Japan-ASEAN Cooperation

Technical Guidelines for the Substitution and the Environmentally Sound Management of Mercury-Containing Medical Measuring Devices in Indonesia

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Published in Pathumthani, Thailand in 2021
by Asian Institute of Technology

ISBN: 978-616-8230-07-7

Recommended citation:

Anton Purnomo, Cynthia Indriani, Rizcky Rezza Bramansyah, D. Wardhana Hasanuddin Suraadiningrat, Guilberto Borongan, Solomon Kofi Mensah Huno (2021). Technical guidelines for the substitution and environmentally sound management of mercury-containing medical measuring devices in Indonesia. Asian Institute of Technology, Regional Resource Center for the Asia and the Pacific. Pathumthani, Thailand.

MINISTRY OF ENVIRONMENT AND FORESTRY
REPUBLIC OF INDONESIA

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KESEHATAN
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INDONESIA

BASEL & STOCKHOLM
CONVENTIONS
REGIONAL CENTRE
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Acknowledgement

Financial Support
This report is funded by the Government of Japan. The Government of Japan is gratefully acknowledged for providing the necessary funding that made the Japan-ASEAN Integration Fund (JAIF 2.0) project ENV/EVN/18/009/REG on *Development of Capacity for the Substitution and the Environmentally Sound Management (ESM) of Mercury-containing Medical Measuring Devices*, and of this publication possible.

From
the People of Japan

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Foreword

Praise and gratitude we pray to the presence of God Almighty for His blessings and grace, that the "*Technical Guidelines for the Substitution and the Environmentally Sound Management of Mercury-Containing Medical Measuring Devices in Indonesia*" can finally be completed.

This is shown by the Government of Indonesia's commitment to reduce and eliminate mercury by ratifying the Minamata Convention on Mercury in 2017 through Law Number 11 Year 2017 concerning Ratification of the Minamata Convention on Mercury and stipulating Presidential Regulation Number 21 of 2019 concerning the National Action Plan for Reduction and Elimination of Mercury. The elimination of mercury-containing medical devices is one of the priority sectors listed in the national action plan. The mercury elimination at health priority sector is achieved by prohibiting the use of mercury-containing medical devices in the form of thermometers, sphygmomanometers and dental amalgam and/or substitution of mercury-containing medical devices with alternatives that are friendly to human health and the environment. One of the activities to support the elimination of mercury-containing medical devices is by issuing the Minister of Environment and Forestry Regulation Number 27 Year 2020 concerning the Management of Discarded Mercury-Containing Medical Devices in which guidelines for managing discarded mercury-containing medical devices have been included.

Further technical guidelines for more detailed management of mercury-containing medical measuring devices were developed through the "*Technical Guidelines for the Substitution and the Environmentally Sound Management of Mercury-Containing Medical Measuring Devices in Indonesia*." These guidelines comprehensively contain national policies and regulations, an overview of mercury-containing medical measuring devices and their alternatives, environmentally sound management of unbroken mercury-containing medical measuring devices, environmentally sound management of broken mercury-containing medical measuring devices, health and safety, emergency response, and guidance and supervision.

We would like to express our gratitude to the Japan-ASEAN Integration Fund (JAIF) for funding the project "Development of Capacity for the Substitution and the Environmentally Sound Management (ESM) of Mercury-Containing Medical Measuring Devices" and for selecting Indonesia for the project implementation. It is hoped that the publication of these guidelines will serve as a reference for all relevant stakeholders at the levels of Ministries/Agencies, Provincial Governments, and Regency/City Governments in conducting an integrated and environmentally sound management of mercury-containing medical measuring devices to protect the environment from pollution and damages as well as to protect the community, especially the next generation from the dangers of mercury.

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Foreword

Praise and gratitude are conveyed to the only deserving God Almighty, because of His blessings and grace, "*Technical Guidelines for the Substitution and the Environmentally Sound Management of Mercury-Containing Medical Measuring Devices in Indonesia*" can be completed.

Presidential Regulation Number 21 Year 2019 concerning the National Action Plan for Reduction and Elimination of Mercury mandates all relevant sectors to take concrete steps in the context of integrated mercury reduction and elimination. Specifically for the priority area of health sector, the effort that must be made is the elimination of mercury-containing medical devices in Healthcare Facilities. Guidelines for elimination efforts have been regulated in Minister of Health Regulation Number 41 Year 2019 concerning the Elimination and Withdrawal of Mercury-Containing Medical Devices in Healthcare Facilities.

These " *Technical Guidelines for the Substitution and the Environmentally Sound Management of Mercury-Containing Medical Measuring Devices in Indonesia*" is a detailed guide to the elimination of mercury-containing medical measuring devices. The contents of these guidelines are to provide guidance on the elimination of mercury-containing medical devices in the form of thermometers and sphygmomanometers and/or substitution of mercury-containing medical measuring devices with alternative non-mercury devices that are friendly to human health and the environment. This manual also provides guidance on the steps that must be taken by stakeholders from the Healthcare Facility to the authorities in the withdrawal, collection and final handling, including monitoring and reporting.

We hope that these guidelines can be taken as a reference for relevant stakeholders, both the Central and Local Governments, as well as other parties in implementing safe and integrated management of mercury-containing medical measuring devices and their wastes in order to protect public health and the environment.

We would like to express our thanks extend our gratitude to the Japan-ASEAN Integration Fund (JAIF) for funding this "Development of Capacity for the Substitution and the Environmentally Sound Management (ESM) of Mercury-containing Medical Measuring Devices" project. In addition, our highest appreciation and gratitude for the contributions of relevant parties both at the central and local levels.

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ABBREVIATIONS AND ACRONYMS

APBD	Regional Budget
APBN	State Budget
AMS	ASEAN Member States
ASEAN	Association of Southeast Asian Nations
ASGM	Artisanal and small-scale gold mining
B3	Hazardous substances
BPPT	Agency for the Assessment and Application of Technology
EPDM	ethylene propylene diene monomer
ESM	Environmentally sound management
GEF	Global Environment Facility
HDPE	High-density polyethylene
HSE	Health, safety and environment
IBC	Intermediated bulk container
ICSC	International Chemical Safety Card
ILO	International Labour Organization
JAIF	Japan-ASEAN Integration Fund
K3RS	Hospital health and safety
MoEF	Ministry of Environment and Forestry
MoH	Ministry of Health
MSDS	Material Safety Data Sheet
NIB	Business Identification Number
PE	polyethylene
PET	polyethylene terephthalate

PP	Government Regulation
Permenkes	Minister of Health Regulation
Permen LHK	Minister of Environment and Forestry Regulation
PPE	Personal protective equipment
PVC	polyvinyl chloride
QR	Quick Response
RAD-PPM	Regional Action Plan for Reduction and Elimination of Mercury
RAN-PPM	National action plan for Reduction and Elimination of Mercury
RFID	Radio-frequency identification
SCBA	Self-contained breathing apparatus
SOP	Standard operating procedure
TSD	Treatment, storage and disposal
UKBM	Community-Resourced Health Efforts
UNDP	United Nations Development Programme
WMS	Warehouse Management System

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INTRODUCTION

1.1. Background

Mercury is a global pollutant, and its adverse impacts on human health and the environment are one of the major concerns in the Southeast Asia region. The Minamata Convention on Mercury, adopted in October 2013, contains a mechanism for controlling mercury throughout its entire lifecycle. Article 4 of the Convention requires its Parties to phase-out the manufacture, export, import, and trade of several mercury-added products, including mercury-containing medical measuring devices (e.g., thermometers and sphygmomanometers) by 2020. While Article 11 requires its Parties to ensure the environmentally sound management (ESM) of mercury wastes.

Indonesia has many regulations on mercury for a wide range of processes and products such as cosmetics, air emission, drinking water, wastewater quality, and artisanal and small-scale gold mining (ASGM). Although Indonesia has ratified the Minamata Convention through Law Number 11 Year 2017, there is still a need to implement the regulations effectively. The Presidential Regulation Number 21 Year 2019 regarding national action plan for reduction and elimination of mercury (Rencana Aksi Nasional *Pengurangan dan Penghapusan Merkuri*, RAN-PPM) has been issued as a basis for implementation framework. The presidential regulation sets out the target for 100 percentage of mercury elimination in the health priority sector by 2020, an action far beyond the phase-out of the devices under Article 4 of the Minamata Convention.

Considering the ratification of the Minamata Convention and the Presidential Regulation on RAN-PPM, the Minister of Environment and Forestry of Indonesia has further issued Ministerial Regulation Number P.81/Menlhk/Setjen/Kum.1/10/2019 for the implementation of the Presidential Regulation. The Ministry of Health of Indonesia (MoH) has issued Ministerial Regulation Number 41 Year 2019 (Permenkes 41/2019) concerning the Elimination and Withdrawal of Mercury-Contaning Medical Devices in Healthcare Facilities. However, the regulation does not provide technical guidelines for collection, transportation, storage, treatment, and substitution

potential for the mercury-containing medical measuring devices.

Indonesia has the first integrated treatment, storage, and disposal (TSD) facility in Southeast Asia, but it still lacks a mercury recycling and disposal facility for mercury wastes with high concentrations. Similarly, there is no final disposal plan or no existing disposal site that has been identified. Indonesia still needs to address the usage, collection, transportation, storage, treatment, and substitution potential for mercury-containing medical measuring devices, especially on accommodating environmental practices in a challenging archipelagic country like Indonesia.

The project "Development of Capacity for the Substitution and the Environmentally Sound Management (ESM) of Mercury-Containing Medical Measuring Devices" was endorsed and approved by the Association of Southeast Asian Nations (ASEAN) and funded through the Japan-ASEAN Integration Fund (JAIF). This JAIF project aims to bridge the abovementioned gaps for Indonesia by developing an inventory and ESM guidelines. It, therefore, aims to contribute towards the overall implementation of the Minamata Convention.

The outcome of the situation assessment and inventory conducted under the project shows that the major obstacles faced by most healthcare facilities in Indonesia in implementing the substitution of mercury-containing medical measuring devices by the end of 2020 are inability to find official guidelines for the management of containing medical devices and materials containing mercury that cannot be used anymore and technical constraints related to containers, storage places for mercury containing medical devices, and spill kits that are not yet available. Other obstacles include unavailability of official or licensed service providers for collecting mercury and/or mercury-containing medical measuring devices, unavailability of funds to purchase substitute medical devices and/or materials and never receiving any notification or warning about substituting medical devices and materials containing mercury.

The inventory result also reveals that the specific guidelines or information needed by the healthcare facilities in managing mercury and mercury-containing medical measuring devices in order to fulfill the year 2020 elimination target include:

- Information on various choices of medical devices that do not contain mercury and non-mercury dental fillings (characteristics of medical devices/materials, performance, use, etc.);
- The procedure for packing mercury-containing medical devices containing mercury and remaining mercury, including the technical standard for safe packaging;
- Information on hazards, risks and management of occupational safety and health risks and the environment related to mercury;
- Standard safety management of temporary storage site of mercury-containing medical devices and remaining mercury;
- Information about standard and guidelines of the use of personal protective equipment from exposure to mercury;
- Notification on official temporary storage places that are available outside the site of healthcare facilities and the utilization of their services;
- Procedures for the safe storage of mercury-containing medical devices and remaining mercury, including the technical standard for the storage place with safety:
- Information on safe handling of work accidents involving mercury;
- Information on international policies, agreements and standards regarding mercury management;
- Notification on official services available specifically for the collection/transportation of remaining mercury and mercury-containing medical devices.

Furthermore, to assist in developing these guidelines, a gap analysis between existing policy framework and actual practices in the field and requirements of the relevant conventions, technical guidelines of the Basel Convention, and other relevant internationally recognized guidelines was carried out under this JAIF project. It was concluded that more details are required on the withdrawal process of mercury-containing medical measuring devices from healthcare facilities, such as the procedures, the mechanisms and the technical requirements for the transportation, the collection (storage depot), and the final treatment.

1.2. Objective

The objective of the technical guidelines is to provide essential information and a set of recommended practices to relevant target users in Indonesia. The technical guideline serves as a guide and management tool for the ESM of discarded mercury-containing medical devices from healthcare facilities and any resulting mercury waste that is subject to the Basel Convention and relevant regulations in Indonesia. The technical guidelines may also be used by Parties to the Minamata and Basel Convention in the Southeast Asian region in fulfilling the requirements of the Conventions. Thus, it may contribute to support the Parties in achieving the target of phase-out of mercury-containing medical devices under the Minamata Convention as well.

1.3. Scope of the guidelines

The scope of the technical guidelines is defined by target users, types of mercury-containing medical devices, and management activities, as described in the sections below.

1.3.1. Target users

These guidelines are intended to be used, as a guide and management tools in the following entities:

- Environmental authorities (central and local);
- Health authorities (central and local);
- Healthcare facilities;
- Material transportation companies;
- Material collection service companies;
- Mercury treatment/disposal facilities;
- Exporting companies.

1.3.2. Types of mercury-containing medical measuring devices

The mercury-containing medical measuring devices covered under these guidelines are limited to the mercury-containing thermometers and sphygmomanometers in healthcare facilities (both public and private) in Indonesia.

1.3.3. Management activities

- The management activities covered under these guidelines are as follows:
- On-site assessment and inventory of medical measuring devices (mercury and non-mercury);
- Mercury-containing devices withdrawal (internal collection);
- Packaging and identification (labeling);
- On-site temporary storage;
- Treatment and/or disposal;
- Export.

1.4. Outline of the guidelines

Chapter I provides introduction to the guidelines including the background, objective, and scope of the guidelines.

Chapter II provides information on the national policies, relevant regulations, and measures for elimination of mercury-containing medical measuring devices from healthcare facilities in Indonesia.

Chapter III provides overview of mercury-containing thermometers and sphygmomanometers and their alternatives.

Chapter IV provides a technical guide on ESM of mercury-containing medical measuring devices from healthcare facilities that are still intact and not punctured or broken. The chapter includes general information, collection, packaging and symbol, and labeling, technical requirements of temporary storage at healthcare facilities or special room, elimination of state-owned assets for government-owned healthcare facilities, off-site transportation, technical requirements of storage depot, treatment facility, export procedure, monitoring, financing, other requirements, and stakeholders involved.

Chapter V provides a technical guide on ESM of mercury-containing medical measuring devices from healthcare facilities that are punctured or broken and mercury spills out or released from the medical devices. This topic includes general information, handling of mercury spills, symbol and labeling, off-site transportation to collection facility/intermediate storage, manifest system, collection facility/intermediate storage, treatment and/or disposal facility, and export procedure.

Chapter VI provides a technical guide on health and safety aspects in managing mercury wastes from medical measuring devices.

Chapter VII provides a technical guide on the emergency response plan in managing mercury wastes from medical measuring devices.

Chapter VIII provides a technical guide on raising awareness and promote the participation of target users involved in the management of mercury wastes from medical measuring devices.

2

ELIMINATION OF MERCURY-CONTAINING MEDICAL MEASURING DEVICES FROM HEALTHCARE FACILITIES

2.1. National policies and regulations

As mentioned in Subchapter 1.1., Presidential Regulation Number 21 Year 2019 on RAN-PPM sets out the target for 100 percent of mercury elimination in the health priority sector by 2020. This target is expected to be achieved through 6 (six) strategies and activities set out in the presidential regulation. The regulation also outlines the success indicators, institutions in-charge and supporting institutions as well as implementation outputs for the period of 2019 and 2020.

The 6 (six) strategies for mercury elimination in the health priority sector under RAN-PPM are as follows:

- Strengthening commitment, coordination, and cooperation between relevant ministries/non-ministerial government institutions;
- Strengthening coordination and cooperation between the central and local governments;
- Development of information system;
- Strengthening community involvement through communication, information and education;
- Application of non-mercury alternative technologies;
- Strengthening law enforcement.

These strategies are elaborated into activities as follows:

- Develop policies or regulations for substitution of mercury-containing medical measuring devices from healthcare facilities;
- Develop guidelines for management of discarded mercury-containing medical measuring devices from healthcare facilities;
- Data collection, processing and analysis;
- Coordination with ministries/local institutions and governments;
- Inventory of mercury use in products and processes of mercury-containing medical measuring devices;
- Develop counselling and awareness raising programme to medical personnel on substitution of mercury-containing medical measuring devices and mercury exposure risk at healthcare facilities;
- Conduct awareness raising and increase capabilities of medical personnel on health risks of mercury use and handling;
- Conduct substitution of mercury-containing medical measuring devices in healthcare facilities;
- Conduct storage of discarded mercury-containing medical measuring devices at a storage depot in each province;
- Provide storage depot in each province to store discarded mercury-containing medical measuring devices;
- Development of technical guidelines for the management of discarded mercury-containing medical measuring devices for healthcare facilities and storage depots;
- Monitoring the domestic distribution of mercury-containing medical measuring devices;
- Curbing illegal trade of mercury-containing medical measuring devices.

Furthermore, Ministerial Regulation Number P.81/Menlhk/Setjen/Kum.1/10/2019 mandates each governor and regent/mayor to develop a regional action plan for reduction and elimination of mercury (Rencana Aksi Daerah *Pengurangan dan Penghapusan Merkuri*, RAD-PPM) for the implementation of RAN-PPM. This RAD-PPM is developed through stages of: (a) development and conduct of technical assessment; (b) development of RAD-PPM material; and (c) issuance of RAD-PPM.

The development of technical assessment is to be conducted through: (a) describing local profile; (b) identify general condition of mercury management for the four priority sectors namely manufacturing, energy, artisanal and small-scale gold mining, and health; (c) identify gaps and challenges in mercury management; and (d) identify regulatory framework relevant to mercury.

The RAD-PPM material is developed based on the technical assessment result for the four priority sectors. If a region does not have activities in one or more priority sectors, the sector/s will be excluded from its RAD-PPM. The stages for development of RAD-PPM material includes: (a) determination of mercury reduction and elimination target; and (b) determination of mercury reduction and elimination activities. The mercury reduction and elimination target is determined based on the national mercury baseline as set out in the regulation and RAN-PPM target. In contrast, mercury reduction and elimination activities are determined based on RAN-PPM strategy, RAD-PPM priority sectors, RAD-PPM target, through the screening method and according to the conditions of each region.

The Minister of Environment and Forestry, minister and/or head of non-ministerial government institutions, governor, and/or regent/mayor, according to their respective authorities, monitor the implementation of RAN-PPM and RAD-PPM and evaluate the monitoring result. Monitoring is carried out to obtain information on the achievement of mercury reduction and

elimination. For the health priority sector, mercury elimination achievement is measured with number and/or types of non-mercury medical devices and success of the implementation of mercury elimination. Evaluation is carried out against the set elimination target with a complementary aim of identifying possible obstacles to implementation. Furthermore, the Minister of Environment and Forestry establishes a RAN-PPM a committee to carry out coordination functions for monitoring and evaluation.

The Circular Letter of Director General of Pharmacy and Medical Devices, Ministry of Health, Number HK.02.02/V/0720/2018 concerning the determination of validity period of distribution license and distribution of mercury-containing medical measuring devices indicated that mercury-containing medical measuring devices can only be distributed or traded in Indonesia until 31 December 2018. The online registration system will automatically revoke the distribution license of mercury-containing medical measuring devices of more than the mentioned date. The owner of the license should return it to MoH cq. Directorate General of Pharmacy and Medical Devices. If after 31 December 2018 there are still mercury-containing medical measuring devices in the market, the distributor or license owner should withdraw the products. Suppose after the mentioned date the distributor still has the products in his/her warehouse. In that case, the products should be destroyed in ways according to the Ministry of Environment and Forestry (MoEF) or re-exported.

The Circular Letter of Director General of Health Service Number HK.02.02/V/0361/2019 obliges each healthcare facility, owned by government or private entity to stop the purchase and use of mercury-containing medical measuring devices. The devices should be collected and stored in a safe and protected container and separated from other hazardous wastes (Indonesia uses the term Bahan Berbahaya dan Beracun, abbreviated as B3, for hazardous substances) in a hazardous waste temporary storage prior to withdrawal notice from a competent institution.

Following Circular Letter of Director General of Health Service Number HK.02.02/V/0361/2019, each healthcare facility must eliminate mercury-containing medical measuring devices as soon as possible and no later than the end of 2020 with measures as determined in the Circular Letter of Director General of Health Service Number HK.02.02/I/2899/2019.

MoH further issued Permenkes 41/2019 concerning the Elimination and Withdrawal of Mercury-Containing Medical Devices in Healthcare Facilities to implement RAN-PPM for the health priority sector. As set out in Permenkes 41/2019, the elimination of mercury-containing thermometer, sphygmomanometer, and dental amalgam will be conducted by 31 December 2020 at the latest.

2.2. Measures for elimination

Under Permenkes 41/2019, elimination of mercury-containing medical measuring devices from healthcare facilities is carried out through;

- development of policy or written commitment by the director or head of the healthcare facilities;
- assessment and inventory of mercury-containing medical measuring devices;
- substitution of mercury-containing medical measuring devices to non-mercury-containing medical measuring devices;
- the temporary storage of unbroken mercury-containing medical measuring devices.

The development of policy or written commitment by the director or head of the healthcare facilities includes team or executive personnel formation, financing, preparation of gradual implementation plan, human resources capacity building, and facility and pre-facility preparation. Assessment and inventory of mercury-containing medical measuring devices are conducted for the planning of elimination and substitution of mercury-containing medical measuring devices. The

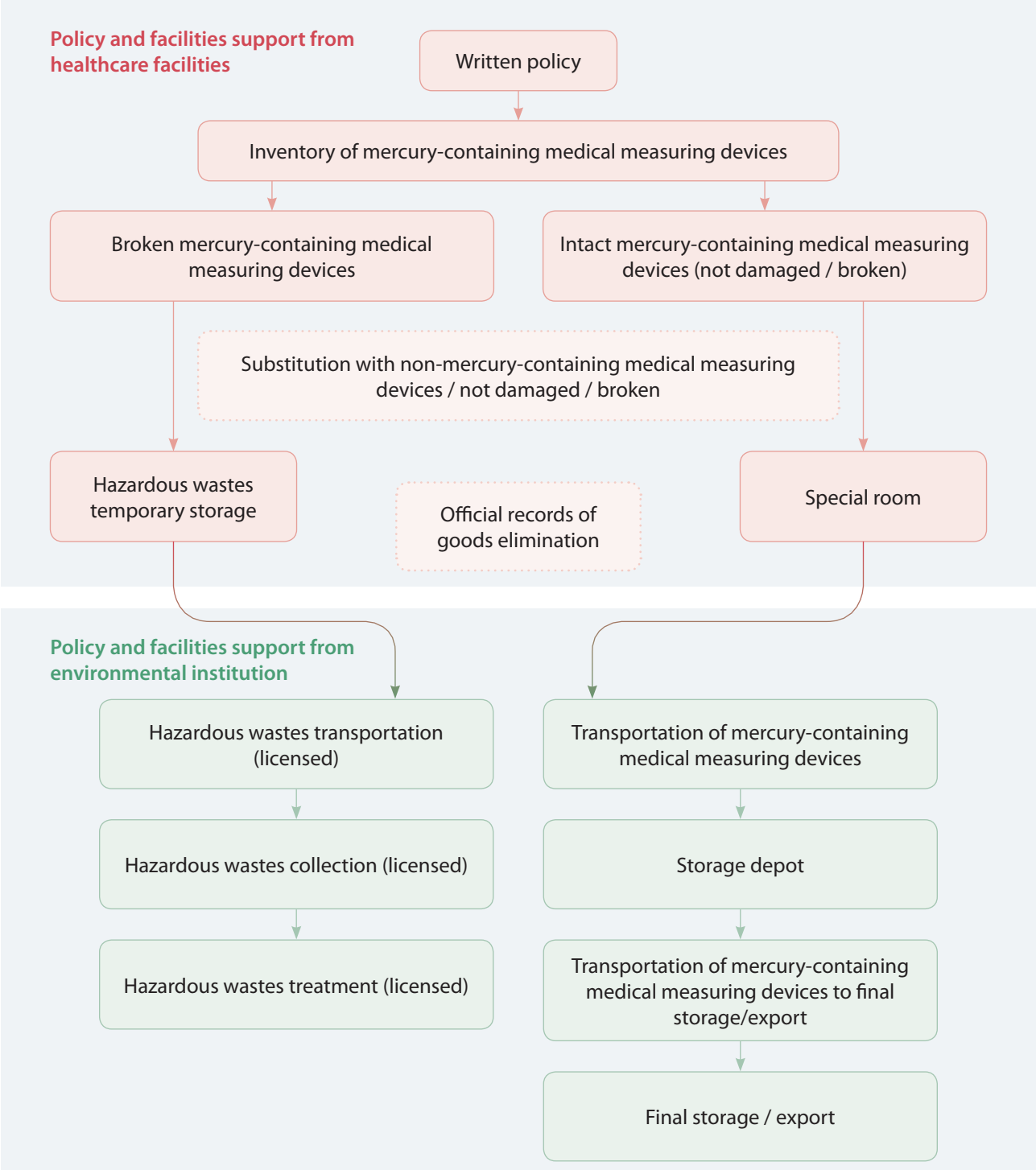
substitution is conducted through planning and procurement based on the assessment and inventory result.

In the case of mercury-containing medical devices that are broken and mercury spills from the devices, they should be stored in a temporary hazardous waste storage according to applicable national regulations. They should not be mixed with other hazardous wastes and not incinerated. Further management after the temporary storage must follow the national regulations for management of hazardous wastes.

The unbroken mercury-containing medical measuring devices, which have been eliminated and stored in a special container and room as temporary storage, must be withdrawn.

Flowchart of measures for elimination of mercury-containing medical measuring devices from healthcare facilities is presented in the Annex. Guidelines of Elimination and Withdrawal of Mercury-Containing Medical Devices in Healthcare Facilities of Permenkes 41/2019. As mentioned in Chapter III of the Annex, eliminating mercury-containing medical measuring devices in healthcare facilities is carried out with measures as in Figure 2.1.

Figure 2.1 **Elimination and withdrawal of mercury-containing medical measuring devices from healthcare facilities in Indonesia**



Source: Adapted from MoH, 2019

3

OVERVIEW OF MERCURY-CONTAINING THERMOMETERS AND SPHYGMOMANOMETERS AND THEIR ALTERNATIVES

3.1. Overview of mercury and its health impacts

Elemental mercury (Hg) is a heavy, silvery metal that melts at -38.9°C and boils at 357°C. It is the only metal that is liquid at room temperature.. Liquid mercury droplet is very mobile and combines with other metals such as tin, copper, gold, and silver to form alloys (solid solutions called amalgams) except iron. Mercury has the highest volatility of any metal, forming a colorless, odorless gas.[1]

Mercury is a naturally occurring heavy metal. At ambient temperature and pressure, mercury is a silvery-white liquid that readily vaporizes and may stay in the atmosphere for up to a year. When released into the air, mercury is transported and deposited globally. Mercury ultimately accumulates in lake bottom sediments, where it is transformed into its more toxic organic form, methyl mercury, which accumulates in fish tissue.[2]

When mercury is spilled, it can break into tiny droplets resulting in a large total surface area. These tiny droplets can volatilize at a rate faster than room ventilation can safely dilute the mercury concentration. The vaporization rate of elemental mercury approximately doubles with every temperature increase of 10°C. 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 jewelry. Some materials are resistant to mercury such as gray and ductile cast iron, carbon steel, 304 and 306 stainless steel, polyvinyl chloride, glass, ceramics, etc.[1]

Mercury may end up in human bodies by any of three pathways, namely respiratory system, digestive system, and skin surface absorption.[3] In volatile particulate form, one of the most toxic forms, mercury is inhalable and once inhaled, it is absorbed by blood. Having transported with blood flow to the brain, mercury affects the body's metabolic processes, resulting in some symptoms such as tremor. Hasanuddin-Suraadiningrat (2019) also mentioned that the first global attention to mercury toxicity was after the Minamata disease outbreaks in Japan. Minamata disease

is caused by methyl mercury – an organic-metal form and also one of the most toxic form of mercury – which may reach the human body through the food web, e.g., seafood and digestive system. Its toxic effects on the central nervous system affects the victims' motor function and coordination as well as other health disorders. Methyl mercury may also enter the human body through skin surface absorption and may cause similar irreversible health disorders and eventual fatality. Inorganic mercury, such as mercuric chlorides, may also enter human bodies through digestive system and may damage the kidneys and eventually fatality.[3]

Mercury exposure's adverse health effects can be tremors, impaired vision and hearing, paralysis, insomnia, emotional instability, developmental deficits during fetal development, and attention deficit, and developmental delays during childhood. Recent studies suggest that mercury may have no threshold below which some adverse effects do not occur.[2]

Figure 3.1 **Example of an alcohol thermometer**

Source: https://www.indiamart.com/proddetail/alcohol-thermometer-18346379048.html

3.2. Medical Thermometers Overview

Medical thermometers, also known as clinical thermometers, have been developed to measure body temperature in human physical examination. The medical thermometers are classified by the technology basis and by the measured body part.

Based on technology, medical thermometers are classified into liquid-filled glass thermometers and electronic or digital thermometers.

- Liquid-filled glass thermometers

The liquid in glass thermometer is the most commonly used device to measure temperature, and it is inexpensive to make and easy to use. The liquid-in-glass thermometer has a glass bulb attached to a sealed glass tube (also called the stem or capillary tube). A very thin opening, called a bore, exists from the bulb and extends down the centre of the tube. The bulb is typically filled with either mercury or red-coloured alcohol. It is free to expand and rise up into the tube when the temperature increases and contract and move down the tube when the temperature decreases.4 An example of an alcohol thermometer can be seen in Figure 3.1.

In the liquid in glass thermometers, the thermally sensitive element is a liquid contained in a graduated glass envelope. The principle used to measure temperature is that of the apparent thermal expansion of the liquid.[4]

- Electronic or digital thermometers

Electronic or digital thermometers display the temperature in digital format and are equipped with either an electronic sensor requiring body contact or an infrared sensor for remote sensing of body temperature.[5] An example of a digital thermometer can be seen in the Figure 3.2.

Medical thermometers can also be classified according to measured body parts; ear, oral, rectal, underarm (axillary), and forehead. Ear, oral, and rectal temperatures are considered the most accurate readings of actual body temperature. Underarm (axillary) and forehead temperatures are considered to be the least accurate because

Figure 3.2 **Example of A Digital Thermometer**

Source: Waras, 2021

they are taken outside of the body rather than inside. However, underarm temperature can be a good way to screen for changes in body temperature.[6]

- Tympanic (ear)

Tympanic infrared thermometers, or ear thermometers, are typically battery-operated units resembling an otoscope probe. The probe, with a disposable plastic cover, is inserted into the outer part of the ear canal to measure the thermal radiation of the tympanic membrane. The signal from the infrared sensor is converted to a digital temperature display.[5] An example of a tympanic infrared thermometer is shown in Figure 3.3.

- Oral

For this method, the thermometer is placed under the tongue. This method is used for adults and children of four years and over who are able to hold thermometer in mouth.[7]

- Rectal

For this method, the thermometer is inserted gently into the rectum. This is mostly done in babies but can be used for children up to 3 years of age. Rectal temperatures can be taken in children older than 3 years, but it might be difficult to keep them as still as they need to stay.[7]

Figure 3.3 **Example of An Alcohol Thermometer**

Source: Waras, 2021

- Underarm (axillary)

For this method, the thermometer is placed in the armpit of young children or adults whose temperature can't safely be done orally. This method is not as accurate as oral or rectal method but can be used as a quick first check. It can be followed with an oral or rectal reading.[7]

- Temporal (forehead)

A temporal artery infrared thermometer, sometimes called a forehead thermometer,

Figure 3.4 **Example of a standing (left) and a handheld (right) temporal artery infrared thermometer**

Source: DanWHS, 2021

Source: Waras, 2021

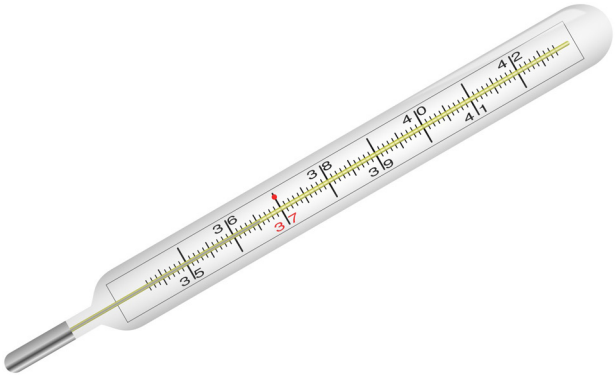
takes the body temperature as the user sides the probe sensor across the patients' forehead, crossing over the temporal artery. Temporal artery thermometers are generally portable, battery-operated electronic devices with a digital display screen.[5] Examples of a standing and a handheld temporal artery infrared thermometers are shown in Figure 3.4.

3.2.1. Mercury-containing thermometers

A mercury-containing thermometer is one of the thermometers which are based on liquid-filled technology. Similar to the other liquid-filled thermometers, a mercury thermometer has a glass tube filled with mercury, and a standard temperature scale is marked on the tube. With temperature changes, the mercury expands and contracts, and the temperature can be read from the scale. Mercury thermometers can be used to determine body, liquid, and vapour temperature.[8] The amount of mercury in the thermometer ranges from 0.5 to 1.5 grams.[1]

The mercury thermometers are cheap, durable, accurate, and easily calibrated. Still, due to the toxicity of mercury which is harmful. If the tube is broken, they are being replaced by electronic models. Other disadvantages of the mercury thermometers are the display is harder to read than the electronic thermometers, cannot be used for thermographs, has slow response, and fragile.[9] An example of a mercury thermometer is shown in Figure 3.5.

Figure 3.5 **Example of A Mercury Thermometer**



Source: https://pixy.org/5872387/

3.2.2. Alternatives to mercury-containing thermometers

It is suggested that when purchasing/procuring non-mercury-containing medical measuring devices, training for maintenance and calibration of the devices are requested for their operating personnel. Example of alternatives for mercury-containing medical measuring devices registered in e-catalogue (https://e-katalog.lkpp.go.id) for thermometers, among others, are digital thermometers.

Fadzil et al. (cited in WHO, 2011) conducted a study at the University of Malaya Medical Centre comparing four different temperature-measuring devices;

- mercury-in-glass thermometer,
- digital oral thermometer,
- liquid crystal forehead thermometers, and
- digital tympanic infrared thermometer.

All four measurements were conducted simultaneously for 207 patients.

Although all three alternatives were comparable to the mercury thermometer, the authors favored the digital thermometer for general use while the tympanic model was suggested for uncooperative patients and the liquid crystal forehead method for home use. Many other scientific papers compare the accuracy and suitability of different thermometers, but the conclusions are sometimes contradictory (various references as cited in WHO, 2011).

Digital clinical thermometers should meet the requirements of either European Norm EN 12470-3:2000+A1:2009 or ASTM E-1112-00. Tympanic infrared (ear) thermometers should meet the requirements of EN-12470-5:2003 or ASTM E1965-98. Temporal artery infrared thermometers should meet the requirements of EN 12470-5:2003 or ASTM E1965-98. In general, digital thermometers, tympanic infrared thermometers, and temporal artery infrared thermometers should conform to EN 60601-1, the basic safety standard for medical electrical devices. More information on requirements for digital thermometers can be seen in the annex of the WHO guidelines.[5]

Available features of digital thermometers

The following specifications, not required by the European Norm nor by the ASTM standard, pertain to features available from different suppliers that may be added according to the needs and desires of the healthcare facility. Some of these optional features may entail additional costs as the following:

- rapid response time (e.g., 10 seconds or less);
- extra-large display or display with magnifying lens;
- audible alarm when the peak temperature is reached;
- display or self-check results during start-up;
- memory function that stores the last temperature reading or many temperature readings;
- automatic shut-off;
- mercury-free or “no added mercury” battery;
- long battery life, for example, 4000 temperature readings of 300 hours;

- easily replaceable or rechargeable battery;
- if solar powered, up to 72 hours per solar charge;
- flexible probe tip;
- dual scale (both °C and °F);
- standard disposable sterile probe covers;
- method of removal of probe covers; manual or eject button;
- customized colours to distinguish between oral, rectal and axillary use;
- resistance to specific disinfectants and cleaners used in the healthcare facility;
- minimal packaging wastes;
- at least one year warranty.[5]

3.3. Sphygmomanometer overview

Sphygmomanometers are medical devices used to measure blood pressure. There are various aspects to consider in classifying sphygmomanometers. However, for simplification, sphygmomanometers may be classified by the technology, methods of measurement, mounting and the measured body part or point of measurement.

Based on the technology, sphygmomanometers can be classified into the following :

- Liquid/mercury column sphygmomanometer;
- Aneroid sphygmomanometer;
- Electronic sphygmomanometer.

More information on each type is described in the sections below.

Sphygmomanometers can also be classified by methods of measurement as follows:

Manual sphygmomanometer

Manual sphygmomanometers estimate arterial blood pressure using the auscultatory technique. Systolic and diastolic blood pressure is detected from Korotkoff sounds using a stethoscope or microphone positioned over a compressed artery during cuff deflation. Liquid/mercury column and aneroid sphygmomanometers use the manual method.[10]

Automatic sphygmomanometer

Automatic sphygmomanometers estimate blood pressure after automatic inflation and deflation of the cuff and display the values on an electronic display. The semi-automated devices require manual inflation. Electronic sphygmomanometers use the automatic method.[10]

Based on how they are mounted, sphygmomanometers can be classified into the following :

- Desktop sphygmomanometer;
- Standing/mobile sphygmomanometer;
- Wall-mounted sphygmomanometer.

An example of wall-mounted sphygmomanometers can be seen in Figure 3.6.

An example of desktop and standing/mobile types can be seen in Figure 3.7.

According to the point of measurement, sphygmomanometers are placed to measure the following different body parts:

- Upper arm

The cuff is usually positioned on the upper arm for even compression of the brachial artery, which is the standard location for blood pressure measurement.[10]

- Wrist

Figure 3.6 **Examples of a wall-mounted mercury sphygmomanometer (left) and a wall-mounted aneroid sphygmomanometer (right)**

Source: https://www.medicalexpo.com/prod/wa-baum/product-79928-519024.html

Source: https://www.tigermedical.com/Products/Wall-Mounted-Aneroid-Sphygmomanometer__AMIAM-DX-LF2118-.aspx

In some electronic devices, the cuff is placed over the radial artery on the wrist. However, these devices may give inaccurate measurements, particularly if the arm is not kept at heart level during measurement and if the radial artery is not evenly compressed.[10]

- Finger

An electronic monitor finger cuff or device is attached to the finger. It could use different techniques.[10]

3.3.1. Mercury-containing sphygmomanometers

The mercury sphygmomanometer is the most conventional form of blood pressure measuring apparatus, and it can be considered the golden standard in the health industry. Mercury sphygmomanometers are made up of manually inflatable cuffs that are attached to measuring units with mercury-infused tubes. While operating the device, it is important to place the apparatus on a flat surface and in an upright position to get the correct readings. These devices are very delicate and require special care, and if accidentally dropped, can cause rupture of mercury, rendering the device useless and potentially hazardous.[11] Examples of a desktop mercury sphygmomanometer and a standing mercury sphygmomanometer are shown in Figure 3.7.

The most significant advantage of using mercury sphygmomanometers is that they are quite easy to use, and if used properly, can last a lifetime. The device can produce the most accurate results without requiring much readjustment.[11] However, due to the toxic nature of its mercury content, the use of mercury sphygmomanometers is phased-out under the Minamata Convention. The amount of mercury in a sphygmomanometer range from 80 to 200 grams.[1]

3.3.2. Alternatives to mercury sphygmomanometer

As mentioned in Permenkes 41/2019, example of alternatives for mercury-containing medical measuring devices registered in e-catalogue (https://e-katalog.lkpp.go.id/) for sphygmomanometers, among others, are

Figure 3.7 **Examples of a desktop mercury sphygmomanometer(left) and a standing mercury sphygmomanometer (right)**

Source: BSCRC-SEA, 2020

the aneroid sphygmomanometers and digital sphygmomanometers.

3.3.2.1. Aneroid sphygmomanometers

Aneroid means "without fluid". These devices do not use mercury and are considered as a safer alternative when compared to mercury based sphygmomanometers. The recording procedure using an aneroid sphygmomanometer is very similar to a conventional mercury sphygmomanometer requiring inflating and deflating the cuff with the exception that most aneroid devices come with an attached stethoscope to the cuff. The device consists of a cuff that is attached by tubes to a dial gauge marked in millimeters of mercury (mmHg). Inside the gauge head, the device uses mechanical parts

Figure 3.8 **Examples of a pocket aneroid sphygmomanometer (left), a palm aneroid sphygmomanometer (middle) and a clock-style aneroid sphygmomanometer (right)**

Source: https://www.cmecorp.com/adc-diagnostix-pocket-aneroid-sphygmomanometer.html

Source: https://www.medisave.co.uk/topaz-deluxe-aneroid-sphygmomanometer-palm-held.html

Source: DanWHS, 2021

to convert the cuff pressure into a gauge-based reading.[12]

Aneroid sphygmomanometers come in various form factors, and some of the commonly found variants are pocket aneroid sphygmomanometer, palm aneroid sphygmomanometer, and clock-style aneroid sphygmomanometer.[12]

Pocket aneroid sphygmomanometer is the most popular variant due to its compact design, portability, and low cost. It is very popular among medical students and nurses.[12] An example of a pocket aneroid sphygmomanometer is shown in Figure 3.8.

Palm aneroid sphygmomanometers are popular in clinical and emergency medical service (EMS) environments where cuffs of various sizes are required. The bulb and dial gauge is designed in a compact form factor to be operated by one hand. It is very easy to switch different cuff sizes as per requirement in emergency situations.[12] An example of a palm aneroid sphygmomanometer can be seen in Figure 3.8.

Clock-style aneroid sphygmomanometers typically have larger dials for viewing from a distance. They are usually found in the doctor's office, clinics, or nursing homes. The dial gauge can be wall mounted, desktop or attached to a portable stand for mobility.[12] An example of a clock-style aneroid sphygmomanometer can be seen in Figure 3.8.

3.3.2.2. Electronic sphygmomanometers

Oscillometric devices are commonly referred to as automatic electronic sphygmomanometers or digital sphygmomanometers. These devices use an electronic pressure sensor for measuring the blood pressure and the readings are given out digitally on a display. These devices have inflatable cuffs like mercury or aneroid sphygmomanometers and the cuff is attached to the electronic unit. However, the main difference is in the technique used for measuring the blood pressure.[12]

Mercury or aneroid sphygmomanometers reports are based on the sounds produced by the blood flowing inside the arteries. Digital sphygmomanometers evaluate and measure the oscillations of the arteries using pressure sensors. As the cuff is inflated and then deflated later, oscillations occur. These oscillations are processed using an algorithm to produce systolic and diastolic values that are digitally displayed on the device display. Automatic digital sphygmomanometers are usually battery operated. Some models designed for field use have dual power sources like batteries and solar cells. They come in two variants, namely full-automatic blood pressure monitor and semi-automatic blood pressure monitor.[12]

Full-automatic blood pressure monitors have an electric pump for inflating the cuff. The operation of the device is very easy and requires minimum inputs from the user. Once the cuff is placed on the upper arm, the device can be switched on and the reports are produced automatically.[12] An example of a full-automatic blood pressure monitor can be seen in Figure 3.9.

The user of a semi-automatic blood pressure monitor has to inflate the cuff manually by hand using the bulb like a conventional device. Once inflated, the device can then start deflating the cuff automatically and beyond this point the reading is produced in a similar way as an automatic device. These devices consume less power and can be more suitable for field operations where resources might be limited.[12] An example of a semi-automatic blood pressure monitor can be seen in Figure 3.10.

The selection of accurate, validated blood pressure measuring devices is important for assessing blood pressure as these devices will provide accurate and reproducible measurements. Accurate blood pressure measurements are essential to managing hypertension, as imprecise measurement can significantly affect diagnosis and treatment.[10]

For non-invasive blood pressure measurement, many medical devices use different technology to display the results. Each type has advantages and disadvantages, making them less or more suitable for a certain use and level of care. A List of the advantages and disadvantages of the various devices is provided in Appendix 1.[10]

Calibration

Even accuracy validated automated blood pressure measuring devices can lose accuracy over time with regular use, usually related to the wear and tear of the cuff and tubing. Because of this, the accuracy of devices must be assessed regularly for effective hypertension management.

Figure 3.9 **Example of A Full-Automatic Blood Pressure Monitor**

Source: DanWHS, 2021

Figure 3.10 **Example of A Semi-Automatic Blood Pressure Monitor**

Source: https://www.amazon.ae/Omron-Semi-automatic-Blood-Pressure-Monitor/dp/B00EH9VEIC

This can be done by visually inspecting the parts and comparing the measurements obtained with the device against those obtained with a gold standard device and method. If the cuff or tubing has lost integrity, or the comparison results differ by an unacceptable amount, the device may need repair or replacement. Devices should be checked regularly in accordance with the manufacturer's user and maintenance manuals. Technical professionals should usually assess accuracy at the institution, the manufacturer (during warranty or in a service contract) or by an approved service centre at the interval prescribed by the manufacturer or as established in the medical equipment management programme.[10]

The frequency of accuracy-checks must be in accordance with the manufacturer's recommendation, which depends on the type of technology. The usual interval is once every 1 or 2 years. Nevertheless, experience shows that, if an electronic blood pressure measuring device is used frequently every day in clinical practice. The integrity of the cuff and tubing and the adequacy of the power source should be checked at least once a month by users or clinical engineers. A more technical check could be performed by an authorized laboratory (metrological testing in order to guarantee accurate measurements by the national calibration or metrology centre in the country), which will measure and calibrate the electronic device against a reference manometer, such as an electronic sensor with a high accuracy of ± 0.1 mmHg and compared with a well-maintained mercury sphygmomanometer with a rated accuracy of only ± 3 mmHg.[10]

It is important to remember that the accuracy of the device is just one of the factors necessary for an accurate measurement. The United Nations Development Programme (UNDP) and Global Environment Facility (GEF) Global Healthcare Wastes Project provides guidance on maintaining and calibrating non-mercury clinical thermometers and sphygmomanometers.[10]

More information on calibration and maintenance of non-mercury thermometers and sphygmomanometers can be seen in this UNDP GEF Global Healthcare Wastes Project Guidance.[13]

4

ENVIRONMENTALLY SOUND MANAGEMENT OF UNBROKEN MERCURY-CONTAINING THERMOMETERS AND SPHYGMOMANOMETERS

4.1. General information

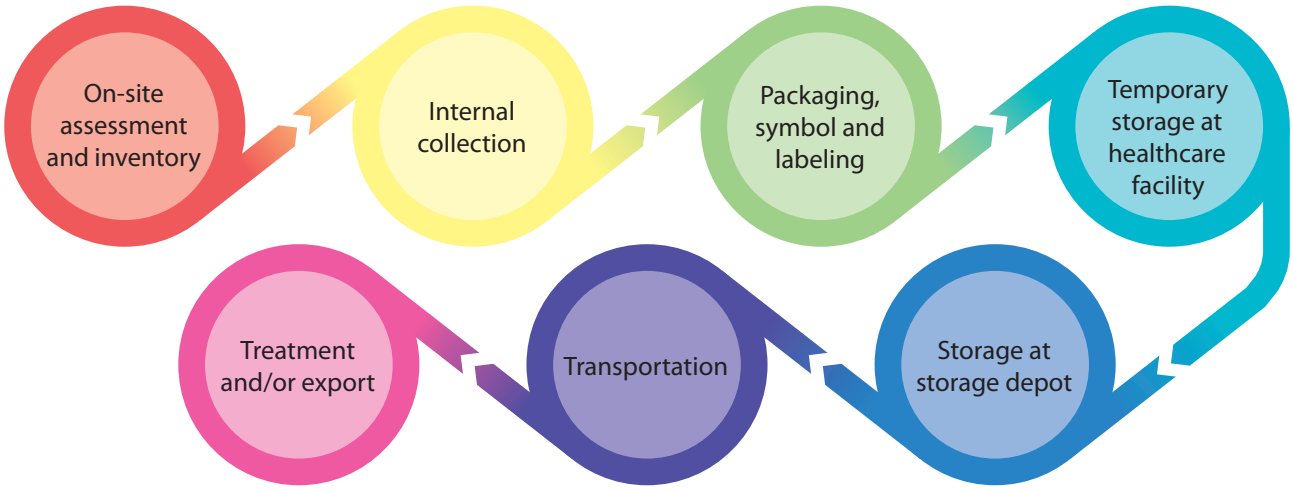
Under Permenkes 41/2019, unbroken or still intact mercury-containing medical measuring devices are regarded as unused assets and will be treated as medical devices and not regarded as hazardous wastes. While the broken mercury-containing medical measuring devices fall under the regime of hazardous wastes and thus follow the national regulations of hazardous wastes, the unbroken mercury-containing medical measuring devices are specifically regulated under Permenkes 41/2019. Therefore, the national regulations on hazardous wastes do not apply for unbroken mercury-containing medical measuring devices.

At the time these technical guidelines were developed, the Ministry of Environment and Forestry of Republic of Indonesia (MoEF) issued the Ministerial Regulation Number P.27/Menlhk/Setjen/Kum.1/12/2020 concerning the Management of Discarded Mercury-Containing Medical Devices (Permen LHK 27/2020) which covers collection, temporary storage, transportation, storage at storage depot, treatment and/or export.

This chapter provides the principles and elements of the ESM of discarded unbroken mercury-containing thermometers and sphygmomanometers, which are in line with the Permen LHK 27/2020. The relevant information in this chapter has been adjusted to the new regulation as necessary. In addition, this chapter provides more technical information to supplement the abovementioned regulation.

The main elements and process flow of the ESM of the discarded unbroken mercury-containing medical measuring devices are presented in a process flow chart as shown in Figure 4.1. The descriptions of the elements and the processes are provided in the following subchapters.

Figure 4.1 **Flowchart of the management of the unbroken mercury-containing medical measuring devices**



4.2. On-site assessment and inventory of medical measuring devices

A proper and thorough assessment and inventory of medical measuring devices being used and or stored at a healthcare facility should be a logical first step in the ESM of such devices. As mentioned in Permenkes 41/2019, a designated team or executive staff should conduct on-site assessment and inventory of mercury-containing medical devices in the healthcare facility.

The assessment activities cover the following:

- Assessment of the feasibility of replacing or substituting mercury-containing medical devices with non-mercury ones, and determining the types of products, costs, and compliance with international standards;
- Assessment of the availability of facilities and infrastructure in maintenance, calibration services including replacement of parts of the devices if necessary;
- Determination of the number of devices to be replaced/substituted;
- Identification of relevant regulations and requirements that must be fulfilled for the implementation of the elimination of mercury-containing medical devices and their temporary storage;
- Assessment of capacity, procedures and safe storage facilities in all sections/units of healthcare facilities, including the existing hazardous wastes management system;
- Identification of facilities and infrastructure for temporary storage of mercury-containing medical devices.

The inventory activities cover the following:

- Recording of available mercury-containing medical devices by classifying them according to the type, quantity, volume, condition, and presence of the mercury-containing medical devices;
- Identification of labeled containers for temporary storage of mercury-containing medical devices to be eliminated based on the type of device;
- Identification of alternative temporary storage, if the healthcare facility does not have a storage place/warehouse;
- Using a special form which must be filled completely and correctly.

The data collected from the on-site assessment and inventory can be used to plan the elimination, substitution and provision of container and temporary storage of mercury-containing medical devices, with the achievement target of end of 2020.

In addition, assessment and inventory of non-mercury containing medical devices already available at the healthcare facility is also important to support the planning of elimination and substitution of the mercury-containing medical devices.

4.3. Internal collection

The person responsible for the healthcare facility management should arrange the internal collection of the mercury-containing medical measuring devices to be discarded by regulation. During the collection, the devices should be separated according to their types. The collected mercury-containing medical measuring devices must be packaged and attached with symbols and labels.

4.4. Packaging

4.4.1. Primary packaging

Each type of mercury-containing medical measuring device should be packaged in its original protective case or container provided by the manufacturer as the primary packaging. In case the original protective case or container is damaged or lost, it should be substituted by a similar container as primary packaging, which fulfills requirements as follow:

- Made of solid and rigid material.

  The primary packaging material and construction will sufficiently protect the device in it and prevent it from breaking when it is dropped during handling. Examples are metals and hard plastics.

- Closed.

  Primary packaging should be tightly closed with a stable structure (leak-proof) to prevent mercury spills due to fragile or broken packaging, further preventing mercury evaporation.

- Does not react with mercury.

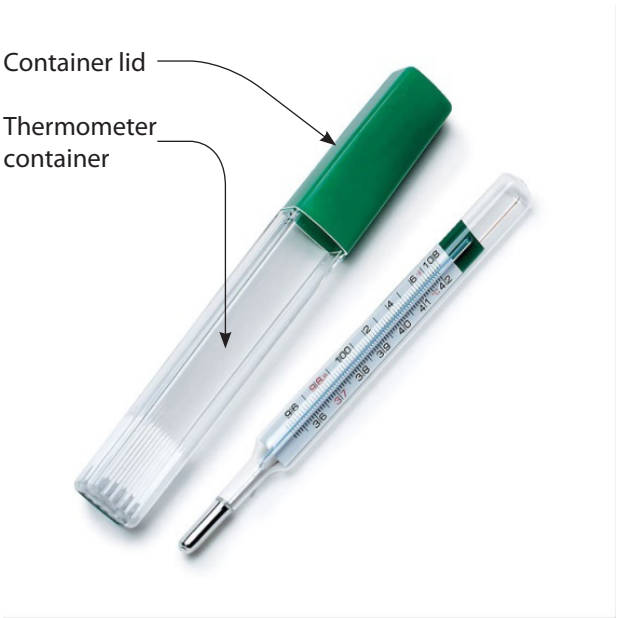
  Primary packaging is made of a material that does not react with mercury or made of a material compatible with the content.

As a reference, the estimated standard sizes of mercury-containing medical measuring devices are as the following:

- A thermometer has a size of about 13 cm x 1.5 cm x 2 cm;

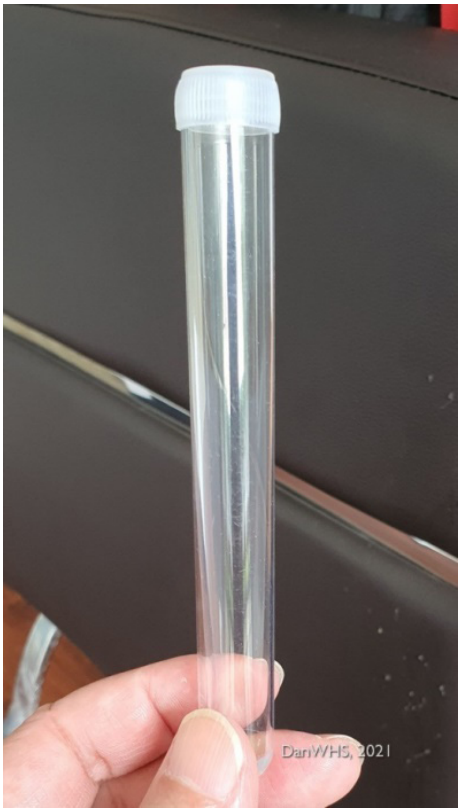
- A sphygmomanometer has a size of about 35 cm x 11 cm x 5 cm.

Figure 4.2 **A Mercury-Containing thermometer with its original container as primary packaging**



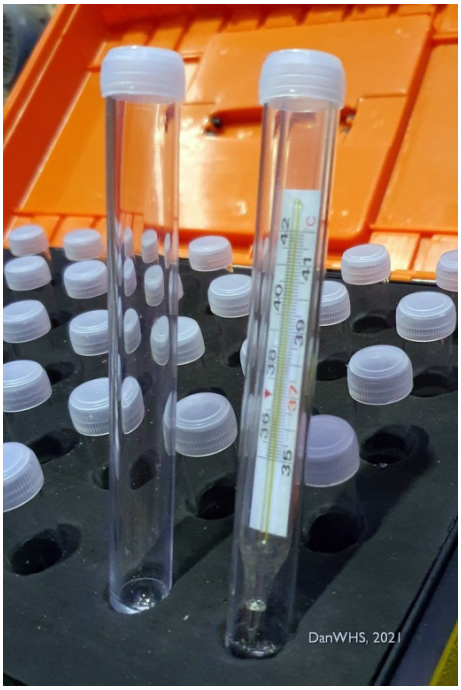
Source: hopkinsmedicalproducts.com

Figure 4.3 **An Example of a non-original or substitute container as primary packaging for a mercury-containing thermometer**



Source: DanWHS, 2021

Figure 4.4 **Prototypes of primary packaging for mercury-containing thermometers in the form of a plastic tube and how to store them in the secondary packaging box**



Source: DanWHS, 2021

Figure 4.5 **Original packaging as primary packaging of a desk mercury-containing sphygmomanometer**

Source: https://www.medical-x-ray.com/item-853.html

For floor-standing sphygmomanometers, their pole and wheel can be dismantled first to reduce their size. The mercury contained in the medical devices does not need to be removed from the medical devices.

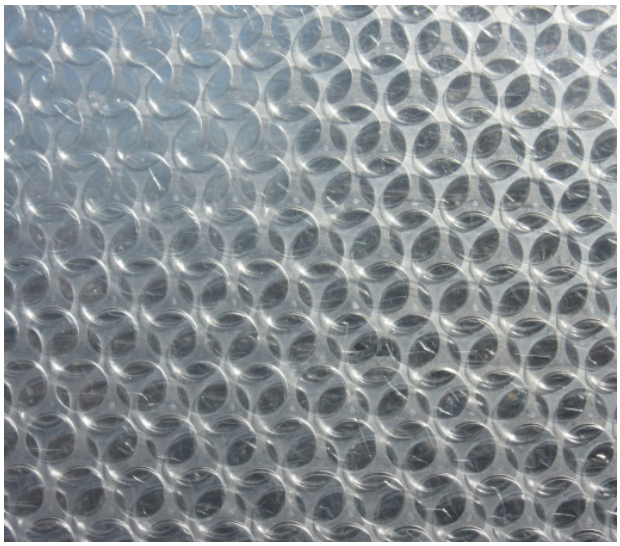
According to Permenkes 41/2019, containers of elemental mercury collected from cleanup spill of broken thermometers and sphygmomanometers are treated. The same as the discarded unbroken mercury-containing thermometers and sphygmomanometers for their storage and withdrawal.

Examples of primary packaging for mercury-containing thermometers are shown in the Figures 4.2 and 4.3.

Some examples of proper containers or packaging for temporary storage and transportation have been made available by the Agency for

Figure 4.6 **Example of Plastic Bubble Wrap (in rolls, left; texture, right)**

Source: https://www.nicepng.com/maxp/u2e6r5i1a9o0a9o0/



Source: https://pixy.org/4750100/

Assessment and Application of Technology in Indonesia (BPPT) albeit as prototypes. In case the original primary packaging for a mercury-containing thermometer is lost, the BPPT has also used a certain plastic tube product as substitute. In addition, secondary containers or packaging made of plastic/polyethylene boxes have also been developed by the BPPT. The current prototype of the secondary packaging box can hold 50 (fifty) plastic tubes (the primary packaging) of mercury-containing thermometers. The primary packaging tube and the secondary packaging box and how the plastic tubes are stored in the box are shown in Figure 4.4.

An example of the original packaging as primary packaging for a desk mercury-containing sphygmomanometer is shown in Figure 4.5.

Each mercury-containing medical measuring device which have been packaged using primary packaging should then be wrapped with plastic bubble wrap minimum of 2 (two) layers. This will protect against possible pressure during transportation from the healthcare facilities to the storage depots and the storage depots to the treatment facility and/or export.

Examples of plastic bubble wrap and illustration of primary unoriginal/substitute packaging of mercury-containing medical measuring devices wrapped in plastic bubble wrap can be seen in Figures 4.7.

4.4.2. Secondary packaging

After the mercury-containing medical measuring devices have been packaged using primary packaging and wrapped with plastic bubble wrap, they should be packaged using secondary packaging.

The secondary packaging should fulfill the following requirements:

- Secondary packaging should be tightly closed with stable structure (leak-proof) to prevent possible mercury spills and leakage during management of the mercury-containing medical devices.
- Secondary packaging is made of a material that does not react with mercury or is made of a material compatible with the content.

The use of the secondary packaging is adjusted with the type, number, and volume of the discarded mercury-containing medical measuring devices. The use of the secondary packaging is carried out prior to transportation.

Figure 4.7 **Illustration of a primary unoriginal/substitute packaging of mercury-containing medical measuring devices in plastic bubble wrap**

Source: BSCRC-SEA, 2021

Mercury-containing medical measuring devices are stored in the secondary packaging for each type (not mixed between different types of mercury-containing medical measuring devices).

Secondary packaging is made of the following materials:

- carbon steel;
- polyethylene terephthalate;

Figure 4.8 **Example of A Secondary Packaging**

Source: BSCRC-SEA, 2020

- ethylene propylene diene monomer;
- polyvinyl chloride;
- polyethylene; or
- high-density polyethylene

Examples of secondary packaging can be in the form of intermediate bulk container (IBC) tanks, drums, or other packaging that meets the requirements. If the secondary packaging has empty spaces, then the empty spaces must be filled with other materials such as foam or plastic that can prevent shocks that may occur during transportation and final treatment process of the mercury-containing medical measuring devices.

Figure 4.9 **Example of Plastic Wrap (left) and Illustration of Packaging with Plastic Wrap (right)**

Source: BSCRC-SEA, 2020

Figure 4.10 **A Prototype of A Secondary Packaging for Mercury-Containing Thermometers (closed, left picture ; open, right picture)**

Source: DanWHS, 2021

An example of a secondary packaging is as in Figure 4.8.

Mercury containing medical measuring devices which have been packaged inside the secondary packaging should then be wrapped with plastic wrap (minimum of 2 (two) layers) as a final safeguard during transportation from the healthcare facility to the storage depots, and from the storage depots to the treatment facility and/or export. Example of plastic wrap and an illustration of wrapping mercury-containing medical measuring devices in plastic wrap can be seen in Figure 4.9.

BPPT has also made a prototype for secondary packaging for mercury-containing thermometers (see Figure 4.10) and tertiary or transportation box made of epoxy coated metal plate, which contains 12 (twelve) secondary packaging boxes, as shown in Figure 4.11.

BPPT has developed a prototype for secondary packaging for mercury-containing sphygmomanometers, which also serves as a transportation box. It is made of epoxy coated metal plate and contains 50 (fifty) original primary packaging of desk mercury-containing sphygmomanometers. The secondary packaging/ transportation box and how to store the original primary packaging into the secondary packaging/ transportation box is shown in Figure 4.12 and Figure 4.13.

Figure 4.11 **A prototype of tertiary/ transportation box for mercury-containing thermometers**

Source: DanWHS, 2021

Figure 4.12 **A Prototype of a secondary packaging/transportation box for mercury-containing sphygmomanometers**

Source: BSCRC-SEA, 2021

4.5. Symbol and label

Mercury-containing medical measuring devices which have been packaged must be attached with symbols and labels. Requirements for the symbols and labels are as in the following sections.

4.5.1. Symbol for primary packaging

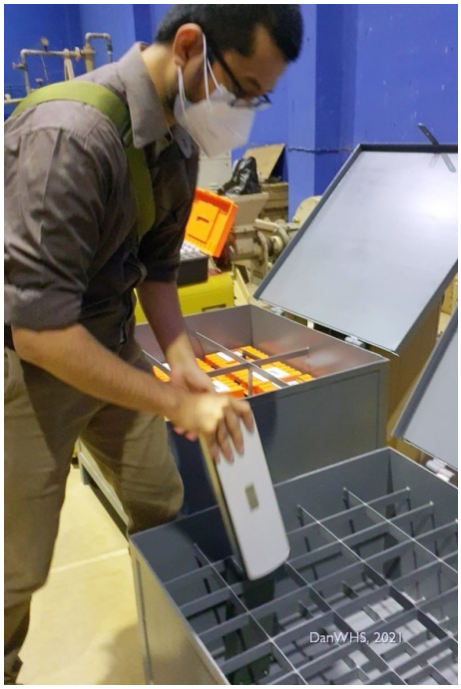
The symbol attached to the primary packaging have labeling as "Danger Mercury" with size adjusted to the size of the packaging, as shown in the figure below.

Figure 4.14 **Basic shape of symbol for primary packaging**

DANGER MERCURY

Source: MoEF, 2020

Figure 4.13 **Storing an original primary packaging of mercury-containing sphygmomanometers into the secondary packaging/transportation box**



Source: DanWHS, 2021

The requirements for symbol for primary packaging are as follow:

- Symbol in the form of sticker or other that attach well to the primary packaging, easy to use and durable;
- Symbol is made of materials that are resistant to water, scratches and chemicals that may affect them (such as plastic, waterproof paper, or metal plate);
- Symbol is placed on the outer sides of the hazardous wastes packaging container that are not hindered.

The minimum symbol size attached to the primary packaging are:

- Thermometer: 1.5 cm x 1.5 cm or larger
- Sphygmomanometers: 5 cm x 5 cm or larger

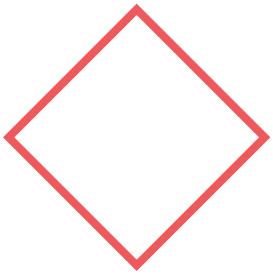
4.5.2. Symbol for secondary packaging

Symbols for secondary packaging are in the form of squares rotated 45⁰ (forty-five degrees) so that they form white-based rhombuses with red borderlines (see Figure 4.15).

The symbols placed on the secondary packaging should be adjusted to the size of the packaging by following the requirements below:

Symbols in the form of stickers or others that attach well to the secondary packaging, easy to use and durable;

Figure 4.15 **Basic shape of symbol for secondary packaging**



Symbols are made of materials that are resistant to water, scratches and chemicals that may affect them (such as plastic, paper, or metal plate);

Symbols are placed on the outer sides of the hazardous wastes packaging container that are not hindered.

The minimum size of each symbol attached to the secondary packaging is 5 cm x 5 cm. The symbols must be attached to each side of the secondary packaging.

The types of symbols placed on the secondary packaging are symbols that indicate the danger classification of health hazard, toxicity, and corrosive as shown in Figure 4.16.

The mercury symbols are depicted in white base colour with thick red borderlines. The health hazard symbol is in the form of black images of human head and chest with images white resembling hexagon stars on the chest. The toxic symbol is in the form of a skull and crossbones.

Figure 4.16 **Symbols of mercury**

Health Hazard | Toxicity | Corrosive

Source: MoEF, 2020

Figure 4.17 **Label of mercury-containing medical measuring devices**

Medical Device Identity Number	:
Type of Medical Device	: Thermometer / Sphygmomanometer
Initial Date of Storage	: (Date-Month-Year)
Warning	: Fragile

Source: MoEF, 2020

The corrosive symbol consists of two images dropped by corrosive liquid.

4.5.3. Label

Each type of mercury-containing medical device should be labeled. The label is a brief description which shows, among others, information on:

- identity number of the mercury-containing medical device;
- type of the mercury-containing medical measuring devices;
- date of initial storage of the mercury-containing medical device; and
- fragile warning.

Label attached to the packaging of each medical device should be adjusted to the size of the packaging by following the provisions as the following:

Label serves to provide the identity of the goods and should be easily read, clearly visible, not easily damaged, and not easily detached from the packaging;

Label is made of material that is resistant to water, scratches and chemicals that may affect it (such as plastic, waterproof paper or metal plate);

Label is placed on the outer sides of the hazardous wastes packaging that are not hindered. If the mercury-containing medical measuring devices have already been packaged with both primary and secondary packaging at one time, the label can be attached only to the secondary packaging;

Label is in rectangular and minimum size of label attached to the primary packaging is as follows:

- Thermometers: 1.5 cm x 6 cm or greater
- Sphygmomanometers: 5 cm x 20 cm or greater

The minimum label size attached to the secondary packaging is 25 cm x 25 cm for each label attached. Label must be attached to each side of the secondary packaging.

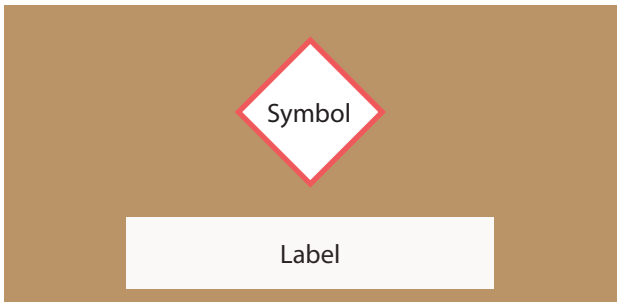
Label is placed on the packaging with criteria of white base colour with black writing and borderlines, as in Figure 4.17.

4.5.4. Placement of symbol and label

Symbols and labels are placed on the primary packaging and secondary packaging of the mercury-containing medical measuring devices. Suppose mercury-containing medical measuring devices have already been packaged with both primary and secondary packaging at one time. In that case, the symbols and labels can be attached only to the secondary packaging.

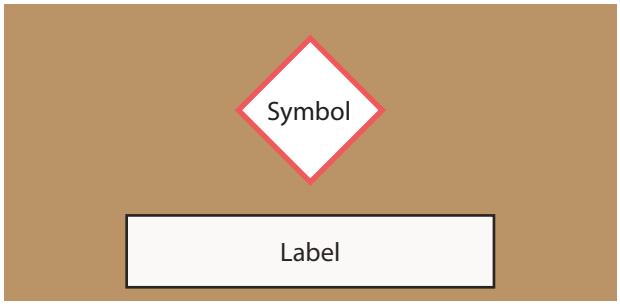
Labels for the mercury-containing medical measuring devices are placed on the packaging below the symbol and must be visible. Examples of the placement of symbols and labels on the packaging are shown in the following figures.

Figure 4.18 **Placement of symbols and label on the thermometer primary packaging (top view)**



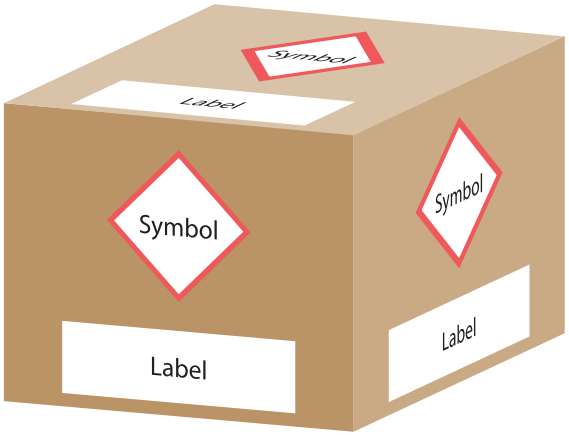
Source: MoEF, 2020

Figure 4.19 **Placement of symbols and labels on the sphygmomanometer primary packaging (top view)**



Source: MoEF, 2020

Figure 4.20 **Symbols and labels on the secondary packaging**



Source: MoEF, 2020

4.6. Temporary storage at healthcare facilities (special room)

The person responsible for the healthcare facility is obliged to store the unbroken mercury-containing medical measuring devices packaged and attached with symbols and labels in a temporary storage facility under the authorization of the responsible person. If the responsible person does not have a temporary storage facility, the discarded mercury-containing medical measuring devices should be stored in other temporary storage facility owned by central or local government hospitals located in the same regency/city area. This handover or transfer should be accompanied with a record of transfer.

The temporary storage facility should fulfill the following requirements:

- The area of the room should be adjusted to the number and volume of the collected discarded mercury-containing medical devices;
- The room must be safe from possibility of damage and leak which may cause mercury spills from medical devices;
- The room can be locked and only accessed by authorities designated by the healthcare facility management (not easily accessed by public);
- The room should have adequate lighting and ventilation;
- The room does not mix the mercury-containing medical measuring devices with hazardous wastes from the healthcare facility's activities;
- The room should have a record of the stored mercury-containing medical measuring devices.

4.7. Elimination of state-owned assets for government-owned healthcare facilities

Prior to withdrawal of mercury-containing medical measuring devices, the process of elimination of state-owned assets for government-owned healthcare facilities must be carried out. The procedures for eliminating state-owned mercury-containing medical measuring devices which are procured with State Budget (*Anggaran Pendapatan Belanja Negara*, APBN) are carried out according to regulatory framework concerning procedures for elimination of state-owned goods. As for mercury-containing medical measuring devices which are procured through Regional Budget (*Anggaran Pendapatan Belanja Daerah*, APBD), the procedures are carried out according to regulatory framework concerning elimination of regional-owned goods. The mercury-containing medical measuring devices eliminated according to provisions of elimination of state/regional-owned goods and collected in a special room at the healthcare facility, will gradually be withdrawn.

4.8. Off-site transportation

Transportation of mercury-containing medical measuring devices is carried out from:

- temporary storage facility to storage depot facility; and
- storage depot facility to treatment facility for discarded mercury-containing medical measuring devices or abroad for export.

Transportation from the temporary storage facility to storage depot facility is conducted by the local health agency at provincial and/or regency/city level according to their authority in coordination with agency responsible for environmental affairs at provincial and/or regency/city level.

Transportation from storage depot facility to treatment facility for mercury-containing medical measuring devices and/or abroad for export is carried out by the Director General responsible for hazardous substances management.

Transportation should fulfill the following requirements:

- Carried out for the discarded mercury-containing medical measuring devices which have been packaged according to the requirements in Subchapter 4.4 and attached with symbols and labels according to the requirements in Subchapter 4.5.
- Accompanied with recording document of the discarded mercury-containing medical measuring devices.

The recording document of the discarded mercury-containing medical measuring devices comprises:

- first part, filled by the person responsible of the healthcare facility;
- second part, filled by transporter of the discarded mercury-containing medical measuring devices from the healthcare facility to storage depot;
- third part, filled by the storage depot manager;
- fourth part, filled by transporter of the discarded mercury-containing medical measuring devices from the storage depot to the treatment facility or abroad for export;
- fifth part, filled by the treater/exporter of the discarded mercury-containing medical measuring devices.

The recording document is prepared according to the format as attached in Annex II of Permen LHK 27/2020 (see Appendix 2 of these guidelines).

As described in Figure 4.1, there are 2 (two) different transportation processes, namely the transportation process from the temporary storage at the healthcare facility to the storage depot and the transportation process from the storage depot to the treatment facility or abroad for export.

The transportation process from the temporary storage at the healthcare facility to the storage depot is not regulated to use transportation service. Transportation service or treatment facility is used to assist MoEF in the transportation process from the storage depot to the treatment facility or abroad for export.

Specific requirements for the transportation process from the storage depot to the treatment facility or abroad for export[1] can also be implemented as in the following paragraphs.

The licensed transporter of the discarded mercury-containing devices should fulfill some basic design criteria. Examples of the design criteria are as follows:

- The registered vehicle should be a closed vehicle;
- The body of the vehicle should be of a suitable size commensurate with the design of the vehicle and the load to be transported;
- There should be a bulkhead between the driver's cabin and the vehicle body, which is designed to retain the load if the vehicle is involved in a collision;
- There should be a suitable system for securing the load during transport;
- Empty air-tight containers, plastic bags, PPE, spill kits, cleaning equipment, and decontaminating agents should be carried in a separate compartment in the vehicle;
- The registered vehicle should be marked with the name and address of the wastes carrier.[1]

The licensed transporter should have appropriate warning signs and placards displayed on the vehicle according to Permen LHK 14/2013 concerning Symbol and Label of Hazardous Wastes.

Before transporting mercury wastes, the transporter should have a routing plan, emergency response or contingency plan, and emergency phone numbers. The transporter should also have a spill kit, PPE, first-aid kit, fire extinguisher, labels, and extra containers in the passenger compartment for use in case of a spill.[1]

Before transporting the mercury-containing medical measuring devices, the transporter should inspect all the waste containers to ensure they are packed and labeled properly.[1]

Whether transporting the mercury wastes in a registered vehicle or in the generator's own vehicle, the waste containers should be placed in the back of the vehicle (cargo compartment of a truck or lorry, back trunk or boot of a car) and not in the passenger section.[1]

All wastes containers should be firmly secured such that the containers do not tip over, slide, or shift during accelerations, stops, turns, and driving over bumps and holes on the road.[1]

Containers should not be stacked more than 1.5 meters high to avoid crushing items.[1] The transport vehicle should be kept locked whenever there is waste in the vehicle except during inspection, loading, and unloading.[1]

The transporter should transport the wastes as soon as possible using the safest or most direct route to the storage facility. If the transporter collects mercury wastes from multiple facilities, the routing plan should reflect the shortest and safest route to minimize time and distances traveled. The transporter should transfer the wastes only to the storage facility or to another licensed transporter.[1]

The transport vehicle should be kept clean and maintained in good running condition.[1] The transport vehicle should be used to transport the discarded mercury-containing medical measuring devices only and not mixed with other hazardous wastes.

4.9. Storage at storage depot

4.9.1. Location

The storage depot for mercury-containing medical measuring devices should be closed, located in safe area and not in natural disaster prone areas, such as flooding, typhoons, hurricanes, brush fires, and earthquakes and it should be accessible by transportation vehicle.

4.9.2. Overall design requirement and procedure

The storage depot facility should fulfill the following requirements:

- closed;
- the area is proportional with the number and volume of the collected mercury-containing medical measuring devices
- the temperature in storage areas should be maintained as low as feasibly possible, preferably at a constant temperature of 21 degrees Celsius[15];
- located in a safe area; and
- not located in natural disaster prone area.

The storage depot is provided by the Minister of Environment and Forestry and given to the governor to be placed at:

- hospitals owned by local government; or
- other location suitable for storage of the discarded mercury-containing medical measuring devices.

Specific requirements for the collection facility of mercury wastes from healthcare facilities can also be implemented as in the following;[1]

The size of the storage area should be sufficient to hold safely the anticipated volume of mercury wastes from the region being served. The estimated maximum volume should account for the different types of wastes (elemental mercury, unbroken mercury thermometers and sphygmomanometers, other mercury-containing medical measuring devices), their respective packaging, and the necessary space needed for shelving or storage racks, aisles, transport carts, etc.[1]

The storage depot should be very secure with closely controlled access and intrusion detection and alarm system. It should have static or natural ventilation supplemented by air conditioning to control temperature and humidity and kept at room temperature.[1]

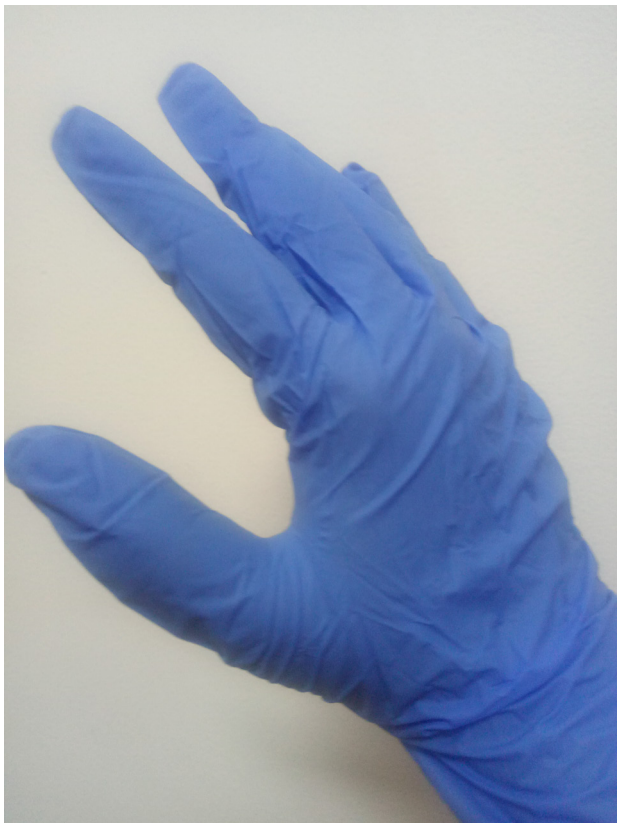
The storage depot should also have heat, smoke, and fire detection and alarm system and a fire suppression system. Fire extinguishers should be installed, inspected regularly, and recharged when needed. The kinds of fire extinguishers available should be consistent with the classes of fires possible in the facility (e.g., paper, cardboard, or plastic fires; combustible liquid fires; electrical fires; etc.). Furthermore, the selection of fire extinguishers should consider the need for personnel safety, limiting the spread of mercury droplets and vapor, mercury cleanup and recovery after the fire, and avoiding stress corrosion of containers and shelves.[1]

The storage depot should have at least four distinct and separate functional areas:

- Receiving area for receiving wastes, re-labeling if necessary, and signing documents;
- Inspection area for checking for leaks, repackaging, secondary containment, and re-labeling if necessary;
- Storage area specific for mercury wastes;
- Administrative and record-keeping area.[1]

PPE, spill cleanup kits, first-aid medical supplies, and wash areas should be located in the receiving area, inspection area, and near but not in the storage area. The PPE, spill kits, first-aid supplies, and wash areas should be easily accessible to personnel. Spill kits should include absorbent

Figure 4.21 **Safety googles (upper left), disposable shoe covers (lower left) and nitrile gloves (right)**



Source: BSCRC-SEA, 2020

pads, plastic liners, vapor suppression and decontamination agents. The PPE should include:

- Safety goggles (See Figure 4.21 for example);
- Rubber or nitrile gloves (See Figure 4.21 for example);
- Respiratory protection; self-contained breathing apparatus (SCBA) for large spills, fit-tested full- or half-face piece air-purifying respirator with mercury vapor cartridges, face mask with sulfur or iodide impregnated activated carbon, face mask made of sandwiched activated charcoal-impregnated cloth, or other mask designed specifically for mercury;
- Disposable shoe covers (See Figure 4.21 for example);

Figure 4.22 **Protective coverall**

Source: https://www.indiamart.com/proddetail/chemical-protection-suits-20783043955.html

- Polymer or rubber-based, protective full-body suits for large spills and protective coveralls (See Figure 4.22 for example);

- Helmets.[1]

The drains in the receiving, inspection and storage areas should be connected to a separate wastewater collection system and not to the regular sewer system nor surface water. Drains in the storage facility should have an easily accessible and replaceable drain trap to capture mercury in the event of a spill.[1]

The storage depot should submit periodic reports regarding safety issues (including accidents and spills), storage conditions, capacity, and monitoring data to the designated government authority, as may be required by national regulations.[1]

The storage depot should have a hazardous wastes management plan which establishes procedures for receiving wastes, internal transport, wastes inspection, re-labeling, repackaging, supplementary containment, storage, facility inspection, general cleaning (housekeeping), spill control, spill cleanup, emergency procedures, worker safety (including hazard identification, hazard mitigation, proper use of PPE, ergonomic techniques for handling wastes, and medical surveillance), reporting, and record-keeping.[1]

All storage depot staff should be familiar with all aspects of the hazardous wastes management plan, receive initial and periodic refresher training, and be equipped to handle spills and other emergencies.[1]

The storage depot should have clear guidelines on repackaging and supplementary containment if outside packaging is inadequate or if primary or secondary containers are broken. If there are indications of a leak in the primary and/or secondary container, the wastes should be placed in an air-tight supplementary container of the appropriate size and strength.[1]

The storage depot should have clear labeling guidelines that describe when a label should be replaced.[1]

Records should be kept until mercury waste is transferred to a long-term (terminal) storage facility or to a treatment and disposal facility. The records should be linked to an identification number or code on the mercury wastes labels.[1]

The records should include the name and contact information of the source of mercury wastes (including generator identification number if available), the quantities (number of containers, weights, approximate volumes) and descriptions of the wastes (including composition and information on how the mercury wastes was generated), special handling procedures or warnings if appropriate, the date when the wastes was received, name and contact information of the transporter (including transporter identification number if available), the name of the person receiving and inspecting the wastes, any notes or observations on the condition of the wastes when received, any corrective actions taken (e.g., repackaging or re-labeling), the manifest or consignment note, and appropriate signatures.[1]

Records of accidents, spills, worker injuries, and chemical exposure should also be kept by the storage facility and made available to relevant government authorities.[1]

Due to the significant risk of adverse health effects resulting from exposure to mercury at the facility, a health surveillance or medical monitoring program should be established.[1]

4.9.2.1. Receiving area

The receiving area should have a sign to guide and instruct the wastes transporters.

The receiving area should have: a cart made of impervious material such as steel, rubber, or hard plastic (do not use aluminum carts); spill kits and emergency supplementary containers for leaking containers or broken packaging; PPE for the

staff; and a separate table or counter for signing documents.

A cart should be used to transfer the wastes to the inspection area and to move the wastes around the facility.

When receiving the wastes, the containers should go through an initial visual inspection to determine the condition of the packaging and containers without opening the primary and secondary containers. If a leak or breakage is suspected, the wastes should be brought immediately to the inspection area.[1]

4.9.2.2. Inspection area

Random check should be done to the secondary packaging of the mercury-containing medical measuring devices which have been sent to the storage depot. The check is carried out to examine the condition of secondary and primary packaging, symbols, labels and the mercury-containing medical measuring devices. If from the check it is found that there is damage on the secondary packaging, primary packaging, mismatch of information, broken mercury-containing medical measuring devices or mercury spills from the devices, check must be done to all mercury-containing medical measuring devices from the same healthcare facility.

Figure 4.23 **Example of bunding on the floor**

Source: https://www.allroundsafety.co.nz/product/durabund-150-floor-bunding.html

The amount of mercury wastes should also be validated such as weight and number of containers. If outer containers have to be opened to test for suspected leaks, this should be done under the fume hood (local exhaust ventilation). Mercury probes or detector tubes could also be used to verify suspected leaks.[1]

The inspection area should be located near the receiving and storage areas. Because of the possibility that leaking containers may be brought in, the inspection area should have engineered spill-control features including containment dikes or bunding on the floor.[1] (see Figure 4.23 for example).

The inspection area should have a mercury vapor detection probe, detector tubes, or other methods to detect leaking mercury containers[1].

The inspection area should have local exhaust ventilation, such as a fume hood or enclosed hood, built in accordance with national guidelines. Ideally, the hood should be connected to an activated carbon filter or other devices specifically designed to remove mercury before the air is discharged. The minimum average face velocity of the hood, when in use, should be about 0.5 meters per second.[1]

The inspection area should have a spill control tray or containment device over which the wastes should be inspected. The containment volume of the tray should be large enough to hold the maximum amount of liquid mercury expected by the facility to be received for inspection.[1]

The inspection area should have emergency supplementary containers to be used for leaking containers, packaging to replace broken or inadequate packaging, labels for re-labeling containers, spill kits, and PPE for the staff.[1]

4.9.2.3. Storage area

The storage area should be clearly marked with warning signs on all doors leading to the storage area. Copies of the spill response and emergency procedures should be on display in the storage area and kept with the spill cleanup kits and PPE.[1]

The storage area should have continuous or periodic monitoring of mercury levels in ambient air using mercury vapor monitors.[1]

Periodic monitors should sample mercury levels at least daily. The monitoring equipment should be able to detect mercury in air in parts per billion.[1]

The storage area should have engineered spill-control features to prevent mercury spills from exiting the area; these should include:

- Flooring that does not have cracks, seams, or other openings where mercury could get lodged in (See Figure 4.24 for example);
- A floor sealant system that is impervious to mercury and makes it easy to collect spilled mercury such as a durable (6 mm thick) plastic flooring or seamless epoxy-coated concrete (See Figure 4.24 for example);
- Suitable containment dikes incorporated into the floor sealant on all doors of the storage area.[1]

The storage area for mercury wastes should be routinely monitored, including daily readings of mercury levels in ambient air. Weekly inspections for leaks and corroded or broken containers, and improper methods of storage, as well as routine tests of the burglar alarms, fire alarms, fire suppression systems, and exhaust ventilation; and monthly inspections of the condition of the PPE and wash units, spill kit contents, flooring (to check for cracks), and files should be carried out. Inspection logs, including the inspection dates, observations, name, and signature of the inspector should be kept and made available to regulatory authority as may be required by law.[1]

During facility inspection, if a container is found to show signs of losing its physical integrity, the container should be removed from the shelf, carefully inspected under the fume hood, placed inside a supplementary container, and then re-labeled before being returned to the shelf.[1]

Mercury wastes from health facilities may be segregated according to the following risk categories based on the amounts of available mercury:

- Risk Level 1 (highest risk): elemental mercury and unbroken sphygmomanometers,
- Risk Level 2: unbroken mercury thermometers.[1]

Shelving and storage racks for Risk Levels 1 and 2 should be fitted with containment trays or shelves made of a material impervious to mercury such as

Figure 4.24 **Example of flooring (left) and floor sealant system (right)**

Source: WHO, 2020

steel. The containment volume of each tray should be at least 125% of the total volume of liquid mercury stored on the tray.[1]

Shelving and storage racks should be able to support the weight of mercury wastes and have back-and-side cross bracing or back-and-side panels to prevent sway. The shelves and racks should not be above shoulder height.[1]

In facilities that store other types of hazardous wastes, mercury wastes should not be stored near incompatible chemicals such as acetylene, alkali metals (lithium, sodium), aluminum, amines, ammonia, calcium, fulminic acid, halogens, hydrogen, nitric acid with ethanol, oxalic acid, and oxidizers.[1]

Lighting, aisle space, stacking, arrangements of containers, and placement of labels and markings should be designed to facilitate inspection of the storage area.[1]

The storage area should be designed to facilitate the transfer of mercury wastes to a long-term (terminal) storage facility or a treatment and disposal facility in the future.[1]

The storage facility should be a non-smoking facility. There should be no eating in the storage area.[1]

4.9.2.4. Administrative and record-keeping area

The administrative and record-keeping area should be separated from the receiving, inspection, and storage areas. Records should be maintained in good order and kept in a secure location.[1]

The administrative and record-keeping area should maintain copies of MSDSs and international chemical safety cards which should be readily available to the staff.[1]

4.10. Treatment

The discarded mercury-containing medical measuring devices stored at the storage depot must be treated by mercury recovery, encapsulation and/or other technology according to science development. If there is no available treatment facility, the discarded mercury-containing medical measuring devices can be exported.

4.10.1. Mercury recovery

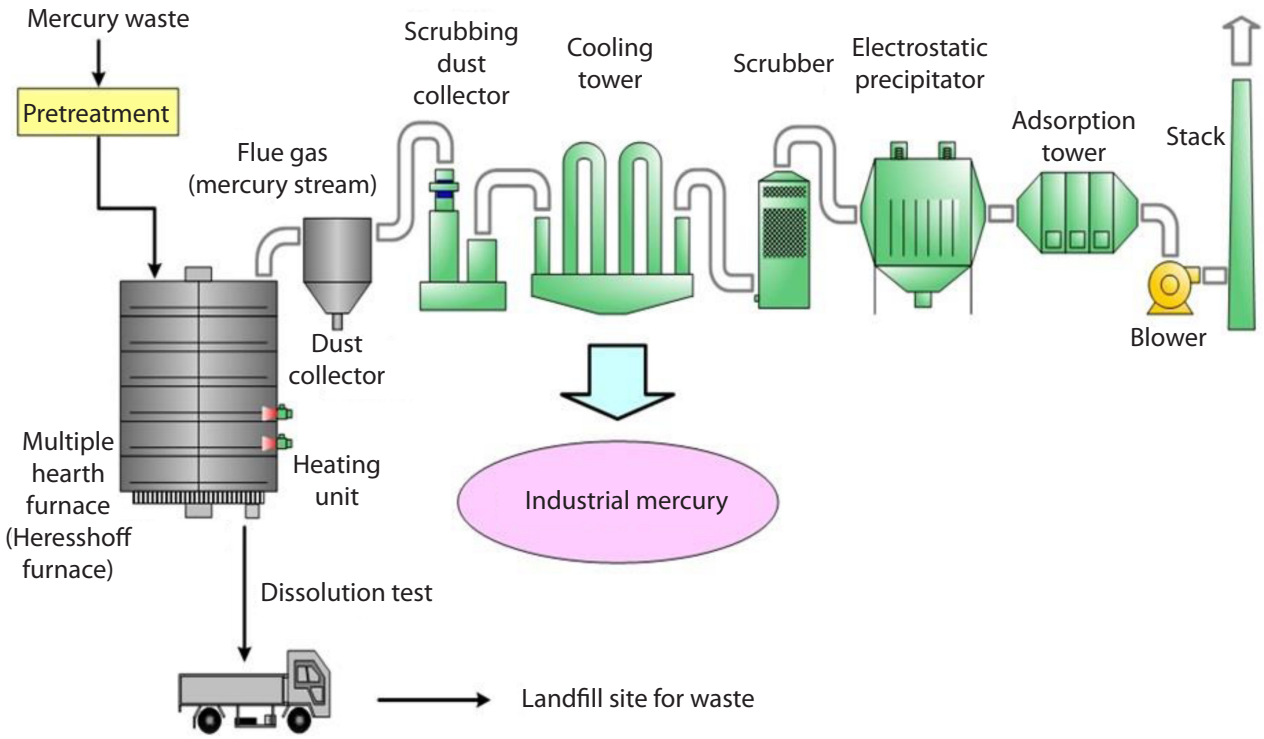
Recovery operations may lead to resource recovery, recycling, reclamation, direct re-use or alternative uses. Recovery/recycling of mercury wastes is an essential component of ESM. Where the mercury is recovered for subsequent reuse, this is referred to as a recovery operation. By contrast, where the mercury is extracted for subsequent disposal operations, this is referred to as physico-chemical treatment. The same or similar processes are used in both cases.[14]

Recovered mercury can only be used for the purposes allowed under national and international law, including the Minamata Convention, where applicable. An additional advantage of recovery/recycling is that it may help to decrease the volume of the wastes.[14]

Mercury recovery from solid wastes generally comprises: (1) pre-treatment; (2) thermal treatment; and (3) purification as shown in Figure 4.25 below. In order to minimize mercury emissions from the mercury recovery process, facilities should employ closed systems. The entire process should take place under reduced pressure in order to prevent leakage of mercury vapour into processing areas (Tanel, 1998 as cited in the Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2015). The small amount of exhaust air that is emitted in the recovery process must pass through a series of particulate filters and a carbon bed that absorbs the mercury before the air is released into the environment.[15]

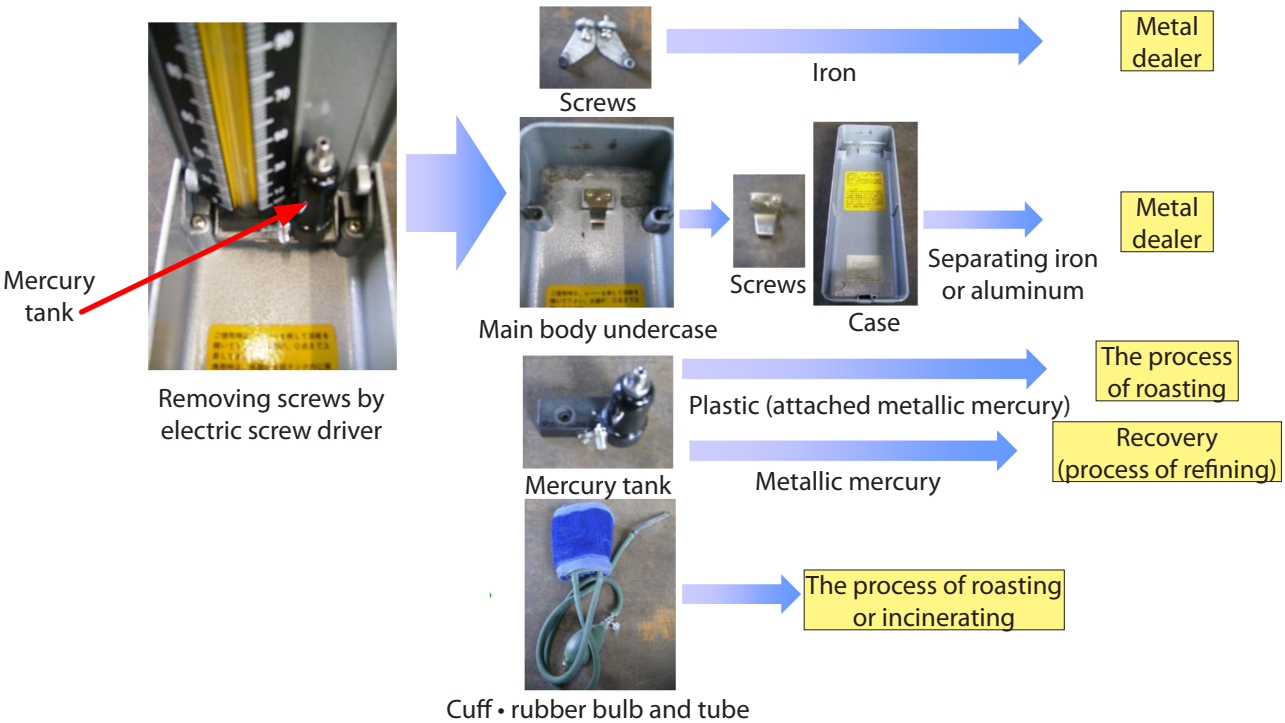
Examples of mercury wastes whose recovery can generate mercury emissions are mercury-added equipment that easily releases mercury into the environment when broken and wastes

Figure 4.25 **Flow of mercury recovery from solid waste**



Source: Nomura Kohsan Co. Ltd 2007, as cited in the Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2015

Figure 4.26 **26 Example of pre-treatment of recovered mercury**



Source: Nomura Kohsan Co. Ltd (2021)

contaminated with high mercury concentrations. The former includes measuring devices containing mercury (thermometers, sphygmomanometers, and manometers) and mercury switches and relays, and could also include mercury-added lamps.[15]

It should be noted that non-thermal processes are also being used for recovery/recycling of mercury wastes, such as chemical oxidation, chemical precipitation, or adsorption treatment. If crushing of mercury added products is a necessary part of recovery, crushing should be conducted to prevent or minimize worker exposure and releases of mercury into the environment.[14]

The Basel Convention Technical guidelines on the environmentally sound recycling/reclamation of metals and metal compounds (R4) focus mainly on the environmentally sound recycling and reclamation of metals and metal compounds, including mercury, that are listed in Annex I to the Convention ("Categories of wastes to be controlled"). It is possible to recycle mercury wastes, particularly those consisting of mercury or mercury compounds, in special facilities with advanced mercury-specific recycling technologies. It should be noted that appropriate procedures should be employed in such recycling to prevent any releases of mercury into the environment.[15]

4.10.2. Encapsulation

Encapsulation is one of the most common technologies to treat medical wastes. As mentioned in Permen LHK P.56/2015, the encapsulation process is principally solidifying wastes to prevent leaching of the wastes and prevent the risk of wastes being accessed by scavengers. Encapsulation is carried out by placing the amount of wastes 2/3 of the container volume and then adding immobilizing material until the container is full. The immobilizing material can be bituminous sand and/or cement. The container can be high density polyethylene (HDPE) or metal drum. After the material is dried, the container is sealed and disposed of in a hazardous wastes landfill.

4.11. Export

The export of mercury wastes for environmentally sound disposal is an effective option for countries without the necessary infrastructure. For example, Indonesia has a significant gas extraction industry. This sector generates large amounts of wastes contaminated with mercury, including catalysts. No recovery/recycling facility was domestically available. The spent catalysts, contaminated with up to 15% of mercury, are exported to companies in Switzerland and the Netherlands for recovery/recycling.[14] Japan also imports mercury waste including spent catalysts from Indonesia.

Export may also be the preferred choice for countries with relatively small amounts of mercury wastes or where the establishment and operation of dedicated facilities are considered too costly. Some countries may see export as an interim solution until domestic facilities become available.[14]

Indonesia is a Party to the Basel Convention and Minamata Convention. Under the Basel Convention, Parties shall take the appropriate measures to ensure that the transboundary movement of hazardous wastes and other wastes only be allowed under certain circumstances as follows:

- The State of export does not have the technical capacity and the necessary facilities, capacity or suitable disposal sites in order to dispose of the wastes in question in an environmentally sound and efficient manner; or
- The wastes in question are required as a raw material for recycling or recovery industries in the State of import; or
- The transboundary movement in question is in accordance with other criteria to be decided by the Parties, provided those criteria do not differ from the objectives of the Basel Convention.[16]

Transboundary movement of hazardous wastes and other wastes must also follow the procedure of Prior Informed Consent (PIC) under the Basel Convention.

Under Article 11 paragraph 3.c of the Minamata Convention, each Party shall take appropriate measures so that mercury wastes is: for Parties to the Basel Convention, not transported across international boundaries except for the purpose of environmentally sound disposal in conformity with this Article and with that Convention. In circumstances where the Basel Convention does not apply to transport across international boundaries, a Party shall allow such transport only after taking into account relevant international rules, standards, and guidelines.[17]

According to PP 22/2021, hazardous wastes can be exported if there is no technology for the hazardous wastes utilization and/or treatment domestically. For export, hazardous wastes generators should apply a written request for notification to the Minister of Environment and Forestry, inform of the export travel route which will be taken, fill the hazardous waste export notification form and have hazardous wastes export permit.

The Minister of Environment and Forestry then sent notification to the competent authority of the importing country and transit country based on the request for notification from the hazardous wastes generators. The notification at least includes identity of the applicant, the identity of hazardous wastes, identity of the hazardous wastes importer at the destination country, the name, the characteristics and amount of the hazardous wastes to be exported, and the time of export. If the notification is consented by the competent authorities of importing country and transit country, the Minister of Environment and Forestry then issues a recommendation for hazardous wastes export. This recommendation becomes the basis for the issuance of hazardous wastes export permits by the Minister of Trade. Requirements and procedures for the application and issuance of the export of hazardous wastes are carried out according to the provisions of national regulations.

4.12. Monitoring

Monitoring on the implementation of the discarded mercury-containing medical measuring devices is conducted by:

- Head of regent/mayor and governor for monitoring on the discarded mercury-containing medical measuring devices stored at the temporary storage facility. The result of the monitoring is submitted to the Minister of Environment and Forestry.
- The Minister of Environment and Forestry for monitoring on the discarded mercury-containing medical measuring devices stored at the storage depot.

Figure 4.26 **Example of QR code**

Source: DanWHS, 2021

The Minister of Environment and Forestry evaluates on the effectiveness of the discarded mercury-containing medical measuring devices management as the reporting material of mercury-containing medical measuring devices elimination to the President of the Republic of Indonesia. The monitoring evaluation is carried out on the number, secondary packaging, symbols, and label.

An online system could be used to monitor the movement of the mercury-containing medical measuring devices. In response to the RAN-PPM, one of the initiative activities conducted by BPPT is to develop a system of mercury monitoring called SIPAMER. The system is a website and android-based platform and has the main function of conducting monitoring of mercury collection process from the health sector and ASGM sector. The system's main features are reporting of existence or ownership of the mercury-containing medical measuring devices, monitoring of picking-up from user to storage depots and warehouse management system (WMS) with radio-frequency identification (RFID).

The flow of the online system which could be used based on the flow of SIPAMER for mercury-containing medical measuring devices is as follows:

- Initial reporting

  User reports their ownership of mercury-containing medical measuring devices to the website of SIPAMER by filling a form.

- Verification of reporting

  The central admin verifies the report and conveys it to the nearest responsible officer from the location of the reporter.

- Pre-Picking up.

  The nearest responsible officer receives the reporting notification and prepares picking-up from the reporter to the agent.

- Picking-up

  The agent receives the task notification from SIPAMER android application and conduct the picking-up. The mercury-containing medical measuring devices are stored in the primary and secondary packaging which have been developed by BPPT as described in Section 4.4.1 and 4.4.2 and attached with a Quick Response (QR) code (see Figure 4.26 for example) for transportation to the storage depot.

- Data recording

  At the storage depot, the data of the container is recorded and attached with RFID for easy checking.

At the time of development of these guidelines, the information system concept is under discussion with MOEF for adjustment with the requirements under Permen LHK 27/2020.

4.13. Financing

Financing the implementation of the discarded mercury-containing medical measuring devices management, which covers transportation, storage at the storage depot, treatment, and export, comes from APBN and APBD according to the provisions of national regulations.

4.14. Other requirements

The new regulation, Permen LHK 27/2020, specifies that the management of the discarded mercury-containing medical measuring devices which covers internal collection, temporary storage, transportation, storage at storage depot, treatment; and/or export is to be carried out by 31 December 2025 at the latest. The discarded mercury-containing medical measuring devices which have not been managed beyond the abovementioned date must be managed according to the national regulations for hazardous wastes management.

4.15. Stakeholders involved

The stakeholders responsible in the elimination and withdrawal of the unbroken mercury-containing medical measuring devices involve the healthcare facilities, hospitals owned by central government or local government, Ministry of Health, Ministry of Environment and Forestry, governor, head of regent/mayor, local health agency and local environmental agency at provincial/regency/city level, transportation service and treatment facility. Their tasks and responsibilities can be seen in Appendix 3.

5

ENVIRONMENTALLY SOUND MANAGEMENT OF BROKEN MERCURY-CONTAINING THERMOMETERS AND SPHYGMOMANOMETERS

5.1. General information

Under Permenkes 41/2019, mercury-containing medical measuring devices from healthcare facilities are divided into two categories with separate management, namely the broken mercury-containing medical measuring devices and the non-broken/still intact mercury-containing medical measuring devices. For broken mercury-containing medical measuring devices, Permenkes 41/2019 regards them as hazardous wastes, and the management refers to the existing national regulations on hazardous wastes.

5.2. Handling of mercury spills

Requirements and procedures for handling and clean-up mercury spills from broken mercury-containing medical measuring devices have been regulated under Permenkes 41/2019. Most of the content in these sections is taken from the regulation. However, information from the UNDP-GEF Guidance[1] is also included in these guidelines to provide additional information that might be useful to the guidelines users in handling mercury spills.

Figure 5.1 **Example of mercury spill-kit**

Source: https://www.indiamart.com/proddetail/mercury-spill-kit-15855940255.html

5.2.1. Spill Kit

Spillage handling must be done immediately to prevent mercury from evaporating. Therefore, every officer in the unit/ward must be knowledgeable of the emergency measures for handling spills and able to use a spill kit before trained personnel come to clean up the spill.

Equipment for handling mercury spills must be budgeted and provided in every ward and room that uses a mercury medical device in a healthcare facility. Mercury spill kit can be purchased or made in the form of a set of equipment for every 20 beds in a healthcare facility and should be replaced once used. An example of a mercury spill kit is shown in the figure below.

Mercury spill kits consist of:

- Standard Operating Procedure (SOP) Sheet;
- a sign to warn of a mercury spill;

Personal protective equipment (PPE)

- goggle;
- masks (minimum N 95. N stands for “Non-Oil”, to be used when no oil is present in the air. 95 means the filter removes 95% of 0.3+ micron particles.18, 19 See Figure 5.2. for example.)
- apron;
- vinyl/ latex gloves;
- disposable shoe covers;

Containers

- air-tight, sealable plastic bags (small and large sizes, thickness : 2 to 6 mils or 50 to 150 microns)
- a container for storing mercury spills partially filled with some water or vapor suppression agent. This container must be puncture-resistant, leak-proof, melt-resistant, not easily broken, sturdy, strong, tightly closed, and labeled;
- a puncture-resistant, leak-proof, tightly closed and labeled plastic or steel jar or container for collecting mercury-contaminated broken glass pieces;
- a container for tools contaminated with mercury. These containers must be puncture resistant, leak-proof, tightly closed and labeled;
- plastic tray;
- regular plastic wastes bags (thickness: 2-6 mils with ties to seal the plastic);

Tools for removing mercury

- tweezers or forceps to remove small broken glass pieces;
- eyedropper or syringe (without the needle) to draw up mercury beads;
- alloy wool;
- 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 dust pan to collect mercury beads;
- brush;
- a flashlight;
- duct tape;

Vapor suppression agents

- sulphur powder, calcium hydroxide powder to absorb mercury (See Figure 5.3 for example);
- absorbent cloth (made from absorbent/ sponge);

Materials for decontamination

- decontaminant solution or commercial decontaminant;
- paper towels/thick tissue;
- piece of soap;
- stickers and felt-tip marker for writing labels.

Figure 5.2 **Example of an N95 Mask**

Source: BSCRC-SEA, 2021

Figure 5.3 **Example of sulphur powder**

Source: Royal Society of Chemistry, edu.rsc.org

5.2.2. Prevention of mercury spread

Prior to handling mercury spills, the main steps to prevent mercury spread and identification of the extent of mercury spills must be carried out as follows

1. Contain the spill:
   If necessary, prevent the mercury beads from traveling further by blocking their path with rags or impervious material. Take steps to keep mercury from falling into drains or cracks. Check to see if anyone's skin, shoes or clothing was splashed with mercury. If shoes, or parts of clothing were contaminated, they should be removed and left around the spill area before allowing the person to leave. Skin that was in contact with mercury should be washed with an alkaline soap.

2. Evacuate the spill area:
   Ask every person to leave the room or the spill area to another place far from the room or the area, giving priority to pregnant women and children. Seek assistance to provide first-aid to anyone requiring immediate medical attention.

3. Close all interior doors leading to other indoor areas:
   Close all interior doors that lead to other indoor areas to minimize the spread of vapors to interior areas. Turn off central ventilation, heating or air conditioning that circulates air from the spill site to other inside areas of the building.

4. Air the room or area to reduce vapor concentration:
   After ensuring that windows and exterior doors are open to outside areas that are free of people, open the windows and exterior doors to dilute the vapor concentrations in the room.

5. Prevent access to the area:
   Put up signs and, if necessary, seeking help from other staff persons, and then leave the area to prepare for cleanup.

5.2.3. Handling of large mercury spills

Procedures for handling large spills of mercury (more than 2 (two) tablespoons) are as the following:

- Turn off air conditioning system;
- Evacuate the room or spill area;
- Put up sign warning that the place is being isolated and no one allowed to enter except trained personnel;
- Report the incident to trained personnel to handle it;
- Record and report to relevant local governmental agencies.

5.2.4. Handling of small mercury spills

Procedures for handling small mercury spills are as the following

1. Prepare for cleanup:
   Remove jewelry, mobile phone, watch and other objects containing metal, take a spill kit, use the mask, gloves, goggles, apron, and shoe wrapping.

2. Remove broken glass pieces:
   Use tweezers or forceps to carefully remove the broken glass pieces, secure the broken glass pieces and wrap them in a puncture-resistant container (securing broken glass). Place the container into a sealable plastic bag.

3. Remove visible mercury beads:
   - Place the jar and container on the plastic tray. Carefully remove visible mercury beads starting from the outside of the spill site and moving towards the center. Using a playing card or piece of plastic, slide the mercury beads onto the plastic dustpan or scoop, and away from any carpet or porous surface. Use a slow, short, sweeping motion to prevent spreading mercury droplets. Carefully place the mercury beads into the plastic container partially filled with water or vapor suppression agents. Do this over the tray to catch any spillage.

   - Eyedropper or syringe can also be used to remove mercury. Hold the eyedropper or syringe almost parallel to the floor to draw in the beads and keep the eyedropper or syringe horizontal when transferring the beads to a container to prevent the mercury from falling out. Try to get as much mercury beads as possible and carefully place them into the container. The container must be resistant to breaking, not melting, sturdy, strong, and can be tightly closed. Close the lid of the container and make sure it closes properly and safely, then seal the container so that there is no release of mercury vapor from the container. Place the container into a sealable plastic bag.

4. Remove hard-to-see beads:
   - Take a bottle containing sulfur and a bottle containing calcium hydroxide. Apply the powder to the floor leading to the spill and mercury beads. This is to reduce mercury contamination. To make it easier, use a flashlight to see where mercury is scattered. Shine the flashlight at a different low angle and the beads of mercury will reflect the light from the flashlight.

   - Using a scoop, mix the powder with spilled mercury. Mercury will be mixed with the powder into a pseudo amalgam gray color in about two minutes. The beads of mercury will disappear slowly.

   - Using a brush and scoop, remove the contaminated powder and put the contaminated powder in a container. Close the container lid tightly. Place the container into a sealable plastic bag.

   - There will be three containers from this cleanup activity, namely container of broken glass pieces of medical devices, container of mercury and container of contaminated powder. Broken glass pieces of medical devices will be treated with hazardous wastes treatment, but for mercury and contaminated powder, they will be stored safely.

5. Dispose of or decontaminate cleanup material:
   Place all contaminated materials used during the cleanup (including cards, plastic pieces, cardboard, paper towels/thick tissue, piece of soap, brush) into a leak-proof, sealable plastic bag. Other items (tweezers, scoop, syringe, etc.) should either be disposed of with the contaminated items in the sealable plastic bag or cleaned thoroughly with the decontaminant solution. The contaminated materials will be treated with hazardous wastes treatment.

6. Label the containers:
   Put writing on the containers: DANGER! MERCURY WASTES. Use picture labels that indicate the containers are dangerous containers of mercury.

7. Remove and dispose or decontaminate PPE:
   Remove PPE beginning with the shoe covers which should be placed in another sealable bag. Then remove the gloves by grasping one glove with the other, peeling off the first glove, sliding the fingers under the remaining glove at the wrist, peeling off the second glove, and discarding both gloves in the sealable plastic bag. Next, remove the goggles by the headband or ear pieces. Remove the apron or coverall without touching the front and turn inside out. Finally, remove the face mask or respirator without touching the front. Dispose of the gloves, shoe covers, apron (and regular face mask if used in lieu of a specialty mask) in the sealable plastic bag. The disposed PPE will be treated with hazardous wastes treatment. Decontaminate goggles and respirators or specialty face mask using the decontaminant solution.

8. Wash hands and all exposed skin:
   Use soap and water to scrub all exposed skin and rinse thoroughly.

9. Removal of containers containing mercury and mercury-contaminated equipment:
   Immediately send containers containing mercury and mercury-contaminated equipment to the unit/installation responsible for handling the wastes of the healthcare facility.

10. Post clean up:
    Keep windows open for 24 hours (where applicable) to ventilate the area after the cleanup. After ensuring all the mercury has been disposed, resume routine cleaning operations.

5.2.5. Cleanup of small mercury spills in cloth/carpet

Procedures for cleanup of small mercury spills in cloth/carpet are as the following:

1. Do steps (1) until (3) for handling of small mercury spills;
2. If there are still small mercury beads, take alloy wool with a diameter of 2.5 cm;
3. Use alloy wool like using a cotton bud, stick it to the mercury beads scatter. Keep alloy wool in contact with mercury. Do not press hard, to avoid mercury entering and absorb into the carpet. The mercury will fill the gap between the alloy wool and form an amalgam;
4. If the alloy wool is no longer able to absorb and there is mercury spilled from the alloy wool, use another alloy wool, do the same the steps in steps number 2) and 3) above;

5. Put the alloy wool in the container and close the lid tightly; There will be three containers from this cleanup activity, namely containers of broken medical devices, containers of mercury and containers of contaminated powder. Broken glass pieces of medical devices will be treated with hazardous wastes treatment, but for mercury and contaminated alloy wool, they will be stored safely;
6. Do steps (5) until (10) for handling of small mercury spills.

5.2.6. Decontamination on hard floor

Procedures for cleanup of small mercury spills on hard floor are as the following:

1. Wear gloves, goggles, and mask;
2. Prepare a bucket of water and mix a drop of liquid cleaner and sulfur and calcium hydroxide each two bottle caps, stir until mixed well;
3. Clean the floor from the rest of the mercury that has been contained and after cleaning, clean again with water as usual.

5.2.7. Clean out contaminated drains

If mercury was spilled over a drain, sink or wash basin, work with the facility engineer to remove and replace the "J", "U" or "S" trap. Put a sheet of plastic or plastic tray under the work area to catch any mercury that might spill out. Hold the old trap over a tray while transferring the mercury to the air-tight container. Dispose of the old trap as hazardous wastes.

The following should NOT be done in the event of a spill:

- Do not touch mercury with bare hands.
- Do not use a vacuum cleaner to clean up mercury. Vacuuming a mercury spill will increase the mercury vapour in the air and increase the likelihood of human exposure. Any vacuum cleaner used for cleanup will become contaminated and will need to be discarded as hazardous wastes.
- Do not wash mercury-contaminated clothing, rugs or other fabrics in a washing machine. The washing machine and wastewater may become contaminated.
- Do not burn shoes, clothing, fabric or anything that has been contaminated with mercury as this puts mercury into the atmosphere.
- Do not use a broom to sweep mercury. The broom will break the mercury into smaller droplets and spread them around a larger area, making it hard to find and pick up.
- Do not pour mercury down a drain. This could contaminate the plumbing system and the sewage disposal system.
- Do not dispose of mercury into a clinical bin, sharps bin or the dust bin.
- Do not walk around the house in shoes or clothes that may have become contaminated with mercury.

5.2.8. First aid in mercury spills incident

Mercury is a metal that does not dissolve in water so if any part of the body is exposed to splashes or spills of mercury it must be immediately cleaned. Mercury is harmful to humans and the environment so early vigilance is very important in the workplace.

The first aid measures that need to be taken if affected by a mercury spill are as follows:

1. The part of the body with direct contact with mercury must be cleaned as soon as possible with running water. Use soap and running water to rub all the affected skin and rinse thoroughly;
2. Clothing or anything worn by officers suspected of being exposed to mercury must be removed immediately;
3. The officer must immediately report the incident of mercury exposure to the authorized work unit;
4. Officers affected by mercury exposure must fill out an incident form regarding the work accident clearly and completely and submit it to the authorized unit/installation (the incident documents are in accordance with the procedures of the healthcare facility);
5. The unit /installation will verify the report and immediately follow up with a doctor who is appointed to handle cases of work-related accidents/illnesses;
6. The doctor will conduct medical monitoring; and
7. If a spill causes acute exposure to a patient or health care facility staff, blood and urine tests will be performed.

5.3. Mercury wastes on-site temporary storage

All medical wastes including mercury, must be collected, and stored temporarily until they are transported to a collection and treatment and/or disposal location. Requirements including licensing for the temporary storage of hazardous wastes, including mercury wastes at healthcare facilities, are regulated under the current or the latest national laws and regulations in Indonesia when these technical guidelines are developed, among others, as follows:

- Law Number 32 Year 2009 concerning Environmental Protection and Management;
- Law Number 11 Year 2020 concerning Job Creation or the Omnibus Law;
- Government Regulation Number 5 Year 2021 concerning Implementation of Risk-Based Business Licensing;
- Government Regulation Number 22 Year 2021 concerning Implementation of Environmental Protection and Management (PP 22/2021);
- Minister of Environment and Forestry Regulation Number P.56/MENLHK-SETJEN/2015 concerning Procedure and Technical Requirement for Hazardous Wastes Management from Healthcare Facilities (Permen LHK P.56/2015);
- Minister of Environment and Forestry Regulation Number P.74/MENLHK/SETJEN/KUM.1/10/2019 concerning Hazardous Substances and/or Hazardous Wastes Management Emergency Response Program (Permen LHK P.74/2019);
- Minister of Health Regulation Number 7 Year 2019 concerning Environmental Health in Hospitals (Permenkes 7/2019);
- Minister of Environment and Forestry Regulation Number P.12/MENLHK/SETJEN/

PLB.3/5/2020 concerning Storage of Hazardous Wastes (Permen LHK P.12/2020).

According to PP 22/2021, in order to be able to conduct storage of hazardous wastes, a hazardous wastes generator must fulfill the following :

Hazardous wastes storage standards which are integrated into the business identification number, for a generator from business and/or activities which must have Statement of Environmental Management and Monitoring Undertaking; and/or

Hazardous wastes storage technical details stated in the environmental approval for :

- A hazardous waste generator from business and/or activities which must have an Environmental Impact Assessment or Environmental Management Efforts and Environmental Monitoring Efforts; and
- A government institution generating hazardous wastes.

Mercury-containing medical measuring devices are categorized in Annex IX of PP 22/2021 under the list of hazardous wastes from general specific sources with code A 337-5 and danger category 1.

Guideline users should first refer to the applicable national regulations relevant to administrative and technical requirements for establishing temporary storage hazardous wastes at healthcare facilities.

Specific requirements for storage of mercury wastes from healthcare facilities[1] can also be implemented as in the following sections.

5.3.1. Storage space design requirements and procedure

The storage space should have ventilation that can eject air from the space directly to the outside and ventilation controls that can stop air circulation from the storage space to the inside of the facility. The exhaust vent from the storage space should not direct air towards crowded areas and should be far from any air intake vents. The storage space should be kept cool and dry at room temperature.[1]

The storage space should be inspected every month to check for leaks, corroded or broken containers, improper storage methods, ventilation, the condition of the PPE and wash area, and updated records.[1]

5.3.2. Storage of mercury-contaminated wastes

Mercury-contaminated wastes that include broken glass or other items with sharp edges or points (e.g., broken thermometers) should be placed in a primary container that is puncture-resistant and air-tight. As a redundant safety measure, the primary container should be placed in a secondary container that further prevents the release of mercury vapor.[1]

Mercury-contaminated wastes that do not contain sharp edges or points or do not result

Figure 5.4 **Examples of a primary container (plastic bottles) and a secondary container (sealable thick plastic bag) for mercury-contaminated broken glass pieces**

Source: BSCRC-SEA, 2020

in sharp edges or points when dropped or smashed (e.g., contaminated rags, paper towels, or pieces of carpet) should be placed in an airtight primary container. As a redundant safety measure, the primary container should be placed in a secondary container that further prevents the release of mercury vapor.[1] Example of a primary container and a secondary container for mercury-contaminated broken glass pieces can be seen in Figure 5.4.

The primary container should be marked with the type of mercury wastes, the estimated amount, the date the material was placed in the container, and additional description if necessary. If the secondary container is not transparent or the label on the primary container cannot be seen, a label should also be placed outside the secondary container.[1]

5.4. Symbol and labeling

Provisions for using symbols and labeling of hazardous wastes for hazardous wastes packaging and/or container, hazardous wastes storage facility and transporter, and hazardous wastes export activity are regulated under Permen LHK 14/2013.

Hazardous wastes symbols for mercury wastes symbolize toxic wastes, corrosive wastes, and hazardous to the environment. More information on hazardous wastes symbols and labels is regulated under Permen LHK 14/2013. The Figure below show the symbols used for mercury wastes.

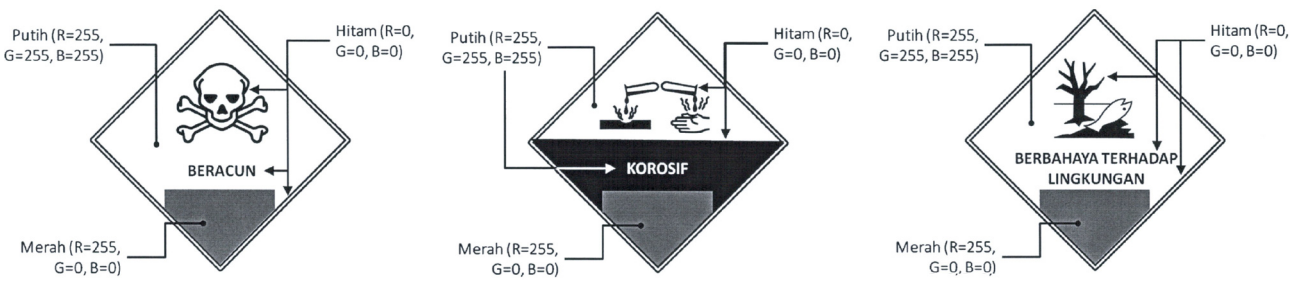
5.5. Off-Site transportation

Under Permenkes 41/2019, transportation of broken mercury-containing medical measuring devices is to be carried out as follows:

- Withdrawal of broken mercury-containing medical measuring devices and mercury spills from the medical devices uses hazardous wastes transporters according to regulatory framework;
- Transportation of mercury wastes from healthcare facilities must be carried out by licensed hazardous wastes transporters according to regulatory framework.

The national environmental regulations are relevant to hazardous wastes transportations, namely PP 22/2021, Permen LHK P.56/2015 and Permen LHK P.4/2020 , covering mercury wastes transportation as hazardous wastes or hazardous medical wastes in general. Use of symbol and label for each packaging and/or container during off-site transportation of hazardous wastes refers to Permen LHK 14/2013. Medical devices contaminated with mercury are categorized as hazardous wastes category 1 and should be transported with a closed vehicle.

Figure 5.5 **Toxic symbol (left), corrosive symbol (middle) and hazardous to the environment (right)**



Source: MoEF, 2013

According to PP 22/2021, a hazardous wastes transporter must have a hazardous wastes transportation recommendation and business license in hazardous wastes transportation field. The recommendation from the Minister of Environment and Forestry is the basis for the issuance of the business license in the hazardous waste transportation field from the Minister of Transportation. The hazardous wastes transporter who has received the business license must conduct the transportation of the hazardous wastes as set out in the recommendation and the business license. They also should submit manifest of hazardous wastes transportation electronically and report hazardous wastes transportation implementation to the Minister of Environment and Forestry with a copy to the Minister of Transportation at least once every six month.

Specific vehicle and their operational requirements are covered under the current or the latest national transportation regulations for hazardous substances or dangerous goods when these technical guidelines are developed, among others, as follows:

- Law Number 17 Year 2008 concerning Shipping;
- Law Number 1 Year 2009 concerning Aviation;
- Law Number 22 Year 2009 concerning Traffic and Road Transport;
- Government Regulation Number 74 Year 2014 concerning Road Transport;
- Government Regulation Number 30 Year 2021 concerning Implementation of Traffic Field and Road Transport;
- Minister of Transportation Regulation Number PM. 90 Year 2013 concerning Safety of Transportation of Dangerous Goods By Airplane as amended by Minister of Transportation Regulation Number PM. 58 Year 2016;
- Minister of Transportation Regulation Number PM. 29 Year 2014 concerning Maritime Environment Pollution Prevention;
- Minister of Transportation Regulation Number PM. 48 Year 2014 concerning Procedures for Loading, Arranging, Transporting and Unloading Goods By Train as amended by Minister of Transportation Regulation Number PM. 52 Year 2016;
- Minister of Transportation Regulation Number PM. 60 Year 2019 concerning Implementation of Transportation of Goods By Motor Vehicle on the Road;
- Minister of Environment and Forestry Regulation Number P.4/MenLHK/ Setjen/ Kum.1/1/2020 concerning Transportation of Hazardous Wastes (Permen LHK P.4/2020);
- Minister of Transportation Decree Number KM. 17 Year 2000 concerning Guidelines for Handling Dangerous Material/Goods In Shipping Activities in Indonesia as amended by Minister of Transportation Regulation Number: KM. 02 Year 2010.
- Director General of Land Transportation Decision Letter No. SK.725/AJ.302/DRJD/2004 concerning Transportation of Hazardous Substances on The Road;
- Circular Letter of Director General of Sea Transportation Number UM. 003/1/2/DK-15 concerning Hazardous Wastes Transportation for Ship Carrying Indonesian Flag.

The current national regulations for hazardous wastes and hazardous medical wastes transportation are considered already sufficient for the mercury wastes from healthcare facilities to be treated as hazardous wastes according to Permenkes 41/2019 which includes broken pieces of mercury-containing medical measuring devices and equipment and PPE from clean-up of mercury spill. The national regulations have requirements for transporters to be equipped with equipment for hazardous wastes handling and procedures for hazardous wastes handling during emergency situations and general requirements including fire extinguisher, first-aid kit and emergency contact.

Specific requirement for transporting mercury wastes is that empty air-tight containers,

plastic bags, PPE, cleaning equipment, and decontaminating agents should be carried in a separate compartment in the vehicle for use in case of a spill.[1]

5.6. Manifest system

The national regulations requires the manifest system under PP 22/2021, Permen LHK P.56/2015, and Permen LHK P.4/2020. Under PP 22/2021, transporters who have received a business license for hazardous wastes transportation must submit hazardous waste transportation manifest electronically to the Minister of Environment and Forestry. Detail and use of the manifest are further regulated under the Ministerial Regulation.

Under Permen LHK P.4/2020, hazardous wastes transportation must be accompanied by manifest electronics (*e-manifest*). This e-manifest is used by the hazardous wastes transporter and generator, collector, utilizer, treater and/or disposer. The use of e-manifest is by filling the data of the transported hazardous wastes. Use of e-manifest by the hazardous wastes generator, utilizer, treater, collector and/or disposer is to confirm the data filled by the hazardous wastes transporter. If the transportation of the hazardous wastes is conducted in multi modes, data filling of the transported hazardous wastes is done by the hazardous wastes transporter who transports the hazardous wastes first. The e-manifest is filled online at: http://festronik.menlhk.go.id.

Obligation to use e-manifest is excluded for hazardous wastes transportation conducted by hazardous wastes generators in the same business work area and/or activity and through public roads, hazardous wastes transportation for export and hazardous wastes transportation for research purpose.

The regulations oblige that the generator and the licensed transporter should keep a copy of the manifest or consignment note, however, there is no specific requirement on the duration. It could be considered that the generator should keep a copy of the manifest or consignment note for at least five years from the date of shipment. The licensed transporter should keep a copy of each shipment's manifest and other for at least five years from the date of shipment.[1]

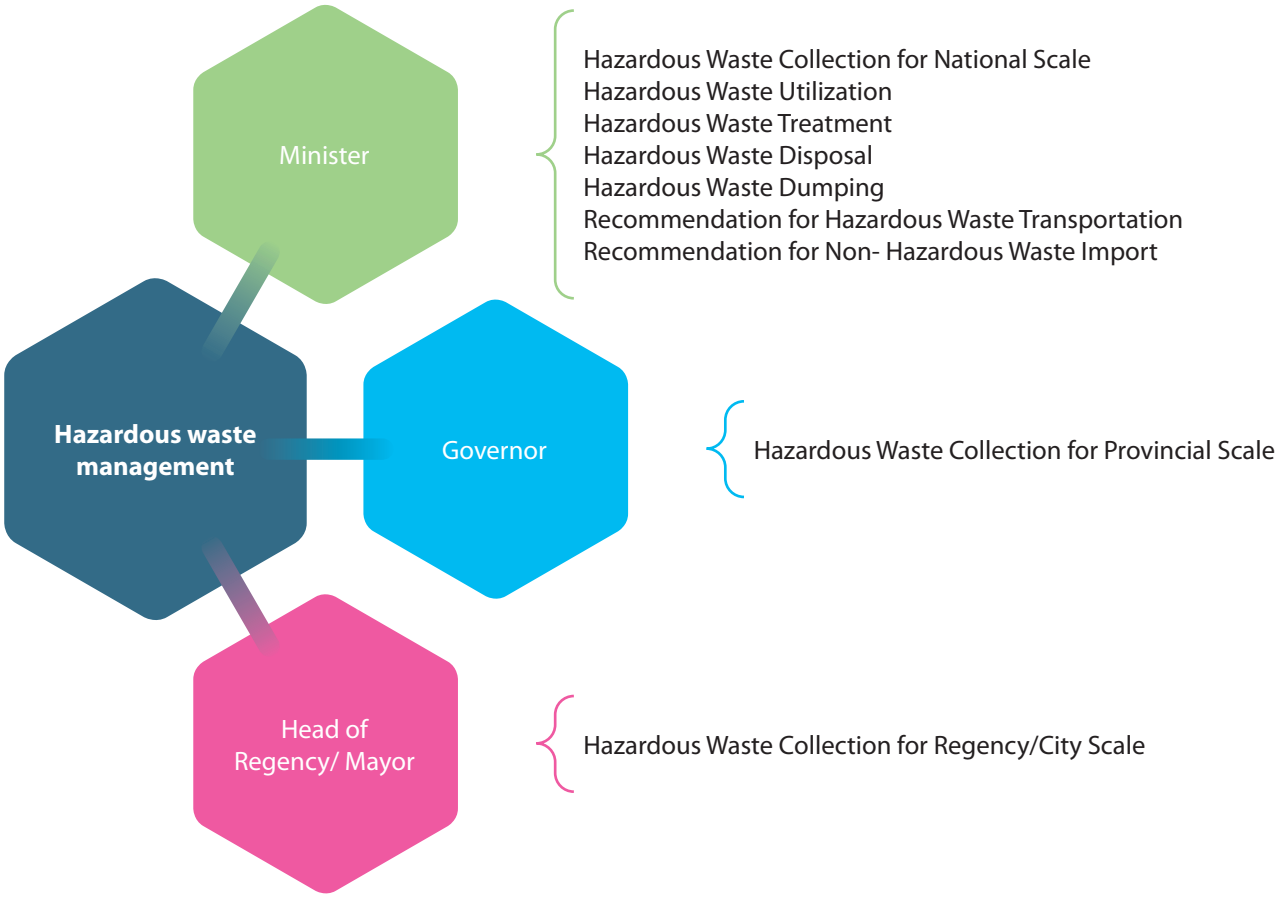
5.7. Collection/intermediate storage

Hazardous wastes collection is an activity of collecting hazardous wastes from a hazardous wastes generator before they are transferred to hazardous wastes utilizer, treater and/or disposer.

Requirements including licensing for collection facility/intermediate storage of hazardous wastes which include mercury wastes from healthcare facilities are regulated under the current or the latest national laws and regulations in Indonesia when these technical guidelines are developed, among others, as follows:

- Law Number 32 Year 2009 concerning Environmental Protection and Management;
- Law Number 11 Year 2020 concerning Job Creation or the Omnibus Law;
- Government Regulation Number 5 Year 2021 concerning Implementation of Risk-Based Business Licensing;
- Government Regulation Number 22 Year 2021 concerning Implementation of Environmental Protection and Management (PP 22/2021);
- Minister of Environment and Forestry Regulation Number P.56/MENLHK-SETJEN/2015 concerning Procedure and Technical Requirement for Hazardous Wastes Management from Healthcare Facilities (Permen LHK P.56/2015);
- Minister of Environment and Forestry Regulation Number P.74/MENLHK/SETJEN/KUM.1/10/2019 concerning Hazardous Substances and/or Hazardous Wastes Management Emergency Response Program (Permen LHK P.74/2019);

Figure 5.6 **Division of the government's authority for issuance of hazardous wastes management technical approval, letter of operational feasibility and recommendation**



- Minister of Environment and Forestry Regulation Number P.12/MENLHK/SETJEN/PLB.3/5/2020 concerning Storage of Hazardous Wastes (Permen LHK P.12/2020).

According to PP 22/2021, a hazardous wastes collector must have an environmental approval and business license for hazardous waste management business field activity. In order to get the environmental approval, a hazardous wastes collector must have a hazardous wastes management technical approval. For hazardous waste collectors who are still constructing their collection facility, they should prepare and submit a report of hazardous wastes facility construction. Based on the report, the Minister of Environment and Forestry, governor and/or head of regent/mayor, according to his/her authority, conducts verification and issues a letter of operational feasibility if the collection facility is in accordance with the technical approval. The letter of operational feasibility becomes the basis for the hazardous wastes collection operational activity to commence and for monitoring on compliance of the person in charge of the business and/or activity in the business license.

The division of the government's authority for issuance of hazardous wastes management technical approval, letter of operational feasibility and recommendation can be seen in Figure 5.6.

Guideline users should first refer to the applicable national regulations relevant to administrative and technical requirements for establishing collection facility/intermediate storage of hazardous wastes.

Specific requirements for mercury wastes from healthcare facilities[1] can also be implemented as in the following sections.

Overall design requirements and procedure

The storage facility should have at least four distinct and separate functional areas:

- Receiving area for receiving and presorting wastes, re-labeling if necessary, and signing documents;
- Inspection area for checking for leaks, repackaging, secondary containment, and re-labeling if necessary;
- Storage area specific for mercury wastes;
- Administrative and record-keeping area.[1]

The storage facility should have clear guidelines on repackaging and supplementary containment if outside packaging is inadequate or if primary or secondary containers are broken. If there are indications of a breakage in the primary and/or secondary container, the wastes should be placed in an air-tight supplementary container of the appropriate size and strength.[1]

Records should be kept until such time that the mercury wastes is transferred to a long-term (terminal) storage facility or to a treatment and disposal facility. The records should be linked to an identifier number or code on the mercury wastes labels.[1]

The records should include the name and contact information of the source of mercury wastes (including generator identification number if available), the quantities (number of containers, weights, approximate volumes), and descriptions of the wastes (including composition and information on how the mercury wastes were generated), special handling procedures or warnings if appropriate, the date when the wastes were received, name and contact information of the transporter (including transporter identification number if available), the name of the person receiving and inspecting the wastes, any notes or observations on the condition of the wastes when received, any corrective actions taken (e.g., repackaging or re-labeling), the manifest or consignment note, and appropriate signatures.[1]

5.7.1. Receiving area

The receiving area should have a sign to guide and instruct wastes generators and transporters.[1]

The receiving area should have: a presort table for incoming wastes; a cart made of impervious material such as steel, rubber or hard plastic (do not use aluminum carts); emergency supplementary containers for broken packaging; PPE for the staff; and a separate table or counter for signing documents.[1]

A cart should be used to transfer the wastes to the inspection area and move the wastes around the facility.[1]

When receiving the wastes, the containers should go through an initial visual inspection to determine the condition of the packaging and containers without opening the primary and secondary containers. If breakage is suspected, the wastes should be brought immediately to the inspection area.[1]

5.7.2. Inspection area

After the initial inspection, the wastes should be brought to the inspection area for a more detailed inspection of the physical integrity and seal of the primary and secondary containers, and proper labeling, and to validate the amount of mercury wastes such as the number and weight of containers.[1]

The inspection area should have emergency supplementary containers to be used for leaking containers, packaging to replace broken or inadequate packaging, labels for re-labeling containers, and PPE for the staff.[1]

5.7.3. Storage area

The storage area for mercury wastes should be routinely monitored, including broken containers, and improper methods of storage, as well as routine tests of the burglar alarms, fire alarms, fire suppression systems, and exhaust ventilation; and monthly inspections of the condition of the PPE and wash units, flooring (to check for cracks), and files. Inspection logs, including the inspection

Figure 5.7 **Examples of elemental mercury containers/flask developed by BPPT**

Source: DanWHS, 2021

dates, observations, name, and signature of the inspector, should be kept and made available to a regulatory authority.[1]

During facility inspection, if a container is found to show signs of losing its physical integrity, the container should be removed from the shelf, carefully inspected under the fume hood, placed inside a supplementary container, and then re-labeled before being returned to the shelf.[1] Example of elemental mercury containers/flask developed by BPPT is shown in Figure 5.7.

The storage facility should be a non-smoking facility. There should be no eating in the storage area.[1]

5.7.4. Administrative and record-keeping area

The administrative and record-keeping area should be separated from the receiving, inspection, and storage areas. Records should be maintained in good order and kept in a secure location.[1]

The administrative and record-keeping area should maintain copies of the material safety data sheet (MSDS) and international chemical safety cards, which should be readily available to the staff.[1]

5.8. Treatment and/or Disposal

Treatment and/or disposal of mercury wastes from healthcare facilities is discussed in Subchapter 4.10.

5.9. Export

Export of mercury wastes from healthcare facilities is discussed in Subchapter 4.11.

6

HEALTH AND SAFETY

Employers should ensure that the health and safety of every employee are protected while they are at work. Every employer should obtain and maintain insurance under an approved policy from an authorized insurer, providing a sufficient level of coverage in case of liability (compensation) for bodily illness or injury sustained by employees arising out of and in the course of their employment in accordance with national law. Health and safety plans should be in place at all facilities that handle mercury wastes to ensure the protection of everyone in and around such facilities. Such plans should be developed for each facility by trained health and safety professionals with experience in managing health risks associated with mercury.[15]

Indonesia has a regulatory framework for occupational health and safety under Law Number 1 Year 1970 concerning Occupational Safety. This Law covers all work places where there are sources of dangers and outlines the requirements for occupational safety, among other things, are provision of personal protective equipment.

Law Number 36 Year 2009 concerning Health states that occupational health efforts are aimed to protect workers so that they can live healthy lives and be free from health problems and adverse effects caused by work. These occupational health efforts include workers in the formal and informal sectors and apply to everyone other than workers in the workplace environment. The Government determines occupational health standards.

According to the Minister of Health Regulation Number 52 Year 2018 concerning Occupational Health and Safety in Healthcare Facilities, management of hazardous substances and hazardous wastes in a safe and healthy manner must be conducted by healthcare facilities according to applicable standards and regulations. Management of hazardous substances and hazardous wastes in health and safety aspects of healthcare facilities must ensure that the management executive guarantees the health and safety of the human resources and that they are free from health problems caused by their work. Failure to implement the hazardous substances and hazardous wastes

management endanger the health and safety of the workers and the patients, their families and the healthcare facilities' environment.

Occupational health and safety aspects which must be conducted in hazardous substances and hazardous wastes management are as follows:

- Identification and inventory of hazardous substances and hazardous wastes;
- Ensure that storage, containers and treatment of hazardous substances and hazardous wastes are according to their characteristics, nature and amount;
- Provision of MSDS according to characteristics and nature of hazardous substances and hazardous wastes;
- Provision of emergency response system for spill/leak of hazardous substances and hazardous wastes;
- Provision of facility for hazardous substances and hazardous wastes safety such as spill kit, warning sign and symbol, etc;
- Ensure the provision and use of PPE according to characteristics and nature of hazardous substances and hazardous wastes;
- Availability of standard operating procedures that ensure work safety in the process of hazardous substances and waste management activities (reduction and sorting, storage, transportation, landfilling and/or disposal of hazardous substances and waste).
- If carried out by a third party, there should be agreement of occupational safety guarantee for manager and healthcare facility due to failure of hazardous substances and hazardous wastes management implementation.

Under Minister of Health Regulation Number 66 Year 2016 concerning Health and Safety in Hospital, management system of health and safety in hospital include:

1. policy establishment of hospital health and safety (*Keselamatan dan Kesehatan Kerja Rumah Sakit,* K3RS);
2. planning of K3RS;
3. implementation of K3RS plan;
4. monitoring and evaluation of K3RS performance; and
5. review and improvement of K3RS performance.

The implementation plan of K3RS includes, the management of hazardous substances from occupational health and safety aspects. It aims to protect the hospital human resources, patients, patients' companions, visitors and hospital environment from exposure and hazardous wastes. The management was conducted through:

- Identification and inventory of hazardous substances in hospital;
- Preparing and having MSDS;
- Preparing facility for hazardous substances safety;
- Developing guidelines and standard operational procedure for safe hazardous wastes management;
- Emergency response system for hazardous substances.

The facility for hazardous wastes safety at minimum includes a cupboard for hazardous wastes, body wash, eye washer, PPE, warning sign and symbol for hazardous wastes and spill kit.

The protection of workers who are engaged in the management of mercury wastes and the general public can be achieved through the following ways:

- By allowing access to facilities to authorized personnel only;
- By ensuring that occupational exposure limits for hazardous substances are not exceeded by

making sure that all personnel use appropriate protective equipment;

- By ensuring appropriate ventilation of facilities to minimize risk from exposure to volatile substances or substances that can become airborne; and

- By ensuring facility compliance with all national and regional laws on workplace health and safety.[15]

Guideline values for mercury concentrations in drinking water and ambient air have been established by WHO are 0.006 mg/L for inorganic mercury and 1 µg/m3 for inorganic mercury vapour (WHO, 2006; WHO Regional Office for Europe, 2000 as cited in the Secretariat of the Basel, Rotterdam and Stockholm Conventions, 2015). Governments are encouraged to monitor air and water in order to protect human health, especially near sites where mercury wastes management activities take place.[15]

Minister of Labor Decree Number KEP. 187/MEN/1999 regulates dangerous chemicals control at workplace. Businessperson or manager that uses, stores, produces and transports dangerous chemicals at the workplace is obliged to control these dangerous chemicals to prevent occupational accidents and diseases.

This control includes the provision of MSDS and label and appointment of chemical health, safety, and environment (HSE) officer and chemical HSE expert. Information to be contained in the MSDS and label is regulated under Article 4 and Article 5 of this regulation. The format of MSDS is regulated in Annex I of this regulation. Annex II of the regulation contains an example of a form that should be submitted by a businessperson or manager on a list of hazardous substances names, characteristics and quantity at the workplace to the local labor agency. The local labor agency then determined the hazard category of the industry whether it is great or medium hazard. Example of an MSDS of mercury thermometer can be found in Appendix 4.20

Minister of Labor Regulation Number 5 Year 2018 concerning Health and Safety At Workplace determined the threshold value for mercury at workplace and businessperson and/or manager is obliged to fulfill requirements of workplace environment health and safety. These requirements include, among other things, control of physical and chemical factors so that they are under the threshold value, provision of cleaning and hygiene facilities at clean and healthy workplace and provision of health and safety officers with health and safety competency and authority at workplace environment. Implementation of the workplace environment health and safety requirements is conducted through activities of measurement and control of the workplace environment and application of hygiene and sanitation.

Presidential Regulation Number 7 Year 2019 concerning Occupational Diseases states that workers diagnosed with occupational diseases are entitled to accident insurance based on the medical certificates even though the working relationship has terminated. This accident insurance is a benefit in the form of cash and/or health service provided when workers suffer occupational accidents or diseases. The occupational diseases include, among other things, types of diseases caused by exposure of factors arising from work activity, which include diseases caused by mercury and its compounds. This entitlement is given if the occupational disease emerges in a maximum of three years since the working relationship has terminated.

Special attention should be paid to sites where mercury-added products are handled. Within the wastes stream, mercury emissions from mercury-added products can lead to exposures that raise health concerns and contribute to environmental releases at multiple points. Waste collectors, truck drivers and workers at transfer stations can be exposed to brief mercury vapour peaks when handling wastes mercury-added products. Wastes management employees at the “working face” of a landfill-the active area where waste is dumped, spread, compacted, and buried-can be repeatedly exposed to mercury vapour.[15]

Disposal facilities, especially where mercury recovery operations are conducted, also present a a high risk of mercury exposure. Major activities

presenting high risk of exposure include the crushing of fluorescent lamps, the extraction of mercury from mercury-added products such as thermometers and barometers, the thermal treatment of wastes containing or contaminated with mercury, and the stabilization and/or solidification of wastes consisting of mercury or mercury compounds.[15]

Employee training in effective ESM and workplace health and safety should be provided to, among other things, ensure employee safety against mercury exposure and accidental injury when managing wastes. The basic knowledge that employees need includes:

- The definition of mercury wastes and the chemical properties and adverse effects of mercury;
- How to identify mercury wastes and to segregate such wastes from other types of wastes;
- Occupational safety standards relevant to mercury and how to safeguard their health against mercury exposure;
- How to use of personal protective equipment, such as body coverings, eye and face protectors, gloves and respiratory protectors;
- Proper labeling and storage requirements, container compatibility and dating requirements, and closed-container requirements;
- How to safely handle mercury wastes, particularly used products containing mercury such as thermometers and barometers, using the equipment available at the facility in which they work;
- How to uses engineering controls to minimize exposure; and
- How to respond in an emergency if mercury in wastes is accidentally spilled.[15]

The International Labour Organization (ILO) and the World Health Organization (WHO), with the cooperation of the European Commission, are commonly undertaking The International Chemical Safety Cards (ICSCs) project. The ICSCs are data sheets intended to provide essential safety and health information on chemicals in a clear and concise way. The primary aim of the cards is to promote the safe use of chemicals in the workplace. The main target users are workers and those responsible for occupational safety and health.[21]

Information provided in the ICSCs are as follows:[21]

- Identity of the chemical;
- Fire and explosion hazards;
- Fire fighting;
- Acute health hazards and prevention;
- Preventive measures;
- First aid;
- Spillage disposal, storage and packaging;
- Classification and labeling;
- Physical and chemical properties and dangers;
- Short-term and long-term health effects;
- Regulatory information and occupational exposure limits;
- Environmental data.

The ICSC for mercury can be found at the ILO website.[22]

7

EMERGENCY RESPONSE

Emergency response plans should be in place at each stage of the mercury waste processing chain (e.g., generation, storage, transport, treatment or recovery, and disposal). While emergency response plans can vary depending on the activities carried out at each stage of waste management and the physical and social conditions of each management site, the principal elements of an emergency response plan include the identification of potential hazards; compliance with legislation governing emergency response plans; specification of actions to be taken in emergency situations, including mitigation measures, personnel training plans, communication targets (e.g., fire services, police, neighbouring communities, local governments, etc.) and methods to be used in case of emergency; and specification of the method and frequency of testing of emergency response equipment.[15]

According to PP 22/2021 concerning Implementation of Environmental Protection and Management, Emergency Response System is a control system for emergencies that covers prevention, preparedness, and handling of hazardous waste management emergencies due to hazardous wastes management accidents. Article 428 of PP 22/2021 obliges any person generating hazardous wastes, hazardous wastes collector, transporter, utilizer, treater and/or disposer to have an Emergency Response System.

The Emergency Response System in hazardous wastes management consists of prevention of hazardous wastes management emergency through the development of hazardous wastes management emergency program, preparedness through training and rehearsal of hazardous wastes management emergency and emergency handling. The hazardous wastes management emergency covers the emergency situations of hazardous wastes management activity, emergency situations of hazardous wastes management at regency/city scale, at provincial scale and national scale.

According to the Minister of Environment and Forestry Regulation Number P.74/MenLHK/Setjen/KUM.1/10/2019 (Permen LHK P.74/2019) concerning Hazardous Substances and/or Hazardous Wastes

Management Emergency Program, the hazardous wastes management emergency program is developed based on identification of hazardous wastes management emergency risks. These risks identification should at least cover information on;

1. type of activity of hazardous wastes management;
2. type of industry;
3. category and characteristics of hazardous wastes;
4. amount of hazardous wastes;
5. source of hazardous wastes;
6. threat potency toward human life safety; and
7. threat potency toward environmental function.

The format for developing the hazardous wastes management emergency program is provided in the annex of Permen LHK P.74/2019. The hazardous wastes management emergency program should at least cover infrastructure and handling functions. The infrastructure at the least covers organization, coordination, facility and equipment including early warning and alarm equipment, handling procedures and emergency training and rehearsal.

The handling procedures are prepared in writing and contain information on;

1. identification of incident; b) reporting of incident;
2. activation or delegation of the hazardous wastes management emergency team;
3. determination of spread of impact estimation;
4. mitigation measures;
5. immediate protection measures;
6. emergency source termination;
7. protection measures for emergency situations handling personnel, workers, community and environment and/or;
8. provision of information on warning of an environmental management emergency.

The document on the handling procedures serves as a basis for emergency handling by the hazardous wastes management emergency team.

The handling functions should at least cover identification, reporting and activation, mitigation measures, immediate protection measures, protection measures for emergency response personnel, workers, community and environment and provision of information and instruction to the community. The handling functions should be adjusted with the type, classification/characteristic and amount of the hazardous wastes polluting and/or damaging the environment media.

The Emergency Response System must be carried out by any person generating hazardous wastes, hazardous wastes collector, transporter, utilizer, treater and/or disposer based on the hazardous wastes management emergency program and according to the person's respective hazardous wastes management activity.

Training and rehearsal of hazardous wastes management activity must be carried out by any person generating hazardous wastes, hazardous wastes collector, transporter, utilizer, treater and/or disposer at least 1 (once) a year to ensure that the Emergency Response System can be conducted.

Emergency handling in hazardous wastes management should at least cover the identification of emergencies in hazardous wastes management and handling environmental pollution and/or damage. If emergency handling in hazardous wastes management involves environmental pollution, recovery of environmental functions must be carried out for land contaminated with hazardous wastes.

In conducting the emergency handling, human life safety must be prioritized. The emergency handling activities should be conducted according to the hazardous wastes emergency program if an emergency situation occurs in the hazardous wastes management. The implementation of the emergency handling must be reported in writing and regularly each day to the Minister of Environment and Forestry, governor, and regent/mayor until the handling activities are completed.

When an emergency occurs, the first step is to examine the site. The person in charge should approach the site cautiously from upwind, secure the scene and identify any hazards. Placards, container labels, shipping documents, material safety data sheets, car identification charts and/or knowledgeable persons on the scene are valuable information sources. The need for site evacuation, the availability of human resources and equipment, and possible immediate actions should then be assessed. In order to ensure public safety, an emergency response agency call should be made and, as an immediate precautionary measure, spill and leak areas should be isolated for at least 50 meters in all directions. In case of fire, a suitable extinguishing agent should be used and the use of water should be avoided.[15]

The "Emergency Response Guidebook" (the United States Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico, 2020) provides a further guide for use by first responders during the initial phase of a transportation incident involving hazardous materials/dangerous goods.[23]

For mercury contained in manufactured articles, the emergency response guide during transportation is presented in the table 7.1.

Table 7.1 **Emergency response guide for transportation of mercury contained in manufactured articles**

POTENTIAL HAZARDS
HEALTH
Inhalation of vapors or contact with substance will result in contamination and potential harmful effects.
Fire will produce irritating, corrosive and/or toxic gases.
FIRE OR EXPLOSION
Non-combustible, the substance itself does not burn but may react upon heating to produce corrosive and/or toxic fumes.
Runoff may pollute waterways.
PUBLIC SAFETY
Call an emergency response telephone number on shipping paper.
Stay upwind, uphill and/or upstream.
Keep unauthorized personnel away.
PROTECTIVE CLOTHING
Wear positive pressure self-contained breathing apparatus (SCBA).
Structural firefighters' protective clothing provides thermal protection but only limited chemical protection.
EVACUATION
Immediate Precautionary Measure
Isolate spill or leak area for at least 50 meters in all directions.
Large Spill
Consider initial downwind evacuation for at least 100 meters.
Fire
Use extinguishing agent suitable for the type of surrounding fire.

EMERGENCY RESPONSE
FIRE
Use extinguishing agents suitable for the type of surrounding fire.
Do not direct water at the heated metal.
Spill or Leak
Do not touch or walk through spilled material.
Do not touch damaged containers or spilled material unless wearing appropriate protective clothing.
Stop leak if you can do it without risk
Prevent entry into waterways, sewers, basements or confined areas.
Do not use steel or aluminium tools or equipment.
Cover with earth, sand or other non-combustible material followed with a plastic sheet to minimize spreading or contact with rain.
Use a mercury spill kit.
Mercury spill areas may be subsequently treated with calcium sulphide/calcium sulfide or with sodium thiosulphate/sodium thiosulfate wash to neutralize any residual mercury.
First Aid
Call emergency medical service.
Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.
Move victims to fresh air if it can be done safely.
Give artificial respiration if the victim is not breathing.
Administer oxygen if breathing is difficult.
Remove and isolate contaminated clothing and shoes.
In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.
Keep the victim calm and warm.

Source: The United States Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico, 2020.

8

GUIDANCE AND SUPERVISION

According to Permenkes 41/2019, guidance and supervision for the implementation of the elimination and withdrawal of mercury-containing medical measuring devices in healthcare facilities are carried out by the Minister of Health, heads of the relevant ministries/institutions, governors, and regents/mayors in accordance with their respective duties, functions, and authorities. Guidance and supervision are directed to achieve the elimination of mercury-containing medical measuring devices in healthcare facilities and withdrawal of those devices.

In this guidance and supervision, the Minister of Health, heads of the relevant ministries/institutions, governors, and regents/mayors in accordance with their respective duties, functions and authorities can give administrative sanctions in the form of written warnings to healthcare facilities which are not fulfilling their obligation to eliminate the mercury-containing medical measuring devices.

Guidance and supervision activities for the elimination and withdrawal of mercury-containing medical measuring devices in healthcare facilities include:

1. Awareness raising

Awareness raising is carried out to increase awareness of community and healthcare facilities on the danger of mercury exposure. Awareness raising is carried out by central and local government to healthcare facilities, community, and relevant stakeholders. Furthermore, healthcare facilities should also conduct awareness raising internally.

2. Monitoring and evaluation

Monitoring and evaluation are carried out on healthcare facilities to find out how far the implementation and withdrawal of mercury-containing medical measuring devices elimination are being implemented. The executing institutions for these activities are the central and local government.

3. Increasing human resources capacity

In order to increase understanding, capability and skill for the implementation of elimination and withdrawal of mercury-containing medical measuring devices in healthcare facilities, training and capacity building in the environmental health sector need to be conducted, particularly for human resources in healthcare facilities related to mercury elimination, storage and withdrawal. Moreover, training and capacity building on mercury wastes handling should include the use of alternative devices (non-mercury-containing medical measuring devices).

This training should be in accordance with curriculum standards, modules and certifications accredited by MoH and can be conducted by central and local government and/or accredited training institutions according to regulatory provision.

4. Communication, information and education

To achieve mercury-free healthcare facilities, communication, information, and education should be provided continuously both to healthcare facilities, the community and general public. Communication, information, and education can be carried out in various ways, among others are as follows:

- conduct stop mercury campaign in healthcare facilities;
- prepare posters, banners, leaflets, videos, pocket books, etc;
- publish mercury-related articles in newspaper or social media;
- prepare mercury-related public service advertisements.

This provision of communication, information, and education can also be carried out in the community outside the healthcare facility, such as households, education institutions, and Community-Resourced Health Efforts (*Upaya Kesehatan Bersumber daya Masyarakat, UKBM).*

5. Award

An award can be given to healthcare facilities conducting elimination and withdrawal of mercury-containing medical measuring devices, with criteria determined by relevant government agencies.

In conducting guidance and supervision of the implementation of elimination and withdrawal of mercury-containing devices, Permenkes 41/2019 has provided an instrument for the guidance and supervision.

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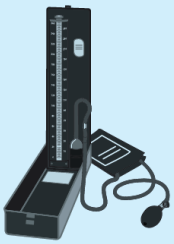
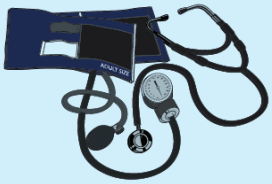
APPENDIX

APPENDIX 1.

Subcategories of Non-invasive Blood Pressure Measuring Devices and Their Advantages and Disadvantages

Type	Manual/analogue	
	Mercury sphygmomanometer	Aneroid sphygmomanometer
Illustration		
Advantages	▪ Often referred to as gold standard or reference. ▪ No need for calibration, inexpensive, does not require electricity.	▪ Inexpensive and portable. ▪ Does not require electricity.
Disadvantages	▪ Risk of noise interference. ▪ Expertise and retraining required to avoid observer error. ▪ Requires manual dexterity to ensure proper cuff deflation rate. ▪ Risk of observer bias and terminal digit preference Requires excellent hearing and vision.	
	▪ Mercury is an environmental hazard.	▪ Requires regular calibration (at least every 6 months). ▪ A device can lose calibration (become inaccurate) when it is jostled or bumped, leading to false readings. ▪ Often inaccurate in clinical practice if no routine accuracy testing.

Source: Who Technical Specifications For Automated Non-Invasive Blood Pressure Measuring Devices With Cuff, 2020

Electronic/automated		
Semi-automated	**Automated, cuff**	**Cuffless technique, mobile app.**
		
▪ Portable. ▪ Easy to use. ▪ Fewer observer errors. ▪ Minimal observer bias or terminal digit preference. ▪ Good for screening. ▪ Home use. ▪ Saves time and clinical resources. ▪ Less expertise and training; required when used in the absence of a health care provider. ▪ Calibration not required.		▪ Can measure during motion or continuously (beat-to-beat). ▪ Easy measurement without discomfort due to inflation, no limb size limitations (e.g. obese patients).
▪ Requires access to continuous power source (electricity or battery). ▪ Requires validation by standard protocol (some are validated only for adults). ▪ Manufacturer variation due to proprietary algorithm for estimation. ▪ Some are inaccurate. ▪ Cost and longevity of device. ▪ Integrity of cuff and tubing to essential to maintain accuracy over time. ▪ Must be replaced periodically because of mechanical failure.		▪ Generally poor accuracy; more trials are needed. ▪ No current accuracy validation standards; devices need to be tested to ensure accuracy.
▪ Requires manual inflation of cuff, which can lead to false measurements if cuff not fully inflated.	▪ Many are not suitable for patients with atrial fibrillation.n	

APPENDIX 2.

Format For Recording Document of Discarded Mercury-Containing Medical Measuring Devices

Each stage in the process of collection, temporary storage, transportation, storage at the storage depot, treatment and/or export of the mercury-containing medical measuring devices should be accompanied by a record document. This record document is prepared to provide information on movement of the discarded mercury-containing medical measuring devices from the healthcare facility to the treatment facility and/or export which covers:

1. Recording of the discarded mercury-containing medical measuring devices at other temporary storage facility belonging to the central government or local government-owned hospital located in 1 (one) regency/city area; and

2. Recording of the discarded mercury-containing medical measuring devices during transportation

   Procedures for recording are elaborated for each activity.

1. Recording of the discarded mercury-containing medical measuring devices at other temporary storage facility belonging to the central government or local government-owned hospitals in 1 (one) regency/city area; and

   - Transfer or handover of the discarded mercury-containing medical measuring devices to other temporary storage facility must be accompanied by a record of transfer which includes at least:
   - Date of transfer;
   - Name and address of the origin healthcare facility;
   - Name and address of the healthcare facility for storage destination;
   - Number and ID of the discarded mercury-containing medical measuring devices;
   - Number of the discarded mercury-containing medical measuring devices for each type (thermometer and sphygmomanometer);
   - Name and signature of the responsible person of the origin healthcare facility
   - Name and signature of the responsible person of the healthcare facility for storage destination.
   - An example of format for the record of transfer is as follows:

RECORD OF TRANSFER OF
DISCARDED MERCURY-CONTAINING MEDICAL MEASURING DEVICES
PROVINCE ..... REGENCY .....

On this day, (day, date, year), we, the undersigned below :

Name	:	filled with name of the responsible person of the origin healthcare facility
Position	:	filled with position of the responsible person of the origin healthcare facility
Address	:	filled with address of the origin healthcare facility

Hereinafter referred to as **FIRST PARTY**

Name	:	filled with name of the responsible person of the destination healthcare facility
Position	:	filled with position of the responsible person of the destination healthcare facility
Address	:	filled with address of the destination healthcare facility

Hereinafter referred to as **SECOND PARTY**

THE FIRST PARTY has transferred the discarded mercury-containing medical measuring devices to the SECOND PARTY, and the SECOND PARTY declares having received the goods from the FIRST PARTY with the following identities:

No	Identity		Note
1	ID number	:	(filled with ID number of the discarded mercury-containing medical devices)
2	Number of the discarded mercury-containing medical measuring devices	:	(Total in Unit)
	Thermometer	:	(Unit)
	Sphygmomanometer	:	(Unit)

Thus the minutes for the transfer of goods were made by both parties, while the goods were in good condition. Since the signing of this record of transfer, these goods become the responsibility of the SECOND PARTY to be stored and then transferred or handed over to the storage depot for the discarded mercury-containing medical measuring devices which is provided by the Government.

The Transferee	The Transferor
SECOND PARTY	FIRST PARTY
(Signature)	(Signature)
(Name)	(Name)

2. Recording of the discarded mercury-containing medical measuring devices during transportation

The provisions for filling out the recording document of the discarded mercury-containing medical devices include:

1. The recording document must be filled out in block and clear letters;

2. The recording document consists of 5 (five) parts with the following details:

a. The first part is filled out and signed by the person responsible of the healthcare facility;

b. The second part is filled out and signed by the transporter of the discarded mercury-containing medical measuring devices (the transportation company of the discarded mercury-containing medical measuring devices or other transporter) from the healthcare facility to the storage depot and signed by the transporter, the representative of the local health agency at regency/city level, and the representative of the agency responsible for environmental affairs at regency/city level;

c. The third part is filled out by the storage depot manager and signed by the storage depot manager, the representative of the local health agency at provincial level, and the representative of the agency responsible for environmental affairs at provincial level;

d. The fourth part is filled out by the transporter of the discarded mercury-containing medical measuring devices from the storage depot to the treatment facility or abroad for export and signed by the transporter, representative of the Ministry of Environment and Forestry and representative of Ministry of Health.

e. The fifth part is filled out by the treater/exporter of the discarded mercury-containing medical measuring devices and signed by the treater (company of the final treatment service or exporter) of the discarded mercury-containing medical measuring devices, representative of the Ministry of Environment and Forestry and representative of Ministry of Health.

f. Number 1 until number 8 in the recording document must be completed when collecting the discarded mercury-containing medical devices at the healthcare facility and filled by the person responsible of the healthcare facility, which include:

NO	CONTENT OF RECORDING DOCUMENT	NOTE
1	Mercury-containing medical devices id number	ID number that has been given from each healthcare facility to identify the number and type of mercury-containing medical measuring devices in the facility.
2	Name and full address of healthcare facility	The name and full address of the healthcare facility from which the mercury-containing medical measuring devices originated.
3	Status	Ownership status of the origin healthcare facility, from the Government or Private or Military or Police.
4	Responsible person	Name of the person responsible for the storage of the mercury-containing medical measuring devices in the healthcare facility.
5	Inspection Date	Date of inspection and packaging of the mercury-containing medical measuring devices.
6	Destination	The location of storage destination

7	Signature of the responsible person	The signature of the person appointed by the healthcare facility and responsible for the management of the discarded mercury-containing medical measuring devices.
8	Type and number of medical devices	The number of each type of mercury-containing medical measuring devices that have been packaged at the healthcare facility.

g. Number 9 until number 17 are parts that must be completed when transporting the discarded mercury-containing medical measuring devices from healthcare facility to the storage depot and filled by:

h. the transporter of the discarded mercury-containing medical measuring devices from the healthcare facility to the storage depot;

i. the agency appointed for the implementation of the transportation originating from the healthcare facility.

NO	CONTENT OF RECORDING DOCUMENT	NOTE
9	Transportation destination and address	Name of destination location and full address of the destination/storage depot
10	Name and full address of transporter	Company name and full address of the company transporting the discarded mercury-containing medical measuring devices
11	Telephone number of transporter	Telephone number of the transporter or the discarded mercury-containing medical measuring devices
12	Vehicle identification	Name and/or police number of the transport vehicle
13	Responsible person	Full name of the person responsible for the transportation process from the healthcare facility to the storage depot
14	Signature of transporter	The signature of the person responsible for the transportation process from the healthcare facility to the storage depot
15	Transportation date	The date when the discarded mercury-containing medical measuring devices are transported
16	Signature of the local health agency at regency/city level	The signature of the representative of the local health agency at regency/city level witnessing the transportation of the discarded mercury-containing medical measuring devices from the healthcare facility
17	Signature of the agency responsible for environmental affairs at regency/city level	The signature of the representative of the agency responsible for environmental affairs at regency/city level witnessing the transportation of the discarded mercury-containing medical measuring devices from the healthcare facility

j. Number 18 until number 23 are parts that must be completed when storing the discarded mercury-containing medical measuring devices at the storage depot and filled by:

k. the storage depot manager in each province; and

l. the agency appointed for the implementation of the discarded mercury-containing medical measuring devices storage at each storage depot.

NO	CONTENT OF RECORDING DOCUMENT	NOTE
18	Location and full address of storage depot	Location name and full address of the storage depot
19	Responsible person	Name of the operator responsible for the storage depot
20	Inspection date	Date of receipt and inspection of the discarded mercury-containing medical measuring devices
21	Signature of the manager	Signature of the storage depot manager
22	Signature of the local health agency at provincial level	The signature of the representative of the local health agency at provincial level witnessing the storage of mercury-containing medical devices at the storage depot
23	Signature of the agency responsible for environmental affairs at provincial level	The signature of the representative of the agency responsible for environmental affairs at the provincial level witnessing the storage of the discarded mercury-containing medical measuring devices at the storage depot

m. Number 24 until number 32 are parts that must be completed when transporting the discarded mercury-containing medical measuring devices from the storage depot to the treatment facility/ export and filled by:

n. transporter of the discarded mercury-containing medical measuring devices from the storage depot to the treatment facility/export; and

o. the ministry appointed for the implementation of transportation from the storage depot to the treatment facility/export.

NO	CONTENT OF RECORDING DOCUMENT	NOTE
24	Name and address of the transporter	Name and full address of the company transporting the discarded mercury-containing medical measuring devices
25	Telephone number of the transporter	Telephone number and area code of the company transporting the discarded mercury-containing medical measuring devices
26	Vehicle identity	Vehicle's police number or name of ship or train number or airplane number and transporter license number which can transport B3 waste
27	Responsible person	Full name of responsible person of the transport company who signs the recording document of the discarded mercury-containing medical measuring devices.
28	Signature of the transporter	Signature of the responsible person from the company transporting the discarded mercury-containing medical measuring devices.
29	Date of transportation	The date when the discarded mercury-containing medical measuring devices are transported.
30	Destination of transportation	Destination of transportation to the final treatment or export
31	Signature of the Ministry of Health	Signature of the representative of the Ministry of Health witnessing the transportation of the discarded mercury-containing medical measuring devices from the storage depot to the treatment facility/export
32	Signature of the Ministry of Environment and Forestry	Signature of the representative of the Ministry of Environment and Forestry witnessing the transportation of the discarded mercury-containing medical measuring devices from the storage depot to the treatment facility/export

p. Number 33 until number 40 are parts that must be completed during the final treatment or export of the discarded mercury-containing medical measuring devices and filled by:

q. treater of the discarded mercury-containing medical measuring devices or exporter of the discarded mercury-containing medical measuring devices; and

r. the ministry appointed for the implementation of the final treatment or export process.

NO	CONTENT OF RECORDING DOCUMENT	NOTE
33	Location and address of the final treatment facility/exporter	Name of location and full address of the final treatment facility/exporter
34	Telephone number of the final treatment facility/exporter	Telephone number and area code of the company of the final treatment facility/exporter of the discarded mercury-containing medical measuring devices
35	Responsible person	Full name of the responsible person from the company of the final treatment facility/exporter who signs the recording document of the discarded mercury-containing medical measuring devices.
36	Signature of the final treatment facility/exporter	Signature of the responsible person from the company of the final treatment facility/exporter who signs the recording document of the discarded mercury-containing medical measuring devices.
37	Date of the final treatment/ export	Date of treatment or date of export of the discarded mercury-containing medical measuring devices.
38	Export destination	Name of company and destination country of export. To be filled if the discarded mercury-containing medical measuring devices are exported
39	Signature of the Ministry of Health	Signature of the representative of the Ministry of Health witnessing the final treatment/export of the discarded mercury-containing medical measuring devices
40	Signature of the Ministry of Environment and Forestry	Signature of the representative of the Ministry of Environment and Forestry witnessing the final treatment/export of the discarded mercury-containing medical measuring devices

3. Document Format

Recording Document of Discarded Mercury-Containing Medical Measuring Devices

Fill out in block and clear letters

PART THAT MUST BE COMPLETED WHEN COLLECTING MERCURY-CONTAINING MEDICAL DEVICES AT HEALTHCARE FACILITY		
1.	Mercury-Containing Medical Measuring Devices ID Number	:
2.	Name and Full Address of Healthcare Facility	:
3.	Status	:
4.	Responsible Person	:
5.	Inspection Date	:
6.	Destination	:
7.	Signature of Responsible Person	:
8.	Type of Medical Devices	Number
	a. Thermometer	(Unit)
	b. Sphygmomanometer	(Unit)

PART THAT MUST BE COMPLETED WHEN TRANSPORTING THE DISCARDED MERCURY-CONTAINING MEDICAL DEVICES FROM HEALTHCARE FACILITY TO STORAGE DEPOT		
9.	Transport destination and address	:
10.	Name and address of transporter	:
11.	Telephone number of transporter	:
12.	Vehicle identity	:
13.	Responsible person	:
14.	Signature of transporter	:
15.	Date of transportation	:
16.	Signature of the local health agency at regency/city level	:
17.	Signature of the agency responsible for environmental affairs at regency/ city level	:
PART THAT MUST BE COMPLETED WHEN STORING THE DISCARDED MERCURY-CONTAINING MEDICAL DEVICES AT STORAGE DEPOT		
18.	Location and full address of storage depot	:
19.	Responsible person	:
20.	Inspection date	:
21.	Signature of manager	:
22.	Signature of the local health agency at provincial level	:
23.	Signature of the agency responsible for environmental affairs at the provincial level	:
PART THAT MUST BE COMPLETED WHEN TRANSPORTING MERCURY-CONTAINING MEDICAL DEVICES FROM STORAGE DEPOT TO TREATMENT FACILITY/EXPORT		
24.	Name and full address of transporter	:
25.	Telephone number of transporter	:
26.	Vehicle identification	:
	a. Vehicle number	:
	b. Vehicle name	:
	c. Transportation permit	:
27.	Responsible person	:
28.	Signature of the transporter	:
29.	Transportation date	:
30.	Purpose of transportation	:
31.	Signature of the Ministry of Health	:
32.	Signature of the Ministry of Environment and Forestry	:
PARTS THAT MUST BE COMPLETED DURING THE FINAL TREATMENT OR EXPORT OF DISCARDED MERCURY-CONTAINING MEDICAL MEASURING DEVICES		
33.	Location name and full address of final treatment facility/exporter	:
34.	Telephone number of final treatment facility/exporter	:
35.	Responsible person	:
36.	Signature of final treatment facility/ exporter	:
37.	Date of final treatment/export	:
38.	Export date	: (filled if discarded mercury-containing medical measuring devices are exported)
39.	Signature of the Ministry of Health	:
40.	Signature of the Ministry of Environment and Forestry	:

APPENDIX 3.

The Tasks And Responsibilities of The Stakeholders Involved In The Elimination And Withdrawal of The Unbroken Mercury-Containing Medical Measuring Devices

No.	Stakeholder	Tasks and Responsibilities
1.	Person responsible at the healthcare facility	Collection and storage of mercury-containing medical measuring devices at healthcare facility. Conduct recording and reporting of the implementation of mercury-containing medical measuring devices elimination and withdrawal. Conduct packaging and attaching of symbol and label.
2	Hospitals owned by central government or local government	Conduct temporary storage of mercury-containing medical measuring devices from healthcare facilities in one area of regency/city if the origin healthcare facilities do not have temporary storage.
3.	Ministry of Health	Conduct recording and reporting of the implementation of mercury-containing medical measuring devices elimination and withdrawal.
4.	Local health agency at provincial level	Conduct transportation (in coordination with local health agency at regency/city level and local environmental agency at provincial and regency/city level) from the temporary storage to the storage depot. Conduct recording and reporting of the implementation of mercury-containing medical measuring devices elimination and withdrawal.
5.	Local health agency at regency/ city level	Conduct transportation (in coordination with local health agency at provincial level and local environmental agency at provincial and regency/city level) from the temporary storage at the healthcare facility to the storage depot facility. Conduct recording and reporting of the implementation of mercury-containing medical measuring devices elimination and withdrawal.
6.	Local environmental agency at provincial level	Coordinate with local health agency at provincial level and regency/city level in transportation from the temporary storage to the storage depot.
7.	Local environmental agency at regency/city level	Coordinate with local health agency at provincial level and regency/city level in transportation from the temporary storage to the storage depot.
8.	Transportation service/ treatment facility	Assist MOEF in transportation from the storage depot to treatment facility or export.
9.	Treatment facility	Final treatment and conduct recording and reporting on the implementation of elimination and withdrawal of mercury-containing medical measuring devices.
10.	Governor	May coordinate with the Minister of Environment and Foresty in the provision of the storage depot. Conduct monitoring on the mercury-containing medical measuring devices at the temporary storage.
11.	Head of regent/mayor	Conduct monitoring on the mercury-containing medical measuring devices at the temporary storage.
12.	The Minister of Environment and Forestry	Provide the storage depots Conduct monitoring on the mercury-containing medical measuring devices at the storage depots Conduct evaluation on effectiveness of the mercury-containing medical measuring devices management as reporting of the mercury-containing medical measuring devices elimination material to the President.
13.	Director General (MOEF)	Transportation from the storage depots to treatment facility or export.

APPENDIX 4.

Example of a Material Safety Data Sheet for Mercury-Containing Medical Devices

Mercury In Glass Thermometer
Safety Data Sheet

Effective date: May 29, 2015 According to 29 CFR 1910:1200 and GHS Rev. 3 Page **1** of **6**

SECTION 1: Identification of the substance/mixture and of the Manufacturer

Chemical Name: Mercury, Hg (CAS No: 7439-97-6)

Manufacturer Product Name: Mercury In Glass Thermometer

Recommended uses of the chemical/product: Mercury is the thermometric fluid in a mercury in glass thermometer. The mercury expands or contracts with change in temperature. The thermometer will have between 1.5 and 30 grams of mercury. Average amount of mercury in a Miller & Weber thermometer is approximately 4.5 grams. The product is hazardous if broken.

Manufacturer Details:

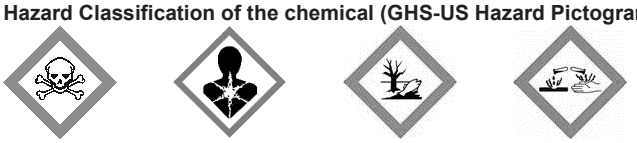
Miller & Weber, Inc.
1637 George Street
Ridgewood, NY 11385-5342
718-821-7110 Fax: 718-821-1673

Emergency Telephone Number:

Chem-Tel, Inc. (Contract Number: MIS0003159)
1-800-255-3924

SECTION 2: Hazards Identification

Hazard Classification of the chemical (GHS-US Hazard Pictograms):



GHS06 GHS08 GHS09 GHS05

Signal word (GHS-US): Danger

Hazard statements (GHS-US):
H330 - Fatal if inhaled
H360 - May damage fertility or the unborn child
H372 - Causes damage to organs through prolonged or repeated exposure
H400 - Very toxic to aquatic life
H410 - Very toxic to aquatic life with long lasting effects

Precautionary statements (GHS-US):
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P260 - Do not breathe vapors, gas
P264 - Wash skin, hands thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P271 - Use only outdoors or in well-ventilated area
P280 - Wear eye protection, protective clothing, protective gloves, face mask
P284 - [In case of inadequate ventilation] wear respiratory protection
P304+P340 - IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P308+P313 - IF exposed or concerned: Get medical advice/attention
P310 - Immediately call a POISON CENTER or doctor/physician
P314 - Get medical advice and attention if you feel unwell
P320 - Specific treatment is urgent (see First aid measures on this label)
P391 - Collect spillage
P403+P233 - Store in a well-ventilated place. Keep container tightly closed
P405 - Store locked up
P501 - Dispose of contents/container to comply with applicable local, national and international regulation.

NFPA/HMIS Ratings (0-4) (Non-GHS): Health: 3*, Flammability: 0, Reactivity: 0, PPG: See Section 8 below.

SECTION 3: Composition/Information on Ingredients

Name	Product Identifier	%	GHS-US Classification
Mercury	CAS No. 7439-97-6	100	Acute Tox. 2 (Inhalation), H330 Repr. 1B, H360 STOT RE 1, H372 Aquatic Acute 1, H400 Aquatic Chronic 1, H410

See Section 16 for full text of H-phrases

Mercury In Glass Thermometer
Safety Data Sheet

SECTION 4: First aid measures

The first aid measures described in this section are for exposure to metallic mercury, regardless of the quantity of the mercury involved in the exposure. The first aid measures below come from the Safety Data Sheets of our bulk mercury suppliers.

Description of first aid measures

General: Never give anything by mouth to an unconscious person. If exposed or concerned: Get medical advice/attention.
After inhalation: Move exposed to fresh air. Give artificial respiration if necessary. If breathing is difficult give oxygen. Loosen clothing and place exposed person in a comfortable position. Immediately seek medical attention.
After skin contact: Wash immediately with lots of water (15 minutes)/safety shower, as necessary. Remove affected clothing and wash all exposed skin area with mild soap and water, followed by warm water rinse. Seek immediate medical advice.
After eye contact: Protect unexposed eye. Rinse exposed eye immediately and thoroughly, pulling the eyelids well away from the eye (15 minutes minimum). Keep eye wide open while rinsing. Immediately seek medical attention. Continue rinsing during transport.
After swallowing (ingestion): Immediately call a POISON CONTROL CENTER OR DOCTOR/PHYSICIAN FOR MOST CURRENT INFORMATION. Rinse mouth with water. Do not induce vomiting. Never give anything by mouth to an unconscious person. Immediately seek medical attention.

Most important symptoms and effects, both acute and delayed

After inhalation: Short-term over-exposures to high concentrations of mercury vapors can lead to breathing difficulty, coughing, acute, chemical pneumonia, and pulmonary edema (a potentially fatal accumulation of fluid in the lungs). Depending on the concentration of over-exposure, cardiac abnormalities, damage to the kidney, liver or nerves and effects on the brain may occur. Long-term inhalation over-exposures can lead to the development of a wide variety of symptoms, including the following: excessive salivation, gingivitis, anorexia, chills, fever, cardiac abnormalities, anemia, digestive problems, abdominal pains, frequent urination, an inability to urinate, diarrhea, peripheral neuropathy (numbness, weakness, or burning sensations in the hands or feet), tremors (especially in the hands, fingers, eyelids, lips, cheeks, tongue, or legs), alteration of tendon reflexes, slurred speech, visual disturbances, and deafness. Allergic reactions (i.e. breathing difficulty) may occur in sensitive individuals.
After skin contact: Symptoms include redness, dry skin, and pain. Prolonged contact may lead to ulceration of the skin. Allergic reactions (i.e. rashes, welts) may occur in sensitive individuals. Dermatitis (redness and inflammation of the skin) may also occur in sensitive individuals.
After eye contact: Symptoms of eye exposure can include redness, pain, and watery eyes. A symptom of mercury exposure is discoloration of the lens of the eyes.
After ingestion: If mercury is swallowed, symptoms of such over-exposure can include metallic taste in mouth, nausea, vomiting, central nervous system effects, and damage to the kidneys. Metallic mercury is not usually absorbed sufficiently from the gastrointestinal tract to induce an acute, toxic response. Damage to the tissues of the mouth, throat, esophagus, and other tissues of the digestive system may occur. Ingestion may be fatal, due to the effects on the gastrointestinal system and kidneys.
Chronic symptoms: Long-term over-exposure can lead to a wide range of adverse health effects. Anyone using mercury must pay attention to personality changes, weight loss, skin or gum discolorations, stomach pains, and other signs of mercury over-exposure. Gradually developing syndromes ("Erethism" and "Acrodynia") are indicative of potentially severe health problems. Mercury can cause the development of allergic reactions (i.e. dermatitis, rashes, breathing difficulty) upon prolonged or repeated exposures. Refer to Section 11 (Toxicology Information) for additional data.

Indication of any immediate medical attention and special treatment needed

If seeking medical attention provide SDS document to physician. (Information for hospital or physician) 1. As soon as possible, have patient drink milk or slurry of activated charcoal to help precipitate mercury in the stomach. 2. Gastric lavage with tap water, milk, or 2-5% solution of sodium bicarbonate, unless spontaneous vomiting is intense and productive, 3. Administer through the lavage tube 0.5-1.0 oz. of sodium or magnesium sulfate in 6-8 oz. of water (unless spontaneous purging has already begun) and a slurry of activated charcoal. 4. Administer BAL (Dimercaprol; 3 mg/kg or 0.3 mL/10 kg) intramuscularly as a 10% solution in oil. If given within three hours after ingestion, severe renal damage may be prevented. Collect urine before and after BAL therapy for mercury analysis. 5. Demulcents (i.e. milk of magnesia, starch, bismuth subcarbonate) and analgesic drugs may be useful and necessary. 4. FIRST-AID MEASURES (Continued) RECOMMENDATIONS TO PHYSICIANS (continued): 6. Because the BAL-Mercury Complex excreted in bile may be partly resorbed in the bowel, it is probably useful to administer activated charcoal every few hours, starting as soon as vomiting subsides. 7. Treat shock by correcting dehydration and electrolyte imbalances. If renal insufficiency develops, treat for acute renal failure. 8. The maintenance of an adequate nutritional status may be troublesome if gastrointestinal disorders becomes severe or persistent. 9. If toxic signs or symptoms recur after an apparent recovery, another course of chelation therapy is warranted. BAL is still appropriate, but a trial of D-Penicillamine or N-acetyl-D, L-penicillamine may be preferable. Either penicillamine compound is given by mouth, usually on an empty stomach, in a dose of 250 mg (4 times daily for adults; 3 times daily in children; 5-10 days). Penicillamine should be withheld until mercury is cleared out of the bowels. A chelating agent should be used until the urine-mercury level falls below 50 micrograms/24 hours. Laboratory Analysis: Determination of beta-2-Microglobulins has been recommended as a useful test for renal function. Electroencephalographic changes may be correlated closely with the clinical state. Analysis of the blood, hair, urine, or feces can be done to determine the level of Mercury exposure. Mercury deposits in the body can be observed in X-Rays.

SECTION 5: Firefighting measures

Extinguishing media

Suitable extinguishing agents: Foam, dry powder, carbon dioxide, water spray, sand.
Unsuitable extinguishing media: None identified, but avoid heavy water stream.

SECTION 8: Exposure controls/personal protection

Control Parameters:

Mercury (CAS No. 7439-97-6)		
USA NIOSH	NIOSH Ceiling (C) (mg/m3)	0.1 mg/m3
USA OSHA	OSHA TWA (mg/m3)	0.05 mg/m3
USA ACGIH	ACGIH TWA (mg/m3)	0.025 mg/m3, (skin)A4 (Not classifiable as a human carcinogen)

Appropriate Engineering controls

Ensure adequate ventilation. Provide exhaust ventilation or other engineering controls to ensure exposure is below occupational exposure limits (where available). Emergency eye was fountains and safety showers should be available in the immediate vicinity of any potential exposure.

Personal Protective Equipment (if thermometer breaks)

If thermometer breaks, avoid all unnecessary exposure. Gloves. Protective clothing. Safety glasses or goggles. Respiratory protection and if operation involves use of more than 1 pound of Mercury, a faceshield is recommended.





Hand Protection: Wear gloves impermeable and resistant to mercury. Neoprene gloves are recommended for routine industrial use. Use triple gloves for spill response, as stated in Section 6 of this SDS. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Use proper glove removal technique without touching outer surface. Avoid skin contact with used gloves.

Eye Protection: Splash goggles or safety glasses. For operations involving the use of more than 1 pound of mercury, or if the operation may generate a spray of mercury, the use of a faceshield is recommended.

Respiratory Protection: Maintain airborne contaminants concentration below provided exposure limits. If respiratory protection is needed, use only protection authorized by 29 CFR 1910.134 or applicable state regulations. Use supplied air respiration protection if oxygen levels are below 19.5% or are unknown.

Skin and Body Protection: Use body protection appropriate to the task (lab coat, coveralls, or Tyvek suit).

General hygienic measures: Do not eat, drink, or smoke during use. Perform routine housekeeping. Wash hands before breaks and immediately after handling the product. If thermometer breaks, avoid getting mercury ON YOU or IN YOU. Avoid contact with skin, eyes and clothing. Wash contaminated clothing before re-wearing.

SECTION 9: Physical and chemical properties

Appearance (physical state, color)	Silver-white liquid	**Explosion Limit (upper and lower)**	Not Determined
Odor	Odorless	**Vapor pressure**	< 0.01 hPa at 20 °C
Odor threshold	Not Applicable	**Vapor density**	6.93 (Air = 1.0)
pH value	Not Applicable	**Relative density**	13.55 g/cm3 at 25 °C
Melting/Freezing point	-38.87 °C	**Solubilities (at 25 °C)**	Soluble in water: 0.00006g/l
Boiling point/ Boiling range	356.6 °C	**Partition coefficient (n-octanol/water)**	Not Determined
Flash point	Not Determined	**Auto/Self-ignition temperature**	Not Determined
Evaporation rate	Not Determined	**Decomposition temperature**	Not Determined
Flammability (solid, gaseous)	Not Determined	**Viscosity (kinematic)**	Not Determined
Upper.Lower flammability limits	Not Determined	**Viscosity (dynamic)**	Not Determined

SECTION 10: Stability and reactivity

Reactivity: Nonreactive under normal conditions. If thermometer is broken, mercury can react with many metals (i.e. calcium, lithium, potassium, sodium, rubidium, aluminum, gold, silver) to form amalgams.

Chemical stability: Stable under normal conditions of use.

Possibility of hazardous reactions: None under normal conditions. Hazardous polymerization will not occur.

Conditions to avoid: Intact thermometer should not be exposed to hydrofluoric acid. Avoid Excessive heat, sources of ignition, direct sunlight and extremely high or low temperatures. If broken, avoid materials incompatible with mercury.

Incompatible materials: acetylene and acetylene derivatives, amines, ammonia, 3-bromopropyne, boron diiodophosphide, methyl azide, sodium carbide, heated sulfuric acid, methylsilane/oxygen mixtures, nitric acid/alcohol mixtures, tetracarbonylnickel/oxygen mixtures, alkyne/silver perchlorate mixtures, halogens (i.e. chlorine, bromine) and strong oxidizers (i.e. chlorine dioxide, perchlorates). Mercury can attack copper and copper alloys. Mercury can react with many metals to form amalgams.

Hazardous decomposition products: If thermometer is broken, toxic vapors of mercury and mercury oxides.

Mercury In Glass Thermometer
Safety Data Sheet

SECTION 11: Toxicological information

Acute toxicity: Inhalation (7439-97-6) LC50 Inhalation – rat – male – 2h < 27 mg/m3. Fatal if inhaled.

Skin corrosion/irritation: Not classified. pH: Not applicable

Serious eye damage/irritation: Not classified. pH: Not applicable

Respiratory or skin sensitization: Not classified

Germ cell mutagenicity: No classified (Based on available data, the classification criteria are not met).

Carcinogenicity: Not classified (Mercury 7439-97-6 IARC Group 3)

Reproductive toxicity: May damage fertility or the unborn child.

Specific target organ toxicity- (single exposure): Not classified.

Specific target organ toxicity- (repeated exposure): (7439-97-6) Causes damage to organs through prolonged or repeated exposure.

See Section 4 of the SDS for most important symptoms and effects, both acute and delayed for inhalation, skin contact, eye contact, ingestion and chronic symptoms of mercury exposure.

SECTION 12: Ecological information

Exotoxicity

LD50 Fish: 0.5 mg/l (Exposure time: 96 h – Species: Cyprinus carpio)

EC50 Daphnia: 5.0 microgram/l (Explosure time: 96 h – Species: water flea)

LC50 Fish: 0.16 mg/l (Exposure time: 96 h – Species: Cyprinus carpio [semi-static])

Persistence and degradability: May cause long-term adverse effects in the environment.

Bioaccumulative potential: 7439-97-6 Carassius auratus (goldfish) – 1,789 d – 0.25 microgram/l.
7439-97-6 Bioconcentration factor (BCF): 155,986

Mobility in soil: No additional information available.

Other adverse effects: Avoid release to the environment.

SECTION 13: Disposal considerations

Waste disposal recommendations: Dispose in a safe manner in accordance with local/national regulations. Mercury and mercury products should never be disposed of with household garbage. Waste disposal must be in accordance with appropriate federal, state, and local regulations. The elemental mercury, in the thermometer, should be recycled. Recycle at a licensed and permitted recycling facility. If the mercury is contaminated by the glass, it may need to be disposed of as hazardous waste. Either way it must be handled at a permitted facility or as advised by your local hazardous waste regulatory authority. It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11).

Ecology – waste materials: Hazardous waste due to toxicity. Avoid release to the environment.

SECTION 14: Transport information

UN-Number: UN3506

UN proper shipping name: Mercury contained in Manufactured Articles

Transport hazard class(es):

Hazard labels (DOT): **8- Corrosive substances**
6.1- Toxic substances*

***Special Provisions:** **A191**

DOT Packing Group: III
DOT Packaging: 49 CFR 173.164

Additional Information: In accordance with 49 CFR 172.101, Column 1 shows an A and a W. The A and W indicate these items are only regulated as a hazardous material if shipped by air or water. The exception to this rule is that if the thermometer meets the definition of a hazardous waste- if the thermometer is broken (required on a manifest by 40 CFR 262 40) or a hazardous substance (which exceeds the Reportable Quantity of 1 lb. for mercury), then the shipment is a regulated hazardous material. If shipping an intact thermometer or thermometers via common carrier and by ground service, and there is less than 1 pound of mercury in the total number of thermometers, the shipment is not regulated as a hazardous material.

SECTION 15: Regulatory information

United States (USA)

SARA Section 304: Reportable Quantity 1 pound. The Superfund Amendments and Reauthorization Act (SARA) section 304 requires that a release equal to or greater than the reportable quantity for this substance be immediately reported to the local emergency planning committee and the state emergency response commission (40 CFR 355.40).

SARA Section 311/312 (Specific toxic chemical listings): Acute, Chronic

SARA Section 313 (Specific toxic chemical listings): 7439-97-6 Mercury

RCRA (hazardous waste code): Mercury Code: U151

TSCA (Toxic Substances Control Act): All ingredients are listed.

EPA TSCA Regulatory Flag: S-S- indicates a substance that is identified in a proposed or final Significant New Uses Rule.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act): 7439-97-6 Mercury 1 lb.

Proposition 65 (California)

Chemicals known to cause cancer: None of the ingredients is listed.

Chemicals known to cause reproductive toxicity for females: None of the ingredients is listed.

Chemicals known to cause reproductive toxicity for males: None of the ingredients is listed.

Chemicals known to cause developmental toxicity: Mercury and mercury compounds.

Canada

Canadian Domestic Substances List (DSL): All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%): 7439-97-6 Mercury

Canadian NPRI Ingredient list (limit 1%): None of the ingredients is listed.

Other Information

This thermometer/thermometers not to be offered for sale into any state where the sale of mercury-in-glass thermometers is prohibited.

SECTION 16: Other information

Full text of H-phrases: see section 3

Acute Tox. 2 (Inhalation)	Acute toxicity (inhalation) Category 2
Repr.1B	Reproductive toxicity Category 1B
STOT RE 1	Specific target organ toxicity (repeated exposure) Category 1
Aquatic Acute 1	Hazardous to the aquatic environment- Acute Hazard, Category 1
Aquatic Chronic 1	Hazardous to the aquatic environment- Chronic Hazard, Category 1
H330	Fatal if inhaled
H360	May damage fertility or the unborn child
H372	Causes damage to organs through prolonged or repeated exposure
H400	Very toxic to aquatic life
H410	Very toxic to aquatic life with long lasting effects

Other Information

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Prepared: May 29, 2015
Effective Date: May 29, 2015
No previous publication of SDS by Miller & Weber, Inc.