

Laboratory Waste Management



**Office of Laboratory Safety and Environmental
Health (OLSEH)
Indian Institute of Science (IISc), Bangalore**

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2 Laboratory Waste Segregation:

Hazardous waste must be segregated and disposed of as per KSPCB requirements. OLSEH or departments may mandate additional safeguards. The details are available in the safety manual, but the summary is:

2.1 Chemical Waste

1. Acids + solvents mixture can spontaneously ignite. Never store/leave a solvent + acid mixture in the lab unattended. If you happen to make such a solution, segregate it and take it outside the building to the waste shed.
2. Acidic waste with fluoride ions must be collected separately in plastic containers, e.g. dilute hydrofluoric acid, ammonium fluoride and buffered oxide etch.
3. Acidic wastes which contain toxic metal salts (Cr, Pb, etc.) must be collected separately.
4. Acid waste that does not contain metallic toxins or fluoride and has a pH>4 can be disposed into the drain with copious amounts of water.
5. Acid waste that does not contain metallic toxins or fluoride and has a pH<4 must be separately collected in plastic containers. IISc does not allow individuals to neutralize acids.
6. Acids + oxidizers react and evolve gas. So unattended acids + oxidizer mixtures present an explosion hazard. In extreme cases, the plastic bottle can burst, spraying acid everywhere. Fresh acids + oxidizer mixtures must be collected separately and kept inside the fume hood for one day. This allows time for the reaction to complete and gasses to escape. Nitric acid is both a strong acid and an oxidizer, so solutions containing HNO₃ should be treated as acid + oxidizer.
7. Solvents + oxidizer mixture can also spontaneously ignite. Never store/leave a solvent + oxidizer mixture in the lab unattended. If you happen to make such a solution, segregate it, and take it outside of the building to the waste shed.
8. Base + solvent mixtures also evolve gasses. So unattended base + oxidizer mixtures present an explosion hazard. In extreme cases, plastic bottles can burst, spraying base everywhere. Fresh base + oxidizer mixtures must be collected separately and kept inside the fume hood for one day. This allows time for the reaction to complete and gasses to escape.
9. Solvents must be separately collected in plastic or metal containers, e.g. benzene, ether, ethyl acetate, acetone, alcohols, hydrocarbons, etc.
10. Non-toxic basic waste with a pH<10 can be disposed into the drain with copious amounts of water.
11. Basic waste with pH > 10 must be separately collected in a plastic container. IISc does not allow individuals to neutralize bases. If they do not have any oxidizer, bases can be stored with solvents.

2.2 Bio-waste

Bio-hazardous waste includes stocks or specimens, live or attenuated vaccines, cell lines, microbiological waste (bacteria, viruses, recombinant nucleic acids etc.). It also includes material that has encountered human blood/blood products and body fluids, items contaminated with blood/blood products and body fluids, biologically contaminated sharps including needles, needles attached to syringes, and blades etc.

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1. First, determine whether the waste is hazardous or not and whether the handling of that waste is regulated by legislation. This step is often called the classification or categorization of the waste.
 2. Hazardous chemical waste, radioactive waste, and infectious wastes should not be mixed or placed in the same waste storage containers.
 3. Treatment depends on the nature of the biohazards. According to the state pollution control board and WHO guidelines, there are several options for treating bio-hazardous waste before disposal. These include chemical decontamination, thermal decontamination (autoclaving) and incineration.

2.2.1 Chemical Decontamination of Bio-waste

Treat the waste with chemical decontaminants like hypochlorite solution or alcohols. Each has its advantages and disadvantages.

2.2.2 Thermal Decontamination (Autoclaving) of Bio-waste

Infectious materials and toxins, together with associated waste, can be effectively decontaminated by autoclaving.

1. (Table) lists the types of bio-hazardous wastes produced laboratory and whether steam autoclaving is appropriate for decontamination. Please note that items requiring autoclave decontamination CANNOT contain chemical or radioactive contaminants.
2. Steam autoclaving is a method for decontaminating biohazardous materials that are only permitted when autoclave efficiency/efficacy is verified by at least annual calibration of autoclaves and weekly cycle monitoring using biological indicators. QC measures must be accurately documented in an autoclave log for verification.
3. An autoclave should be installed in a well-ventilated room away from high-traffic. Don't keep autoclaves in corridors.
4. All biohazardous waste bags decontaminated via steam autoclave must be indicated as such by the presence of heat-activated autoclave tape (presence of dark bars on tape indicates that the contents have reached high temperature).
5. Appropriate personal protective equipment (PPE) must always be worn while autoclaving biological hazards. This includes closed-toe/heel shoes, lab coats, gloves (heat resistant gloves for unloading autoclave) and eye/face protection. Autoclaves must be operated at $\geq 121^{\circ}\text{C}$ for ≥ 60 minutes. Biohazard bags should be loosely opened and placed within a secondary containment vessel (i.e. tray) to allow maximum steam penetration during sterilization. Bio-hazardous waste bags CANNOT be filled more than half full to maximize the efficiency of sterilization. The Autoclave handler will return any bags that are overfilled.
6. DO NOT run samples previously treated with bleach (or any other strong oxidizer) or any other toxic chemicals/radioisotopes through the autoclave. After biological and chemical indicator assays have been completed, biohazardous waste tags must be removed. Decontaminated bags should be placed in unmarked black garbage bags and disposed of with regular garbage to the municipal landfill. Unsuccessful biological indicator assays require re- autoclaving of all waste processed since the last successful assay. As a result, frequent biological indicator assays are recommended.

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7. Biological and Chemical Indicators are sealed vessels containing a glass ampule of bacterial spores (usually *Geobacillus stearothermophilus*), a species of bacteria exceptionally resistant to the steam sterilization process) within growth media and are used to ensure the efficacy of the autoclave run. The biological indicator vial (attached to a string or other retrieval device) is placed in the centre of a representative load within the autoclave (different load types should be tested separately). The autoclave cycle is run as per SOP. A separate, negative control vial should be placed outside the autoclave for direct comparison following cycle completion.
 8. Following the cycle, the glass ampule is crushed, releasing the bacterial spores into the growth media. After incubation for 24-48 hours, the growth of spores not killed during the sterilization cycle resulted in a diagnostic colour change of the media. A colour change, representing bacterial growth, indicates ineffective decontamination of the load. Lack of colour change indicates successful decontamination. Lack of change of color in the negative control vials, suggests a possible fault with the indicators, and the cycle/test must be repeated with new biological indicators.
 9. Biological indicators must be used at least weekly to provide quality control for the decontamination of biohazardous waste. If the autoclave has been used for biohazardous waste decontamination, then indicator test is not needed, but a log is mandatory.
 10. Chemical indicator tape is to be used on each autoclaved item to verify that the item has been autoclaved. Heat sensitive ink within the tape changes colour to indicate that the tape has been exposed to high heat. The presence of these lines does not indicate that the contents have been successfully decontaminated, only that it has reached a high temperature. Confirmation of decontamination with biological indicators (as previously described) is required before disposal.

2.3 Radioactive waste

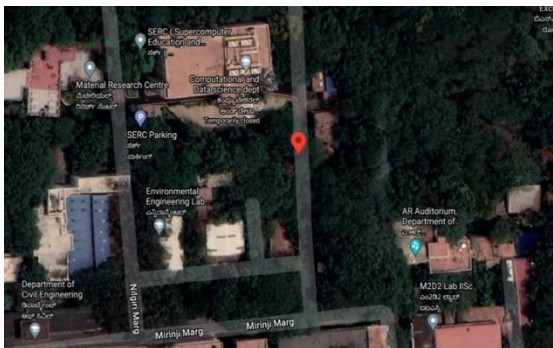
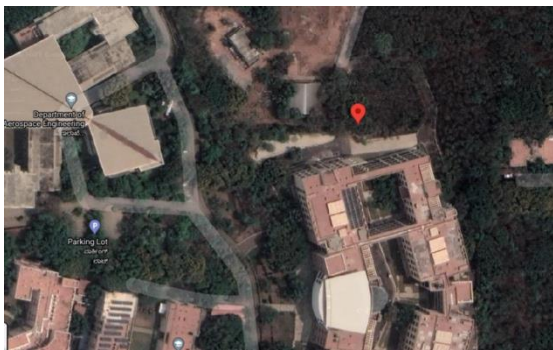
1. Monitor potentially contaminated materials before committing them to radioactive waste. If no detectable RAM is found, dispose of the item as non-radioactive trash. Items may include worn gloves, bench paper, Kim wipes, glass wear, etc. **All materials used with H-3, C-14, S-35 shall be committed to radioactive waste.**
2. Segregate radioactive materials as per Radioactive Materials Safety Manual. Do not mix incompatible wastes.
 - a. Solids:
 - i. Place solid materials into the corresponding step can.
 - ii. When the bag is full, remove and securely close the waste bag with tape or a plastic tie.
 - iii. Attach a completed radioactive waste tag to the bag.
 - iv. Store the full waste bag in the designated waste storage area.
 - v. Bag radioactive materials source vials separate from other solid wastes.
 - b. Aqueous:
 - i. Using a funnel, if needed, place aqueous radioactive wastes into the 20-litre carboy.
 - ii. There is no need to segregate aqueous waste by isotope.
 - iii. Immediately attach a completed radioactive waste tag to the carboy.

- iv. Assure that the carboy remains in its secondary tray.
- c. Mixed/Solvent:
 - i. Using a funnel, if needed, place chemical wastes that also include radioactive materials into glass bottles, preferably a bottle like the original container.
 - ii. Immediately attach a radioactive waste tag and a hazardous waste tag to the carboy.
 - iii. Fill out both tags with the required information.
 - iv. Assure that the carboy remains in its secondary tray.
3. Do not generate chemical wastes that contain isotopes other than H-3 (tritium), C-14, Cs-137 or Co-60.

3 Storage of Hazardous Waste

3.1 Chemical waste

According to the guidelines of the Karnataka state pollution control board, chemical waste should be stored in a centralized waste shed. IISc has two such waste sheds in two different locations. Users can drop waste at the sheds, as per the published schedule. One of the sheds is near the SERC dept, and the other is behind the New Chemical Science Building. OLSEH organizes the waste collection from the waste sheds. There are 02 doors used for the entrance and exit in the shed. The waste storage area is properly ventilated. Only an authorized person is allowed to go inside the shed with all the PPE's. It's a smoke-free zone. Inside both the sheds, ABC type fire extinguisher is placed, and a lab attendant has been trained to use the fire extinguisher in a fire emergency.



3.1.1 Guidelines for waste sheds

1. Flammable, ignitable, reactive, and non-compatible wastes should be stored separately.
2. The storage area should be provided with flameproof electrical fittings.
3. Automatic smoke, heat detection system should be provided in the sheds. Adequate firefighting systems should be provided for the storage area, along with the areas in the facility.
4. Loading and unloading of wastes in storage sheds should only be done under the supervision of well trained and experienced staff.
5. A fire break of at least 04 meters between two blocks of stacked drums should be provided in the storage shed. One block of the drum should not exceed 300 MT of waste.
6. A minimum of 1-meter clear space should be left between two adjacent rows of drums in pair for inspection.
7. The storage and handling should have at least two routes to escape in the event of any fire in the area.
8. Doors and approaches of the storage area should be of suitable sizes for entry of fork lift and firefighting equipment.
9. Must have appropriate measures to prevent percolation of spills, leaks, etc., to the soil and groundwater. The storage area should be provided with a concrete floor or steel sheet depending on the characteristics of waste handled. The floor must be structurally sound and chemically compatible with wastes.
10. The storage area floor should be provided with secondary containment such as proper slopes and a collection pit to collect wash water and the leakages/spills etc.
11. All the storage yards should be provided with a proper peripheral drainage system connected with the sump to collect any accidental spills in roads or within the storage yards and accidental flow due to fire fighting.
12. The storage areas are being inspected daily for detecting any signs of leaks or deterioration, if any. Leaking or deteriorated containers should be removed and ensured that such contents are transferred to a sound container.
13. In case of spills/leaks/dry adsorbents/cotton should be used for cleaning instead of water.
14. Proper slope with collection pits is provided in the storage area to collect the spills/leakages.
15. Storage areas should be provided with an adequate number of spill kits at suitable locations. The spill kits should be provided with compatible sorbent material in adequate quantity.
16. Smoking is prohibited in and around the storage areas.
17. Good housekeeping needs to be maintained around the storage areas.
18. Signboards showing precautionary measures to be taken in normal and emergencies should be displayed at appropriate locations.
19. The wastes containing volatile solvents or other low vapour pressure chemicals should be adequately protected from direct exposure to sunlight, and adequate ventilation should be provided.
20. Only authorized persons to enter and be trained in hazardous waste handling procedures should access the storage site.

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21. Students who bring lab wastes to chemical sheds should come in proper PPEs and bring the wastes in trolley.

3.1.2 Guidelines for storage drums/containers

1. The container shall be made or lined with the suitable material, which will not react with, or in other words, compatible with the hazardous wastes proposed to be stored.
2. No drums should be opened in the storage sheds for sampling etc., and such activity should be done in designated places outside the storage areas.
3. Drums containing wastes stored in the storage area should be labelled properly, indicating mainly type, quantity, characteristics, source, date of storing etc.

3.1.3 Waste-collection as Shed

In between the pickup, scheduled labs can store lab waste in the waste shed nearest to them.

1. The chemical shed operates from Monday to Saturday.
2. A lab attendant registers the type of wastes received, its quantity, and department/lab and contact person.
3. The waste must be labelled with the waste label, and it should not leak.
4. The sheds don't accept bio-wastes, empty chemical bottles, and unknown chemicals.

3.2 Bio-waste storage

Bio-waste must be stored properly in labs. Waste is collected from labs once a week.

Radioactive waste storage radioactive waste is collected in a landfill as per AERB guidelines, under the supervision of the radioactive safety officer appointed by AERB.

1. Radioactive materials should be stored in a storage area or designated area, or specific area.
2. Stored radioactive materials must be adequately shielded.
3. The storage area must be always locked and can only be accessed by appointed personnel.
4. Only appointed personnel are allowed to mobilize the radioactive material from the storage area.
5. Radioactive materials that have been removed from the storage area have to be checked and ensured in good condition.
6. The details of the radioactive materials, including the type of sources, activity, relocation, and the name of the person responsible, must be recorded whenever the radioactive material is taken in/out from the storage area.
7. The storage area must be checked & regularly monitored to detect the presence of leakage or contamination. Perform leakage test if necessary.
8. In the event of leakage or contamination, appointed personnel must inform RSO and Safety Officer of the location of stored radioactive materials.
9. Record of all findings and investigations must be kept for future reference.

4 Laboratory Waste Disposal

OLSEH collects laboratory waste through registered vendors on monthly, Bi-monthly and biyearly schedules in the following categories

- a) Bio-hazardous waste- Weekly
- b) Liquid Waste- Monthly

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- c) Solid Waste- Monthly
 - d) Toxic Waste- Monthly
 - e) Waste oil - Monthly
 - f) Radioactive waste- Monthly
 - g) Unknown Chemicals- Every 02 Months
 - h) Empty Chemical Bottles- Every 02 Months
 - i) Old/Empty Compressed Gas Cylinders- Once in 06 Months.

OLSEH has hired two vendors named Gomti Research and Pharma Pvt. Ltd for waste collection. The vendor sent the vehicle to our campus for collecting the wastes as per the announced frequency. For collecting chemical wastes, pickup points for the departments have been fixed, and all departments ensure keeping the wastes from their lab to the pickup points. The vehicle goes to all the pickup points for collecting up the wastes. A total of 10 pickup points has been designated inside the campus. Reminder emails are sent to all before a waste collection.

The following are the SOP for each class of waste

4.1 Bio-hazardous waste disposal guideline

1. Bio-hazardous waste collected in a lab must be held in approved clear autoclave bags within clearly labelled "Bio-hazardous Waste" bins.
2. Autoclave bags MUST NOT be filled more than half full (overfilled bags will be returned for re-packaging).
3. Only properly treated and sealed waste can be given to the waste collector.
4. After proper treatment of bio-hazardous waste, record the weight of the waste.
5. The waste collector will collect waste from designated pickup points, one a week. The weight of the waste must match the declared weight.

4.2 Liquid chemical waste disposal guidelines

1. Use 04-litre bottles or 25-litre jerry cans for storing solvent waste.
2. Unless chemical compatibility or safety mandates otherwise, use only plastic bottles. Glass bottles are not accepted for disposal due to the possibility of breakage.
3. Please ensure that the solvent wastes bottles/cans are tightly sealed.
4. Chemical waste will NOT be collected from individual labs separately. The waste should be kept outside the department/Centre/Unit near the common pickup point on the pick-up day.
5. The waste should be labelled with chemical waste labels. Printed labels are available with the OLSEH office. Labels can also be downloaded from the OLSEH website.
6. Waste bottles with missing details will not be picked up. OLSEH expect all fields, like name of departments/lab, contact person, name, mobile number, type of solvent etc., to be mentioned clearly.

4.3 Solid chemical waste disposal guidelines

1. Fill all non-sharp solid waste in garbage bags. Please use high quality, thick garbage bags that don't tear easily. The filled bag must be tied off so that the waste cannot leak or spill out.

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2. Do not use cardboard boxes; they leach out in the rain. OLSEH will not pick up waste in cartons.
 3. Sharps (needles, syringes, pipettes, broken glass) must be collected in puncture-proof solid chemical waste containers. Such boxes are available online.
 4. All wastes must be labelled using the chemicals waste labels uploaded on the OLSEH website.

4.4 Toxic Chemical Waste disposal guidelines

1. Toxic chemicals refer to any materials that are environmental pollutants, like metal-complexes, Cr, Pb, Cd, Hg, etc.
2. Use 04-litre bottles or 25-litre jerry cans for storing solvent waste.
3. Unless chemical compatibility or safety mandates otherwise, use only plastic bottles. Glass bottles are not accepted for disposal due to the possibility of breakage.
4. Please ensure that bottles/can is tightly sealed.
5. Chemical waste will NOT be collected from individual labs separately. Please bring the segregated chemical waste to a common pickup point outside your Department/Center/Unit during the pickup.
6. Chemical waste will NOT be collected from individual labs separately. Waste should be kept outside the department/Centre/Unit near the common pickup point before the pickup slot.
7. The waste should be labelled with chemical waste labels. Printed labels are available with the OLSEH office. Labels can also be downloaded from the OLSEH website.
8. Waste bottles with missing details will not be picked up. OLSEH expect all fields, like name of departments/lab, contact person, name, mobile number, type of solvent etc., to be mentioned clearly.

4.5 Waste oil disposal guidelines

1. Oil can be from any source, like pumps, diesel generators, etc. It can also be used or unused.
2. Use only plastic bottles. Glass bottles will not be accepted for disposal.
3. Please ensure that oil wastes bottles/can cap are tightly sealed.
4. Oil waste will NOT be collected from individual labs separately. Please bring the segregated oil waste to a common pickup point outside your Department/Center/Unit during the pickup.
5. Label the bottle/can with Oil waste labels. Get the printout and paste it.
6. Waste bottles with missing details will not be picked up. We expect all fields, like name of departments/Lab, contact person name, mobile number, type of solvent, etc., to be mentioned clearly.

4.6 Radioactive waste guidelines

Waste is not sent out of campus. It is collected and disposed of in a designated area on campus, as per the Environmental Health and Safety radioactive waste processing procedures

1. Waste is collected monthly.
2. Waste can be in cans, disposal bags, waste tags, tape, carboys and secondary containers, solvent bottles and secondary containers, portable meters, standard PPE.
3. Hazard Control Measures:

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- a. Avoid direct handling of radioactive materials or contaminated items.
 - b. Use secondary containment for liquids when possible.
 - c. Mark radioactive or contaminated materials with the words "Radioactive."
4. Wear personal protective equipment, including a laboratory coat, gloves, eye protection, and full shoes.
 5. Make sure all materials are properly packaged and tagged before making a waste collection request.

4.7 Unknown chemicals disposal guidelines

1. As much as possible, your lab should not generate unknown laboratory waste. Disposal of unknown waste is very expensive. This option is provided just to manage unforeseen cases.
2. Stick the Chemical waste label on the bottle/can and write UNKNOWN in the name tag. Labels can be obtained from the OLSEH website.
3. Other details like the location of the chemical, responsible individual, contact number, etc., must be filled in. OLSEH shall not pick up waste with incomplete information.
4. Don't open or pour the contents into a new bottle. Leave it in as it is. If you feel moving the chemical is dangerous, don't move it. Contact OLSEH at safety.olseh@iisc.ac.in

4.8 Empty chemical bottle/container disposal guidelines

Empty chemical containers can contain residual amounts of chemicals. To ensure that this residue is handled properly, the containers must be disposed of properly. The following procedure must be followed:

1. All chemical containers, liquid or solid, must be rinsed three times. Use a reasonable amount of water.
2. The first rinse should be collected as chemical waste and disposed of appropriately; the second and third rinses can go down the drain.
3. Dry the empty container by letting it sit in a well-ventilated area. Use a fume hood (if you have access to one) or find an isolated area far from the public.
4. Use proper PPEs during the rinsing of chemical bottles or containers.
5. Deface the container label. The chemical name should be crossed or blacked out before being discarded.
6. Any broken glass containers must be placed in a rigid box marked as "broken glass".
7. Store the bottles and dispose of them when OLSEH collects empty bottles.

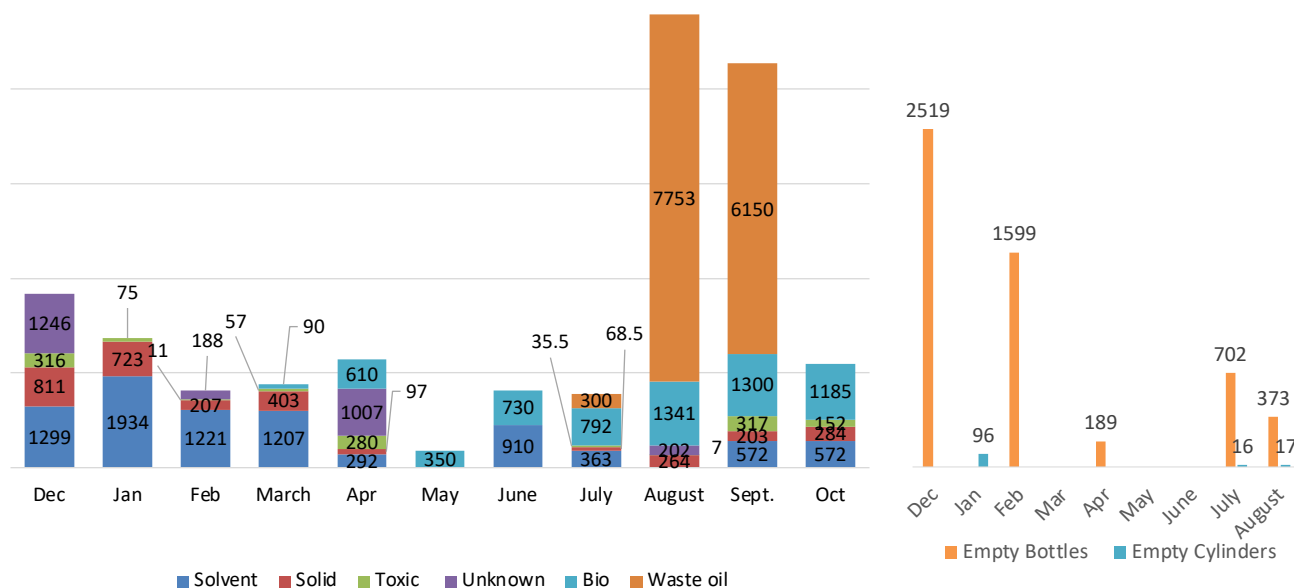
4.9 Old/empty compressed gas cylinder disposal guidelines

1. OLSEH has hired M/s Bhuruka Gases Pvt. Ltd. to collect the Old/Empty compressed gas cylinders across the campus.
2. The vendor is scheduled to come every six months, but extra pickups can also be arranged.
3. All cylinders must be capped.
4. Cylinders cannot be transported using private vehicles, autos, bikes etc. Only vehicles that are designed to handle cylinders are allowed.
5. Check the belt/chain in the vehicle for keeping the cylinder in a vertical position.
6. Gate Pass must be presented at the security gate.
7. With a vehicle, along with the driver minimum of 01 helpers should be in the vehicle.

8. The helper must have PPE's like hard safety shoes and gloves.

5 Waste Disposed of through Vendors

The data is in litres or kg (whichever is appropriate).



6 List of MoU for Waste Collection

1. Gomati Research and Pharma Pvt. Ltd- Chemical Wastes
2. SMI Industries- Oil Waste
3. Medicare Environmental Pvt. Ltd.- Bio-Waste

7 KSPCB Certification

IISc has KSPCB certification for all the categories of waste it generates, except bio-waste. The paperwork for bio-waste is under process at KSPCB.

8 Challenges with Waste Collection: Toxic Gas Cylinders

In India, very few agencies/vendors collect toxic gas cylinders due to its complex disposal process. All collections are ad-hoc with little to no oversight. After many attempts, we were able to find three vendors. Unfortunately, due to lack of a permanent business, the agencies quoted Rs. 52 Lakhs, 48 Lakhs and 30 Lakhs for just 15 cylinders.

If the government creates a mandate that all toxic cylinders must be disposed of safely, the ecosystem will respond. New companies will take up this work, and the prices will come down.