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GOOD PRACTICES FOR SAFETY IN LABORATORY





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FOREWORD

Laboratories as a work place cause exposure to various types of Hazards such as Chemical Hazards, Biological Hazards, Radiological Hazards and Physical Hazards. Defining the hazards, understanding the source of hazards and analyzing the workflow in laboratory to identify the potential sources of exposure to hazards in a laboratory is a starting point towards preventing the exposure of the laboratory personnel to potentially unsafe situations.

Toxic Chemicals, Radio isotopes and Biological Pathogens are regularly handled in the respective laboratories by qualified and trained professionals and accordingly good laboratory practices for safety in Laboratory activity are required to be followed in a routine basis.

A laboratory is also responsible for safe disposal of the waste generated during working since it will be released in the environment and accordingly safe disposal of the chemical, biological and radiological waste generated.

Bureau of Indian Standards (BIS) under the Chemical Department (CHD) has a dedicated technical committee CHD 07 – Chemical Hazards which is formulating Indian Standard for:

- Terminology, methods of sampling and test, codes of practices and guidelines relating to chemical hazards and Occupational Health and Safety related to Chemicals;
- Classification of hazardous chemicals and chemical hazards;
- Code of safety for operational hazards in Chemical industries and Chemical laboratories; and
- Safety data sheets and cards for hazardous chemicals.

Till date, 90 Indian Standards have been published releted to the Code of Safety for Chemcials, and 03 Indian Standards releted to Code of Practice in Chemical, Radiochemical and Microbiological Laboratory. The Programme of Work may be accessed via the link given below:

Link : Programme of Work of CHD 07

This booklet is an attempt to present the salient features of the Indian Standards related to Laboratory Safety which can be used by the laboratories in keeping their work place safe and secure. In case of further information required, the following Published Indian Standards can be referred:

- IS 4209 : 2013 - Chemical Laboratories — Code of Safety (*Second Revision*)
- IS 4906 : 2017 - Radiochemical Laboratory — Code of Safety (*First Revision*)
- IS 9457 : 2025 - Safety Colours Safety Signs and Accident Prevention Tags — Code of Practice (*Second Revision*)
- IS 12035 : 1986 - Code of Safety in Microbiological Laboratories
- IS 17889 : 2022 - Material Safety Data Sheets — Guidelines
- IS 18149 : 2023 - Transportation of Dangerous Goods — Guidelines

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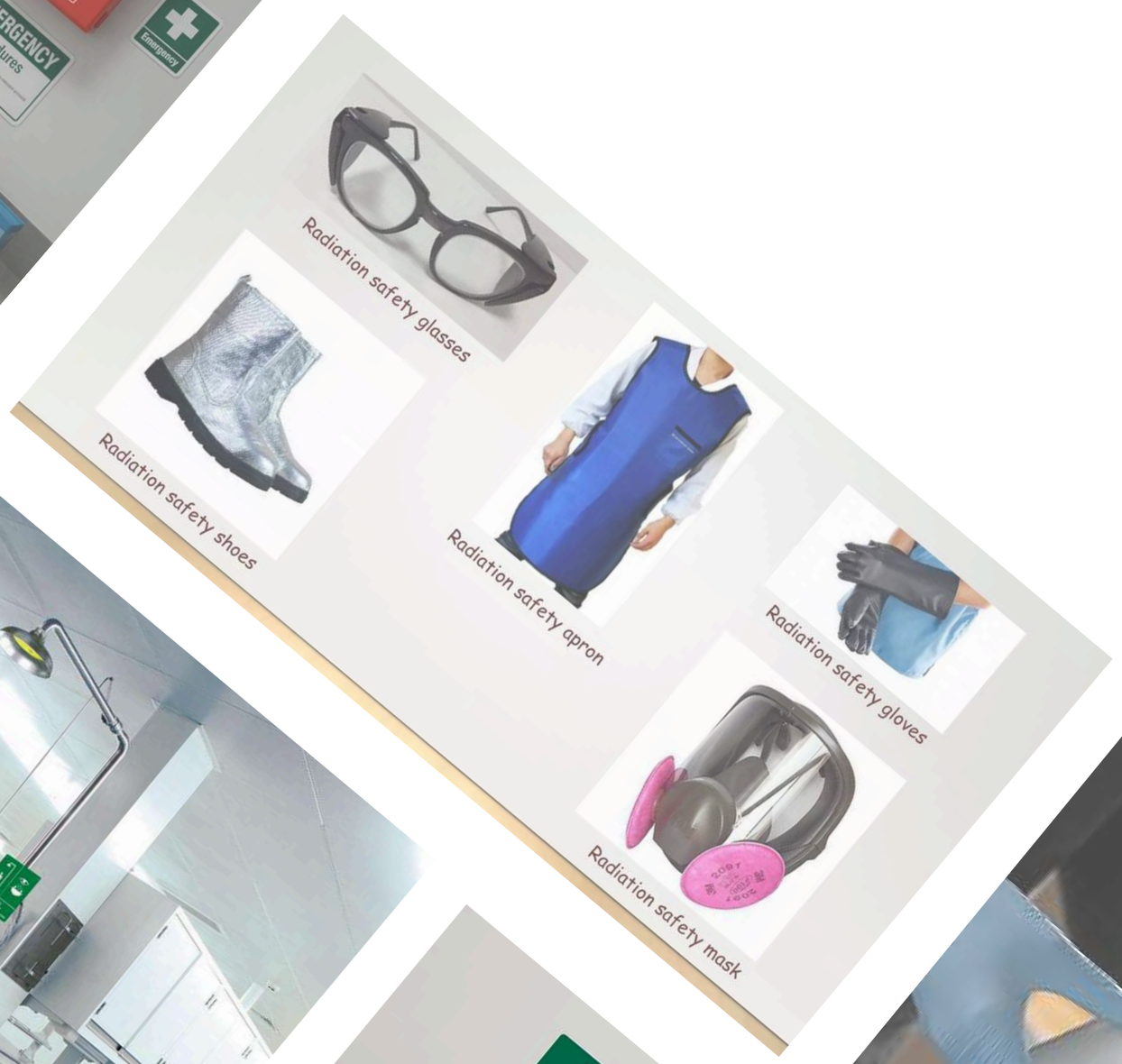
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General Aspects of Laboratory Safety in Chemical Laboratory

1 Knowing what You are Working with and Effective Communication

1.1 Making a laboratory a safe workplace depends on an interplay of design, communication and safe laboratory practices being followed. Knowing the toxicity and bio /radiological hazards of the chemicals biological and radiological material which are being handled in the laboratory is the first step which will provide necessary mandate in terms of design of a laboratory and the safety practices to be followed keeping in mind the toxicity and hazard likely to be faced during routine work.

1.2 BIS has published IS 17889 : 2022 Material Safety Data Sheets — Guidelines. Material Safety Data Sheet (MSDS) or simply SDS (Safety Data Sheet) is the means of communicating information about the hazardous properties of a material to the users, plant workers, people handling material in transit, the government agencies involved and general public. This is an essential component of hazard communication.

1.3 An MSDS shall provide the relevant information about a chemical product, in following 16 section headings.

1. Chemical product and company identification;
2. Hazards identification;
3. Composition/information on ingredients;
4. First-aid measures;
5. Fire-fighting measures;
6. Accidental release measures;
7. Handling and storage;
8. Exposure controls and personal protection;
9. Physical and chemical properties;
10. Stability and reactivity;
11. Toxicological information;
12. Ecological information;
13. Disposal considerations;
14. Transport information;
15. Regulatory information; and
16. Other information

1.4 A large majority of accidents in laboratories are due to human factors and can, therefore, be avoided. The two most important causes are ignorance of precautions to be taken and disregard of safety rules. For eliminating these causes, proper instructions are necessary.

1.5 Presence of a second person within viewing distance to avoid working in isolation while carrying out and providing immediate help if required is a golden safety rule in laboratory working.



1.6 Safety information and emergency procedures should be prominently displayed in each laboratory. Emergency procedures should be posted in each laboratory giving telephone numbers of,

a) Fire brigade;
b) Ambulance;
c) Supervisor/Safety coordinator; and
d) Hospital

1.7 Specific first aid measure to be followed in case of spillage and other exposure to toxic chemicals should also be known to the laboratory personnel. The rules involving smoking, electrical work, open flames, handling flammable material and static electricity should be strictly followed. Firefighting equipment and emergency exits should be kept clean and ready for immediate use.

2 Safety Aspects in Design of the Laboratory

2.1 A laboratory is not a haphazard collection of rooms; but a well-planned and designed building, where each room has a definite function and whose arrangement relative to the others also serves a definite objective. Thus in the design of each room as also of the whole laboratory there has to be a proper appreciation of the purpose. It is important that, in the planning of the laboratory, there should be consultation and collaboration between the architect and the engineer on the one hand, and the senior workers in the laboratory on the other. Even in old laboratories quite a lot may be achieved by minor alterations and adjustments to make them safe places for work.

2.2 The design of the laboratory will depend upon the specific needs of a particular laboratory. Laboratory design aspects which are related to making them safe places of work include specific requirements as per classification of laboratory.

2.3 Radiochemical Laboratories have been classified as Types A, B and C based on the safety requirements for handling different quantities of open sources in a wide range of operation and facilities available. For low level radiochemical work Type C laboratory is quite adequate. For larger amounts, facilities must be upgraded to meet the requirements of Type B or Type A laboratories.



2.4 In the case of Microbiological laboratories, four levels of containment depending upon the infectious agents are prescribed.

- Level Pl requires only standard laboratory practices with work performed on open benches;
- Level P2 requires laboratory with limited access with facility for decontamination of equipment and discarding of materials;
- Level P3 requires in addition higher levels of containment and stringent regulations, such as use of biological safety cabinets, controlled air flow, etc.; and
- Level P4 requires that the laboratory be situated in a separate building or in a controlled area of a building with air locks and maximum safety cabinets.

2.5 In chemical laboratories, from safety point of view, the bay layout is preferable to separate suite of rooms because, in case of an accident, there is a greater chance of some other worker being in sight. Moreover, every laboratory should be provided with a few minimum necessities to ensure safety in working. Each laboratory room shall have two easily accessible exits (a fire escape, if a second door cannot be provided). If a bay layout is provided for each semi-enclosed cubicle, there should be an escape arrangement from the side away from the workbenches.

The arrangement of immovable fittings should be such as to provide adequate moving space between benches. There should be no fittings on the floor, which would hinder or obstruct free movement. The design and arrangement of benches will naturally vary according to the function of each laboratory but adherence to certain minimum requirements would go a long way to reduce accidents.

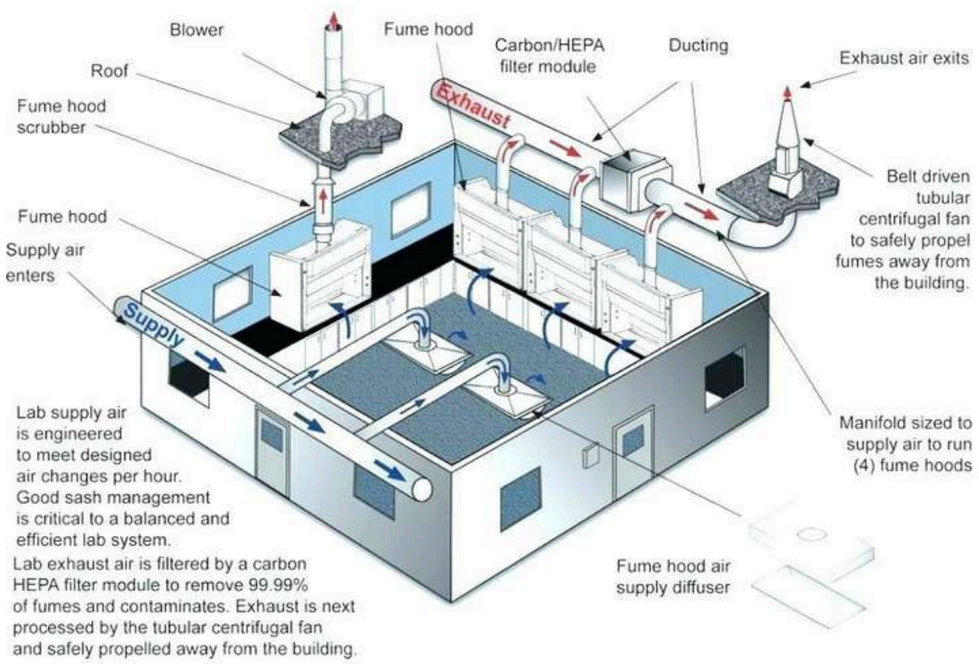
2.6 Benches should not be too deep and the service line controls should be placed at the front below the bench top. The reagent shelves should be easily accessible and should not be unduly high. The reagent shelves should be provided with beading (and with centre partitions in the case of double-side shelves) to prevent bottles falling off due to vibrations.

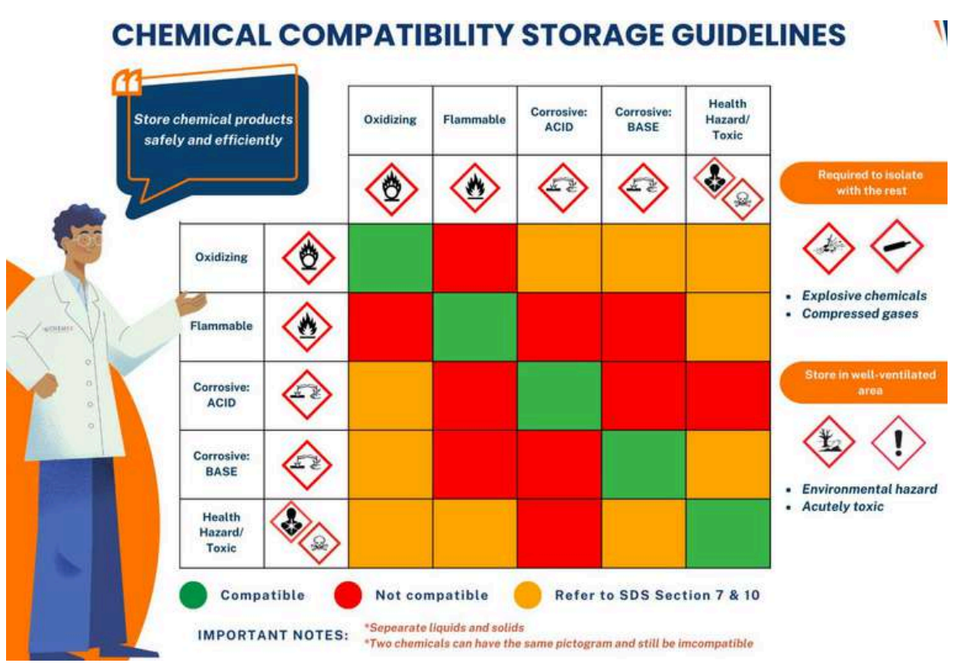
2.7 Laboratories should also be provided with adequate ventilation and efficient exhaust to prevent the buildup of the concentration of toxic vapors in the atmosphere. It is preferable to have separate rooms for:

a) Doing pressure reactions and other hazardous operation;
b) Overnight reactions; and
c) Work involving large quantities of solvents.

2.8 In rooms where work with extremely poisonous gases is done, it is advisable to have an air inlet at the bottom (balanced-draught cupboard) so arranged as to sweep everything to the exhaust. It is desirable to have at least one such cupboard in every chemical laboratory.

2.9 While storing chemicals, it is necessary to know the incompatibles — those that react exothermally with one another. For example, fuels and reducing agents are incompatible with oxidizing agents. No two incompatibles should be stored together. Annex A of IS 4209 : 2013 gives an elaborate list of incompatible chemicals which should be stored separately.





2.10 The following items should be available as protective equipment in all chemical laboratories. The main items are:

1. *Safety Glasses/Face Shields* — Eye protection at minimum level implies safety goggles;
2. *Aprons* — Various types of aprons are available like PVC, rubber or cotton to protect against specific hazards; and
3. *Gloves* — Wear protective gloves to handle chemicals (rubber, PVC, etc). To handle sharp objects use gloves made out of leather, canvas, etc.





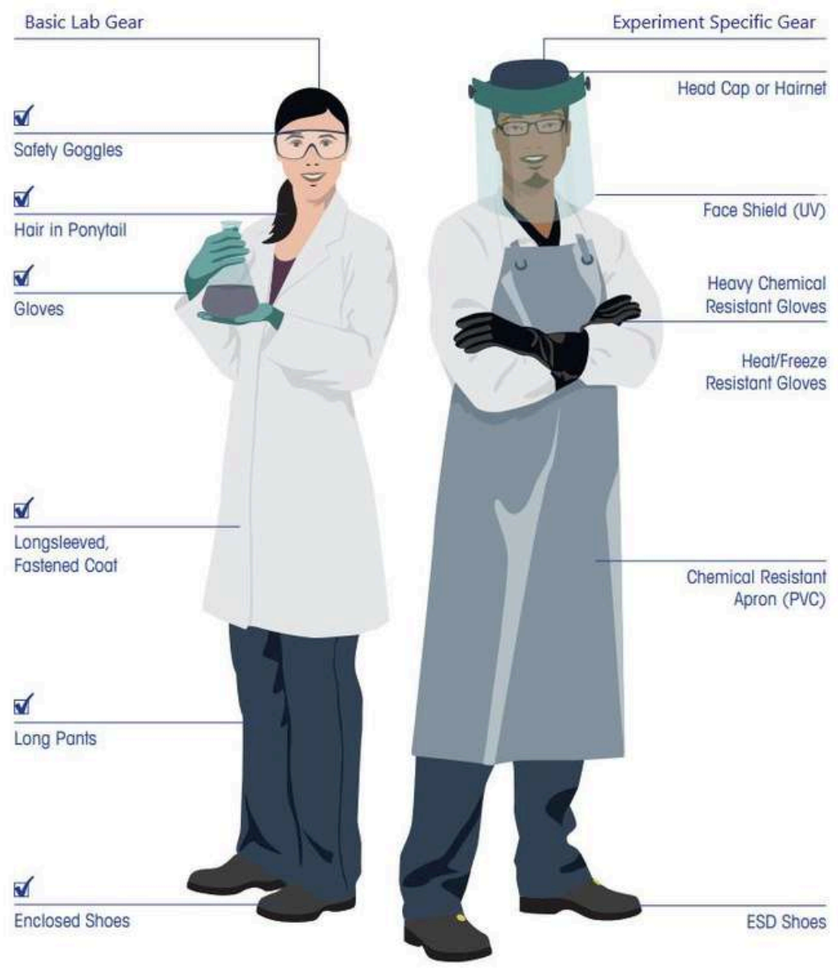
2.11 Other items for specialized protection should be available and all personnel must be aware of their location and use. They are,

1) *Safety Equipment:*

- Fire blankets;
- Eye wash devices; and
- Safety showers.

2) *Personal Protective Equipment:*

- Breathing apparatus;
- Positive pressure hoods;
- Helmets; and
- Gas masks.



2.12 All the personal protective equipment for common use should be kept in their proper places, and cleaned thoroughly after use. Defective equipment should be immediately replaced.

Good Practices for Safety in Chemical Laboratory

1 General

1.1 If it is necessary to continue an experiment overnight, leave precise and adequate information to night shift assistants or security staff.

1.2 Use proper equipment for experiments carried out under reduced or elevated pressure.

1.3 Vacuum flasks and desiccators should be regularly checked for signs of damage.

1.4 All experiments involving use of toxic chemicals should be carried out in a fume cupboard.

1.5 Use a cloth for protection when inserting glass tubing, rods or thermometers into bungs or tubing. Use a lubricant, wherever necessary.

1.6 Compressed gas cylinders, when standing upright, should always be properly supported. Never connect a gas cylinder directly to the apparatus, always interpose a system of traps. Always turn off a gas cylinder at the main valve after use and release any excess pressure in the regulator.

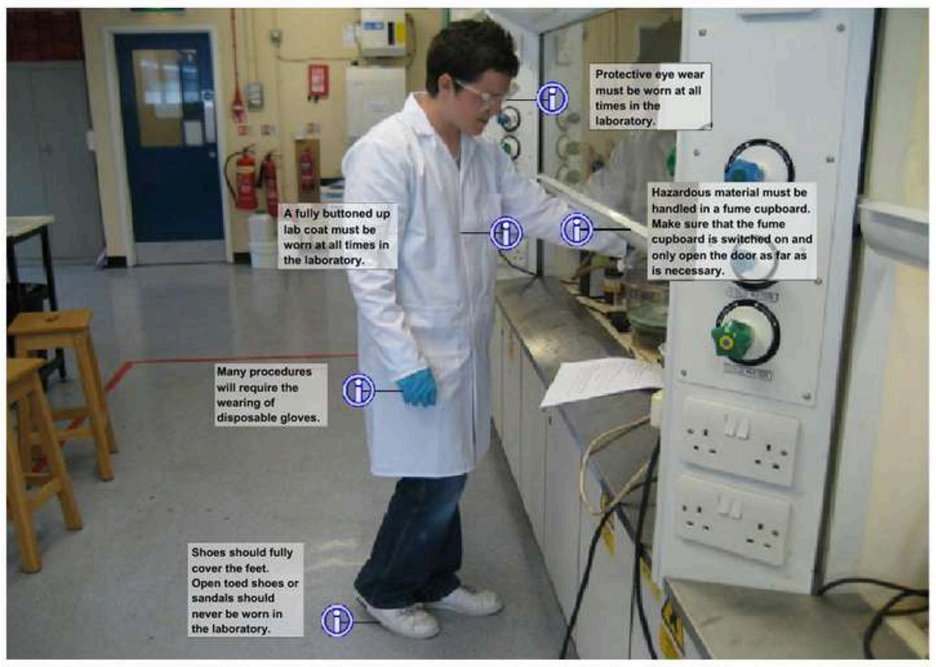
1.7 It is to be ensured that condenser tubing does not become trapped. Make sure that all rubber connections to a condenser are well secured.

1.8 Highly volatile/inflammable chemicals should not be stored indefinitely inside refrigerator, unless suitably modified by removing the bulb and the thermostat outside the refrigerator cabinet. On no account must any food or drink be kept in laboratory refrigerators.

1.9 Labels on reagent bottles should not be altered or tampered with.

1.10 Nitrogen should be preferred to air on all capillary bleeds as a large number of organic substances oxidize at high temperatures.

1.11 Use proper stirring system after taking the volume of the flask into account.



2 Solvent Extraction and Solvent Stripping

2.1 If extraction is carried out in a separating funnel, release the pressure at frequent intervals by inverting the funnel with the stopper securely held and opening the top with care. Point the funnel away from the eyes and naked flames.

2.2 Always ensure that the condensing systems are adequate to cope with solvent use.

2.3 Chemicals like dialkyl ethers, tetrahydrofuran form peroxides in contact with air and sunlight. They should be stored in dark bottles.

2.4 Do not attempt to distil solvents nearly to dryness since these concentrates may contain explosive peroxides.

2.5 Naked flame should not be used for reactions involving inflammable solvents.

3 Vacuum Distillation

3.1 Distillation under reduced pressure should always be carried out behind adequate shields.

3.2 Always use a suitable trap between the sources of vacuum and the apparatus.

3.3 Evacuate the apparatus and check for leaks before commencing heating. Avoid heating by direct flame.

3.4 Never subject the apparatus to rapid changes of pressure; at the end of distillation, allow it to cool before slowly admitting air.

3.5 Do not use water-cooled condenser, if the distillate is entering the condenser above 160 °C.



4 Organic Preparative Reactions

4.1 Special conditions must be complied with for experiments continued outside normal working hours; leave special instructions to the night shift assistants and security staff.

4.2 It should be ensured that the stirring gear is in good order before starting an experiment. Do not restart a stirrer, if it has been stopped for any length of time in a heated reaction flask; allow it to cool first.

4.3 Condenser capacity should be in excess of requirements. Always make provisions for rapid removal of the heating source.

4.4 The bench should be kept dry in the vicinity of an experiment involving alkali metals. It should be ensured that pieces of the metal do not fall into water or oil baths during addition.

5 Pressure Reactions

5.1 Utmost care should be taken in carrying out sealed tube reactions. When the pressure is likely to develop, a sealed tube should never be filled up more than one-third of its volume. The initial runs should be done with very small quantities of reactants.

5.2 Sealed tubes should be protected by a steel tube or a wire cage and the temperature should be raised gradually. These reactions should be carried out in a separate room behind a safety screen. Before opening the tube, it should be well-cooled in ice, tip is then blown off with a pointed flame and when the pressure has been released, the tube may be cut. Autoclave and other pressure vessels should be set up in separate rooms and not in the general laboratory.

5.3 The autoclaves should have safety valves in proper working conditions.



6 First-Aid Measures

Specific first aid measures are required to be followed in case of exposure to specific chemicals.

6.1 Inhalation

Remove victim from exposure and move to fresh air immediately. Remove contaminated clothing and loosen remaining clothing. Allow victim to assume most comfortable position and keep warm. Keep at rest until fully recover. If breathing is difficult, qualified personnel should administer oxygen. If not breathing, give artificial respiration. Do not use mouth-to-mouth resuscitation without knowing the chemicals inhaled by the victim. In case of HCN, gas only use the Silvester method. Do not give anything to drink or do not induce vomiting if person is unconscious. In event of cardiac arrest, apply external cardiac massage. Seek immediate medical assistance.

6.2 Skin Contact

Move person away from contamination. Flush immediately with plenty of water for at least 15 min while removing contaminated clothing and shoes. If necessary, arrange for transport to hospital or to a doctor for medical attention. The information regarding the hazardous chemical along with details of first-aid given should accompany the casualty. Wash contaminated clothing before reuse.

6.3 Eye Contact

Flush eyes thoroughly with water for at least 15 min. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. Call a physician, preferably an ophthalmologist, immediately or arrange for transport to hospital for immediate medical attention and treatment of eye injury. Information regarding the chemical that is material safety data sheet should accompany the patient.

6.4 Ingestion

Do not induce vomiting. Have victim rinse out mouth with water, and then drink sips of water to remove taste from mouth. Do not give liquids to a drowsy, convulsing or unconscious person. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lungs. Seek medical attention immediately or arrange for transport to hospital for immediate medical attention and treatment. Information regarding the chemical swallowed, its concentration and quantity, material safety data sheet of the chemical should accompany the patient.

6.5 Special Treatments

6.5.1 For Hydrogen Fluoride, Hydrofluoric acid or Related Compounds

These chemicals cause destructive and extremely painful burns on tissues when they come in contact. Immediate action should be taken, if splashed.

a) *Splashes in the Eye* — Splashes of hydrogen fluoride or hydrofluoric acid in the eyes must be treated immediately by flooding for at least 15 min with large volumes of gently running water from a tap. The urgent removal of patient to hospital is essential since failure to treat correctly may result in loss of vision.

b) *Splashes on the Skin* — All contaminated clothing should be removed and flood the skin with large volumes of running water. Thereafter 2 percent calcium gluconate gel should be applied liberally to the affected parts and massaged into the skin till medical aid is available. If nails have been penetrated by the acid the gel be liberally applied over and around the nail and the area, and massaged continuously for at least 15 min.

6.5.2 All cases of hydrogen fluoride or hydrofluoric acid splashes must be referred to hospital after washing the skin and starting the above treatment with the ointment.

6.5.2.1 For hydrogen cyanide

Observe the following rules in case of hydrogen cyanide inhalation:

a) Care should be taken so that rescuer does not fall a victim to the same gas;

b) If conscious and breathing, remove the patient immediately to the hospital; and

c) If breathing stops, place the casualty in the prone position with the mouth down with a clear breathing passage. Give artificial respiration by the Silvester method. Do not use the mouth-to-mouth method because the first-aider may inhale the hydrogen cyanide gas himself. Artificial respiration should be given by a trained first-aider.



Good Practices for Safety in Radiochemical Laboratory

1 Laboratory Techniques and Equipment

1.1 Choice of Process

The quantity of radioactive material chosen for any specific purpose should not be greater than the minimum dictated by experimental needs. It is preferable to work with solutions rather than dry powdery materials. The manipulation processes selected should be those which avoid excessive transfers from one vessel to another.





1.2 Equipment

1.2.1 Special equipment consisting of tongs, forceps, trays and for the higher levels of gamma-activity apparatus, with adequate shielding should be provided. All equipment used or handling radioactive materials should be confined to the activity area and should be treated as contaminated.

1.2.2 Containers for active materials should as far as possible incorporate necessary shielding close to the source. Pipetting of solutions and operation of wash bottles should never be performed by mouth, but by means of compression bulbs and by remote handling equipment wherever necessary. Glass blowing on contaminated apparatus shall be done with special techniques which do not involve mouth operations. Squeeze type wash bottles and propipettes are useful for those operations.

1.3 Storage Cell

In addition to active areas, the laboratory should have provision for a well-designed cubicle for storing radioactive sources. The area should be designed with some understanding of utilization of sources.



1.4 Decontamination Procedures

1.4.1 In any establishment using radioisotopes, contamination either direct or indirect is unavoidable in spite of the stringent measures adopted to prevent it. The types of contaminations which are common to any radioisotope laboratory are of three types:

a) Personnel contamination;
b) Equipment contamination; and
c) Work area contamination.

1.4.2 Decontamination of each type mentioned above may be achieved by careful manipulation of a set of procedures outlined below.



1.4.3 Personnel Decontamination

Personal cleanliness should be watched in all operations where there is a likelihood of even the slightest contamination; persons working with radioisotopes (including those of low toxicity) should wash their hands thoroughly with detergents before leaving the work area, either temporarily or at the end of the working period. Particular attention should be paid to the finger nails. After washing, the contaminated parts should be checked rigorously for any fixed residual contamination. For instance, if washing with detergents and water fails to bring down the level of contamination below permissible level, say in the case of hand, other methods should be tried. One may resort to treatment with suitable chemicals, such as potassium permanganate and sodium bisulphite or EDTA solution. However, chemical treatment should be conducted carefully because this will enhance chances of uptake through porous skin. Even mild abrasions or scrubbing shall be done with soft nylon brush in such a way as not to injure the skin. However, treatment with chemicals shall always be done with utmost discretion depending upon the site of contamination and only under medical supervision. For example, any contamination in the eye or near the eye should be removed only with water and not chemicals. Similarly, treatment of face and other sensitive organs should be conducted with greatest caution and on proper supervision of the authorized physician.

Care shall be taken to avoid contamination of abrasions, cuts and puncture wounds and any person with any of these handicaps shall not be allowed to work with radioisotope, without proper sealing of the open wound. If skin break or cut occurs while working in an active area, the authorities concerned shall be informed immediately for contamination check-up and further decontamination. Needless to say, a medical officer should be consulted in all cases of contamination of cuts and sores.

1.4.4 Decontamination of Laboratory Equipment and Work Areas

Any equipment which has been used in connection with any radioactive work should be treated as contaminated unless proved otherwise by a careful survey. The types of decontamination treatment will depend upon the nature of contaminant and upon the type of surface contaminated:

a) Glassware may be cleaned on a routine basis with chromic acid solution. If unsuccessful, other cleaning agents, such as concentrated nitric acid, ammonium citrate, penta sodium triphosphate and ammonium bifluoride should be tried. The solutions used for cleaning should be disposed off adequately as active waste.

b) All metal objects may be cleaned by washing with a detergent solution followed, if necessary, with dilute nitric acid or a 10 percent solution of sodium citrate or ammonium bifluoride. In the case of stainless steel hydrochloric acid should be avoided as this will result in corrosion leading to greater difficulty in future decontamination work. Brass polish for brass, oxalic acid for rusty surfaces, ammonium citrate, dilute acids and organic solvents are also recommended for decontamination purposes.

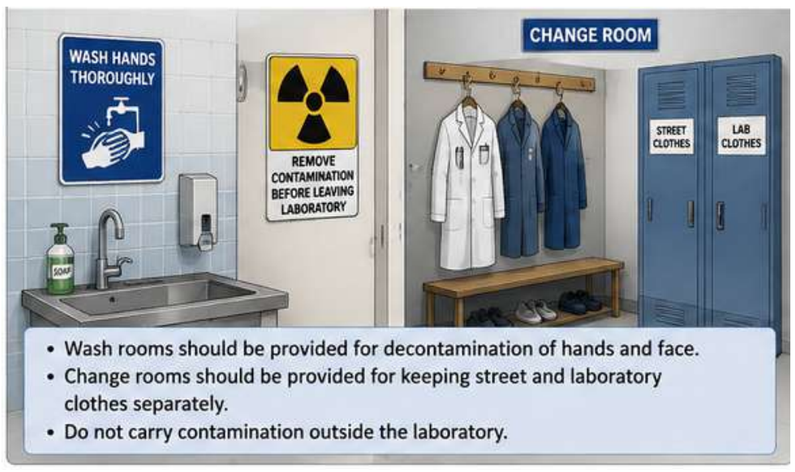
c) Though plastic paint surfaces may be decontaminated often successfully by using acetone, trichloroethylene or a 10 percent hydrochloric acid solution, it is advisable to strip off the paint and replace with new coatings.

d) The above mentioned procedures are mostly for wet spillage on various surfaces. However, if a dry contamination occurs on any surface, as a first step in the process of decontamination a vacuum cleaner with a high efficiency filter should be used followed by suitable methods mentioned above.

e) Protective apparel and personal clothing of staff or clothing, bedding of hospital patients who are being treated with radioisotopes shall be monitored regularly. If there is any significant contamination, they should be segregated and stored until the activity has fallen below the safe level as recommended in Table 2 of IS 4906 : 2017, failing which they should be laundered in a special laundering facility or discarded.

1.5 Wash Room and Change Rooms

Every facility handling radioactivity should be equipped with change rooms at entry and wash room near the working place. The change room is a place where on entry into the building the worker changes into company clothing or overalls as required and goes into the hot areas. At the time of leaving working area, he passes through the change rooms, is monitored and then wears his personal clothing. Change room is also equipped with showers as well as decontamination solution. A change room acts as a barrier against movement of radioactive contamination outside working areas. Washrooms equipped with showers should be installed in a facility. These would facilitate immediate cleanup in case of sudden spills, or suspected contamination.



2 General Safety Rules in Radiochemical Laboratory

A good safety culture in the laboratory would help control radiation exposure and contamination control. Good working practices are summarized below:

a) Laboratory coats should be worn in laboratory.

b) Unnecessary materials should not be accumulated in the laboratory.

c) The movement and storage of radioactive material shall be under the control of a responsible person acquainted with safety procedures and regulations.

d) The maintenance of an inventory of radioactive sources is very necessary.

e) Eating, smoking and drinking are prohibited in the laboratory.

f) No mouth operation are allowed, for example, pipettes, wash bottles and labels shall not be put in the mouth.

g) Solid and liquid waste materials shall be monitored and segregated properly.

h) When wearing gloves disposable tissues should be used for handling taps, switches, etc.

i) Gloves, clothing, apparatus and benches shall be monitored after work with radioactive materials.

j) Radioactive work should not be undertaken by a person having open cuts/wounds.

k) TLD badges/dosimeters shall be worn on person and a record of the external dose received by the person shall be maintained.

l) Radiation symbols shall be posted wherever active sources are handled.

m) Contaminated areas should be cordoned off.

n) A radiochemical laboratory should not be used as a normal sitting place.

o) External radiation hazards may be minimized by making use of special equipment, such as long handled forceps, tongs, etc., while manipulating active sources from a distance of 15 cm to 100 cm. Drip trays of stainless steel or plastic, lined with absorbent paper, help to minimize the spread of contamination in case of spills. The tray should be without rough surfaces, or sharp corners, to facilitate easy decontamination. For higher levels of gamma activity, adequate shielding should be provided for containers of active materials and as far as possible incorporate necessary shielding close to the source. All manipulation should be done in a drip tray or in some form of double containers.

p) Pipetting of solutions and operations of wash bottles should never be performed by mouth, but by means of compression bulbs, remote handling pipettes, squeeze type wash bottles, etc.

q) Never look down into a beaker or test-tube containing several millicuries of a strong beta emitter. Glassblowing on contaminated apparatus shall be done with techniques which do not involve mouth operation.

r) Placards bearing radiation symbols are required in the laboratory. The placards should also bear health safety instructions and should be put up, wherever radioactive sources are being manipulated or stored.

s) Equipment used for handling radioactive materials should be confined to the active area of laboratory.

3 Radioactive Waste Disposal

Operations in a radiochemical laboratory result in the generation of radioactive wastes. All the operations should be carried out in such a way that the amount of waste is minimized by appropriate use of methods and management procedures.



3.1 Solid Wastes

3.1.1 The solid wastes may comprise of mops/gloves, filter paper containing precipitates, tissue papers, contaminated glass apparatus, cotton, etc. These are segregated as inflammables/compressible or non- compressible. The wastes are collected in polyethylene/PVC bags and packed in suitable containers and monitored for its radioactivity. It is then properly tagged. The waste packets should be characterized with respect to its contents and activity to ensure compliance with regulatory requirements.

3.1.2 The wastes should not be disposed off to the environment directly. The disposal should be in accordance with the regulatory stipulations as mentioned before. Authorization from the regulatory body should be obtained before disposal/transfer of radioactive wastes under the Atomic Energy (*Safe Disposal of radioactive Wastes Rules*), 1987, G.S.R. 125.

3.2 Liquid Wastes

Radiochemical laboratories should be properly designed to handle liquid waste so as to have no leakage to environment and contamination in the facility. Very low levels of radioactive liquid effluents can be directly discharged to the sink which drains to liquid waste hold up tank or delay tank which after activity assessment can either be discharged to the environment directly or transferred to the waste management facility. The disposal limit for the discharges should conform to those prescribed by the regulatory body.

3.3 Gaseous Effluents

3.3.1 The gaseous effluents from the laboratory are exhausted through a suitable ventilation system to the environment. The gaseous radioactive effluents evolved from the fume hood and glove boxes should be monitored before discharge to the environment. Adequate gas cleaning system should be provided to ensure that the discharges of airborne releases are within the authorized limits of AERB.

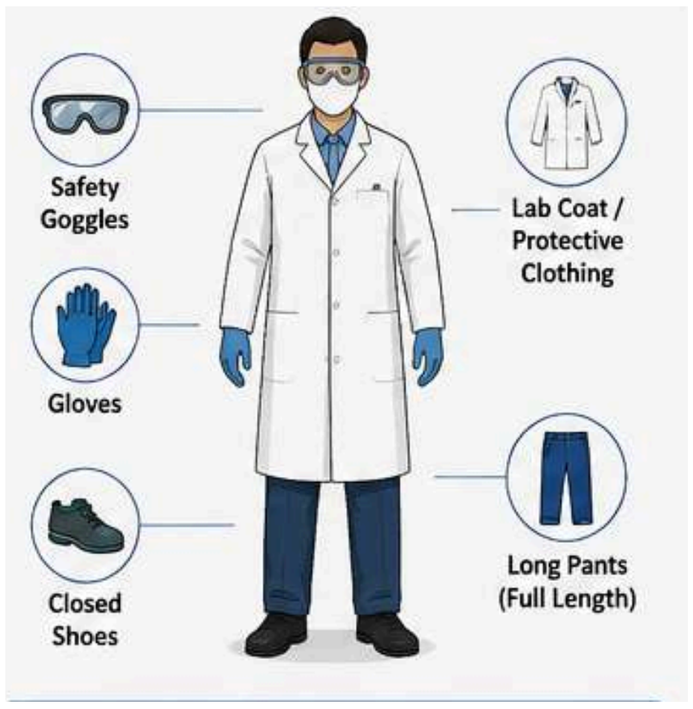
3.3.2 In order to ensure safe transport, relevant regulations in ‘Safety Code for the Transport of Radioactive Materials, AERB/SC/TR-1, 1986’ should be followed for properly packing the radioactive waste to be transported. For any major problems connected with the safety of handling and disposal of radioactive materials, advice may be sought from Atomic Energy Regulatory Board, Mumbai.

4 Protective Clothing

4.1 In any radioisotope laboratory, the type of protective clothing required will depend upon the nature of work. For usual laboratory work (Type C) the ordinary laboratory coats are quite adequate. If work involves decontamination of equipment, a change of shoes in addition is advisable. Overshoes made of plastic or rubber material may be used.

4.2 Work shall not be carried out with radioactive materials or materials suspected to be carrying contamination without wearing rubber gloves. Rubber gloves used for handling active materials should not be used for handling other items, even in the active laboratory. Contaminated gloves should be thoroughly washed before taking off. The wearing and removal of the gloves should be in the same way as that of the surgical technique to minimize the contamination of hands. It is necessary to point out here that while these gloves might provide adequate protection against soft beta rays, they are not adequate against hard beta rays. Heavier rubber gloves are more robust and give some measure of protection against beta radiation; they may be made more comfortable to wear by lining with cotton fabric.





5 Respirators

When the concentration of air-borne activity in working atmosphere goes above the maximum permissible levels during any major or minor operation, special precautions have to be taken. These include the wearing of a fully impervious clothing made up of a full rubber suit with boots, gloves and helmet and fresh air is supplied through an airline. Before donning such a wear, a full change of clothing is recommended. However, where the contamination level is not so high and is only occasional, lighter type of suit made of thin plastic material may be used with a simple airline hood. During short periods of Emergency, a high efficiency respirator is used along with a hood to cover the head. The body as a whole is covered with plastic overalls. In a radioisotope laboratory an accident, such as even a spillage might warrant use of respirators and protective apparel. It is necessary to ensure the periodic check-up of handling equipment and examination at frequent intervals of respirators and protective clothing. This would help in keeping them ready for any emergency work.

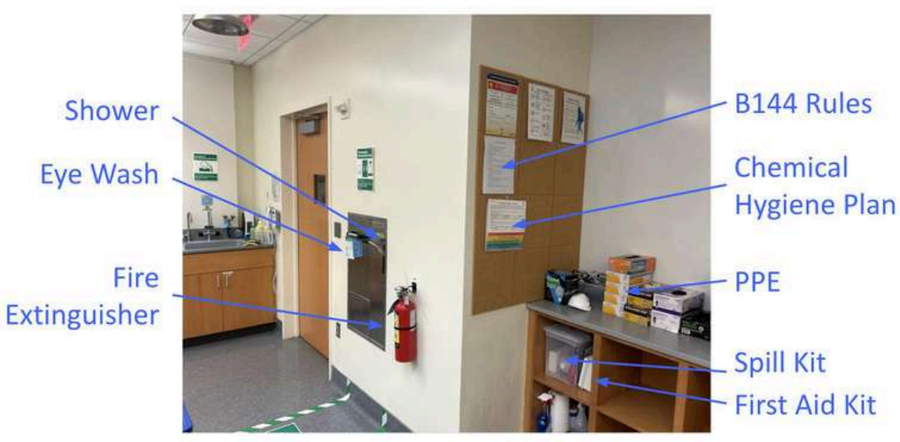
Good Practices for Safety in Microbiological Laboratory

i) Whenever indicated, special rooms should be set aside for microbiological work.



ii) The ventilation should be of the non-recirculation type. Air exhausted from the room should be freed from infectious material by passing it through high efficiency particulate filters.

iii) Air flow should be from areas of lesser risk to areas of greater risk, that is, from clean halls and corridors into microbiological laboratories and then vented through ductings fitted with filters.



iv) Areas of high risk, for example, tuberculosis laboratories and laboratories doing work on pathogenic viruses should be marked by the Biological Hazard Symbol and marked ‘Caution - Do not Enter Without Permission”. No casual visitors or children below twelve years of age should be allowed to enter.



v) Personal Protective Equipment — Aprons, masks, gloves, goggles, safety pipetting devices must be provided and it must be ensured that personnel actually use them.

vi) Biological Safety Cabinets — For work with hazardous bacteria, safety cabinets of the negative air pressure type should be used. The cabinet should have a glass partition, separating face and infective material or manipulations could be done through a glove-port in a sealed cabinet. The exhaust from the cabinet should be freed from infective material by suitably HEPA filters which must be checked periodically by DOP test for critical flow rates and changed if necessary. A laminar flow cabinet meant for the protection of material being handled is not the same as a safety cabinet meant for the protection of the operator.



vii) The work-bench should be provided with a water-proof cover, which may be removed and soaked in a disinfectant solution if spillage occurs. Discard jars or trays with disinfectant should be provided at the work-bench to place infected pipettes, swabs, etc.

viii) A first aid kit, periodically inspected and maintained should be placed in an unlocked drawer and prominently labelled.



ix) Foot-operated taps, adequate disinfectant solution and towels must be provided next to the work-bench. Shower facility should be provided for use when emerging from a room processing highly hazardous bacteria/or for an emergency use.

x) All laboratory personnel should be immunised with all approved vaccines available. A full course of inocculations should be administered if immunization was not done in childhood. Booster doses should be given at appropriate time intervals. Tuberculin negative staff should be rendered tuberculin positive with BCG. Regular X-raying should be done of personnel handling M tuberculosis. A medical record of immunizations, investigations, accidental exposure to pathogens, job related and other illnesses of personnel should be maintained.



xi) All procedures should be performed gently without spilling or splashing infective material on to the body, clothes or bench. All operations creating aerosols should be avoided.



xii) Infected material should be discarded in a jar or tray of disinfectant.

xiii) A charged loop may be drawn from the cooler to the hotter part of the flame to avoid spluttering. Alternately, the loop may be dipped in disinfectant before flaming.



xiv) Oral pipetting should be avoided. A rubber teat or safety pipetting devices should be used. The transfer to a liquid medium should be done by allowing fluid to gently run down along the wall of the container. The residual fluid should not be expelled.

xv) While handling infective material in syringes, needle must be fitted tightly.

xvi) Centrifugation should be done after careful balancing. Preferably, unbreakable tubes should be used. The tubes should not be filled up to the brim. In case of accident, close the lid and switch off the centrifuge and wait for aerosol to settle (10 min) before attempting to disinfect.

xvii) All plate cultures with sporulation organisms should be sealed. All work involving highly infectious pathogens should be carried out in the biosafety hoods.



xviii) Contaminated materials should be suitably autoclaved wherever possible. The autoclave should be readily accessible to prevent the transport of contaminated material through corridors and rooms.

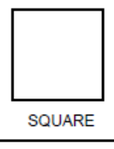
xix) Glassware should be kept submerged in disinfectant prior to autoclave. As far as possible disposable syringes, needles and plastic ware should be employed.



xx) With hazardous bacteria, centrifugation, sonication, blending, etc, should be performed inside a safety cabinet.

Annexure - A

General Meaning and Use of Geometric Shapes, Safety Colours and Contrast Colours in Laboratories

Sl No.	Geometric Shape	Meaning	Safety Colour	Contrast Colour	Graphical Symbol Colour	Example of Use
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	 CIRCLE WITH DIAGONAL BAR	Prohibition	Red	White	Black	a) No smoking; b) No unauthorised vehicles; and c) Do not drink.
ii)	 CIRCLE	Mandatory action	Blue	White	White	a) Wear eye protection; b) Wear personal protective equipment; and c) Switch off before beginning work.
iii)	 EQUILATERAL TRIANGLE	Warning	Yellow	Black	Black	a) Danger hot surface; b) Danger acid; and c) Danger high voltage.
iv)	 SQUARE  RECTANGLE	Safe condition means of escape safety equipment	Green	White	White	a) First aid room; b) Fire exit; and c) Fire assembly point.
v)	 SQUARE  RECTANGLE	Fire safety	Red	White	White	a) First alarm call point; b) Fire fighting equipment; and c) Fire extinguisher.
vi)	 SQUARE  RECTANGLE	Supplementary information	White or the colour of the safety sign	Black or the contrast colour of the relevant safety sign	Symbol colour of the relevant safety sign	As appropriate to reflect message given by graphical symbol
vii)		Radiation warning sign	Magenta	Yellow	Yellow	Radiation hazard

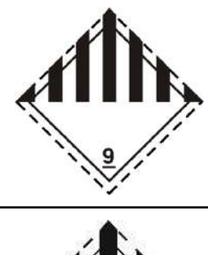
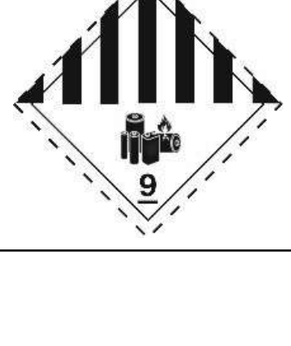
Sl No.	Geometric Shape	Meaning	Safety Colour	Contrast Colour	Graphical Symbol Colour	Example of Use
(1)	(2)	(3)	(4)	(5)	(6)	(7)
viii)		Radiation warning sign (Internationally)	Black	Yellow	Yellow	Radiation hazard
ix)		X-Ray radiation	Red	Yellow and white	Black	X-Ray radiation
x)		Radiation in sealed source	Red	Black	Black	a) Radiation source; and b) Radioactive material (For general public)
xi)		Transport: Category I radiation label	Black	White	Black (colour of bar-red)	Radiation level on external surface: Not more than 0.005 mSv/h
xii)		Transport: Category II radiation label	Black	Upper part- yellow lower part- white	Black (Colour of Bar- Red)	Radiation level on external surface: More than 0.005 mSv/h but not more than 0.5 mSv/h
xiii)		Transport: Category III radiation label	Black	Upper part- yellow lower part- white	Black (colour of bar-red)	Radiation level on external surface: More than 0.5 mSv/h but not more than 2 mSv/h

Annexure - B

Labelling and Identification of Dangerous Goods Handled in Laboratories

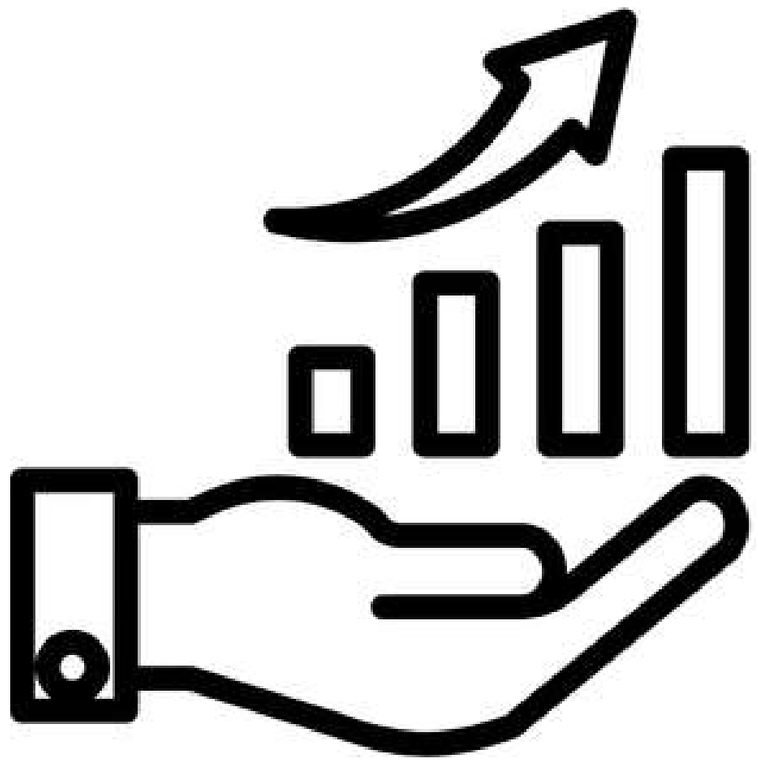
Label model No.	Division or Category	Symbol and symbol colour	Background	Figure in bottom corner (and figure colour)	Specimen labels	Note
Class 1: Explosive substances or articles						
1	Divisions 1.1, 1.2, 1.3	Exploding bomb: black	Orange	1 (black)		-** Place for division – to be left blank if explosive is the subsidiary hazard -* Place for compatibility group – to be left blank if explosive is the subsidiary hazard
1.4	Division 1.4	1.4: black Numerals should be about 30 mm in height and be about 5 mm thick (for a label measuring 100 mm × 100 mm)	Orange	1 (black)		* Place for compatibility group
1.5	Division 1.5	1.5: black Numerals should be about 30 mm in height and be about 5 mm thick (for a label measuring 100 mm × 100 mm)	Orange	1 (black)		* Place for compatibility group
1.6	Division 1.6	1.6: black Numerals should be about 30 mm in height and be about 5 mm thick (for a label measuring 100 mm × 100 mm)	Orange	1 (black)		* Place for compatibility group
Class 2: Gases						
2.1	Division 2.1: Flammable gases	Flame: black or white	Red	2 (black or white)		-
2.2	Division 2.2: Non-flammable, non-toxic gases	Gas cylinder: black or white	Green	2 (black or white)		-
2.3	Division 2.3: Toxic gases	Skull and crossbones : black	White	2 (black)		-
Class 3: Flammable liquids						
3	-	Flame: black or white	Red	3 (black or white)		-

Label model No.	Division or Category	Symbol and symbol colour	Background	Figure in bottom corner (and figure colour)	Specimen labels	Note
Class 4: Flammable solids; substances liable to spontaneous combustion;substances which, in contact with water, emit flammable gases						
4.1	Division 4.1: Flammable solids, self-reactive substances, polymerizing substances and solid desensitized explosives	Flame: black	White with 7 vertical red stripes	4 (black)		-
4.2	Division 4.2: Substances liable to spontaneous combustion	Flame: black	Upper half white, lower half red	4 (black)		-
4.3	Division 4.3: Substances which, in contact with water emit flammable gases	Flame: black or white	Blue	4 (black or white)		-
Class 5: Oxidizing substance and organic peroxides						
5.1	Division 5.1: Oxidizing substances	Flame over circle: black	Yellow	5.1 (black)		-
5.2	Division 5.2: Organic peroxides	Flame: black or white	Upper half red, lower half yellow	5.2 (black)		-
Class 6: Toxic substances and infectious substances						
6.1	Division 6.1: Toxic substances	Skull and crossbones: black	White	6 (black)		-
6.2	Division 6.2: Infectious substances	Three crescents superimposed on a circle: black	White	6 (black)		The lowerhalf of the label maybear the inscriptions : “INFECTIOUS SUBSTANCE” and “In the case of damageor leakage immediately notify Public Health Authority” in blackcolour.

Label model No.	Division or Category	Symbol and symbol colour	Background	Figure in bottom corner (and figure colour)	Specimen labels	Note
Class 7: Radioactive material						
7A	Category I - WHITE	Trefoil: black	White	7 (black)		Text (mandatory), black in lower half of label: “RADIOACTIVE” “CONTENTS ...” “ACTIVITY ...” One red vertical bar should follow the word: “RADIOACTIVE”
7B	Category II - YELLOW	Trefoil: black	Upper half yellow with white border, lower half white	7 (black)		Text (mandatory), black in lower half of label: “RADIOACTIVE” “CONTENTS ...” “ACTIVITY ...” In a black outlined box: “TRANSPORT INDEX”; Two red vertical bars should follow the word: “RADIOACTIVE”
7C	Category III - YELLOW	Trefoil: black	Upper half yellow with white border, lower half white	7 (black)		Text (mandatory), black in lower half of label: “RADIOACTIVE” “CONTENTS ...” “ACTIVITY ...” In a black outlined box: “TRANSPORT INDEX”. Three red vertical bars should follow the word: “RADIOACTIVE”
7E	Fissile material	-	White	7 (black)		Text (mandatory) : black in upper half of label: “FISSILE”; In a black outlined box in the lower half of label: “CRITICALITY SAFETY INDEX”
Class 8: Corrosive substances						
8	-	Liquids, spilling from two glass vessels and attacking a hand and a metal: black	Upper half white, lower half black with white border	8 (white)		-
Class 9: Miscellaneous dangerous substances and articles, including environmentally hazardous substances						
9	-	7 vertical stripes in upper half: black	White	9 underlined (black)		-
9A	-	7 vertical stripes in upper half: black; battery group, one broken and emitting flame in lower half: black	White	9 underlined (black)		-

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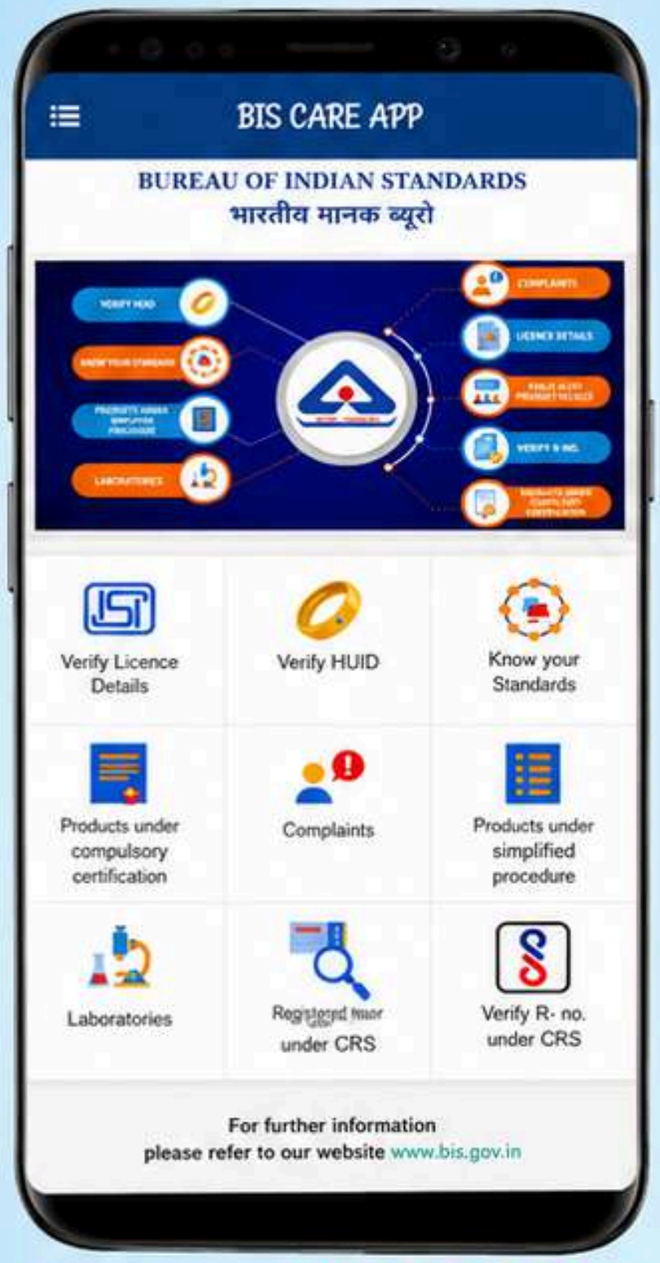
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