Code of practice for safety in aerosol manufacture

Published by the Department of Labour

Published by the Department of Labour
Wellington
New Zealand

First published: 1986

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1 Introduction

1.1 Definition of an Aerosol

An aerosol is defined as a package comprised of a self-pressurised non-returnable dispenser, constructed of metal, glass or plastic which contains a fluid product and which is fitted with a valve to dispense the product in the form of a spray, liquid, paste, foam or powder.

1.2 Pressure Release of Products

The most widely used means of providing propelling pressure is by way of a substance which is a liquid when contained under pressure, but which at normal temperatures and at atmospheric pressure instantly reverts to a gas. This substance is known as the propellant. Compressed gases and gases dissolved in solvents are also to be considered as propellants.

1.3 Manufacturing Steps

During the manufacture of a typical aerosol product, there are several distinct stages. These include the storage and transportation of propellants, the manufacture of product concentrates, the filling of propellants and concentrates into containers, disposal of defective aerosols, and checking of the finished product by weight and pressure testing.

1.4 General

Each of these stages involves certain hazards to personnel and it is the purpose of this Code of Practice to pinpoint these hazards and to discuss methods of coping with them. A number of these hazardous situations are actually subject to legislation administered in the Department of Labour, and where this is the case the particular Act or Regulation in question is referred to and suggestions given on means of compliance. Many of the provisions discussed may not in fact be directly covered by legislation and hence the control suggestions given cannot be enforced. However, it is strongly suggested that, as and where practicable, these provisions be adopted in the interests of a safer working environment.

2. Transportation, Storage and Use of Propellants

2.1 General

2.1.1. Materials used as propellants in aerosol packages may be classified into three distinct groups. These are:

(a) Hydrocarbon propellants;

(b) Chlorofluorocarbon propellants; and

(c) Compressed gas propellants.

2.1.2 Hazards associated with transportation, storage, and use of aerosol propellants fall into the general categories of explosion and fire, and toxicity.

2.1.3 Propellants must be stored in safe areas, away from access by unauthorized persons and protected from vandalism (see Section 2.2.5).

2.1.4 If cylinders are used for storage of propellants, these must comply with the general points of Regulations 8 and 14 of the Dangerous Goods (Class 2 - Gases) Regulations 1980.

2.1.5 Cylinders must be handled with care, which includes not dropping them, and not leaving them freestanding (i.e. unchained or unchecked) or without the protective valve cap in place.

2.2 Hydrocarbon Propellants

2.2..1 General Hydrocarbon gases used as aerosol propellants may be mixtures of propane, iso-butane, and normal butane.

2.2.2 Unodorised hydrocarbon Propellants

2.2.2.1 The use of unodorised hydrocarbon propellants, as is usual for aerosols, requires an approval to be granted by the Chief Inspector of Dangerous Goods for exemption from the provisions of Regulation 39 of the Dangerous Goods (Class 2 -Gases) Regulations 1980 (herein after referred to as the Regulations). As pointed out in Part (2) of Regulation 39, this exemption is given provided that flammable gas detectors are installed around the storage vessel, with these detectors set to trigger at 20% of the lower explosive limit and to give an audible and visible alarm signal.

2.2.2.2 Hydrocarbon propellant is often purchased in bulk as “unodorised butane”, or else the odorising material (an organic sulphide or mercaptan) may be removed before use by passing the gas through molecular sieves.

2.2.3 Tanks to be Painted White Tanks for the transportation and storage of hydrocarbon propellants which exceed 5 kg water capacity must be protected from corrosion by painting with white paint or some other light-reflecting coating (Regulation 41 of the Regulations).

2.2.4 Isolation Distances A very important aspect of the whole subject of hydrocarbon propellant storage is the positioning of storage facilities in relation to other buildings or public places. The Regulations are very specific on this question, with clear isolation distance/volume criteria given for cylinders and storage tanks. If any difficulty is encountered with interpretation of these provisions, then the Dangerous Goods Division of the Department of Labour should be approached for advice. Regulations 55, 56, 69, 71, 73 and 74 of the Regulations are relevant to these considerations.

2.2.5 Fencing of Propellant Storage Areas

2.2.5.1 Areas set aside for hydrocarbon propellant storage must be adequately fenced (unless such an area is part of a larger fenced area which excludes the public) against unauthorised access and to prevent possible vandalism. The fence may be of open construction, but must reach a

minimum height of 2 metres above ground level.

2.2.5.2 Under certain circumstances of tank size (less than 7,500 litres water capacity, the provision of guardrails or stanchions, and enclosure of tank fittings with a locked non-gastight dome) a fence need not be provided.

2.2.5.3 Expanded details of fencing requirements are given in Regulation 57 of the Regulations.

2.2.6 Electrical Earthing and Bonding

2.2.6.1 Static electrical sparks capable of igniting hydrocarbon propellant vapour can very readily be generated during normal tank filling procedures, by the passage of hydrocarbon propellant in pipes, or from extraneous sources. It is therefore vital to ensure adequate earthing and bonding of all appropriate equipment.

2.2.6.2 Thus, earthing and bonding is of particular importance when storage tanks are being filled from nearby tank wagons or tank cars. Regulation 52(1) part f(iv), of the Regulations requires the vehicle to be electrically bonded to the receiving container and to be kept so until the transfer is completed. It is recommended that a clearly marked and effective earthing point be provided for use during tanker discharge.

2.2.6.3 The storage vessels themselves, if above ground, must be electrically bonded and earthed, and the effectiveness of the bonding and earthing and of the resistance to earth must be measured at 12-monthly intervals. These provisions are required only for tanks above 10,000 litres water capacity but are recommended for all tanks. Regulation 72 of the Regulations is the relevant legislative requirement.

2.2.7 Safety Valves on Tanks and Pipelines

2.2.7.1 Storage tanks, and piping either connecting adjacent vessels or conveying hydrocarbon propellant from storage to usage areas, should be fitted with certain valves for safety reasons. Some of these valves are required under various aspects of the Regulations, and others are recommended as giving additional safety in certain situations.

2.2.7.2 Regulation 43 gives a detailed discussion of valves required on tanks for the storage or transportation of hydrocarbon propellants. The reader should consult this Regulation for the exact requirements in terms of safety valves, excess flow valves, shut-off valves, etc.

2.2.7.3 Skid tanks are required to have valves and fittings as required for storage tanks. However, parts of

Regulation 66 allow a departure from these requirements if certain provisions are met.

2.2.7.4 Transfer pipework should be fitted with appropriately positioned excess flow valves to limit the flow of propellant in the event of damage to pipes.

2.2.7.5 A safety cut-off valve should be placed near the point where the transfer piping enters the filling unit. The valve should be manually operated, with additional remote operation possible from within the filling area. The valve should be linked with flammable gas detectors, and with ventilation and fire alarm systems.

2.2.7.6 All return-to-tank piping should have a non-return valve fitted to stop the back-flow of hydrocarbon propellant, which might create an additional hazard in the event of an emergency.

2.2.8 Propellant Leaks

2.2.8.1 Whenever a propellant leak from storage or transport facilities is observed or suspected, the first task should be to ensure the safety of nearby personnel.
2.2.8.2 Flammable gas detectors, installed as required by Regulation 39 of the Regulations when unodorised gas is to be used, will give warning of leakages. Portable gas detectors may be used to search for small localised leaks (e.g. in pipes). Such portable detectors must be suitable for use in flammable atmospheres.

2.2.8.3 Physical evidence of a leak of hydrocarbon propellant often takes the form of dripping liquid or frost forming around the point of leakage. Frosting around cylinders represents an extremely high leakage rate. Leakage from below the liquid level will cause an audible hiss.

2.2.3.4 Vapours which accumulate in a confined area as a result of a leak represent a major explosion hazard. Hydrocarbon propellants are heavier than air and will accumulate in hollows and sumps, The Regulations require adequate ventilation and suitable topography to prevent this.

2.2.9 Water Spray Protection

2.2.9.1 An approved hydrant system to protect against fire must be provided for all tank installations storing hydrocarbon propellants. Depending on the capacity of the storage vessel(s) in any particular case, either a length of hose, or for larger tanks a fixed water spray system, will be necessary.

2.2.9.2 The water delivery rate for the fixed spray

system must be at least 500 litres per square metre per hour to the whole surface of each tank. Further, although the spray system may be automatic, it must also be capable of manual control from a safe position.

2.2.9.3 Regulation 78 of the Dangerous Goods (Class 2-Gases) Regulations is concerned with water spray systems.

2.2.10 Additional Fire Control Considerations

2.2.10.1 Apart from hydrants and water spray systems discussed above, adequate fire extinguishing apparatus which accords with Part X of the Regulations must also be provided at storage places and usage areas for Class 2(d) dangerous goods.

2.2.10.2 Regulation 82 of the Regulations requires a sign with the words "Flammable Gas, No Smoking" to be displayed on any premises where dangerous goods of Class 2(d) are stored.

2.2.10.3 Part (2) of this Regulation further requires no person to bring a source of ignition within 15 metres of any place where Class 2(d) dangerous goods are stored, filled or transferred.

2.2.11 Toxicity of Hydrocarbon Propellants

2.2.11.1 Hydrocarbon propellants exert their toxic effects as simple asphyxiants. Prolonged exposure to high concentrations will induce typical asphyxiant symptoms such as drowsiness and loss of co-ordination.

2.2.12 Miscellaneous Considerations

2.2.12.1 Regulation 79 lists a number of provisions related to pipework and hoses. Among these regulations are:

(a) the pipe to be seamless, and to allow for expansion and contraction;

(b) flexible hoses to be tested to certain pressures and have a maximum bursting pressure;

(c) relief valves to be installed between two shut-off valves in any pipe;

(d) transfer hoses to be electrically conductive and failing this, to have inbuilt earthing wires; and

(e) hoses to be made of material resistant to Class 2(d) dangerous goods.

The transfer system must be subjected to pressure testing and visual inspection at specified intervals as outlined in Regulation 80.

2.2.12.2 Storage tanks for hydrocarbon propellants may not be installed underground, unless specific approval (with possible conditions) is given by the Chief Inspector of Dangerous Goods.

2.3 Chlorofluorocarbon Propellants

2.3.1 General

2.3.1.1 The second major group of chemical compounds which find extensive use as aerosol propellants are the chlorofluorocarbons.

2.3.1.2 The three major chlorofluorocarbons used as propellants are:

(a) fluorotrichloromethane(F-11)

(b) dichlorodifluoromethane (F-12)

(c) 1,2 dichloro- 1,1,2,2- tetrafluoroethane (F-114).

2.3.1.3 The general provisions of Parts I and II of the Dangerous Goods (Class 2-Gases) Regulations 1980 apply to chlorofluorocarbons. Regulation 19 of these Regulations gives maximum filling ratios for cylinders containing chlorofluorocarbons.

2.3.2 Some Properties of Chlorofluorocarbons

Chlorofluorocarbons are heavier than air, are toxic in high concentrations (see later), and are nonflammable. They will, however, decompose if exposed to naked flames or red-hot surfaces, with the evolution of acidic products of decomposition. Situations where decomposition can occur must be avoided, or else adequate ventilation must be provided to remove chlorofluorocarbon vapours.

2.3.3 Propellant Leaks

2.3.3.1 If a leak is suspected in storage vessels, valves, or transport pipework containing chlorofluorocarbon propellants, the source of the leak may be traced by using devices such as electronic detectors or halide lamps.

2.3.3.2 Care must be exercised before entering any area where high concentrations of chlorofluorocarbon vapours are known or suspected to be present. Vapour levels should be monitored, particularly in low-lying areas. Breathing apparatus may be necessary to enable repairs to be effected, and ventilation in the form of low-level extraction should be provided.

2.3.4 Toxicity of Chlorofluorocarbons

2.3.4.1 The common chlorofluorocarbons are best described as being of low toxicity. In high concentrations and after prolonged periods of exposure to the vapour, a

mild narcotic effect might be observed. However, very high concentrations (of the order of a few %) would result in drowsiness or loss of consciousness, even after only a short exposure.

2.3.4.2 Threshold Limit Values for the common chlorofluorocarbons likely to be used as aerosol propellants are all set at 1,000 ppm.

2.3.4.3 Liquid propellant spraying onto the skin or into the eyes presents a serious hazard by virtue of the freezing effect on evaporation.

3.Product Concentrate Manufacture

3.1 The Manufacturing Area

3.1.1 Adequate Ventilation Essential The area where product concentrates are prepared must be adequately designed for the purpose. Thus adequate ventilation of the general work area must be ensured, by the provision of low and/or high level ventilation as appropriate. It should be noted that the vapours of most solvents are heavier than air. Local exhaust ventilation of a container may additionally be necessary where the toxicity of a concentrate gives rise to concern.

3.1.2 Electrical Equipment Electrical equipment and fittings must be flameproof for use in areas where flammable liquids are being handled. The document MP 6105, “Electrical Wiring in Hazardous Locations” is the generally accepted standard, although certain local supply authorities may have slightly different requirements. Consultation with these authorities is recommended.

3.1.3 Preventing and Containing Spillages Major spillages of liquid can be confined by providing suitable floor sills. Automatic level controls on vessels will ensure that overfilling is prevented.

3.2 Formulating Operations

3.2.1 Transfer of Liquids As much as possible, liquids should be pumped through pipework between storage containers and mixing vessels. Otherwise, special safety containers should be used for transporting flammable liquids.

3.2.2 Protection Against Dusts Where powdered solids are being added to mixing vessels, it will be necessary for workers to wear suitable respiratory protection, whether the dust is toxic or simply has nuisance potential. Fabric dust masks may be as much as is necessary, but if a

greater risk exists, then canister respirators may be appropriate. Section 36 of the Factories and Commercial Premises Act lays down requirements for protection of workers against inhalation of airborne dust (see Appendix 2).

3.2.3 Toxicity of Concentrates The toxicity of concentrates and solvents will vary over a wide range; at all times the objective must be to limit worker exposure to airborne contaminants to below the Threshold Limit Value. Adequate ventilation is most effective in this regard (see 3.1.1 above) but substitution may have to be considered in some cases.

3.2.4 Static Electricity

3.2.4.1 To protect against the hazards of static electricity, all processing vessels and pipelines containing or conveying flammable liquids should be bonded and earthed. Plastic containers are highly inadvisable for use with flammable liquids because of the difficulty of providing adequate earthing.

3.2.4.2 The transfer of flammable liquids should be carried out with care, with particular attention being given to ensure sub-surface filling.

3.2.4.3 The Department of Labour has recently produced the booklet "Guidelines or the Control of Static Electricity in Industry". This discusses in some detail the hazards posed by static electricity, with particular attention being paid to the problem of static generation in flammable liquids.

4. Aerosol Filling

4.1 Filling Area

4.1.1 Location The product concentrate filling area should be located in a separate room which is partitioned off from the concentrate mixing room and from general warehouse space. It is recommended that the partitioning wall be of fire-resistant material.

4.1.2 Housekeeping Organisational and housekeeping procedures should be adequate to ensure that quantities of components and packing materials are kept to the minimum in the filling area. This will assist in reducing fire risks and in the general organisation of work space.

4.1.3 Forklift Trucks In areas where flammable concentrates or propellants are present then forklift trucks or other appliances used for transporting components must have flame-proof motors.

4.2 Concentrate Filling

4.2.1 Ventilation at Filling Head If volatile and/or flammable concentrates are to be filled then the area about the concentrate filling head should be equipped with adequate exhaust ventilation and flame-proof equipment will be necessary. Section 36 of the Factories and Commercial Premises Act is relevant here (see Appendix 2).

4.2.2 Siting of Ventilation Outlets The outlets of ducting leading from exhaust ventilation equipment should be positioned remote from air intakes, away from sources of ignition, and so as to ensure the adequate dispersal of contaminants by prevailing winds.

4.2.3 No Can/No Fill Arrangement In order to ensure that concentrate is not unnecessarily ejected over the floor an automatic no can/no fill system is essential.

4.2.4 Combined Concentrate and Propellant Filling In many cases the concentrate filling and propellant charging operations are integrated into the one filling system. If this is the case, then exhaust ventilation and flame-proof equipment supplied will serve a double purpose.

4.3 Valve Insertion and Crimping

4.3.1 Emergency Conveyor Control The conveying line must be fitted with several adequately spaced emergency stop controls to enable faults to be rectified swiftly and in safety.

4.3.2 Crimp Measurement It is important to the standard of the finished product (and indirectly to safety) to check the consistency and adequacy of the depth and diameter of the valve crimp. The crimp gauges must themselves be regularly checked against a standard.

4.4 Propellant Filling Operations

4.4.1 General Unauthorised persons should be barred from the propellant filling area. Personnel working in this area should be equipped with appropriate safety equipment and/or clothing. This is further discussed in Appendix 1.

4.4.2 Guarding on the Filling Machine The propellant filling machine should be fitted with adequate and appropriate guarding to protect operators from the effects of propellant blow outs during filling. Wired safety glass or clear polycarbonate plastic would be appropriate materials for guarding.

4.4.3 Compliance with Threshold Limit Values The

overriding safety concern in the filling of aerosol propellants is that the concentration of propellant vapour in the filling room atmosphere should not exceed the Threshold Limit Value (TLV) for the particular propellant in use. This will ensure compliance with Section 36 of the Factories and Commercial Premises Act 1981.

4.4.4 Ventilation Provisions To ensure that Threshold Limit Values are complied with, adequate ventilation will be necessary. This may take the form of general room ventilation, or it may be that specific local exhaust ventilation around the filling head area will be necessary.

4.4.5 Procedure with Change of Propellants With a filling system which uses a variety of different propellants, it is important to check that the correct propellant lines are connected up at the start of each day's work. Colour coding of the relevant linkages will ensure that the correct connections are made.

4.4.6 Maintenance Work Always ensure that propellant supplies are properly isolated before any maintenance work is undertaken. The atmosphere should be monitored for compliance with flammability limits and Threshold Limit Values.

4.5 Hydrocarbon Propellant Filling

4.5.1 General The following section is concerned with specific hazards posed by the use of hydrocarbons in propellant filling. The properties and toxic hazards of hydrocarbon propellants are discussed in Section 2.2.11.

4.5.2 Propellant Lines Supply lines for hydrocarbon propellants should be securely supported in a safe and adequately ventilated position. The lines should have good electrical continuity.

4.5.3 Losses of Propellant Vapour It is probable that some hydrocarbon vapour will be lost in the vicinity of the filling machine from such sources as faulty crimping, can disengagement, etc. These vapours must be extracted to a safe place by the provision of suitable exhaust ventilation.

4.5.4 Enclosure of Filling Machines The total enclosure and ventilation of the propellant filling machine is one way of ensuring that levels of propellant vapour in the air are maintained at safe concentrations. Enclosures around filling machines should be substantial, with a blast panel roof. Electrical equipment in the enclosed area must be flame-proof.

4.5.5 Ventilation of Enclosures The aim with such a system is to ensure that leaks of hydrocarbon vapour are extracted at source and not allowed to build up to a toxic

or explosive concentration in the filling room.

4.5.6 Interlocking The ventilation equipment should be interlocked as follows:

(a) The ventilation must be running before the filling machine can be started. It is recommended that an adequate time delay be incorporated, say 10 minutes;

(b) A failure of the ventilation equipment must lead to the cut off of the propellant supply.

4.5.7 Criteria for Ventilation Efficiency The effectiveness of exhaust ventilation systems is best measured by whether or not hydrocarbon contaminant levels are maintained below the relevant TLV.

4.5.8 Gas Detectors Automatic gas detectors give additional protection in the event of a major leakage of flammable propellant vapour. These detectors should be interlocked with the propellant supply line valve so that this valve is cut off if the gas detector is triggered. Under normal circumstances, gas detectors are set to trigger when the flammable vapour level reaches 20% of the Lower Flammable Limit (LEL). Apart from cutting off the propellant supply, detectors should also emit an audible and visual alarm signal.

5.Disposal of Aerosols

5.1 Rejected Aerosol Cans

5.1.1 General Leaking aerosol cans must not be allowed to remain in the open atmosphere of the factory and discharge their contents which may be flammable and/or toxic.

5.1.2 Safety Containers Closed safety containers should be provided at several points (e.g. at filling stations, near water baths, etc.), as receptacles for rejected aerosol cans. These safety containers should be emptied at suitable intervals into a waste bin in the factory yard.

A further alternative would be to provide a chute discharging to a suitable waste receptacle.

5.2 Waste Collection

5.2.1 Inform Contractors The contractor who removes the waste bin should be informed of the nature of the refuse and the potential hazard of leaking aerosol cans.

6. Weight and Pressure Checking

6.1 Check Weighing

6.1.1 General Detection of overfilled and under- filled containers should be achieved by check-weighing procedures. Obviously overfilled containers may be high in pressure but underfilled containers, if the product concentrate fill has been omitted, can also be overpressurised. Non-standard weight cans should be disposed of into a closed safety container as in 5.1 above.

6.2 Use of Pressure Gauges

6.2.1 General Pressures can be checked by the use of an appropriate gauge. This gauge should itself be checked regularly against a standard.

6.3 Water Bath Pressure Testing

6.3.1 Introduction A standard pressure testing method in aerosol manufacture is the water bath test. This should test all products on the conveyor line which are not heat-sensitive, by total immersion in warm water. For those products affected by heat, alternative methods such as halide detection or a leak detector/rejector machine should be used.

6.3.2 Temperature Limit The water temperature must not exceed a maximum of 60°C; at this temperature a two- to three-fold pressure rise will occur in the cans. Temperature control on the bath should be by way of a fail-safe thermostat.

6.3.3 Clean Water Clean water must be used in the bath at all times to enable fine leakage bubbles to be detected.

6.3.4 Guarding the Bath It is important that the water bath be covered by an adequate wire mesh or safety glass guard to protect operators from the dangers of exploding cans.

6.3.5 Operator Personal Protection Operators must wear a face shield while working at the water bath check station.

6.3.6 Removing Excess Water Excess water must be blown out of the valve cups after the cans have passed through the water bath. This removes the risk of corrosive failure of the can at some later stage.

APPENDIX 1

Protective Clothing and Equipment

1. Protective glasses should be worn at all times in the filling area. Full face shields must be worn by operators at the water bath test position.
2. Workers' overalls should be of cotton or similar material; synthetic materials can generate static electrical sparks.
3. Gloves should provide suitable protection against liquid concentrates and propellants. PVC would be a suitable glove material.
4. Eye wash stations should be provided at strategic positions.
5. Respiratory protective apparatus should be available for use in a maintenance or repair situation, or wherever a concentration of hazardous vapour might accumulate. (see the requirements of Section 36 of the Factories and Commercial Premises Act reproduced in Appendix 2).
6. General legislative duties with respect to protective clothing are outlined in Section 21 of the Factories and Commercial Premises Act (see Appendix 2).

APPENDIX 2

Pertinent Legislation

1. The two major pieces of legislation which contain sections relevant to safety and/or health matters in aerosol filling operations are the Dangerous Goods (Class 2 -Gases) Regulations 1980 and the Factories and Commercial Premises Act 1981.

2. The Dangerous Goods (Class 2 - Gases) Regulations are particularly relevant to the storage, transportation and use of propellant gases in aerosol filling. These Regulations have been discussed in Chapter 2 of this Code with particular attention given to those aspects which refer to hydrocarbon gases and chlorofluorocarbons since these account for almost the entire quantity of propellant gases used.

3. At various points throughout the text of this Code, reference has been made to relevant Sections of the Factories and Commercial Premises Act 1981. This Act provides comprehensive legislation covering the safety, health and welfare of persons employed in factories and undertakings. Certain Sections with relevance to the conditions existing in factories where aerosols are manufactured are reproduced below for the information of the reader.

21. PROTECTIVE CLOTHING AND EQUIPMENT - (1) The occupier of an undertaking shall provide for workers who are engaged in any process or activity that involves a risk of bodily injury to them, or a danger to their health, from flying particles or fragments, or from falling objects, or from scalding, corrosive, irritant, toxic, or explosive substances, or from electromagnetic or ionising radiation, or from any similar cause, such protective clothing and equipment as may be necessary to afford them reasonable protection against that risk or danger.

(2) The occupier of an undertaking where any worker is required to work in or upon, or in the vicinity of, any pile, heap, tank, silo, load, or other aggregation, of any solid material that is in such a form or state, or composed of pieces or particles so small, that is, is capable of subsiding or flowing, in such a manner as to trap or engulf that worker, shall ensure that there is provided for the use of that worker a suitable safety harness or lifeline securely fastened at its extremity, and sufficiently strong to enable that worker to be pulled from that material if trapped or engulfed as aforesaid.

(3) The occupier of an undertaking shall ensure that workers use the protective clothing, equipment, and hearing protection devices, provided by him so often as the circumstance for which they are provided arise.

22. STORAGE OF DANGEROUS SUBSTANCES - The occupier of an undertaking shall ensure that every container in that undertaking holding any material that is, or is likely to be corrosive, irritant, toxic, radioactive, explosive, or otherwise capable of endangering the health of any person who may come into contact with it or be in its vicinity, is -

(a) Safely and securely stored; and

(b) Clearly labelled.

31. PRECAUTIONS WITH RESPECT TO EXPLOSIVE OR FLAMMABLE SUBSTANCES - Where there is present in any undertaking dust, gas, mist, vapour, or other such substance, of such a character and to such an extent as to be liable to give rise to an explosion or explode on ignition, the occupier of the undertaking shall take all reasonable precautions:-

(a) To prevent the explosion of the substance by -

(i) The effective enclosure of all plant producing the substance; and

(ii) The removal or prevention of accumulation of the substance, wherever situated in the undertaking; and

(iii) The exclusion or effective enclosure of all possible sources of ignition; and

(b) To restrict the spread and effects of any explosion of the substance by the provision of suitable chokes, baffles, and vents, or by other equally effective appliances or measures.

35. VENTILATION - The occupier of an undertaking shall ensure that each room in the undertaking is so ventilated as to -

(a) Provide a supply of fresh air sufficient for the workers using the room; and

(b) Carry off and render harmless, so far as is practicable all steam, fumes, dust, and other impurities, arising in the course of the work done in that undertaking.

36. REMOVAL OF STEAM, FUMES AND DUST - (1) The occupier of an undertaking in which any process is carried on that gives off -

(a) Any steam, fume, dust or other impurity, of such a character and to such an extent as to be likely to be injurious or offensive to any worker employed in that undertaking; or

(b) Any substantial quantity of dust of any kind - shall take all practicable steps to ensure that the workers are protected against inhalation of that steam, fume, dust, or impurity, and that it is prevented from accumulating in any workroom.

(2) Without limiting the generality of subsection (1) of this section, where the nature of any process giving off any steam, fume, dust or impurity, as aforesaid carried on in an undertaking makes the provision of such appliances practicable, the occupier of that undertaking shall provide and maintain, as near as possible to the point of origin of the steam, fume, dust, or impurity, exhaust appliances that prevent the steam, fume, dust, or impurity from entering the workrooms situated in that undertaking.