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भारतीय मानक मसौदा
नाइट्रोबेंजीन — सुरक्षा संहिता
(IS 8388 पहला पुनरीक्षण)

Draft Indian Standard
Nitrobenzene — Code of Safety
(*First Revision of IS 8388*)

ICS 71.080.30

Chemical Hazards Sectional Committee, CHD 07

Last date for Comments: 31 March 2025

FOREWORD

(*Formal clause to be added later later*)

Nitrobenzene is a pale yellow liquid with a distinct almond-like odour. The colour of the liquid varies from pale yellow to yellowish brown depending on the purity of the compound. Nitrobenzene is also known as the oil of mirbane or nitrobenzol and is represented by the formula, $C_6H_5NO_2$. Being a high boiling point liquid, the probability of poisoning by inhalation of vapour from the cold liquid is not much. Since nitrobenzene is a highly toxic substance, it will produce either acute poisoning by absorption of a large amount in a short time or chronic poisoning by continued exposure to small amounts. It can be absorbed by inhalation, ingestion, or directly through the intact skin. Its toxic reaction is enhanced by subsequent ingestion of ethanol. In industry, the major hazard is absorption through the skin. The reduction of nitrobenzene to aniline probably outranks all other uses of nitrobenzene as an industrial chemical. It reflects its importance as the starting material for dyestuffs and other organic intermediates.

The elimination of accidents is vital to public interest. Accidents produce social and economic loss and impair individual or group productivity. Realization of this loss has led the authorities to devote a good deal of attention to safety education. Apart from general precautions, some typical precautions are required to be taken during manufacture, storage and handling of nitrobenzene. The standard also prescribes safety measures for controlling hazards and essential information on symptoms of poisoning, first-aid, medical treatment, storage, handling, labelling and employee safety. This standard is intended to guide the users in the recognition of these hazards and in establishing safe handling procedure

This standard was originally published in 1977. With a view to update the standard based on the experience of last five decades and on the currently available data the Committee felt a need to revise the standard. In this revision general properties have been incorporated and modifications have been made to update safety measures for controlling hazards and essential information on symptoms of poisoning, first-aid, medical treatment, storage, handling, labelling and employee safety based on the currently available data and last four decades experience.

The properties of nitrobenzene listed in 4 have been taken from literature and have been included for information only. Moreover, these properties pertain to pure nitrobenzene. BIS has published a separate standard IS 2630: 2021 on the requirements and the methods of sampling and test for nitrobenzene.

The various clauses of the standard have been aligned with the format being applied for all Indian Standards on code of safety of chemicals.

In the preparation of this standard, the considerable assistance has been derived from Chemical Safety Data Sheet No. 21 'Nitrobenzene' issued by the Manufacturing Chemists' Association, USA.

1 SCOPE

1.1 This standard describes properties of nitrobenzene, the nature of hazards associated with it and essential information on its storage, handling, packing, labelling, disposal of waste, cleaning and repairing of containers, selection and training of personnel protective equipment and first aid.

1.2 This code does not deal with specification for design of buildings, chemical engineering plants, storage vessels, equipment for operations control and waste disposal.

NOTE

Attention of the users of this code is directed to the fact that the production, storage, transport, import, and export of nitrobenzene in India is controlled by the Chief Controller of Explosives of the Government of India under 'The In-flammable Substances Act 1952'.

2 REFERENCE

The Indian standards listed in Annex A contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards.

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 4155 shall apply.

4 PROPERTIES OF NITROBENZENE

4.1 General Information

The most hazardous property of nitrobenzene is its toxicity. Nitrobenzene can be absorbed through the skin and inhalation of its vapours can be harmful. At temperatures greater than nitrobenzene's flash point, air mixtures of nitrobenzene may explode or cause a flash fire. Vapours can flow along surfaces to distant ignition sources and flash back. Static discharge may also ignite nitrobenzene vapours, though accidental ignition is rare due to its relatively high ignition initiation energy point.

4.1.1 *Chemical Name* — Nitrobenzene

4.1.2 *Common Name & Synonyms*

Nitrobenzol, Nitrobenzolum, Essence of mirbane, Oil of mirbane, Nitrobenzene, Phenyl nitride, and Benzene nitrite.

4.1.3 *Uses*

Nitrobenzene is used as a solvent for various plastics and certain synthetic fibers, similar to nitrobenzene. It finds application in thinning polyester resins, cleaning tools used with these resins, and dissolving two-part epoxies and superglues before they harden. Additionally, nitrobenzene is utilized as a volatile component in some paints and varnishes. Its strong degreasing capabilities are particularly useful in preparing metal surfaces before painting or soldering, as well as in removing rosin flux after soldering operations. It is useful in the preparation of aniline further processed into products such as dyes, pharmaceuticals, and rubber chemicals.

4.2 Identification

4.2.1 *Formula* — C₆H₅NO₂

4.2.2 CAS Number — 98-95-3

4.2.3 UN Number — UN1662

4.2.4 UN Class — 6.1 (Toxic substance)

4.3 Physical Properties

4.3.1 General

Nitrobenzene is a colorless to pale yellow oily liquid composed of a benzene ring with a single substituted nitro group. Nitrobenzene is a liquid at room temperature.

4.3.2 Molecular Mass — 123.11 g/mol

4.3.3 Physical State — liquid

4.3.4 Colour — light to dark yellow

4.3.5 Odour — sweet and characteristic, bitter-almond-like

4.3.6 Boiling Point (at 760 mm) — 210 °C to 212 °C

4.3.7 Melting Point — (-) 94.7 °C

4.3.8 Freezing Point — 4.97 °C to 5.13 °C

4.3.9 Density — 1.196 g/cm³ at 25 °C

4.3.10 Relative Density at 20 °C/4 °C (water = 1) = 1.204

4.3.11 Vapour Density (air = 1) — 4.24

4.3.12 Specific Gravity — 1.20 g/cm³ at 25 °C

4.3.13 Viscosity at 20 °C — 2.03 mPa.s

4.3.14 Vapour Pressure

4.3.14.1 vapour pressure at 20 °C — 0.2 kPa

4.3.14.2 vapour pressure at 25 °C — 4.3 kPa

4.3.15 Heat of Combustion — (-) 3 260 kJ/mol

4.3.16 Refractive Index at 20 °C — 1.551 and 1.552

4.3.17 Solubility in Water

Nitrobenzene is slightly soluble in water, with a solubility of 0.19 percent soluble in water at 20 °C.

4.3.18 Solubility in Other Solvents

Nitrobenzene is more soluble in organic solvent such as benzene, diethyl ether, methanol, chloroform, and ethanol.

4.3.19 Light Sensitivity — No information available

4.3.20 Hygroscopicity — Not applicable

4.3.21 Latent Heat of Vaporization — 360 kJ/kg

4.3.22 Latent Heat of Fusion — 22.5 cal/g

4.4 Chemical Properties

4.4.1 Reactivity

4.4.1.1 Nitrobenzene is incompatible with bases, oxidizing agents, and reducing agents. It reacts vigorously with strong bases and may react with oxidizing or reducing agents to produce hazardous conditions.

4.4.1.2 Nitrobenzene may react explosively with materials such as chromic anhydride, chromyl chloride, hexachloromelamine, hydrogen peroxide, nitric acid, acetic acid, nitrosyl chloride, nitrosyl perchlorate, nitryl perchlorate, permonosulfuric acid, potassium tert-butoxide, thiodiglycol, and hydrogen peroxide.

4.4.1.3 For safe storage, nitrobenzene should be kept in containers made of gas-tight steel that comply with safety regulations, fitted with appropriate filling apparatus, and sealed with well-fitting airtight screw plugs or caps.

4.4.1.4 Nitrobenzene forms explosive mixtures with air on intense heating. The product is chemically stable under standard ambient conditions.

4.4.2 *Polymerisation* — Not applicable

4.4.3 *Oxidation* — No information available

4.3.4 *Allotrope Formation* — No information available

4.4.5 *Corrosion Properties*

Nitrobenzene does not typically cause corrosion in carbon steel or 13 Cr steel under normal conditions. It is generally considered non-corrosive to these materials at ambient temperatures and concentrations.

4.5 Fire and Explosion Hazard Properties

4.5.1 *Ignition Temperature* — 480 °C

4.5.2 *Flash Point*

4.5.2.1 *Open cup* — 77 °C

4.5.2.2 *Closed cup* — 87.8 °C

4.5.3 *Explosive Limit*

4.5.3.1 *Upper explosion limit* — 40 percent by volume in air

4.5.3.2 *Lower explosion limit* — 1.8 percent by volume in air at 93.3 °C

4.5.4 *Fire Risk*

Nitrobenzene is combustible. Although the vapour given off at elevated temperatures is flammable, nitrobenzene may be handled with little danger of fire. The flash point of the liquid is much higher than the temperatures at which it is normally handled. Flammable toxic vapour may be given off at elevated temperatures if the material becomes involved in the fire.

4.5.5 *Explosion Hazard*

4.5.5.1 Nitrobenzene is not likely to explode, as are the higher nitrated derivatives. However, when this is heated beyond its flash point it becomes as dangerous as gasoline at normal temperature. Such mass of air which contain more than 1.8 percent of the vapour can be exploded at a temperature greater than the flash point.

4.5.5.2 Nitrobenzene should never come in contact with strong alkalis, like caustic soda and caustic potash, as a violent reaction ensues, and the mixture may catch fire giving rise to noxious fumes. Also, during manufacture of nitrobenzene, the concentration of m-dinitrobenzene remains below 0.01 percent.

4.5.6 *Decomposition Temperature* — 380 °C

4.5.7 *Flammable Limits Lower* — 1.8 volume percent

5 HAZARDS ASSOCIATED WITH NITROBENZENE

5.1 General Information

Nitrobenzene is readily absorbed by direct contact through the intact skin, by inhalation of the vapour, or when ingested. Absorption in toxic quantities first manifests itself by cyanosis or 'blue lip'. A bluish tinge may be seen in the finger nailbeds, lips, and lobes of ears, conjunctiva, mucous membranes, and tongue. Cyanosis is caused by the conversions of the hemoglobin of the red blood cells to methemoglobin, which, unlike hemoglobin or oxyhemoglobin, is incapable of releasing its oxygen content to the tissues of the body so that varying degrees of tissue anoxic or asphyxia result. Early in this type of poisoning, a mild euphoria or sense of well-being is usually noted. As the concentration of methemoglobin rises, a patient complains of headache, drowsiness and occasionally of nausea and vomiting. If the methemoglobin content continues to rise, the patient becomes stupors, and he may even become unconscious. Such patients are seriously ill and death may ensue, if proper treatment is not promptly rendered.

5.2 Routes of entry

5.2.1 Skin

The repeated dermal exposure to liquid nitrobenzene can cause drying of the skin, and blue nails. The chemical burns may develop after prolonged exposure. Prolonged contact with skin may cause bluish skin, itching, irritation and eczema/chapping, and cracking of the skin.

5.2.2 Eyes

Nitrobenzene and its vapours are irritating to the eyes and mucous membranes. The exposure to high concentrations of nitrobenzene may lead to severe effects. The symptoms may include a burning sensation, redness, tearing, inflammation, and possible corneal injury. Therefore, proper safety measures and personal protective equipment should be used to avoid these adverse effects.

5.2.3 Ingestion

In an unlikely event if nitrobenzene is ingested it could cause systemic toxicity with symptoms like headache, lethargy, lack of coordination. It may also cause blue nails and lips. The higher amount of ingestion can be life threatening.

5.2.4 Inhalation

Inhalation of nitrobenzene vapours may cause nausea, vomiting, head-ache, faintness, fatigue, and bronchial irritation. Exposure to high concentration may cause irritation to the mucous membranes and upper respiratory tract and further the patient may complains of headache, dizziness, occasionally nausea and vomiting.

5.2.5 Long term effects

The repeated exposures to low concentrations of nitrobenzene may lead to chronic nitrobenzene poisoning. Systemic toxicity most commonly occurs after ingestion or prolonged or high concentration inhalation, rarely after extensive dermal exposure. The repeated or prolonged exposure to the nitrobenzene can produce target organs damage.

5.3 Toxicity information

Nitrobenzene is considered a highly toxic substance, primarily causing a condition called methemoglobinemia, where the blood's ability to carry oxygen is impaired, leading to symptoms like bluish skin discoloration, dizziness, headache, nausea, weakness, and shortness of breath upon exposure through inhalation, ingestion, or skin contact; high levels of exposure can result in depressed respiration, disturbed vision, and coma.

- a) Threshold Limit Value (TLV) — 1 ppm (5 mg/m³) for an 8-hour time-weighted average (TWA)
- b) Short Term Exposure Limit (STEL) — No data available
- c) Immediately Dangerous to Life or Health (IDLH) — 200 ppm
- d) Lethal Dose (LD₅₀), (rat), Dermal — 2 100 mg/kg
- e) Lethal Dose (LD_{Lo}) (rat), Oral — 640 mg/kg
- f) Inhalation (Rat) Lethal Concentration (LC) — 2.81 mg/l at 4 h.
- g) Recommended Exposure Limit (REL) — 1 ppm

5.4 Antidote

Methyl blue can be used as antidote for nitrobenzene poisoning.

5.5 Health Hazards

5.5.1 Signs and Symptoms

The symptoms of mild nitrobenzene poisoning are head-ache, slurred speech, lethargy, lack of coordination, sweet taste in mouth. The severe symptoms are very rare and may include coma, low blood pressure.

5.5.2 Acute Toxicity

5.5.2.1 Toxic effects

The toxic effects of nitrobenzene are essentially acute and give the signs and symptoms described in 5.1.

5.5.2.2 Local effects

5.5.2.2.1 Very rarely a dry scaly dermatitis may develop in workers exposed to nitrobenzene and is probably due to the defatting action of nitrobenzene upon the skin.

5.5.2.2.2 Nitrobenzene, upon skin contact, can similarly deplete moisture and oils, leading to dryness, brittleness, and potential peeling, which is generally considered a minor effect. Prolonged or repeated exposure may result in drying, cracking, or irritation of the skin. High vapour concentrations can cause drowsiness and irritation of the eyes or respiratory tract.

5.5.2.2.3 Nitrobenzene causes moderate to severe irritation in the eye, presenting symptoms such as sore, red eyes, and tearing. Vapours are also irritating to the eyes.

5.5.3 Chronic Toxicity

5.5.3.1 Systemic effects

Repeated exposures to low concentrations of nitrobenzene may give rise to a clinical picture which has been reported as chronic nitrobenzene poisoning. Such cases may present varying degrees of pallor, low-grade secondary anemia, fatigability and anorexia. However, upon complete cessation of exposure, such individuals promptly regain their normal levels of health with no permanent residual pathology being demonstrable.

5.5.3.2 Nitrobenzene tumors of the bladder

It has been thoroughly demonstrated that the absorption of nitrobenzene never gives rise to tumors of the bladder, either benign or malignant. The term 'Nitrobenzene Tumors' is, therefore, a misnomer.

6 PERSONAL PROTECTIVE EQUIPMENT

6.1 Availability and Use

While personal protective equipment is not an adequate substitute for good, safe working conditions, adequate ventilation and intelligent conduct on the part of employees working with nitrobenzene. Though it is considered as a second line of defense, the proper and adequate usage of the protective equipment shall certainly reduce the severity of the incidences. Furthermore, in many instances the only practical means of protecting the worker, particularly in emergency situations. The personal protective equipment (PPEs) protects only the worker wearing it, and other unprotected workers in the area may be exposed to danger.

6.2 Non-Respiratory Equipment

6.2.1 Eye and Face Protection

Wear chemical safety goggles and face shields when contact is possible [*see* IS 8521 (Part 1)]. The right kind of eye and face protection should be selected, used, and maintained where personnel are exposed to eye and face hazards including physical, mechanical, chemical, optical radiation and biological (*see* IS 8520). According to IS 8520 category H-4, which deals with chemical splash protection: Goggles should be worn along with a full-face shield. The face shield must be of sufficient length to cover the neck portion as well.

6.2.2 Skin Protection

Clothing made of impervious materials may be worn to protect the body against the splashes. Rubber gloves should be worn for hand protection. Fireproof overalls should be worn when operations involving nitrobenzene fires are encountered (*see* IS 8519 and IS 8807).

6.2.3 Head Protection

Hard hats should be worn where there is danger of falling objects. If hard hats are not considered necessary, soft-brimmed hats or caps may be worn to give protection against liquid leaks and splashes (*see* IS 2925).

6.2.4 Foot and Leg Protection

Workers handling nitrobenzene should wear leather safety shoes with steel toe caps or rubber gumboots for adequate foot protection. Leather leg guards are recommended to prevent exposure to spills and splashes. After any contamination, shoes must be thoroughly cleaned and ventilated to minimize further risks. These safety measures are essential for ensuring safe handling practices and minimizing potential health hazards associated with (*see* IS 10667).

6.2.5 Body, Skin and Hand Protection

Clothing made of impervious materials may be worn to protect the body against the splashes. Nitrile rubber gloves should be worn for hand protection as specified in IS 6994 (Part 1). Fireproof overalls should be worn when operations involving nitrobenzene fires are encountered (*see* IS 8519 and IS 8807).

CAUTION — Skin creams do not afford adequate protection.

6.3 Respiratory Equipment

6.3.1 Severe exposure to nitrobenzene vapour may occur in tanks, during equipment cleaning, repairs, during decontamination following spills, failure of pipelines or equipments. Employees who may be subject to such exposures shall be provided with proper respiratory protection such as:

- a) Air-line respirator;
- b) Self-contained breathing apparatus; and
- c) Canister type gas masks.

CAUTION — Filter type respirators do not offer protection against gases and are unsuitable for use when working with nitrobenzene.

6.3.1.1 Air-line respiration

These are suitable for use only where conditions will permit safe escape in case of failure of the compressed air supply. These masks are usually supplied with air pipes to the area from a compressor. It is extremely important that the air supply is taken from a safe source, and that it is not contaminated by oil decomposition from inadequate cooling at the compressor. The safer method is to use a separate compressor of the type not requiring internal lubrication. Pressure reducing and relief valves as well as suitable traps and filters, shall be installed at all mask stations. Better control of air quality pressure breathing air may be ensured by the use of high rom standard cylinders, with demand type valve and face piece.

6.3.1.2 Self-contained breathing apparatus

This apparatus permit the wearer to carry a supply of oxygen or air compressed in the cylinder [*see* IS 10245 (Part 1), and IS 10245 (Part 2)] and the self-generating type which produces oxygen chemically (*see* IS 15803). These allow considerable mobility. The length of time, a self-contained breathing apparatus provides protection varies according to the amount of air, oxygen, or regenerating’ material carried. Compressed oxygen should not be used where there is danger of contact with flammable liquids, vapours, or sources of ignition, especially in confined spaces, such as tanks or pits.

6.3.1.3 Canister type gas masks

This apparatus is equipped with full-face pieces with the proper canister for absorbing phenol vapour. These will afford protection against concentrations not exceeding 2 percent by volume when used in accordance with manufacturers instructions. The oxygen content, of the air shall not be less than 16 percent by volume. The masks should be used for relatively short exposure periods only. They may not be suitable for use in an emergency since, at that time, the actual vapour concentration is unknown and an oxygen deficiency may exist. The wearer shall be warned to leave the contaminated area immediately on detecting the odour of a harmful vapour. This may indicate that the mask is not functioning properly, that the vapour concentration is too high, that the canister is exhausted, or that the mask is not properly fitted.

6.3.2 The respirator should be selected (upper limit de-vices) based on Assigned Protection Factor (APF) as specified in Table 1.

Table 1 Respirator Selection

(Clause 6.3.2)

Sl. No.	Assigned Protection Factor (APF)	Respirator Selection
(1)	(2)	(3)
i)	10 (Up to 2 500 ppm)	Any chemical cartridge respirator with organic vapour cartridge(s), or any supplied-air respirator
ii)	25	Any powered, air-purifying respirator with organic vapour cartridge(s)

iii)

50

Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front or back-mounted organic vapour canister; or any self-contained breathing apparatus with a full facepiece

6.3.3 Escape

Air purifying full face-piece respirator with a high efficiency particulate filter. Appropriate escape type self-contained breathing apparatus.

7 STORAGE, HANDLING, LABELLING AND TRANSPORT

7.1 General

All personal handling nitrobenzene should use proper personal protective equipment. Appropriate firefighting equipment should be available in the vicinity while handling nitrobenzene. Persons handling nitrobenzene should have adequate training in use of firefighting equipment.

7.1.1 Equipment Design

The operation should be carried out in a perfectly closed type system. The equipment to handle nitrobenzene should be located in the open area or well ventilated area, because nitrobenzene is highly toxic in nature.

7.1.2 Ventilation

7.1.2.1 Good natural ventilation is considered sufficient in places where nitrobenzene is handled. Since nitrobenzene vapour is 4.24 times heavier than air, a down draught mechanical exhaust may be needed in those operations where general ventilation is considered inadequate. The air flow should be away from the work area.

7.1.2.2 Vent lines from closed system holding vessels should be extended well above the roof level of process buildings, so that vapour shall not enter buildings.

7.1.3 Air Monitoring

Certain regulations prescribe testing of atmosphere where the processes of manufacturing or manipulation of nitro-compounds are being carried out. Routine monitoring of contamination level indicates effective functioning of technical control measures and steps to be taken if it is not so.

7.2 Storage

7.2.1 Nitrobenzene is commonly stored in a steel tank. Locate storage tanks away from any area where fire hazard is acute. Bulk storage tanks should be located in the open. Storage of any combustible material should not be allowed in the building.

7.2.2 Storage tanks may be constructed of stainless-steel storage tanks should be placed in retaining basins, also to be constructed of concrete or welded steel. The basins should be adequate to retain the full contents of the tank or tanks. Water lines should be provided to allow instant flooding of basin.

7.2.3 Sealed tanks should be equipped with frangible discs or safety valves set to release at a predetermined pressure. End of pressure relief line should go out through flame arrester to a safe area.

7.2.4 Vent line of tank should go to a cooled condenser to condense the vapours and return it back to tank. An ample safety factor should be allowed to protect the tank itself. Vent of condenser should go to safe area through flame arrester. Firefighting facilities applicable to the type of tank protected

7.2.5 Storage and handling facilities shall be sited in well-ventilated areas to prevent the accumulation of pockets of nitrobenzene vapours. Earth every tank to prevent static electricity from accumulating.

7.2.6 Build a dyke around storage tanks to keep the liquid from flowing out, so that disposal can be controlled in case the tank is ruptured. Inspect every tank periodically, and keep it under safe condition.

7.2.7 Pipelines shall be supported by steel stanchions or concrete sleepers. Wood shall not be used.

7.2.8 Pipelines shall have adequate electrical continuity and shall be earthed.

7.3 Handling

7.3.1 General

7.3.1.1 When nitrobenzene is transported, refrain from transporting it together with other materials. Adequate care shall be taken not to drop the containers or cause them any damage.

7.3.1.2 Put a sign in a conspicuous place indicating the presence of hazardous chemicals. Protect the containers from direct sunlight. No smoking should be permitted in the vicinity of the material.

7.3.1.3 If leaks or spills occur, only properly trained personnel shall remain in the area. Leaking containers shall be removed to an isolated, well-ventilated area and the contents transferred to other sound containers. All spills shall be flushed away promptly with water.

7.3.1.4 All empty tanks or other containers which have contained nitrobenzene, except when they are opened for the purpose of cleaning them and rendering them free of nitrobenzene vapours, shall be kept securely closed unless they have been thoroughly cleaned.

7.3.2 Tanks

7.3.2.1 Protection against electrostatic charges which can cause ignition. This may include the bonding and grounding of the tank, piping, and other ancillary equipment and the use of bottom or dip-pipe loading to minimize material splashing in the tank.

7.3.2.2 In case flexible hoses is to be used, it should be metal braided hose of appropriate pressure rating. Upbraided hose should not be used.

7.3.2.3 Nitrobenzene, being a solvent, requires careful consideration of compatible materials to prevent dissolution. It is a polar solvent and should not come into contact with similar materials such as PVC or natural rubber, as these elastomers are susceptible to failure. Compatible materials for handling nitrobenzene include most metals, polytetrafluoroethylene (PTFE), and tetrafluoroethylene (ETFE). These materials are resistant to nitrobenzene's sol-vent properties, ensuring safe storage and handling without risk of material degradation. Adhering to these guidelines is crucial to maintain safety and prevent potential hazards associated with nitrobenzene exposure.

7.3.2.4 Nitrobenzene is pumped from storage tanks using suitable pumps. Filling small containers by gravity requires grounding of both containers and transfer pipes to prevent fires from static charges. This precaution dissipates static electricity that could ignite nitrobenzene vapours, ensuring safe handling and transfer operations.

7.3.2.5 One storage tank equal in capacity to the largest tank in use should be kept free at all times to transfer nitrobenzene in case of emergency.

7.3.2.6 Empty drums or containers used for nitrobenzene storage must be stored securely to prevent unauthorized interference and should be tightly closed. It is important to note that an empty container with residual nitrobenzene, sufficient to wet its interior, may pose a greater explosion risk due to the larger volume of explosive mixture it contains compared to a full container. Awareness of this potential hazard is crucial for safe handling and storage practices for nitrobenzene.

7.4 Labelling

7.4.1 Each container (including tankers) shall carry an identifying label or stencil as depicted Fig. 5 of IS 1260 (Part 1) or Label Model No 6.1 of Annex-B of IS 18149. The material shall be packed in suitable drums conforming to IS 2552. The storage containers shall be labelled or marked to identify as follows:

a) Name of material;

b) Name of the manufacturer;

c) Lot/batch number;

d) Net, gross and tare mass; and

e) Physical, chemical and toxicological data as per the criteria given in the relevant schedule of the *manufacture, storage and import of Hazardous Chemicals Rules*, 1989. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

7.4.2 The following cautionary label is recommended for use in combination with any other statements required by statutes, regulations, etc.:

NITROBENZENE
DANGER. EXTREMELY HAZARDOUS.
LIQUID AND VAPOUR RAPIDLY ABSORBED
THROUGH THE SKIN. SHOULD NOT GET IN

EYES, ON SKIN, ON CLOTHING. AVOID
BREATHING VAPOUR. USE ONLY WITH
SUFFICIENT VENTILATION.

7.4.3 In case of contact, remove at once contaminated clothing including footwear and flush skin or eyes with plenty of water (preferably with warm water) for at least 15 min. Get medical aid. Launder clothing before re-use.

7.4.4 Manufacturers name with label warnings required by regulations or ordinances form part of the label or placard.

7.4.5 Each drum shall be labelled as follows:

DANGER! KEEP WELL CLOSED AND PROTECTED FROM
DIRECT SUNLIGHT. NITROBENZENE IS ABSORBED
THROUGH THE SKIN. AVOID CONTACT WITH SKIN

7.4.6 Each tanker and each railroad car carrying one or more containers of nitrobenzene must bear the "DANGEROUS" placard in addition.

7.5 Transport

7.5.1 The Rules and Regulations for transportation of hazardous chemicals shall be strictly adhered to. During shipping in drums the materials may have to be stored in such a way that it should fulfil all instruction of storage given under **7.1** and **7.2**.

7.5.1.1 Unloading Tankers

Unloading stations should be equipped with safety showers (*see IS 10592*). The truck should be spotted accurately and levelled. Stoppers/pegs should be used to avoid movement of truck during unloading. Supplier's instructions for unloading should always be followed and all caution markings on both sides of trucks should be read and observed.

Tanker unloading should be preferably to tank at same level or at lower level. Truck should not be unloaded to a tank at higher elevation.

7.5.1.2 Unloading Drums

Unloading can be done by gravity/siphoning or using a pump. Ensure that all fittings are tight. Ensure piping and containers are grounded to avoid build-up of static charge.

7.5.1.3 Driver

Vehicle driver should be aware of the potential hazards of the load and should know standard procedure (dos and don'ts) in the event of an accident or an emergency.

Driver should carry TREM card when vehicle is on road.

NOTE — If transport of the hazardous chemical is involved it shall be carried out in accordance with the *Central Motor Vehicles Rules, 1989*. While referring to the statutes, the stipulations given in the subsequent amendments of those statutes shall be taken into account.

8 SPILLAGE, LEAKAGE AND WASTE DISPOSAL

8.1 General

All personal attending to spill/leak should use proper personal protective equipment and firefighting equipment while handling nitrobenzene.

8.2 Spillage

8.2.1 General Information

Proceed with caution. Restrict access to area. Keep unprotected personnel away and upwind of spill area to avoid vapours inhalation. Avoid contact with spilled product. Protect sewers and waterways from contaminated runoff. Notify proper authorities. Keep inert absorption media readily available.

8.2.2 Land Spill (Spill on Land)

8.2.2.1 Containment

Nitrobenzene may be contained by building dikes, digging pit or barrier using earth, and or similar materials. Absorb bulk material with fly ash, cement powder or commercial sorbents. Remove contained product as soon as possible to prevent spread of contamination. Remove trapped material using suction hoses.

8.2.2.2 Consequences

Any nitrobenzene that escapes may get vaporized or get absorbed in soil or get mixed in waterways.

8.2.2.3 Mitigation

Area cleared of spilled nitrobenzene should be flushed with water.

8.2.3 Water Spill (Spill in Water)

Nitrobenzene is sparingly soluble in water, meaning it dissolves to a limited extent. Its solubility in water is approximately 8.3 g/l at room temperature.

8.2.3.1 Containment

In the event of a spill, cease water use immediately. Notify relevant authorities to halt water intake or monitor for contamination. Nitrobenzene, which dissolves in water, poses contamination risks. Prompt action is critical to prevent environmental harm and ensure safety compliance.

8.2.3.2 Mitigation

Nitrobenzene is highly soluble in water. Contaminated water should be diluted or allowed to stand for nitrobenzene to evaporate. High concentrations require distillation for separation and safe disposal leakages

8.3 Leakages

8.3.1 General Information

8.3.1.1 In case of any leak of nitrobenzene from a drum or tank, isolate all ignition sources from immediate area. Do not touch or walk-through spilled material. Stop leak if it can be done without any risk. Arrange to transfer the contents to another tank or drum in case leak cannot be stopped.

8.3.1.2 Leak from a pipeline or storage vessel-nitrobenzene will form a pool of liquid on the ground. The liquid now can be restricted with earth and then absorbed using absorbents.

8.3.2 Leak from the Tanker

If possible, apply a sealant (suitable like M-seal) for minor leak. In case of major leaks, arrange to transfer the material in another tanker or fill in barrels/drums. Dripping leaks should be collected in smaller containers.

8.3.2.1 Caution

Eliminate all ignition sources (no smoking, flares, sparks or flames) from immediate area. Use PPEs while handling nitrobenzene. Remain upwind to avoid nitrobenzene inhalation. Use grounded pipes to avoid static charge igniting nitrobenzene.

8.4 Waste Disposal

8.4.1 General

8.4.1.1 Statutory regulations regarding health and pollution are to be strictly followed. Waste may be washed away to a sewer after being diluted with a large quantity of Water (approximately one percent slurry).

8.4.1.2 Care shall be taken to keep any person away from the place where waste materials are buried. It shall be made certain that there is no danger of pollution of underground water sources used as sources of drinking water.

8.4.1.3 Small quantities of nitrobenzene or waste may be disposed of by burning. Disposal of containers and material should be hazardous waste.

8.4.1.4 Water contaminated with nitrobenzene should be treated before allowing it to flow out of the plant.

8.4.1.5 Returnable drums should be thoroughly washed inside and outside with water, drained, and covered tightly before returning. Non-returnable containers, before scrapping, should be thoroughly washed with water until all traces of nitrobenzene are removed.

8.4.2 Tank and Equipment Cleaning and Repairs

8.4.2.1 Preparation of tank and equipment

8.4.2.1.1 Since inspection, washing and repairs of tanks are hazardous operations, cleaning should be done under the direct supervision of trained personnel who are thoroughly familiar with the hazards and the safeguards necessary for the safe performance of the work. The main hazards are exposure to nitrobenzene (liquid and vapour).

8.4.2.1.2 Tanks and equipments pumps, lines and valves should be drained and washed before being repaired. No attempt should be made to repair equipments till free of nitrobenzene. While opening flanges, the lower bolts farthest away should be loosened first, taking care to avoid contact with the drippings.

8.4.2.1.3 Pipelines into or out of the tank should be disconnected, preferably by removing a complete small section and providing a blank flange on the open end to protect against human error and unsuspected leaks. Valves, cocks should not alone be relied upon.

8.4.2.1.4 Remove completely the residues by washing the tank with cool water. Then wash the tank with hot water (60 °C) repeatedly.

8.4.2.1.5 Introduce live steam in the tank, keeping open the bottom outlet for constant drainage of condensate water.

8.4.2.1.6 When all nitrobenzene smell is gone, cool the tank, and confirm the absence of nitrobenzene liquid and vapours.

8.4.2.2 *Entering Tank/Vessel*

8.4.2.2.1 A tank/vessel or any other confined space shall not be entered without a valid work permit clearing the equipment for safe entry.

8.4.2.2.2 be sure that the equipment can be left by the original entrance. Put on a respiratory equipment and a relief rope.

8.4.2.2.3 One man on the outside of the tank should keep the man in the tank under constant observation, and at least two men should be available to aid in case of any risk to the man in the tank.

8.4.2.2.4 Special ventilation and a continuous fresh air supply are recommended during the entire time men are cleaning, inspecting or repairing the tank.

8.4.2.2.5 During the course of the work, tests shall be made to determine that no further washing is necessary, that no oxygen deficiency exists and that no harmful gas or vapour is present. This is essential as the residues which are not completely removed by washing get stirred up and may decontaminate the tank atmosphere.

8.4.2.2.6 On tanks having opening only at the top, complete removal of vapour has to be ensured. Chances of exhaust gases being recycled inside the tank should be eliminated.

8.4.2.3 *Repairs*

8.4.2.3.1 No repair work such as cutting, riveting, welding should be undertaken on tanks and equipments unless a work permit has been issued by an authorized person.

8.4.2.3.2 In all cases, if repair work is interrupted for more than an hour, the work permit should be revalidated before resumption of work.

9 FIRE PREVENTION AND FIRE FIGHTING

9.1 General

9.1.1 Nitrobenzene is combustible. In case of insufficient ventilation and/or in use, it may form flammable/explosive vapour-air mixtures. Solvent vapours are heavier than air and may spread along floors. Places that are not ventilated, such as unventilated below-ground level areas like trenches, conduits, and shafts, are particularly prone to the presence of flammable sub-stances or mixtures. Vapours are heavier than air, spread along floors, and form explosive mixtures with air. Vapours may form explosive mixtures with air.

9.1.2 The detection system shall be able to sense the presence of smoke or heat during the initial growth period of fires. Various types of detectors which operate at predetermined temperatures or which detect the smoke photo-electrically or electronically are employed to suit individual risks. Detectors are made to operate audible or visual alarms or both. They are also linked to the fire authority control room. Good as they are, automatic detection systems only detect the fire after it has started. Since fire patrols often discover conditions which might lead to a fire and correct them in time, consideration shall be given to establishing regular fire prevention patrols in addition to automatic systems. All personnel engaged in fire-fighting operations must use appropriate PPEs to prevent exposure.

9.1.3 Move container from fire area if without risk. Use water from side and from safe distance to keep fire exposed containers cool.

9.2 Prevention

9.2.1 As nitrobenzene is easily absorbed in human body, improve the equipment and operation methods lest nitrobenzene should leak or its vapour should transpire.

9.2.2 Adequate personal protective equipments are to be worn while washing, repairing tanks and other equipments or attending to leaks and spills.

9.2.3 The maximum concentration of nitrobenzene for a 60 min exposure is considered to be 100 ppm. In case of a lower concentration for a short-time operation, a canister type gas mask may be used provided oxygen in the air is more than 16 percent by volume.

9.2.4 In case vapour concentration is unknown or is above 100 ppm or oxygen is less than 16 percent put on an airline respirator or self-contained breathing apparatus.

9.2.5 It is advisable to absorb spillings in sand first and then wash the floor after collecting the moist sand to avoid exposure.

9.2.6 Caution to be taken during Use

9.2.6.1 Since drums are not pressure containers, do not use any pressurized gas to transfer nitrobenzene from the drums.

9.2.6.2 Avoid direct contact with skin.

9.2.6.3 Persons handling it shall wear personal protective equipment, such as goggles, aprons, gloves, and rubber sheets.

9.2.6.4 Workers should be instructed emphasizing the need for handling nitrobenzene in accordance with approved methods.

9.2.6.5 For emptying drums, place the bung up and use a bung wrench to remove the body plug. Stand on the side and open the plug about half turn. Allow the internal pressure, if any, to release and then open it full.

9.2.6.6 Do not use empty containers for any other product.

9.2.6.7 The empty containers, before discarding, should be thoroughly cleaned of their contents and treated with an inactivating agent.

9.3 Fire fighting

9.3.1 Although nitrobenzene is a nitrated compound, it behaves much like a straight hydrocarbon, that is, it requires an external supply of oxygen to burn.

9.3.2 Use carbon dioxide, dry chemical or foam extinguishers when fire is still small.

9.3.3 In case the fire gains headway, it becomes difficult to approach the fire because of too fierce flames and toxic gas. Put on breathing apparatus while fighting fire.

9.3.4 Water may be used successfully if applied in the form of a fog or spray. It is advisable to enclose the fire area with water jets.

10 TRAINING

10.1 Safety in handling nitrobenzene depends upon the effectiveness of employee education, training, and supervision. The education and training of employees to work safely and to use the personal protective equipment and other safeguards provided for them is a responsibility of the supervisor.

10.2 Employee education and training should emphasize the need for safely handling nitrobenzene according to the methods outlined in the manual, in order to avoid spilling or splashing, leaks, skin contact, inhalation of vapours, or ingestion. Unauthorized and untrained employees should not be permitted in areas where nitrobenzene is being handled.

10.3 Before being placed on the job, all new employees should be instructed and trained to maintain a high degree of safety in handling procedures. Older employees should be re-instructed and trained periodically.

10.4 Each employee shall know the location, purpose, and maintenance of personal protective equipment (PPEs) and be thoroughly trained when and how to use it. Each employee shall know the location of safety showers, fountains for flushing the eyes, and hose lines.

10.5 Only reliable, dependable, and properly trained employees shall be given the responsibility of all operations involving storage, handling, transport, and emergency management involving nitrobenzene.

10.6 Employees should be trained to report to the proper authority all suspected leaks or equipment failure.

10.7 They should be instructed to inform supervisors of any signs of illness or skin-related problems.

10.8 Workers should be specifically instructed that ingestion of even small amounts of alcoholic beverages preceding or following absorption of nitrobenzene will increase its toxic effects. Habitual users of alcohol shall not be permitted to work in the area where potential exposures to this compound exist.

10.9 Each employee should know what to do in emergency and the first-aid measures and should realize the necessity for the prompt application of first aid in case of contact with nitrobenzene or exposure to the vapours.

11 HEALTH MANAGEMENT, FIRST-AID AND MEDICAL TREATMENT

11.1 Health Monitoring

11.1.1 Personal Hygiene

11.1.1.1 Carefully wash hands, face, and feet before meal. A warm water bath before leaving the factory is essential, taking care to wash the head properly.

11.1.1.2 Employees should bathe daily after finishing work. They should report any abnormality related to any inhalation or ingestion of nitrobenzene to the medical department. Avoid alcoholic drinks while being exposed to nitrobenzene or soon after the exposure, as these increase the risk of poisoning.

11.1.1.3 Food should not be stored or eaten near the place where nitrobenzene is being handled. Should not consume alcohol if the possibility of nitrobenzene inhalation, ingestion

11.1.1.4 Work clothes should be compulsorily laundered every day on the premises. Clothing contaminated with nitrobenzene while working shall be promptly removed and washed before reuse. To minimize the possibility of skin contact, men working with nitrobenzene should have two lockers and should be required to keep work clothing separated from personal clothing.

11.1.1.5 Emergency showers and eye wash fountains should be provided in areas where potential exposure to nitrobenzene exists (*see* IS 10592).

11.1.2 Physical Examination

11.1.2.1 Pre-placement physical examinations

Pre-placement medical examination should be directed toward the medical fitness of employees for a particular occupation. As a worker who handles nitrobenzene, it is unsuitable to employ an anaemic person, a person with heart and kidney trouble, a person suffering from any urinary disease, a person prone to allergy, and a heavy drinker. Carry out a blood test and employ a normal healthy person.

11.1.2.2 Periodic examination

11.1.2.2.1 Regular health examinations shall be carried out at intervals of not more than 3 months. Conduct blood tests every month. It is necessary to check the conditions of workers who may be exposed to nitrobenzene from time to time and confirm that no case of anaemia is found.

11.1.2.2.2 By conducting urine tests (urobilinogen, porphyrin, occult-blood test, and the deposit), acute and chronic poisoning of nitrobenzene may be prevented. It is desirable to carry out the examination of urine once in two weeks, especially once a week in summer.

11.2 First Aid

11.2.1 General Principles

11.2.1.1 Take off the contaminated clothes at once and wash the skin immediately and thoroughly with plenty of soap and tepid water. Speed in removing nitrobenzene from the skin is of prime importance. Do not put on contaminated clothes again unless they are cleaned up sufficiently. Carry a toxic patient on a stretcher to the medical department or first aid station. No matter how slight his symptoms are, refrain from speaking loudly or

doing anything which may disturb the patient. Do not give a patient any such stimulant which contains alcohol. Do not use any tincture (containing alcohol) as a cardiac.

11.2.1.2 If a patient has consciousness, he may drink fluids containing carbohydrates, such as orange juice and sweetened lemonade. Even though severe headache is complained of, drugs such as acetanilide, acetophenetidine, and other methemoglobin producers shall not be given. Headache may be relieved by codeine administered by nursing personnel.

12.2.2 *Contact with Skin*

Remove all contaminated clothing. Get under an emergency shower. Wash the affected area thoroughly with soaps and tepid water.

11.2.3 *Contact with Eyes*

Wash the eyes with a large amount of water, holding apart the eyelids, for at least 15 min. Though nitrobenzene does not give too much irritation to the eyes, it is apt to injure the cornea. A competent physician should be consulted as early as possible.

11.2.4 *Ingestion*

Ingestion of nitrobenzene should be treated by the administration of an emetic such as mustard and water or a lukewarm emulsion of soap and water, provided the patient is conscious.

11.2.4.1 *Caution*

Never give anything by mouth to an unconscious person

11.2.5 *Inhalation*

Inhalation of the vapors requires the same treatment as that for skin absorption or ingestion except that an emetic is needed only when nitrobenzene is swallowed. Medical help must be provided in case of headache, slurred speech, or lethargy.

11.2.5.1 Burning nitrobenzene in a confined area may deplete oxygen from the air, causing asphyxiation. Remove the patient immediately to fresh air and start effective artificial respiration if breathing has ceased. Call a physician at once.

11.2.6 *First-Aid Kit*

Additional requirement of methyl blue in first aid kit. Flushing of skin or rinsing of mouth is first aid in case of a nitrobenzene poisoning. If a patient has consciousness, he may drink fluids containing carbohydrates, such as orange juice and sweetened lemonade. Even though severe headache is complained of, drugs such as acetanilide, acetophenetidin and other methemoglobin producers shall not be given. Headache may be relieved by codeine administered by nursing personnel.

11.3 *Suggestions to Physicians*

11.3.1 If possible, while the patient is acutely ill, methemoglobin concentrations of the blood should be determined quantitatively at least every half an hour. Such a check should be continued until it is established definitely that the concentration of methemoglobin is steadily decreasing.

11.3.2 If the concentration of methemoglobin reaches 40 percent in venous blood samples, 1 000 ml of 5 percent glucose may be administered intravenously and repeated in an hour, if necessary. This appears to stimulate the reversion of methemoglobin to hemoglobin.

11.3.3 The patient shall be comfortable in an oxygen tent, Oxygen serves to relieve headache transiently, apparently due to supersaturation of the hemoglobin and plasma with oxygen, but does not seem to hasten the reversion of methemoglobin to hemoglobin. Under such treatment, acutely toxic patients with methemoglobin concentrations as high as 76 percent in venous blood samples usually make eventful recoveries within 24 h, with no demonstrable permanent, residual pathology.

11.3.4 It is imperative that patients be closely observed and remain in bed for 24 h if methemoglobin content has reached 40 percent.

11.3.5 An intravenous injection of 10 ml to 20 ml of 2 percent ammonium thiosulphate and a large dose of vitamin C at one time shall contribute to a quick recovery.

11.4 *Medical treatment*

Washing of skin or eyes using a large amount of water. Stomach wash by medical professionals.

12 ADDITIONAL INFORMATION

Additional information essential for particular equipment used for handling of nitrobenzene, Security measures to be taken while handling of nitrobenzene etc. as essential for controlling hazards may be collected and applied.

ANNEX A

(Clause 2)

LIST OF REFERRED STANDARDS

<i>IS No.</i>	<i>Title</i>
IS 1260 (Part 1) : 1973	Pictorial marking for handling and labelling of goods Part 1 Dangerous goods (<i>first revision</i>)
IS 2552 : 1989	Steel drums (galvanized and un-galvanized) — Specification (<i>third revision</i>)
IS 2925 : 1984	Specification for industrial safety helmets (<i>second revision</i>)
IS 4155 : 2023	Glossary of terms relating to chemical and radiation hazards and hazardous chemicals (<i>first revision</i>)
IS 6994 (Part 1) : 2021/ ISO 374-1 : 2016	Protection of arms and hands Part 1 Protective gloves against dangerous chemicals and micro-organisms-terminology and performance requirements for chemical risks (<i>first revision</i>)
IS 8519 : 2024	Guide for selection of occupational protective clothing — Body protection (selection, care, and maintenance) (<i>first revision</i>)
IS 8520 : 2023/ ISO 19734 : 2021	Eye and face protection — Guidance on selection, use, and maintenance (<i>first revision</i>)
IS 8521 (Part 1) : 2022/ ISO 16321-1 : 2021	Eye and face protection for occupational use Part 1 General requirements (<i>first revision</i>)
IS 8807 : 1978	Guide for selection of industrial safety equipment for protection of arms and hands
IS 10245 (Part 1) : 1996	Breathing apparatus Part 1 closed circuit breathing apparatus (compressed oxygen cylinder) — Specification (<i>first revision</i>)
IS 10245 (Part 2) : 2023	Respiratory protective devices — Specification Part 2 Self-contained open circuit breathing apparatus (<i>second revision</i>)
IS 10592 : 2018	Industrial emergency showers, eye and face fountains and combination units — Specification (<i>first revision</i>)
IS 10667 : 1983	Guide for selection of industrial safety equipment for protection of foot and leg
IS 15803 : 2008	Respiratory protective devices — Self-contained closed circuit breathing apparatus chemical oxygen (KO ₂) type, self-generating, self-rescuers — Specification
IS 18149 : 2023	Transportation of dangerous goods — Guidelines