TTC, Navi Mumbai	Distillation of Solvents	As per Order
17	JHS Chemipharma Pvt. Ltd., (Formerly known as Om Pharmaceuticals & Chemicals), R-69, Rabale, TTC, MIDC, Thane, Navi Mumbai	Distillation of solvents	550 MT/M
18	Shiv Shakti Oxalates Pvt. Ltd., Plot No. A-84/1, MIDC, Kurkumbh, Daund, Pune	Chemical & Solvent Distillation	1250 MT/M

19	Baba Rang Udyog Plot No. H-16, MIDC Taloja, Raigad	Distillation of spent solvents	20 MT/M
20	M/s. Balaji Rang Udyog Pvt. Ltd., Plot No. 44, MIDC Taloja, Tal. Panvel, Dist. Raigad	1) Recycling of Waste oil 2) Distillation of spent solvents	1) 15000 KL/A 2) 240 MT/A
21	M/s. Rang Rasayan Udyog, Plot No. W-158, MIDC Taloja, Tal. Panvel, Dist. Raigad	1) 2, 4 Dinitro Aniline 2) 6 Bromo 2, 4 DNA 3) 2, 6 DC DNA 4) 2, 6 DB DNA	1) 2.0 MT/M 2) 1.0 MT/M 3) 0.5 MT/M 4) 0.5 MT/M
22	M/s. Sumitomo Industries, Plot No. 17/6, Indl. Area, MIDC Taloja, Tal. Panvel, Dist. Raigad	1) Distillation of Solvents like Methanol and DMF 2) Acrylic Polyol 3) Epoxy Modified Resin	1) 30 MT/M 2) 20 MT/M 3) 20 MT/M
23	Ms. Super Petroleum Products Pvt. Ltd., Plot No. 96 MIDC Taloja, Raigad	1) Organic Thinner 2) Organic Solvent By using distillation method for following:- a) Contaminated Solvents b) Spent Solvent c) Industrial Solvent in Distillation residue d) Spent mother liquor e) Other spent industrial Solvents	1) 125 MT/M 2) 180 MT/M
24	M/s. Shree Samarth Engineers, Plot No. E-15, MIDC Lote Parshuram, Ta. Khed, Dist. Ratnagiri	1) Butyl Acetate 2) Distillation of Spent Solvents	1) 10 MT/M 2) 160 MT/M
25	M/s. Taaj Healthcare Pvt. Ltd., Plot No. B-14, MIDC Lote Parshuram, Tal. Khed, Dist. Ratnagiri	1) Photo organic Chemiclas 2) Textile Chemicals 3) Mono Chloro Acetic Acid 4) Dimethyl Amine Hydrochloride 5) Industrial	1) 59 MT/M 2) 4.0 MT/M 3) 40 MT/M 4) 300 MT/M 5) 500 MT/M

		Solvents (DMF, Acetone, IPA, Acetonitrile)	
26	M/s. Anand Acid and Chemical Company, Plot No. K-38, MIDC Additional Ambernath Indl. Area, Dist. Thane.	Distillation mixed solvents	184 MT/M
27	M/s. Annex Pharmaceutical & Chemicals Pvt. Ltd., Plot No. G-25, MIDC Area, Dist. Ahmednagar.	Distillation mixed solvents and glycol	1200 MT/M
28	M/s. Juliet Industries, Plot No. E-16, Opp. ASB Ltd., Additional Ambernath MIDC, Thane.	Distillation of Spent Solvents	50 MT/M
29	M/s. Kunal Chemcial Indutries, Plot No. W-5, MIDC Kurkumbh, Tal. Daund, Dist. Pune.	Recovered Solvent (Distillation of Spent Solvent on Job Work Basis)	600 MT/M
30	M/s. Alok Chemicals Pvt. Ltd., EL-25/5 (Ground Floor), MIDC Bhosari, Dist. Pune.	1) Spin Finish for Polypropylene Yarn 2) Water Based Cleaning Liquid 3) Perfumery Chemicals 4) Distillation of Spent Solvents	1) 3.0 MT/M 2) 1.0 MT/M 3) 200 Kg/M 4) 9.7 KL/M
31	M/s. Archem Industries, Plot No. A-47, MIDC Kurkumbh, Tal. Daund, Dist. Pune.	1) Distillation of Spent Solvents 2) 2, 4, Dichloro Amino Phenol 3) Methyl Salicilate	1) 325 MT/M 2) 200 Kg/D 3) 450 Kg/M
32	M/s. J. P. Fine Lab, A-51, MIDC Kurkumbh, Dist. Pune.	Distillation of Spent Solvents	3000 Ltrs/M
33	M/s. Namau Chem Pvt.Ltd., Plot No. N-27, Additional MIDC, Ambarnath, Dist. Thane.	1) Compound Solvents 2) Packing & Repacking of Acid/Solvents, Fine	1) 300 MT/M 2) 250 MT/M 3) 275 MT/M

		Chemicals & Alliey Chemicals 3) Distillation of Solvents	
34	M/s. Ortho Chem (MFG), Plot No. W-16, MIDC Industrial Area, Hingna road, Nagpur.	1) Distillation of Spent Solvents 2) Caustic as by product	1) 40 MT/M 2) 6.0 MT/M
35	M/s. Punarnava Rasayan Pvt. Ltd., Plot No. B-11, MIDC Tembhurni, Tal. Madha, Dist. Solapur.	Distillation of Spent Solvents	1300 MT/M
36	M/s. Ramkamal Chemicals Pvt. Ltd., Plot No. A-77, Kurkumbh Indl. Area, MIDC, Tal. Daund, Dist. Pune.	Distillation of Spent Solvents	700 MT/M
37	M/s. Vighnaharta Oil and Chemicals Pvt Ltd, Plot no: W-53(II), MIDC Taloja Industrial Area. Taloja Tal: Panvel Dist: Raigad.	Distillation of Spent Solvents	120 MT/M

List of recyclers/reprocessors under rule – 9, MPCB 2018

Sr. No.	Name and Address of Industry	Type of Hazardous Waste Recycled	Capacity Allotted as per Authorisation / registration (MT/A)
1	**M/s. Saai Pharma,** Plot No. B-45, MIDC Wai, Tal. Wai, Dist. Satara 2 **M/s. Sanket Chemicals,** Plot No. D-18/6, TTC MIDC Turbhe, Navi Mumbai	Used Food Grade HNP / Rolling Oil Spent Solvent	1000
2	**M/s. Sanket Chemicals,** Plot No. D-18/6, TTC MIDC Turbhe, Navi Mumbai	Spent Solvent	240
3	**M/s. Bombay Metal Works,** S. No. 183, H. No. 5/2, Dahisar Road, Pimpri, Thane	Aluminium Dross & Scrap	5000
4	**M/s. EFTEC (India) Pvt. Ltd.** G-9, MIDC Ranjangaon, Tal. Shirur, Dist. Pune 412220	PVC Waste Sealer	300
5	**M/s. Sigma Electric Manufacturing Corporation Pvt. Ltd.** Unit 1, Gat No. 154/155, Mahalunge, Chakan Talegaon Road, Chakan, Tal. Khed, Dist. Pune	Copper Scrap / Druid	2000
6	**M/s. Vidhi Industries** S. No. 106, Village Sheurg, Tal. Panvel, Dist. Raigad	Aluminium Dross and Skimming	3600
7	**M/s. Shree Laxmi Metal Industries,** G. No. 62, 64, Vill. Chindwadli, Wada Shahapur Road, Wada, Dist. Palghar	Aluminium Scrap	720
8	**M/s. Sai Parma,** Plot No. B-45, MIDC, Sultanpur, Tal. Wai, Dist. Satara	Used Food Grade HNP / Rolling Oil	1000
9	**M/s. Delta Finochem Pvt. Ltd.,** Gat No. 504/507, Plot No. 18/19, Gonde Dumala, Tal. Igatpuri, Dist. Nashik	Spent Solvent	3600

10	**M/s. Moonlight Metal Industries Pvt. Ltd.** Sr. No. 6, Kaman Road, Sativali Village, Vasai East, Dist. Palghar	Aluminium Scrap	1200
11	**M/s. Vishal Metal Industries,** A/13, Patel Estate, Near Flora Hotal, Vasai Kaman Road, Decdol, Vasai East, Dist. Palghar 421202	Aluminium Scrap	300
12	**M/s. Tinna Rubber & Infrastructer Ltd.** Gut No. 113/2, 115, Village Pali, Tal. Wada, Dist. Palghar	Tyre Scrap	32000
13	**M/s. Hindustan Metal Company** M Survey No. 122, Village Mondha, Tal. Hingna, Dist. Nagpur	Re-refining of Aluminium Dross & Skimming Waste	3000
14	**M/s. Pioneer Industrial Corporation** Plot No. 122, Village Mondha, Tal. Hingna, Dist. Nagpur	Re-refining of spent solvents	3600
15	**M/s. Anshika Metal Industries** A/p. Niphan, Khopoli Pen Road, Tal. Khalapur, Dist. Raigad	Aluminium Dross / Scrap	3500
16	**M/s. Darshan Chemicals** Plot No A-38/39, MIDC Pawane, Thane Belapur Road, Navi Mumbai 400705	Re-processing of spent Solvent	12000
17	**M/s. Krestar Inc,** Survey No. 84/2, 85/2, 85/5, 85/6, 85/7, 87/12, 87/13, of village Belobdakhar, Tal. Uran, Dist. Raigad	Reconditioning / repairing & washing of ISO Tanks	600 Nos/M

Annexure 5

Project activities with timeline

Date	Details of the project activities
28th July 2018	INAE-DST consultative meeting on 'Laboratory Safe Practices and Waste Disposal in Academic and R & D Institutes' at Savitribai Phule Pune University, Pune
15th Nov 2018	Recommendations of the consultative meeting submitted to President, INAE
11th Jan 2019	Meeting of President, INAE with Secretary DST
19th February 2019	Pilot project on 'Safe Laboratory Practices and Laboratory Waste Disposal': Proposal submitted
20th March 2019	Pilot project approved by INAE
14th June 2019	Project extension sought at no additional cost basis up to 31st Aug 2019
30th Nov 2019	Draft final report submitted to President, INAE for comments

Table 1A: Laboratory safety checklist @ SPPU – Chemistry department

Lab Nos---------->	**#8**	**#7**	**#6**	4	5	Garware Block	7	8	Garware Block	10
1. LAB SPACE										
Location (GF, FF, SF etc)	GF	GF	GF	GF	GF	GF	FF	GF	FF	FF
Lab space, no of work benches, no of occupants	16X16	16X16	16X16	3,4	4	9,9	4	4	4	4
Entrances, Exits (Nos., Clear and unobstructed)	1	1	1	2,2	1	2	1	1	1	1
Safety Showers / Eyewash, location, working?	Common on GF			NA	N	N	N	N	N	N
First aid Box available, condition?	Y	Y	Y	Na	y	y	y	y	y	n
Fire Extinguishers Types, Nos., Location, time to reach	Common in corridor			Na		3	y	N	y1	y1
Emergency telephone nos displayed (Y/N)	Intercom	Intercom	Intercom	Na	y	y	y	y	y	n
Emergency Lighting available (Y/N)	N	N	N	Na	N	N	N	N	N	N
Spill kit available Y/N	N	N	N	Na	N	N	N	N	N	N
Are the labs accessible to all at all times?	Y	Y	Y	Y	y	y	y	y	y	y
Access restriction.. How (manual/electronic system)	N	N	N	N	N	N	N	N	N	N
Periodic inspections of labs (Y/N) if Yes by whom? (mnager/Auditors/Councillar)	N	N	N	N	N	N	N	N	N	N
2. ELECTRICAL										

Electrical Grounding	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Plugs, Wires, Pins, Condition & Integrity	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
Extension boards	Fixed	Fixed	Fixed	Y	N	Y	N	Y	N	N
Sockets above 15 A must have circuit breakers	Common in corridor			Y	Y	Y	Y	Y	Y	Y
Temporary heating devices (water bath, heating mantle, heater/stirrer, etc)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Protective guards on moving objects	NA	NA	NA	Y	Y	Y	Y	Y	Y	Y
Adequate lighting all over the labs	OK can be better		Y	Y	Y	Y	Y	Y	Y	Y
Refrigerators, location. condition, loaded	OK	OK	OK	N	1	Y	Y	Y	Y	Y
Ovens, location (to be away from flammables)	No	NO	No	Y, GF	Y	Y	Y	Y	Y	Y
Furnace (to be away from flammables)				Y, GF	N	N	Y	Y	Y	Y
Use of Microwave oven	N	N	N	Y	N	Y	N	Y	Y	Y
Use of Hot air drier	N	N	N	N	N	Y	Y	N	Y	Y
Instruments that require High voltage	N	N	N	N	N	N	N	N	N	N
3. VENTILATION										
Windows / (No, location,adequate?)	2 Closed	2 Closed	2 open	3,GF	Y	Y,8	Y	4	Y	Y,9
Fume Hoods Y/N Nos.	2 NW	2 NW	2 working	N	2	4 (NOT WORKING)	N	N	Y	N

Working of fume hoods	NO	No	Yes	N	2	NOT PROPERLY	N	N	Y	N
Laminar flow	NO	No	N	N	NA	N	Y	Y	N	N
4. UTILITY LINES										
Water (valves, location and labels for cut off)	Common line for all LABS									
Gas (valves, location and labels for cut off)	NA	NA	NA	3, TF	N	N	N	Y	N	N
Air / Vaccum (valves, location and labels for cut off)	NA	NA	NA	N	Y	Y	N	N	N	Y
Electrical Mains (valves, location and labels for cut off)	Common in corridor				Y	Y	Y	Y	Y	Y
Distilled water unit (Y/N). Is it used overnight?	NA	NA	NA	Y	Y	Y	Y	Y (NOT USED OVERNIGHT)	Y	Y
5. HOUSE KEEPPING										
Storage of Empty bottles, boxes	sent to yard			N	N	N	N	Y	N	N
Labeling on drawers / cupboards	n	n	N	N	Y	N	Y	Y	Y	Y
Condition of tables / chairs	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
Lab coats, storage	OK	OK	OK	N	Y	Y	Y	Y	Y	Y
Walkway, Passage Clear	OK	OK	OK	Y	Y	Y	Y	Y	Y	Y
Old cardboard boxes and other packing materials,	partly	partly	partly	Y	N	Y	N	Y	N	Y
Clutter on working bench	y	y	N	N	N	N	N	N	N	N
Clutter in Fume hood	y	y	N	NA	N	N	N	N	N	N
Clutter on writing table	OK	OK	N	N	N	N	N	N	N	N

6. PERSONAL PROTECTION										
Safety Glasses (for Chemcals / flames/lasers etc)	Available	Available	Available	Y	Y	Y	Y	Y	Y	Y
Laboratory Coats / Aprons	Available	Available	Available	Y	Y	Y	Y	Y	Y	Y
Gloves, Gas masks (are these avaiable, using)	Y/N	Y/N	Y/N	Y	Y	Y	Y	Y	Y	Y
Shoes, (appropriate?)	N	N	N	N	Y	Y	Y	Y	Y	N
Protective Shield / Visor	N	N	N	N	N	N	N	Y	N	N
7. FLAMMABLE SOLVENTS										
Common solvents (names)	MeOh, DCM, Ac2O, EtOAc, Pet et									
Bottles / containers capped / closed	Y			Y	Y	Y	Y	Y	Y	Y
Quantity	15X2.5L	10X2.5	10X2.5	5	25	25	10	2.5	25	25
Waste solvents	n	n	3X2.5	N	Y	Y	N	N	N	N
Solvents on work bench	Y	Y	Y	N	Y	Y	Y	N	Y	N
Labelling	partly	partly	partly	Y	Y	Y	Y	Y	Y	Y
Solvents Inventory	N	N	N	N	Y	Y	Y	N	Y	Y
Records of Issue from Stores	N	N	N	N	N	N	Y	N	Y	Y
8. CHEMICALS										
Chemicals Inventory	Y	N	N	Y	Y	Y	Y		Y	Y
Records of Issue from Stores	N	N	N	N	Y	Y	Y	N	Y	Y
Storage racks available Y/N	Y/N	Y/N	Y/N	Y	Y	Y	Y	Y	Y	Y

Storage alphabetically, compatibility wise	N	N	N	Y, alphabet	Y	Y	Y	Y	Y	Y
Hazardous (Bromine, HF, etc)	N	N	N	N	Y	Y	N	Y	Y	Y
Reactive (Na,	Na Wire drawn.	Wire drawn.	N	N	Y	Y	N	N	Y	N
Pyrophoric	N	N	N	N	N	N	N	N	N	N
Acids Storage: H2SO4, HNO3, HCL, HClO4, H3PO4, etc	Y	Y/N	Y/N	Y	Y	Y	N	Y	Y	Y (good condition)
Acid storage condition	OK	OK	OK	GF	HOOD	HOOD	OK	OK	HOOD	Y
Bottles / containers capped / closed	OK	OK	OK	Y	Y	Y	Y	Y	Y	Y
Acid Anyhydrides	N	N	N	N	N	N	N	N	Y	N
Labelling	N	N	Y/N	Y	Y	Y	Y	Y	Y	Y
Alkalis	OK	OK	OK	N	Y	Y	N	Y	Y	Y
Smell of chemicals/ acids / solvents in labs	OK	OK	OK	Y	N	N	N	N	Y	N
9. GAS CYLINDERS										
H2, location, Nos & whether Chained	NO	NO	NO	Y,TF,1	N	N	N	N	N	N
N2 Location, Nos & whether Chained	2, No	1, No		Y,TF,2	Y	Y,2,N	Y	N	N	N
O2 Location, Nos & whether Chained	1, No			N	N	Y,1,N	1, OUTSIDE	N	N	N
Others Location, Nos & whether Chained	NH3			Y,TF,1	N	N	N	CO2 IN ATC LAB	N	N
LPG Nos & where located, condition of piping, regulator, valves, etc	N	NO	NO	N	N	N	Y,1	Y,2	N	N
Records of issue & return	N	NO	NO	Y	Y	Y	Y	Y	Y	Y

Gas Trolley Y/N	Common	Common	Common	Common	Common	Common	Common	Common	Common	Common
Gas leak detectors, if any	N	NO	NO	N	N	N	N	N	N	N
Segregation of gases (Toxic gases, flammable, oxidizing and inert gases)	N	NO	NO	N	N	N	N	N	N	N
10. OTHERS										
Handling, storage and use of LN2	Y	n	N	N	N	N	Y	Y	Y	N
Hot Oil / Silicone oil	N	n	N	Y	Y	Y	N	N	Y	N
11. POLICY, MANUALS ETC	N	N	N	N		N				
Safety Policy, Safety Manual (Y/N), if yes, is it on web	N	N	N	N	Y	Y	Y	Y	Y	Y
MSDS access	N	N	N	N	N	N	N	N	N	N
Written SOPs	N	N	N	N	N	N	N	N	N	N
Instrument Manuals Access	N	N	N	N	N	N	N	N	N	N
Accident reporting, system, formats, records	N	N	N	N	N	N	N	N	N	N
Lab Safety Orientation / Training	N	N	N	N	N	N	N	N	N	N
Fire Safety Training	N	N	N	N	N	N	N	N	N	N
Emergency Evacuation plans & training	N	N	N	N	N	N	N	N	N	N
Mock Drills for above	N	N	N	N	N	N	N	N	N	N
Audits	N	N	N	N	N	N	N	N	N	N
12. WORKING IN LAB										
Buddy System	N	N	N	N	N	N	N	N	N	N

Working in after/ before silent hours	Y	Y	Y	N	NA	N	Y	Y	Y	Y
Risk assessment	N	N	N	N	Y	Y	N	Y	N	N
Experimental records	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
13. WORK PRACTICES (enforced through audits/surprise checks)										
Long Hair/beard tied, Loose clothing, Pants-Full/Half, Jewellery, contact lens, etc	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Pipette out	N	N	N	N	N	Y	N	Y	N	N
Separating funnel	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Others										
Lab notebooks, signed by supervisor	N	N	N	Y	Y	Y	Y	Y	Y	Y
Eating / Drinking in labs	N	N	N	Y	N	N	N	N	N	N
Storage of water/ food in Refrigertaor	N	N	N	N	N	N	N	N	N	N
Wash hands after work with soap /water	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Soap, Hand Towel	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Any system to avoid repeated procurement?	N	N	N	Y	N	N	N	N	N	N
Any system to share surplus chemicals?	N	N	N	N	Y	N	N	N	N	N
Procure mercury free instruments	N	N	N	N	N	N	N	N	N	N
To prevent spill during movement of chemicals in the lab (trolleys, trays or secondary container/bucket should be	N	N	N	Y	Y	Y	Y	Y	Y	Y

used).										
Avoid distraction to other laboratory person										
Hazardous substance store should be prohibited for visitors				N	N	N	N	N	N	N
Smoking, tobacco chieving, consuming food in the lab should be avoided				N	N	N	N	N	N	N
Routine check for disposal drums (are they removed once 80% filled)		NA	NA	NA	NA	NA	NA	NA	NA	NA
14. INSTRUMENTS										
Are all instruments in use are calibrated?	N	N	N	N	Y	Y	Y	Y	Y	Y
Are all non-fucntional instruments labelled as ' Not in use'?				N	Y	N	Y	Y	Y	Y
Is every common instrument has trained incharge?				N	Y	Y	Y	Y	N	Y
Are log books maintained for recording instrument conditions after every use?				N	N	N	Y	Y	Y	Y
15. ANY OTHER LAB SAFETY CONCERN										
Radiations and radioacitive materials, handling, storage, use and disposal	N	N	N	N	N	N	N	N	N	N

Table 1B: Laboratory safety checklist @ SPPU – Biotech department

Lab Nos---------->	**1**	**2**	**3**	4	5
1. LAB SPACE					
Location (GF, FF, SF etc)	SF	FF	SF	SF	Second floor
Lab space, no of workbenches, no of occupants	One/5	2 B/4o	3	1	4 benches; 8 people
Entrances, Exits...(Nos., Clear and unobstructed)	1/clear	1E, Clear	1	1	1 clear entrance and exit
Safety Showers / Eyewash, location, working?	None	No	Not available	Not available	NA
First aid Box available, condition?	None	Yes	Not available	Not available	Yes one common first aid box is available in department
Fire Extinguishers Types, Nos., Location, time to reach	None	Yes	Not available inside lab	Not available inside lab	NA
Emergency telephone nos displayed (Y/N)	None	No	N	N	NA
Emergency Lighting Available (Y/N)	None	No	N	N	NA
Spill kit available Y/N	None	N	N	N	NA
Are the labs accessible to all at all times?	Yes	Yes	Yes	Yes	Yes
Access restriction.. How (manual/electronic system)	None	Manual	N.A.	N.A.	NA
Periodic inspections of labs (Y/N) if Yes by whom? (manager/Auditors/Councillar)	None	N	N	N	NA

2. ELECTRICAL					
Electrical Grounding	Y		Y	Y	Yes
Plugs, Wires, Pins, Condition & Integrity	Y		Variable	Variable	Yes
Extension boards	Y		Y	Y	3
Sockets above 15 A must have circuit breakers	Y		Y	Y	Don't know
Temporary heating devices (water bath, heating mantle, heater/stirrer, etc)	Y		Y	Y	Yes (Dry block)
Protective guards on moving objects	Y		N	N	NA
Adequate lighting all pver thenlabs	Y		Y	Y	Yes
Refrigerators , location. condition, loaded	Y		Y	Y	2 (near entrnce door; loaded)
Ovens, location (to be away from flammables)	Y		Y	Y	NA
Furnace (to be away from flammables)	Y		N.A.	N.A.	NA
Use of Microwave oven	Y		Y	Y	Yes
Use of Hot air drier	Y		N	Y	NA
Instruments that require High voltage	Y		N.A.	N.A.	Yes (Eppendorf; Sonicator)
3. VENTILATION					
Windows / (No, location,adequate?)	Yes	Y	Y	Y	Yes (3 double door windows)
Fume Hoods Y/N Nos.	None	N	N.A.	N.A.	No
Working of fume hoods	NA	N	N.A.	N.A.	No
Laminar flow	None	Y	Y	Y	Yes (1)

4. UTILITY LINES					
Water (valves, location and labels for cut off)	Yes	Y	Y	Y	Yes
Gas (valves, location and labels for cut off)	None	N	N	N	No
Air / Vaccum (valves, location and labels for cut off)	None	N	N	N	No
Electrical Mains (valves, location and labels for cut off)	None	Y	Y	Y	Ni
Distilled water unit (Y/N). Is it used overnight?		Y	NA	Y	No
5. HOUSE KEEPPING					
Storage of Empty bottles, boxes	Racks	Y	Y	Y	Yes; in cupboards, Almirahs and Drawers
Labeling on drawers/cupboards	Yes	Y	Y	Y	Yes
Condition of tables/chairs	OK	Y	Y	OK	Satisfactory
Lab coats, storage	Yes	Y	N	Y	Yes
Walkway, Passage Clear	No	Y	Y	Y	Yes
Old cardboard boxes and other packing materials,	Yes	Y	N	N	No
Clutter on working bench	Yes	N	Sometimes	Sometimes	No
Clutter in Fume hood	NA	N	N.A.	N.A.	No
Clutter on writing table	Yes	N	N.A.	N.A.	No
6. PERSONAL PROTECTION					
Safety Glasses (for Chemcals /	Yes	Y	Y	Y	Yes

flames/lasers etc)					
Laboratory Coats / Aprons	Yes	Y	Y	Y	Yes
Gloves, Gas masks (are these available, using)	Yes	Y	Y	Y	Yes
Shoes, (appropriate?)	Yes	Y	Y	Y	Yes (closed shoes)
Protective Shield / Visor	NA	N	Y	Y	Yes
7. FLAMMABLE SOLVENTS					
Common solvents (names)	None	Y	Methanol, Aceton, Ethyl aectate, Proponal, Pet Ether	Y	Methanol; trizol; ethanol; chloroform; butanol; formaldehyde
Bottles / containers capped / closed	None	Closed	Y	Y	Yes closed capped bottles
Quantity	NA	5Ltrs	appr 10 Nos		4 l (Methanol); 100 ml Trizol; rest 500 ml bootles
Waste solvents	NA	1Ltrs	Y		NA
Solvents on workbench	None	Y	N	Y	Ethanol (70%)
Labelling	Yes	Y	Y	Y	Yes
Solvents Inventory	Yes	Y			Yes
Records of Issue from Stores	NA	Y			Yes
8. CHEMICALS					
Chemicals Inventory	Yes	Y	Y	Y	Yes
Records of Issue from Stores	NA	Y			Yes
Storage racks available Y/N	Yes	Y	Y	Y	Yes
Storage alphabetically,	Yes	Compatibility	Y	Y	Yes

compatibility wise					
Hazardous (Bromine, HF, etc	NA	N	Y	N.A.	NA
Reactive (Na,	NA	N	Y	N.A.	NA
Pyrophoric	NA	N	N.A.	N.A.	NA
Acids Storage: H2SO4, HNO3, HCL, HClO4, H3PO4, etc	HCl	Y	Y	Y	HCl in glass bottles
Acid storage condition	Good		Ventilated Space Cupboard		HCl in glass bottles
Bottles / containers capped / closed	Yes	Bottled and Closed	Y		Closed capped bottles
Acid Anhydrides	None	Y, Bottled and Closed	N.A.		NA
Labelling	Yes	Y			NA
Alkalis	None	Y, Bottled and Closed	Y		NA
Smell of chemicals/acids/solvents in labs	Yes	Y	N	N	NA
9. GAS CYLINDERS					
H2, location, Nos & whether Chained	None	NA	N.A		No
N2 Location, Nos & whether Chained	None	NA	N.A	2, Not chained	No
O2 Location, Nos & whether Chained	None	NA			No
Others Location, Nos & whether Chained	None	Y		Co2, 6, Not chained	No
LPG Nos & where located, condition of piping, regulator, valves, etc.	None	1, Good condition	1 Lab		No

Records of issue & return	None	N			No
Gas Trolley Y/N	None	N	Y	Y	No
Gas leak detectors, if any	None	N	N	N	No
Segregation of gases (Toxic gases, flammable, oxidizing and inert gases)	None	NA	N	N	No
10. OTHERS					
Handling, storage and use of LN2	NA	Cryocans	N.A	Y	Yes; 3 l cylinder
Hot Oil / Silicone oil	NA	NA	N.A	N	Na
11. POLICY, MANUALS ETC					
Safety Policy, Safety Manual (Y/N), if yes, is it on web	None	N	Y, Web also	Y, Web also	Yes
MSDS access	None	N	Y, Web also	Y, Web also	Yes
Written SOPs	Yes	N	Y	Y	Yes
Instrument Manuals Access	Yes	Y	Y	Y	Yes
Accident reporting, system, formats, records	None	N	N	N	No
Lab Safety Orientation / Training	None	Y	Y	Y	Yes
Fire Safety Training	None	N	Y	N	No
Emergengency Evacuation plans & training	None	N	N	N	No
Mock Drills for above	None	N	N	N	No
Audits	None	N	N	N	NA
12. WORKING IN LAB					
Buddy System	None	N	N	N	No

Working in after/ before silent hours	Yes	Y	Y	Y	No
Risk assessment	None	N	Y	Y	Yes
Experimental records	Yes	N	Y	Y	Yes
13. WORK PRACTICES (enforced through audits/surprise checks)					
Long Hair/beard tied, Loose clothing, Pants-Full/Half, Jewellery, contact lens, etc	Yes	Full Pants, Jewellery, long hair tied	N	Y	Yes
Pipette out	Yes	Y	N	N	Yes
Separating funnel	Yes	Y	N.A.	N.A.	No
Others					NA
Lab notebooks, signed by supervisor	Yes	N	Y	Y	Yes
Eating / Drinking in labs	Restricted	N	N	N	Not allowed
Storage of water/ food in Refrigertaor	No	N	N	N	No
Wash hands after work with soap /water	Yes	Y	Y	Y	Yes
Soap, Hand Towel	Yes	Y	Y	Y	Yes
Any system to avoid repeated procurement?	Yes	N	Y	Y	stock checking
Any system to share surplus chemicals?	Yes	N	N.A.	N.A.	Yes
Procure mercury-free instruments	NA	Y	N.A.	N.A.	Yes
To prevent spill during movement of chemicals in the lab (trolleys, trays or secondary container/bucket should be		Y	Y	Y	Na

used).					
Avoid distraction to other laboratory person		Y	Y	Y	Na
Hazardous substance store should be prohibited for visitors	None	Y	Y	Y	Na
Smoking, tobacco chieving, consuming food in the lab should be avoided	Yes	Avoided	Y	Y	Not allowed
Routine check for disposal drums (are they removed once 80% filled)	NA	Y	N.A.	N.A.	Yes
14. INSTRUMENTS					
Are all instruments in use are calibrated?	Yes	N	Some yes	N	Yes
Are all non-fucntional instruments labelled as ' Not in use'?	Yes	Y	Y	N	Yes
Is every common instrument has trained incharge?	No	N	Y	Y	Yes
Are log books maintained for recording instrument condition after every use?	Yes	Y	Y	Y	Yes
15. ANY OTHER LAB SAFETY CONCERN					
Radiations and radioactive materials, handling, storage, use and disposal	None	N	N.A.	N.A.	NA

Table 2A: Laboratory safety checklist @ ICT – Lab safety

Lab Nos---------->	**Oil Building Labs**	**CE – Basement-1**	**CE -Main Build 1**	**CE-Basement-2**	**CE-3**	**Food Dept Labs**	**DBT Labs**
1. LAB SPACE							
Location (GF, FF, SF, Basement(B), Common Lab(CL) etc)	Oils Building; GF, FF, SF, CL	B(Main Building), CL(oils Building)	Computer Lab(Physics Building); Advance Lab (Physics Building)	Basement (main bldg)	Basement	Main Building	DBT Building (GF, FF, SF, Terrace)
Lab space, no of work table (WT), no of occupants(O)	[CL: 20ft * 16ft; WT:1 (Wooden PC platform); O:8][GF: 30ft* 30ft; WT:2; O:4] [FF: 10ft*20ft; WT:0(granite floor only); O:15][SF: 70 ft*25 ft; WT: 4 (side granite floor); O: 32]	[CL: 6ft * 12ft, wooden PC platform], [B-1: 10ft * 18ft, WT:0, Granite floor, wooden PC], [B-2: 20ft * 30 ft, WT:3, Granite floor], [B-3: 15ft * 25ft, WT: 3, Granite floor], O: 2	CL: 25ft * 20ft; WT:1 (Wooden PC Platform); O: 13; AL: 20 ft * 20 ft; WT: 1; O: 8	B: 20ft * 30ft, WT: 6(Wooden platform), O: 10	AL: 20ft *20 ft; CL: 20 ft * 20 ft; AL: L shaped side granite floor; O: 3; CL: Wooden side floor and Granite floot; O:5	[211: 25 ft * 20 ft: WT: 01; wooden Side Table:01; O: 11] [213: 25 ft *20 ft: WT: 02; Wooden side table with granite floor: 01; O: 10] [215: 25 ft * ft; O:no fulltime occupancy as it is an Analytical lab]	{DBT Building: 70*70 ft; Side Granite Fooring for experimentation; O: 25} {FF: O-10;} {SF: O: 20} (Terrace: O:10} SF: WT: 1; GF:1}
Entrances, Exits...(Nos., Clear and unobstructed)	1Entrance, 1 Exit; Obstructed	[B-1: 1 entrance, 1 Exit, Obstructed], [B-2: 1 entrance, 1 Exit, Obstructed], [B-3: 1entrance, No exit]	CL: Entrance is Exit Point; No Extra Safe Exit; AL: 1 Entrance and 1 Exit	1 entrance, 1 exit (obstructed)	one entrance for both lab; safety exit to only computer lab	Entry is Exit; Clear passage	GF: 1 Entrance; 3 Exit{ FF, SF: Entrance is exit} {Terrace has one fire exit};no obstruction on the pathways
Safety Showers / Eyewash, location, working?	N.A. (Not Available)	N.A. (Not Available)	No	NA	eyewash in analytical lab; in working condition	No	not available
First aid Box available, condition?	N.A. (Not Available)	N.A. (Not Available)	Yes	Yes, Updated on regular basis	yes	Yes, maintained	yes to every floor lab
Fire Extinguishers Types, Nos., Location, time to reach	Available; Type: C; 30 sec	Available; Type: C; 30 sec	Yes; Type C	Available (chemical & electrical fire); 15 sec	not in lab; but available in common passage; 0.5min time to reach	not in lab but in common passage; dry CO2	type c in every lab; 1 min to reach
Emergency telephone nos displayed (Y/N)	N	N	Yes	Y	no	no	yes to every floor lab
Emergency Lighting Available (Y/N)	N	N	No	N	no	no	no
Spill kit available Y/N	N	N	No	N	no	no	no

Are the labs accessible to all at all times?	N	N	No	N	no	yes for male students; limited time for female students	no
Access restriction.. How (manual/electronic system)	Not Applicable	Not Applicable	Not Applicable	NA	no	no	electronic entry
Periodic inspections of labs (Y/N) if Yes by whom? (Manager/Auditors/Councillar)	N	N	N	Y	no audits	no	internal audit by specific employee
2. ELECTRICAL							
Electrical Grounding	Y	Y	Y	Y	Y	no idea about current status	yes
Plugs, Wires, Pins, Condition & Integrity	Unsatisfactory	Unsatisfactory	CL: Satisfactory; AL: Unsatisfactory	Satisfactory	old but in satisfactory condition	old; but satisfactory	satisfactory
Extension boards	6	3	CL: 2; AL: 0	3	1	no extension boards are used	no extension boards
Sockets above 15 A must have circuit breakers	Y	Y	Y	Y	CB at every electric board	no circuit breaker	no c b
Temporary heating devices (water bath, heating mantle, heater/stirrer etc.)	4	6	2	6	WB;1; HM:3; Mechanical stirrer: 3	wb:1; hm:1; Magnetic stirrer:5; overhead stirrer: 01	hm: 10; plates: 5; os: 5
Protective guards on moving objects	N.A. (Not Available)	N.A. (Not Available)	N.A. (Not Available)	NA	yes	yes	yes
Adequate lighting all over the labs	Y	N	Y	Y	yes	yes	yes
Refrigerators, location. condition, loaded	Yes, Two Newly Procured; Heavily Loaded;		Not applicable	Yes (not functional)	yes; not heavily occupied	3; 1old;2 new; space is maintained; not heavily loaded	new, 6; properly managed and spacious
Ovens, Location (to be away from flammables)	Yes, Two, Old Model; Heavily Loaded; Not far away from expt floor where reactions are conducted	Yes, One, away from expt setup	Not applicable	Yes(vacuum oven), away from flammables	yes; away from reaction floor	oven: 1 yes; no flammable reaction in that specific lab	2; long enough from work floor
Furnace (to be away from flammables)	Yes, Two, New Model; Very less used; Not far away from expt floor where reactions are conducted	Yes, One, Near expt floor	Not applicable	Yes (one), Frequently used.	not functional	no	1; long enough from work floor

Use of Microwave oven	Not Available	N	Not applicable	NA	not available	no	yes; SF;
Use of Hot air drier	Not Available	N	Not applicable	NA	NA	no	no
Instruments that require High voltage	TOC, GC, HPLC, Ultrasonic Horn-Bath, Pumping Motors, Centrifuge, Oven, Furnace, Pyrolysis Reactor, Autoclave, etc	GC, HPLC, DSC, Furnace, Pyrolysis setup, high-pressure autoclave	Not applicable	GC, Ultrasonic horn, Pumping motor (vacuum oven), furnace, autoclave	yes; one small autoclave for vapor pressure	centrifuge only	TOC, GCMS, HPLC, LCMS, Furnace, Autoclave reactor, CHNS
3. VENTILATION							
Windows / (No, location,adequate?)	[SF: No: 4; Adequate: Yes] [CL: 0; Inadequate] [FF: 1; Inadequate]	Not adequate for basement	CL: 0; AL: Adequate	Two (windows closed, not adequate ventilation)	Windows: 2; Adequate wit powerful exhaust	2 windows; adequate	GF; Enough windows; FF and SF not enough windows
Fume Hoods Y/N Nos.	Yes	Not functional	Not applicable	Yes (1)	N	n	Y; 4
Working of fume hoods	1	NA	Not applicable	Yes (1)	Not Applicable	not applicable	2 new; 2 old satisfactory
Laminar flow	1	N	Not applicable	NA	No	no	4
4. UTILITY LINES							
Water (valves, location and labels for cut off)	Water Tap:4; No Labels	Water tap: 4, No labels	Water Tap: 2; No Labels	Water tap (1), Yes labelled	Taps:3; No labels	1 tap; not labelled; but used for general labware glass washing done	GF: 8; FF: 2; SF; 4; Terrace: 2; cutoff valve yes; no labelling
Gas (valves, location and labels for cut off)	Gas Line Valve Location: 2; Safety Assembly: Yes; Condition: Newly Fabricated	Gas line valve near GC, Safety Assembly: No	Not applicable	Yes (GC), labelled	1 nitrogen gas line; no labels	no	10; Cutoff yes; labelled
Air / Vaccum (valves, location and labels for cut off)	Not Available	NA	Not applicable	NA	No	no	no
Electrical Mains (valves, location and labels for cut off)	Mains:1; Cut Off Labels: No	Mains:1; Cut Off Labels: No	CL: Mains1, Cut Off Labels-No ; AL: Mains 1, Cut off labels-No	No	Yes; No Cut off labels	no mainswitch at that specific lab	every lab has 1, but not labelled
Distilled water unit (Y/N). Is it used overnight?	Y; 1; Used 3 times a week for 5 6 hours	N	No	Not available	Y; No extensive use	no	1; 20 L; but currently out of order; (solvent distillation; PRAMA)

5. HOUSE KEEPING							
Storage of Empty bottles, boxes	Not Available; Dumped Directly	Not Available; Dumped Directly	Yes	Yes	Cardboard box for storage	glassware is stored at one common dept facility	no storage; dumped as per ict policy
Labeling on drawers / cupboards	Yes	Yes	Yes	Yes	yes	yes	yes
Condition of tables/chairs	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Satisfactory	old; but still satisfactory	table; Good; chairs good
Lab coats, storage	Personal Apron storage in cupboards	Personal Apron available	Personal Apron storage in cupboards	Personal labcoats available	personal cupboard	personal lab coats in cupboard	in personal cupbaords, no common
Walkway, Passage Clear	Yes; Obstructed	Yes, Clear	CL: Clear; AL: Obstructed safety exit door; Need to keep it open	Yes	clear	clear	all pathways are clear
Old cardboard boxes and other packing materials,	Yes; Dumped during trimonthly lab cleaning	Discarded on regular basis	Yes; Dumped during monthly lab cleaning	Dumped on regular basis	no	yes; dumped during trimonthly lab cleaning	regular dumping
Clutter on working bench	Yes; Heavily Occupied working table	Y	Clean Working bench	No	clean; not heavily occupied	depending on student expt routine; or else not clutter on work floor	clutter cleared by selected employees for cleaner labs
Clutter in Fume hood	No	NA	Not applicable	No	na	no	no
Clutter on writing table	Yes; crowded few days a lab	N	Clean writing bench	yes, frequently	clean; not heavily occupied	maintained and clean	no
6. PERSONAL PROTECTION							
Safety Glasses (for Chemicals / flames/lasers etc)	Yes; common facility to all	N	Yes; common facility to all	Yes (available for everyone)	yes	used depending on reaction	yes
Laboratory Coats / Aprons	Yes; common facility to all	Y	Yes; Personal property	Yes (available for everyone)	yes	yes	yes
Gloves, Gas masks (are these available, using)	yes; used regularly	Y	Yes; common facility to all	Yes	yes	yes	yes
Shoes, (appropriate?)	Yes; General use shoes; do not meet standard of safety	Y, Not appropriate as per safety standards	Yes; personal; only 2 pairs are available that meets standard	Yes; General use shoes; do not meet standard of safety	yes; personal; do not meet standard	yes; general shoes are used	yes, but not of that standard
Protective Shield / Visor	Not Available	N	not available	Not available	1 visor	no. since no such reactions are carried out	yes

7. FLAMMABLE SOLVENTS							
Common solvents (names)	Hexane; Methanol, Acetone, Toluene, Ethanol, Acetonitrile	Alcohols, Pentane, Hexane, Touelene, Acetone, ACN, etc	Ethanol; Acetone;	Hexane; Methanol, Acetone, Toluene, Ethanol, Acetonitrile	Hexane; Methanol, Acetone, Toluene, Ethanol, Acetonitrile, Heptane, Ethyl acetate	ethanol; ACN, Methanol, Hexane, PET ether	Hexane; Methanol, Acetone, Toluene, Ethanol, Acetonitrile, ethyl acetate
Bottles / containers capped / closed	Capped	Y	Capped	Capped	capped	capped	capped
Quantity	Depend on Selective reactions	Depending on reaction	Depend on Selective reactions	Depend on Selective reactions	all 500 ml bottles of each chemicals are in stock	30 litre per month	this will vary according to reactions carried out; cannot be specific with the value
Waste solvents	5 litre a week; stored for institute disposal activity	stored for Institute disposal activity	cannot be predicted	5 litre a week; stored for institute disposal activity	stored in glass bottles; institute level disposal	15 litre per month	dumping through can to ict
Solvents on work bench	Yes; Heavily Occupied	Yes, Occupied	AL: Clean Work Bench	No	no	depending on student expt routine	no
Labelling	Yes	Yes	Y	Yes	yes	yes	yes
Solvents Inventory	Yes; Updated Regularly	Yes, Updated twice in a year	Y	Yes	yes; not updated	no	yes
Records of Issue from Stores	Yes; Updated Regularly	Yes, updated regularly	Yes; Updated Regularly	Yes	no	no	yes; staff employed for looking after these matters
8. CHEMICALS							
Chemicals Inventory	Yes; Updated Regularly	Yes, updated regularly	Yes; Updated Regularly	Yes, Updated regularly	yes; not updated recently	no	yes, updated regularly
Records of Issue from Stores	Yes; Updated Regularly	Yes, updated regularly	Yes; Updated Regularly	Yes, Updated regularly	no	no	yes; staff employed for looking after these matters
Storage racks available Y/N	Yes; Heavily crowded	Yes; Heavily crowded	Yes; Heavily crowded	Yes (arranged properly)	yes; enough occupied	yes, heavily crowded	yes; crowded
Storage alphabetically, compatibility wise	Yes; Alphabetically	Yes; Alphabetically	Yes; Alphabetically	Yes; Alphabetically	yes; alphabetically	yes, alphabetically	Yes; Alphabetically
Hazardous (Bromine, HF, etc.)	Yes	Yes	No	No	no	yes	no
Reactive (Na, etc.)	No	No	No	Yes	no	no	no
Pyrophoric	No	No	No	No	no	no	no
Acids Storage: H2SO4, HNO3,	Separate Acid Storage available and	Separate Acid Storage available	No	Separate Acid Storage available and	yes; labelled	yes	yes, maintained regularly

HCL, HClO4, H3PO4, etc	maintained	and maintained		maintained			
Acid storage condition	Poor	Poor	Not applicable	Average	satisfactory	need to upgrade	unsatisfactory
Bottles / containers capped / closed	Capped	Caped	Capped	Capped	capped	capped	capped
Acid Anhydrides	Not available	Not available	Not applicable	NA	not available	no	yes;
Labelling	Yes	Yes	Yes	Yes	yes	yes	yes
Alkalis	Yes	Yes	Yes	Yes		yes	yes
Smell of chemicals/acids/solvents in labs	No; 4 Exhaust Fans are continuously operated to avoid any chemical smell in the lab	Yes, Exhaust fans are there but not working properly	CL: No Smell since only computational work is going on there; AL: Yes(Combined lab; no control on what other reactions are going on)	No; 2 exhaust fans are in continuously use	no	no	a little smell; GF: 4 exhaust; FF-1, SF(AC lab): No
9. GAS CYLINDERS							
H2, location, Nos & whether Chained	Gas Cylinder Bank; The one in use is chained all time; other are kept in standing position	Cylinder is located in common gas bank	Not applicable	NA	not applicable		Gas Cylinder Bank; The one in use is chained all time; other are kept in standing position
N2 Location, Nos & whether Chained	Gas Cylinder Bank; The one in use is chained all time; other are kept in standing position	Cylinder is located in common gas bank	Not applicable	Gas Cylinder Bank; The one in use is chained all time; other are kept in standing position	gas cylinder outside lab and chained; gas line brought to lab		Gas Cylinder Bank; The one in use is chained all time; other are kept in standing position
O2 Location, Nos & whether Chained	Gas Cylinder Bank; The one in use is chained all time; other are kept in standing position	Cylinder is located in common gas bank	Not applicable	Gas Cylinder Bank; The one in use is chained all time; other are kept in standing position	not applicable		Gas Cylinder Bank; The one in use is chained all time; other are kept in standing position
Others Location, Nos & whether Chained	Not Applicable	N2 in B-1 lab for DSC, chained	Not applicable	NA	not applicable		no
LPG Nos & where located, condition of piping, regulator, valves etc	No:1; Near Laminar Cabinet; Condition: Satisfactory	NA	Not applicable	NA	not applicable	1; used for laminar cabinet	no LPG is used
Records of issue & return	Yes	Yes	Not applicable	Yes	no	yes; by HOD office employees	yes; staff employed for looking after these matters
Gas Trolley Y/N	Yes	Yes (common dept facility)	Not applicable	Yes (available in common with	gas trolley used from dept gas bank	no	yes

				department)			
Gas leak detectors, if any	no facility	NA	Not applicable	No	no facility	no	no
Segregation of gases (Toxic gases, flammable, oxidizing and inert gases)	no facility	NA	Not applicable	NA	no facility	not applicable	no
10. OTHERS							
Handling, storage and use of Liquid Nitrogen	Not Applicable	NA	Not applicable	NA	Not Applicable	not used	yes; certified vendor; 10 litre per month
Hot Oil / Silicone oil	Yes; Silicon Oil(Rarely used): 25 litres in 3 years	Yes, Silicone oil in heating bath	Not applicable	Yes; silicon oil (on regular basis); 20 liters per year	silicon oil used; rarely; quantum cannot be predicted	not used	silicone oil: 5 litre for 4 last yr
11. POLICY, MANUALS ETC							
Safety Policy, Safety Manual (Y/N), if yes, is it on web	No	No	Safety Manual prepared; hard copy kept in both labs	No	n	no	no
MSDS access	Yes; MSDS of Commonly used Chemicals is kept accessible to all; selective MSDS are expected to be read by individual	No	Yes; Accessible; personal MSDS with individual usage	Yes; MSDS of Commonly used Chemicals is kept accessible to all; selective MSDS are expected to be read by individual	Yes; MSDS of Commonly used Chemicals is kept accessible to all; selective MSDS are expected to be read by individual	no	no
Written SOPs	No	Yes	No	Yes	No	yes	yes
Instrument Manuals Access	With Incharge	Yes available at commonplace	With selective in charge	Yes	with in charge	training given by incharge and then permitted for operation	open access to all labmates
Accident reporting, system, formats, records	No	NA	No	NA	reporting of an accident to all labmates via mail/messages	no	no
Lab Safety Orientation / Training	No Orientation	NA	No	No	no	no	no
Fire Safety Training	Yes; 4 months back for chemical engg dept only	Yes; 4 months back for chemical engg dept only	Common Dept. Fire safety training; 4 months back	Yes; 4 months back for chemical engg dept only	Yes; 4 months back for chemical engg dept only	no	no
Emergency Evacuation plans & training	No; Not Emergency Training	NA	No; Not Emergency Training	No; Not Emergency Training	no	no	no

Mock Drills for above	No	No	No	No	no	no	no
Audits	No	No	No	No	no	no	yes by specific staff
12. WORKING IN LAB							
Buddy System	What is this?	?	Not applicable		What is this?	What is this?	no
Working in after/ before silent hours	Working after office hours permission taken	Working after office hours with all required permissions	Working after office hours permission taken	Working after office hours permission taken	Working after office hours permission taken	Working after office hours permission taken	Working after office hours permission taken
Risk assessment	No assesment	No assesment	No assesment	No assesment	no assesment	no assesment	no
Experimental records	Not maintained/displayed in common	Maintained with respective students	Not maintained/displayed in common	Not maintained/displayed in common	not maintained/displayed	logbook is maintained for each equipment	no written record
13. WORK PRACTICES (enforced through audits/surprise checks)						newly added students are trained for lab ethics so that lab operations go fluently	
Long Hair/beard tied, Loose clothing, Pants-Full/Half, Jewellery, contact lens, etc	No assessment	No assessment	No assessment		No assessment	mistake can be pointed out by any lab mate; if anyone is doing any wrong practice	yes by faculty
Pipette out	No assesment	No assesment	No assesment		No assessment	not applicable	no
Separating funnel	No assesment	No assesment	No assesment		No assessment	not applicable	no
Others	No assesment	No assesment	No assesment		assessment of PPE by safety in charge is done	not applicable	no
Lab notebooks, signed by supervisor	Not maintained	Not maintained	No assessment		not maintained	not compulsory; Varies from student to student	no
Eating / Drinking in labs	Prohibited; still complete enforcement is not achieved	Prohibited; still complete enforcement is not achieved	Completely prohibited	Not allowed and followed by everyone	Prohibited; still complete enforcement is not achieved	drinking of water is allowed; complete enforcement of eating food not yet achieved	Prohibited; still complete enforcement is not achieved
Storage of water/ food in Refrigerator	Not Allowed	Not Allowed	Not applicable	Not Allowed	Not Allowed	not allowed at all	not allowed

Wash hands after work with soap /water	Yes; Followed regularly	Yes; Followed regularly	Yes; Followed regularly	Yes; Followed regularly	Yes; Followed regularly	Yes; Followed regularly	yes
Soap , Hand Towel	Soap available; Hand Towel: No	Soap available; Hand Towel: No	Soap available; Hand Towel: No	Soap available; Hand Towel: No	Soap available; Hand Towel: No	Soap available; Hand Towel: No	soap yes; towel no
Any system to avoid repeated procurement ?	No	No	Earlier stock of specific chemical is checked	Yes	no facility; but inventory is checked before ordering	will check inventory and then decide the next course of action	all chemicals come through lab store, initially assessed at lab store; employee assessed
Any system to share surplus chemicals?	No	No	amount of surplus chemical is inquired physically in the lab	Yes	no facility; update is given on asking by labmates	no	in stores
Procure mercury free instruments	No system available	No system available	No system available	No system available	no	no	No system available
To prevent spill during movement of chemicals in the lab (trolleys, trays or secondary container/bucket should be used).	Trays are generally used to avoid spillage	Trays are generally used to avoid spillage	No system available	Trays are generally used to avoid spillage	Trays are generally used to avoid spillage	Trays are generally used to avoid spillage	trays are used
Avoid distraction to other laboratory person	No system available to avoid distraction in lab	No system available to avoid distraction in lab	Yes; Due to common Lab Facility	No system available to avoid distraction in lab	No system available to avoid distraction in lab	No system available to avoid distraction in lab	No system available to avoid distraction in lab
Hazardous substance store should be prohibited for visitors	unknown visitors are kept away from chemical storage locations	Yes	unknown visitors are kept away from chemical storage locations	unknown visitors are kept away from chemical storage locations	unknown visitors are kept away from chemical storage locations	unknown visitors are kept away from chemical storage locations	no access
Smoking, tobacco chieving, consuming food in the lab should be avoided	Eating food-Drinking water-cold drinks is Prohibited; still complete enforcement is not achieved	Eating food-Drinking water-cold drinks is Prohibited; still complete enforcement is not achieved	Eating food-Drinking water-cold drinks is Prohibited; still complete enforcement is not achieved	Not allowed	Eating food-Drinking water-cold drinks is Prohibited; still complete enforcement is not achieved	not allowed at all	Eating food-Drinking water-cold drinks is Prohibited; still complete enforcement is achieved
Routine check for disposal drums (are they removed once 80% filled)	No; Done by Ph.D. students on their own	No; Done by Ph.D. students on their own	No; Done by Ph.D. students on their own	No; Done by Ph.D. students on their own	done by cleaning staff	daily cleaning so not checking of drum is required	everything is monitored by employees; lab assistance
14. INSTRUMENTS							
Are all instruments in use are calibrated?	no; calibration is done according to in charge convenience and instrument condition	no; calibration is done according to in charge convenience and	Yes	Yes	yes	yes	not all, few are calibrated

		instrument condition					
Are all non-functional instruments labelled as ' Not in use'?	No	No	Yes	Yes	no labels	not labelled; but kept aside and informed labmates as under maintenance	no
Does every common instrument has trained incharge?	Yes	Yes	No	Yes	yes	yes	incharge exists, open to all
Are log books maintained for recording instrument conditions after every use?	we have logbooks, but students try to skip making entries to the logbook; lab culture needs to be developed	Not on regular basis	we have logbooks; but students try to skip making entries to the logbook; lab culture needs to be developed	Yes	yes	yes	yes
15. ANY OTHER LAB SAFETY CONCERN	Safety Audit and Assesment needs to be carried out regularly; Safe Lab practice culture needs to be developed	Need regular Safety Audit and Assesment; Safe Lab practice culture needs to be developed. Basement labs need proper ventilation and connection to the security guards in case of emergency.	Reward to scholars who follow safety norms regularly; Alarm System for power cutoff emergency	Safety Audit and Assesment needs to be carried out regularly	electric audit should be done; safety in charge appointment other than student	regular training sessions for all masters-PhD students is must; to create healthy environment between seniors and juniors	3rd party safety audit; solvent discarding is an major issue; ict should look into this seriously; student training for safety is required

Table 2B: Laboratory safety checklist @ ICT– Storage & disposal of chemical waste

Lab no--------->	**Oil Building Labs**	**CE – Basement-1**	**CE -Main Build 1**	**CE-Basement-2**	**CE-3**	**Foods**	**DBT**
1. SOLIDS							
1a SOLIDS (NEUTRAL) Silica gel, Alumina etc.							
How collected	Solid waste is segregated in separate dustbin; cleaning staff collect it from the lab premises and take for their action accordingly	Solid waste is segregated in separate dustbin and collected by cleaning staff	Not applicable	Solid waste is segregated in separate dustbin; cleaning staff collect it from the lab premises and take for their action accordingly	Chemical solid residue left is wrapped in tissue paper and dumped in chemical waste dustbin	Not applicable	Separate containers ; dry waste and wet waste separate; disposal as per ICT norms
Quantity (Kg) per week/fortnight/Mo	5 kg per week	2 kg per week	Not applicable	2 kg per week	1 kg per week		3 kg per week
How disposed	3rd party disposal	3rd party disposal	Not applicable	3rd party disposal	3rd party disposal		ICT policy
Quantity (Kg) per week/fortnight/Mo	5kg	2 kg	Not applicable	2 kg	1 kg per week		3 kg per week
Unscheduled disposal	No		Not applicable	NO	NO		NO
1b. SOLIDS (REACTIVE)							
How collected	Chemical solid residue	Cleaning Staff from dustbins	Not sure about the	Cleaning Staff from dustbins	Chemical solid residue	Not applicable	No reactive

	left is wrapped in tissue paper and dumped in chemical waste dustbin		statistics		left is wrapped in tissue paper and dumped in chemical waste dustbin		waste
Quantity (Kg) per week/fortnight/Mo	0	0	Not applicable	0	0		NA
How disposed	NA	NA	Not applicable	NA	NA		NA
Quantity (Kg) per week/fortnight/Mo	0	0	Not applicable	0	0		NA
Unscheduled disposal	It is recommended that disposal should not be done; still dumping of some quantum in basin is observed; as a result basins get clogged and causing choking	It is recommended not to dispose solids directly into the basin as it will choke the drainage system.	Not applicable	It is recommended not to dispose solids directly into the basin as it will choke the drainage system.	NA		NA
1C. Segregation of dry reagents (Oxidizing salts, Flammable Solids, Water -	No facility available with us	Not available	Not applicable	Not available	Not applicable	Not applicable	No such waste is generated

reactive solids, other) Or any other methods							
2. LIQUIDS							
2a Organic Halogenated							
How collected	Stored in glass vessel	Stored in glass bottles (solvents/chemicals)	Not used	Stored in glass bottles (solvents/chemicals)	Not applicable/not used	Not collected	Yes
Quantity (L) per week/fortnight/Mo	1 litre per week	0.5-1 litre per week	Not applicable	1-2 litre per week		Very rarely used	2 litre
How disposed	3rd party disposal	3rd party disposal	not applicable	3rd party disposal		Dumped in basin	ICT policy
Quantity (Kg) per week/fortnight/Mo	1 litre per week	0.5-1 litre per week	not applicable	1-2 litre per week			
Unscheduled disposal	It is recommended that disposal should not be done; still dumping of some quantum in basin is observed	It is recommended that disposal should not be done; still dumping of some qauntum in basin is observed	Not applicable	It is recommended that disposal should not be done; still dumping of some qauntum in basin is observed		Dumped in basin	May be; not perfectly sure about the disposal
2b Organic Non Halogenated							
How collected	Stored in glass vessel	Stored in glass bottles (solvents/chemical	Not used	Stored in glass bottles (solvents/chemical	Not applicable	Not collected	Yes

		s)		s)			
Quantity (L) per week/fortnight/Mo	3 litre per week	2 litre per week	Not applicable	2-3 litre per week		Not applicable	5 litre
How disposed	3rd party disposal	3rd party disposal	Not applicable	3rd party disposal			ICT policy
Quantity (Kg) per week/fortnight/Mo	3 litre per week	2 litre per week	Not applicable	2-3 litre per week			
Unscheduled disposal	It is recommended that disposal should not be done; still dumping of some qauntum in basin is observed	It is recommended that disposal should not be done; still dumping of some quantum in basin is observed	Not applicable	It is recommended that disposal should not be done; still dumping of some quantum in basin is observed			
2c Aqueous Acids / Alkalis/Neutral							
How collected	Stored in glass vessel	Stored in glass bottles (solvents/chemicals)	Yes; stored in glass	Stored in glass bottles (solvents/chemicals)	Not collected; dumped after dilution in basin	Not applicable	Stored in glass bottles
Quantity (L) per week/fortnight/Mo	1 litre per week	0.5-1 litre per week	Not sure about the statistics	1-2 litre per week	Not stored		2 litre
How disposed	3rd party disposal	3rd party disposal	Not sure about the statistics	3rd party disposal	Dumped in basin		

Quantity (Kg) per week/fortnight/Mo	1 litre per week	0.5-1 litre per week	Not sure about the statistics	1-2 litre per week	Not stored		
Unscheduled disposal	It is recommended that disposal should not be done; still dumping of some quantum in basin is observed	It is recommended that disposal should not be done; still dumping of some quantum in basin is observed	Not sure about the statistics	It is recommended that disposal should not be done; still dumping of some quantum in basin is observed	It is recommended that disposal should not be done; still dumping of some quantum in basin is observed		Yes; some times
2d Solvent							
How much procured?	20 litre a month	10 litre a month	Not applicable	10-12 litre a month	5 litre a month	30 litre a week	Not sure
waste quantity produced (L/month)?	15 litre a month	7-8 litre a month	Not applicable	4-5 litre a month	4 litre a month	15 litre a week	Not sure
How waste stored?	In glass vessels	In glass bottles	Not applicable	Glass bottles	In glass vessels	2.5 l glass bottLes are used for storage	NA
Disposal how & when, Records	3rd party disposal, done once in last 5 year; no records maintained	3rd party disposal, done once in last 5 year; no records maintained	Not applicable	3rd party disposal, done once in last 5 year; no records maintained	3rd party disposal, done once in last 5 year; no records maintained	Reuse option is opted sometimes by Rotavac	NA
2e Others like Oils etc							

2f Segregation of liquids (Organic acids, Mineral acids, Bases, Oxidizers, Per-chlorates, flammable or combustibles liquids, other)	No segregation	No segregation	No segregation	No segregation	No segregation	Not applicable	By employee, regularly once in a week
3. Surfactant waste							
waste quantity produced?	Not applicable	NA	Not applicable	NA	1 kg per week	Used at very low quantum	NA
How stored?	Dumped to basin probably	Directly into basin	Not applicable	NA	Dumped in basin after dilution	No storage	NA
How disposed?	If stored given to cleaning staff for disposal	NA	Not applicable	NA	Not applicable	Dumped in basin with dilution	NA
4. Electronic waste							
Quantity produced	Not applicable	NA	5 kg in last 6 month	NA	Not applicable	No e-waste is generated in specific	1 kg per month
How electronic waste is stored ?	Not applicable	NA	Stored in cardboard boxes; few spares assessed by IPC if they can be used	Stored in cupboard if generated	Not applicable		Dumped in regular dustbin

How electronic waste is disposed ?	Not applicable	NA	Waste collected as per institute policy	Institute will collect as per the quantity of waste produced	Not applicable		ICT policy
5. Biological waste							
Quantity generated?	1 kg per week	NA	NA	NA	Not applicable	10 kg per week	10 kg per week
Sterlization before storage?	Yes	NA	NA	NA		Yes	Yes
Storage procedure?	Under strict observation	NA	NA	NA		No storage; dumped immediatel y after sterilization	Yes
Disposal procedure?	Sterilization after use and dumped in general dustbin; which is further taken by cleaning staff	NA	NA	NA		Liquid waste after sterilization is dumped in basin	ICT norms
6. Glass waste							
Quantity generated?	1 kg per week	Quantity not fixed	1 kg per week	Quantity not fixed	1 kg per month	1 kg per month	2 kg per month
Storage procedure?	Broken glassware bin is kept in lab	Broken glassswares kept in separate dustbin	Stored in cardboard boxes	Broken glassswares kept in separate dustbin	Broken glassware in cardboard box	Separate dustbin	Separate dustbin

Disposal procedure?	Cleaning staff take away the waste for appropriate action	Cleaning staff take away the waste for appropriate action	Glass vendor is invited if any repair is possible ; or cleaning staff take away the waste for appropriat e action	Cleaning staff take away the waste for appropriate action	Cleaning staff take away the waste for appropriate action	Cleaning staff take away the waste for appropriate action	ICT policy
7. Plastic waste							
Quantity generated?	5 kg per week	Quantity Not fixed	Not applicable	1-2kg per week	No plastic waste ISgenerated	Eppendorf tubes; 5 kg per month	4 kg per week
Storage procedure?	Stored in regular dust bins	Stored in regular dustbins; no segregation	Not applicable	Stored in regular dustbins; no segregation		Plastic waste storage separate facility	Separate dustbin
Disposal procedure?	Cleaning staff take away the waste for appropriate action	Cleaning staff take away the waste for appropriate action	Not applicable	Cleaning staff take away the waste for appropriate action		Cleaning staff take away the waste for appropriate action	ICT
8. Biodegradable waste							
Quantity generated?	2 kg per week	0.5-1 kg per week	0.5 kg per week	0.5-1 kg per week	4 kg per week	2kg per week	1 kg per month

Storage procedure?	Stored in regular dustbins	Stored in regular dustbins	Not stored; directly dumped to dustbin	Stored in regular dustbins	Stored in regular dustbins	Stored in regular dustbins	Separate bins are available
Disposal procedure?	Cleaning staff take away the waste for appropriate action	Cleaning staff take away the waste for appropriate action	Cleaning staff take away the waste for appropriat e action	Cleaning staff take away the waste for appropriate action	Cleaning staff take away the waste for appropriate action	Cleaning staff take away the waste for appropriate action	ICT policy
9. Gases /Particulates							
Any provision for collection/disposal of gases/particulates generated in the laboratory	No provision; only exhaust are available; analytical lab do not have any specific provision	No provision for such cases; if any gases generated during process it will directed into atmosphere through exhaust	No provision;	No specific provision for collection but well functioning fume hood is used to carry the reactions	No provision; only exhaust are available; analytical lab do not have any specific provision	No provision	No
10. Any other methods for segregation/disposal of specific waste	Waste segregation status is very poor (solid-liquid-gas; all of them)	No such methods as of now	No such methods as of now	No such methods as of now	No	Not proper Need of substantial improveme nt	Poor condition
11. Lab records for							

procurement/storage/disposal of chemicals							
Is there any provision for record of chemicals procured/used/stored/disposed in the lab (Lab notebooks near weighing balance, chemical storage/disposal area, etc.)	No records are maintained	No record maintained for consumption of chemicals/solvents; logbook is maintained for weighing balance and GC, HPLC instruments.	No records are maintained	Chemicals procured through online system. Logbooks are maintained near weighing balance and other instruments	No	No records are maintained	Yes
Is their centralized record for chemicals purchased/disposed ?	No records are maintained	No records are maintained	No records are maintained	No record for disposed chemcials	Yes for purchase; no for disposal	No records are maintained	Yes
12. Storage of waste before disposal							
Is the waste labelled ?	No	Segregated as solvents, acids etc	No	Yes, unknown sample is labeled as unknown	Yes	Yes	No
Is label providing detail information about the waste?	No	No	No	Only name or type	Not detail; just name	Details are mentioned on label	NA
Is waste storage container compatible with its content?	Not sure	Stored generally in glass vessels	Not sure	Yes, stored mostly in glass bottles	Yes; compatible	Since no hazardous chemical are used; compatibility is not an issue	Compatible

13. Lab basin Wastewater							
Wastewater generated from the lab basin (kL per day)	50 litre per day	25-30 liter per day	25 litre a week	30-40 litres per day	30 litres per day	Not predicted	100 litre per day
Typical BOD/COD of the wastewater generated from lab basin	Data not available	Data not available	Data not available	Data not available	Data not available	Data not available	NA
Is there any provision of sump (where wastewater can be collected for periodic testing) for the laborator wastewater before it get mix with other wastewater?	Yes, out side lab building at ground floor	Yes, outside lab building at ground floor	Yes, outside lab building at ground floor	Yes, outside lab building at ground floor	Yes, out side lab building at ground floor	Yes	Yes, outside the building

Table 3: Laboratory safety checklist @ IISER, Kolkata

Lab Nos---------->	1	2	3	4	5	5	7	8	9
1. LAB SPACE									
Location (GF, FF, SF, etc)	3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	GF	3rd Floor	3rd Floor
Lab space, no of work benches, no of occupants	650 sq ft; 5; 8	750 sq ft; 4; 9	750 sq ft; 4; 9	750 sq ft; 4; 9	750 sq ft; 4; 9	750 sq. ft.; 3; 8	750 sq ft; 2 optical tables; 6	750 sq ft; 4; 11	700 sq ft; 4; 8
Entrances, Exits...(Nos., Clear and unobstructed)	2 (unobstructed)	2 (unobstructed)	2 (unobstructed)	2 (unobstructed)	2 (unobstructed)	2 (unobstructed)	2 (unobstructed)	2 (unobstructed)	3 (unobstructed)
Safety Showers / Eyewash, location, working?	Yes (in the corridor outside)	Yes (in the corridor outside)	Yes (in the corridor outside)	Yes (in the corridor outside)	Yes (in the corridor outside)	Yes (in the corridor outside)	Yes (in the corridor outside)	Yes (in the corridor outside)	Yes (in the corridor outside)
First aid Box available, condition?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fire Extinguishers Types, Nos., Location, time to reach	Yes, 2 nos, in corridor, ABC	Yes, 2 nos, in corridor, ABC	Yes, 2 nos, in corridor, ABC	Yes, 2 nos, in corridor, ABC	Yes, 2 nos, in corridor, ABC	Yes, 2 nos, in corridor, ABC	Yes, 2 nos, in corridor, ABC	Yes, 2 nos, in corridor, ABC	Yes, 2 nos, in corridor, ABC
Emergency telephone nos displayed (Y/N)	No	Yes	No	No	No	N	N	N	N
Emergency	No	No	No	No	No	N	N	N	N

Lighting available (Y/N)									
Spill kit available Y/N	No	No	No	No	No	N	N	N	N
Are the labs accessible to all at all times?	Yes	Yes	Yes	Yes	Yes	Y	Y	Y	Y
Access restriction.. How (manual/electronic system)	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual	Manual
Periodic inspections of labs (Y/N) if Yes by whom? (manager/Auditors/Councillar)	No	No	No	No	No	No	No	No	No
2. ELECTRICAL									
Electrical Grounding	Yes	Yes	Yes	Yes	Yes	Y	Y	Y	Y
Plugs, Wires, Pins, Condition & Integrity	Good	Good	Good	Good	Good	Good	Good	Good	Good
Extension boards	None	2 nos	2 nos	None	None	2 Nos	4 Nos	3 Nos	No
Sockets above 15 A having circuit breakers	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Temporary heating devices (water bath, heating mantle,	Yes (>10)	Yes (>10)	Yes (>10)	Yes (>10)	Yes (>10)	Yes (3)	No	Yes (>10)	Yes (>10)

heater/stirrer, etc)									
Protective guards on moving objects	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Adequate lighting all over the labs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Refrigerators, location. condition, loaded	3 (service corridor)	2 (inside lab)	2 (inside lab)	1 (inside lab)	1 (inside lab)	1 (inside the lab), Good	No	2 (inside the lab), Good	2 (1 inside the lab; 2 outside), Good
Ovens, location (to be away from flammables)	1 (service corridor)	2 (inside lab)	2 (inside lab)	3 (inside lab)	1 (inside lab)	1 (inside the lab)	No	1 (inside the lab)	1 (outside the lab)
Furnace (to be away from flammables)	None	None	None	None	3	None	None	None	None
Use of Microwave oven	None	1	None	None	None	1 (synthesis)	No	1 (synthesis)	None
Use of Hot air drier	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Instruments that require High voltage	None	Yes	None	None	None	Yes	Yes	Yes	Yes
							No		
3. VENTILATIO									

N									
Windows / (No, location,adequate ?)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Fume Hoods Y/N Nos.	3	4	5	4	4	1	One	4 nos	3 nos
Working of fume hoods	Working	Working	Working	Working	Working	Working	Working	Working	Working
Laminar flow	No	No	No	No	No	No	No	No	No
4. UTILITY LINES									
Water (valves, location and labels for cut off)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gas (valves, location and labels for cut off)	No gas lines	No gas lines	No gas lines	No gas lines	Yes	No gas lines	No gas lines	No gas lines	No gas lines
Air / Vaccum (valves, location and labels for cut off)	No air/vacuum lines	No air/vacuum lines	No air/vacuum lines	No air/vacuum lines	No air/vacuum lines	No air/vacuum lines	No air/vacuum lines	No air/vacuum lines	No air/vacuum lines
Electrical Mains (valves, location and labels for cut off)	Yes (outside lab)	Yes (inside lab)	Yes (inside lab)	Yes (inside lab)	Yes (inside lab)	Yes (inside lab)	Yes (inside lab)	Yes (inside lab)	Yes (outside lab)
Distilled water unit (Y/N). Is it used overnight?	No	Yes, No	No	No	No	N	N	N	N
5. HOUSE KEEPPING									

Storage of Empty bottles, boxes	Yes	Yes	Yes	No	No	No	No	No	No
Labeling on drawers / cupboards	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Condition of tables / chairs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lab coats, storage	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Walkway, Passage Clear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Old cardboard boxes and other packing materials,	No	No	No	No	No	No	No	No	No
Clutter on working bench						No			
Clutter in Fume hood						No			
Clutter on writing table						No			
6. PERSONAL PROTECTION									
Safety Glasses (for Chemicals / flames/lasers etc)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Laboratory Coats / Aprons	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Gloves, Gas masks (are these available, using)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shoes,	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(appropriate?)									
Protective Shield / Visor	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
7. FLAMMABLE SOLVENTS									
Common solvents (names)	EtOAc, Hexane, DCM, Methanol, Toluene, etc	EtOAc, Hexane, DCM, Methanol, Toluene, etc	EtOAc, Hexane, DCM, Methanol, Toluene, etc	EtOAc, Hexane, DCM, Methanol, Toluene, etc	Acetone, Ethanol, Hexane, DCM, EtOAc, IPA etc		No	Acetone,Ethanol, Hexane,DCM, EtOAc,IPA etc	Acetone,Ethanol, Hexane,DCM, EtOAc,IPA etc
Bottles / containers capped / closed	Drums (25 L), Bottles (4L)	Drums (25 L), Bottles (4L)	Drums (25 L), Bottles (4L)	Drums (25 L), Bottles (4L)	Drums (25 L), Bottles (2.5L)	Drums (25 L), Bottles (4L)	No	Drums (25 L), Bottles (4L)	Drums (25 L), Bottles (4L)
Quantity	6 Drums, 10 Bottles	20 Drums, 30 Bottles	5 Drums, 12 Bottles	7 Drums, 50 Bottles	7 Drums, 30 Bottles	4 Drums, 30 Bottles	No	10, 20	10, 30
Waste solvents	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Solvents on work bench	No	No	No	No	No	No	No	No	No
Labelling	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Solvents Inventory	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Records of Issue from Stores	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

8. CHEMICALS									
Chemicals Inventory	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Records of Issue from Stores	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	No	N.A.	N.A.
Storage racks available Y/N	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Storage alphabeticaly, compatibility wise	Both alphabetically and compatibility	Both alphabetically and compatibility	Compatibility	Alphabetically	Alphabetically	Alphabetically	No	Both alphabetically and compatibility	Both alphabetically and compatibility
Hazardous (Bromine, HF etc	Bromine	Bromine	Bromine	Bromine	Bromine	No	No	Br2	Br2
Reactive (Na,	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Pyrophoric	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Acids Storage: H2SO4, HNO3, HCL, HClO4, H3PO4, etc	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Acid storage condition	Yes	Yes	Yes	Yes	Yes	Good	No	Yes	Yes
Bottles / containers capped / closed	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Acid Anhydrides	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Labelling	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Alkalis	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Smell of chemicals/ acids / solvents in labs	No	No	No	No	No	No	No	No	No

9. GAS CYLINDERS									
H2, location, Nos & whether Chained	No	No	No	No	1 Nos, Inside lab, chained	No	No	No	No
N2 Location, Nos & whether Chained	4 Nos, Inside lab, unchained	4 Nos, Inside lab, chained	4 Nos, Inside lab, chained	1 Nos, Inside lab, chained	4 Nos, Inside lab, chained	1 No., unchained	Inside lab, 2, chained	Inside lab, 5, chained	Inside lab, 5, chained
O2 Location, Nos & whether Chained	No	No	No	No	2 Nos, Inside lab, chained	1 No., unchained	No	No	No
Others Location, Nos & whether Chained	No	No	No	No	Ar -3 Nos, NH3 -2 Nos Inside lab, chained	No			
LPG Nos & where located, condition of piping, regulator, valves, etc	No	No	No	No	No	No	No	No	No
Records of issue & return	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Gas Trolley Y/N	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Gas leak detectors, if any	No	No	No	No	No	No	No	No	No

Segregation of gases (Toxic gases, flammable, oxidizing and inert gases)	No	No	No	No	No	No	No	No	No
10. OTHERS									
Handling, storage and use of LN2	Yes, 50 L	Yes, 100 L	No	Yes, 50 L	Yes, 50 L	No	No	No	Yes, 50L
Hot Oil / Silicone oil					Yes	Yes	No	Yes	Yes
11. POLICY, MANUALS ETC									
Safety Policy, Safety Manual (Y/N), if yes, is it on web	Yes, not on web	Yes, not on web	Yes, not on web	Yes, not on web	Yes, not on web	Yes, not on web	Yes, not on web	Yes, not on web	Yes, not on web
MSDS access	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Written SOPs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Instrument Manuals Access	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Accident reporting, system, formats, records	No	No	No	No	No	No	No	No	No
Lab Safety Orientation / Training	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Fire Safety Training	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Emergengency Evacuation plans & training	No	No	No	No	No	No	No	No	No
Mock Drills for above	No	No	No	No	No	No	No	No	No
Audits	No	No	No	No	No	No	No	No	No
12. WORKING IN LAB									
Buddy System					Yes				
Working in after/ before silent hours					Yes				
Risk assessment	No	No	No	No	No	No	No	No	No
Experimental records	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13. WORK PRACTICES (enforced through audits/surprise checks)									
Long Hair/beard tied, Loose clothing, Pants-Full/Half, Jewellery, contact lens, etc	Enforced	Enforced	Enforced	Enforced	Enforced	Enforced	Enforced	Enforced	Enforced
Pipette out									

Separating funnel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Others									
Lab notebooks, signed by supervisor	No	No	No	No	No	Yes, monitored by supervisor	No	No	No
Eating / Drinking in labs	No	No	No	No	No	No	No	No	No
Storage of water/ food in Refrigerator	No	No	No	No	No	No	No	No	No
Wash hands after work with soap /water	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Soap, Hand Towel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Any system to avoid repeated procurement?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Any system to share surplus chemicals?	No	No	No	No	No	No	No	No	No
Procure mercury free instruments									
To prevent spill during movement of chemicals in the lab (trolleys, trays or secondary container/bucket should be used).	No	No	No	No	No	Yes	Yes	Yes	Yes

Avoid distraction to other laboratory person									
Hazardous substabce store should be prohibited for visitors	No	No	No	No	No	No	No	No	No
Smoking, tobacco chieving, consuming food in the lab should be avoided	No	No	No	No	No	No	No	No	No
Routine check for disposal drums (are they removed once 80% filled)	No	No	No	No	No	Yes	Yes	Yes	Yes
14. INSTRUMENTS									
Are all instruments in use are calibrated?	Yes	Yes	N.A.	Yes	Yes	Yes	Yes	Yes	Yes
Are all non-functional instruments labelled as ' Not in use'?	Yes	Yes	N.A.	Yes	Yes	Yes	Yes	Yes	Yes
Is every common instrument has	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes

trained incharge ?									
Are log books maintained for recording instrument condition after every use ?	Yes	Yes	N.A.	Yes	Yes	Yes	Yes	Yes	Yes
15. ANY OTHER LAB SAFETY CONCERN									
Radiations and radioacitive materials, handling, storage, use and disposal						N.A.			

Table 4: List of items required and budgets to upgrade the next level for SPPU, Pune

NOTE: Based on student strength of department and scope for expansion

Sr. No.	Category	Items	Quantity	Cost (INR)
1	BULK STORAGE	Remote bulk solvent storage facility 50' × 50' @ INR 1200/sqft	1	3,000,000
		Remote chemicals and acid storage facility 30' × 30' @ INR 1200/sqft	1	1,080,000
		Remote gas cylinder storage facility 20' × 20' @ INR 1200/sqft	1	480,000
		Fixed fire extinguishing systems for above	1	800,000
		Solvent transfer pumps for bulk solvents,	3	100000
2	FIRE SAFETY	Portable fire extinguishers (ABC, CO_2 and Foam type)	30	150,000
		Fire blankets	15	30,000
		Fire buckets with sand and scoops	25	5,000
		Stand for fire buckets	5	10,000
		Safety Showers and eyewash with plumbing	15	75,000
3	VENTILATION	Fume hoods complete with piping and blowers and scrubbers	30	3,000,000
4	ELECTRICAL SAFETY	Provision of electrical wiring, E & MCBs and switches insulation, non-sparking, covered industrial fittings in all chemical labs)	-	1,000,000
		Provision of flame & explosion proof Furnaces & Ovens, Heating mantles, magnetic stirrers, Refrigerators etc	-	2,000,000

5	LAB ACCESSORIES	Solvent storage cans in labs, @ INR INR 5000 each	50	250000
		Solvent storage cabinets, @ INR 80000 each	20	1,600,000
		10/20L drums for Waste solvent storage and disposal	50	20,000
		Solvents and Gas cylinder trolley	5	50,000
		Gas cylinders manifold & related piping	2	50,000
		Brackets and chains for cylinders in labs	30	100,000
		Chain pulley block arrangement to lift gas cylinders to FF	1	100,000
		Refurbishment of Lab drainage and water lines	1	200,000
		Provision of a second exit, wherever feasible	-	100,000
		One time provisions of PPE (lab coat, safety goggles, gloves, masks,)	200	300,000
6	DOCUMENTATION AND TRAINING	Documentation and training module for lab safety training and waste disposal	-	100,000
		Safety orientation and training	-	200,000
7.	WASTE DISPOSAL	One time provision for disposal of old chemicals		200,000
TOTAL, INR				**15,000,000**

Documentation includes:

Safety policy and manual, safety rules, systems of enforcements.

Internal phones for communication, List of emergency phone numbers.

Building evacuation procedures, mock drills, accident reporting, investigations, reports & Recommendations.

Rules for electrical safety, Laser safety, radiation safety and much more.

Table 5: List of items required and budgets to upgrade the next level for ICT, Mumbai

NOTE: Based on student strength of department and scope for expansion

Sr. No.	Category	Items	Quantity	Cost (INR)
1	BULK STORAGE	Remote bulk solvent storage godown 60' × 60' @ INR 1200/sqft	1	4,320,000
		Remote chemicals and acid storage godown 50' × 50' @ INR 1200/sqft	1	3,000,000
		Fixed fire extinguishing system for above	1	1,000,000
		Solvent transfer pumps for bulk solvents (@ INR 30,000 each)	5	150,000
2	FIRE SAFETY	Portable fire extinguishers (ABC, CO2 and Foam type)	50	250,000
		Fire blankets (@ INR 2000 each)	40	80,000
		Fire buckets with sand and scoops	100	20,000
		Stand for fire buckets	50	100,000
		Safety Showers and eyewash with plumbing	40	200,000
		Provision for installation of smoke and fire alarm system	1	3,000,000
3	VENTILATION	Fume hoods complete with piping and blowers and scrubbers	30	4,500,000
4	ELECTRICAL SAFETY	Provision of electrical wiring, E & MCBs and switches insulation, non-sparking, covered industrial fittings in all chemical labs	-	3,000,000
		Provision of flame & explosion proof Furnaces & Ovens, Heating mantles,	-	3,000,000

		magnetic stirrers, Refrigerators etc.		
5	LAB ACCESSORIES	Solvent storage cans in labs, @ INR 5000 each	80	400,000
		Solvent storage cabinets, @ INR 80000 each	30	2,400,000
		10/20L drums for Waste solvent storage and disposal	100	40,000
		Spill kits	40	200,000
		Solvents and Gas cylinder trolley	5	50,000
		Gas cylinders manifold & related piping	10	250,000
		Brackets and chains for cylinders in labs	50	100,000
		Chain pulley block arrangement to lift gas cylinders to FF	2	100,000
		Provision of a second exit, wherever feasible	-	340,000
		One-time provisions of PPE (lab coat, safety goggles, gloves, masks, etc.)	300	300,000
6	DOCUMENTATION AND TRAINING	Documentation and training module for lab safety training and waste disposal	-	200,000
		Safety orientation and training	-	500,000
7	WASTE MANAGEMENT SYSTEM	STP with pretreatment for treatment of laboratory wastewater (Capacity 150 m^3/day)	1	3,500,000
TOTAL, INR				**31,000,000**

Documentation includes:

Safety policy and manual, safety rules, systems of enforcements.

Internal phones for communication, List of emergency phone numbers.

Building evacuation procedures, mock drills, accident reporting, investigations, reports & Recommendations.

Rules for electrical safety, Laser safety, radiation safety and much more.

Table 6: List of items required and budgets to upgrade the next level for IISER, Kolkata

NOTE: The items and the estimates are based on student strength of department and scope for expansion

Sr. No.	Category	Items	Quantity	Cost (INR)
1	BULK STORAGE	Remote bulk solvent storage facility 70' × 50' @ INR 1200/sqft	1	4,200,000
		Remote chemicals and acid storage facility 50' × 40' @ INR 1200/sqft	1	2,400,000
		Remote gas cylinder storage facility 30' × 30' @ INR 1200/sqft	1	1,080,000
		Fire extinguishing systems	1	1,500,000
		Solvent transfer pumps for bulk solvents	5	185,000
2	FIRE SAFETY	Safety Showers and eyewash with plumbing	30	200000
		Fire blankets	40	100,000
3	ELECTRICAL SAFETY	Provision of electrical wiring, E & MCBs and switches insulation, non-sparking, covered industrial fittings in all chemical labs)	-	2,000,000
		Provision of flame & explosion proof Furnaces & Ovens, Heating mantles, magnetic stirrers, Refrigerators etc	-	2,000,000
4	LAB ACCESSORIES	Solvent storage cans in labs, @INR 5000 each	100	500,000

		Solvent storage cabinets, @INR 80000 each	50	4,000,000
		Solvents and Gas cylinder trolley	10	100,000
		Gas cylinders manifold & related piping	10	300,000
		Brackets and chains for cylinders in labs	30	75,000
		Provision of a second exit, wherever feasible	-	60,000
		One time provisions of PPE (lab coat, safety goggles, gloves, masks, etc.)	200	300,000
5	DOCUMENTATION AND TRAINING	Documentation and training module for lab safety training and waste disposal		100,000
		Safety orientation and training	-	400,000
TOTAL, INR				**19,500,000**

Documentation includes:

Safety policy and manual, safety rules, systems of enforcements.

Internal phones for communication, List of emergency phone numbers.

Building evacuation procedures, mock drills, accident reporting, investigations, reports & Recommendations.

Rules for electrical safety, Laser safety, radiation safety and much more.

Table 7: Key infrastructure currently available at SPPU, ICT and IISER-K

KEYS: SATISFACTPORY (**S**), UNSATISFACTORY (**US**)

Sr. No.	Category	Items	University/Institute		
			SPPU	ICT Mumbai	IISER-K
1	LAB SPACE	Lab space per occupant	US	US	S
		No of entry/exits	US	US	S
		Housekeeping	US	US	S
2	BULK STORAGE	Bulk storage of solvents and chemicals	US	US	US
3	FIRE SAFETY	Fire hydrant system	US	US	S
		Portable fire extinguishers	US	S	S
		Fire blankets	US	US	US
		Sand Buckets	US	US	US
		Fire alarm system	US	US	S
4	VENTILATION	Fume hoods	US	US	S
5	ELECTRICAL SAFETY	Provision of electrical wiring, E & MCBs and switches insulation, non-sparking, covered industrial fittings in	US	US	US

		all chemical labs)			
		Provision of flame & explosion proof Furnaces & Ovens, Heating mantles, magnetic stirrers, Refrigerators etc.	US	US	US
6	LAB ACCESSORIES	Chemical storage	US	US	S
		Solvent storage in labs	US	US	US
		Central bulk solvent storage	US	US	US
		Waste solvent collection	US	US	S
		Waste chemical disposal	US	US	S
		Gas cylinders central storage	US	S	US
		Gas cylinders in labs, chained	US	US	S/US
		Trolleys for gas cylinder movement	US	S	S
		Personal Protection Equipments (PPEs) and Lab safety equipments, Eye wash, Safety Showers	US	US	S
		Spill kits	US	US	US

		Chemical storage	US	US	S
		Solvent storage in labs	US	US	US
		Waste solvent collection	US	US	S
		Waste chemical disposal	US	US	S
7	WASTE MANAGEMENT SYSTEM	STP/ETP	No	No	S
8	TRAINING AND EDUCATION	Safety Training	No	No	Yes/No
		Safety Manual	No	No	No

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- Articles published in Chemical and Engineering News (ACS) on Laboratory Safety http://pubs.acs.org/iapps/wld/cen/results.html?line3=Safety%20in%20Laboratories

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