

# Mercury Country Situation Report 2018



*Mercury Country Situation Report - Sri Lanka*  
*2018*

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## *Forward*

*Sri Lanka is signatory to the Minamata Convention on Mercury since 2014. Sri Lanka does not have a mercury production industry. However, we have found high levels of mercury in some locations such as Negombo lagoon. One of the major sources of mercury contamination is mercury in products such as CFL bulbs and medical apparatus etc. CEJ found high levels of mercury in skin whitening creams in its research in 2011. While the concerned agencies such as Ministry of Environment and Ministry of Health have programmes to eliminate mercury, those initiatives are yet in their preliminary stage. Lack of awareness is still a bottleneck for the elimination of mercury in products and practices including the use of mercury amalgam in the dentistry and mercury in Ayurvedic products. Lack of scientific research and survey in this field is also a major issue. I thank all the agencies for providing data and information to produce this country situation report. I also thank IPEN for giving the opportunity to engage in this study.*

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## *Acknowledgement*

*Special thanks goes to Mr.Anura Jayathilake, Director, EPC & CM of the Ministry of Mahaweli Development & Environment. Support given by Deputy director Mr. Mahinda Werahera and Ms. Ruchira Perera from the ministry is gratefully recalled. I also must thank all the stakeholders for contributing with their knowledge, ideas and suggestions. My thanks goes to Mr.Hemantha Withanage for the guidance given in carrying out this project and also to Mr. Dilena Pathragoda for the invaluable support during the project.Support given by CEJ staff during the project period is remarkable. Finally, I thank everyone who supported me to make this effort a success.*

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## List of Acronyms

AC	- Alternating Current
AFR	- Alternative fuels and raw materials
AGWR	- Artisanal Gold Waste Recovery
APC	- Air Pollution Control
ASGM	- Artisanal and Small-scale Gold Mining
BOI	- Board of Investment of Sri Lanka
BP	- Blood pressure
CEA	- Central Environmental Authority
CFL	- Compact fluorescent lamps
CRT	- Cathode ray tubes
DVD	- Digital video disc
E-Waste	- Electronic and electrical waste
EDB	- Export Development Board
EPZ	- Export Processing Zone
ESP	- Electro Static Precipitator
GSMB	- Geological Survey and Mines Bureau
HS	- Harmonized System
ITI	- Industrial Technology Institute
LAs	- Local Authorities
LCD	- Liquid crystal display
MC	- Municipal Council
MIA	- Mercury Initial Assessment
MoMD&E	- Ministry of Mahaweli Development and Environment
MOH	- Ministry of Health
MRI	- Medical Research Institute
MRT	- Mercury Recovery Technology
MSD	- Medical Supplies Division
MSW	- Municipal solid waste
NEA	- National Environmental Act
PCC	- Paranthan Chemicals Corporation
PCW	- Puttalam Cement Works
ROP	- Registrar of Pesticides
SLADC	- Sri Lanka Ayurvedic Drugs Corporation
SLC	- Sri Lanka Customs
SLS	- Sri Lanka Standards
SPC	- State Pharmaceuticals Corporation
UC	- Urban Council
UNDP	- United Nations Development Programme
UNEP	- United Nations Environment Program
UNIDO	- United Nations Industrial Development Organization
UOM	- University of Moratuwa
UV	- Ultra-violet

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## *Introduction*

Mercury is acknowledged as a highly potent neurotoxin. When mercury enters water bodies it comes into contact with bacteria and forms methylmercury which later enter into organisms through food chains. Mercury is accumulated and biomagnified when it moves upwards in the food chain. Human can be exposed to methylmercury by eating fish and other sea foods<sup>1</sup>. Sri Lanka being an island, fishery is common in sea areas and also in the inland tank system built by the ancient kings. Therefore, fish is a major source of protein in communities living by the coastline as well as the inland making the whole population vulnerable to mercury poisoning through contaminated fish.

Mercury is mainly responsible for the disease called “Minamata disease”. This disease was first recorded in 1956 around Minamata Bay, Japan where massive mercury pollution was observed due to industrial waste water. Human and animal deaths continued for 36 years.

Mercury has been detected in fish and human hair samples in our previous study in communities around Negombo lagoon<sup>2</sup>. There has been lot of complaints about the fly ash emitted from Norochcholai coal power plant. Lives of people around the plant are at risk. We must not forget that this type of ash contains mercury. There are around 14 industrial zones operating around the country under board of investment (BOI). Therefore, the potential that mercury is being used in some industries is quite high. In addition to that, jewelry making at domestic level was also observed. Mercury is essentially used in Ayurvedic medicine. However, doctors stress that it is no longer toxic when the drug is in final stages and has cured many patients who could not be cured using western medicine. In the health sector mercury is still used for dental fillings by some doctors. In addition to that, thermometers and blood pressure gauges and other healthcare instruments containing mercury are still being used. However, the government has planned to import only mercury free equipment. During the National stakeholder validation meeting, representatives from the Medical Supply Division of the Ministry of Health, Sri Lanka stated that starting from this year (2018) only digital thermometers will be imported to the country. Another representative from the Ministry of Health, Sri Lanka, further explained that the Ministry of Health has stopped registering importers of aloe which is used for dental fillings. Products containing mercury

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<sup>1</sup> Heavy Metals in the Environment: Microorganisms and Bioremediation, edited by Edgardo R. Donati

<sup>2</sup> [http://english.arnika.org/publications/download/132\\_e76bad3688359339299247c5e34b2ce1](http://english.arnika.org/publications/download/132_e76bad3688359339299247c5e34b2ce1)

also include fairness creams, CFL, batteries, switches and pesticides. E-waste has become a problem in Sri Lanka as there is no proper mechanism to dispose of it and thus they end up in open dumps. These aspects are discussed in detail in this report. In addition to that several relevant legal provisions are also discussed.

Sri Lanka signed the Minamata Convention on 8<sup>th</sup> October 2014 and ratified it on 19<sup>th</sup> June 2017. Since then an initial assessment has been carried out at the ministry level. A mercury country situation report provides an overall scenario of the country's mercury usage and uphold the discussion about mercury in Sri Lanka and provides an opportunity for CEJ to work in collaboration with government agencies and to continue the campaign on phasing out/eradicating mercury from the country.

### *Mercury Supply Sources and Trade in Sri Lanka*

Mercury mining is not carried out in Sri Lanka at present. Therefore 100% of mercury demand is met through imports. According to the Department of Customs, Sri Lanka had imported 2800 kg of Mercury in 2015 and it is a higher value than previous years. However, only 1817 kg of mercury was imported in 2016. However, this trend could be changed with Sri Lanka signing the Minamata Convention. According to the Article 3 of the Minamata Convention, each party to the convention must identify individual stocks of mercury or mercury compounds exceeding 50 metric tons, as well as sources of mercury supply stocks exceeding 10 metric tons per year.

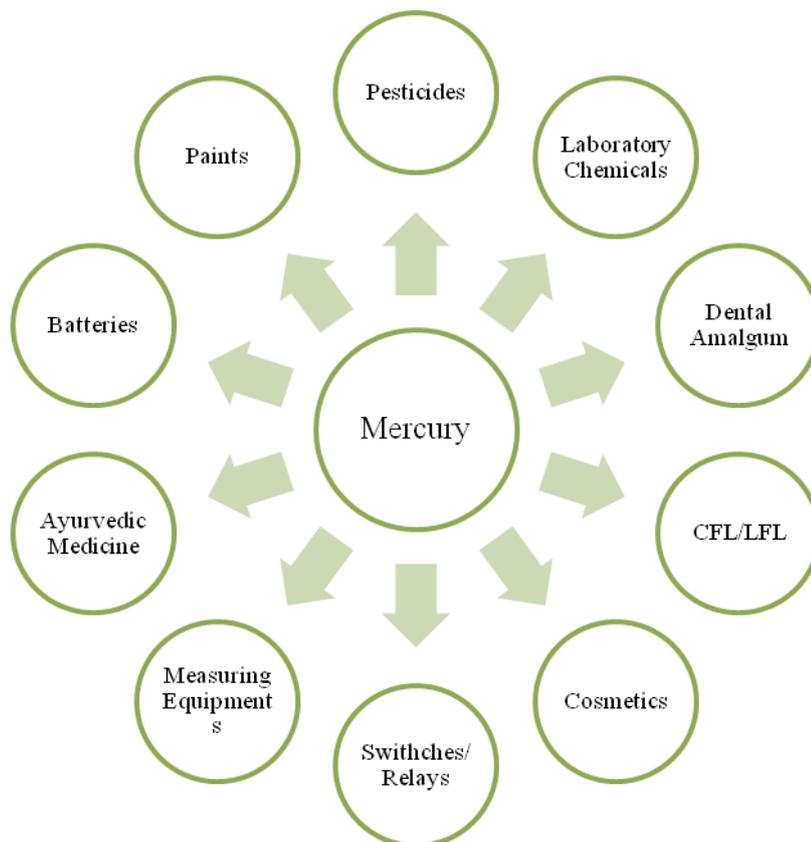
In case where mercury is found in Sri Lanka in the future, provisions can be made under Section 33 of Mines and Mineral Act, No. 33 of 1992 to prohibit primary mercury mining. It prohibits mining of certain minerals such as Uranium, Thorium, Beryllium, Lithium and Coral. Mercury can also be added to this list if necessary.

There is no legal prohibition or restriction for importing mercury in current regulations. However, the import export control Act No 1 of 1969 can be amended to control future mercury importation by including mercury into the list of controlled importation (schedule I)

During the study we were able to contact one mercury importer (M.D.Peiris Limited) According to them they would import mercury only if they get a tender. They had supplied mercury to Sri Lanka Ayurvedic Drugs Corporation.

### *Mercury Added Products*

There are many products which contain mercury and most of them are not manufactured in Sri Lanka but imported to the country. Following chart categorizes mercury containing products.



However according to paint manufacturers, paints with mercury are not found in Sri Lanka, except in Colombo dockyard which use marine paints to repairs ships. Data on use and import of mercury added switches and relays is lacking due to the availability of wide range of products under the HS codes under which electric switches and relays are imported. Other categories are discussed below.

## Dental amalgam

Mercury is used in dental practice to fill tooth cavities. An amalgam is prepared using pure mercury and aloe. Dental surgeons, staff and the patients can be exposed to mercury during the process. Number of dental surgeons practicing within Sri Lanka was recorded as 1279 by 2014<sup>3</sup>. Although there are alternatives, dental surgeons prefer amalgam due to several reasons:

1. Cost effective
2. Technique is uncomplicated and simple
3. Strong, lasts longer and less breakage
4. Moisture control is not much necessary as it is in alternatives

Government sector has taken initiatives to reduce use of amalgam by introducing composite filling since 2013. Also, the government is planning to use only composite fillings by 2020. Private sector dental institutes use around 150-180 kg of mercury every year. However major private hospitals and dental clinics have taken initiatives to reduce use of mercury.

Mercury separators to separate mercury from the dental waste were distributed in 2013 to health institutions. But they are not being used due to limitation of recycling facilities and administrative and management issues. Current practice in government institutions is to collect tooth and mercury waste in closed containers. According to the Environmental management framework for healthcare waste & infrastructure development in 2012 the practice of disposing mercury waste was incineration<sup>4</sup>.

Medical Supplies Division of MOH is the main supplier of dental amalgam for dental health institutions under ministry whereas dental institutions under provincial health authorities purchase dental amalgam from regional medical supplies divisions.

	Unit	Annual amount supplied		
		2014	2015	2016
<b>Dental amalgam (30 g bottles)</b>	No. of bottles	5202	5236	5861
	Kg	156.06	157.08	175.83

Table 1 Source – Medical Supply Division, Ministry of Health

Data shows that there is an increasing trend in amalgam purchase from 2014 -2016.

<sup>3</sup> <http://www.dental.health.gov.lk/statistics/hr>

<sup>4</sup> <http://admin.indiaenvironmentportal.org.in/files/file/Healthcare%20waste%20management-Draft.pdf>

Ministry of Health guidelines regarding management of mercury in the health sector dated 24-01-2013 issued by the Secretary of Health, instructs to collect dental amalgam using amalgam separators for safe handling.

Amalgam importation is controlled under the Special Import License and Payment Regulations, No. 1 of 2011 published in the Gazette Extraordinary No. 1739/3 of 02 January 2012. It is classified under HS code 2843.90. Amalgam is not a banned item to import. However, Ministry of Health has stopped registering amalgam importers to discourage it's import.

*During the national stakeholder validation meeting, it was suggested to organize a discussion/meeting with Dental Faculty, University of Peradeniya which is the only dental faculty in Sri Lanka to convince the students to avoid using amalgams and aware them about the deleterious effect of mercury.*

### *Mercury in Ayurvedic Medicine*

Ayurvedic medicine uses mercury to produce certain drugs in a detoxified form. These drugs are called “Rasa Aushada” in Sinhala which means mercury containing drugs. According to the available information 30 -40 % of the all ayurvedic medicines contain heavy metals including mercury. Sri Lanka Ayurvedic Drugs Corporation (SLADC) is the main manufacturer of “Rasa” or mercury containing drug preparations. In addition to that few other manufacturers also have been identified.

Sector	Institution	Amount of mercury containing drugs (kg)			Other mercury containing products (kg)
		2014	2015	2016	2016
Government	SLADC	1815	1715	1590	367
	Siddha Hospital in Kaithadi	13	9	8	-
Private	Crimiraja (Liveris & Sons Pvt. limited)	58	89	118	10
	Mangala Rasa Osu	54	59	79	20

Table2 Source- Minamata Initial Assessment, MoM D& E

Purified and detoxified mercury through a special process called “Ashtavidasanskarana” is used to make seven drug formulas. The following table shows the mercury usage in each formula.

Name of drug preparation	Mercury content (kg)	Output of drug preparation (kg)	Total quantity of drug prepared(kg)		
			2014	2015	2016
1. Wathagajendrasinghe rasa	2.725	70	840	700	560
2. Ramabana rasa	12.0	75	675	600	675
3. Krimigathana Wati	2.0	36	216	108	252
4. Arogyawardana Wati	0.36	15	45	75	15
5. Sankawati	1.8	25	25	25	100
6. Somanatha Rasa	0.5	20	100	140	180
7. Swasakutara rasa	3.0	25	200	275	175

Table3 Source- Minamata Initial Assessment, MoMD& E

According to medical institutes demand for these drugs is higher than the current production/supply.

### *Mercury Usage in Homeopathy Medicine*

All Homeopathy drugs are imported from India. Around 3000 Homeopathy preparations are imported to the country under two HS codes HS 3004.90.19 and HS 3004.90.90.(Guide, 2017)

HS Code	Imported quantity (kg)		
	2014	2015	2016
3004.90.19	93.64	50.40	120.00
3004.90.90	17,585,212.30	17,561,584.43	20,276,607.47

Table4 Source - Minamata Initial Assessment, MoMD& E

There are twenty homeopathic preparations containing mercury in trace quantities (nano level), which is undetectable.

- |                                   |                             |
|-----------------------------------|-----------------------------|
| 1. Mercurius Protoidatus          | 11. Mercurius Bromatus      |
| 2. Mercurius Solubilis Hahnemanni | 12. Mercurius Corrosivus    |
| 3. Mercurius Sablimatus           | 13. Mercurius Cum kali      |
| 4. Mercurius Sulphuricus          | 14. Mercurius Cynatus       |
| 5. Mercurius Tannicus             | 15. Mercurius Dulcies       |
| 6. Mercurius Vivus                | 16. Mercurius Iodatus flaus |
| 7. Mercurius Perennis             | 17. Mercurius Iodatus ruber |
| 8. Mercurius Aceticus             | 18. Mercurius nitrosus      |
| 9. Mercurius Auratus              | 19. Mercurius Phosporicus   |
| 10. Mercurius Biniodatus          | 20. Mercurius Preacipitatus |

Homeopathy drugs required by the government sector are supplied through *State Pharmaceuticals Corporation (SPC)*, while private Homeopathic practitioners should obtain drug list registration from Homeopathic Medical Council before import.

*Preparing guidelines and standards for “Rasavedakama” on minimizing the use of mercury and prescribing Rasaoushada (medicaments with mercury) especially for large scale manufacturers in consultation with sector experts and, enforcing them through Indigenous Medicine sector of the Ministry of Health was suggested during the National stakeholder validation meeting.*

### *Mercury in Measuring Instruments*

This mainly includes thermometers and blood pressure gauges.

#### **Thermometers**

Thermometers are used in health institutions, veterinary practice, laboratories (industries, schools, universities and other institutions with testing facilities) as well as in households and most of them are mercury contained.

Medical thermometers are purchased through medical supplies division of Ministry of Health. Private medical institutions purchase thermometers through local suppliers.

Item purchased	SR Number	Quantity			
		2013	2014	2015	2016
<b>Clinical oral Thermometer</b>	22302002	3,052	2,002	1,375	193
<b>Clinical rectal Thermometer</b>	22302001	28	124	67	114
Total		3,080	2,126	1,442	<b>307</b>

Table 5 Source - Minamata Initial Assessment, MoM D& E

Thermometers are used to measure air temperature. They are also used in laboratories, dairy industry and other industries which involve thermo sensitive processes. In addition to that households tend to have thermometers to check body temperature in case of fever. The total number of **mercury-filled thermometers** imported to Sri Lanka was around **244,907** in 2016. Out of this 240,790 are medical thermometers while 3,804 are distributed in education sector and 313 in industrial sector. According to the Medical Supply Division of the Ministry of Health, only digital thermometers will be imported, starting from 2018.

The current disposal practices of damaged/broken **medical thermometers** include burning in deep pit or incineration. However, it seems that Ayurvedic and private institutes lack knowledge on proper disposal methods compared to government institutions. Government

institutions get instructions at meetings held at Regional Director of Health Services (RDHS) offices and are made aware about the circulars issued by the MOH.(Worldbank)

### **Medical Blood Pressure Gauges**

BP meters with mercury are still used in most of the hospitals in health sector. Only a few major hospitals use digital manometers. The number of BP meters recorded in 2016 was 36,406. Bio -Medical Engineering (BME) division of Ministry of Health purchase and repair blood pressure gauges for line institutions. Hospitals under the Provincial Health Authorities purchase locally or receive them as donations.

Institutions	Number of BP gauges
<b>Government sector</b>	21,575
<b>Private sector</b>	13,738
<b>Ayurvedic</b>	1,093
Total	<b>36,406</b>

Table 6Source- Minamata Initial Assessment, MoM D& E

### **Barometers**

Barometers are used to measure atmospheric pressure. Meteorology Department is the highest single user of mercury barometers having 41 in regional observing stations and in the headquarters. In addition, University physics laboratories and schools with advanced level classes with science sections have barometers. Meteorology department is planning to import digital barometers. But keeping few mercury barometers as it is necessary for calibration purposes.

## *Mercury Containing Bulbs*

Mercury is added to form a vapour which produces light when current passes through it under a vacuum. Mercury is an essential component in following types of bulbs.

Category	Description	Amount of Mercury in Individual Component or Product (g)
Linear fluorescent	Straight tubes that can range widely in length, width, and output	<0.1
CFL	Folded or spiraled in order to approximate the physical volume of an incandescent bulb	<0.01
High intensity discharge	Includes metal halide, ceramic metal halide, high pressure sodium, and mercury vapor lamps. Operate similar to fluorescent lamps; however do not use phosphor powder. specialty lamps produced for commercial or municipal use, such as street lighting	<1
Neon	Red neon lamps do not contain mercury, but mercury is necessary to produce every other color in a neon lamp.	Mercury content per sign can range from < 30 mg to several hundred mg
Mercury short-arc	Spherical and are filled with argon and mercury vapor at low pressure. Used for special applications, such as search lights, specialized medical equipment, photochemistry, and ultraviolet-curing spectroscopy.	0.1-1

Table 7 Source – UNEP 2016

Although LED bulbs, a more energy efficient type has been introduced to the market, Linear Fluorescent and CFL are still being used for house lighting.

Mercury added light sources and parts (for local assembling plants) are imported to the country under the main category of ‘Electric filament or discharge lamps, including sealed beam lamp units and ultra-violet (UV) or IR lamps; arc-lamps’. During last four years, about 99% of the mercury-containing lamps imported to Sri Lanka were fluorescent lamps, from which over 87% comprised of energy efficient AC CFL. Non-mercury alternatives for these lamps with more energy saving specifications are now widely available on the local market, thus the demand for fluorescent lamps seems to be declining.

There is only one CFL/LFL recycling factory in Sri Lanka which has the capacity to recycle 30 million bulbs annually. (Asia Recycling (Pvt) Ltd, Orel Corporation). The plant currently receives and recycles 100,000 to 150,000 bulbs every month which is less than 10% of the CFL imported to Sri Lanka monthly. Mercury and phosphorous powder is extracted using dry process and exported to Germany for further separation. Extracted glass, plastic and metal are sold to different companies within the country for reuse.

Year	Number of bulbs recycled	Approximate mercury content (kg)
2013	917,382	3-5
2014	1,056,978	3-5
2015	839,435	3-4
2016	<b>1,054,402</b>	3-5

Table 8 source – Asia Recycling Pvt Ltd



*Figure 1 Pre Processing done manually*



*Figure 2 Mercury Recovery using Dry process*

If a good collection mechanism can be established this plant can be operated to its maximum capacity. The support of the government, CFL importers and distributors, general public is important.

## *Batteries with Mercury*

Mercury is usually added to batteries to prevent the build-up of internal gases that can cause the battery to bulge and leak. However, there are specific batteries where mercury is added to obtain specific features. In mercuric oxide batteries, mercury is used as an electrode rather than an additive to control gas build-up and used in hospitals, military facilities and commercial applications. Mercury accounts for up to 40% of the battery weight and cannot be reduced without reducing the energy output of the battery. A battery can contain more than 25mg of mercury. Button cell shaped batteries contain up to 1% of its weight or sometimes more. These batteries are in the shape of coin or button and used in small electronic devices. Zinc-air, silver-oxide, and alkaline manganese oxide batteries are few examples of button cell shaped batteries.

Button-cell battery type	Uses
<b>Zinc Air</b>	Mostly used in hearing aids due to their high energy concentration and ability to continuously discharge energy. Also used for small devices, such as wristwatch pagers and ear speech processors.
<b>Silver Oxide</b>	Used in various devices, such as hearing aids, watches, cameras, and clocks.
<b>Alkaline Manganese Oxide</b>	Used in toys, calculators, remote controls, and cameras.

Table 9

In average one of these batteries can contain 5 mg of mercury. But compared to mercuric oxide batteries button cell shaped batteries contain small amount of mercury. Quantities of batteries imported to Sri Lanka in year 2016 are given in the table below.

HS code	Product description	Quantity imported in 2016	
		(kg)	(tonnes)
<b>HS 8506.30</b>	Mercuric oxide	6.38	<b>0.006</b>
<b>HS 8506.40</b>	Silver oxide	3217.44	<b>3.217</b>
<b>HS 8506.60</b>	Air-zinc	250.05	<b>0.250</b>
<b>HS 8506.80</b>	Other primary cells and primary batteries	443646.39	<b>443.646</b>

Table 10 Source- SLC data obtained from Minamata Initial Assessment, MoM D& E

## Cosmetics with Mercury

Skin lightening creams are popular in the country especially among the younger generation. There are about 23 local cosmetics and pharmaceutical manufacturing industries. In addition to that these products are also imported to the country.



Figure 3 Few Fairness cream brands found in Sri Lankan Market

National Medicines Regulatory Authority Act No 5 was created in 2015 replacing the Cosmetics Devices and Drugs Act No 27 of 1980<sup>5</sup>. Even though CCD act covered cosmetics section, it has been removed in the new NMRA act. Until 2015, cosmetics products had been registered by the Ministry of Health based on Sri Lanka Standards. During the registration process mercury content was checked. Registration process involved submission of an application to the Cosmetics Drugs and Devices Authority by the manufacturer, evaluation by the cosmetic subcommittee of the Ministry of Health where assessment of heavy metals (Cadmium, mercury, lead, arsenic) was taken from the approved laboratory (ITI) and the subsequent granting of approval. This process has not been continued after 2015 due to change in the mandate of the institution.

According to the Minamata convention skin lightening creams and soaps with more than 1ppm of mercury content should be phased out by 2020. According to the available SLS

<sup>5</sup> Jayakody, R. L. (2015). The National Medicines Regulatory Act: Its birth, provinces and challenges. Ceylon College of Physicians, 53-56

specifications on cosmetics, the maximum permissible mercury concentration for skin creams, lotions and powders is 1 mg/kg (1 ppm). However, mercury limits are not specified for soaps. A survey conducted by Centre for Environmental Justice in 2013 on the mercury level of skin whitening creams in the market detected mercury in 25 out of 46 samples. Mercury concentrations ranged from 0.06 - 30137.66 ppm<sup>6</sup>. Most of the products with high levels of mercury were imported products.

*However, NMRA is now reconsidering the regulations of the previous CCD act regarding cosmetics. In case NMRA restart the registration process, it can be strengthened by providing necessary laboratory facilities accredited for mercury testing and human resources. Laboratory of the Industrial Technology Institute (ITI) and Bureau Veritas are the approved laboratory but not yet accredited for testing of mercury. The National Drugs Quality Assurance laboratory of Ministry of Health does not have adequate facilities to analyze the heavy metals. This was revealed during the national stakeholder meeting.*

### *Laboratory Chemicals and Equipment*

Metallic mercury and other mercury compounds are imported to Sri Lanka for laboratory use. The following table shows the imports of mercury containing compounds and metallic mercury.

HS Code	Description	Net weight imported in 2016 (kg)*
<b>HS 28.05</b>	Alkali or alkaline-earth metals; rare-earth metals, scandium and yttrium, whether or not intermixed or inter-alloyed; mercury.	
<b>HS 2805.40</b>	- Mercury	1817.85
<b>HS 28.52</b>	Inorganic or organic compounds of mercury, whether or not chemically defined, excluding amalgams.	
<b>HS 2852.10</b>	- Chemically defined All organic or inorganic compounds of mercury meeting the requirements (a) to (e). a) Separate chemical elements and separate chemically defined compounds, whether or not containing impurities. b) Mixtures of two or more isomers of the same organic compound (whether or not containing impurities), except mixtures of acyclic hydrocarbon isomers (other than stereoisomers), whether or not saturated. c) These products either dissolves in water or other solvents provided that the solution constitutes a normal and necessary method of temporarily for safety or for transport purposes. The used solvent does not render the product suitable for specific use other than for general use.	27.35

<sup>6</sup> <http://ejustice.lk/wp-content/uploads/2017/10/CEJ-MERCURY-Research-paper-Dec-2012.pdf>

	d) Mentioned product with an added stabilizer (including anti-caking agent) necessary for their preservation or transport.	
	e) Mentioned product upon the addition of anti-dusting agent or a colouring substance added to facilitate identification or for safety reasons. These additives do not render the product particularly suitable for specific use rather than for general use.	
<b>HS 2852.90</b>	- Other Compounds of mercury that does not meet the requirements of HS Code: 2852.10.00 (a) to (e)	186.30
<b>HS 29.31</b>	Other Organo-inorganic compounds	
<b>HS 2931.90.20</b>	--- Organo-mercury compound	No imports since 01.01.2013 to date

Table 11 Source- SLC data/ Minamata Initial Assessment, MoMD& E

According to import data 1817.85 kg of metallic mercury was imported to the country in 2016. This amount is distributed among educational sector (laboratories), health sector (preparation of Ayurvedic drugs) and industrial sector (Artisanal Gold Waste Recovery)

Following mercury containing chemicals are used in School and University laboratories.

Chemical compound	Formula	Uses
<b>Mercury(II) sulphate</b>	HgSO <sub>4</sub>	<ul style="list-style-type: none"> <li>Chemical oxygen demand – measuring of the oxygen equivalent of organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant (0.4 g).</li> <li>Barbiturates test – detection for the presence of barbiturates (0.003 g).</li> </ul>
<b>Mercury(II) chloride</b>	HgCl <sub>2</sub>	<ul style="list-style-type: none"> <li>Qualitative analysis of anions and cations in samples.</li> </ul>
<b>Mercury(II) oxide</b>	HgO	<ul style="list-style-type: none"> <li>Preparation of staining solutions. Used in hematoxylin and eosin staining for nuclear detail/definition in oxidation of hematoxylin to hemalein (minute quantities).</li> <li>Formic acid test – analysis of formic acid present in foods, beverages and other materials (0.001 g).</li> <li>Identification of isopropyl alcohol (0.25 g).</li> </ul>
<b>Nessler's reagent</b>	K <sub>2</sub> HgI <sub>4</sub> (0.09 mol/L) in KOH (2.5 mol/L)	<ul style="list-style-type: none"> <li>Identification for the presence of [NH<sub>4</sub>]<sup>+</sup> (0.1 mL)</li> </ul>
<b>Millon's reagent</b>	Hg(NO <sub>3</sub> ) <sub>2</sub> (5 % w/v) in HNO <sub>3</sub>	<ul style="list-style-type: none"> <li>Identification of tyrosine residues in proteins (2 drops).</li> </ul>

Table 12 Source- Minamata Initial Assessment, MoMD& E

Following chemicals were also found in University laboratories.

- Mercury(I) oxide : Hg<sub>2</sub>O
- Mercury(II) phosphate : Hg<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>
- Mercury(I) sulphate : Hg<sub>2</sub>SO<sub>4</sub>
- Mercury(II) thiocyanate : Hg(SCN)<sub>2</sub>
- Mercury(II) Nitrate Dihydrate : Hg(NO<sub>3</sub>).2H<sub>2</sub>O
- Mercury(I) chloride : HgCl
- Mercury(II) iodide : HgI<sub>2</sub>
- Mercury(II) acetate : Hg(CH<sub>3</sub>CO<sub>2</sub>)<sub>2</sub>
- mercury(II) sulphide : HgS
- Mercury(II) bromide : HgBr<sub>2</sub>

In addition to the above chemical compounds, following laboratory equipment also contain mercury.

- Calomel electrode (Hg:Hg<sub>2</sub>Cl<sub>2</sub> 0.75:0.25)
- Dropping mercury electrode
- Barometer
- Hygrometer
- Boyle's apparatus
- Hygroscope
- Manual universal tensometer (University of Moratuwa, Faculty of Engineering)
- Mercury hollow cathode lamp for atomic absorption spectrophotometer
- Blaine apparatus (Tokyo Cement Group, used for cement calibration)
- Distillation column with mercury (University of Peradeniya, Faculty of Engineering)
- Mercury spectral lamp (University of South Eastern University, Faculty of Applied Science)

### *Biocides and Pesticides with Mercury*

Sri Lanka only has pesticide formulation plants and all the chemicals including active ingredients are imported. They can be in the form of wettable powder or water dispersible granules. Pesticides and biocides used in Sri Lanka reported to be consisted of average mercury content of 36.9 ppm. According to studies conducted in Brazil, amounts of trace elements present in pesticides decrease in order; Pb>Cr>Hg>As (source: ROP).

Registration of pesticides with following mercury compounds (as active ingredient) were regulatory banned in 1987 and legally banned in 2001 by the Extraordinary Gazette No. 1190/24 of 29/06/2001 under the control of Pesticides Act No. 33 of 1980.

- ✓ Mercuric (II) chloride: 7487-94-7
- ✓ Mercuric oxide: 21908-53-2
- ✓ Mercury: 7439-97-6
- ✓ Mercurous (I) chloride: 7546-30-7

Office of the Registrar of Pesticide was also established under this act. Issuing licences to pesticides through an evaluation procedure is the main function of this office.

*In addition to that, since 2013 Office of the Registrar of Pesticide take reports on every pesticide product annually for 10 heavy metals. Mercury is contained as a general contaminant in every pesticide. According to those reports, 100% of pesticides contain less than 1000 ppb mercury, 50 % of pesticides contain less than 20 ppb mercury. In a recent research they had found trace amount of mercury in rice samples in Kandy district. But these levels were in compliance with globally accepted CODEX standards. But in imported rice*

varieties elevated mercury levels had been observed. said Dr. Sumith. Registrar of Pesticides during the national stakeholder meeting.

## *Emissions*

### *Coal Power Plants*

Sri Lanka’s only coal fired power plant is located at Norochcholai in the North Western Province and is in operation since 2011. The total power generation capacity in 2016 was 900 MW.



*Figure 4 Norochcholai Power Plant*

Annual coal usage at the power plant for the period of 2012-2016 was given in the table below.

Year	Total amount of coal received (tonnes)	Annual coal consumption (tonnes)
<b>2012</b>	739,948	609,239
<b>2013</b>	1,032,510	677,633
<b>2014</b>	1,551,148	1,371,539
<b>2015</b>	1,702,222	1,880,012
<b>2016</b>	2,198,480	<b>2,004,021</b>

Table 13 Source: Minamata Initial Assessment, MoM D& E

An Electro Static Precipitator (ESP) is installed in each power generation unit and collects about 850 tonnes of total coal fly ash every day, from which a part is sold to cement manufacturers, roofing sheets manufacturers and brick manufacturers where the rest is dumped in the ash yard. Fly ash and bottom ash originated from the power plant was tested for the presence of mercury (as Hg). The test results indicated that mercury was not detected

in fly ash and bottom ash samples tested (**limit of detection, 0.05 mg/kg**). Minamata Initial Assessment conducted by the Ministry of Mahaweli & Environment calculated an annual mercury emission level of coal as 312.4 kg.

In addition to that information is available on two coal fired industrial boilers. The annual average coal consumption in industrial boilers estimated to be 24,000 tonnes.

	<b>Industrial boiler 1</b>	<b>Industrial boiler 2</b>
<b>Location</b>	Seethawaka EPZ (Western Province)	Pannala (North Western Province)
<b>Year of commencement</b>	January 2016	2006
<b>Operating practice</b>	Continuous	Intermittent (shut down for 10 days per month)
<b>Use</b>	Steam and power generation (1 MW)	Only steam generation
<b>Daily coal consumption (average)</b>	40 tonnes	40 tonnes
<b>Annual coal consumption (average)</b>	<b>14,400 tonnes</b>	<b>9,600 tonnes</b>
<b>Country of origin of coal</b>	Indonesia	Indonesia

Table 14

Draft National Environmental (Stationary Source Emission Control) Regulations under the National Environmental Act No. 47 of 1980 mention the limits of mercury emissions for thermal power plants as 0.001 mg/Nm<sup>3</sup>.

### *Cement Production*

Coal is used as the energy source in clinker production. The Puttalam Cement Works (PCW), which is located in Palaviya, Puttalam (North Western Province) is the only fully integrated cement manufacturing plant in Sri Lanka. The below table shows the coal import data during the period of 2012-2016

<b>Year</b>	<b>Imported coal amount (tonnes)</b>
<b>2012</b>	76,491
<b>2013</b>	81,084
<b>2014</b>	93,665
<b>2015</b>	101,550
<b>2016</b>	<b>64,245</b>

Table 15 Source - Siam City Cement (Lanka) Limited

The plant operates using a dry process with two identical kilns. Each kiln has a capacity of 1100 tonnes/day. The plant approximately produces 1.3 million tonnes of cement and

640,000 tonnes of clinker annually<sup>7</sup>. Limestone, the main raw material, is obtained from a company owned limestone mine in Aruwakkaru, Puttalam. Clay which is another raw material is supplied from an area named Vanathawillu in Puttalam district. These raw materials contain trace concentrations of mercury. Mercury containing fly ash from coal combustion is also added to make the cement chemically resistant.

In 2002, this facility started using alternative fuel source mainly rice husk and saw dust. This process is named as Co-processing. This facility is then approved to co-process alternative fuels and raw materials (AFR), including hazardous wastes (also known as scheduled wastes<sup>8</sup> in Sri Lanka) and non-hazardous wastes. To date, the plant has co processed biomass wastes and textile scraps. They have also processed petroleum sludge, waste oil, and expired pharmaceuticals. The AFR co-processing currently provides up to 35% of the kiln fuel, primarily from non-hazardous wastes including biomass and textile scraps. Mercury content in the AFR varies with type and amount of the co-processed waste, sometimes higher compared to virgin raw materials, which may increase the total input of mercury to the cement production.

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<sup>7</sup> Wijayasundara, M. (2011). Sustainability in Manufacturing Built Materials: Cement Manufacturing Using Alternative Fuel and Raw Material in Cement Kilns

<sup>8</sup> Prescribed list of waste, which refers as scheduled waste to facilitate the easy identification of Waste types which should follow this regulation without undergoing expensive analytical methods; National Environmental (Protection & Quality) regulation No. 01 of 2008 as amended by the gazette notification No 1534/18

## *Mercury in Waste*

### *Municipal Solid Waste*

Proper management of municipal solid waste has never been accomplished in Sri Lanka. Local authorities are primarily responsible for management of municipal solid waste. Average MSW generation in Sri Lanka was around 6,500-7,000 tonnes/day in 2015<sup>9</sup>. However, only 50% of the generated municipal waste (about 3,500 tonnes/day) was formally collected by the respective LAs island-wide due to burning and dumping near roadsides. The table below summarizes MSW generation, collection, recycling, composting or biogas generation and disposal/dumping in Western province and other provinces.

	Unit	Western Province (3 Districts)	Other Provinces (22 Districts)	Total
<b>Total MSW Generation</b>	t/day	26,00.93	7,210.00	9,810.93
	<b>t/year</b>	<b>936,334.80</b>	<b>2,595,600.00</b>	<b>3,531,934.80</b>
<b>Total MSW Collection</b>	t/day	1,965.11	1,802.00	3,767.11
	<b>t/year</b>	<b>707,439.60</b>	<b>648,720.00</b>	<b>1,356,159.60</b>
	<b>%</b>	<b>75.55</b>	<b>24.99</b>	<b>38.40</b>
<b>Total MSW Recycled</b>	t/day	120.89	829.00	949.89
	<b>t/year</b>	<b>43,520.40</b>	<b>298,440.00</b>	<b>341,960.40</b>
	<b>%</b>	<b>4.65</b>	<b>11.50</b>	<b>9.68</b>
<b>Total MSW Composted and Used for Biogas Generation</b>	t/day	139.00	447.00	586.00
	<b>t/year</b>	<b>50,040.00</b>	<b>160,920.00</b>	<b>210,960.00</b>
	<b>%</b>	<b>5.34</b>	<b>6.20</b>	<b>5.97</b>
<b>Total MSW Disposed in Sanitary Landfills or Open Dumped</b>	t/day	1,705.22	526.00	2,231.22
	<b>t/year</b>	<b>613,879.20</b>	<b>189,360.00</b>	<b>803,239.20</b>
	<b>%</b>	<b>65.56</b>	<b>7.30</b>	<b>22.74</b>

Table 16 Note: All percentage values were calculated based on total MSW generation  
Source: Western province Waste Management Authority data /Minamata Initial Assessment, MoM D& E

Waste incineration has not been introduced to Sri Lanka. However, one sanitary landfill has been established in Dompe (western province) with a capacity of 6 tons/day. In addition to that two semi-engineered sanitary landfills are operated in Nuwara Eliya with the capacity of 25 tons/day. Rest of the garbage is open dumped. Meethotamulla, Karadiyana, and Gohagoda are such open dump sites.

<sup>9</sup> Mannapperuma, N. (2015). Business Opportunities Available in the Waste Management Sector –. Retrieved from <http://www.wmawp.lk/sn/admin/userfiles/files/Pre%20Bid%20UDA.pdf>



*Figure 5 A view of Meethotamulla dump site*

Minamata Initial Assessment conducted by the Ministry of Mahaweli & Environment showed that release of mercury due to open waste burning as 12287 kg/Hg/yr.

### *Electronic Waste*

E-waste accounts for 22 % of the world mercury consumption<sup>10</sup>. There is no e-waste separation during the collection of MSW. E-waste contains mercury. According to the published reports, e-waste content in MSW range from 0.1-1.4%. (EML, 2016) Ex:- compact fluorescent lamps (CFL), fluorescent lights (tube lights) and other mercury containing lamps, electric switches and relays (mechanical doorbells, thermostats), liquid crystal display (LCD) monitors, audio equipment, laptops or notebook computers, telephones, digital video disc (DVD) players, fax machines, photocopiers. These items can contain about 2-10 mg per equipment. Waste Management Unit of CEA has estimated e-waste generation rate in Sri Lanka around 20,000 tons/year.

Hazardous waste (scheduled waste) management regulation under National Environmental (Protection and Quality) Regulations, No. 1 of 2008 under the National Environmental Act (NEA), No. 47 of 1980, published by Gazette Extraordinary 1534/18 dated 01.02.2008 has listed Electric and electronic waste in the list of hazardous waste (scheduled waste). According to the regulations, every generator, collector, store, transporter, recover, recycler

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<sup>10</sup> Honda, S. (2008). E-Waste Management, Mercury in e-waste, Environmentally unsound disposal. Minamata City Kumamoto, Japan. Retrieved from [www.techmonitor.net/tm/images/4/4f/08jul\\_aug\\_sf1.pdf](http://www.techmonitor.net/tm/images/4/4f/08jul_aug_sf1.pdf)

and disposer of e-waste should obtain a license from the CEA. The CEA has mandated that the e-waste should be given only to authorized collectors. Ten organizations have been registered by the end of 2016 as e-waste collectors. In addition, there are number of informal collectors.

CFL and fluorescent bulbs are recycled by a leading bulb company with a market share of 48%. The plant is operational since 2011 and has the capacity to recycle up to 30 million bulbs annually which is approximately 3 times of CFL usage in the country. One company has obtained approval from CEA to recycle cathode ray tubes (CRT). They have recently granted environmental clearance to establish a facility at Katunayaka EPZ to process e-waste to recover precious metals.

Formal recycling is still not much expanded and most of them do only partial recycling. Other formal sector organizations recycle different types of e-waste through their informal network to extract metals and plastics. These metals and plastics are sold to local recyclers while printed circuit boards are exported.

Informal sector is efficient and well organized but not regulated well. Once the valuable parts are recovered, rest is dumped in to municipal solid waste most of the time or stocked within the premises.

### *Manufacturing Processes*

Sri Lanka does not have any industries which use mercury during the manufacturing process. (Chlor-alkali and Acetaldehyde as in the Part I of Annex B) or (Vinyl chloride monomer, Sodium or Potassium Methylate or Ethylate, polyurethane using mercury containing catalytsas in the Part II of Annex B).

A chlor-alkali plant was established in the 1970's under Paranthan Chemicals Corporation (PCC). The plant was based on solar salt, of which Sri Lanka produced about 80,000 tonnes per year<sup>11</sup>. From this raw material, caustic soda (sodium hydroxide, NaOH) was produced in the De-Nora type diaphragm cells (Diaphragam process) simultaneously generating about

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<sup>11</sup> UNIDO. (1977). Chemical Industry Development: Terminal Report. Vienna: UNIDO executing agency for UNDP

950 tonnes of chlorine gas. PCC ceased manufacturing activities of Chlor-alkali plant in 1985.

*During the Stakeholder validation meeting it was confirmed that there is no polyurethane produced using mercury catalysts within BOI industrial zones.*

#### *Jewelry Manufacturing*

Jewelry manufacturing industry in Sri Lanka employs about 15000 individuals currently (National Gem & Jewelry Authority). Out of those, 10,000 are registered as individual craftsmen while the rest are employed in factories and workshops producing jewelry mainly for the export market. There may be around 1,500 unregistered craftsmen. The industry is located mainly in central and southern provinces. Recovery of gold from the gold dust is practiced in the industry using mercury. Individual craftsmen do this yearly or every 6 months. Gold dust is mixed with mercury and the resulting amalgam is heated to evaporate off mercury. Most of them do not use safety gear. Since the majority of them work inside the house where family members reside, the exposure to mercury is high. Most of them are not aware about the health risks of mercury.

The draft Assaying and Hallmarking Regulation 2016 provides the legal power to the Assaying Officer for inspection of Jewelry Manufacturers. But it seems that no actions are taken regarding practicing safety measures during gold recovery. Introducing best available techniques to the industry and awareness raising is necessary. Research work done regarding the health issues of the industry workers is minimum.

#### *Artisanal and Small-Scale Gold Mining*

Small-scale gold mining is not a significant activity in Sri Lanka. A few incidents of such mining has been recorded in river beds (Ex:-Kelani River). However, the use of mercury to extract gold in this situation has not been confirmed. If these practices are becoming significant in the future, it may be regulated by amending Mines and Mineral Act No 33 of 1992.

## *Mercury Storage and Waste*

As mercury is not mined in Sri Lanka, but imported from other countries, mercury stocks remain with the importers/merchants. As activities such as ASGM are not significant in the country, these stocks should also be small. During the study we were able to contact one mercury importer. According to them they imported mercury only if they get a tender. They had supplied mercury to Sri Lanka Ayurvedic Corporation.

Mercury waste containing metallic mercury, organic and inorganic mercury compounds is listed as scheduled waste by the National Environmental (Protection and Quality) Regulations, No. 1 of 2008 published by Extraordinary Gazette no. 1534/18 dated 01/02/2008

A scheduled waste license has to be obtained if somebody is generating transporting or processing mercury containing waste. Scheduled Waste License is issued by CEA and is evaluated by technical committee appointed by CEA under the provisions of Basel Convention (This TEC focuses on all the matters related to management of chemicals including import, use and export and to BRS and Minamata Conventions). This is a top level committee to take all decisions on chemical management and the decisions will be conveyed to BRS -NCC for national level decision making. Asia Recycling Pvt Ltd which happens to be the only CFL recycling factory has their waste stored in a safe container to be sent to Sweden for recovery of mercury. They have obtained a Scheduled Waste License from the CEA for collection, transportation, storage and recycling. The majority of the other places such as laboratories do not collect and store mercury wastes safely.

Recovery of mercury is minimal in the country. Some guidelines have been given in the health sector to collect the broken instruments and bulbs etc. and collect dental amalgam using amalgam separators. Other than that, no mercury recovery was observed except for CFL.

Even though some items of inorganic and organic mercury compounds (except amalgam) have been listed under the import and Export control Act 01 of 1969 as licensed item, mercury waste is not listed under the same act. Therefore, import and export of mercury waste is not regulated. However, the Import and Export Control Department refers the request for importation, to the BRS (Basel, Rotterdam ,Stockholm) technical committee prior

to granting the approval for importation. Thereby, risk of importing mercury waste can be reduced.

### *Communication with Government Agencies*

Focal point for the Minamata Convention in Sri Lanka is Ministry of Mahaweli Development and Environment. During the study we communicated with Environment Pollution Control and Chemical Management division of the ministry. In addition to that we also communicated with Department of Customs, Gem & Jewelry Research & Training Institute, Geological Survey and Mining Bureau, Ministry of Health, Industrial Technology Institute, Board of Investment, National Water Supply and Drainage Board, Department of Pesticides, Institute of Indigenous Medicine and Western Province Waste Management Authority, etc.

The Stakeholder Validation Workshop was held at Hector Kobbekaduwa Agricultural Research and Training Institute, Colombo 7, Sri Lanka on 2<sup>nd</sup> April 2018 with the participation of number of stakeholders representing National Water Supply & Drainage Board, Geological Survey & Mining Bureau, Ministry of Health, Sri Lanka Customs, Gem & Jewelry Research & Training Institute, Institute of Indigenous Medicine University of Colombo, Ministry of Mahaweli Development & Environment, Industrial Technology Institute, Board of Investment, Department of Pesticides and the Medical Supply Division, Ministry of Health.

Latest developments regarding mercury in the country and issues existing in respective agencies/ institutes in taking decisions and working towards eliminating mercury were discussed.

During the discussions, the representative from the Ministry of Mahaweli Development & Environment mentioned about the initial work conducted by the ministry in assessing mercury in education, health and industrial sectors and also on the initiatives by the National Medical Research Authority in the process of re activating the provisions in the previous CCD act in controlling standards for the fairness creams. The representative from the Department of Pesticide



*Figure 6 National Stakeholders meeting at Colombo*

mentioned that since 1983, Department of Pesticide had banned mercury containing pesticides. In addition, that they conduct surveillance program to test 10 heavy metals including mercury in pesticides and rice.

A representative from the Geological Survey & Mining Bureau mentioned that license for small scale gold mining in rivers are no longer issued. Yet, there is a practice to recover gold from waste once a year using mercury.

Furthermore, practices of CFL bulbs importation and life cycle, mercury in Ayurvedic medicine, water testing programs in rivers, mercury in paints used in shipping industry and related research, illegal mercury imports and need for further researchbased data was discussed.

### *Conclusions and Recommendations*

Mercury is being used in certain sectors and certain consumer products in Sri Lanka. However, Sri Lanka does not have significant manufacturing processes utilizing mercury. Knowledge about handling mercury, mercury compounds and mercury waste are not adequate and most people are unaware of the risk. Certain measures can be taken to reduce the use of mercury and to ensure that mercury is safely handled.

- Environment Protection License (EPL) procedure has been introduced under National Environmental Act 47 of 1980 to monitor and regulate the industries which pollute the environment. Certain measures can be taken to minimize mercury pollution under its provisions such as including certain industries to “the prescribed list”. (assembling and manufacturing CFL and LFL bulbs, switches and relays containing mercury, coal power plants, coal powered industrial boilers)
- Make modifications to the EPL procedure to identify whether mercury is used by an industry and to what extent.
- Laws should be established by an Act to regulate manufacturing, selling and importation of cosmetics listing the maximum limit of mercury concentration in cosmetics to comply with the obligations as new NMRA act does not cover cosmetics

- Draft National Environmental (Stationary Source Emission Control) Regulations should be implemented and mercury emission limits should be monitored.
- New regulations should be established to implement the Extended Producer Responsibility for mercury containing equipment especially e-waste.
- Develop separate HS sub codes to classify mercury containing products/equipment to take regulatory measures of banning/restriction
- Shifting to mercury free alternatives ex:- dental amalgam, measuring equipments etc
- Monitoring the process taken from the importer to the end user to avoid misuse of mercury
- Regular testing of communities with the highest exposure to mercury (such as fishing, jewelry manufacturers) for their health and mercury concentrations in the body
- Private medical institutes and hospitals should be monitored for proper disposal practice of mercury
- Conduct training programs periodically at relevant institutions with regard to mercury usage, health risk of mercury exposure
- Educate e-waste collectors about the health risk of mercury and how to properly handle of e waste

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