Chemical Safety Manual

July 2021

School of Chemical Sciences

http://www.niser.ac.in/scs/
https://www.niser.ac.in/content/niser-safety-committee

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1. Preamble

National Institute of Science Education and Research (NISER), is committed to create, maintain, and enhance a safe and healthful environment for all individuals associated with the institution, including students, faculty, staff, hospital patients, and visitors. In order to follow this vision, this Handbook is documented to be used as a safety manual for all personnel working in laboratories to ensure safe work conduct and practices in the premises of School of Chemical Sciences at NISER, Jatni, Khurda, Odisha. Safe chemical practices are the most basic and fundamental parts of any lesson and having acquired good chemical safety habits early, students are better prepared when they move on to more advanced courses.

It demonstrates the institute Policy and strategy towards ensuring health and safety whilst working within School of Chemical Sciences. This document describes the safety training required and policies that must be followed to conduct laboratory research. It is designed to facilitate safe working and avoid accidents by providing a framework within which a safe method of work can be established. It is therefore important to read and understand the advice given within this handbook before initiating the laboratory work.

This Handbook is reviewed and updated annually Suggestions for inclusion, corrections and revisions for future editions of this Handbook should be sent to the member(s) of the Safety Regulation Committee.

Faculties/staffs/students/scholars are requested to sign and return the declaration form attached at the end of this document which states that you have attended the safety orientation programme as well as read the handbook and are satisfied with the roles and responsibilities of each individual as well as School of Chemical Science with respect to safety. In case of any query, the immediate Supervisor or the School of Chemical Sciences, Safety regulation committee may be contacted for help.

Please note that this safety manual has been prepared based on the standard safety measures required at laboratories. In case of use/practices of specific chemicals or methods, specified safety regulations need to be furnished by the concerned individual/laboratory in order to avoid any hassle.

"SAFETY IS FIRST AND MUST FOR ALL"

Note:

1. *Layout Plan of School of Chemical Sciences Building for each floor is included as pages 14-19*
2. *Declaration form is included as page no. 20*

2. Duties and Responsibilities

The Institute: It is responsibilities of the institute administrative head to constitute a safety committee on institute level / school level for insuring a safe, healthy and secure working environment. Next in row to ensure regular inspections by safety committee to improve unsafe conditions. Also support for arrangement / procurement of adequate resources (such as fire extinguishers and other safety equipments).

The Supervisor: It is the responsibility of supervisor / guide to formulate additional / own safety rules for their area of supervision followed by regular safety inspections. They are encouraged to train the lab worker / researcher for the safe operation of equipments.

Individuals (Students, Staffs and Faculty): It is the responsibility of individuals to observe safety rules and procedures established by institute safety committee and supervisors'.

3. Chemistry laboratory Safety Rules at a Glance

For teaching labs:

1. The lab work should not begin until pre-lab discussion describing the experiment & safety precautions has been completed. Perform your lab experiment(s) only when Faculty/TA/ Technician or any other qualified staff is present in the lab.

For all:

2. **Personal Protective Equipments:** Always wear lab coats in the labs. Full sleeve shirts & long pants are preferable dress over short sleeve shirts, shorts or short skirts. Always wear closed toe shoes (open toed shoes, sandals & flip-flops are not allowed). Wear gloves whenever required by your lab procedure. Always wear chemical splash goggles while you & your batch mates are working in the lab and clean your goggles before wearing.
3. Contact Lenses are not allowed. Various fumes may accumulate under the lens and cause serious injuries or blindness.
4. Hair: Tie long hair behind the head (hair is flammable).
5. Finger nails: Synthetic finger nails should be removed. These are highly flammable.
6. Bag/book bags: All bag/book bags must be placed away from chemicals, solvents, acids and lab equipments.
7. Food/Drink: Food and drinks are not allowed at any time in lab. No gum chewing, no eating in the lab.
8. Do not heat flammable liquids /substances with open flame or similar energy source.
9. If you break thermometer, equipment or spill chemicals you must notify your supervisor/faculty/staff.
10. Never pipette by mouth. Do not taste or sniff chemicals directly.
11. You are not allowed to do any unauthorized experiment. Do not play mad scientist. Pay attention to procedure in which how chemicals are to be added to each other.
12. You are never allowed to work alone.
13. Read Material Safety Data Sheets (MSDS) for the chemical(s) you need in your experiment & follow the recommendations for safe use & disposal of the material.
14. Identify and locate safety & first aid equipments. This includes fire extinguishers, eyewash & shower stations.
15. If safety information says that a chemical should be used inside fume-hood, then don't use anywhere else.

16. Don’t drain chemicals, some chemicals can be, if it is, be sure to wash it away rather than risk an unexpected reaction with chemicals 'leftovers' later. Most of the chemicals require different method of disposal. Use proper waste container for the purpose.
17. Maintain/Manage your lab book and data.
18. Paste important emergency information for ongoing overnight reactions (mention fire extinguisher type for fire emergency if caused by the reaction).
19. Identify the symbols/labels on chemical bottle and learn how to interpret these labels.
20. Do not use solvents near open flame.
21. Always pour acids in to water not vise-versa.
22. If chemical come in to contact with skin/eyes: wash with copious amount of water & consult your instructor.
23. Never point test tube towards you or any other person. Never leave burners unattended.
24. Use mercury spill kit for mercury spills.
25. Put sharp waste in sharp container (eg. needle).
26. Clean up broken glass-wares immediately and dispose in glass waste container.
27. Beware of hot glass: it looks exactly like cold.
28. Don’t use electrical equipments with frayed/twisted wires.
29. Clean your workplace & restore it to its original state & wash your hands properly before you leave the lab.

4. Pictograms:

The hazardous pictograms are graphic images indicating the type of hazard a hazardous product presents such as fire, health hazard, corrosive, etc. Most pictograms are outlined by red, diamond-shaped border. The common pictograms for chemical safety are shown below. These pictograms are finalized by the globally harmonized system (GHS) of classification and labelling of the chemicals.

5. Laboratory Safety Guidelines

A. ELECTRICAL SAFETY

Electricity is associated with a number of hazards: shock, burns, falls, fire and explosion. Shock normally arises as a result of touching a conductor that is intentionally live, or one that has become so as a result of a fault. When working with experimental equipment, the risk of electrical shock can be reduced by adopting the following general practices:

- Ensure all metal work is earthed – contact the Maintenance Section.
- Use a Residual Current Device.
- Do not handle the equipment with wet hands, and do not work in close proximity to water supplies or other unearthed metalwork where there may be a chance of touching 'live' parts of the equipment.
- Switch off when making any alterations or modifying circuits.
- Turn off equipments if not in use.
- Turn off all electrical connections when you close the lab expect refrigerators.

B. SAFETY THROUGH PERSONAL PROTECTIVE EQUIPMENT (PPE)

The term Personal Protective Equipment (PPE) refers collectively to equipment such as safety glasses, goggles, aprons, lab coats, protective shoes, respiratory protective equipment (mask) and similar equipment used to protect the person during their work. Personal Protective Equipment is the last resort and only protects the wearer from harm. Alternative methods for controlling the hazards must have been considered.

(i) Eye Protection: The eyes are very easily damaged, and injury to them is probably more serious than to any other organ.

Ordinary glasses do not provide adequate protection

Contact Lenses. In general, injury data is lacking to clearly indicate that contact lens wear should be restricted during work with hazardous chemicals; however, appropriate eye protection is always necessary (Spectacles are advisable over the contact lenses). Below is a list of some chemicals that can react with contact lenses or for regulatory reasons should **not** be used when wearing contact lenses:

- 1,2-dibromo-3-chloropropane (DBCP)
- 4,4'-methylene dianiline
- Ethyl alcohol

- Ethylene oxide
- Isopropyl alcohol
- Methylene chloride

In the event of a chemical exposure, **begin eye irrigation immediately and remove contact lenses as soon as practical**. Do not delay irrigation while waiting for contact lens removal.

(ii) Chemicals splash safety goggle: All members of academic and technical staff and all research workers must wear Safety Glasses at all times inside the teaching and research laboratories.

(iii) Gloves: Appropriate gloves should be warned:

- To protect against accidental contact with chemical substances, namely those that may be absorbed through the skin or that are corrosive, harmful, irritant or otherwise damaging to the skin, or biological hazards
- To protect against abrasions and general mechanical hazards, e.g. when moving bricks and rubble, or when handling gas cylinders.

Gloves should NEVER be warn when using rotating machinery

- To protect against extreme cold, for example when handling cryogens
- To protect against heat e.g., when taking things out of an oven or furnace
- To protect against electricity, or to have anti-static properties.

(iv) Masks and Respirators: Respiratory protective equipment (RPE) e.g. masks and respirators, like Personal Protective Equipment (PPE), lies at the bottom of the hierarchy of control measures because it protects only the person wearing it.

- ✓ *Please use mask while using Bromine, Bromide derivatives, Inorganic cyanides and silica gel etc.*

(v) Footwear: Footwear that adequately covers the feet and offers protection against spillages and falling objects **should** be warned at all times inside the laboratory. Sandals and flip flops do not provide adequate protection to the feet. **Do not walk around in bare feet**

(vi) Laboratory Coats

Clean, fastened lab coats and aprons **should** be worn in all laboratories and workrooms where hazardous substances are being used. Lab coats **must not** be worn:

- Outside the work area
- In refreshment areas, the library and offices etc

(vii) Lone Working

Lone working in the Laboratories is **strictly prohibited** when working outside normal working hours. **There must be at least one other person present there. Never perform any experiment alone.**

Apparatus and Experiments left Unattended (Overnight Running)

It is accepted that experiments and apparatus may have to be left running overnight. However, in some instances, either because of the nature of the experiment or equipment or because of a failure of a service, such as water or electricity supply, a hazardous situation may arise. In these circumstances it is essential that adequate instructions are left to ensure that the equipment can be made safe.

For Overnight Reactions there must be a note with following points

- ✓ Name of the Person:
- ✓ Contact number:
- ✓ Reaction structure:
- ✓ Condition:
- ✓ In emergency, possible precautions, for eg. mention fire extinguisher type (water, sand, CO_2 etc) for fire emergency if caused by reaction:

(viii) Disposal of Chemicals

The uncontrolled disposal of solid, liquid or gaseous hazardous and toxic waste is strictly forbidden. Never dispose of chemicals by throwing them in the waste bin. **Never** dispose of hazardous or toxic chemicals down the sink.

Research workers are responsible for disposal of all unwanted chemicals in a safe and proper manner. Any spilt chemicals should be cleaned up immediately.

Read Material Safety Data Sheets (MSDS) for the chemical you need in your experiment and follow the recommendations for safe use and disposal of the material. MSDS should be available for every chemical you use in the labs. Containers must be suitable for the type of waste. In general the following guidelines should be followed:

- Glass bottles can be used for most chemicals **except** hydrofluoric acid waste.
- Plastic bottles are suitable for acids and alkalis. Do not put aggressive solvents such as ether or dichloromethane, or mixtures containing aggressive solvents, in plastic containers unless.
- Steel drums are suitable for organic solvents, neutral aqueous solutions and oils but are **not** suitable for acids or alkalis.
- Containers designed for solids **must not** be used for liquids and vice versa.
- Containers **must not** be overfilled.

- Containers **must** be clearly labelled with full details of contents and the name of the person transferring the waste. Major components **must** be listed and where possible the original container.
- Use Sharps refuse containers for sharp waste (e.g syringe-needle).

C. CHEMICAL SAFETY INFORMATION AND GUIDELINES

The information contained within this section and associated guidance applies to the handling, use, storage and disposal of hazardous substances.

(i) Labelling

All containers of chemicals must be clearly labelled with accurate information as to the contents and where possible, with the appropriate hazard warning symbol, e.g.:

Handling Chemicals – Reducing the Risks

- The minimum quantity of chemical necessary should only be used.
- Always wear personal protective equipments.
- Hence, pipetting liquids or solutions by mouth is strictly prohibited.
- Never deliberately taste, swallow or inhale any chemical.
- Suitable protective equipment must warn when handling chemicals.
- Be careful while handling Acids, alkalis and other corrosive materials.
- Always wash your hands after handling chemicals.
- Never carry bottles by the neck or in the pocket.
- Do not overfill bottles or flasks.
- Chemicals which give off harmful vapours or dust, or which are toxic, odoriferous, volatile or harmful should only be used in a fume cupboard.
- Do not eat or drink in the presence of chemicals. Eating and drinking is **not** permitted inside laboratories, workshops or other areas (including offices) where chemicals and other potential contaminants such as lab coats are present.

(ii) Highly Reactive Substances and Spontaneously Flammable Solids

This class of compound includes alkali metals, alkali metal hydrides, organoalkali metal reagents, lithium aluminium hydride, zinc organometallics and aluminium organometallics. They are all air- and moisture-sensitive and contact with water should be avoided at all times.

(iii) Flammable Materials

The flash-point of a flammable liquid is the minimum temperature at which it forms a vapour above its surface in sufficient concentration to be ignited. The temperature at which burning is sustained will usually be higher and is sometimes called the burning point. The auto-ignition temperature is the minimum temperature at which vapours of the liquid will ignite spontaneously without a source of ignition.

A flammable liquid is generally defined as a liquid which has a flash-point below 21 ºC **or** which has a flash-point between 21 ºC and 55 ºC and will support burning at 55 ºC. The majority of organic materials are flammable, and many organic solvents are highly flammable (e.g. ethanol, acetone, ether, petroleum products, and toluene to name just a few). Examples of typical flammable liquids used in the laboratory are given below:

Liquid	Flashpoint	Comments
Ether Acetone	-45 ºC -18 ºC	Flashpoint < 0 ºC Extremely Flammable
Toluene Ethanol	+4 ºC +21 ºC	Flashpoint 0 to 21 ºC Highly Flammable
White Spirit Diesel Fuel	+39 ºC +50 ºC	Flashpoint > 21 ºC Flammable

(iv) Organometallic Reagents

It is safest to use organometallics as standardized solutions in an appropriate solvent. Organoalkali metal reagents, zinc organometallics and aluminium organometallics supplied commercially in *Sureseal* bottles should be handled in the following way:

- A positive gas flow or over-pressure in the bottle should be produced by attaching a needle to a vacuum line gas outlet that is then thoroughly purged with a flow of nitrogen or argon. The needle is then fed through the Sure-seal septum while the gas flow is continued. A syringe which has been purged with nitrogen or argon can then be used to remove the required quantity of standard solution.
- Alternatively, a balloon filled with nitrogen or argon can be used to produce the over pressure, a needle being attached to the balloon.
- Syringes that lock the needle to the syringe should be used for transferring reagents.

Certain standard reagents (in particular, *n*-butyllithium) may be provided without a septum or Sure-seal. In such circumstances, the solutions can be removed using an argon- or nitrogen-purged syringe.

Regardless of the circumstances, reagent bottles should be securely clamped while performing any of the manipulations described above.

Never use paper towels to clean syringes or needles contaminated with organometallics as this will result in combustion after a short period of time.

(v) Disposal of Residues.

Large quantities of organometallics should be diluted with an inert solvent such as toluene (particularly if neat). Iso-propanol is added very slowly to the stirred solution under argon or nitrogen, with the reaction vessel being cooled in an ice bath. Water and primary alcohols should never be used for this purpose. Ensure that the reaction is complete before disposing of the solution as chemical waste. Small quantities (such as residues from a syringe) can be rinsed into a beaker and iso-propanol added slowly. Where Grignard reagents supplied in steel cylinders are used, every effort should be made to safely empty the cylinder prior to disposal via the Chemical Waste Store.

(vi) Lithium Aluminium Hydride and Alkali Metal Hydrides

These are most often used as dispersions in mineral oil. The dispersions can be transferred to reaction vessels (previously purged with nitrogen or argon) using a spatula or large syringe fitted with a large gauge needle. An inert (aprotic) solvent such as **dry** toluene is added and the oil is washed from the hydride by allowing the solid to settle, then using a syringe to remove the solvent. It is important to have a dry beaker or round bottomed flask available to dispose of the solvent waste, which will contain small amounts of the hydrides.

Hydrides supplied commercially as pure solids should **never** be handled in the open atmosphere. A glove box should be used for this purpose. They should also be stored in closed containers. Dry lithium aluminium hydride ($LiAlH_4$) often contains finely-divided lithium metal which can result in spontaneous ignition. Dry sodium hydride will often ignite immediately in contact with air. When weighing out $LiAlH_4$ and lithium borohydride ($LiBH_4$) always use an aluminium boat (or aluminium foil).

(vii) When using LiAlH4:

- Do not assume that different batches of LiAlH4 will react or behave in the same Manner
- Before starting work, make sure that the fume cupboard is clear of all other equipment and flammable material.
- For large scale reactions i.e. > 5g $LiAlH_4$, particularly where using a volatile solvent such as diethyl ether.

- For particularly large scale reactions it is always good practice to have an experienced member of staff available particularly at the initial stages.
- Constant monitoring is vital – only leave the reaction once it has settled down.

(viii) Disposal of Residues.

Residues can be destroyed by slowly adding iso-propanol. Large quantities of metal hydrides should be destroyed under an argon or nitrogen atmosphere, with the hydrides being suspended in an inert solvent and the reaction vessel being cooled in an ice bath. Again iso-propanol can be used for alkali metal hydrides or lithium aluminium hydride. However, a safer method for lithium aluminium hydride is addition of ethyl acetate.

(ix) Alkali Metals

Lithium, sodium and potassium can be handled in air but should never be air-exposed for a prolonged period. They are supplied in mineral oil that can be cleaned off with tissue paper or washed off with an inert solvent (such as toluene or hexane). Residues (including tissue paper) should be washed with iso-propanol before disposal. Rubidium and Caesium should only ever be used in a glove box.

How to dispose Sodium and Potassium?

Ref: Herbert W. Roesky *Inorg. Chem.* **2001,** *40,* 6855-6856.

(x) Unstable and Explosive Materials

Certain classes of material should always be suspected of being potentially unstable. These include substances with a high degree of unsaturation, or with a significant content of oxygen or nitrogen or both. Halogen atoms in combination with oxygen or nitrogen atoms should also be given careful consideration. Examples of unstable substances include acetylenes, perchloric acid, perchlorates, peroxides (including peroxide forming compounds), isopropyl ether, decalin, ethyl nitrate and picric acid.

Prevention of Exposure to Carcinogens, Mutagens and Substances Toxic to Reproduction (Carcinogens etc)

In the first instance, as with all hazardous substances, exposure to a carcinogen, mutagen and substance toxic to reproduction (carcinogens et al) should be prevented by using a safer alternative where one is available, and its use is reasonably practicable. Carcinogenic, toxic and other properties of chemical substitutes should be established and taken into account when considering alternatives.

(xi) Inorganic Cyanides

All the reactions of inorganic cyanides should be carried out after the permission from the Principal Investigator/Supervisor.

Inorganic cyanides can be oxidised to cyanate using aqueous hypochlorite solution. The residue should be made alkaline then treated with sodium hypochlorite solution (about 1 litre, 15 per cent available chlorine, per gram-mole suspected cyanide). After half-an-hour carry out the following test for cyanide:

- Take two or three drops of the test solution, make alkaline and add a few drops of a freshly made, strong solution of ferrous sulphate.
- Boil, cool then acidify with dilute hydrochloric acid, followed by one or two drops of 1% ferric chloride solution.
- If a deep blue colour or precipitate forms, ferric cyanide is present, hence all the cyanide has not been destroyed. The solution should be allowed to stand for a longer period of time and if necessary, more sodium hypochlorite solution added.

When a negative test for cyanide is obtained, i.e. absence of blue colour, the mixture may be safely washed away down the drain with copious amounts of cold water.

(xii) Hydrofluoric Acid (HF)

HF should only be used only in fume cupboard. All the reactions should be performed in plastic container.

(xiii) Malodorous Materials

The use of malodorous thiols and mercaptans (particularly those that smell of gas, thiols may be oxidised with permanganate or bleach) MUST be notified to the Department prior to work commencing.

(xiv) Mercury

Mercury is a highly toxic, fairly unreactive metal that is resistant to corrosion. Repeated or prolonged exposure to mercury vapour can result in damage to the central nervous system however the acute toxicity of mercury varies significantly with the route of exposure. Mercury is a bio-accumulator and poses an environmental hazard.

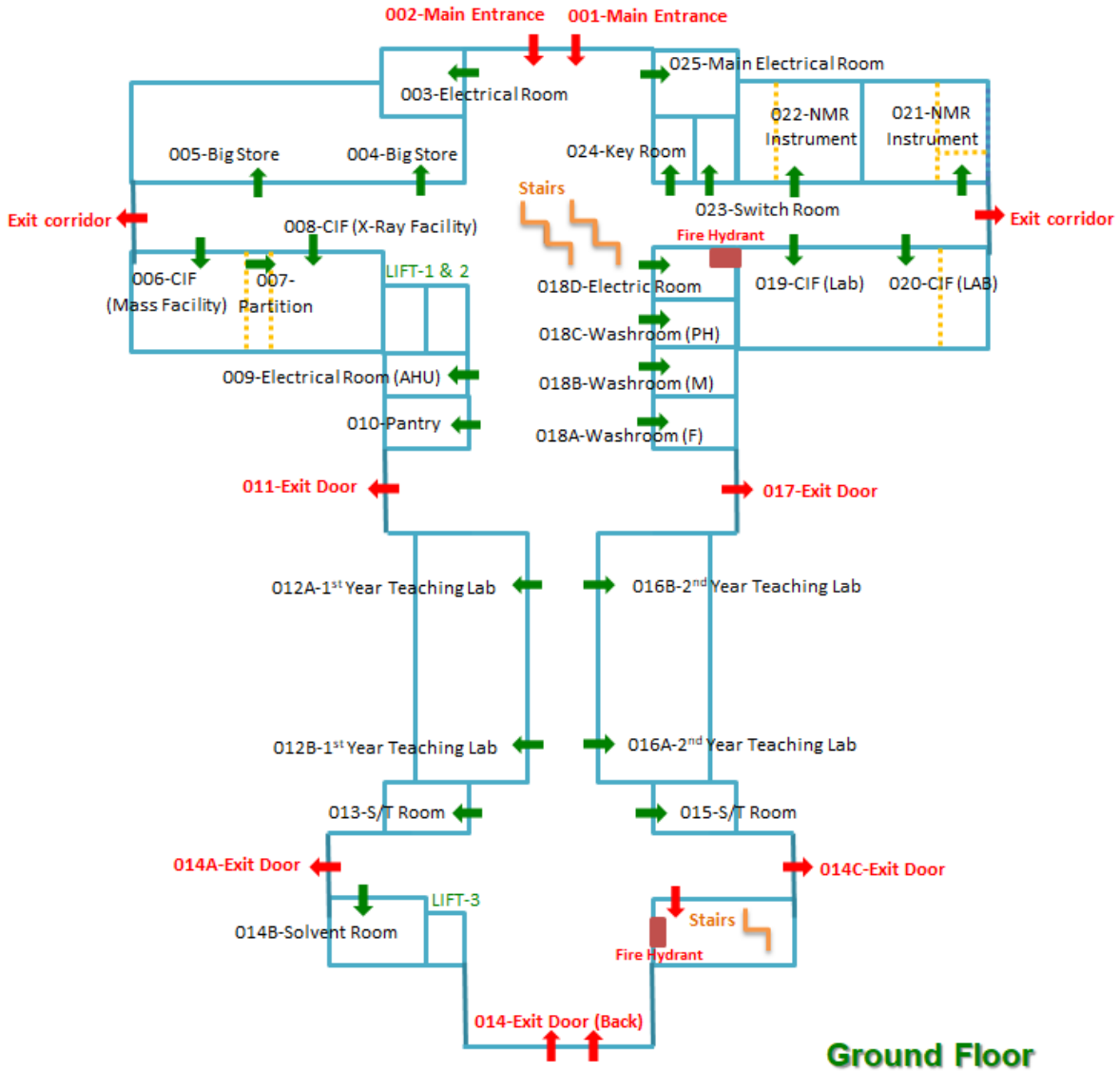
(xv) Spent Catalysts

Never put a spent hydrogenation catalyst in the waste bin; it may catch fire spontaneously later. Osmium, platinum and palladium residues should be damped down with water and reserved for recovery. Other catalysts such as Raney nickel should be stored under water ready for disposal.

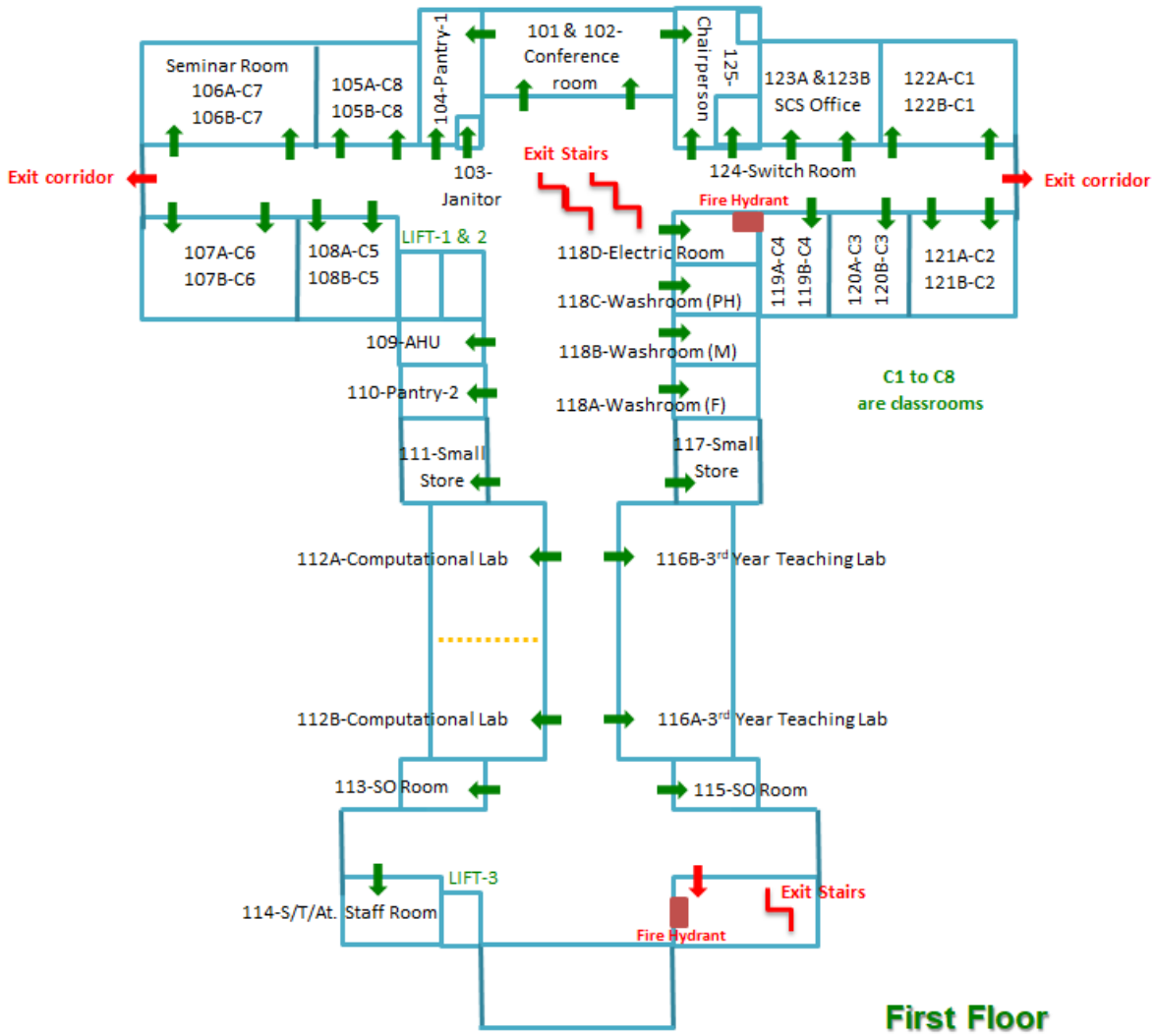
(xvi) Silica Waste

Crystalline silica is a respiratory sensitizer. Possible long term effects of dust inhalation include silicosis and other related pulmonary respiratory diseases. Exposure to silica dust causes the lung to produce fibrotic nodules, which over a period of time will change in size leading to increasing breathlessness and eventual death.

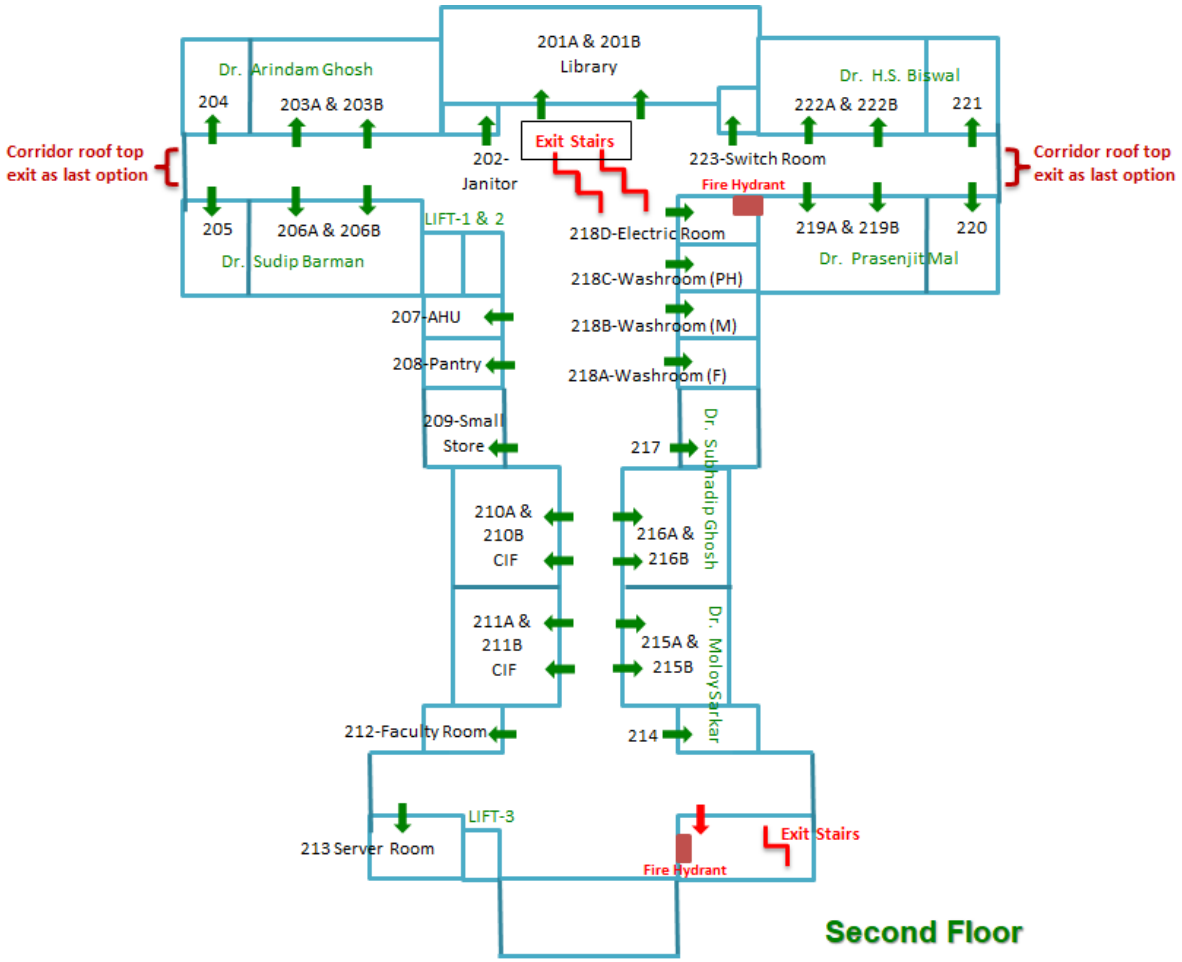
Care must be taken to reduce as much as possible the generation of airborne dust (often invisible to the naked eye) by containment, or whatever preventive measures are applicable (including wearing personal protective equipment e.g. a face mask). Airborne silica is likely to be generated when filling and emptying columns, and when scraping bands from plates. Spent silica from columns and plates should be placed in the dedicated waste silica bins.



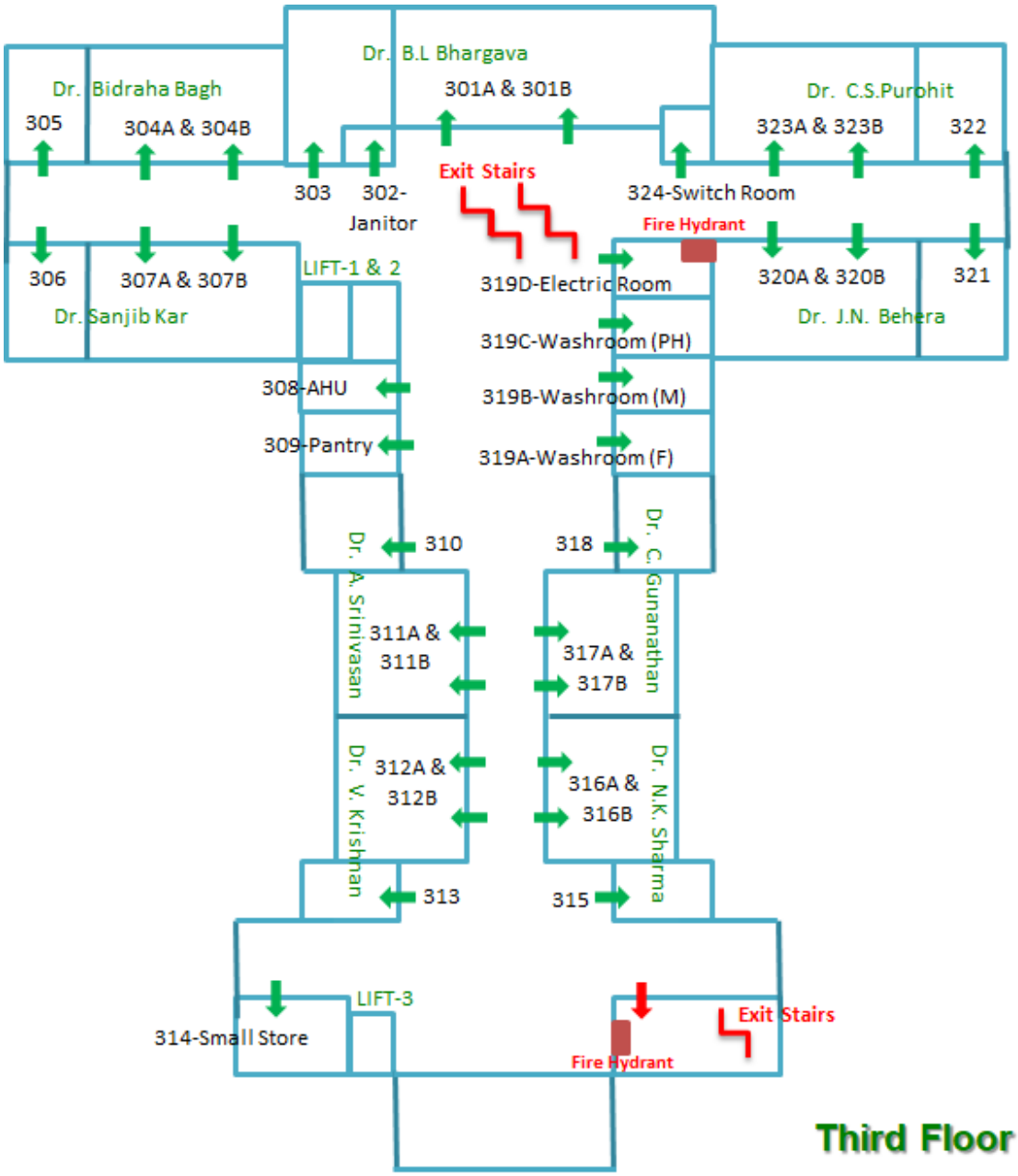
Schematic presentation of ground floor infrastructure of School of Chemical Sciences



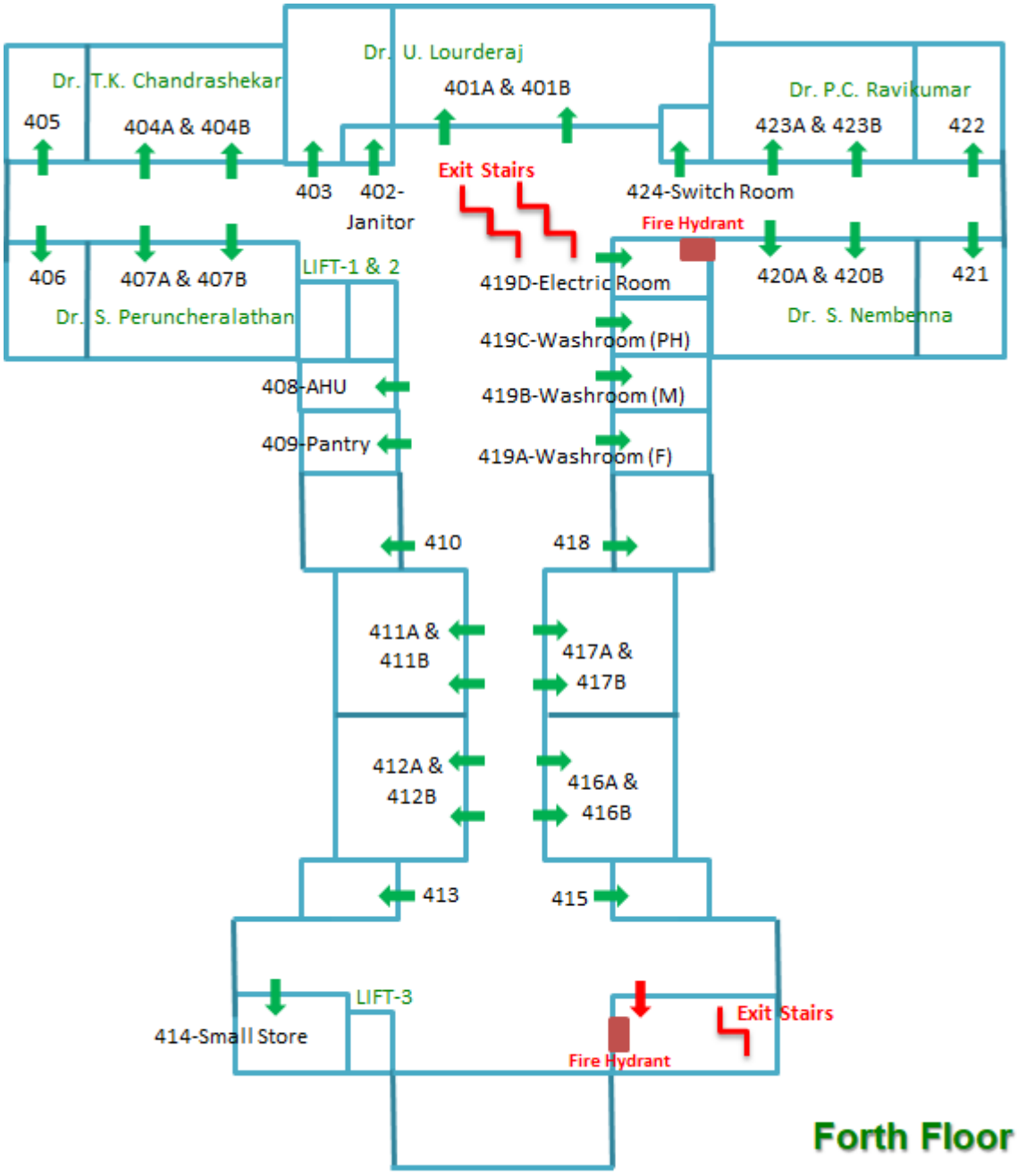
Schematic presentation of First floor infrastructure of School of Chemical Sciences



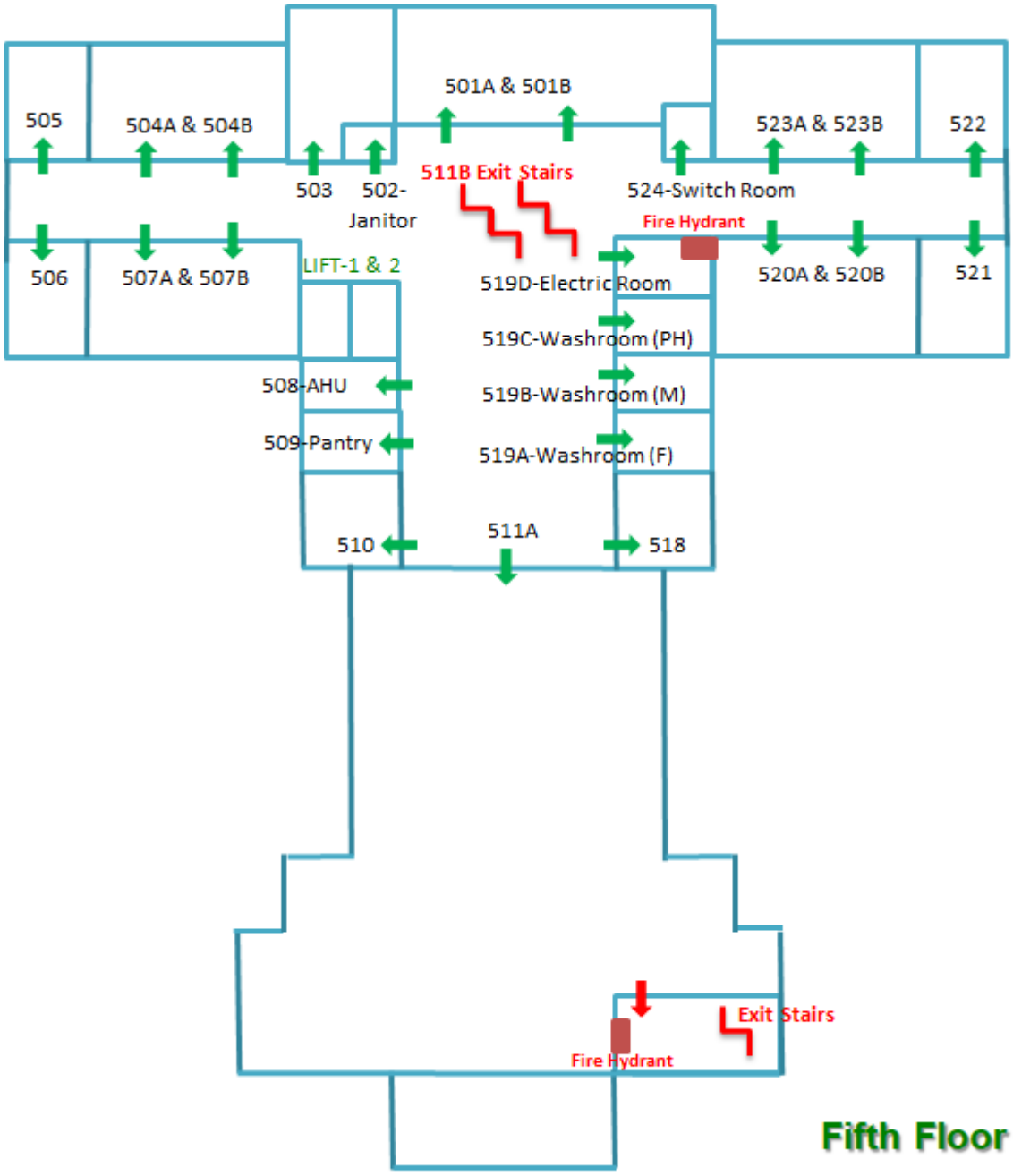
Schematic presentation of Second floor infrastructure of School of Chemical Sciences



Schematic presentation of Third floor infrastructure of School of Chemical Sciences



Schematic presentation of Fourth floor infrastructure of School of Chemical Sciences



Schematic presentation of Fifth floor infrastructure of School of Chemical Sciences

Laboratory User Safety Declaration Form

School of Chemical Sciences, NISER, Bhubaneswar

(Each lab user should complete this form and submit this to the scientific officer who is member of the departmental safety committee)

Name of the user :

Roll No./P.F.No. :

Affiliation/Department :

Designation :

DECLARATION

I declare that:

-I have attended the lab safety orientation seminar Yes ☐ No ☐ **Date:**

-I know locations of:

- Fire extinguishers
- First aid kits
- Lab exits
- Telephones/intercoms

-I have read the departmental safety manual, understood safety guidelines, and agree to abide by rules mentioned therein.

Signature: _____

Date: _____