# Manual for Chemical and Hazardous Substances Storage

*(Annexed with the Notification of the Department of Industrial Works regarding the Manual for Chemical and Hazardous Substances Storage, dated 27th November 2007)*

**1. Definition**

**"Chemical substance"** means a substance composed of an element or a compound formed when elements are chemically bonded.

**"Hazardous substance"** means hazardous substance listed under the responsibility of the Department of Industrial Works according to the Notification of Ministry of Industry issued under the provisions of the second paragraph of Section 18 of the Hazardous Substance Act B.E. 2535.

**"Chemical and hazardous substances storage manual"** means either a storage of chemical substance or a storage of hazardous substance or both.

**"Storage facility"** means a warehouse used to store chemical and hazardous substances.

**"Storage"** means storage of chemical and hazardous substances inside and outside a storage facility but not including storage in tank, silo and portable/bulk container cryogenic liquefied gas or refrigerated liquefied gas.

**"Walls"** means walls of a warehouse where chemical and hazardous substances are stored that is constructed of fire-resistant materials or built as fire walls, as deemed appropriate.

**"Fire-resistant materials"** means construction materials that are non-combustible.

**"Fire walls"** means the vertical partitions built to separate the internal area of the building and prevent the spread of fire, which are constructed of fire-resistant materials that can withstand fire. The fire-resistant ratings are, depending on types of materials and thickness of walls, 30 minutes, 60 minutes, 120 minutes and 180 minutes in compliance to the international standards.

**"Safety signs"** means specific signs and symbols identifying activities, situations and providing information or operational procedures related to safety and/or occupational health, with which colors and symbols are coordinated and entitled to be in compliance to concerned laws.

**"Packaging"** means packages and International Bulk Containers (IBCs) used to contain chemical or hazardous substance for storage in the storage facility.

**"Packages"** means a container of chemical or hazardous substance having maximum capacity of not exceeding 450 liters and maximum net mass not higher than 400 kg.

**"Intermediate Bulk Containers (IBCs)"** means containers of chemical or hazardous substance having a capacity of:

a) not more than 3.0 $m^3$ (3,000 liters) for solids and liquids classified in Packing Group II and III;

b) not more than 1.5 $m^3$ for solids classified in Packing Group I when packed in flexible, rigid, fiberboard, wooden or composite IBCs having inner plastic receptacle.

c) not more than 3.0 $m^3$ for solids classified in Packing Group I when packed in metal IBCs.

**"Salvage packages"** means a special package, into which damaged, defective, leaking or non-conforming packages or chemicals or hazardous substances that have spilled or leaked, are placed for purposes of transport for recovery or disposal.

**"Classification of chemical and hazardous substances for storage"** means classification of chemical and hazardous substances by their physical, chemical properties or their possible hazards for purposes of safety storage.

**"Preventive measures"** means measures taken to prevent any dangers that may occur from chemical and hazardous substances storage, which comprises various activities such as hygiene management, operating instructions, training and spill & leak response, etc.

**"Special requirements"** means additional requirements for a storage facility of chemical and hazardous substances of specific properties, which are explosives, gases, flammable substances and oxidizing substances.

**"ADR"** means Accord européen relatif au transport international des marchandises dangereuses par route (The European Agreement Concerning the International Carriage of Dangerous Goods by Road)

**2. Storage facility**

Storage facility must be stable and strong in according to the building control law and must have the following specifications:

**2.1 Walls and fire walls**

2.1.1 Walls and fire walls must withstand fire. A height of fire walls must be 0.30-1.00 meters above the roof and 0.30-0.50 meters extended from the sides. These specifications shall conform to the special requirements or any other methods that can restrict the spread of fire.

2.1.2 A chemical and hazardous substances storage warehouse that its area's width is less than 30 meters and its space is from 1,200 $m^2$ must build a fire compartment that a distance between each compartment must not exceed 40 meters or as approved by the Department of Industrial Works.

2.1.3 In case where a storage facility's distance from other building is less than 10 meters, the wall facing to such building must be built with a fire wall that can withstand fire for at least 90 minutes, except for a storage facility of non-combustible substances.

**2.2 Floors**

2.2.1 Must have sufficient load bearing capacity to support all the chemical and hazardous substances stored;

2.2.2 Must be resistant against water and chemicals;

2.2.3 In case that flammable liquids, flammable gases and explosives are stored, the floor must be conductive and anti-static;

2.2.4 Must not absorb liquids, smooth and level, non-slippery, no cracks and easy to be cleaned.

**2.3 Doors and Emergency Exits**

The number, dimension, location and material used to construct the doors are determined depending on the design and purpose of the room, the use of the door and the space as follows:

2.3.1 At least 2 doors for entrance and exit are required including an emergency exit which is situated on the opposite side.

2.3.2 Entrance and exit doors at the loading docks must be safe for the workers to passing by, kept clear all the time and clearly indicated with signs.

2.3.3 Emergency exit must be easily opened outward with its width at least 1.10 meters and must not be key-locked and not a sliding-door type as well as it must not be the exit to the dead-end area.

2.3.4 Emergency lighting must be provided near the emergency exit route and clearly identified with a sign that can be clearly seen in the dark and must be kept clear from the obstruction.

2.3.5 The emergency exit must be placed on two opposite sides of the building. If it is a big building it must be ensured that the emergency exit has been placed at each 35 meters.

2.3.6 A fire door is integrated in a fire wall that can withstand fire for not less than a withstanding time of the fire wall.

2.3.7 The fire door that is integrated in a fire wall that separates rooms must be automatically closed and interlocked with fire alarms.

2.3.8 Doors for entrance/exit, a loading dock and a fire door that are sliding-type must be fitted with a safety device to prevent them from being derailed.

**2.4 Roof**

2.4.1 The roof, not only constructed for rain protection, but it must be designed to vent heat and smoke during fire.

2.4.2 The main structure of the roof must be constructed of non-combustible material.

2.4.3 The roof materials must withstand fire for 30 minutes.

2.4.4 The roof must be ceiling-free, except when it a ceiling is necessary such as in the temperature-controlled room, the ceiling must be non-combustible and it is required to install a heat and smoke detector under the roof.

2.4.5 Where the storage is done in the vertically-separated rooms, it must be assured that the floor and its structure can withstand fire for at least 90 minutes.

**2.5 Ventilation system**

2.5.1 Storage facility must be well ventilated taking into consideration types of chemical and hazardous substances it is stored as well as must have the safe working conditions.

2.5.2 Ventilation system must be provided in the storage facility, naturally or mechanically.

2.5.2.1 Natural ventilation, for example ventilation through the openings between the double roofing constructions.

2.5.2.2 Mechanical ventilation, which must be designed by a specialist.

**2.6 Electrical system, emergency lighting and electrical equipment**

2.6.1 Design and installation must conform to the latest version of Electrical Installation Standards of Thailand which is determined by the Electrical Engineering Technical Committee of the Engineering Institute of Thailand.

2.6.2 Electrical system and emergency lighting in a storage facility must be designed and installed for a purpose of fire or explosion protection.

2.6.3 Lighting in a storage facility must be installed above the traffic ways and must be at least 0.5 meters above the hazardous substances. Type of lamps and installation locations must not develop heat to the chemical or hazardous substances.

2.6.4 Metal halide and mercury lamps must be cased to prevent the light bulbs from falling down.

2.6.5 Electrical equipment must be grounded and have a short-circuit prevention system installed.

2.6.6 In a dangerous area where the flammable substances are stored and transferred must be provided with the explosive-proof electrical system and electrical equipment as appropriate to types of substance stored.

**2.7 Lightning protection**

Lightning protection must be conformed to the standard of lightning protection for buildings determined by the Electrical Engineering Technical Committee of the Engineering Institute of Thailand and must perform as follows:

2.7.1 The building must be installed with the lightning protection system.

2.7.2 Any building located within a 30-meter distance to a building where the explosive or flammable substances are stored must be installed with a lightning protection system.

2.7.3 Installation and design of the lightning protection system must be carried out by a specialist.

**2.8 Alarm system**

2.8.1 There are 2 kinds of alarm system:

2.8.1.1 **Fire alarm system**, which is either working manually by a worker or automatically by a detector. Alarming sound must be audible in the entire storage facility and will generally alarm for 1 minute with constant and continuous siren sound.

2.8.1.2 **Gas alarm system** is a sound signal working when a gas detector has detected that a gas concentration is higher than a designated level. Alarming sound must be audible throughout the entire storage facility so that the workers can perform their emergency procedure. The alarm signal for gas alarm is an increasing tone, which is constant for one minute at a certain level and decreasing after this time.

The alarm sound for fire and gas alarm must be different.

2.8.2 **Manual alarm call point (button pushing type)** must be installed at the suitable location every 30 meters as a maximum distance. The sound level must be loud and different from the normal environmental sounds and must be tested at least once a month.

2.8.3 **Detectors** are generally designed to be able to detect many forms of fire phenomena, which are heat detector, smoke detector, flame detector or gas detector. Selection of detector is variable to types of chemical or hazardous substance and each environmental condition. In some storage facility, it may require multiple types of detector for more efficient detection. The design and installation of detectors shall conform to the technical standards with the approval and certification by engineers who are registered with the Engineering Institute of Thailand.

**2.9 Fire extinguishing**

**2.9.1 Fire extinguishers**

2.9.1.1 A storage facility must provide fire extinguishers in a number and capacity that are sufficient for quantity of chemical and hazardous substance in storage and they must be inspected at least once every 6 months. A 12-kg ABC powder fire extinguisher should be provided at least 1 unit for each 200 $m^2$ area and two 50-lb ones should be provided at the flammable liquid storage facility;

2.9.1.2 Fire extinguishers must be installed in suitable locations where a map indicating all fire extinguisher locations must be prepared;

2.9.1.3 Fire extinguishers must be easily moved and conveniently used;

2.9.1.4 Fire extinguishers and signs indicating their locations and directions must be in red color;

2.9.1.5 Types of fires:

Class A fires are fires in combustible solids such as wood, cloth, rubber, paper and plastics, etc.

Class B fires are fires in combustible liquids and combustible gases such as gasoline, lubricating oil, lacquer, tar, solvent, natural gas and cooking gas, etc.

Class C fires are fires involving energized electrical equipment

Class D fires are fires in combustible metals such as magnesium, lithium and sodium, etc.

2.9.1.6 Types of fire extinguishing agents, which shall be correctly used according to a type of fire as follows:

| Fire Extinguishing Agents | Types of Fires | | | |
|---|---|---|---|---|
| | **Class A Combustible solids** | **Class B Combustible liquids & gases** | **Class C Electrical equipment** | **Class D Combustible metals** |
| Water (portable fire extinguisher) | Yes | No | No | No |
| ABC dry chemical | Yes | Yes | Yes | No |
| BC dry chemical | No | Yes | Yes | No |
| Foams | Yes | Yes for liquids<br>No for gases | No | No |
| Aqueous Film Forming Foam (AFFF) | Yes | Yes | No | No |
| Carbon dioxide | No | Yes | Yes | No |
| D dry chemical | No | No | No | Yes |

**2.9.2 Firefighting water system**

2.9.2.1 Water sprinkling system must be installed in a storage facility at locations that can sprinkle water or fire-extinguishing-agent water suitably over the respective areas. In case of the in-rack sprinklers, at least one sprinkler head must be installed every two racks.

2.9.2.2 Water hydrant system: a number and distance between each sprinkler head depends on the hose length and water pressure. Generally, the water hydrants are placed at a distance of 50 meters.

2.9.2.3 Hose must have suitable length and numbers to control fire and must be ready to use in emergency. Hose couplings and hose nozzles must be of the same models or those compatible with the equipment used by the local government's fire department.

2.9.2.4 Water supply must be sufficient for firefighting for at least 2 hours. There should be reserved water supply that can be used at a capacity of 100 $m^3$/hr for a less than 2,500 $m^2$ storage facility and 200 $m^3$/hr for a greater than 4,000 $m^2$ storage facility.

2.9.2.5 Design and installation of the extinguishing water system must be inspected and certified by the professional engineer who is certified by the Engineering and Architectural Professional Council.

**2.10 Used fire water**

2.10.1 Used fire water must be discharged to a storage pond and properly treated before released to the public water.

2.10.2 Capacity of a storage pond must be sufficient to retain the water and prevent the overflow of water. The capacity depends on the area of the storage facility as follows:

| Total area of the storage facility ($m^2$) | Capacity of Storage Pond ($m^3$) |
|---|---|
| 25 | 6 |
| 20 | 12 |
| 75 | 18 |
| 100 | 25 |
| 150 | 40 |
| 200 | 55 |
| 250 | 70 |
| 300 | 90 |
| 400 | 125 |
| ≥ 500 | 150 |

2.10.3 The storage pond could be a cement pond built outside the storage facility or built a slope area at the storage facility to prevent the used water flow off.

**3. Storage classification of chemical and hazardous substances**

For safety storage of chemical and hazardous substances, storage classification must be properly determined to fit specific hazard characteristics of such substance. The main hazard characteristics that shall be considered are flammability, explosion and oxidization; other characteristics are toxicity and corrosion. Irritation, health hazard and eco hazard are not taken to consideration for a storage classification.

**3.1 Storage classification of chemical and hazardous substances**

3.1.1 **Storage Class 1 Explosive Substances** are explosive substances as defined by the explosive substance law of the Defense Ministry, or dangerous goods Class 1 of UN Recommendations, or Thailand Requirements on Land Transportation for Dangerous Goods, Volume 1 (TP 1)

3.1.2 **Storage Class 2A Compressed, Liquefied and Dissolved Gases** are gases that are completely gaseous at 20°C and the standard pressure of 101.3 kPa, including gases listed in Class 2 of UN-Recommendations or Thailand Requirements on Land Transportation for Dangerous Goods, Volume 1 (TP 1). This includes gases that are specifically allocated to other classes (e.g. hydrogen fluoride to Class 8) but it does not include the compressed gases that are packed in aerosol containers and refrigerated liquefied gas or cryogenic liquefied gas.

3.1.3 **Storage Class 2B Pressurized Small Gas Containers; aerosol can/aerosol container** are pressure receptacles, aerosol dispenser, containers made of metal, glass or plastic intended to be used once only, which contain compressed, liquefied or dissolved gases with or without liquid, paste or powder chemicals, which are equipped with a dispensing device that enables the contents in the form of solid or liquid particles suspended in gas to be released as foam, paste or powder or in liquid form.

3.1.4 **Storage Class 3A Flammable Liquids** are liquids having a closed-cup flash point not higher than 60°C. Certain flammable liquid which are viscous may be placed in Type 3A or Type 10 depending on their viscosity, fire spreadability and formation of an explosive atmosphere.

3.1.5 **Storage Class 3B Flammable Liquids** are liquids having a closed-cup flash point between 60-93°C and not water-miscible.

3.1.6 **Storage Class 4.1A Flammable solids with explosive property** are substances defined in the UN Recommendations on the Transport of Dangerous Goods, Division 4.1 or Thailand Requirements on Land Transportation for Dangerous Goods, Volume 1 (TP 1), namely solid desensitized explosive.

3.1.7 **Storage Class 4.1B Flammable Solids** are substances defined in the UN Recommendations on the Transport of Dangerous Goods, Division 4.1 or Thailand Requirements on Land Transportation for Dangerous Goods, Volume 1 (TP 1) that do not have explosive property but can be ignited through friction or flame can spread rapidly when ignited. The burning time, resulting from a test, is less than 45 seconds in 100-mm length or the rate of burning is higher than 2.2 mm/second. If such solids are powders of metal or metal alloys, they must be able to be ignited and the reaction spreads over the whole length of the samples in less than 10 minutes. These include the self-reactive substances. 3.1.8 **Storage Class 4.2 Substances liable to spontaneous combustion** are substances defined in the UN Recommendations on the Transport of Dangerous Goods, Division 4.2 or Thailand Requirements on Land Transportation for Dangerous Goods, Volume 1 (TP 1) that are the following substances:

3.1.8.1 **Pyrophoric Substances** are substances which generate heat within 5 minutes of coming in contact with air and the temperature will rise to the auto-ignition temperature.

3.1.8.2 **Self-heating Substances** are substances which generate heat when in contact with air in an ambient temperature long enough that the heat generated is more than it loose to the environment so that the accumulated temperature rises to the auto-ignition temperature. These substances will ignite only when in large amounts (kilograms) and after long periods of time (hours or days).

3.1.9 **Storage Class 4.3 Substance which in contact with water emit flammable gases** are substances as defined in the UN Recommendations on the Transport of Dangerous Goods, Division 4.3 or Thailand Requirements on Land Transportation for Dangerous Goods, Volume 1 (TP 1), which in contact with water or moist air can emit flammable gases that can form explosive mixture with air which is dangerous to human and environment.

3.1.10 **Storage Class 5.1A, 5.1B, 5.1C Oxidizing Substances** are substances defined in the UN Recommendations on the Transport of Dangerous Goods, Division 5.1 or Thailand Requirements on Land Transportation for Dangerous Goods, Volume 1 (TP 1), which, while in themselves not necessarily combustible, may, generally by yielding oxygen, cause or contribute to the combustion of other material. Such substance may be contained in other mixtures.

3.1.10.1 **Storage Class 5.1A Oxidizing substances** that are highly reactive, as follows:

| UN-Number | Substance |
|---|---|
| 1445 | Barium chlorate |
| 1447 | Barium perchlorate |
| 1449 | Barium peroxide |
| 1450 | Bromates, inorganic, N.O.S. |
| 1452 | Calcium chlorate |
| 1453 | Calcium chlorite |
| 1455 | Calcium perchlorate |
| 1461 | Chlorates, inorganic, N.O.S. |
| 1462 | Chlorites, inorganic, N.O.S. |
| 1470 | Lead perchlorate |
| 1471 | Lithium hypochlorite, dry or lithium hypochlorite-mixtures with more than 39% available chlorine (8, 8% available oxygen) |
| 1472 | Lithium peroxide |
| 1475 | Magnesium perchlorate |
| 1479 | Oxidizing solid, N.O.S. |
| 1481 | Perchlorates, inorganic, N.O.S. |
| 1483 | Peroxides, inorganic, N.O.S. |
| 1484 | Potassium bromate |
| 1485 | Potassium chlorate |
| 1489 | Potassium perchlorate |
| 1491 | Potassium peroxide |
| 1494 | Sodium bromate |
| 1495 | Sodium chlorate |
| 1496 | Sodium chlorite |
| 1502 | Sodium perchlorate |
| 1504 | Sodium peroxide |
| 1506 | Strontium chlorate |
| 1508 | Strontium perchlorate |
| 1510 | Tetranitromethane |
| 1513 | Zinc chlorate |
| 1745 | Bromine pentafluoride |
| 1746 | Bromine trifluoride |
| 1748 | Calcium hypochlorite, dry or calcium hypochlorite-mixtures with more than 39% available chlorine (8, 8% available Oxygen) |
| 1843 | Perchloric acid with more than 50% but not more than 72% acid by mass |
| 2015 | Hydrogen peroxide, stabilized or hydrogen peroxide, aqueous solution, stabilized, with more than 60% hygrogen peroxide |
| 2466 | Potassium superoxide |

| UN-Number | Substance |
|---|---|
| 2495 | Iodine pentafluoride |
| 2547 | Sodium superoxide |
| 2723 | Magnesium chlorate |
| 2741 | Barium hypochlorite with more than 22% available chlorine |
| 2880 | Calcium hypochlorite, hydrated or calcium hypochlorite, hydrated mixture, with not less than 5, 5% but not more than 10% water |
| 3085 | Oxidizing solid, corrosive, N.O.S. |
| 3087 | Oxidizing solid, toxic, N.O.S. |
| 3098 | Oxidizing liquid, corrosive, N.O.S. |
| 3099 | Oxidizing liquid, toxic, N.O.S. |
| 3212 | Hypochlorites, inorganic, N.O.S. |
| - | Potassium metaperiodate |
| - | Sodium metaperiodate |
| - | Periodine acid |

3.1.10.2 **Storage Class 5.1B Oxidizing substances that are moderately reactive**, as follows:

| UN-Number | Substance |
|---|---|
| 1438 | Aluminium nitrate |
| 1446 | Barium nitrate |
| 1448 | Barium permanganate |
| 1454 | Calcium nitrate |
| 1456 | Calcium permanganate |
| 1457 | Calcium peroxide |
| 1458 | Chlorate and borate mixture |
| 1459 | Chlorate and magnesium chloride, mixture; solution |
| 1463 | Chromium trioxide; anhydrous |
| 1469 | Lead nitrate |
| 1473 | Magnesium bromate |
| 1476 | Magnesium peroxide |
| 1477 | Nitrates, inorganic, N.O.S. |
| 1479 | Oxidizing solid, N.O.S. |
| 1482 | Permanganates, inorganics, N.O.S. |
| 1486 | Potassium nitrate |
| 1487 | Potassium nitrate and sodium nitrite, mixture |
| 1488 | Potassium nitrite |
| 1490 | Potassium permanganate |
| 1498 | Sodium nitrate |
| 1499 | Sodium nitrate and potassium nitrate |
| 1500 | Sodium nitrite |
| 1503 | Sodium permanganate |
| 1509 | Strontium peroxide |

| UN-Number | Substance |
|---|---|
| 1515 | Zinc permanganate |
| 1516 | Zinc peroxide |
| 1796 | Nitrating acid mixture |
| 1802 | Perchloric acid, with not more than 50% acid by mass |
| 2014 | Hydrogen peroxide, aqueous solution, with not less than 20% but not more than 60% hydrogen peroxide |
| 2032 | Nitric acid, red fuming |
| 2427 | Potassium chlorate, aqueous solution |
| 2428 | Sodium chlorate, aqueous solution |
| 2429 | Calcium chlorate, aqueous solution |
| 2469 | Zinc bromate |
| 2573 | Thallium chlorate |
| 2626 | Chloric acid; aqueous solution, with not more than 10% chloric acid |
| 2627 | Nitrites, inorganic, N.O.S. |
| 2719 | Barium bromate |
| 2721 | Copper chlorate |
| 2722 | Lithium nitrate |
| 2726 | Nickel nitrite |
| 2976 | Thorium nitrate, solid |
| 2381 | Uranyl nitrate, solid |
| 3084 | Corrosive solid; oxidizing, N.O.S. |
| 3085 | Oxidizing solid, corrosive, N.O.S. |
| 3086 | Toxic solid; oxidizing; N.O.S. |
| 3087 | Oxidizing solid, toxic, N.O.S. |
| 3093 | Corrosive liquid; oxidizing, N.O.S. |
| 3098 | Oxidizing liquid, corrosive, N.O.S. |
| 3099 | Oxidizing liquid, toxic, N.O.S. |
| 3122 | Toxic liquid; oxidizing; N.O.S. |
| 3139 | Oxidizing liquid, N.O.S. |
| 3210 | Chlorates, inorganic, aqueous solution, N.O.S. |
| 3211 | Perchlorates, inorganic, aqueous solution, N.O.S. |
| 3213 | Bromates, inorganic, aqueous solution, N.O.S. |
| 3214 | Permanganates, inorganic, aqueous solution, N.O.S. |
| 3218 | Nitrates, inorganic, aqueous solution, N.O.S. |
| 3219 | Nitrites, inorganic, aqueous solution, N.O.S. |
| 3247 | Sodium peroxoborate, anhydrous |
| - | Chromyl chloride |
| - | Potassium iodate |
| - | Sodium iodate |
| 1451 | Caesium nitrite |
| 1465 | Didymium nitrate |
| 1466 | Ferric nitrate |
| 1474 | Magnesium nitrate |
| 1477 | Nitrates, inorganic, N.O.S. |

| UN-Number | Substance |
|---|---|
| 1479 | Oxidizing solid, N.O.S. |
| 1482 | Permanganates, inorganic, N.O.S. |
| 1492 | Potassium persulfate |
| 1493 | Silver nitrate |
| 1505 | Sodium persulfate |
| 1507 | Strontium nitrate |
| 1514 | Zinc nitrate |
| 1872 | Lead dioxide |
| 2014 | Hydrogen peroxide, aqueous solution, with not less than 20% but not more than 40% hydrogen peroxide |
| 2208 | Calcium hypochlorite-mixture, dry with more than 10%, but not more than 39% available chlorine |
| 2464 | Beryllium nitrate |
| 2465 | Dichloroisocyanuric acid, dry or dichloroisocyanuric acid salts |
| 2467 | Sodium percarbonate |
| 2468 | Trichloroisocyanuric acid, dry |
| 2627 | Nitrites, inorganic, N.O.S. |
| 2720 | Chromium nitrate |
| 2724 | Manganese nitrate |
| 2725 | Nickel nitrate |
| 2727 | Thallium nitrate |
| 2728 | Zirconium nitrate |
| 3085 | Oxidizing solid, corrosive, N.O.S. |
| 3087 | Oxidizing solid, toxic, N.O.S. |
| 3098 | Oxidizing liquid, corrosive, N.O.S. |
| 3099 | Oxidizing liquid, toxic, N.O.S. |
| 3139 | Oxidizing liquid, N.O.S. |
| 3210 | Chlorates, inorganic, aqueous solution, N.O.S. |
| 3211 | Perchlorates, inorganic, aqueous solution, N.O.S. |
| 3213 | Bromates, inorganic, aqueous solution, N.O.S. |
| 3214 | Permanganates, inorganic, aqueous solution, N.O.S. |
| 3215 | Persulfates, inorganic, N.O.S. |
| 3216 | Persulfates, inorganic, aqueous solution, N.O.S. |
| 3217 | Percarbonates, inorganic, N.O.S. |
| 3218 | Nitrates, inorganic, aqueous solution, N.O.S. |
| 3219 | Nitrites, Inorganic, aqueous solution, N.O.S. |
| - | Sodium perborate – Monohydrate |
| - | Iodine acid |
| - | Calcium iodate |
| - | Iodine pentoxide |

3.1.10.3 **Storage Class 5.1C is Ammonium nitrate and ammonium nitrate mixtures**

3.1.11 **Storage Class 5.2 Organic peroxides** are substances defined in the UN Recommendations on the Transport of Dangerous Goods, Division 5.2 or Thailand Requirements on Land Transportation for Dangerous Goods, Volume 1 (TP 1), which are an organic substance that contains 2 oxygen atoms in a structure as –O-O- (peroxide) and are considered to be structural derivatives of hydrogen peroxide where one or both of the hydrogen atoms is replaced by an organic radicals; and are mixtures containing ≥ 5% of organic peroxide. These organic peroxides are thermally unstable substances, which may undergo exothermic self-accelerating decomposition.

3.1.12 **Storage Class 6.1A and 6.1B Toxic substances** are substances that are liable to cause death or serious injury, acutely or chronically, to human health by skin contact, inhalation or swallow.

3.1.12.1 **Storage Class 6.1A Combustible toxic substances, as follows**;

- Water-miscible flammable liquids having a closed-cup flash point between 60-93°C;
- Water-immiscible combustible liquids having a closed-cup flash point higher than 93°C;
- Combustible solids that are not classified as the Flammable solids in Storage Class 4.1B

3.1.12.2 **Storage Class 6.1B Non-combustible toxic substances** that are non-combustible liquids and non-combustible solids.

3.1.13 **Storage Class 6.2 Infectious substances** are substances that contain micro-organisms or pathogens that are known or assumed to cause diseases to humans or animals. Theses micro-organisms include bacteria, viruses, rickettsias, parasites, fungi as well as genetically-reengineered micro-organisms.

3.1.14 **Storage Class 7 Radioactive substances** are element or compound that component of its atomic structure is unstable and decays by releasing radiation. This shall conform to the Atoms for Peace law.

3.1.15 **Storage Class 8A and 8B Corrosive substances** are substances, which by chemical action, will cause severe damage when in contact with living tissue or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport. These substances may cause other kinds of harms as well. They are following classified:

3.1.15.1 **Storage Class 8A Combustible corrosive substance**s as follows:

- Water-miscible flammable liquids having a closed-cup flash point between 60-93°C;

- Water-immiscible combustible liquids having a closed-cup flash point higher than 93°C;

- Combustible solids that are not classified as the Flammable solids in Storage Class 4.1B

3.1.15.2 **Storage Class 8B is non-combustible corrosive substances** that are non-combustible liquids and non-combustible solids.

3.1.16 **Storage Class 9** (not considered in a storage classification)

3.1.17 **Storage Class 10 Combustible liquids** are combustible liquids that are not classified in the Storage Class 3A and 3B.

3.1.18 **Storage Class 11 Combustible solids** are combustible solids that are not classified as Flammable solids in the Storage Class 4.1B.

3.1.19 **Storage Class 12 Non-combustible liquids** are liquids that are not combustible.

3.1.20 **Storage Class 13 Non-combustible solids** are solids that are not combustible.

**3.2 How to classify chemical and hazardous substances**

**3.2.1 Safety Data Sheet (SDS)**

The business operator must provide the SDS of all chemical and hazardous substances to be stored. Structure of the SDS must contain general information of the product, hazard identifications, composition and information of the ingredients, first aid measures, firefighting measures, accidental release measures, handling and storage, exposure control and personal protection, physical and chemical properties, stability and reactivity, toxicological information, ecological information, disposal considerations, transport information, regulatory information and other information.

**3.2.2 Storage procedure**

Before the chemical storage is taking place, a person who is responsible for chemical storage shall learn the basic safety information presented in the label, the manifest document or in the Safety Data Sheet in order to be able to classify the chemicals and hazardous substances for storage, which shall be put into the following order of importance:

3.2.2.1 Infectious substances (6.2)

3.2.2.2 Radioactive substances (7)

3.2.2.3 Explosive substances (1)

3.2.2.4 Compressed, liquefied and dissolved gases and pressurized small gas containers (2 A and 2 B)

3.2.2.5 Spontaneously combustion substances (4.2)

3.2.2.6 Substance which in contact with water emit flammable gases (4.3)

3.2.2.7 Organic peroxides (5.2)

3.2.2.8 Oxidizing substances (5.1A, 5.1B, 5.1C)

3.2.2.9 Flammable solids (4.1A, 4.1B)

3.2.2.10 Flammable liquids (3A, 3B)

3.2.2.11 Combustible toxic substances (6.1A)

3.2.2.12 Non-combustible toxic substances (6.1B)

3.2.2.13 Combustible corrosive substances (8A)

3.2.2.14 Non-combustible corrosive substances (8B)

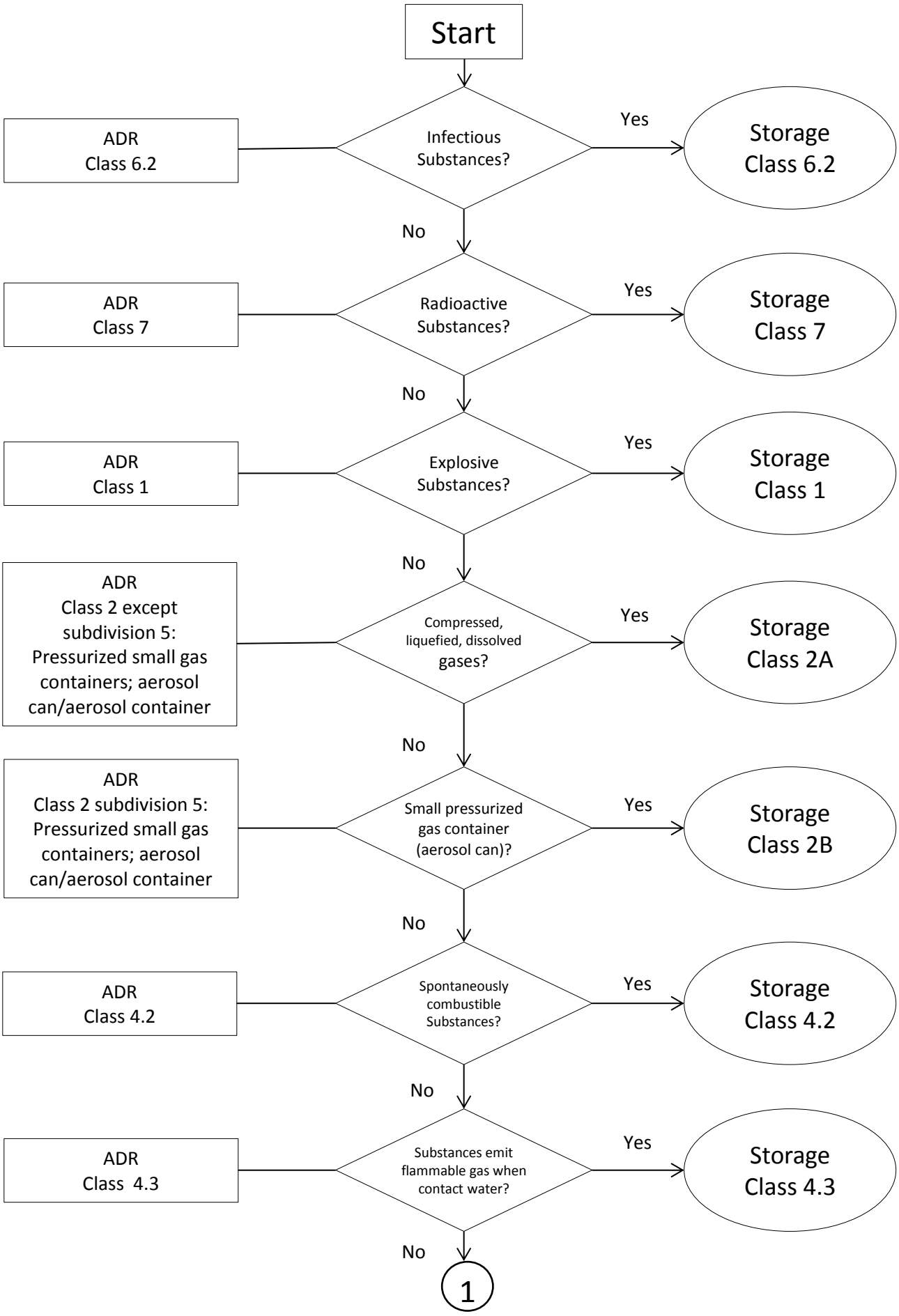
3.2.2.15 Combustible liquids, if not classified in 3 A or 3 B (10)

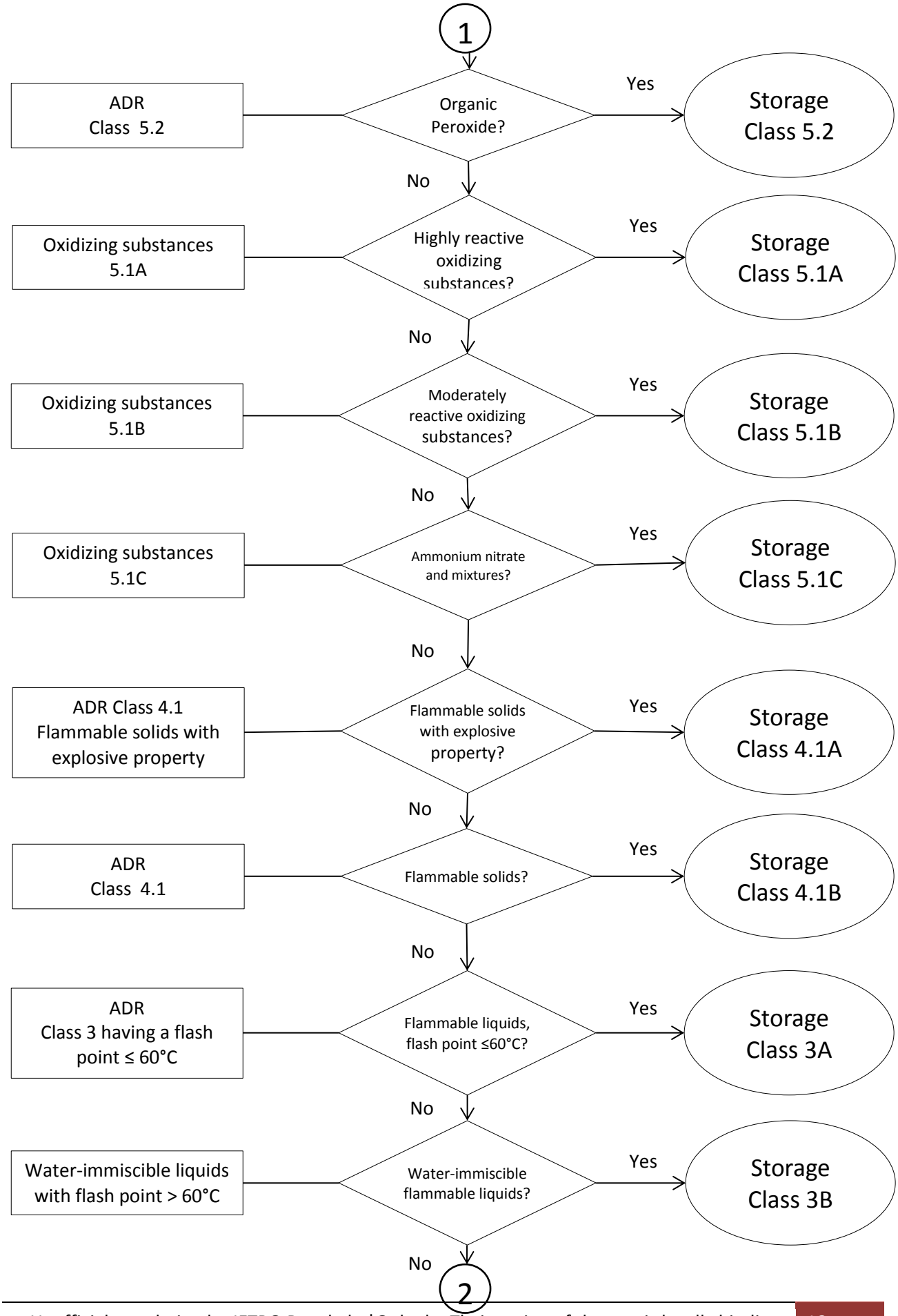
3.2.2.16 Combustible solids (11)

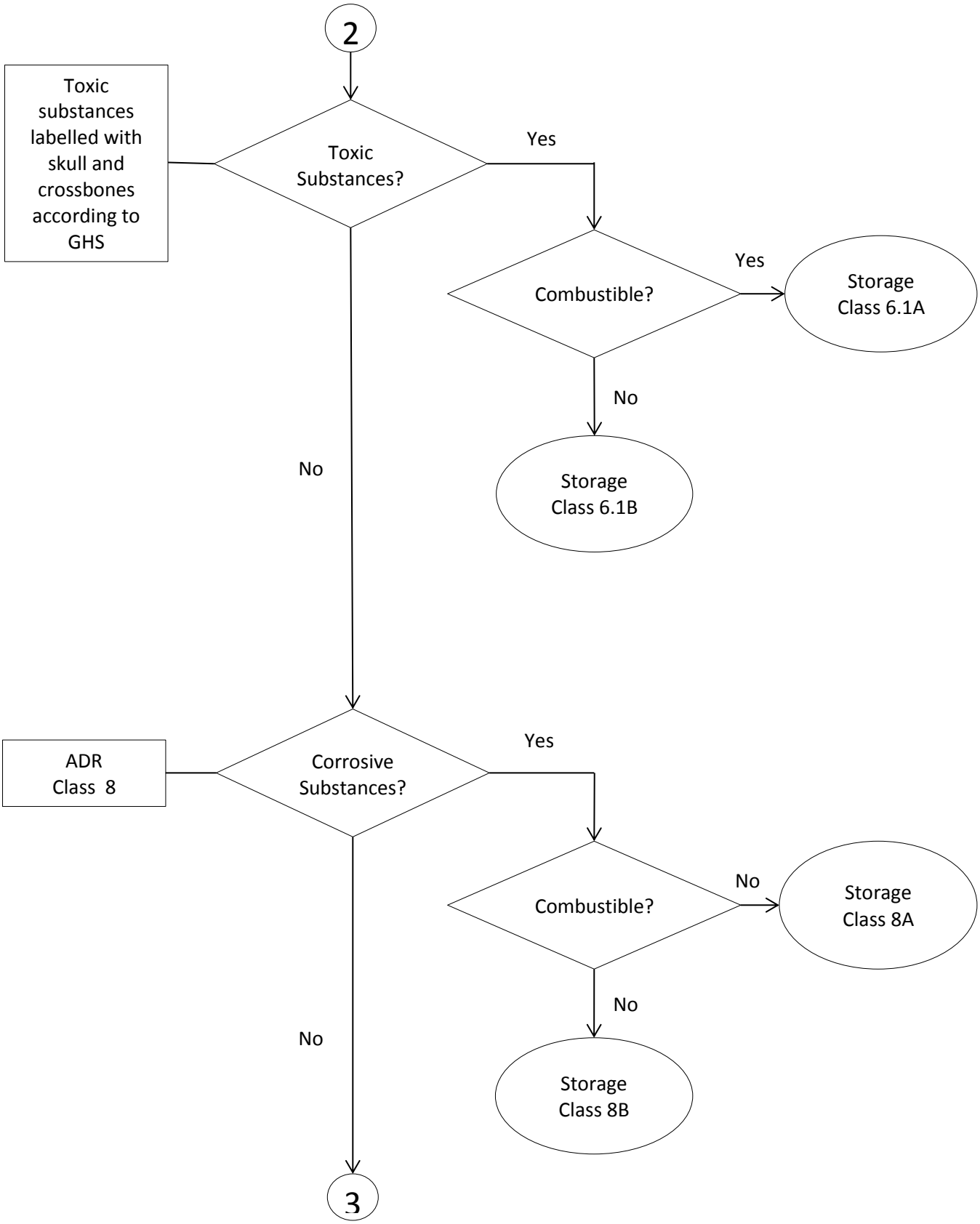
3.2.2.17 Non-combustible liquids (12)

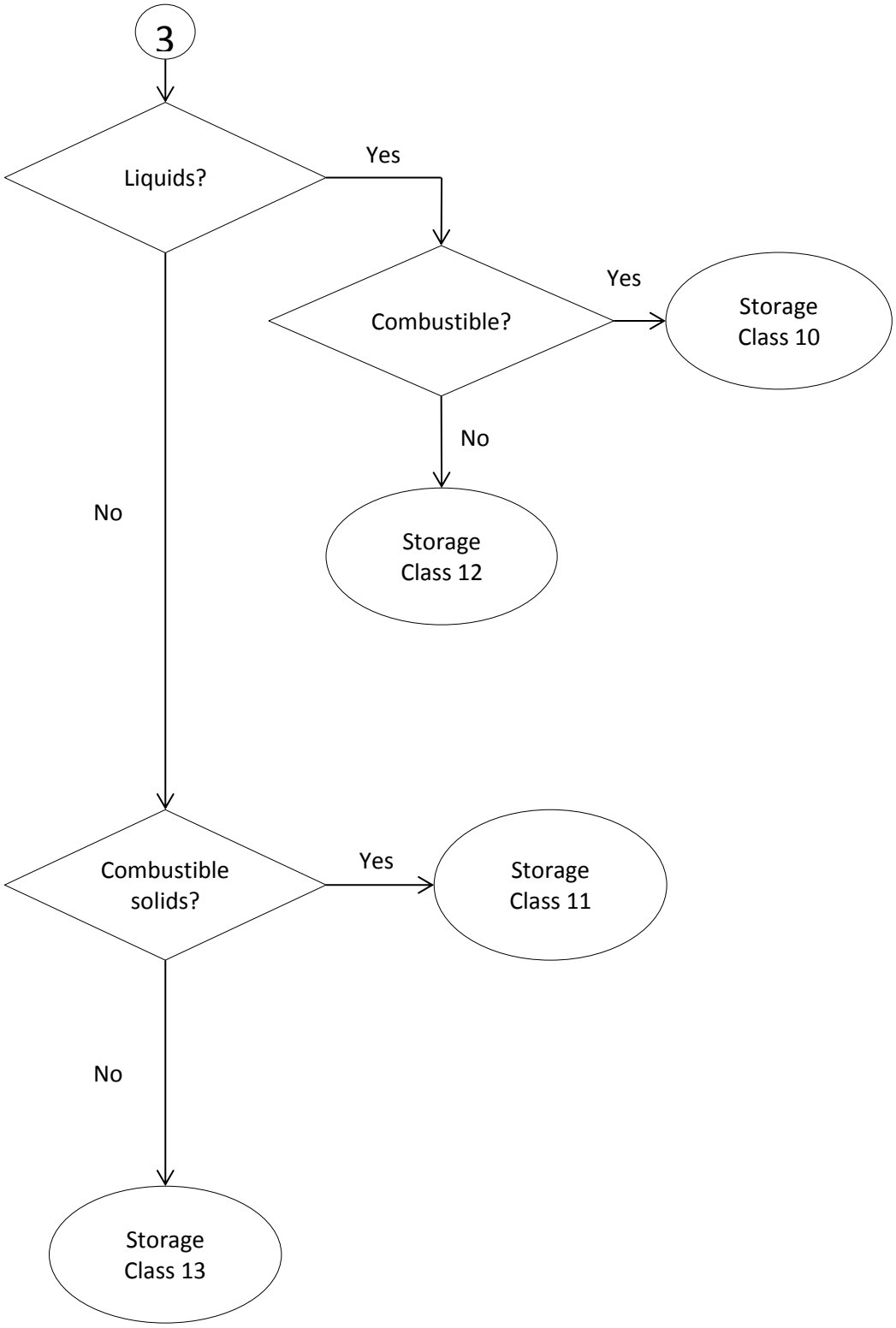
3.2.2.18 Non-combustible solids (13)

The storage of mixtures that are formed by many kinds of chemicals shall be considered based on the main property of such mixtures.


Start
ADR
Class 6.2
Infectious Substances?
Yes
Storage Class 6.2
No
ADR
Class 7
Radioactive Substances?
Yes
Storage Class 7
No
ADR
Class 1
Explosive Substances?
Yes
Storage Class 1
No
ADR
Class 2 except subdivision 5: Pressurized small gas containers; aerosol can/aerosol container
Compressed, liquefied, dissolved gases?
Yes
Storage Class 2A
No
ADR
Class 2 subdivision 5: Pressurized small gas containers; aerosol can/aerosol container
Small pressurized gas container (aerosol can)?
Yes
Storage Class 2B
No
ADR
Class 4.2
Spontaneously combustible Substances?
Yes
Storage Class 4.2
No
ADR
Class 4.3
Substances emit flammable gas when contact water?
Yes
Storage Class 4.3
No
1


1
ADR
Class 5.2
Organic
Peroxide?
Yes
Storage
Class 5.2
No
Oxidizing substances
5.1A
Highly reactive
oxidizing
substances?
Yes
Storage
Class 5.1A
No
Oxidizing substances
5.1B
Moderately
reactive oxidizing
substances?
Yes
Storage
Class 5.1B
No
Oxidizing substances
5.1C
Ammonium nitrate
and mixtures?
Yes
Storage
Class 5.1C
No
ADR Class 4.1
Flammable solids with
explosive property
Flammable solids
with explosive
property?
Yes
Storage
Class 4.1A
No
ADR
Class 4.1
Flammable solids?
Yes
Storage
Class 4.1B
No
ADR
Class 3 having a flash
point ≤ 60°C
Flammable liquids,
flash point ≤60°C?
Yes
Storage
Class 3A
No
Water-immiscible liquids
with flash point > 60°C
Water-immiscible
flammable liquids?
Yes
Storage
Class 3B
No
2


2
Toxic substances labelled with skull and crossbones according to GHS
Toxic Substances?
Yes
Combustible?
Yes
Storage Class 6.1A
No
Storage Class 6.1B
No
ADR Class 8
Corrosive Substances?
Yes
Combustible?
No
Storage Class 8A
No
Storage Class 8B
No
3


3
Liquids?
Yes
Combustible?
Yes
Storage
Class 10
No
Storage
Class 12
No
Combustible
solids?
Yes
Storage
Class 11
No
Storage
Class 13

**3.3 Storage of chemical and hazardous substances**

3.3.1 **Separate Storage** means storage of chemical and hazardous substances in different storage areas;

- In the same warehouse, they will be stored and separated from other substances by a fire compartment, which can withstand fire for at least 90 minutes.

- In the outdoor area (outside the warehouse), they will be stored and separated from the other areas in the suitable gaps such as 5 meters between flammable and inflammable substances, or 10 meters between other kinds of substances, or they are separated by a fire wall that can withstand fire for at least 90 minutes.

3.3.2 **Segregate Storage** means storage of more than 2 kinds of chemical and hazardous substances at the same storage area, which requires sufficient protective measures and must take special storage requirements by their specific properties such as for explosive, oxidizing or flammable, etc. into account in according to the conditions specified in the Chemical and Hazardous Substances Storage Table.

**Chemical and Hazardous Substances Storage Table**

| Storage Class | | 1 | 2A | 2B | 3A | 3B | 4.1A | 4.1B | 4.2 | 4.3 | 5.1A | 5.1B | 5.1C | 5.2 | 6.1A | 6.1B | 6.2 | 7 | 8A | 8B | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Explosive | 1 | 17 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Pressurized, liquefied, dissolved gases | 2A | - | 17 | 4 | - | - | - | - | - | - | - | - | 10 | - | - | - | - | 18 | 5 | | - | 5 | | |
| Pressurized Small Gas Containers (aerosol can) | 2B | - | 4 | | 1 | 1 | - | - | - | - | - | - | 10 | - | 2 | 2 | - | 18 | 4 | 4 | 6 | 6 | 6 | 6 |
| Flammable liquids | 3A | - | - | 1 | 17 | | - | - | - | - | - | - | - | - | | - | - | 18 | 9 | 9 | | 3 | | |
| | 3B | - | - | 1 | | | 12 | 4 | - | 4 | - | - | - | 7 | | | - | 18 | | | | | | |
| Flammable solids | 4.1A | - | - | - | - | 12 | 17 | 12 | - | - | - | - | - | 14 | - | - | - | - | 12 | 12 | 12 | 12 | 12 | 12 |
| | 4.1B | - | - | - | - | 4 | 12 | | 4 | 4 | - | - | - | 13 | 8 | - | - | 18 | | | | | | |
| Substances liable to spontaneous combustion | 4.2 | - | - | - | - | - | - | 4 | | 4 | - | - | - | - | - | - | - | 18 | 4 | 4 | 4 | 4 | | |
| Substance which in contact with water emit flammable gases | 4.3 | - | - | - | - | 4 | - | 4 | 4 | | - | - | - | - | - | - | - | 18 | 4 | 4 | 4 | 4 | 4 | |
| Oxidizing substances | 5.1A | - | - | - | - | - | - | - | - | - | | | - | - | - | - | - | - | - | - | - | - | - | - |
| | 5.1B | - | - | - | - | - | - | - | - | - | | | 10 | - | 15 | 15 | - | 18 | 11 | | 11 | 11 | | |
| | 5.1C | - | 10 | 10 | - | - | - | - | - | - | - | 10 | 17 | - | - | - | - | 18 | 10 | 10 | 10 | 10 | 10 | 10 |
| Organic peroxides | 5.2 | - | - | - | - | 7 | 14 | 13 | - | - | - | - | - | 17 | - | - | - | - | - | - | 16 | 16 | 16 | 16 |
| Combustible toxic substances | 6.1A | - | - | 2 | | | - | 8 | - | - | - | 15 | - | - | | | - | 18 | | | | 3 | | |
| Non-combustible toxic substances | 6.1B | - | - | 2 | - | | - | - | - | - | - | 15 | - | - | | | - | 18 | | | | 3 | | |
| Infectious substances | 6.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - |
| Radioactive substances | 7 | - | 18 | 18 | 18 | 18 | - | 18 | 18 | 18 | - | 18 | 18 | - | 18 | 18 | - | | 18 | 18 | 18 | 18 | 18 | 18 |
| Combustible corrosive substances | 8A | - | 5 | 4 | 9 | | 12 | | 4 | 4 | - | 11 | 10 | - | | | - | 18 | | | | | | |
| Non-combustible corrosive substances | 8B | - | | 4 | 9 | | 12 | | 4 | 4 | - | | 10 | - | | | - | 18 | | | | | | |
| Combustible liquids (unless 3A or 3B) | 10 | - | - | 6 | | | 12 | | 4 | 4 | - | 11 | 10 | 16 | | | - | 18 | | | | | | |
| Combustible solids | 11 | - | 5 | 6 | 3 | | 12 | | 4 | 4 | - | 11 | 10 | 16 | 3 | 3 | - | 18 | | | | | | |
| Non-combustible liquids | 12 | - | | 6 | | | 12 | | | 4 | - | | 10 | 16 | | | - | 18 | | | | | | |
| Non-combustible solids | 13 | - | | 6 | | | 12 | | | | - | | 10 | 16 | | | - | 18 | | | | | | |

mixed storage is permitted in principle

mixed storage is permitted under conditions specified by numbers

separated storage

**Storage Conditions according to the Storage Table**

1. Mixed storage of flammable liquids and pressured gas container (aerosol) is permitted under the following conditions: The compartment must be ventilated and the total number of goods stored should not exceed 60 % of the useable capacity of the warehouse. The total quantity of flammable liquids and contents of the aerosol dispenser should not exceed 100,000 liters.

2. Pressurized gas containers can be stored together with toxic substances under the following conditions: The size of the fire compartment must be limited to 60 m² and the maximum capacity of the goods is limited to 60 % of the total capacity of the compartment. The temperature of the room should not exceed above 50 °C. The compartment must be ventilated and must have two emergency exits. At each exit a 6-kg ABC powder fire extinguisher must be available. If the compartment is bigger than 60 m² then these goods have to be segregated by appropriate measures or separated.

3. Materials that cause the rapid start or spread of fire, such as packaging materials, should be separated from toxic substances or flammable liquids.

4. Mixed storage is permitted if the products do not react with each other in the event of an incident. This can be achieved by segregated storage, e.g. physical separation, large gaps, separate containment basins, storage in safety cabinets.

5. In the storage room in which the maximum of 50 filled pressurized gas cylinders are permitted to store, out of these numbers, not more than 25 pressurized gas cylinders with flammable, oxidizing or toxic gases are permitted. Combustible substances (8A and 11) (excluding flammable liquids) may be stored if the storage area is separated from the pressurized gas cylinders by a wall with at least 2-m height made of non-combustible materials and the combustible substances is stored away from the wall at least 5 m.

6. Mixed storage is permitted if the safety requirements for the entire stock are applied to meet the requirements of storage class 2B.

7. Mixed storage is permitted for flammable liquids having a flash point above 61 °C provided that the mixed storage will not react in the dangerous way (combustion and/or evolution of considerable heat, evolution of flammable, asphyxiant, and/or toxic gases, formation of corrosive substances, the formation of unstable substances, or dangerous rise in pressure). In such case there must be safety distances (5 metres) between those goods.

8. Flammable toxic substances (6.1A) may be stored together with flammable solids (4.1B).

9. Flammable liquids and corrosive substances in breakable containers must not be stored together except that the preventive measures are adopted to prevent the interaction with each other in the event of an incident.

10. Mixed storage is permitted except with flammable gases.

11. Additional preventive measures are required to get approval from the Department of Industrial Works for the safety storage.

12. Flammable solids (4.1A) having explosive property may be stored together with other substances of class 3B, 4.1B, 8A, 8B, 10, 11, 12 or 13 if the safety distances designed to prevent any danger to the surroundings of a warehouse are adequate or may be required to increase. This must be checked in each case.

13. Mixed storage of organic peroxides (5.2) and flammable solids (4.1B) is permitted.

14. Mixed storage with propellants and radical initiators is permitted if they do not contain any heavy metals.

15. Oxidizing substances (5.1B) may be stored together with combustible toxic substances (6.1A) and non-combustible toxic substances (6.1B) up to a total quantity of 20 tons by taking the following safety measures: The warehouse must have a fire alarm system, an automatic fire extinguishing system and a company-run semi-professional fire brigade (employed only for firefighting with the company owned fire truck. Quantities up to 1 ton don't require these additional safety measures.

16. When organic peroxides are stored together with other chemical and hazardous substances, it is necessary to check in each case whether the safety distances (between the warehouse and the communities) designed around the warehouse is adequate to prevent any dangers or it is needed to be increased.

17. Specific safety requirements of each substance shall be considered.

18. Radioactive substances should be considered separately according the IAEA Safety Standards and with the approval of the competent authority.

3.3.3 Storage of small-quantity substances in the storage facility means the storage of some specific chemical and hazardous substances in small quantities, which are substances in the storage classes 2B, 3A, 3B, 4.1B, 4.3, 5.1B, 5.1C, 5.2, 6.1A, 6.1B, 8A, 8B, 10, 11, 12 and 13 together with other kinds of substances of large quantities, where normally the mixed storage is prohibited but, if necessary, is temporarily permitted for the storage in small quantities. However, it must be assured that:

(1) the safety measures necessary for other classes of chemical and hazardous substances are sufficient.

(2) these small-quantity chemical and hazardous substances must not be interactive with other chemical and hazardous substances already in stored.

(3) the measures are added, for example a 5-m safety distance, a safety cabinet or a special compartment for the separate storage, etc..

(4) the separation, e.g. walls or wire mesh, is installed for the storage of aerosol.

The storage of small-quantity chemical and hazardous substances that is permitted shall be as following table:

| **Storage Class** | **Storage Facility having storage capacity < 5,000 kg** | **Storage Facility having storage capacity > 5,000 kg** |
|---|---|---|
| 1 | - | - |
| 2A | - | - |
| 2B | 500 cans | 500 cans |
| 3A | Flammable liquids having flash point < 23°C, 100 liters;<br>Flammable liquids having flash point between 23-60°C, 200 liters | Flammable liquids having flash point < 23°C, 100 liters;<br>Flammable liquids having flash point between 23-60°C, 200 liters |
| 3B | < 5,000 kg | 5,000 kg |
| 4.1A | - | - |
| 4.1B | 200 kg | 200 kg |
| 4.2 | - | - |
| 4.3 | 200 kg | - |
| 5.1A | - | - |
| 5.1B | 200 kg | 200 kg |
| 5.1C | 100 kg | - |
| 5.2 | 100 kg (In small packaging with capacity of less than 100 g for solids and 25 ml for liquids only) | - |

| Storage Class | Storage Facility having storage capacity < 5,000 kg | Storage Facility having storage capacity > 5,000 kg |
|---|---|---|
| 6.1A | 50 kg | 50 kg |
| 6.1B | 200 kg | 200 kg |
| 6.2 | - | - |
| 7 | - | - |
| 8A | < 5,000 kg | 5,000 kg |
| 8B | < 5,000 kg | 5,000 kg |
| 10 | < 5,000 kg | 5,000 kg |
| 11 | < 5,000 kg | 5,000 kg |
| 12 | < 5,000 kg | 5,000 kg |
| 13 | < 5,000 kg | 5,000 kg |

For the storage classes 1, 2A, 4.1A, 4.2, 5.1A, 6.2, and 7, even in small quantities, are not permitted for mixed storage with other storage classes. They must be strictly complied with the Chemical and Hazardous Substances Storage Table.

**4. Preventive Measures**

To prevent any dangers that may occur from the storage, following measures shall be achieved:

**4.1 Hygiene Management**

Hygiene management means a management carried out to control environmental factors from affecting the workers' health.

4.1.1 Personal hygiene for the workers whose work are related to chemical and hazardous substances:

4.1.1.1 Workwear shall be provided to the workers to be suitable to their working conditions and the workwear shall be separately kept in a specific place;

4.1.1.2 Foods, drinks or smoking is prohibited in the storage facility. Specific place for eating, drinking or smoking shall be provided separately from the storage facility;

4.1.1.3 It is not permitted to reside in the storage facility;

4.1.1.4 Hands and face washing station and shower room shall be provided at least one station to 15 workers and shall be increased in consistent with the numbers of workers. Where the numbers of workers exceeds 7 workers, it shall be considered as 15 workers;

4.1.1.5 Safety shower and eye bath shall be provided at the working sites for emergency use.

4.1.2 Health check, recording, reporting and submission of a health-check report shall be in accordance to the labor protection law. The employer shall keep a health check record including other concerned health information for the inspection by the officer at all time.

4.1.3 The storage facility hygiene

4.1.3.1 The storage facility shall be kept clean, sanitary, orderly and well ventilated;

4.1.3.2 The storage facility's floors shall be cleaned up regularly once a week;

4.1.3.3 Immediate cleaning is required when a spillage occurs to minimize and prevent a carry away of the chemicals;

4.1.3.4 Containers or any objects must be kept clear off the emergency exits or the fire extinguishers;

4.1.3.5 Chemical and hazardous substances must not been kept on a passage way or at a working space.

**4.2 First aid**

4.2.1 First aid room must provide first aid kits and equipment such as scissors, tweezers, rubber tourniquets, thermometers, cotton balls, plasters and/or bandages, wound cleanser, skin disinfectants, ammonia aromatic inhalation, fever reducers/pain relievers, burn ointments, eye cleansing kits and first aid bags, etc.

4.2.2 Medical equipment and supplies necessary for the first aid practices must be prepared in a clean and sanitary condition and are ready to use. The equipment must also be regularly checked and maintained, after which a report is required.

**4.3 Personal protective equipment**

4.3.1 The basic personal protective equipment should consist of the following equipment:

4.3.1.1 Safety shoes must have a steel toe cap and are chemical resistant and slip resistant. When used in storage of flammable gases or flammable liquids, the safety shoes must be antistatic.

4.3.1.2 Protective clothes are the outfits that protect the body from chemical or hazardous substances. The protective efficiency depends on the risk level at the workplace and the outfit material, which shall be in accordance with the recommendation of the outfits' manufacturer.

4.3.1.3 Safety helmet is used to protect the head from injury and shall be suitable for different head sizes and shapes. It shall be made from impact resistant materials such as polyethylene or fiber, etc.

4.3.1.4 Safety glasses used for eyes protection must be durable, impact and heat resistant. They must have side shields to protect both sides of the eyes. In case where the work is related to corrosive liquids, the safety glasses should be full-face shielded type. The safety glasses should not have the following qualifications: high weight, improper fit, difficult to clean, visible distortion, limited visible angles, reflective, not anti-fog.

4.3.1.5 Gloves are used to protect the hands during work. They must be durable and resistant to chemical and hazardous substance absorption as well as able to protect the fingers from abrasion, pressing and the packaging cannot slip out of the hands.

4.3.1.6 Respiratory protective equipment (mouth and nose) is used to protect the respiratory system from chemical or hazardous substances. The equipment must be suitably selected to the substance characteristics such as particles, dusts, gases and vapors.

4.3.2 Personal protective equipment rules

4.3.2.1 The workers whose work involves chemical or hazardous substance must wear the personal protective equipment as necessary and suitable to such work.

4.3.2.2 The personal protective equipment must always be kept in good conditions and ready for efficiently use at all times.

**4.4 Safety signs**

The safety signs are:

(a) Prohibition signs are signs designed to prohibit the operation that may cause hazards

(b) Warning signs are signs designed to warn about incidents or hazards that may occur

(c) Mandatory signs are signs indicating the obligations needed to be complied with

(d) Information signs are signs indicating specific information such as fire exit, first aid room, etc.

4.4.1 Prohibition, warning, mandatory and information signs must be prepared in suitable sizes and put at the areas, which are clearly visible and related to the sign purpose.

4.4.2 The workers or any person who will enter such respective areas must be controlled to strictly comply with the signs.

**4.5 Traffic routes and loading docks**

4.5.1 Traffic routes, including stairs and loading docks, must be located and dimensioned to ensure easy, safe and appropriate access for the numbers of workers and vehicles.

4.5.2 Traffic routes must be clearly identified by a clearly-visible color that is outstanding from the surface color; usually white or yellow, and must be located where the safe distance between the vehicles and the objects or the vehicles and the pedestrians are indicated.

4.5.3 Loading docks, where the goods are loaded and unloaded, must be suitable to the sizes of the goods. Loading dock platform must have at least one exit point and safe enough to prevent the workers from falling off.

**4.6 Transfer of chemical and hazardous substances**

4.6.1Transfer of chemical and hazardous substances to the storage facility requires an inspection of containers, packages, labels and quantity of hazardous substances. If the containers or packages are not in good conditions, they must not be transferred to the storage facility.

4.6.2 Capacity of the forklifts used in the storage facility must be suitable with the quantities and kinds of hazardous substances they are handling with.

4.6.3 The forklifts used at the storage facility where flammable liquids, flammable gases and explosives are stored must be installed with the system that prevents the explosion.

4.6.4 Changing of the batteries for the electrical forklifts must be carried out outside the storage facility in a well-ventilated place where the fire prevention measure is provided in case that the fire may be caused by hydrogen gas during battery charging.

**4.7 Storage measures for chemical and hazardous substances inside the building**

Examination and checking of the containers or packages shall be carried out as follows:

4.7.1 Prior to the storage, the conditions of containers or packages must be checked. If the containers or packages are so damaged that they cannot be taken into the storage facility, the specific area must be designated for repacking or packing in the salvage packages.

4.7.2 Chemical or hazardous substances that their packages are damaged or those are repacked must be used before others.

4.7.3 Spilled chemical must be disposed by appropriate methods.

4.7.4 Chemical wastes or hazardous substances including their containers must be appropriately disposed.

4.7.5 It must be assured that the containers or packages stored on the pallet will not fall off the shelf.

4.7.6 Carefully check that nails in wooden pallets may damage the containers or packages.

**4.8 Spill and emergency response**

Chemical spill may occur from a transfer of chemical or hazardous substances or a damaged container. Measures to minimize the risks of chemical spill require equipment readiness and immediate response, safety information (MSDS) and careful treatment to prevent the effect to environment.

Spill and leak response approach:

4.8.1 Necessary equipment

4.8.1.1 Personal protection equipment

4.8.1.2 Empty bucket made of material that is not reactive with the spilled or leaked chemicals

4.8.1.3 A tape for writing or drawing signs or symbols on for affixing on the bucket

4.8.1.4 Absorbents such as Diatomaceous earth or other kind of absorbent that is suitable and not hazardously reactive, etc.

4.8.1.5 Detergent

4.8.1.6 Others such as bloom sticks, shovels, wrenches and funnels, etc.

4.8.2 Evaluate and identify the spilled chemical (type and quantity), possible effect to environment and assess the situation so that the hazard control plan can be decided.

4.8.3 Put out a warning sign and isolate the area by barricades

4.8.4 If the spill is liquid, absorb spill by absorbents that are suitable to such spilled chemicals.

4.8.5 Use Diatomaceous earth if the spill is flammable liquid or oxidizing liquid.

4.8.6 If the spill is solid, clean up according to the recommendations in the MSDS and the manufacturer.

4.8.7 If the spill is flammable and explosive, ensure to warn about the combustion, ignition and danger from friction during cleaning.

4.8.8 Ensure that the spilled or leaked chemical will not directly drain to the public water.

4.8.9 After using the equipment, they must be checked and regularly cleaned to ensure that they are always readiness for use.

4.8.10 A report of the spill and leak incident identifying cause, scale, response and recommendation to prevent such incident shall be prepared.

**4.9 Waste disposal**

4.9.1 Used containers shall be disposed or reused according to the related regulations.

4.9.2 Expired chemical or hazardous substances shall be kept in the storage facility for disposal.

4.9.3 Waste spilled chemical, used absorbents, used water, expired chemicals or hazardous substance, contaminated packages, contaminated and damaged pallets and other contaminated materials must be disposed in according to the safety information of such contaminants or recommendations of the manufacturers or transferred to the waste disposal facilities that are approved by the Department of Industrial Works.

**4.10 Maintenance plan for safety equipment**

Regular maintenances are required to ensure the proper function of all safety equipment; therefore the storage facility is required to prepare the maintenance measures for safety equipment as follows:

4.10.1 Detailed maintenance plan for each safety equipment according to the recommendation of the equipment manufacturer is required.

4.10.2 The following equipment must be checked for their readiness to use: heat, smoke, radiation or gas detectors, alarm system, fire extinguishing equipment, lightning rod, personal protective equipment, forklifts and emergency lights, etc.

4.10.3 When the equipment mentioned in 4.10.2 is broken, it shall be repaired to be in a normal condition.

4.10.4 A check and maintenance report must be prepared for inspection at all times.

**4.11 Operating instructions**

4.11.1 The operating instructions for the workers in the storage facility for chemical and hazardous substances shall be provided as follows:

4.11.1.1 Handling of each type of chemical and hazardous substances in the storage facility;

4.11.1.2 Safety information of all chemicals in the storage facility;

4.11.1.3 Operating procedures in case of fire;

4.11.1.4 Operating procedures in case of chemical spill;

4.11.1.5 First aid;

4.11.1.6 Waste disposal;

4.11.1.7 Operating procedures for chemical loading and unloading at the storage facility;

4.11.1.8 Equipment and handling procedures

4.11.1.9 Daily housekeeping

4.11.2 Operating instructions include scopes, procedures and responsibilities, written in a clear and concise language, pictures or symbols.

4.11.3 Each worker must comply with his/her daily operating instructions.

4.11.4 All of the operating instructions must be kept at the place recognized by all workers and it must be clearly visible.

**4.12 Training**

Training for the workers of the storage facility of chemical and hazardous substances is required at least once a year in the following training topics:

4.12.1 Storage classifications, safety information and storage methods

4.12.2 How to use the personal protection equipment

4.12.3 Operating procedure for emergency and emergency response drills

4.12.4 Fire suppression by fire extinguishers

4.12.5 Forklift driver training

4.12.6 Spill & leak response

**4.13 Other preventive measures**

4.13.1 In case where it is needed to dispense chemicals to other container, the dispensing must be carried out outside the storage facility and the appropriate measures to handle such chemicals must be provided.

4.13.2 An operational license and risk prevention measures are required for those working in risk such as maintenance, construction and renovation and working in high places, etc.

4.13.3 A regular housekeeping is required at the storage facility to check for any irregular matters such as damaged packages, leaked containers, placing things in a non-permitted area,

etc. When these irregular matters are found, immediate actions are needed and a housekeeping report must be prepared after the housekeeping is finished.

4.13.4 Updated information must be prepared for the emergency response team in case of fire. The information are trade names, chemical names, numbers of packages or containers, total weights, storage areas, type of fire extinguishing chemicals used, list of chemicals and hazardous substances in the storage.

4.13.5 Emergency response plan must be prepared for the events of a fire, explosion, gas leakage or critical chemical spillage or leakage.

**5. Special requirements**

**5.1 Special requirements for explosives**

5.1.1 Regulations of the Defence Industry Department, Defence Industry and Energy Center regarding the Storage of Ammunitions and Explosives B.E. 2542 (1999), which classifies explosive materials to 6 divisions according to their characteristics and predominant hazards and potential to cause harms and damages to human and property as follows:

5.1.1.1 Division 1.1 Mass-Detonating means substances or materials that cause mass explosion hazard.

5.1.1.2 Division 1.2 Non Mass-Detonating, Fragment Producing means substances or materials that cause harms from their blast fragment when exploded but they are not mass explosion hazard.

5.1.1.3 Division 1.3 Mass Fire means substances or materials that cause harms from a fire and sometime followed by explosion or blast and fragment or both, but they are not mass explosion hazard.

5.1.1.4 Division 1.4 Moderate Fire, No Blast means substances or materials that are not highly harmful. Explosive effect is restricted only inside a package, no blast and fragment.

5.1.1.5 Division 1.5 Very Insensitive Substances which have a Mass Explosion Hazard; these substances are insensitive for explosion in a normal transportation condition and have very little probability of transition from deflagration to detonation.

5.1.1.6 Division 1.6 Extremely Insensitive Articles which do not have a Mass Explosion Hazard; these substances are extremely insensitive and demonstrate a negligible probability or accidental initiation or propagation.

5.1.2 Special requirements for explosives shall be in accordance to the following laws concerning the storage of ammunitions and explosives of the Defence Ministry:

5.1.2.1 Revolutionary Council Order No. 37, dated 21st October 1976;

5.1.2.2 The Arms Control Act B.E. 2530 (1987)

5.1.2.3 The Firearms, Ammunition, Explosives, Fireworks and Imitation Firearms Act B.E.2490 (1947)

5.1.2.4 Regulation of the Defence Ministry regarding the Storage of Ammunitions and Explosives of the Private Weapons Manufacturing Factory B.E. 2543 (2000)

5.1.2.5 Regulation of the Defence Industry Department, Defence Industry and Energy Center regarding the Storage of Ammunitions and Explosives B.E. 2542 (1999)

**5.2 Special requirements for gases**

5.2.1 Requirement for the storage of gases in the storage facility:

5.2.1.1 All kinds of gases must be contained in containers that have passed the test in according to the requirements specified in Chapter 6.2 of Thailand Requirements on Land Transportation for Dangerous Goods, Volume 2 (TP II) or the standards of the Thai Industrial Standards Institute and the containers' valves shall be protected by covers at all times.

5.2.1.2 Natural or mechanical ventilation is required. Ventilation must be 2 air changes per hour. The openings for ventilation shall be positioned as technically appropriate.

5.2.1.3 For toxic gases, detectors of such toxic gas must be installed.

5.2.1.4 For flammable gases, gas detectors must be explosion protection.

5.2.1.5 The electrical installations should be explosive proof if flammable gases are stored.

5.2.1.6 The floor in a room where the flammable gases are stored must be antistatic.

5.2.1.7 Toxic gases must be stored in a strictly controlled area.

5.2.1.8 Flammable gas cylinders must be segregated from oxidizing gas cylinders for at least 2 meters.

5.2.1.9 Mixed storage of pressurized Small Gas Containers (aerosol can) and other chemicals or hazardous substance is permitted but they should be segregated by walls or wire mesh, for example.

5.2.1.10 Pressurized Small Gas Containers (aerosol can) must be stored indoor only to protect them from the sunlight.

**5.3 Special requirements for flammable gases (3A and 5.2)**

5.3.1 Electrical equipment and vehicles must be explosion protection.

5.3.2 Water sprinkling system and water hydrants should be provided in a sufficient number where suitable when flammable gases are stored.

5.3.2.1 In case where the water sprinkling system is installed, the storage facility's walls should withstand fire for at least 90 minutes.

5.3.2.2 In case where the water sprinkling system is not installed, the walls should withstand fire for at least 180 minutes.

5.3.2.3 Firewalls separating each room must be at least 0.3m higher than the roof and extended from the sides or other methods that can restrict the spread of fire can be applied.

5.3.3 The walls of the building where flammable gases are stored, if they can withstand fire less than 90 minutes, such building must be distant from other buildings for at least 10 meters.

5.3.4 Natural or mechanical ventilation is required. Ventilation must be 5 air changes per hour. The openings for ventilation shall be positioned as technically appropriate.

5.3.5 Dispensing flammable liquids

5.3.5.1 Electrical equipment used in a room where the dispensing is carried out must be explosion protection.

5.3.5.2 Antistatic measures must be applied such as the workers' outfits are made of 100% cotton and the shoes are antistatic, etc.

5.3.5.3 Equipment and tank that are made of metal must be grounded.

5.3.5.4 Dispensing hoses must be antistatic.

5.3.5.5 Dispensing rooms must be opening and well ventilated.

5.3.5.6 In case of the dispensing of water-immiscible flammable liquids, the floor must have a minimum slope of at least 1% for draining liquid to the drainage system or a sump that can contain waste liquid.

**5.4 Special requirements for oxidizing substances**

5.4.1 Mixed storage of oxidizing substances and other chemicals shall be in accordance to 3.3 of the Storage Table.

5.4.2 Wooden pallet shall be prohibited to use especially with oxidizing liquids.

5.4.3 The storage facility should only have one floor and have firewalls that can withstand fire for at least 90 minutes, which are built 1m above the roof and 0.5m extended from the sides.

5.4.4 Combustible materials such as unused packages, unused pallets or other combustible materials are prohibited to keep in the same storage place with oxidizing substances.

**6. Storage outside the building**

6.1 The storage area outside the building must be cleaned up to prevent fire accident, for example cutting grasses, keep the area clear of wastes or combustible materials, etc.

6.2 The storage area must be free of heat sources such as electrical equipment, heat surfaces, ignition, flame and friction.

6.3 The storage area must not be used as a parking lot or traffic routes.

6.4 The surface of the storage area must have sufficient load bearing capacity for total weight of chemical and hazardous substances to be stored, non-slippery, no cracks, water resistant, corrosive resistant and have a drainage system connected to a sump or a containment that can contain waste liquids from running off site.

6.5 To minimize a deterioration rate of chemical and hazardous substances that may cause by high-temperature weather at the storage area outside the building, construction of a roof shall be considered to prevent sunlight and rain.

6.6 Containers must be placed upright on a pallet. If it is necessary to stack the containers, a height must not be higher than 3 meters. Drum wedges are needed for horizontal storage to prevent the drums from rolling over.

6.7 A traffic route from the fire extinguisher station to the storage area outside the building must be wide enough and always kept clear of obstacles.

6.8 Substances in the Storage Class 1, 2B, 4.1A, 4.2, 4.3, 5.1 and 6.1 are not permitted to store outside the building.

**6.9 Special requirements for the Storage Class 2A, 3A, 3B**

6.9.1 Storage Class 2A: The storage area must be roofed and have a distance from other buildings at least 5 meters. The surface must be flat and level. The storage area must be equipped with the securing equipment to prevent the gas cylinders from falling over. The storage area must be secured with a net, from which the gas cylinders must be stored at least 1-meter away. Other materials must not be stored with the gas cylinders.

6.9.2 Storage Class 3A, 3B outside the building: The storage area must have a distance from other buildings at least 10 meters. The floor must have a minimum slope of at least 1% for draining liquid to a sump or a containment that can contain waste liquid from running off site.