# Guidelines for Safe Disposal of Hazardous Wastes Generated from Laboratories

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# Abbreviations

BMWM: Bio – Medical Waste Mangement Rules

CETP: Common Effluent treatment Plant

CPCB: Central Pollution Control Board

DRI: Diary Research Institutions

FAO: Food and Agriculture organization

HWC: Hazaroud Chemical waste

HWMR : Hazardous Waste Managemnt Rules

ICAR : Indian Council of Agricultural Research

PPE : Personal Protective equipment

SPCBs: State Pollution Control Boards

SWMR: Soild Waste Management Rules

TSDF: Treatment, Storage and Disposal Facility

VI: Veterinary Institute

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# Foreword

Unscientific disposal of hazardous and other waste through burning or incineration leads to emission of toxic fumes comprising of Dioxins & Furans, Mercury, heavy metals, causing air pollution and associated health-related problems. Disposal in water bodies, or in municipal dumps leads to toxic releases due to leaching in land and water entailing into degradation of soil and water quality. The workers employed in such unscientific practices suffer from neurological disorders, skin diseases, genetic defects, cancer etc.

Proper chemical management is necessary to protect the health and safety of the university and surrounding communities and the environment. There are federal and state regulations that require all generators of chemical waste receive training and follow proper waste management and disposal procedures. These regulations have severe monetary and civil penalties associated with them. Its Institution responsibility to minimize the amount of waste produced and follow the scientific disposal methods in a way that has the least impact on environment and human health.

This booklet provides the proper management and safer alternate methods of disposals to help minimize risks and maintenance of safe laboratory environment. Integrating these guidelines in to teaching curriculum will help reinforce the students on importance of lessening the impact and protecting the environment. I am confident these guidelines are necessary, timely and will prove to be useful and practical to implement.

**Dr. R.C. Agrawal**
National Director, NAHEP

# Preface

The hazardous wastes belong to a category of special wastes containing certain chemicals, metals and pathogenic organisms which can cause damage to the environment even at low concentrations. If not properly managed for safe disposal, it can have frightening repercussions on health and environment. Indiscriminate disposal of these wastes into the environment without proper treatment could lead to contamination of water resources (Source: ENVIS, CPCB, 2012).

All of the ICAR institutes have chemical, biological and veterinary laboratories established for academic and research (also service purposes, at times). While the types of waste generated are largely non-hazardous, there are few wastes that fall under hazardous categories (eg spent concentrated Sulphuric acid, phenols etc). There are Legal and Regulatory Requirements, Standard Operating Procedures (SOPs), recommended practices etc. for safe methods of disposals of these wastes. Accordingly there are organized systems/practices in place for collection and safe disposals. All the Institutes follow the prescribed methods and some have established their own facilities for treatment and safe disposals including establishment of Effluent Treatment Plants (ETPs). However, at times the disposal of these wastes is an issue as the quantities are small and the disposals though the organized disposal system proves costly. In view of the potential issues that could emerge out of unsafe storage and disposals, the institutes should consider using the organized systems of waste disposals and strictly adhere to SOPs. In cases where the quantities are small and organized disposal becomes costly, the alternate safe methods (eg: disinfection and disposal, autoclaving and disposal, dilution and disposal) needs to be followed.

In keeping with the requirements of the Institutions and the challenges it can pose, especially in terms of environmental and health risk, the Envrionemnt Safeguard Unit - NAHEP has devised to serve as a reference guide at laboratories

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ESS- NAHEP

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# Section 1 – Safe Disposal of Hazardous Chemical Wastes

*Photo courtesy: CCSHAU, Hisar*

The Hazardous Waste Management Rules 3(1)(17) defines hazardous waste as, any waste which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger or is likely to cause danger to health or environment, whether alone or in contact with other wastes or substances, and shall include – (i) waste specified under column (3) of Schedule-I; (ii) waste having equal to or more than the concentration limits specified for the constituents in class A and class B of Schedule-II or any of the characteristics as specified in class C of Schedule-II; and (iii) wastes specified in Part A of Schedule-III in respect of import or export of such wastes or the wastes not specified in Part A but exhibit hazardous characteristics specified in Part C of Schedule-III.

While the Institutes are following the SoPs and using the organized systems for disposal, certain constraints exist, especially in cases where the quantities are small (smaller than the prescribed quantities as per Hazardous Waste Management (HWM) rules eg: the chemicals like Benzene, Arsenic Cadmium, etc used and generated in the laboratories are less than the quantity (i.e., ranges from 1.5 to 5 mg /L per annum) prescribed as per the HMW rules.

Management of the hazardous wastes at the laboratory site may not be feasible considering the limitation of technical expertise, time and manpower. Considering this, suggested that, the hazardous waste of (Chemical wastes, expired reagents/solvents, remnants of samples after analysis) may be transferred to nearest Treatment, Storage and Disposal Facility (TSDF), by following the guidelines as per The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 Similarly, the liquid waste may be handover to Common Effluent Treatment Plant (CETP) for treatment purpose or treat the chemical waste as per the discharge norms prescribed by CETP. Norms are stated in annexure 1

Institutions are advised to collect the wastes in amber colored bottles and handover to TSDF at every 3 to 4 months[1] intervals based on the quantity generated.

The most common chemical wastes generated in the universities that are classified under Class A & C and safer alternate methods of disposals are listed hereunder. The universities are advised to discuss the option internally and consult State Pollution Control Boards (SPCB) and opt for the most suitable and safe methods.

1 Institution can decide the months based on the quantity generated and hand over to authorized agency but never discharge the chemical waste into sewers without treatment.

## Table 1: Hazardous Chemicals Classification and Alternative Disposal Options

| S. NO | Type of wastes generated in labs | Hazard category quantity /Type | Alternate methods of disposal |
|---|---|---|---|
| Class A & Concentration limit: 50 mg/kg | | | |
| 1 | **Antimony** | **Class A : A1 Concentration limit: 50 mg/ kg** | **Steps:**<br>**A**dd the salt to large amount of water.<br>**P**repare a solution with 400 grams of sulfur, 1100 grams of NaOH and add water to bring the volume of the solution up to 4 liters. To this solution add, 216 grams of soda ash, Na2CO3, and let it dissolve[2]. Let this stand 24 hours.<br>**R**emove aqueous layer, check the pH and then neutralize with acid or basic material, to bring, to pH 6-8.<br>**H**andover to a Common Effluent Treatment Plant (CETP) for treatment purposes or treat the waste as per the discharge norms prescribed for CETP.<br>**T**he sludge may be disposed of in a landfill, in accordance with local regulations. |

2 https://patents.google.com/patent/CA2147249A1/en

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| 2 | **Arsenic** | **A2 Concentration limit : 50 mg / kg** | **Methods:**<br>**P**lace the chemical in a trench or pit and ignite from a safe distance with a detonating cord ("det cord"). Caution should be taken to ensure that any solvents are completely burnt.<br>OR<br>**D**ispose of the reagent, both solid and solution, by cautiously adding it to a solution of ethyl acetate in dry Tetrahydrofuran (THF) in ratio of 1:2 under an atmosphere of nitrogen. Never add reagent residues to water or alcohols. Treat the contaminated apparatus with ethyl acetate. Later, at least after 1 hour, wash the apparatus with water and dilute hydrochloric acid and then re-rinse it with water. Handover to a Common Effluent Treatment Plant (CETP) for treatment purposes or treat the waste as per the discharge norms prescribed for CETP |
| 3 | **Benzene** | **A18 Concentration limit: 50 mg / kg** | **Method:**<br>**D**issolve or mix with flammable solvent (flammability rating 2 or 3) and then burn in pit or trench in an area at least 10 meters away from combustible material or in a 45/55- gallon drum (use slow burning to ignite) |
| 4 | **Phenol** | **A 19 Concentration limit: 50 mg / kg** | **Methods:**<br>**L**ow levels of solid waste (e.g. gels, contaminated paper towels etc) should be placed into a suitable, leak-tight container and then into a yellow bag and treat as clinical waste for incineration. |

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| | | | **P**henol/chloroform mixtures can be treated as halogenated waste solvent and disposed of accordingly.<br>**I**ncineration is the recommended method of disposal. Dissolve the phenol with a combustible solvent and burn in chemical incinerator equipped with an afterburner or scrubber[3]<br>**A**queous solutions or buffer containing phenol may be disposed off in shatter proof bottle using the carrier. Low levels of solid waste (e.g. gels, contaminated paper towel) should be placed into suitable, leak-tight container and then into a yellow bag and treated as clinical waste for incineration. |
| | | | **I**f phenol waste is the solid waste form, it should be disposed buy making packages of phenol in paper or other flammable material and burning in suitable combustion chamber. If it is in a liquid form, by absorbing it in vermiculite, dry sand, earth or similar material and disposing in a secured sanitary landfill or atomizing in a suitable combustion chamber.[4] |

3 https://apps.who.int/iris/bitstream/handle/10665/39958/9241510889-eng.pdf?sequence=1&isAllowed=y ( Phenol: health and safety Guide published by WHO for international programme on chemical safety ( a collaborative programme of UNEP, the International Labour Organization, and the World Health Organization)

4 https://www.researchgate.net/post/How_can_I_dispose_phenol
(Yogesh Chandra Tripathi, Forest Research Institute Dehradun/FRI. Division of Chemistry and Bioprospecting ( Ph.D. Chemistry – Medicinal Chemistry ))

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| 5 | **Ammonia & Ammonia Compounds** | **C1 Concentration limit is 20,000 mg /kg** | **Steps:**<br>**D**ilute the alkali 1 to 10 times with water (diluted alkalis are less dangerous).<br>**S**elect an acidic material. Strong acids (e.g., hydrochloric acid, sulphuric acid) must be diluted 1:10 or greater prior to utilization.<br>**Neutralization procedure**<br>***S****lowly add diluted base to a solution of the acidic material selected above. (Always check pH.)*<br>***C****ontinue the process until a pH of between 6 and 8 is obtained.*<br>***D****ilute the solution further, approximately 1 to 10, with water.*<br>***H****andover to a Common Effluent Treatment Plant (CETP) for treatment purposes or treat the waste as per the discharge norms prescribed for CETP.* |
| 6 | **Inorganic peroxides** | **C2 Concentration limit is 20,000 mg /kg** | **Steps:**<br>**A**dd oxidizing agent to a large volume of a concentrated solution of sodium hypo-bisulfite (sodium metabisulfite) or a ferrous salt.<br>**A**cidify with dilute Sulphuric acid. |
| | | | When reduction is complete (i.e., when heat generation stops), neutralize the solution with soda ash or dilute hydrochloric acid.<br>**D**ispose of in sewer system with a large amount of excess water. |

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| 7 | **Acidic halides** | **C16 Concentration limit is 20,000 mg /kg** | **Steps:**<br>**T**ake a large container, containing an excess of sodium bicarbonate (or sodium carbonate, or calcium carbonate) and slowly add in the organic acid halide, and mix thoroughly.<br>**D**ilute with water until pH of approximately 6-8 is obtained, let it stand 24 hours.<br>**H**andover to a Common Effluent Treatment Plant (CETP) for treatment purposes or treat the waste as per the discharge norms prescribed for CETP.<br>**A**lways remember that organic halides may react violently with water. Take necessary precautions while diluting with water. Wear PPE, maintain safe distance, keep first aid kit handy etc. |
| 8 | **Inorganic acids** | **D2 Concentration limit: 50,000 mg /Kg** | ***Steps:***<br>**D**ilute acids 1 to 10 with water. Dilute acids are less dangerous. Dilution should always be by adding acid to water (until fizzing stops), but not water to acid which should be strictly avoided.<br>**S**elect a basic material, such as sodium bicarbonate, potassium bicarbonate, calcium bicarbonate, limestone. Strong bases (e.g., sodium hydroxide and potassium hydroxide) must be diluted 1:10 times with water prior to utilization |

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| | | | **Neutralization procedure**<br>***S****lowly add diluted acid to a solution of the basic material selected above. (Always check pH.)*<br>*Continue the process until a pH between 6 and 8 is obtained.*<br>***D****ilute the solution further, approximately 1 to 10 times, with water.*<br>***H****andover to a Common Effluent Treatment Plant (CETP) for treatment purposes or treat the waste as per the discharge norms prescribed for CETP* |
| **Others**<br>**(Following chemical waste are not categorized as hazardous but might pose some threats)** | | | |
| 9 | **Alkali Metals** | | **Method 1**<br>**G**enerate the metal alkoxide and hydrogen: Small amounts of the metal (approximately 1 gram) are allowed to react with an alcohol (e.g., ethyl alcohol) in a slow, controlled fashion (for example, in a cooled reaction flask).<br>**T**he hydrogen gas is released into the atmosphere.<br>**T**he metal alkoxide is subsequently hydrolyzed with water by adding to the mixture drop-wise to yield the metal hydroxide and alcohol. (This procedure presents a high fire risk) Take necessary precautions while diluting with water (wear PPE, maintain safe distance, keep first aid kit, fire extinguisher handy etc.)<br>**H**andover to a Common Effluent Treatment Plant (CETP) for treatment purposes or treat the waste as per the discharge norms prescribed for CETP. |

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| | | | **OR**<br>**Method 2**<br>**A**lkali metals such as those employed in liquid metal coolant systems can be safely reacted to form hydroxides by first dissolving the alkali metal in relatively inert metals such as lead or bismuth.<br>**T**he alloy thus formed is contacted with a molten salt including the alkali metal hydroxide and possibly the alkali metal carbonate in the presence of oxygen. This oxidizes the alkali metal to an oxide which is soluble within the molten salt.<br>**T**he salt is separated and contacted with steam or steam-CO. sub.2 mixture to convert the alkali metal oxide to the hydroxide.<br>**T**hese reactions can be conducted with minimal hydrogen evolution and with the heat of reaction distributed between the several reaction steps[5]. |

5 Johnson, T R. *Method for the safe disposal of alkali metal*. United States: N. p., 1977. Web. https://www.osti.gov/biblio/5454959-method-safe-disposal-alkali-metal

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| 10 | **Aqueous solutions of water-miscible flammable organic solvents (e.g., solutions of less than 18% acetone, ethanol, methanol and other water-soluble and water-miscible solvents** | | **Steps:**<br>**A**dd solution to an available flammable solvent (acetone, acetonitrile, benzene, etc of flammability rating 2 or 3)<br><br>**B**urn in pit or trench, in an area 10 meters away from any combustible material, or in a 45/55-gallon drum (use slow burning fuse to ignite) |
| 11 | **Iodine** | | **Steps:**<br>**I**n the fume hood, if possible, cautiously add iodine to a solution of sodium thiosulfate (300 ml of 4%) containing sodium carbonate (0.1 g).<br>**S**tir until all of the iodine has dissolved (solution becomes colorless).<br>**N**eutralize to a maximum pH of 8.5 with sodium carbonate (if pH larger than 9, iodine will re-dissolve).<br>**W**hen reduction is complete, add sodium carbonate or dilute hydrochloric acid to neutralize the solution. |

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| | | | **H**andover to a Common Effluent Treatment Plant (CETP) for treatment purposes or treat the waste as per the discharge norms prescribed for CETP |
| 12 | **Sodium Hypo-chlorite** | | **Steps:**<br>**T**o the sodium hypochlorite solution, add a large excess of a bisulfite or a ferrous salt and acidify with dilute sulphuric acid.<br>**W**hen the reduction is complete, add soda ash or dilute hydrochloric acid to neutralize the solution.<br>**H**andover to a Common Effluent Treatment Plant (CETP) for treatment purposes or treat the waste as per the discharge norms prescribed for CETP |
| 13 | **Cyanides** | | **Steps:**<br>**P**lace in a large container (e.g. 5 liters drum) and make alkaline (pH > 10) with a sodium hydroxide solution.<br>**A**dd an excess of ferrous sulphate solution.<br>**H**andover to a Common Effluent **T**reatment Plant (CETP) for treatment purposes or treat the waste as per the discharge norms prescribed for CETP |

## Disposals of hazardous chemical wastes: Dos and Don'ts

### Do's

- Wear safety equipments like gloves, boots, goggles, overalls, aprons, while handling the chemicals.
- Always have a second person to assist, while handling the chemicals.
- Read all labels prior to handling or moving chemicals.
- Label chemicals clearly with permanent stickers.
- Segregate waste as hazardous and nonhazardous waste.
- Always dilute acids at a ratio of approximately 1:10 prior to neutralization.

### Don'ts

- Don't mix unknown chemicals together and dispose.
- Don't store/ keep chemicals on floor.
- Don't use the chemicals from unlabeled containers.
- Don't eat, drink, gum chew, during the disposal process.
- Don't sweep spilled chemicals with broom.
- Don't dump cloth soaked in spilled chemicals in waste bin.
- Don't use mobile phone while handling disposals.

### General Instructions:

1. Consider the above-mentioned methods in the table only after proposer understanding and in case of no other alternatives.
2. In case of dilutions – always add the material to be diluted to water but not *vice versa*. In case of acids, dilution can be done until the fizzing stops.

3. Wear protective gear and keep the fire safety equipment like fire extinguisher, fire alarm box, telephone, emergency shower/eyewash, and first aid kit, etc ready. Where there is a chance of flames/fire accidents in the process.

4. The personnel following the mentioned methods should take all precautions that are necessary.

5. Make sure that, vehicle is available to reach hospital in case of any unwanted incidents like explosions.

*Eye Washer*

*Photo courtesy: CIFE, Mumbai*

# Section 2 – Safe Disposal of Biological Wastes - Laboratory Cultures

*CCSHAU, Hisar 1*

Biological waste with objectionable or putrescent characteristics, containing viable microorganisms that are either not known to be hazardous to humans or are minimally potentially hazardous, is not considered as infectious laboratory waste. However, safe disposal of lab cultures through disinfection is important to avoid any unexpected consequences.

Steam autoclaving usually is considered to be the method of choice for decontaminating cultures and the laboratory glassware etc. used for the same. Location of the autoclave within the laboratory minimizes storage and transport problems. It provides a technically proved treatment method for rendering any potentially infectious material safe. Autoclaved waste can be disposed of as general waste.

All the AUs must make the autoclaving facility accessible for students and researchers and provide necessary instructions on use and safe disposal

of all cultures. The instructions can also be placed in the laboratory for information. The procedure of the autoclaving and disposal mechanism is presented below:

### 1. Sharps Contaminated with Biological Waste

Sharps are items that are capable of puncturing, cutting or abrading the skin, e.g., needles, scalpel blades, slides and cover slips. Sharps are deactivated by autoclaving. Place sharps in a container that is red, rigid, puncture resistant, leak-proof and labelled with the biohazard symbol.

- Autoclave your sharps container for a minimum of 30 minutes at 121°C and 15psi.
- Log the autoclave run duration, quantity of processed waste, date, and operator.
- Label the sharp container with the words "autoclaved".
- Deface any biohazard symbols.
- Dispose of the container as follows:
  - Submit to an authorized agency. Note on the request that the container has been autoclaved.
  - Leave your autoclaved container at collection point to pick up by agency.

### 2. Liquid Waste

Liquid wastes, e.g., cell culture media and serum are deactivated either by autoclaving or chemical disinfection.

Most liquid wastes can be deactivated with bleach.

1. Chemically disinfect with a 1:10 final dilution (vol/vol) of household bleach.
2. Swirl flask contents and allow a contact time of 30 minutes
3. Pour down a sink drain connected to the campus sewage system and flush the plumbing with an excess of water

Alternatively, liquid waste may be autoclaved for 30 minutes at 121°C and 15psi

### 3. Solid Waste

- Solid biological waste, e.g., pipettes, tissue culture flasks, and multiple well plates, are typically deactivated by autoclaving.
- Collect solid biological waste directly into autoclavable bags
- Tie a knot at the upper third of the bag and affix heat sensitive indicator tape near the knot
- Use a secondary container to place all autoclave bags till its disposal
- Ensure that the autoclave operates for 30 minutes at 121°C and 15psi
- Record in the log book, details of autoclave in run duration, quantity of processed waste, date and operator
- Deposit the bag in the red-lidded totes designated for laboratory waste

### List of Dos and Don'ts

### Dos

- Restrict access to the laboratory when experiments are in progress.
- Always use mechanical pipetting devices.
- Wash hand after handling the material and before the exiting the laboratory.
- Wipe the bench with a cleaning agent; after complition.

### Don'ts

- Never do mouth pipetting.
- Do not eat, drink, smoke, and apply cosmetics in the work area.
- Ensure that all other tubes and tips used in the project do not come in contact with the bacteria

# Section 3 – Safe Disposal of Bio-Medical Wastes

The Bio-Medical Waste Management and Handling Rules (BWMH), 2016 defines the following rules:

- As per the rule 3 (f) 'Bio-medical Waste' means any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps, including the categories mentioned in Schedule I.
- BWMH rules are applicable to all persons who generate, collect, receive, store, treat, dispose or handle bio medical, waste in any form includes hospital, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, Ayush hospitals, clinical establishment, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, first aid rooms of schools, forensic laboratories and research labs.
- Rule 8 (1) states no untreated Bio Medical waste shall be mixed with other waste and containers and bags referred to in sub rule (2) shall be labeled as (Biohazard and Cytotoxic hazardous) specified in Schedule IV.

In case of ICAR institutes, BMW is produced in Veterinary institutes/ universities (VI) and dairy research institutes (DRI) from academic laboratories, referral laboratories, research facilities, semen stations, hospitals, health camps etc.

In case of veterinary operations involving the study of zoonotic diseases, infected animal carcasses and tissues, contaminated fomites such as disposable instruments and supplies, and contaminated bedding materials are the most common sourse for Bio Medical waste. As per the prescribed procedures the disposal of such wastes is done through vendors/agencies/

etc. recognized or authorized by State Pollution Control Boards. All ICAR institutes/ universities follow these norms and procedures. However, there are certain wastes like spent phenols which are used for cleaning/ disinfection in postmortem facilities etc, cannot be disposed into drains and need to collect in a separate tank and handed over to appropriate agencies when appropriate quantity of waste collected in the tank. *(Collection and quantity of waste need to be discussed with state pollution control board)*

Listed below are the most common Bio-medical wastes produced from VI and DRI of academic laboratories, referral labs, research labs, hospital, health camps, etc and the appropriate methods of disposals as per the prescribed rules/ procedures and standards:

***Photo Courtesy: TANUVAS Chennai***

**Table 2: Biomedical waste classification – categories, treatment, processing and disposal options as per the Schedule I**

| Category (Color) | Type of Waste | Type of bag and container to be used | Appropriate disposal methods |
|---|---|---|---|
| Yellow | **Animal Anatomical Waste** Experimental animal carcasses, body parts, organs, tissues, including the waste generated from animals used in experiments or testing in veterinary hospitals or colleges or animal houses. | Yellow colored non chlorinated plastic bags | Disposal should be through Incineration or plasma pyrolysis or deep burial. In the absence of above facilities, autoclaving or microwave/hydroclaving followed by shredding/mutilation/ combination of sterilization and shredding. Treated waste can be sent |
| | **Soiled Waste** Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components. | Yellow colored non chlorinated plastic bags | for energy recovery |
| | **Expired/Discarded Medicines** Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc. | Yellow colored non-chlorinated plastic bags or containers | Expired `cytotoxic drugs and items contaminated with cytotoxic drugs to be returned back to the manufacturer or supplier for incineration at temperature >1200$^0$C Encapsulation or Plasma Pyrolysis at >1200$^0$C the wastes can also be directly sent to common bio-medical waste treatment facility |

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| | **Chemical Waste**<br>Chemicals used in production of biomedicals, chemicals used in disinfection as insecticides, etc | Yellow coloured containers or non-chlorinated plastic bags | Dispos of by incineration or Plasma Pyrolysis or Encapsulation in hazardous waste treatment, storage and disposal facility. |
| | **Chemical Liquid Waste**<br>Liquid waste generated due to use of chemicals in production of biological and used or discarded disinfectants, Silver X-ray film developing liquid, discarded formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-keeping and disinfecting activities etc. | Separate collection system leading to effluent treatment system | After resource recovery, the chemical liquid waste shall be pre-treated before mixing with other waste forms. The combined discharge shall conform to the discharge norms given in Schedule III. |
| | Discarded linen, mattresses, beddings contaminated with blood or body fluid. | Non-chlorinated yellow plastic bags or suitable packing material | Non- chlorinated chemical disinfection followed by incineration or Plasma Pyrolysis or sent for energy recovery. In absence of above facilities, shredding or mutilation or combination of sterilization and shredding can be followed. |

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|---|---|---|---|
| | Microbiology, Biotechnology and other clinical laboratory waste<br>Blood bags, laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures. | Autoclave safe plastic bags or containers | Pre-treat to sterilize with non-chlorinated chemicals on-site as per National AIDS Control [6]Organization or World Health Organization guidelines, thereafter send for Incineration. |
| **Red** | **Contaminated waste (Recyclable)**<br>Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vaccutainers with their needles and gloves. | Red coloured non-chlorinated plastic bags or containers | Autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent to registered or authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making, whichever is possible. Plastic waste should not be sent to landfill sites. |

6 https://dhr.gov.in/sites/default/files/Bio-medical_Waste_Management_Rules_2016.pdf

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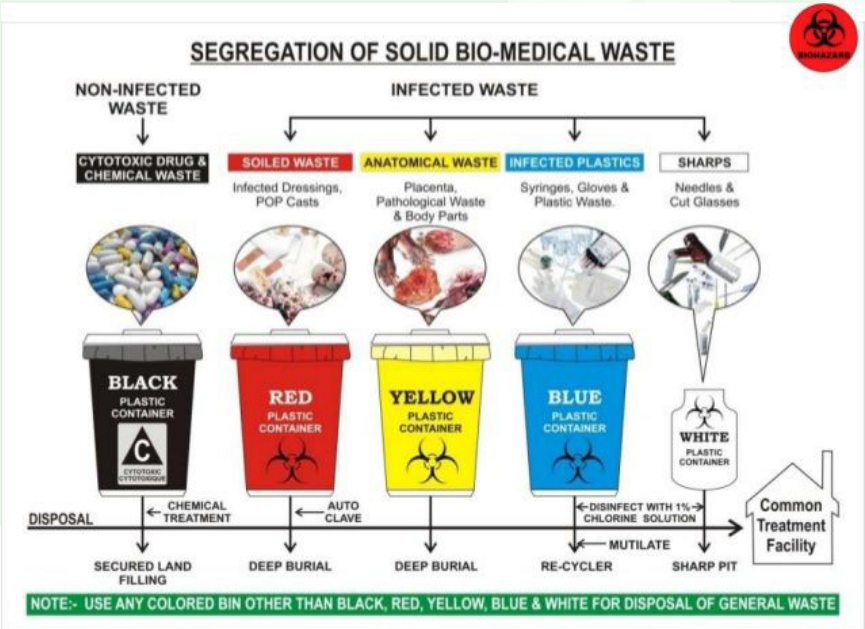
|---|---|---|---|
| **White (Translucent)** | **Waste sharps including metals**<br><br>Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades, or any other contaminated sharp object that may cause puncture and cuts. This includes both used, discarded and contaminated metal sharps. | Puncture proof, leak proof, tamper proof containers | Disposal methods can be by autoclaving or dry heat sterilization followed by shredding or mutilation or encapsulation in metal container or cement concrete, combination of shredding cum autoclaving; and sent for final disposal to iron foundries (having consent to operate from the State Pollution Control Boards or Pollution Control Committees) or sanitary landfill or designated concrete waste sharp pit. |
| **Blue** | **(a) Glassware:** Broken or discarded and contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes. | Cardboard boxes with blue colored marking | Disposal can be after disinfection (by soaking the washed glass waste after cleaning with detergent and sodium hypochlorite treatment) or through autoclaving or microwaving or hydroclaving and then sent for recycling. |
| | (b) Metallic Body Implants | Cardboard boxes with blue colored marking | Disposal can be after Disinfection or through autoclaving or microwaving or hydroclaving and then sent for recycling. |

***Figure 1: System of Segregation of Solid Bio-Medical Wastes***




Source: https://www.greengenra.com/how-to-get-bio-medical-waste-registration-in-delhi-ncr/

*Photo courtesy: IVRI, Izatnagar*

## 3.1. Carcass Disposal Methods

There may be a need for carcass disposals in case of livestock research institutes, laboratories associated with veterinary colleges, breeding farms etc. safe disposals become utmost important in such facilities.

Further it is mandatory under Prevention and Control of Infectious and Contagious Diseases Animal Act, 2009, to dispose of the fall animal / carcasses properly.

### Measures to be taken While Transporting Carcasses to Disposal Site

- The site where the animal died is to be disinfected with 5% formaldehyde after removal of the carcass. Sprinkling of bleaching powder can also be done. The personnel handling the carcass should wear complete PPE.
- Separate system should be instituted for collection of carcasses.
- The transport of material must be carried out by vehicles, which are easy to clean and disinfect. The bottom of the vehicles must be water proof to prevent infective material or liquid from leaking out during transportation.
- It should not be overloaded – half a metre or more (depending on distance to be travelled and temperature) should be left clear for expansion of carcasses.
- Carcasses should not be slashed before loading.
- Vehicles should travel slowly to avoid splashing of contaminated material.
- Staff should carry a supply of an approved disinfectant and basic equipments to deal with minor spills during the journey.
- The diseased animal should not be touched without protective clothing and gloves. The personnel involved in handling should wear PPE, especially if the cause of death is a contagious or zoonotic disease.

- ❖ All vehicles must be cleaned and disinfected before leaving the premises and after unloading.
- ❖ The quantity of wash water generated during cleaning of vehicles should be treated with freshly prepared 3% solution of DuPont "RelyOn" multipurpose disinfectant cleaner or freshly prepared (<24hrs) 10% bleach solution (1part household bleach, 9 parts clean water).

## Carcuss Disposal Options:

### 1. Incineration:

a. Complete combustion of carcasses to be ensured.

b. Air pollution control devices should be installed and the emission from incinerators should comply the General Emission Standards mentioned under Standard for incineration section in SWM Rules. 2016.

### 2. Deep Burial:

a. Burial should be according to different species, such as 1.5 meters for mature cow, 0.3 cubic meters per mature sheep, 1.0 cubic meters per 200 grown broilers/ commercial layer chicken which requires adaquate land.

b. Place carcasses in the trench. Consider puncturing/venting the carcass before they are placed in the trench to minimize the likelihood of gas-filled carcasses emerging from the soil cover. If more than several layers of carcasses will be placed in the trench due to the number of animals culled, a layer of feed, straw or hay (bedding materials, which should be destroyed) should be placed between each layer of carcasses. Alternately, place 0.5 metres of soil over the carcasses after they have been placed in the trench to allow the methane to dissipate for the first week, then finish filling the trenches to ground level.

[7]Recommended procedures for managing blood spills and trauma scenes. 2014. Environment health and safety, Towson University.
https://www.towson.edu/public-safety/environmental-health-safety/documents/blood-spills-and-trauma-scenes-8-1-14.pdf

c. Cover the carcasses with the excavated earth, being sure to grade the surface soil to facilitate runoff.

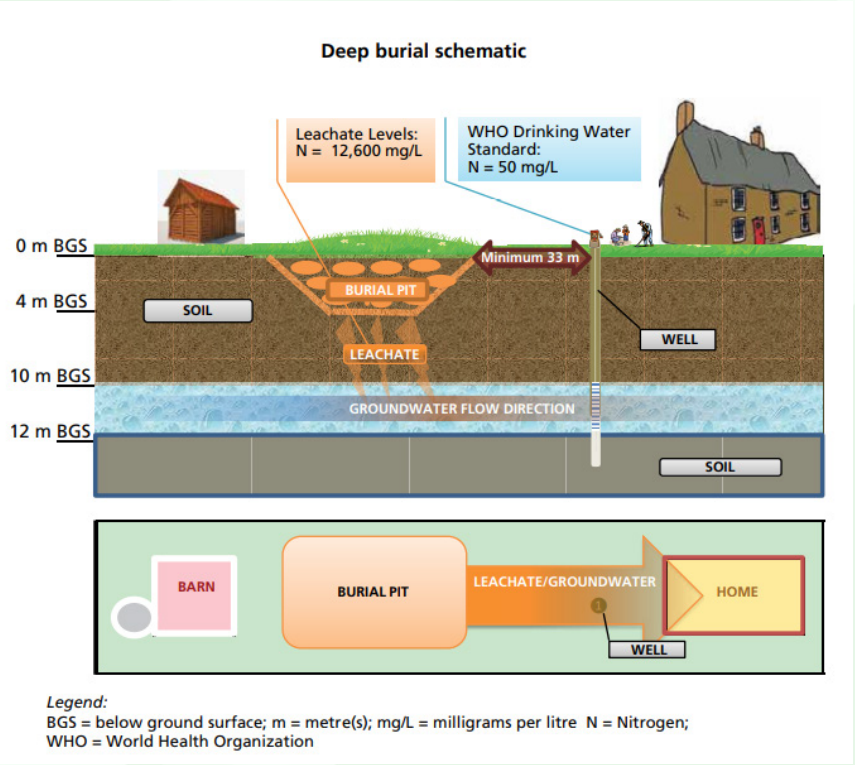
d. Regularly inspect and maintain the site by adding additional backfill to prevent pooling of water if necessary.

**Measures to be taken up for Deep Burial:**

- ❖ Ensure all employees involved in the operation wear personal protective equipment in accordance with an assessment of potential hazards.
- ❖ Ensure that personnel who will be operating equipments are properly trained in its use.
- ❖ Ensure that all equipments should thoroughly be washed, clean and disinfected befor disposal.
- ❖ Do not excavate near existing buildings and roads, which could undermine structural stability and cause collapse.
- ❖ Ensure the accessibility of heavy transport vehicles to disposal site.
- ❖ Consider nature of soil/rock formation in the available area.
- ❖ Ensure that the deep burial site should be relatively impermeable and no shallow well should be close to the site. Ensure that the ground water table level should be a minimum of six meter below the lower level of deep burial pit.
- ❖ Proximity to habitation and water catchment areas, bores and wells: The pits should be distant from habitation, and sited so as to ensure that no contamination occurs to the surface water or ground water. The area should not be prone to flooding or erosion.
- ❖ Ensure that burial site is away from services like water, gas, electricity, telephone lines, drainage, sewerage and other improvements or structures, including aerial lines.

## Deep Burial: Advantages and Disadvantages

| Advantages | Disadvantages | Time/ Cost |
|---|---|---|
| • On farm<br>• Easy to implement | • Public health risk<br>• Biosecurity risk<br>• Pathogens may survive<br>• Not sustainable<br>• Regulatory limitations<br>• Limited future land use<br>• Required heavy equipments or excessive labour | • Fast<br>• Low cost |




Source: Lori Miller, USDA, 2018, Carcass management guidelines, FAO

### 3. Above Ground Burial

a. Land should be adequately available for burial according to type of species such as 1.5 cubic metres per mature cow, 0.3 cubic metres per mature pig or sheep, 1.0 cubic metres per 200 grown broiler/ commercial layer chickens.

b. Excavate the trench 50 to 60 cm deep and place a 30 cm deep layer of carbonaceous material in the trench. Carbon material to line trenches such as wood chips, rice straw, or similar materials. To estimate the amount of carbon material, use 0.75 cubic metres per mature cow, 0.15 cubic metres per mature pig or sheep, or 0.5 cubic metres per 200 grown broiler/commercial layer chickens.

c. Place carcasse in the trench. Before filling the rest of the pit with soil lime is added to pits to prevent earthworms from bringing contaminated material to the surface after pit closure.

d. Puncture/vent the carcasse by stabbing the area posterior to the ribs and the thoracic and abdominal cavities.

e. Cover the carcasse with the excavated earth, being sure to grade the surface soil to facilitate runoff.

f. Stabilize or seed the surface of the excavated area in accordance with local requirements to minimize soil erosion.

g. Place plastic or metal mesh on top of the piles, if needed, to prevent scavenger intrusion.

### Measures to be taken up for Above-Ground Burial

I. Ensure that animals do not have any access to burial sites. Covers of galvanised iron/wire meshes may be used. Fence the area, to restrict access by scavengers and unauthorized persons.

II. Burial must be performed under close and dedicated supervision.

III. The institution shall maintain a record of all pits for deep burial. Ensure all disposal personnel are trained in safety, biosecurity and operational procedures.

IV. Thoroughly clean and disinfect all disposal equipments after the burial.

V. Verify that the technique is proven for the pathogen of concern before use

VI. Groundwater and bedrock should at least be120 cm to 240 cm below the ground surface or as recommended by a qualified soil scientist. (60 cm to 120 cm below the trench bottom).

## Above Burial: Advantages and Disadvantages

| Advantages | Disadvantages | Time/ Cost |
|---|---|---|
| • Safe<br>• On-farm<br>• Readily available<br>• Fast Implementation<br>• Public acceptance<br>• Scavenger not observed to disturb properly constructed piles | • No | • Fast<br>• Low cost |

Source: Carcass management guidelines - FAO

*The location of the deep burial site should be authorised by the prescribed local authority (eg: SPCB, Municipal Corporation etc.)*

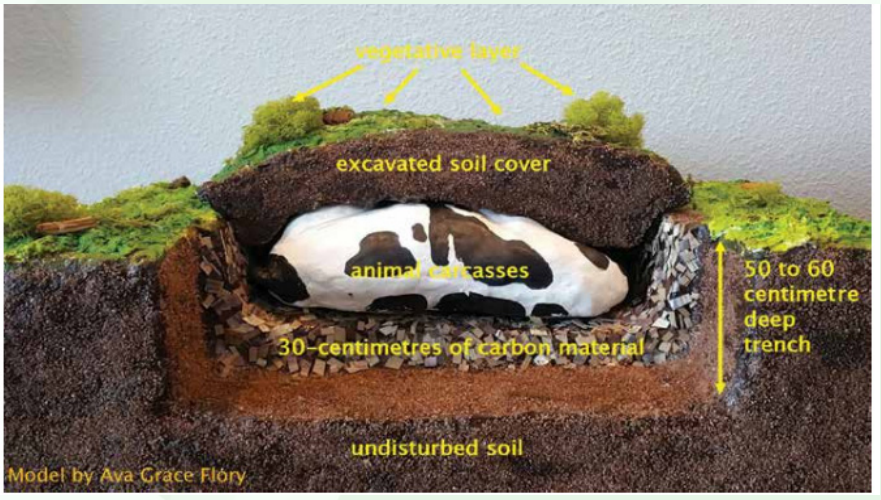



*Figure 3: Above- ground burial schematic*

Source: G.A. Flory consulting, Carcass management

## Instructions to Worker's Protection

- Use recommended PPE includes gloves, boots, overalls, goggles mask etc.
- Avoid touching the eyes, mouth, and nose after touching any contaminated material while wearing PPE
- Do not eat, drink, smoke, after wearing PPE
- Perform good hand hygiene such as hand-washing with soap and water or incase of non availability of soap and water use an alcohol-based hand rub after removing PPE.
- The persons handling carcasses should avoid any contact with other persons or animals without bathing, changing clothing and taking appropriate disinfection measures.
- Persons to handling infected animals or carcasses should first be vaccinated against the particular diseases.

*CCSHAU, Hisar*

# Section 4: Basic Requirements & Instructions at Laboratories

A standard list of basic laboratory safety rules is given below, to be followed in every laboratory that uses hazardous materials or processes. These basic rules provide behavior, hygiene, and safety information to avoid accidents in the laboratory. Laboratory specific safety rules are required for specific processes, equipment, and materials, which should be addressed by laboratory specific SOPs

## Design & Construction of Laboratories

- It should have sufficient space and ventilation.
- It should have lighting and continuous water supply facility.
- It should have stack rooms, store rooms etc. should be spacious and well ventilated.

## Electricity supply and safety measures in Laboratories

- It should have regular and stabilized electricity supply (220-230 volts) preferably captive should be ensured.
- It should have provision of standby source for power supply to sensitive and costly equipments.
- Ground all sources of power supply for human and equipment safety.

## Fire safety measures in Laboratories

- All the laboratories should be equipped with firefighting facilities, first aid kit, look into the feasibility for provision of eye wash fountains, safety showers, etc.
- An efficient hood system is necessarily required at laboratories in order to remove various toxic and hazardous fumes from the work place generated during use of organic solvent/or during acid digestion.


The top surface of working bench should be made of acid and alkali resistant materials

All the students, technicians, housekeeping staff should be oriented on immediate response to accidental burns, acid spills, fire etc.

### What to do when a fire breaks out

- Escape to safe place.
- Shout for help and call fire station.
- Find a safe passage to exit the building, if trapped.
- Always use the staircase if you are trapped in a high-rise building.
- Grab wet blanket, wrap your body it and crawl out.
- If door is on fire, wet some cloth and place them under the door to stop smoke from entering the room.
- Do not run if your body catches fire. stop drop and roll to put out the fire.
- Provision of adequate number of exit doors in case of emergency.
- Fire safety instructions should be displayed in the form of posters.
- Organize mock trails.


*Photo courtesy: ANGRAU, Guntur*

## Waste management in Laboratories

- Segregated the hazardous waste as per the colour code.
- Laboratories should have separate channel for liquid waste collection.
- Label all the hazardous waste substances with precautions for the users in the laboratories.


*Photo courtesy: GADVASU, Ludhiana*

# Annexures 1

## Treated Effluent QualityStandards

| S. No. | Industry | Parameter | Standards | | |
|---|---|---|---|---|---|
| (1) | **(2)** | **(3)** | (4) | | |
| "55" | **Common EffluentTreatment Plants (CETP)** | | | | |
| | **A. Inlet Quality Standards** | For each Common Effluent Treatment Plant (CETP), the State Board will prescribe Inlet Quality Standards for General Parameters, Ammoniacal- Nitrogen and Heavy metals as per design of the Common Effluent Treatment Plant (CETP) and local needs & conditions. | | | |
| | **B: Treated Effluent Quality Standards** | | Max. permissible values (in milligram/litre except for pH and Temperature) | | |
| | | | **Into inland surface water** | **On land for irrigation** | **In to sea** |
| | | General Parameters | | | |
| | | **pH** | **6 - 9** | **6 - 9** | 6-9 |
| | | Biological Oxygen Demand, $BOD_3$, 27 °C | 30 | 100 | 100 |
| | | Chemical Oxygen Demand (COD) | 250 | 250 | 2 50 |

| | | | | | |
|---|---|---|---|---|---|
| | | Total Suspended Solids(TSS) | 100 | 100 | 100 |
| | | Fixed Dissolved Solids(FDS) | 2100 | 2100 | NS* |
| | | Specific parameters | | | |
| | | Temperature, ° C | Shall not exceed more than 5°C above ambient water temperature | Shall not exceed more than 5°C above ambient water temperature | Shall not exceed more than 5°C aboveambien t water temperature |
| | | Oil & Grease | 10 | 10 | 10 |
| | | Ammonical –Nitro-gen | 50 | NS* | 50 |
| | | Total Kjeldahl Nitrogen (TKN) | 50 | NS* | 50 |
| | | Nitrate-Nitrogen | 10 | NS* | 50 |
| | | Phosphates, as P | 5 | NS* | S* |
| | | Chlorides | 1000 | 1000 | NS* |
| | | Sulphates, as $SO_4$ | 1000 | 1000 | NS* |
| | | Flouride | 2 | 2 | 15 |

| | | | | | |
|---|---|---|---|---|---|
| | | Sulphides, as S | 2 | 2 | 50 |
| | | Phenolic compounds (as $C_6H_5OH$) | 1 | 1 | 50 |
| | | Total Res. Chlorine | 1 | 1 | 10 |
| | | Zinc | 5 | 15 | 15 |
| | | Iron | 3 | 3 | 30 |
| | | Copper | 3 | 3 | 30 |
| | | Trivalent Chromim | 2 | 2 | 20 |
| | | Manganese | 2 | NS* | 20 |
| | | Nickel | 3 | NS* | 30 |
| | | Arsenic | 0.2 | NS* | 02 |
| | | Cyanide, as CN | 0.2 | NS* | 02 |
| | | Vanedium | 0.2 | NS* | 02 |
| | | Lead | 0.1 | NS* | 0.1 |
| | | Hexavalent Chromium | 0.1 | NS* | 0.1 |
| | | Selenium | 0.05 | NS* | 0.05 |
| | | Cadmium | 0.05 | NS* | 0.05 |
| | | Mercury | 0.01 | NS* | 0.01 |
| | | Bio-assay test | As per industry-specific standards | As per industry-specific standards | As per industry-specific standards |

*NS-Not specified

Notes:

1. *Discharge of treated effluent into sea shall be through proper marine outfall. The existing shore discharges shall be converted to marine outfalls. In cases where the marine outfall provides a minimum initial dilution of 150 times at the point of discharge and a minimum dilution of 1500 times at a point 100 m away from discharge point, then, the State Board may relax the Chemical Oxygen Demand (COD) limit:
   Provided that the maximum permissible value for Chemical Oxygen Demand (COD) in treated effluent shall be 500 milligram/litre.
2. *Maximum permissible Fixed Dissolved Solids (FDS) contribution by constituent units of a Common Effluent Treatment Plant (CETP) shall be 1000 milligram/litre. In cases where Fixed Dissolved Solids (FDS) concentration in raw water used by the constituent units is already high (i.e. it is more than 1100 milligram/litre) then the maximum permissible value for Fixed Dissolved Solids (FDS) in treated effluent shall be accordingly modified by the State Board.
3. In case of discharge of treated effluent on land for irrigation, the impact on soil and groundwater quality shall be monitored twice a year (pre- and post-monsoon) by Common Effluent TreatmentPlants (CETP) management. For combined discharge of treated effluent and sewage on land for irrigation, the mixing ratio with sewage shall be prescribed by State Board.
4. Specific parameters for some important sectors, selected from sector-specific standards

| | **Sector** | Specific Parameters |
|---|---|---|
| | Textile | Bio-assay test, Total Chromium, Sulphides, Phenolic compounds |
| | Electroplating Industries | Oil & Grease, Ammonia-Nitrogen, Nickel, Hexavalent Chromium, Total Chromium, Copper, Zinc, Lead, Iron, Cadmium, Cyanide,Fluorides, Sulphides, Phosphates, Sulphates, |

| | | |
|---|---|---|
| | Tanneries | Sulphides, Total Chromium, Oil & Grease, Chlorides |
| | Dye & Dye Intermediate | Oil & Grease, Phenolic compounds, Cadmium, Copper, Manganese, Lead, Mercury, Nickel, Zinc, Hexavalent Chromium, Total Chromium,Bio-assay test, Chlorides, Sulphates, |
| | Organic chemicals manufacturing industry | Oil & Grease, Bio-assay test, Nitrates, Arsenic, Hexavalent Chromium,Total Chromium, Lead, Cyanide, Zinc, Mercury, Copper, Nickel, Phenolic compounds, Sulphides |
| | Pharmaceutical industry | Oil & Grease, Bio-assay test, Mercury, Arsenic, HexavalentChromium, Lead, Cyanide, Phenolic compounds, Sulphides, Phosphates." |

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