Hazardous Waste Management
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ENVIRONMENTALLY SOUND MANAGEMENT OF MERCURY WASTE GENERATED FROM THE HEALTH CARE FACILITIES

CENTRAL POLLUTION CONTROL BOARD

(Ministry of Environment & Forests)
Website: www.cpcb.nic.in

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Ministry of Environment & Forests

FOREWORD

Mercury based medical instruments are commonly used in Health Care Facilities (HCFs) for diagnosis. There is a risk of exposure to mercury arising from breakage or disposal of mercury bearing instruments; such as thermometers, blood pressure measuring apparatus etc., which may directly affect the patients and healthcare workers.

Being a toxic metal, mercury has potential to effect health adversely on exposure even at lower concentrations. Realizing the need, guidelines for management of the mercury bearing waste by Health Care Facilities has been prepared envisaging information on mercury bearing medical instruments and precautions to be taken to avoid mercury contamination during the use or routine maintenance of such medical instruments. These guidelines incorporate the procedure to be adopted for collection of mercury spills, safe storage and handling methods and disposal of mercury bearing waste from various sources in an environmentally sound manner.

The contribution of Ministry of Health & Family Welfare (MoH & FW), All India Institute of Medical Sciences (AIIMS), Dr.T.K.Joshi, Director, Centre for Occupational and Environmental Health, Maulana Azad Medical College and Toxics Link, New Delhi and CPCB officials is gratefully acknowledged. The efforts of Shri J.Chandra Babu, Scientist 'C', Shri B.Vinod Babu, Sc'D' & I/c HWMD and able supervision of Shri J.S.Kamyotra, Member Secretary is highly appreciated.

Hopefully this document would be useful to all the stakeholders for environmentally sound management of mercury waste, generated from the Health Care Facilities and other sources in the Country.

(S.P.Gautam)

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Abbreviations

BMW	-	Bio-medical Waste
BMW Rules	-	Bio-medical Waste (Management & Handling) Rules,1998
CPCB	-	Central Pollution Control Board
CBWTF	-	Common Bio-medical Waste Treatment Facility
EDTA	-	Ethylenediaminetetraacetic acid
EPR	-	Extended Producer Responsibility
HW (M, H & TM) Rules	-	Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008
HCF	-	Health Care Facility
Hg	-	Mercury
IMA	-	Indian Medical Association
NIOSH	-	National Institute for Occupational Safety and Health Administration (NIOSH)
OSHA	-	US Occupational Safety and Health Administration
PCC	-	Pollution Control Committee
PPE	-	Personal Protective Equipment
SPCB	-	State Pollution Control Board
TSDF	-	Treatment Storage and Disposal Facility
WHO	-	World Health Organisation

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1. Introduction

For centuries, elemental mercury is an ideal choice for use in medical devices that measure temperature (thermometers) and pressure (sphygmomanometers), and in other applications where density and flexibility were needed (esophageal dilators). Thus, mercury-containing devices have been an integral part of health care facility (HCF) operations.

Considering the adverse health impacts due to possible spillages of mercury during the use of mercury containing devices in HCFs, it is felt necessary to prepare guidelines for ensuring proper management of mercury bearing waste generated from HCFs. These guidelines outline precautions to be taken by the health care staff in the event of mercury spillages possibly due to the breakage of mercury base devices and its handling in an environmentally sound manner. This document is confined to provide guidance on the aspects especially precautions to be taken to avoid mercury spillages during the routine maintenance of mercury based medical instruments as well as routine use of medical instruments, precautions to be taken in case of mercury spillage, mercury spill collection procedures, storage of collected waste contaminated with mercury and suggests final disposal options.

1.1 Salient properties of mercury

Elemental mercury is a heavy, silvery coloured metal that melts at -38.9^{0}C and boils at 357 ^{0}C. It is the only metal that is liquid at room temperature. Drops of elemental mercury have a high surface tension and appear round. The liquid droplet is very mobile and can combines with other metals such as tin, copper, gold, and silver to form alloys (called amalgams). An exception is iron which does not amalgamate with mercury. The density of mercury is 13.5 g/cm ^{3} at 25 ^{0}C. When elemental mercury is spilled, it can break into very small droplets resulting in a large total surface area. These tiny droplets can volatilize at a faster rate with an instant increase in room temperature and proper room ventilation can safely dilute the mercury concentration, but in most of the bio-medical instruments, mercury is confined. The amount of elemental mercury vapour produced depends on the amount of mercury spillage, surface area (amount of tiny beads produced), room temperature (as vapour increases with warmer air), air flow and physical disturbance of the spilled material. Small droplets of spilled mercury can lodge in cracks, adhere to carpet fabric, mix with dust, go down drains, stick to the soles of shoes, and dissolve to form alloys with the metals in watches and jewellery. Some materials are resistant to mercury. Salient characteristics of mercury are given in Table 1.

1.2 Behaviour of mercury in environment: Elemental mercury is a persistent, mobile and bio-accumulative element in the environment. Most of the mercury found in the environment is inorganic since mercury is never broken down into other chemical and harmless form. Once mercury enters into the environment, mercury permanently exists in the environment by changing its chemical forms depending on the environment. The possible behaviour of mercury in the environment is depicted in **Figure (1).**

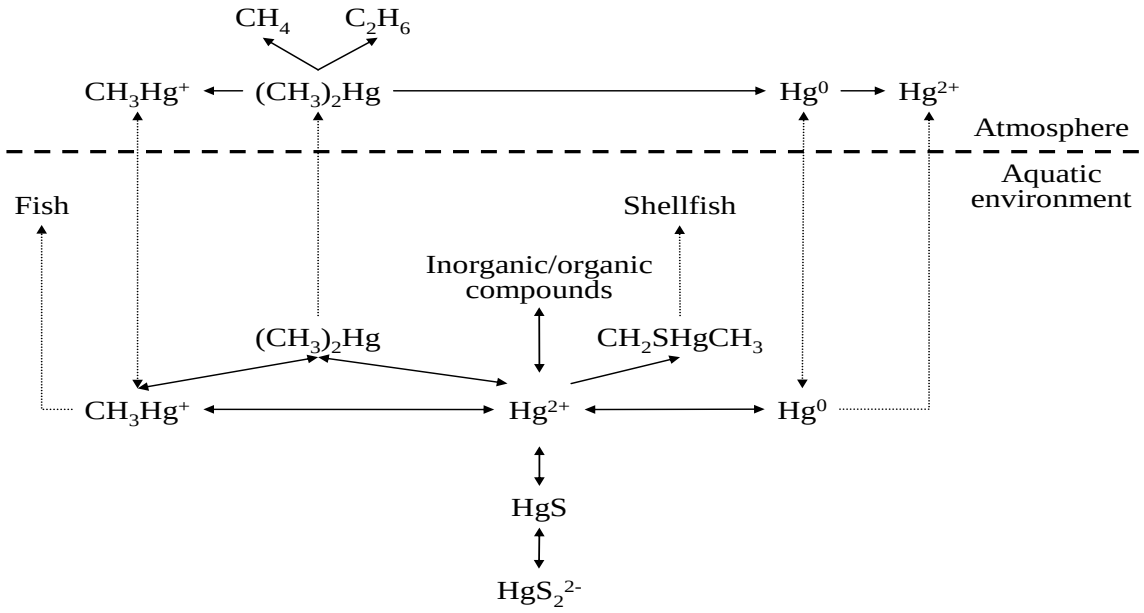

Figure (1) Behaviour of mercury in environment

1.3 Problem associated with mercury

Mercury exists in three forms i.e elemental, inorganic and organic form. Elemental mercury vapours are colourless and odourless and very toxic when inhaled. Mercury is a potent neurotoxin, a global priority pollutant and a persistent bio-accumulative (meaning that it is a process by which a toxic gets accumulated in animal tissues). It persists in the environment for a long time, and it is extremely toxic in small amounts. Exposure to mercury impacts the central and peripheral nervous system and it can damage the brain, spinal cord, kidneys, eyes and liver. Also, mercury can easily crosses the placenta, passing from mother to unborn child, where it can impact neurological development of the fetus.

In HCFs, exposure to mercury can occur through inhalation, ingestion, or skin contact and vary according to the metal speciation. The three forms of mercury namely the elemental, inorganic and organic mercury have different target organs and cause different sets of symptoms and signs. Elemental mercury mainly affects lungs causing a chemical pneumonitis, and is a neurotoxin affecting the brain. Inorganic mercury causes gastrointestinal ulceration/bleeding, and causes proximal tubular necrosis leading to renal failure. The mercuric salts are more toxic than mercurous salts. Organic mercury mainly affects the brain. When exposures are very high, all three forms become neurotoxin.

Index showing thresholds for onset of neurological symptoms in human body (level at which neurological symptoms would appear in the most susceptible adults) (WHO 1990)

Index	**Threshold**
Average daily intake	3-7 µg Hg/kg
Body burden	15-30 mg·Hg (50 kg body weight)
Total mercury in blood	20-50 µg·Hg/100 ml
Total mercury in hair	50-125 µg·Hg/g

1.4 Pathways of mercury release from HCFs

Use of elementary mercury containing items in HCFs creates many pathways by which mercury may be released into the environment. The following are likely pathways of mercury release in environment:

a) release of mercury into the air in patients area or into wastewater stream due to spillage in working environment and wards.
b) release of mercury in environment by medical waste incinerators due to burning of medical waste mixed with the waste containing mercury and other chemicals used in HCFs;
c) disposal of mercury-containing medical waste including mercury base residual dental amalgams without any pre-treatment such as stabilization or solidification;

The most common routes of exposure in the HCFs is due to inhalation of elemental mercury vapours after a spill or accidental skin contact with mercury. Accidental spills of liquid mercury may increase the levels of mercury vapours to harmful levels in the confined space. A small spill of elemental mercury in a carpeted patient room may become a major clean-up challenge. For all these reasons, mercury spills in the HCFs is required to be managed properly to reduce the health or environmental impacts.

2 Mercury base medical instruments use in health care facilities

Mercury-containing products can be found almost in every HCFs. They range from medical instruments and clinical laboratory chemicals to electrical fluorescent lamps. Some of the mercury based instruments used for diagnosis purposes by the health care facilities are (a) Thermometers (used for measurement of body temperatures); (b) Sphygmomanometers (used for measurement of blood pressure); (c) Dental amalgam (Dental cavity fillings); (d) Esophageal dilators (also called bougie tubes); (e) Feeding tubes; (f) Gastrointestinal tubes; (g) Miller-Abbott tube (used to clear intestinal obstructions); (h) Intraocular pressure devices; (i) Strain gauge; (j) Urinometer; (k) X-Ray machines; (l) Medical batteries; (m) Thimerosal; (n) Barometers used in respiratory therapy; (o) Laboratory chemicals (fixatives, stains, reagents, preservatives) etc.,. Mercury content in some of the medical instruments used in health care facilities and their application is summarized in **Table 2.** Uses of mercury base medical instruments are given in the following paragraphs:

(a) Mercury Thermometer: A clinical thermometer containing mercury generally measures body temperature within the range of 35°C – 42°C. It is estimated that on an average, a typical thermometer may contains 0.5 to 3.0 grams of mercury. Major reason for breakage of clinical thermometers in wards is the instrument slipping out of the hand while shaking it to bring down initial readings. As per estimates, the monthly average rate of breakage of mercury based glass thermometer in a 300 bedded hospital is around 70 and if the hospital is attached with a nursing school, the break rate can be much higher. Any breakage of mercury thermometer should be handled carefully while collecting and confirming spilled mercury. A typical mercury thermometer is given in **Figure (2).**

Figure (2) & (3) Mercury Thermometer and Sphygmomanometer

(b) Sphygmomanometers: Sphygmomanometers are used exclusively for blood pressure measurement. This includes a mercury manometer, an upper arm

cuff, a hand inflation bulb with a pressure control valve and requires the use of a stethoscope to listen to the korotkoff sounds. A typical Sphygmomanometers contains about 60 grams of mercury and a typical Sphygmomanometer is shown in given in **Figure (3).**

(c) Dental amalgam: Mercury is frequently used for dental amalgam **[(Figure (4) & Figure (5)].** Amalgam is the mercury alloy used primarily for dental fillings. The mercury is set free under certain circumstances by external effects such as mechanical or biological influences.

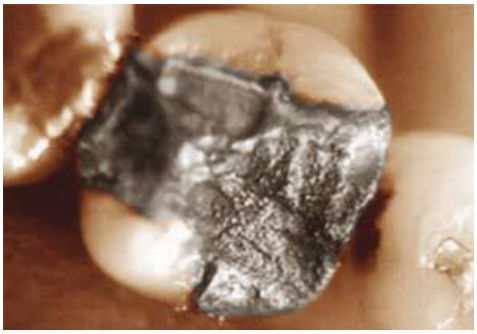

Figure (4) & (5) Mercury in dental amalgam

Prior to the mid-1980s, dentists mixed their own mercury dental clinics. They used dental amalgam dispensers to dispense a proportionally measured amount of liquid mercury combined with silver, tin, and copper, as well as small amounts of other metals, including zinc, indium, or palladium. After mixing, the resulting amalgam was packed into a person's tooth, creating a filling.

Dental amalgam dispensers **[Figure (6)]** used to mix elemental mercury with other powdered metals to create a dental amalgam used in tooth restoration and for filling cavities. Dental amalgam still contains mercury but is currently sold in pre-packaged capsules. Non-mercury alternatives for dental amalgam are made of resin and composite materials, including glass ionomer cement, gold foil, gold alloy, and metal and ceramic dental fillings and crowns.

Dental amalgam dispensers can leak or malfunction causing a mercury release. Spills from bulk elemental mercury that is stored on-site would present a significant risk of exposure as well as extensive cleanup costs. Estimates of mercury used in dentistry suggest that the average dentist using 2 or 3 pounds (1 to 1.5 kg) annually.

Figure (6) Proportional dental amalgam dispenser with elemental mercury

Figure (7) Esophageal dilators with mercury weights

(d) Esophageal dilators: An esophageal dilator **(Figure (7)**, also referred as a bougie tube, which is used to dilate the esophagus of a patient in response to medical conditions or treatments that cause esophageal narrowing or tissue shrinkage. The dilator is a long, flexible tube that is slipped down the patient's throat into the esophagus, where it remains in place for several minutes before it is extracted. Older esophageal dilators consist of thick latex-coated tubing with approximately 2-3 pounds of elemental mercury which is used as a weight at the bottom of the tube. The density and liquid properties of mercury make it ideal to use as a flexible weight, necessary to insert the tube into the patient's constricted esophagus.

(e) Feeding tubes : A feeding tube is a medical device used to provide nutrition to patients that cannot obtain nutrition by swallowing. They are used to administer food or drugs. The most common feeding tube is the nasogastric tube, which is passed through a patient's nose, past the throat, and into the stomach. The tubes are usually made of polyurethane and silicone. Older tubes can contain a small amount of mercury as a weight at the bottom of the tube, which helps guide the tube into place using gravity. Weighted feeding tube may contain mercury greater than one gram. The polyurethane coating of a feeding tube is not easily broken during normal handling. However, if a leak or break occurs, there is a chances of mercury spill.

(f) Gastrointestinal tubes : A gastrointestinal tube is used to eliminate intestinal obstructions. Types of gastrointestinal tubes include Miller Abbott, Blakemore **(Figure 8)**, and Cantor tubes. The tube is passed down a patient's esophagus, through the stomach, and into the small intestine to help remove or reduce intestinal obstructions. Historically, these tubes had a balloon containing mercury as the flexible weight, which would help guide the tube into place. When filled to capacity, these devices contained approximately 2 pounds of mercury.

The large amount of mercury contained in gastrointestinal tubes would cause a significant risk of exposure as well as extensive cleanup costs if spilled.

Figure (8) Blakemore Gastrointestinal tube

Miller-Abbott tube is a double-channel intestinal tube with an inflatable balloon at its distal end, used for diagnosing and treating obstructive lesions of the small intestine. Over time, the latex covering of the esophageal dilator tubing can become brittle and cracked, which may lead to a mercury release.

(g) Intraocular pressure devices: Small bags of mercury were historically used as weights to apply pressure to the eye prior to cataract surgery. These mercury-filled balloons, which were the size of a small egg, contained approximately 175 grams of elemental mercury that was double or triple bagged and placed on the patient's eye prior to surgery. When placed on the eye, the weight of the mercury on the eyeball kept fluid from accumulating at the normal rate, softening the eyeball prior to surgery. This practice reduced the pressure within the eyeball, simplifying surgery. However, this method is no longer used. These mercury-filled balloons can be easily broken or ruptured - especially as they get older and the integrity of the rubber balloon degrades.

(h) Strain gauge: A strain gauge is a sensor attached to a plethysmograph, which measures arterial blood flow. The strain gauge **(Figure 9 & 10)** consists of elemental mercury contained in a fine rubber tube, which is placed around a patient's limb or digit (e.g., forearm, leg, calve, finger, or toe). A standard limb-style mercury strain gauge contains approximately 1.25 grams of elemental mercury. Pressure is applied to the patient's limb and the increase in its circumference is measured.

This measurement indicates changes in blood flow and is used to measure blood pressure and check for blood clots. The technique is called 'strain gauge plethysmography'. The mercury is contained in a silastic rubber tube. Swelling of the body part results in stretching of the tube, making it both longer and thinner,

which increases electrical resistance. The mercury is used as a measuring element for this electrical continuity. Strain gauges seldom break during normal handling and use, hence requires proper care from mercury exposure due to such mercury spill.

Figure (9) Limb strain gauge-used for legs

Figure (10) Digit strain gauge – for fingers and toes

As a gauge ages, the copper electrodes at the ends are dissolved into the mercury. It appears as a darkening of the mercury, which begins at the end of the gauge and progresses toward to middle. This process causes the pressure in the gauge to go down, and eventually the gauge will lose electrical continuity when it is stretched too far. If this happens, the strain gauge will no longer work.

(i) Urinometer: A urinometer **(Figure 11)** was an instrument used to measure the specific gravity of urine. It was a glass device with a mercury-weighted bulb and an air-filled stem with graduated scale above. Urinometers are basically small hydrometers with a relatively small amount of mercury - less than one gram. When the urinometer is placed in liquid, the float displaces a certain weight and the level to which it sinks is a measure of specific gravity. Mercury may be contained in the bulb of the urinometer, acts as a weight, which makes the urinometer float upright in the liquid urine. The point on the scale, which is in line with the upper level of urine, represents the specific gravity. Urinometers are now rarely used and mercury urinometers are no longer produced or available for sale as urine dipsticks are presently used to measure the specific gravity in a urine analysis.

Figure (11) Mercury Hydrometer/Urinometer Figure (12) X-Ray Machine

(j) X-Ray machines: X-ray machine **(Figure 12)** may contain small mercury levelling switches as part of the positive beam limitation (PBL) system, also referred to as the automatic collimation system, which is mounted on the x-ray tube housing. The PBL system is an automatic collimation system used in stationary radiographic equipment. The mercury switches in this system usually account for approximately 3-4 grams of mercury per machine, although some may contain significantly more. As long as the system remains intact, there is a low probability of mercury releases from this device. Therefore, care should be taken whenever handling this equipment to prevent a mercury release.

(k) Electronic equipment: Mercury cells **(Figure 13 & 14)** used in medical equipment contains Mercuric Oxide (HgO). The discharged cells need to be disposed off safely.

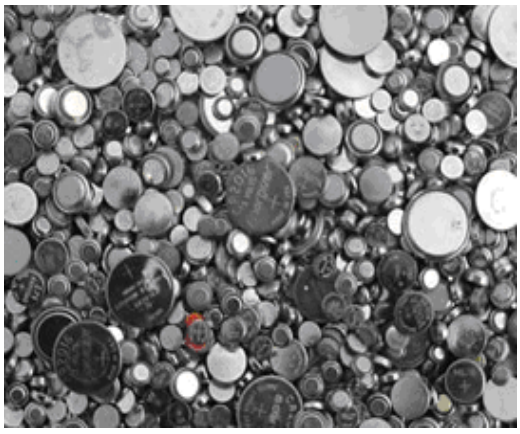

Figure (13) & (14) Mercury base Button Cell and Medical Battery

(l) Thimerosal : Thimerosal, a mercury containing preservative is added to vaccines to protect against bacterial contamination. It is composed of nearly 50 % mercury which can metabolize to ethyl mercury and thiosalicylate. Figures 15 & 16 shows thimerosal based vaccination.

Figure (15) Mercury in Thimerosal vaccination

Figure (16) Thimerosal Base

(m) Barometer used in respiratory therapy:_A mercury barometer is used to calibrate blood gas analyzers in hospitals. In general a typical barometer holds 450 grams of elemental mercury.

Figure (17) Barometers used in Respiratory Therapy

(n) Fixative: One of the compounds widely used in laboratories is B-5 fixative. This mercury containing fixative has been used in histology to aid in identification of certain cell types. The tissue would be placed in a container with the B-5 fixative and left until the solution had penetrated the tissue. Then the tissue would be stained and placed onto a slide for microscopic examination. During the rinse process, there is a possibility of some mercury discharge into the sewer system. Several brands of B-5 fixative have been developed using Zinc Chloride instead of mercury.

3.0 Sources of mercury bearing waste generation in HCFs

Use of mercury bearing clinical thermometers and sphygmomanometers (blood pressure gauges) are the main sources of mercury contamination in hospitals, where breakage results in a potentially hazardous spillage which may affect both patients and staff. In the event of higher ambient temperatures in hospitals which may enhance the release of mercury vapour after a spill. Unless such spillages are dealt with quickly and efficiently, contamination of the floor and fabric of the room will continue to produce harmful mercury vapour. As per some studies, the occurrence of accidental spillage due to breakage of mercury thermometers is estimated at two thermometers per bed per year. The possible areas of mercury exposure in health care facilities are (a) Accident & Emergency Department; (b) Dental Department; (c) Endoscopy Department; (d) Instrument Repair Workshop; (e) Laboratories ; (f) Outpatients Clinics; (g) Pharmacy; (h) Stores and Wards and (i) wastewater drains and ETP.

Apart from the above, mercury spillage due to breakage/leakage of other medical instruments, residual mercury base dental amalgams, clinical reagents and laboratory chemicals, drugs, fluorescent light tubes, switches and other electrical devices are the other sources of mercury emission from health care facilities. Uses and modes of release of mercury into the environment from health care facility is summarised in **Table 3.**

A study conducted by All India Institute of Medical Sciences (AIIMS) on "Assessment of Awareness of Environmental Mercury Pollution in Health Care System: Solutions & Strategies for Prevention", the analysis results of the wastewater samples collected by CPCB indicated that mercury concentration is in the order of 01 to 05 μg/l . Though the observed values are far below the limits prescribed under 'Schedule VI: General Standards for Discharge of Environmental Pollutants, the presence of mercury in wastewater indicate occurrence of mercury contamination in hospitals.

3.1 Categorisation of mercury bearing waste generated from HCFs

Elemental mercury as such present in medical instruments used in HCFs does not fall under the category of hazardous waste as long as these instruments are in use. Mercury containing waste is generated due to accidental breakage of mercury base instruments, obsolete medical instruments containing mercury no longer in use or items contaminated with mercury including mercury spill as well as residual mercury base dental amalgam. Such waste is categorised as 'Hazardous Waste'

which is required to be stored safely on-site or disposed off at the earliest as per these guidelines and in consultation with the State Pollution Control Board (SPCB) or Pollution Control Committee (PCC).

4.0. Strategies for managing mercury bearing waste generated in HCFs

Source reduction (using alternate materials or alternate processes not requiring mercury), waste minimisation (using mercury in existing processes more efficiently or completely), emission reduction / treatment (using end-of- pipe engineering controls to capture mercury before it can be emitted or treatment to reduce the amount or toxicity of the waste) are the suggested strategies for management of mercury bearing waste in health care facility which include the following:

a) Segregation of reusable and non-reusable mercury containing products
b) Recycling mercury-containing products when they can no longer be used.
c) Proper handling and disposal of mercury waste, mercury-containing equipment, collected mercury spill, residual mercury base dental amalgam and laboratory chemicals.
d) Establishing protocols for proper cleanup of spills involving mercury.
e) Enforcing compliance with suggested or institutional policies.
f) Using alternatives for products that contain mercury.

4.1 Mercury source reduction

Healthcare Sector is required to take adequate steps for eliminating mercury pollution. It is required to ensure appropriate source segregation so that mercury is segregated from the waste stream before it is sent for on-site bio-medical waste treatment facility or a Common Bio-medical Waste Treatment Facility (CBWTF) for disposal. Such source segregation programs may require significant initial educational and implementation efforts. Also, standard operational practices should be practiced for clearing of mercury spills, calibrating mercury based instruments, and handling of mercury bearing instruments.

Another preventive step to stop mercury from entering the medical waste stream is to label segregated infectious waste and ensure that broken mercury devices or the waste contaminated with mercury including dental amalgams do not mix with bio-medical waste. It is vital to ensure that waste amalgam, broken equipment and elemental mercury and other mercury bearing waste are stored in designated areas of the hospital/medical facility and disposed of through authorized medical

instrument manufacturers, authorized hazardous waste recycling or Treatment Storage and Disposal Facilities (TSDFs) or as specified by the respective SPCB/PCC. Apart from this using alternate materials or alternative processes not requiring mercury would reduce substantial mercury pollution.

4.2 Alternatives to mercury base medical instruments in HCFs

HCFs can solve their mercury waste and acute mercury exposure problems by replacing mercury based instruments with the appropriate alternatives. Considering the toxic nature of the mercury, all the HCFs are required to gradually phase out mercury containing equipment (thermometer, BP Instruments etc.) and replace them with a good quality non-mercury based equipment to prevent potential toxic effects of mercury on patients and health care staff –doctors, nurses and the health care workers. Some of the non-mercury alternatives in HCFs suggested are as follows:

i. Alternatives to mercury thermometers include electronic, infrared, chemical strip, and alcohol/spirit thermometer.
ii. Mercury BP apparatus cuffs can be replaced by aneroid and electronic blood pressure gauges.
iii. Use of gastrointestinal tubes weighted with tungsten gel or sterile water instead of mercury.
iv. Use of indium-gallium strain gauges, doppler and photo cell equipment in place of mercury-filled strain gauges.
v. Use of 'pre-encapsulated mercury amalgam alloy' in place of the dental amalgam dispensers.
vi. Non-mercury plethysmographic equipment is replacing the mercury containing strain-gauge equipment that is used for measuring blood pressure in fingers, toes and other specialty areas.
vii. "B-5" Fixative previously containing mercuric chloride be replaced with zinc chloride based fixative.
viii. Barometers can be replaced with aneroid units.

Mercury dental amalgams can be replaced with the composites which are available in the market. Summary of the above is provided in **Table 4** and few alternates to the mercury based instruments are given in **Figures (18) to (24)**.

Figure (18) Mercury free Digital Thermometer

Figure (19) Electronic Thermometer

Figure (20) Aneroid Sphygmomanometers

Figure (21) Electronic Sphygmomanometers

Figure (22) Digital Sphygmomanometers

Figure (23) Tungsten gel weighted bougies

Figure (24) B-5 Fixative has been developed using zinc chloride in place of mercury.

Note: All the electronic alternates do contain metallic button cells containing mercury, for which special care should be taken for disposal of these cells and for internal instruments containing mercury should strictly be avoided especially mercury containing esophageal dilator, feeding tubes, gastrointestinal tubes, dental amalgam etc.,

5.0 Guideline for storage of mercury base medical instruments and precautions to be taken during maintenance of mercury base medical instruments

Regular calibration and maintenance of the medical instrument is essential for diagnosing the patients and in general maintenance is done within the HCFs. Proper storage of mercury base instruments are required besides handling of mercury spillages. Following guidelines are suggested for storage of mercury base medical instruments:

i) Mercury-containing thermometers and other equipment used in HCFs should be kept in a container that does not have a hard bottom. Plastic container to a glass container is preferred as the possibility of breakage will be minimal.

ii) Cleaning and refilling of instruments with mercury should be done only in a designated place (reserved room) and only by a properly trained and authorised staff, in accordance with the manufacturers handling procedures.

iii) To minimise spills and exposure during maintenance/calibration, the devices (e.g. sphygmomanometers) should be kept in a tray and there should be no drains within the room to prevent discharge of mercury spill into wastewater stream. Mercury based instruments should not be handled directly over a sink to avoid direct entry of mercury in to the waste water stream.

iv) Mercury base medical devices should be used only in rooms without carpeting or the flooring surface not smooth in nature.

v) Mercury devices should not be used in units with beds that have high structures or projections that can break wall-mounted sphygmomanometers, or in areas where patients cannot be moved quickly in the event of mercury spills if any.

5.1 Precautions to be taken during accidental spillages or breakages of mercury base equipment in HCFs

Following precautions to be taken in the event of accidental spillages of mercury in the HCFs:

i) Ensure that all the patients, people and the staff are moved away from the mercury spill area.

ii) In case, the heaters and air conditioners which are in heating mode should be turned off to minimise volatization of the mercury spill.

iii) Proper ventilation has to be seen by opening windows and ventilators.

iv) Any ventilation system that would spread mercury vapour to other sensitive areas should be closed. If possible, lower temperature should be maintained as this process lowers the amount of mercury that can vapourize.

v) Vacuum cleaner should not be used at all to clean up mercury spill as mercury will contaminate the vacuum cleaner as well as heat from the cleaner will vapourize the mercury and drastically increase exposure to the surrounding environment. If a vacuum cleaner has been used to clean up mercury spill, it would become unfit for re-use unless the entire vacuum cleaner is decontaminated.

vi) Precaution should be taken not to handle mercury spills/broken equipment with bare hands and appropriate personal protective equipment (rubber gloves, goggles, face shields and clothing) should be used.

vii) As far as possible jewellery should be removed as mercury will bind with the metal and rubber gloves should be used at the time of handling mercury spills.

viii) After handling mercury, hands must be carefully washed before eating or drinking. The gloves used during handling of mercury should be segregated and stored safely in a designated place.

ix) Broom should never be used to clean up mercury as it breaks up into mercury droplets and moves them around, making it harder to decontaminate the area.

x) The mercury spills should never be discharged into the drain/sewer as it can lodge in the plumbing, and contaminate the septic tank and sludge in sewage treatment plants.

xi) Mercury-contaminated items should not be washed in a washing machine as the mercury can contaminate the sewage system and the washing machine.

xii) All the items such as shoes, clothing, fabric or any item that has been contaminated with mercury during the mercury spill collection process should be either decontaminated or treated as hazardous waste.

In case of larger mercury spill (i.e more than 3 gms of mercury), as far as possible collect spills at temperatures below 25°C, to avoid volatility of mercury at higher temperatures.

5.2 Accident Report

Large mercury spillage (more than 3 grams of mercury) should be considered as an adverse event or incident and should be reported to the respective State Pollution Control Board (SPCB)/Pollution Control Committee (PCC) as per *Form –III of the Bio-medical Waste (Management & Handling) Rules, 1998 and amendments made thereof* ***(Annexure –I).***

5.3 Mercury Spill Kit for mercury spill management

'Mercury Spill Kits' are essential for management of mercury spills. Mercury spillage collection kit should be kept at all the suitable places in HCFs to allow rapid access to use the same in the event of mercury spillages. Every HCF should have at least two or three kits. The number of spill kits may be decided depending upon the number of beds. Mercury Spill Kits need to be used only by trained personnel to prevent further exposures. Although mercury spill kits can be fabricated by putting together the following items and storing them in a marked box or portable container:

- Personal protective equipment (PPE): rubber or nitrile gloves, safety goggles or protective eyewear, respiratory protection, face mask (designed particularly for mercury) or If no specialty masks are available, a face mask with a 0.3 micron HEPA filter to capture amalgam particles and mercury-laden dust), coveralls, apron, and other protective clothing, disposable shoe covers, containers.

- Air-tight, sealable plastic bags (small and large sizes, thickness 40 to 150 microns).

- Small, air-tight, rigid plastic container or glass bottled half filled with some water or vapour suppression agent for collecting elemental mercury.

- Air-tight, puncture-resistant, rigid plastic or steel jar or container with a wide opening for collecting mercury-contaminated broken glass.

- Plastic tray.

- Regular plastic waste bags (thickness: 40 to 150 microns).

- Tools required for removing mercury:

    - Flashlight (electric torch) to locate shiny mercury beads.

    - Plastic-coated playing cards or thin pieces of plastic to push mercury beads into a plastic scoop or pan; if these are not available, use index cards, pieces of cardboard, or stiff paper.

    - Small plastic scoop or plastic dust pan to catch the mercury beads.

    - Tweezers to remove small broken glass pieces.

    - Eyedropper or syringe (without the needle) to draw up large mercury beads.

    - Duct tape or sticky tape to pick up tiny mercury droplets.

- Vapour suppression agents:

    - Sulfur powder (available from pharmacies) to absorb mercury by forming mercuric sulfide (or Zinc /copper flakes to absorb mercury by forming amalgams).

    - Commercial absorbent pads or vapour suppressants which contain a foam pad saturated with a suspension containing small amounts of sodium thiosulphate, copper sulphate, calcium chloride, and potassium iodide.

- Small quantities of a propylene glycol solution or sodium thiosulphate or copper sulphate may also be used as vapour suppression agents.

➢ Brush to remove powder or flakes.

➢ Utility knife blade.

➢ Materials for decontamination:

- Vinegar, hydrogen peroxide, and cotton swabs for final cleaning when using sulfur powder.

- Decontaminant solution or commercial decontaminant (made of 10 % sodium thiosulphate solution or a mixture of sodium thiosulphate and EDTA).

7

Figure (25) Mercury Spillage collection Kit

Figure (26) Dental Amalgam Collection Kit

Whenever a spill kit is used, the most senior staff involved in the cleanup should take responsibility for ensuring that the contents are replenished as soon as possible. All spill kits should have a sheet attached indicating when they were used and verifying that the expended supplies have been replaced. The sheet should be signed and dated by the responsible staff.

5.4 Suggested steps for mercury spill cleanup in HCFs: Step-by-step instructions that are specific to the health care facility are given in subsequent paras:

i) Evacuate area: As far as possible, keep people who are not involved in the cleanup away from spill area to limit exposures and to prevent the spread of contamination.

ii) **Put on face mask:** In order to prevent breathing of mercury vapour, wear a protective face mask as suggested under Section 5.3.

Figure (27) Mercury vapour-proof masks

iii) **Remove jewellery:** Remove all jewellery from hands and wrists so that the mercury cannot combine (amalgamate) with the precious metals.

iv) **Wear gloves:** Put on rubber or latex gloves. If there are any broken pieces of glass or sharp objects, pick them up with care. Place all broken objects on a paper towel, fold the paper towel and place in a puncture proof plastic bag or container provided with lid. Secure the plastic bag/container and label it as containing items contaminated with mercury.

v) **Locate mercury beads:** Locate all mercury beads and look for mercury in any surface cracks or in hard-to-reach areas of the floor. Check a wide area beyond the spill. Use the flashlight to locate additional glistening beads of mercury that may be sticking to the surface or in small cracked areas. Cardboard sheets should be 'used to push the spilled beads of mercury together'.

vi) **Use syringe without a needle/eyedropper and sticky tape:** A syringe (without a needle) shall be used to suck the beads of mercury. Collected mercury should be placed slowly and carefully into an unbreakable plastic container/glass bottle with an airtight lid half filled with water. After removing larger beads, use sticky tape to collect smaller hard-to-see beads. Place the sticky tape in a punctured proof plastic bag and secure properly. Commercially available powdered sulfur or zinc stains mercury a darker colour and can make smaller beads easier to see (powder sulfer may be used because (i) it makes the mercury easier to see since there may be a color change from yellow to brown and (ii) it binds the

mercury so that it can be easily removed and suppresses the vapourization of any missing mercury).

vii) **Collection in leak-proof bag or container:** Place all the materials used during the cleanup, including gloves, mercury spills collected from the spill area into a leak-proof plastic bag or container with lid and sealed properly and labeled as per these guidelines and such collected waste should be stored in a designated area only.

viii) **Cleaning of the floor surfaces contaminated with mercury and cleaning of room surfaces:** Sprinkle sulphur or zinc powder over the area. Either powder will quickly bind any remaining mercury. In case, zinc powder is used, moisten the powder with water after it is sprinkled and use a paper towel to rub it into cracks in the flooring. Use the cardboard and then dampened paper towels to pick up the powder and bound mercury. Place all towels and cardboard in a plastic bag and seal all the bags that were used and store in a designated area.

All the mercury spill surfaces should be decontaminated with 10 % sodium-thiosulfate solution. Keep a window open to ventilate after the cleanup. After ensuring all the mercury has been removed, resume normal vacuuming and utilise the cleaned area for routine operation.

ix) **Labelling :** All the bags or containers containing items contaminated with mercury should be marked properly and labeled as per these guidelines **(Aannexure –II).**

Steps to be followed for mercury spill clean up is given in **Figure 28.**

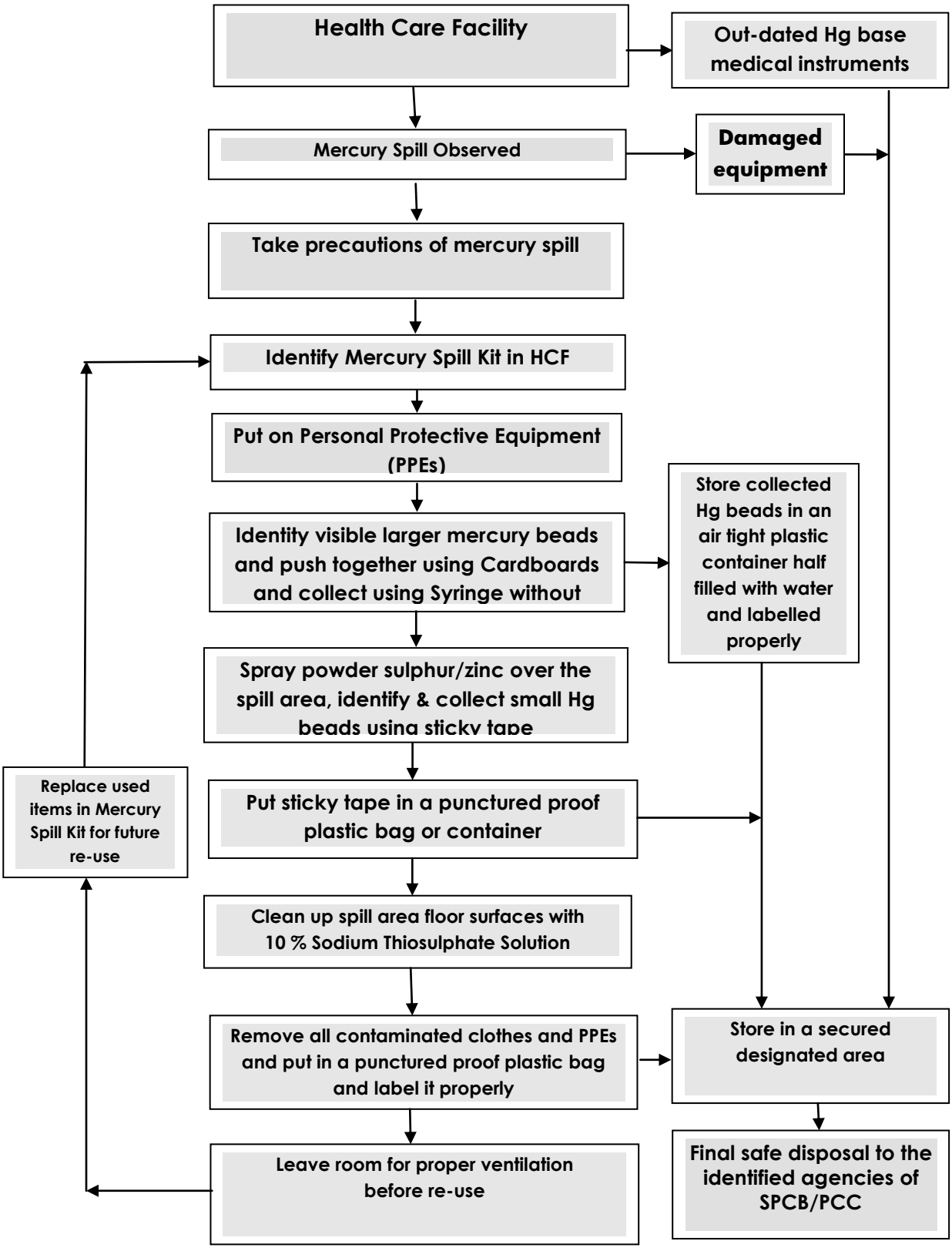

Figure 28. Mercury Spill clean-up procedure

5.5 Storage of mercury bearing waste

5.5.1 Storage of mercury bearing waste within HCF: It is vital to ensure that mercury waste amalgam from dental health care facilities, mercury base broken equipment and or obsolete mercury devices and other items contaminated with elemental mercury generated in the process of cleanup are labeled properly and stored safely in a separate collection containers or puncture proof bags/containers in a designated storage area within the health care facility prior to its final disposal.

As far as possible, the storage of mercury bearing waste within the health care facility for a longer period should be avoided and it should be sent to the authorized common bio-medical waste treatment facility (CBWTF) or transported to an authorized Centralized Storage Facility/ hazardous waste treatment storage and disposal facility located nearby or sale/auction to the authorized recyclers or medical instrument manufacturers identified by the respective State Pollution Control Board (SPCB)/Pollution Control Committee (PCC). Following points may be followed for storage of mercury bearing waste with the HCFs:

(i) The storage room should be away from the patient area or the staff (preferably a workshop)
(ii) The storage place should be away from the heat generating equipment.
(iii) The storage room should be provided with mercury spill kit provision, proper ventilation (preferably with exhaust fan).
(iv) The floor of the storage room should have smooth tiled floor with adequate slope, lighting arrangement.

5.5.2 Storage of mercury bearing waste at Centralised storage facility

The Centralised storage facility may be provided at the existing common bio-medical waste treatment facilities to facilitate safe collection and storage prior to final disposal either through an authorized recyclers or TSDF or equipment manufacturer. These facilities shall be set up as per the authorization from the respective State Pollution Control Board/Pollution Control Committee under the provisions of Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008. Suggested precautions for storage of mercury bearing waste within the centralized storage facility are as follows:

i) Mercury bearing waste should be stored in a locked and dedicated room or partition that is not in an area of high use.

ii) Exhaust gases should be routed through carbon filtration.

iii) Dedicated containers should be in good condition and made of hard plastic or metal but not wood.

iv) The room should have smooth tiled floor or durable (e.g., 6 mm) plastic sheeting or in case, concrete floor, it should be coated with a durable epoxy. Adequate slope should be provided so as to provide proper drainage and easy collection of spills if any.

v) The storage area should be marked or delineated clearly by fencing, posts, or walls in order to limit access to it.

vi) A recording system on the condition of the storage area should be established, details of which shall include the observations, name of inspector, date inspected, etc.

vii) The outside of the storage site should be provided with a board giving details w.r.t type of waste stored & its quantity, storage duration, contact details in case of any emergency etc.

viii) The storage site should be subjected to routine inspection for leak /spill detection, and general status of the site.

ix) Only trained personnel should be engaged in handling waste.

x) A copy of the Material Safety Data Sheet should be available in the area.

5.6 Mercury waste disposal options

The disposal options for mercury bearing waste are suggested as follows

a) **Disposal through medical equipment manufacturers**: Considering the added benefits of reducing the amount of mercury ending up in the environment, and decreasing the demand for new raw mercury, as far as possible, mercury bearing waste should be "recycled" into new mercury-containing products following the principles of extended producer responsibility (EPR) as EPR

is a suite of policy tool for reducing the generation of wastes by promoting greater recycling and resource recovery. In Delhi, two medical equipment manufacturers has been authorized by the Delhi Pollution Control Committee for collection of mercury bearing waste generated from health care facilities. For such details, please refer to DPCC website (i.e www.dpcc.delhigov.nic.in/mercury_waste.htm)

b) **Disposal of mercury bearing waste through mercury recovery units:** Most encouraging and sustainable mercury disposal option is to forward mercury bearing waste for reclaiming of the mercury either by mercury distillation or roasting methods and reuse of recovered mercury.

c) **Disposal through Hazardous Waste Treatment Storage and Disposal Facility (TSDF):** Disposal option for disposal of mercury bearing waste containing residual mercury and not economically viable for recovery, such waste need to be disposed of through a nearby authorized Common Hazardous Waste Treatment, Storage and Disposal Facility (TSDF) following the manifest as stipulated under the HW (M, H & TM) Rules, 2008 for final disposal of such waste in a secured landfill after ensuring pre-treatment by stabilization technique meeting the requirements of criteria for final disposal of hazardous waste in a secured landfill as suggested under the CPCB guideline. State-wise list of TSDFs which are presently in operation are given in **Table 5.**

d) **Disposal through a Common Bio-medical Waste Treatment Facility (CBWTF):** Very feasible option for disposal of mercury bearing waste is to handover properly segregated mercury bearing waste to an authorised common bio-medical waste treatment facility (CBWTF) representative being CBWTF operator collects the waste daily from the member health care facility, on charge basis for further treatment and safe disposal as to be authorised by the SPCB/PCC under the BMW Rules. The role of CBWTF may be restricted to the following:

- Safe collection of mercury bearing waste from HCFs
- Safe removal /transportation/transfer of elemental mercury from damaged and end of life medical instruments and storage of the same in leak proof steel containers under controlled conditions.
- Safe storage of residual mercury bearing waste as described in section 5.5.
- Sale of elemental mercury resource to any authorized recyclers or manufacturers identified by the SPCB/PCC.
- Final disposal of all mercury bearing waste and equipment to nearby TSDF for final disposal in SLF after pre-treatment.

Suggested mercury waste disposal options are given in **Figure 29**. All the places where storage of mercury waste is required, the guidelines given for storage of mercury bearing waste should be adopted.

6.0 Mercury Audit - Maintenance of stock inventory and records for purchase, used/broken, disposed mercury bearing wastes/materials

In order to arrive at annual average mercury spills due to breakages of the medical devices containing mercury in HCFs, there is a need to maintain proper records with regard to the annual purchase of mercury based instruments, no. of instruments broken, no. of mercury based instruments available as on the date, no. of times the mercury based instruments broken, quantity of mercury spillage occurred, quantity of recovered mercury spillage, storage methods and final disposal method followed to prevent the loss of mercury. Such records need to be maintained and audit statement is required to be submitted by HCFs along with annual report to be submitted by the HCFs in accordance with the Bio-medical Waste (Management & Handling) Rules, 1998 i.e. on or before 31 st January every year.

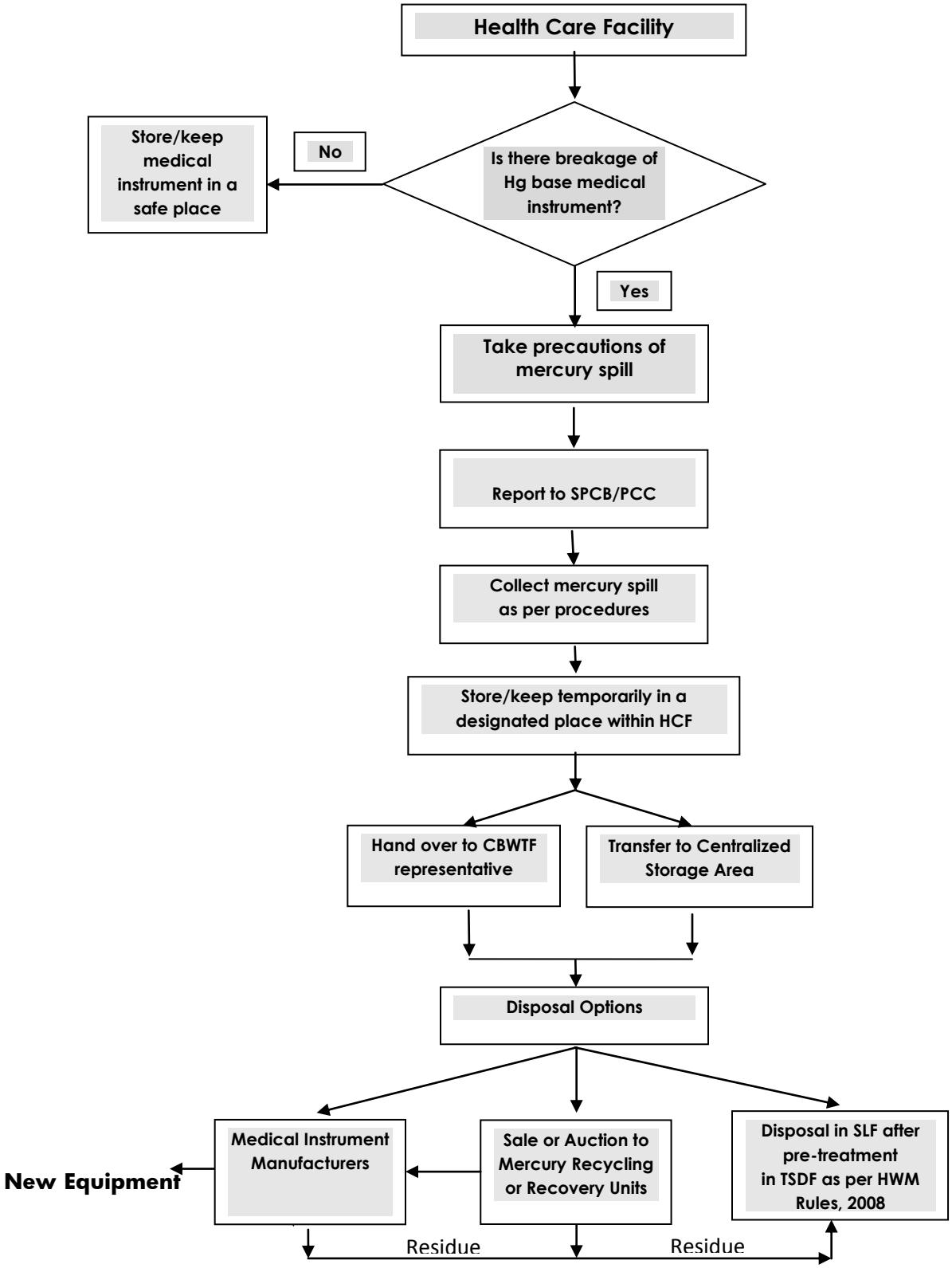

Figure 29. Final disposal options for mercury waste generated from HCFs

7.0 Training and awareness activities

Awareness on the hazards of mercury is crucial to maintain the health and safety onsite. The administrator of the health care facility should take pro-active role in maintaining the 'safe management of mercury waste in a healthcare facility' with an objective to minimize exposure to patients, health workers, housekeeping staff and the community, to prevent environmental pollution and health impacts. In order to accomplish these objectives, a mercury waste management plan is essential. A plan should include *Education and training of staff and community* – awareness-raising, public education, periodic training on mercury management, simulation (response to mock spills). As a part of periodic awareness/training programme, following aspects be emphasized, which include:

(i) Impart awareness/education on chemical properties of mercury, probable health impacts
(ii) Proper maintenance of mercury devices – safe procedures for calibration and preventive maintenance
(iii) Appropriate labelling and collection – segregation of mercury from infectious and regular wastes, use of appropriate containers, labelling
(iv) Mercury spill management – spill kits, procedures for spill management, staff training
(v) Mercury waste collection plan – procedures for on-site storage and transport to a designated storage/disposal area
(vi) External management strategies – take-back arrangements with vendors for used or obsolete mercury devices, arrangements with approved mercury recycling facilities (if available), gradual phase-in of non-mercury devices
(vii) Proper disposal methods – transport to approved treatment and disposal facilities (if available)

Apart from awareness workshops, poster display within the premises of HCE may be made in all the wards.

It is also important to have trained individuals available at all times who are familiar with management of mercury spills and the use of a spill kit in the Health Care Facility. Notices/placards should also be adequately posted throughout the facility listing trained individuals with contact numbers for easy access to the trained personnel in the event of any mercury spill.

8.0 Policies and the workplace/indoor air standards for mercury in health care facilities for voluntary compliance including switching over to non-mercury base medical instruments

8.1 Mercury exposure limits: Recommendation from the Scientific Committee on Occupational Exposure Limits for elemental mercury and inorganic divalent mercury compounds, SCOEL/SUM/84, European Commission, May 2007; the threshold limit value (daily exposure level above which it is believed a worker could suffer adverse health effects) or TLV assigned by the American Conference of Governmental Industrial Hygienists (ACGIH) is 0.025 mg per m^3 averaged over a normal 8-hour work day and a 40-hour work week. The National Institute for Occupational Safety and Health Administration (NIOSH) has a recommended exposure limit (REL) for mercury vapour of 0.05 mg per m^3 as a time-weighted average (TWA) for up to a 10-hour work day and a 40-hour work week where as The US Occupational Safety and Health Administration (OSHA) regulates the level of mercury vapours to which workers can be exposed i.e Permissible Exposure Limit (PEL) and for mercury vapour is a ceiling value of 0.1 mg per m^3 in air.

Factories Act, 1948, stipulates mercury level in the work zone environment in ambient air at 0.01 mg/Nm^3 (time weighted average concentration 08 hrs) & 0.03 mg/Nm^3 as short term exposure limit (15 minutes).

8.2 Mercury phase out in HCFs: Considering the probable impacts due to the mercury pollution, there is a need to take a policy decision by the Ministry of Health & Family Welfare in consultation with all the stakeholders including Health Departments of State Governments or Union Territory Administration for switching over to the non-mercury base medical instruments in place of mercury base medical instruments in a time bound and phased manner as implemented by the Delhi Government in National Capital Region. A road map need to be evolved by the Ministry of Health & Family Welfare in this regard in consultation with all the stakeholders considering the priority medical instruments which can be phased out keeping in view the funds requirement for adopting non-mercury base medical instruments, availability of calibration centres, as well as standardisation requirements for the non-mercury base medical instrument besides discouragement or imposing restrictions for manufacture of mercury base medical instruments and encouragement for manufacture of non-mercury base medical instruments within the country at a cheaper cost than imports.

9.0 Regular monitoring to detect mercury exposure, health impacts study and maintenance of records:

Medical examination (blood test or urine analysis) for the Health Care as well as CBWTF Staff and especially those having chances for exposure/ exposed to mercury and handling mercury base instruments or waste should be done **at least once in six months** following the standard methods, and such records should be maintained.

Based on the findings of the afore-said medical examination, appropriate remedial measures should be taken by the HCFs i.e the persons who are directly involved in mercury exposure should be replaced by in every two years on rotation basis to minimize effects of mercury exposure and associated health impacts. Records should be submitted to Regulatory Authorities/ State Health Departments on voluntary basis.

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Table 1. Salient characteristics of mercury

General Properties	**Description**
Name	Mercury / quicksilver / hydrargyrum
Symbol	Hg
Atomic number	80
Elemental category	Transitional element
Group, period, block	12, 6, d
Standard atomic weight	200.59(2) $g.mol^{-1}$
Electronic configuration	$[Xe]4f^{14}5d^{10}6s^2$
Electrons per shell	2, 8, 18, 32, 18, 2
Physical properties	
Phase	liquid at standard conditions for temperature and pressure
Density (near r.t.)	(liquid) 13.534 $g{\cdot}cm^{-3}$
Melting point	234.32 K, - 38.83 °C, -37.89 °F
Boiling point	629.88 K, 356.73 °C, 674.11 °F
Critical point	1750 K, 172.00 MPa
Heat of fusion	2.29 $kJ{\cdot}mol^{-1}$
Heat of vapourization	59.11 $kJ{\cdot}mol^{-1}$
Specific heat capacity	(25 °C) 27.983 $J{\cdot}mol^{-1}{\cdot}K^{-1}$
Vapour pressure	P (Pa) 1 10 100 1 k 10 k 100 k at T (K) 315 350 393 449 523 629
Atomic properties	
Oxidation states	4, 2 (mercuric), 1 (mercurous) (mildly basic oxide)
Electronegativity	2.00 (Pauling scale)
Ionization energies	1st: 1007.1 $kJ{\cdot}mol^{-1}$ 2nd: 1810 $kJ{\cdot}mol^{-1}$ 3rd: 3300 $kJ{\cdot}mol^{-1}$
Atomic radius	151 pm
Covalent radius	132±5 pm
Van der Waals radius	155 pm
Miscellaneaous	
Crystal structure	rhombohedral
Magnetic ordering	diamagnetic
Electrical resistivity	(25 °C) 961nΩ·m
Thermal conductivity	(300 K) 8.30 $W{\cdot}m^{-1}{\cdot}K^{-1}$
Thermal expansion	(25 °C) 60.4 $\mu m{\cdot}m^{-1}{\cdot}K^{-1}$
Speed of sound	(liquid, 20 °C) 1451.4 m/s
CAS registry number	39-97-6
Most stable isotopes	^{194}Hg, ^{195}Hg, ^{196}Hg, ^{197}Hg, ^{198}Hg, ^{199}Hg, ^{200}Hg, ^{201}Hg, ^{202}Hg, ^{203}Hg, ^{204}Hg

Table 2. Typical mercury content in some of the medical instruments used in health care facilities and their applications

S. No.	Product	Mercury Content	Applications
1)	Dental amalgams	< 1mg (about 50% in silver coloured dental amalgams)	Tooth restoration
2)	Fever and other thermometers	0.5 to 3 grams	Fever (Temperature) measurement
3)	Manometers	300-600 grams	Blood pressure measurement
4)	Sphygmomanometers	20-60 grams	Blood pressure measurement
5)	Mercury batteries (mercuric oxide, silver oxide, mercury zinc, mercuric oxide, zinc air, contaminant in other types of batteries)	5-25 mg	Blood analyzers, defibrillators, fetal monitors, hearing aids,holter monitors, pacemakers, pagers, picker calibers, spirometer alarms, telemetry transmitters, temperature alarms
6)	Chemical reagents (Mercury (II) oxide, mercury chloride, mercury (II) chloride, mercury (II) sulphate, mercury nitrate, mercury iodide, sulphuric acid (commercial grade; mercury as impurity), Zenker's solution.)	-	-
7)	Pharmaceuticals	Around 0.01%	Vaccines eye drops, herbal medicines, (thimerosal, phenylmercuric acetate (PMA), phenylmercuric nitrate),; Mercurochrome; Veterinary chemicals (mercuric chloride, phenyl mercuric nitrate & sodium ethlymercurithiosalicylate)

Source: Patterns of mercury-containing products (Huber 1997; Environment Canada 2002; Mercury Policy Project 2005; UNEP 2005)

Table 3. Uses and modes of release of mercury in the environment from HCFs

Used in	**Modes of release of mercury in the environment**
Thermometers (measurement of body temperature)	Slipping and breakage during use hence Hg spillage
Barometers (in respiratory therapy to calibrate blood gas analysers)	Slipping and breakage
Sphygmomanometers (measurement of blood pressure)	Slipping and breakage during use
Dental amalgam	Hg vapourizes from amalgam and get impregnated in gum Leakage of amalgam dispensers
Esophageal dilators / bougie tubes (dilate esophagus)	Leak or breakage
Feeding tube (provide nutrition to patients)	Leak or breakage
Gastrointestinal tubes (Cantor tubes and Miller Abbott tubes, clear intestinal obstructions)	Spillage and rupture of tube
Intraocular pressure device (apply pressure to the eye prior to cataract surgery)	Broken or rupture
Strain gauge (measure arterial blood flow)	Breakage
Urinometer (measure specific gravity of urine)	Breakage
X-ray machines	Hg release by mishandling
Laboratory chemicals (fixatives, stains, reagents, preservatives)	B-5 fixative is discharged into the sewer system during rinsing of tissues
Medical batteries (blood analysers, monitors, hearing aid, halter monitor, pacemaker, spirometer, temperature alarm etc)	Breakage
Thimerosal (a Hg containing preservative to prevent bacterial contamination in vaccines)	
Cleaning products	Through wastewater

Table 4. Alternates to some of the mercury base medical instruments

S. No.	Product	Applications	Alternatives
1)	Dental amalgams	Tooth restoration	Dental amalgams capsule , Newer alternatives to mercury amalgam fillings are Gold, silver, gallium, ceramic, porcelain, polymers, composites, glass ionomers, etc.
2)	Fever and other thermometers	Fever measurement	electronic digital, expansion, aneroid, single-use thermometers, glass, thermometers containing a Ga/In/Sn "alloy", etc.
3)	Manometers	Blood pressure measurement	Non-mercury liquid, needle bourdon gauges, aneroid manometers, and digital manometers
4)	Sphygmomanometers	Blood pressure	Electronic vacuum gauge, expansion, aneroid
5)	Mercury batteries (mercuric oxide, silver oxide, mercury zinc, mercuric oxide, and Button Cell batteries)	Blood analyzers, defibrillators, fetal monitors, hearing aids, holter monitors, pacemakers, pagers, picker calibres, spirometer alarms, telemetry transmitters, temperature alarms	Lithium zinc, low-mercury alkaline batteries and rechargeable mercury- and cadmium free Versions
6)	Surgical - esophageal dilator		silicone-filled dilator; tungsten-filled dilator
7)	Chemical reagents	-	Mercury (II) oxide, mercury chloride, mercury (II) chloride, mercury (II) sulphate, mercury nitrate, mercury iodide, sulphuric acid (commercial grade; mercury as impurity).
8)	Cultural Uses and Traditional Medicine and Pharmaceuticals	Mercury has been used in various pharmaceuticals such as vaccines, eye drops, and other products, mainly as a preservative.	Mercury-free pharmaceuticals and chemicals such as 2-phenoxy-ethanol also be used as vaccine preservatives
		In Laboratories stains, fixatives, re-agents, and calibration solutions in the form of mercury chlorides and thimerosal	chemical changes such as zinc formalin; process changes such as using poly vinyl alcohol for B5/Fixatives.
		In Maintenance of	digital technology; energy efficient

		fluorescent lights; thermostats and levelling devices; electrical relays; and batteries	lighting; mercury-free batteries; and recycling of lights and batteries
		For **Housekeeping** purposes, bleach solution containing sodium hypochlorite and thimerosal additives; caustic drain cleaners*	thimerosal-free products; organic oils and compounds

Source: *Patterns of mercury-containing products (Huber 1997; Environment Canada 2002; Mercury Policy Project 2005; UNEP 2005) and Mercury-free Alternatives to Mercury-containing products (UNEP 2002; 2006)*

Table 5. State-wise Hazardous Waste Treatment Storage and Disposal Facilities in Operation

S. No.	Name of the State/UT	Number of Common TSDFs in operation
1	Andhra Pradesh	Total 02 TSDFs with Secured Landfill Facility and Common Incinerator Facility at following sites:
		(i) M/s Hyderabad Waste Management Project (Ramky Enviro Engineers Ltd) Survey no. 684/1, Dundigal village, Qutbullapur Mandal, R.R. Dist- 500 043 (A.P)
		(ii) M/s Coastal Waste Management Project, Jawaharlal Nehru Pharma City, E-Bonangi, IDA, Parawada, Vishakhapatnam
2	Gujarat	Total 08 TSDFs. Out of 08 TSDFs, following 04 sites have only Secured Landfill Facility:
		(i) M/s Naroda Enviro Project Ltd., GIDC Odhav, Dist-Ahmedabad
		(ii) M/s The Green Environment Services Co-op. Society Ltd. Survey no. 89-90-91, Vill Vinzol, Ahmedabad, Gujarat
		(iii) M/s Vapi Wate & Effluent Management Co. Ltd. Plot no. 4807, Phase IV GIDC, Vapi, Dist: Valsad, Gujarat.
		(iv) M/s Gujarat Maritime Board, Alang Dist. Bhavnagar
		and, remaining following 04 sites have Secured Landfill Facility as well as Common Incinerator Facility:
		(i) M/s Nandesari Environment Control Ltd, 519-P, GIDC, Nandesari, Dist. Vadodara.
		(ii) M/s Bharuch Enviro Infrastructure Ltd. Plot no. 9701-9716, GIDC, Ankleshwar-393002
		(iii) M/s Gujarat Env. Protection & Infrastructure Ltd., Village Gabheni, Near Sachin G.I.D.C. Surat – 394 230. Gujarat.
		(iv) M/s Saurashtra Enviro Projects Pvt Ltd. Survey no. 415, 417 & 418, Vill Juna katariya, Tal-Bhachau, Dist-Kutch, Gujarat
3	Haryana	01 TSDF namely M/s. Gujarat Enviroprotection & Infrastructure Limited, Pali, Faridabad District, Haryana.
4	Himachal Pradesh	01 TSDF with only Secured Landfill Facility at M/s Shivalik Solid Waste Management Ltd. Vill Majra, P.O. Dabhota, Teh. Nalagarh, Distt Solan (H.P)
5	Karnataka	01 TSDF with only Secured Landfill Facility at Dabaspet, Bangaluru, Karnataka.
6	Kerala	01 TSDF with only Secured Landfill Facility at M/s Keral Enviro Infrastructure Ltd., Common TSDF Project, Inside Fact-CD Campus, Ambalmedu, Kochi-682 303, Kerala.
7	Madhya Pradesh	01 TSDF with only Secured Landfill Facility and Common Incinerator Facility at M/s Madhya Pradesh Waste Management Project , Plot No. 104, Industrial Area No.-II, Pithampur, Dist- Dhar 454 775 (M.P.)

S. No.	Name of the State/UT	Number of Common TSDFs in operation
8	Maharashtra	Total 04 TSDFs . Out of 04 TSDFs, only M/s. Trans Thane Waste Management Association, Mahape, Navi-Mumbai has only secured landfill facility. And, remaining following 03 TSDFs have Secured Landfill Facility as well as Common Incinerator Facility as follows:
		(i) M/s. Vidharbha Enviro Protection Ltd., Butibori Industrial Area, Mouza- Mandawa, Taluka- Hingana, Dist- Nagpur. Maharashtra.
		(ii) M/s. Maharashtra Enviro Power Ltd. Plot No. 56, MIDC Ranjangaon, Taluka- Shirur, Dist – Pune.
		(iii). M/s Mumbai Waste Management Ltd., Plot No. P-32, MIDC Taloja, Tal: Panvel, Dist. Raigad- 410 208
9	Orissa	01 TSDF with M/s. Orissa Waste Management Project, Sukinda, Dt. Jajjpur. Orissa.
10	Punjab	01 TSDF with only Secured Landfill Facility at Nimbua, Derabassi
11	Rajasthan	01 TSDF with only Secured Landfill Facility at M/s Rajasthan Waste Management Project (M/s Ramky Enviro Engineers Ltd) Survey no. 1018/13, Vill-Gudli,Tehsil-Mavli, Zinc Choraha to Debari Railway Station Road, Dist-Udaipur (Rajasthan)
12	Tamilnadu	01 TSDF with only Secured Landfill Facility at M/s. Tamilnadu Waste Menagement Ltd (M/s Ramky Agencies, Hyderabad) Gummidpoondi in Thiruvallur District
13	UP	Total 03. Following 03 TSDFs with only Secured Landfill Facility at :
		(i) M/s Bharat Oil & Waste Management Ltd. Gate No. 672, Vill. Kumbhi, NH-2, Kanpur Dehat (UP)
		(ii) M/s Uttar Pradesh Waste Management Project (M/s Ramky Enviro Engineers Ltd.,) Plot No. 672,Village – Kumbhi, Tehsil: Akbarpur, on SikandaraRoad- NH –2, Dist – Kanpur Dehat (U.P.)
		(iii) M/s Industrial Infrastructure Services (India) Ltd. UPSIDC Leather Technology Park Banthar, Unnao, U.P.
14	Uttarakhand	01 TSDF with Secured Landfill Facility and Common Incinerator Facility# at M/s Bharat Oil & Waste Management Ltd. Mauza Mukimpur, Roorkee-Laskar Road, Roorkee, Haridwar.
15	West Bengal	01 TSDF with Secured Landfill Facility as well as Common Incinerator Facility at M/s West Bengal Waste Management Ltd. J.L. no. -103, Mouza-Shrikrishnapor, P. S. -Sutahata Dist- Purba Midnapore, Haldia- 721 635 (W.B.).
16	Daman, Diu, Dadra & Nagar Haveli	01 TSDF with only Secured Landfill Facility at M/s Gujarat Enviro Protection & Infrastructure (D&NH) Pvt Ltd, Survey no. 9/1, Mota Randha Village,Silvassa-396230
	Total	**29**

Source: CPCB website i.e www.cpcb.nic.in

Annexure -I

ACCIDENT REPORTING

FORM III

(see Rule 12 of the Bio-medical Waste (Management & Handling) Rules, 1998)

ACCIDENT REPORTING

1. Date and time of accident:

2. Sequence of events leading to accident**:**

3. The waste involved in accident**:**

4. Assessment of the effects of the accident on human health and the environment,.

5. Emergency measures taken

6. Steps taken to alleviate the effects of accident**:**

7. Steps taken to prevent the recurrence of such an accident**:** ……

Date …… Signature ……
Place…… Designation……

Annexure –II

Marking of Mercury Waste Container

HAZARDOUS WASTE *

Handle with Care

Waste Category No	Compatible Group .....
Total Quantity	Date of Storage
Contents and State of the Waste :	
Sender's Name & Address	Receiver's Name & Address
Phone	Phone .....
E-mail.....	E-mail .....
Tel. & Fax No	Tel.& Fax No .....
Contact Person	Contact Person .....
In case of emergency please contact	

Note :

1. *Background colour of lab I fluorescent yellow,*
2. *The words 'HAZARDOUS WASTES' & 'HANDLE WITH CARE' to be prominent and written in red in Hindi, English and in Vernacular Language*
3. *Label should be of non-washable material.*

** delete which ever is not applicable*

Annexure –III

Rule 21. Manifest system (Movement Document to be used within the country only) as per Hazardous Waste (Management , Handling & Transboundary Movement) Rules, 2008

(1) The occupier shall prepare six copies of the manifest in Form 13 comprising of colour code indicated below and all six copies shall be signed by the transporter:

Copy number with colour code	**Purpose**
Copy 1 (White)	To be forwarded by the occupier to the SPCB/PCC
Copy 2 (Yellow)	To be retained by the occupier after taking signature on it from the transporter and the rest of the four copies to be carried by the transporter.
Copy 3 (pink)	To be retained by the operator of the facility after signature.
Copy 4 (orange)	To be returned to the transporter by the operator of facility/recycler after accepting waste.
Copy5(green)	To be returned by the operator of the facility to SPCB/PCC after treatment and disposal of wastes in TSDF.
Copy6 (blue)	To be returned by the operator of the facility to the occupier after treatment and disposal of hazardous wastes in TSDF.

(2) The occupier shall forward copy number 1 (white) to the State Pollution Control Board or the Committee of the UT as the case may be and in case the hazardous wastes is likely to be transported through any transit State, the occupier shall prepare an additional copy each for intimation to such State or the Union Territory and forward the same to the concerned State Pollution Control Board or Committee before he hands over the hazardous wastes to the transporter.

(3) No transporter shall accept hazardous wastes from an occupier for transport unless it is accompanied by copy numbers 3 to 6 of the manifest.

(4) The transporter shall submit copies number 3- to -6 of the manifest duly signed with date to the operator of facility along with the waste consignment.

(5) Operator of facility upon completion of treatment and disposal operations of the hazardous wastes shall forward copy 5 (green) to the State Pollution Control Board/Committee and copy 6 (blue) to the occupier. Copy 3 (pink) shall be retained by the operator of facility.

Annexure -IV

Hazardous Waste Manifest

1.	Occupier's Name & Mailing Address (including Phone No.) :	
2.	Occupier's Registration No. :	
3.	Manifest Document No. :	
4.	Transporter's Name & Address (including Phone No.) :	
5.	Type of Vehicle :	(Truck/Tanker/Special Vehicle)
6.	Transporter's Registration No. :	
7.	Vehicle Registration No. :	
8.	Designated Facility Name &Site Address :	
9.	Facility's Registration No. :	
10.	Facility's Phone :	
11.	Waste Description :	
12.	Total Quantity :	……m^3 or MT
13.	Consistency :	(Solid/Semi-Solid/Sludge /Oily /Tarry /Slurry)
14.	Transport Description of Wastes :	
15.	Containers :	Number | Type |
16.	Total Quantity :	……m^3 or MT
17.	Unit Wt/Vol. :	…… .. m^3 or MT
18.	Waste Category Number :	

19.	Special Handling Instructions & Additional Information :	
20.	OCCUPIER'S CERTIFICATE :	I hereby declare that the contents of the consignment are fully and accurately described above by proper shipping name and are categorised, packed, marked, and labeled, and arc in all respects in proper condition for transport by road according to applicable national government regulations.
	Typed Name & Stamp Signature : Month Day Year	
21.	'Transporter Acknowledgement of Receipt of Wastes	
	Typed Name & Stamp : Signature : Month Day Year	
22.	Discrepancy Note Space	
23.	Facility Owner or Operator's Certification of Receipt of Hazardous Waste	
	Typed Name & Stamp : Signature : Month Day Year	

Note: Manifest Format as per HW (M, H & TM) Rules, 2008. This copy has to be used in accordance with Rule 21 of the HW (M, H & TM) Rules, 2008

REFERENCES

1) Bio-medical Waste (Management & Handling) Rules, 1998 and amendments.

2) Hazardous Waste (Management , Handling & Transboundary Movement) Rules, 2008 and amendments, notified under the E (P) Act, 1986 by the Ministry of Environment & Forest, Government of India.

3) Occupational Safety and Health Guideline for Mercury Vapour, U.S. Occupational Safety and Health Administration, Washington, DC. (http://www.osha.gov/SLTC/healthguidelines/mercuryvapour/recognition.html)

4) "Managing Small Mercury Spills," Fact Sheet, Health Care Without Harm Europe (Praha, Czech Republic) and Health & Environmental Alliance (Brussels, Belgium), October 2006 (http://www.noharm.org/europe/issues/toxins/mercury/resources.php).

5) Threshold Exposure Limits for mercury as per Factories Act, 1948.

6) "Managing Small Mercury Spills," Fact Sheet, HCWH Europe and HEAL (ibid.).

7) U.S. Environmental Protection Agency's website "Mercury Releases and Spills: Cleanups and Proper Disposal," updated December 02, 2009 (http://www.epa.gov/hg/spills/).

8) "Mercury Spill Information and Cleanup Guidance," Indiana Department of Environmental Management, May 2007.

9) "Personal Protective Equipment Information for Mercury," Canadian Centre for Occupational Health and Safety, updated December 21, 1998.

10) UNDP Draft guidelines for mercury waste management.

11) CPCB News Letter 'Parivesh' on 'Mercury : Environmental Implications & Toxicity' , December 2009.

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