Toxics Link
for a toxics-free world

MERCURY FREE INDIA

Right Choices

A study by Toxics Link

About Toxics Link

Toxics Link is an environmental organisation, engaged in disseminating information and help strengthening campaigns against toxic pollution, providing cleaner alternatives and bringing together groups and people concerned with, and affected by, this problem.

"We are a group of people working together for environmental justice and freedom from toxics. We have taken it upon ourselves to collect and share information about the sources and dangers of poisons in our environment and bodies, as well as about clean and sustainable alternatives for India and the rest of the world."

Zero Mercury Working Group

The Zero Mercury Working Group (ZMWG) is an international coalition of more than 80 public interest environmental and health non-governmental organizations, from 42 countries from around the world, formed in 2005 by the European Environmental Bureau and the Mercury Policy Project.

ZMWG strives for zero supply, demand, and emissions of mercury from all anthropogenic sources, with the goal of reducing mercury in the global environment to a minimum. The Mission is to advocate and support the adoption and implementation of a legally binding instrument which contains mandatory obligations to eliminate, where feasible, and otherwise minimize, the global supply and trade of mercury, the global demand for mercury, anthropogenic releases of mercury to the environment, and human and wildlife exposure to mercury.

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FOREWORD

For the past several decades, there has been a growing body of literature and knowledge about the disastrous health and environmental impacts of mercury. In fact the Minamata tragedy, which left over 2200 (as in 2001) victims crippled or dead, was a call to action. However despite this, mercury continues to be used in everyday life, almost ubiquitously, through thermometers, dental amalgam, lighting, paints, artisanal gold mining, besides being released in industrial processes like chlor alkali manufacture and emission from coal based energy production. The impacts are on everyone, but the poorest and the vulnerable populations like children and pregnant women are particularly exposed and impacted.

Mercury is a toxic heavy metal, which is bio-accumulative, biomagnifies, and is persistent. It metabolizes into the deadly methyl mercury naturally. Mercury can pass through skin, blood-brain & placental barrier and cause devastating effects on the functioning and growth of brain of developing fetus. The ability of mercury for trans-continental or trans-boundary movement makes it an issue of global concern.

Toxics Link has been working continuously on the issue of mercury since 2003, starting with the publication of the report "Mercury in India, Toxic Pathways" for the UNEP based global mercury assessment. Since then it has worked extensively both in India as well as with partners regionally and internationally, to help reduce its use in various sectors like health care and lighting, to raise public awareness, and to conduct research about its impacts on food (fish, water) and the environment.

The global issues around mercury concern mining, trade, supply, demand, and its substitution to less or non-toxics processes. The challenges are widespread and difficult, especially in areas like artisanal small-scale gold mining. However in India mercury is neither mined nor produced, but is totally imported. It is however exported from here. For example, in the year 2012-13 the total import & export of elemental mercury was 165 tons & 45 tons, respectively. Mercury-containing instruments, mercury compounds, batteries containing mercury, clinical thermometers are also imported into India in large quantities. However in the overall picture, the Indian challenges for mercury substitutions are manageable, but require a clear road map, industry cooperation, citizen's awareness, and a committed public policy.

With the signing of the intergovernmental legally binding UNEP Minamata Convention on mercury in Japan in October 2013, ten years of concerted global action was brought to a conclusion. Its implementation will however need 50 countries to ratify it. The major focus of the Treaty is to control and regulate mercury trade, reduce supply and usage control, reduce mercury emissions and releases and ensure mercury wastes are handled in safe and environmentally sound manner. Financial support to assist concerned governments and others in implementing the treaty is likely to be made available through the Global Environment Facility (GEF).

In India too, over the past years, progress has been made in reducing mercury use in hospitals, and the chlor alkali industry. Encouragingly, the Central Ministry of Health and Family Welfare, as well as some State governments (including Delhi) and numerous hospitals have opted for mercury free operations in hospitals under their control. But problems abound. Studies show extensive contamination of fish, water as well as the existence of contaminated sites. There is also the controversial use of mercury in Ayurvedic medicine, as well as in religious practices. Mercury continues to be available in open markets, and there are also several unregulated units producing items like mercury thermometers and lighting fixtures in very toxic conditions, in the absence of any trade or other restrictions. There are no collection or recycling facilities for end-of-life mercury based fluorescent lighting, which also has higher amounts of mercury compared to global norms. Though the chlor alkali industry has largely shifted to non-mercury processes, yet the surplus mercury from this changeover has not been retired but introduced back into the market. The issue of mercury emissions from coal fired power plants is an important though unresolved one, and is especially critical for a country where such plants play a vital and increasing role for energy security. Finally the infrastructure for storage and disposal of used mercury needs to be urgently invested in.

This report is an effort to suggest a possible roadmap for mercury reduction and its ultimate elimination in India. It has been formulated using our years of experience on the ground and knowledge of the sector, with the hope that India will take calibrated measures for a mercury free future.

Ravi Agarwal
Director

ABBREVIATIONS

AMAP	Arctic Monitoring and Assessment Programme
ASGM	Artisanal and Small Scale Gold Mining
BAT	Best Available Techniques
BEP	Best Environmental Practices
BIS	Bureau of Indian Standards
CAGR	Compound Annual Growth Rate
CFL	Compact Fluorescent Lamp
CHC	Community Health Centre
CoP	Conference of the Parties
CPCB	Central Pollution Control Board
CREP	Charter on Corporate Responsibility for Environment Protection
CSIR	Council of Scientific and Industrial Research
DGFT	Directorate General of Foreign Trade
DGHS	Directorate General of Health Services
DPCC	Delhi Pollution Control Committee
EPR	Extended Producer Responsibility
ESP	Electrostatic Precipitator
GEF	Global Environment Facility
ICL	Incandescent Lamp
IITR	Indian Institute of Toxicology Research
INC	Intergovernmental Negotiating Committee
IPD	In Patient Department

IPHS	Indian Public Health Standards
MoHFW	Ministry of Health and Family Welfare
MRT	Mercury Recovery Technology
MTPA	Metric Tons Per Annum
NEP	National Environment Policy
NGO	Non-Governmental Organization
NIP	National Implementation Plan
NRHM	National Rural Health Mission
OPD	Out Patient Department
PHC	Primary Health Centre
SME	Small & Medium Enterprise
SPCB	State Pollution Control Board
UNEP	United Nations Environment Programme
UV	Ultra Violet

EXECUTIVE SUMMARY

Mercury is a naturally occurring substance in the earth's crust and is usually found as cinnabar which is mined and refined to obtain pure mercury. It is the most toxic heavy metal which is liquid at room temperature and evaporates easily. However, mercury has wide application in product manufacturing and industrial processes.

Naturally occurring mercury is often found in very small amounts in oceans, rocks and soils, which become airborne when rocks erode, volcanoes erupt and soil decomposes. It then circulates in the atmosphere and is redistributed throughout the environment. Once present in the water bodies or in the soil system, the elemental mercury can get converted to an organic form of Methyl Mercury due to bacterial action and this is known to be the most toxic forms of mercury. Once transformed into the organic methyl mercury, not only can it accumulate in the fatty tissues of fishes but it also has the potential of reaching the top of the food chain.

The two properties that make mercury extremely unmanageable are bio-accumulation and bio-magnification. In growing children and infants, mercury concentration can go up many times making them highly vulnerable to mercury toxicity. The exposure to mercury during pregnancy poses risk to the foetus and affects growth of the baby. Mercury can cause damage to the central nervous system in growing children and can also lead to malformation in new born babies.

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Global Negotiations & Minamata Convention

Enough scientific evidence has been collected through various research studies conducted across countries on mercury emissions into ecosystems and oceans both from natural and anthropogenic sources. There are established evidences of mercury emissions being carried over long distances and mercury deposits found in the Arctic thus making it a global pollutant and a cause of global concern. Several governments and civil society groups have consistently raised concerns on health and environmental impacts of this metal which finally led to the UNEP Governing Council Decision 25/5 of 2009 to prepare a global legally binding instrument on mercury[1]. It also mandated the Executive Director UNEP to create a process of Intergovernmental Negotiating Committee (INC) for finalisation of the treaty and the first meeting of the INC thus commenced in 2010. This committee met for five times, over a period of 4 years, and finally the treaty text for the Minamata Convention was drafted and agreed by the committee in Geneva in January 2013. The treaty was finally adopted in October 2013 at a diplomatic conference in Japan; however, it will come into force only after its ratification by 50 countries. The process of ratification by 50 countries is likely to take some time as countries require time to prepare for implementation of the provisions of the treaty. There are also economic and political considerations which determine the process of signing the treaty. It is difficult to predict any definite time frame for the treaty to be operative; however, based on past experiences, it is expected to become effective by 2015.

Minamata Convention is aimed to protect human health and environment from anthropogenic emissions and releases of mercury and mercury compounds. The major focus of the treaty is:

- Control and regulate mercury supply ™
- Control demand side, thereby reducing the usage;
- Ban on manufacturing of mercury containing products by 2020;
- Reduce mercury emissions and releases;
- Identify and remediate sites contaminated with mercury;
- Safe handling of mercury waste and retiring excess mercury for long-term storage;
- Strict reporting mechanism to be in place on mercury movement and the measures adopted for complying with treaty provisions.

Overall, a global treaty on mercury is expected to incorporate provisions that, if taken together and accurately implemented over time, will essentially reduce total anthropogenic mercury emissions and releases into the global environment.

Country Baseline

Mercury finds a wide range of application in India, however there are no estimates of its inventory or the scale of emissions and releases into environment and their impacts. It is imperative to understand the magnitude of the problem associated with mercury and thus equally important to estimate the total domestic consumption, emissions and releases. It might be extremely difficult to examine all its application across sectors but an attempt can be made to estimate its usage in few important sectors and gauge national consumption.

1 http://www.unep.org/hazardoussubstances/MercuryNot/MercuryNegotiations/tabid/3320/language/en-US/Default.aspx

In 2001, UNEP in the Global assessment of mercury attempted to draw up an inventory for the mercury usage in India according to which the largest consumer of mercury in India was the Chlor-alkali sector consuming approximately 150-200 tons of mercury annually for the production of caustic soda and chlorine. However, the scenario has changed significantly in the last decade with the Chlor-alkali industry shifting from mercury-based technology to membrane cell technology thus considerably reducing the usage of mercury in this sector. There have been developments in other sectors as well which are responsible for gradual reduction in mercury consumption, though management of this highly toxic metal continues to be a grave environmental and human health concern.

It is imperative to understand the magnitude of the problem associated with mercury and thus equally important to estimate the total domestic consumption, emissions and releases.

India does not produce or mine mercury, therefore the total mercury requirement of the country is met only through imports. A close look at the import data suggests that there has been an overall reduction in mercury imports. The data from Directorate General of Foreign Trade indicates that mercury is also exported from India, which is indicative of the fact that there is a possibility of presence of mercury traders in India engaged in trading mercury in the country. Besides the import of elemental mercury, mercury-containing instruments, mercury compounds, mercury containing batteries, etc. are also imported in large quantities. In year 2012-13 the total import of elemental mercury is 165 tons, whereas the export is 45 tons.

The imported mercury is used in various products and processes, which includes healthcare instruments, dental amalgam, batteries, CFL & other lighting equipment, paints & cosmetics, traditional Ayurveda, Siddha medicines & cultural products. The various processes where mercury is used include Chlor-alkali process, vinyl chloride monomer, etc.

Mercury has been used in medical instruments, such as clinical thermometers and sphygmomanometers, because of its unique physical and chemical properties. These instruments are largely manufactured in India though some of the demand is also met through imports. Fever thermometers are usually manufactured by the small scale sector, whereas sphygmomanometers are manufactured by comparatively larger agencies. Currently, in India, approximately 8.32 million units of thermometers and 0.225 million units of sphygmomanometers are manufactured every year. Considering 1 gm and 60 gm of mercury usage in a thermometer and sphygmomanometer, respectively, the total mercury usage by this sector is 21.82 tons.

Mercury in products: Mercury is used in dentistry, primarily in amalgam fillings for teeth. Dental amalgams are typically 40-50% elemental mercury by weight and rest of the part comprises of other metals such as tin, copper, nickel, palladium, etc. Mercury in dental practice is used in two different methods – the most common being to buy silver alloy and mercury separately and mix them. The second method is to procure encapsulated amalgams containing pre-measured amounts of mercury, silver, zinc and other alloys. The total mercury used in filling dental cavities in India is estimated at 49.6 tons and is referred to as contact amalgam, while 15-50% of the amalgam that may remain unused even after filling the cavity is referred to as non-contact amalgam which is never placed into a tooth. According to the primary survey findings during the study[2], on an average, 32.5% of the actual amount of filling is the non-contact amalgam. The estimated amount of non-contact amalgam is 16T, thereby aggregating total mercury use of about 65 tons in dental practices in India.

The CFL market share in India is growing rapidly – about 36% in the past half-a-decade – both on account of individual preference and for the light being energy efficient. This is also promoted by successive governments to reduce its overall energy requirements. India currently manufactures about 400 million units of CFL in a year. According to the government estimation, the CFL lights available in India typically contain mercury in the range of 3-12 mg[3]. However, a recent study conducted by Toxics Link revealed mercury dosing in the range of 2.27 mg to 62.56mg per CFL[4]. Therefore, an average of 21.21 mg of mercury per CFL has been considered for estimation purpose, based on which the total mercury consumption by Indian CFL manufacturing industries is approximately 8.5 tons per year.

Mercury in processes: Apart from these products, there are processes which use mercury as a raw material; Chlor-alkali industry is one such process. However, there are only two plants out of a total of 36 plants that are operating partly on mercury cell technology with a total capacity of 14,800 tons/year of caustic soda and consume approximately 2.96 tons of mercury annually. The shift in the Chlor-alkali sector has helped in reducing mercury usage in industrial process in India.

The following table gives a glimpse into the amount of mercury used in different sectors in the country.

MAJOR CONSUMERS OF MERCURY IN INDIA (2010-2013)

Mercury	Consumers	Amount (estimated through primary study) *(tons/annum)*
Elemental Mercury	Clinical thermometer	21.82
	Blood pressure	
Elemental Mercury/ Mercury Oxides	Dental amalgams	65
	Compact fluorescent lamps	8.5
Mercury	Chlor-alkali industries in 2013	2.96
Total		98.28

2 Mercury in our Mouth – an estimation of mercury usage and release from the Dental Sector in India
3 *Guidelines for Environmentally Sound Mercury Management in Fluorescent Lamp Sector, Central Pollution Control Board, Ministry of Environment & Forests, Government of India, November 2008*
4 *Source: Toxics in that Glow, Toxics Link, 2011*

The figure of 98.28 tons per annum consumption of mercury is only from a few known sectors where data has been available and does not represent the total mercury consumption in India. Other sectors such as cultural usage, Ayurveda medicines, soaps, cosmetics, fungicides, switches, relays and other electronic products also account for significant mercury consumption.

Mercury waste: The mercury usage in various products and processes leads to the generation of mercury laden waste and mercury emission into environment. Estimate of annual mercury waste generation from CFL and Chlor-alkali sector is 8.3 tons and 296 tons, respectively, totalling to 304.3 tons/yr (approx.). An approximate mercury release from healthcare instruments and dental amalgam is 26.4 tons/yr.

Mercury emission: Mercury is also emitted into the air from various anthropogenic activities including coal fired powered plants, smelting industries, cement industries, oil and gas industries, etc. According to a recent estimation, the total mercury emission from anthropogenic sources in India is approximately 161.05 tons/yr with stationary combustion (coal fired thermal power plant) being the major contributor (140 tons/yr). The following table gives a glance of mercury waste generation and its emission and release into environment:

MERCURY WASTE, RELEASES AND EMISSION FROM DIFFERENT USAGE

Sl. No	Sector	Waste per year (in tons)	Release/ Emission per year (in tons)
1	Healthcare instruments	-	8
2	Dental sector		
	Non-contact amalgam		16
	Cremations		1.4
	Leaching from amalgam filling		1
3	CFL		
	Household sector	0.3	
	Commercial sector	8.0	
4	Chlor-alkali sector	296*	
	Total	304.3	26.4

* *This waste is likely to be eliminated during 2013 as the only two facilities currently operating on mercury are to be phased out or converted to mercury free, thus substantially reducing the total waste generation.*

The Chlor-alkali sector yet continues to be the highest generator of mercury laden sludge/waste and poses a challenge in managing the toxic waste.

Issues with Mercury in India

India imports its total requirement of mercury and currently there are no regulations controlling such imports into the country. However records of such imports and exports into/out of the country is maintained with the Directorate General of Foreign Trade which gives details of the total quantity of import, country imported from and the total value of such imports. Similar data is also available for exports. Mercury as a commodity is also freely traded within the country and is openly bought and sold in chemicals markets and there are no legal requirements to maintain records of such domestic transactions making tracking of this metal almost impossible. There are also no specific requirements for storage or sale in markets, which is a matter of concern as consumption or sale records are not mandatory to be maintained.

The major complications lie with the manufacturing of mercury containing healthcare instruments specially thermometers and preparation of dental amalgam. Most thermometer manufacturing units fall under the SME sector and operate from non-industrial premises with very little safeguards and monitoring. There are serious concerns of mercury release into environment during the course of thermometer production in such units. The units being located in thickly populated areas also escalate the threat to the population around. Another area of concern is the downstream waste generation both from sphygmomanometers and thermometers and safe handling and management of such products at the end of their life is imperative.

Apart from these healthcare instruments, dental amalgam also contains mercury as one component of preparation and it poses serious challenges to the environment because of the increasing amount of mercury release and emission in environment from non-contact amalgam – in the absence of any collection mechanism – and through the cremation of bodies with mercury filling, respectively. When replacing with the alternative restorative material, the huge cost differential between these two is seen as a bottleneck in this course of shifting. Reluctance to shift to non-mercury alternate fillings is on account of being at ease with the use of material and procedure, and the mind-set and perception of dentists. Younger dentists are relatively more comfortable in making this shift; the older ones are reluctant to use alternate materials.

The issue of mercury in lighting products has concerns both at the upstream and downstream ends. The issue on the upstream end is of excessive mercury dosing in lamps in the absence of any guidelines or standards on dosing. On the downstream end, the country lacks the mechanism for handling and disposing the spent CFLs and the mercury confined in it. These mercury containing lamps, at the end of their life, ultimately land up in the cities' landfills and pose grave threat to the environment. Absence of an appropriate regulatory framework, indifferent approach of the manufacturers towards their responsibility and lack of consumer awareness are some of the reasons for the current state of mismanagement.

Mercury emissions from industrial processes are another issue of concern in India that needs to be addressed. India does not have any standards for mercury in air or separate emission standards from such point sources like the thermal power plants, smelting industry, cement plants or waste incineration which emits mercury as a by product. This is one of the most critical areas and poses enormous challenge to the policy makers and regulators as any control mechanism will require significant technological and financial inputs and changes in the existing policy framework. Besides emission into air, mercury release from various industrial and manufacturing processes is also an important area that needs to be addressed. Some of the issues related to the release of mercury are: estimation of such releases, technology to capture mercury from such release and a sound monitoring mechanism to constantly monitor this release. The issues of emissions and releases are complex and at times interlinked, hence will require to be addressed collectively in specific cases.

Mercury toxicity and contamination is a complex issue that requires deep understanding and a scientific approach, and needs to be developed among various groups.

The country generates approximately 304 tons of mercury containing waste from various sectors which needs to be managed and disposed of appropriately confirming to the provisions of the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008. However, there are several gaps in the practice adopted and most mercury containing waste finally ends up in the landfills or the waste streams. The country lacks infrastructure for managing such wastes. Dearth of such infrastructure and appropriate mechanism in place, there are possibilities of this waste being disposed of indiscriminately that may lead to mercury contamination. Hindustan Lever thermometer plant at Kodaikanal is one such case which was responsible for the contamination of areas around the plant in the absence of any comprehensive strategy and infrastructure. Dealing with such contaminated sites is another grave task as there are no protocols or guidelines for handling such situations. Mercury toxicity and contamination is a complex issue that requires deep understanding and a scientific approach, and needs to be developed among various groups. This clearly identifies the need for building capacity among all the stakeholders to deal with mercury and the related issues.

Achievements in India

Not only does the environmental policy articulate the need to manage hazardous waste, the Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008, also defines mercury waste and mandates its safe management. While there are many areas which require attention, some significant achievements are also evident in select sectors where mercury related issues have been addressed. The Chlor-alkali industry clearly stands out as one such important achievement on account of the CREP[5] – a voluntary initiative by the industry which has been responsible for shifting almost 95% of the industry from mercury-based technology to its alternate, thereby reducing the total mercury consumption. Achievements noticeable in other sectors include:

5 http://hspcb.gov.in/Charter%20on%20corporate%20responsibility%20for%20Env.%20Protection.pdf

- Hospitals in Delhi, both government and private, shifted from mercury-based thermometers and sphygmomanometers to alternates;
- Many other hospitals across the country have also shifted to non-mercury alternate measuring instruments;
- Delhi Government issues instructions for procurement of only non-mercury measuring instruments for the hospitals;
- Central Government issues guidelines for shifting to non-mercury based measuring instruments in their hospitals;
- States of Punjab and Manipur also issue instructions for phasing out of mercury-based healthcare instruments;
- State experiences of shifts in respective hospitals provide the necessary groundwork for nationwide shift to be made possible;
- CPCB issues guidelines for storage of surplus mercury-based measuring instruments[6];

BIS draws up a draft standard of 5 mg of mercury content for lamps up to 30 watts. Most of these achievements have been possible with sustained efforts from civil society groups and the response of various stakeholders and is indicative of mutual trust and growing environmental consciousness.

Planning for Action

While there have been conspicuous progress on issues related to mercury in various sectors and these aptly demonstrate the capability of the industry and other stakeholders to innovate and adapt to new technologies, there are many areas which will require detailed planning, drawing up of a clearly defined roadmap for future and reviewing periodic progress for effective implementation of the Minamata Convention. The country has previous experience of drawing a Nation Implementation Plan for the Stockholm Convention. The learning from it can be effectively utilised in making such a detailed plan for the Minamata Convention as well. A clearly defined roadmap with activities and deliverables (as detailed below) with a stipulated time frame and resources would serve best to realize our global commitments.

- India may develop and adopt a national implementation plan in consultation with all the major national and regional stakeholders, NGOs and Civil Society Organizations, so as to draw up a clearly defined roadmap for mercury management in the country and fulfil its global obligation;
- There is a need to regulate and control its mercury supply sources so as to prevent it from becoming a hotspot for trading and possibly black marketing. A strict reporting mechanism of mercury movement across the country will be critically important;
- A comprehensive and a separate national regulation on mercury in line with the Minamata Convention is required to accomplish our global commitments;

6 http://www.cpcb.nic.in/Guidelines_for_ESM_%20MercuryW_fromHCFs.pdf

- There is a need for gradual phase out of all mercury containing products and replace them with alternates within the time frame as stipulated in the convention. Encourage Indian manufacturers to produce such equipment in the country;
- Mandatory standardization of mercury dosing in CFL for environmental safety and sound disposal of spent CFL needs to be effectively implemented;
- Adoption of improved technology for reducing mercury emission and releases into environment will be critical;
- Any surplus mercury, mercury waste and mercury-laden waste are to be managed in an environmentally sound manner through inventorisation & quantification, safe collection, recovery, purification & recycling, stabilization and solidification of mercury waste;
- The country will require to develop a protocol or guidance document, which will help in identifying, assessing, prioritizing, managing and, as appropriate, remediating contaminated sites;
- Training & capacity building on the use of alternative instruments, incorporation of alternate dental restoration in the study curriculum, fund allocation by government for shifting to alternates are some of the recommended suggestions to be adopted for adherence to the treaty.

The entire mercury management – including shifting from current usage to alternates, environmentally sound disposal of waste, reduction of emission and release in the environment – will require investment for which India may need assistance from multilateral funding along with technical assistance in respect of those national level activities that are intended to implement this Convention. Mercury emissions is the most critical area of intervention for India as fossil fuel based energy is the primary source of energy generation with the current capacity of 121 GW along with a capacity addition of 169 GW in the next two five year plans. Currently there are no standards for emission from such point sources nor any innovation or technological shift considered till date. Recent reports on levels of emissions and its impending health and environmental impacts have also been reported, bringing the issue under focus for urgent intervention. The need for an expert body or a task force to understand the requirements of technological intervention, identification of such technology and its adaptation to local conditions, setting up of standards for emissions and its monitoring mechanism would be critical and essential.

Financial resource will be a prerequisite in fulfilling the treaty obligations and the country will need to identify such funds and make allocation based on specific sector. Though there is a provision for financial assistance, it may not be adequate to meet the entire national requirements. Cost calculation is a dynamic process and will vary depending on the scale and market factors. However, based on current prices for products it is estimated that shifting of mercury-based instruments in the state health services across India would require an allocation of 512 million rupees whereas the dental care in government sector would require approximately twice the cost of what is being spent today. The cost for shifting from mercury to non-mercury instruments in the private sector will eventually be borne by individual consumers as the healthcare industry is likely to pass it down to the consumers.

Reducing mercury emissions from industrial sources will be a cost-intensive intervention as that would require sourcing of appropriate technology, which is still under innovation hence difficult to estimate. Issues of interim and final storage are critical and cost intensive as they would require facility creation, and cost of monitoring and oversight which will require detailed calculations.

In order to comply with this treaty, Ministry of Environment, Forests & Climate Change will need to act as the nodal agency for planning, coordinating and initiating environmental programmes and policies in India. However, the Ministry of Environment, Forests & Climate Change will require participation and support from the Ministry of Coal, Ministry of Health & Family Welfare, Ministry of Consumer Affairs, Food and Public Distribution, agencies like CPCB, industry associations, and other implementing agencies. There is also a need to identify all the key stakeholders thus ensuring participation in the process of drawing up a national plan and further implementation of such plans. While the treaty has timelines in place for many of the activities, it will be important and critical to start the planning process without any delay. There is a need to notify and prepare all the stakeholders for some of the shift that the treaty envisages, as participation and cooperation from the stakeholders is pertinent for making these transitions possible in order to fulfil our global obligation.

INTRODUCTION

1.1 Facts about Mercury

Mercury is a shiny silvery metal which is liquid at room temperature and standard pressure with symbol Hg and an atomic number 80. It is a naturally occurring substance in the earth's crust and is found as mercury sulphide (cinnabar) HgS which is mined and then processed to obtain pure mercury. A heavy, odourless, lustrous liquid metal that sinks in water, mercury is a rather poor conductor of heat – as compared to other metals –but a fair conductor of electricity.

Mercury occurs naturally and is found in very small amounts in oceans, rocks and soils. It becomes airborne when rocks erode, volcanoes erupt and soil decomposes. It then circulates in the atmosphere and is redistributed throughout the environment. Large amounts of mercury also become airborne when coal, oil or natural gas is burned as fuel or mercury-containing garbage is incinerated. Once in the air, mercury can fall to the ground with rain and snow, landing on soils or water bodies thereby causing contamination. Lakes and rivers are also contaminated with mercury through the discharge of mercury laden industrial waste or municipal sewage to water bodies or into open land. Once present in these water bodies or in the soil system, this elemental mercury can get converted to organic form of methyl mercury –one of the most toxic forms of mercury – due to bacterial action. Once transformed not only can it accumulate in the fatty tissues of fishes but it also has the potential of reaching the top of the food chain.

The two properties that make mercury extremely unmanageable are bio-accumulation and bio-magnification. Bio-accumulation is the retention of the toxic substance in the tissues, especially muscles, thus increasing the potential for mercury toxicity. Bio-magnification is the process by which the toxic metal increases in concentration as it moves up the food chain (upto 1,00,000 times the original levels sometime)[7].In growing children and infants, the mercury concentration can go up many times thus making them highly vulnerable to mercury toxicity. Mercury can not only cause damage to the central nervous system in growing children,but can also lead to malformation in new born babies. Exposure to mercury during pregnancy creates risk to the foetus and that can affect the growth of the baby.

7 Lurking Menace, Toxics Link

QUICK FACTS

- Most toxic substance known to humans.
- Mercury can pass through skin, blood-brain & placental barrier and can cause devastating effects on the function and growth of brain in the growing foetus.
- It is neuro & nephro-toxicant and can damage kidney and central nervous system.
- Mercury can cross global barriers and can move from one country to other.
- It bio-accumulates and bio-magnifies.
- Likely route of exposure: inhalation or absorption of inorganic mercury vapour after a spill or during a manufacturing process or ingestion of methyl mercury from contaminated fish.
- It can pose significant health threat when spilled in a small and poorly ventilated room.

There are studies across the world, which have identified prenatal methylmercury exposure with impaired development of sensory, motor and cognitive functions. This causes learning difficulties, poor coordination and inability to concentrate among children. The adult population, on the other hand, gets exposed to the increased rates of cardiovascular disease.

Mercury also has some unique physical and chemical properties making it a highly versatile metal which is known to have multiple usage both in product manufacture and processes. It has been widely used in manufacturing of measuring instruments such as thermometers, manometers, barometer, sphygmomanometer, lighting products, electrical and electronic products, batteries and dental amalgam, etc. It also has some important industrial usage such as in the production of vinyl chloro momoner, in Chlor-alkali industry and in small scale gold mining. Many of these products and processes have commercially viable alternates to mercury available that can subsitute mercury usage and reduce mercury emission into environment.

1.2 Background of the Mercury Treaty

The subject of mercury toxicity has been of immense concern to the international community due to mercury's nature of global transportation and its ability to transform from inorganic to an organic form and its capacity to bio-accumulate and bio-magnify. Many Governments and Civil Society Organisations have put in sustained efforts to generate new data in order to highlight the toxicity of mercury and the need to bring forth global action for sound mercury management.

The determined efforts bore fruit in 2003 when UNEP[8] declared mercury to be the pollutant of global concern due to its persistence in the atmosphere and its negative effects on human health and the environment.

8 *http://www.mercury2013.com/news/Mercury-UNEP%27s-%E2%80%98Pollutant-of-Greatest-Global-Concern%E2%80%99/58/*

In February 2009, the Governing Council of UNEP adopted Decision 25/5 on the development of a global legally binding instrument on mercury. By its decision 25/5 III, the Council/Forum requested the Executive Director to convene an Intergovernmental Negotiating Committee (INC) with a mandate to prepare a global legally binding instrument on mercury, commencing its work in 2010 with the goal of completing it prior to the twenty-seventh regular sessions of the Governing Council/ Global Ministerial Environment Forum, in 2013.

On Saturday, 19 January 2013 at Geneva, in the early morning hours, Governments agreed to the text of this global legally binding instrument on mercury and delivered the "Minamata Convention on Mercury".[9]

1.2.1 Mercury Convention

The Intergovernmental Negotiating Committee (INC) to prepare a global legally binding instrument on mercury was established in accordance with section III of decision 25/5 of 20 February 2009 of the Governing Council of the United Nations Environment Programme (UNEP). By that decision the Council agreed to the elaboration of a legally binding instrument on mercury and asked the Executive Director of UNEP to convene an INC with the mandate to prepare a draft treaty text.[10]

The committee started its negotiation process and held its first meeting in Stockholm from 7 to 11 June 2010;the second in Chiba, Japan, from 24 to 28 January 2011; the third in Nairobi from 31 October to 4 November 2011, and; the fourth in Punta del Este, Uruguay, from 27 June to 2 July 2012. The fifth and the final INC 5 meeting were held in Geneva from 13 to 18 January 2013 and that finalised the treaty. The treaty was accepted in October 2013 at a diplomatic conference in the city of Minamata,Japan; however, it will come into force once 50 countries ratify the treaty – a process that is likely to take some time.

There are economic and political considerations which determine the process of signing and ratifying the treaty and also a preparatory time for countries to do ground work. Hence it is difficult to predict any definite time frame for the treaty to be operative. Overall, the mercury treaty seeks to control & regulate mercury trade, reduce supply & demand, control and reduce mercury emissions & releases with an objective to safeguard health.

The financial support required to assist developing country parties and parties with economies in transition in implementing the treaty is likely to be made available through the Global Environment Facility (GEF). For the purpose of this Convention, the GEF Trust Fund shall be operated under the guidance of and be accountable to the Conference of the Parties. The treaty also has provisions

9 *http://www.unep.org/hazardoussubstances/Mercury/tabid/434/Default.aspx*
10 http://www.moew.government.bg/files/file/Chemicals/Mercury/REPORT_FROM_INC5_AND_TEXT_OF_MINAMATA_CONVENTION-1.pdf

for seeking technical assistance by parties in meeting some of the requirements; however, the details of such mechanism are likely to be finalised in the Conference of Parties meeting that commence subsequent to the treaty being adopted.

Overall, a global treaty on mercury should be expected to incorporate provisions that, if taken together and entirely implemented over time, will significantly reduce anthropogenic mercury emissions and releases into the global environment.

1.2.2 Salient Features of the Convention

Minamata Convention is aimed to protect human health and the environment from anthropogenic mercury emissions and releases. The treaty primarily focuses on:

- Controlling and regulating mercury trade;
- Reducing supply and usage control;
- Lessening mercury emissions and releases;
- Ensuring mercury waste handling in safe and environmentally sound manner.

Table 1-1 gives a quick glance on the major aspects of the treaty (the entire treaty text is available on the UNEP website.)[11]

TABLE 1-1: QUICK LOOK AT THE CONVENTIONS

Hg supply sources & Trade (Art 3)	Hg added products	Manufacturing Process using Hg/Hg compounds	Emissions (air)	Releases (land & water)	Wastes
New primary mining is banned as of entry of the treaty into force by a government.	Based on 'Positive list' approach, the products to be phased out are listed in the Part 1 of Annexure A of the treaty. The others which are presumably not addressed by the treaty includes products essential for civil protection & military uses; products for research, calibration of instrumentation, for use as reference standard; products used in traditional or religious practices and vaccines containing thimerosal as preservatives.	Phase out processes using mercury include Chlor-alkali production (2025) & acetaldehyde production using mercury or mercury compounds as a catalyst (2018).	Objective is controlling and where feasible reducing emissions of mercury and mercury compounds. *Note: Emissions mean air emissions from point sources in Annex D. Country discretion decides what is feasible.*	Concerns controlling – where feasible – reducing releases of mercury and mercury compounds – often expressed as "total mercury" – to land and water from the relevant point sources not addressed in other provisions of this convention.	Mercury waste means: Consisting of mercury or mercury compounds; Containing mercury or mercury compounds; or Contaminated with mercury or mercury compounds in a quantity above the relevant thresholds defined by the Conference of the Parties in collaboration with the relevant bodies of the Basel Convention in a harmonized manner.
Pre-existing primary mercury mining to be banned after 15 yrs as of date of entry into force by any government.	Few products are scheduled to be phased out by 2020 with a provision of five-year exemption, if required, by governments which can be renewed for a total of ten years. Hence, the effective phased out date being 2030.	Parties are supposed to "discourage" the development of new processes using mercury.	Air emission sources included in the treaty are coal-fired power plants & industrial boilers; smelting & roasting processes used in production of non-ferrous metals (only lead, zinc, copper, and industrial gold); waste incineration, and; cement clinker production facilities.	A Party with relevant sources shall take measures to control releases and may prepare a national plan setting out the measures to be taken to control releases and its expected targets, goals and outcomes.	Mercury wastes are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law or this Convention.

11 http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/INC5/5_7_REPORT_ADVANCE.pdf

Hg supply sources & Trade (Art 3)	Hg added products	Manufacturing Process using Hg/Hg compounds	Emissions (air)	Releases (land & water)	Wastes
	Dental amalgam to be phased down gradually.	Parties can propose additional processes to be phased-out, including information on technical & economic practicality as well as environmental & health risks and benefits	Emission sources that were deleted from the treaty during negotiations were oil and gas; facilities in which mercury-added products are manufactured; facilities that use mercury in manufacturing processes recognised in Annex D; iron and steel manufacturing including secondary steel; and open burning.	The Conference of the Parties shall, as soon as practicable, adopt guidance on BAT & on BEP, taking into account any difference between new & existing sources and the need to minimize cross-media effects.	Each Party shall take appropriate measures so that mercury waste is only recovered, recycled, reclaimed or directly reused for a use allowed to a Party under this Convention or for environmentally sound disposal pursuant to paragraph 3 (a), Article 11. Parties are encouraged to cooperate with each other & with relevant intergovernmental organizations and other entities, as appropriate, to develop and maintain global, regional & national capacity for the management of mercury wastes in an environmentally sound manner.

HIGHLIGHTS

Mercury & its Impact on Health

- Mercury is a naturally occurring substance – neuro- and nephro-toxin– and can damage kidney and central nervous system.
- Mercury bio-accumulates and bio-magnifies, which makes it unmanageable.
- Mercury can pass through skin, blood-brain & placental barrier and can cause devastating effects on the function and growth of the brain and growing foetus.
- The ability of trans-continental or trans-boundary movement beyond one country to other makes mercury an issue of global concern.

Evolution of Mercury Treaty – Minamata Convention

- Several studies, reports and evidence from mercury poisoning including the Minamata Tragedy of Japan has led to the Governing Council of UNEP to adopt its Decision 25/5 on the development of a global legally binding instrument on mercury.
- Intergovernmental Negotiating Committee (INC) was formed to negotiate the Treaty.
- INC met five times over a period of 4 years (2009-2013).
- On Saturday, 19 January 2013, at Geneva, in the early morning hours, Governments agreed to the text of the "Minamata Convention on Mercury".

Minamata Convention

- The treaty was adopted in October 2013 at a diplomatic conference in Japan. However, it will be implemented once 50 countries ratify it.
- Major focus of the Treaty is to control and regulate mercury trade; reduce supply and usage control; lessen mercury emissions and releases; ensure mercury waste handling in safe and environmentally sound manner.
- Financial support to assist concerned governments and others in implementing the treaty is likely to be made available through the Global Environment Facility (GEF).

COUNTRY BASELINE

2.1 Mercury Usage in India

Mercury finds a variety of application in India across many sectors consuming significantly large amounts of mercury. However, as there is no official/government data on the total mercury usage and inventory of mercury in India, it is important to estimate and understand the domestic requirements of mercury. Even though it might be extremely difficult to examine all its applications across sectors, an attempt can be made to evaluate its usage in select sectors.

In 2001, UNEP, in the Global assessment of mercury, attempted to draw up an inventory for the mercury usage in India. According to the UNEP report, the largest consumer of mercury in India was the Chlor-alkali sector consuming approximately 150-200 tons of mercury annually for the production of caustic soda and chlorine. However, this scenario has changed significantly since 2003 with the Chlor-alkali industry adopting an improved technology and initiating the phase out of mercury in the production of caustic soda. There have been developments in other sectors too which are responsible for a gradual shift in the overall consumption of mercury.

India does not produce mercury; its domestic requirements are completely met through imports. A close look at the import data suggests that there has been an overall reduction in total imports; however, the graph presents an uneven but not so steady downslide. Besides the import of elemental mercury, mercury-containing instruments, mercury compounds and batteries containing mercury, etc. are also imported in large quantities. This imported mercury metal is used by various industries; however, there is no comprehensive government data on the usage of mercury in India.[12]As per recent statistics, mercury is mainly used in:

- Thermometers and other measuring devices
- Electronics
- Dentistry
- Mercury containing batteries

12 *"Technical Background Report to the Global Atmospheric Mercury Assessment", AMAP and UNEP*

- Lighting equipment
- Thermostat switches
- Fungicides
- Paints, cosmetics
- Drugs, pharmaceutical products
- Traditional uses including Ayurveda and Siddha medicine
- Chlor-alkali industry

Data from the Directorate General of Foreign Trade indicates that mercury is also exported from India, though not mined or produced in India. This is indicative of the fact that there is a possibility of presence of mercury traders in India who are engaged in trading this commodity from India.

2.1.1 Mercury-added Products

2.1.1.1 Healthcare Instruments

Mercury is used in medical instruments such as clinical thermometers and sphygmomanometers because of its unique physical and chemical properties. These instruments have been widely used in the healthcare industry and these appliances are almost treated and accepted as gold standards by the healthcare practitioners. These instruments are largely manufactured in India though some of the demand is also met through imports. Fever thermometers are usually manufactured by the small scale sectors, which are located mostly in the northern parts of the country. On the other hand, sphygmomanometers are manufactured by comparatively larger agencies. These are available in the market under numerous brand names and are used universally by the healthcare industry as well as individual households.

According to the research conducted during 2003[13], approximately 5 million thermometers and 0.2 million sphygmomanometers were produced in India annually. However, this has, in year 2012, increased to approximately 8.32 million units and 0.225 million units per annum, respectively (refer Section A & Section B).

Section A

There is an absence of secondary information on the current levels of clinical thermometer production in India. In such a scenario, the domestic production has been calculated on the basis of primary information and import data of clinical thermometers. As per the interaction with the healthcare instrument importers,[14] nearly 80% of the domestic clinical thermometers used in India are locally manufactured while the remaining 20% demand is met through imports.

13 Mercury in India, Toxic Pathways, Toxics Link, 2003
14 Primary Research: As reported by owner of Gulati Surgicals – a leading farm of healthcare instruments in Delhi

On the basis of this, the calculation for domestic manufacturing is as given below.

Domestic Market Size (import + local manufacturing) = X million units

20% of X	= 2.08 million units[15]
X	= 2.08/0.20
	= 10.4 million units

2.08 million units (import) + local manufacturing= 10.4 million units

- Local manufacturing= (10.4 – 2.08)= 8.32 million units
- Mercury content in each thermometer = 1 gm
- Total mercury in Indian thermometer = 8.32*1
- Total mercury = 8.32 tons

Section B

According to primary research, as reported by the representative of Industrial Electronic & Allied Products (Diamond brand), the market size of mercury-based sphygmomanometer in India is 2.25 lakh units, with Diamond manufacturing approximately 1.75 lakh units per annum.

Mercury content in each sphygmomanometer	: 60 gm
Total mercury consumption by this sector in India	: (2.25 * 60)
	: 13.50 tons

Total mercury usage by the healthcare instruments in India is (8.32 + 13.50) tons = 21.82 tons.

2.1.1.2 Dental Amalgam

Mercury is used in dentistry, mostly in amalgam fillings for teeth. Dental amalgams are typically 40-50% elemental mercury by weight while the rest comprise of other metals such as tin, copper, nickel, palladium, etc. In India, the accessibility to better dental care is constrained to urban India. About 80% of dentists work in major cities in India, as the demand for dental care is mostly in cities. Limited healthcare services are available to rural population; seekers of oral healthcare among the rural population are also very few in number. This is slowly but gradually shifting as some of the government sponsored healthcare schemes covering the rural population are providing dental care and this is likely to alter the total mercury usage in dental care in India. Mercury, for dental use, can be obtained in two ways. The first and most extensively used way in India is to buy silver alloy and mercury separately and mix them. The second way is to buy encapsulated amalgams containing pre-measured amounts of mercury, silver, zinc and other alloys. The capsules are available in three sizes: single (400 mg of material), double (600 mg), and triple (800 mg). A membrane present inside the capsule keeps the mercury separated from

15 Import Data for 2012-13 Chart-2

the silver, zinc and other alloys. Once the mercury is in contact with the other materials, it binds to them rapidly and the mixture begins to harden quickly.

As per the study conducted by Toxics Link,[16] the total mercury used in filling dental cavities in India is assessed to be 49.6tons which is called contact amalgam. The entire calculation, based on the primary survey of the dentists across India, is as follows:

T_{AC}	=	$(NA_{DF} * N_D * N_I * C_{Hg})$
T_{AC}	=	Amount of mercury used in dental restoration per year
NA_{DF}	=	Number of patients treated with amalgam (1.75 per day/dentist, survey findings)
N_D	=	Number of dentists (1.21 lakh)
N_I	=	Number of days in a year (313 days)
CHg	=	Average amount of mercury used in each filling in tons (0.75g * 10-6 mercury in each filling)
T_{AC}	=	(1.75 * 121000 * 312 * 0.75 * 10-6)
	=	49.6 T

About 15-50% of the amalgam may remain unused after the use. The excess amalgam that is unused after a tooth is filled is called "non-contact" amalgam – one that was never placed into a tooth or was never in contact with any human tissue. On the other hand, contact amalgam is the amalgam that has been in contact with human teeth or tissue. Processes like replacing amalgam fillings, polishing a fresh amalgam filling to remove the excess amalgam can generate contact amalgam.

According to the primary survey findings during the study[17], on an average, approximately 32.5% of the actual amount of filling is the non-contact amalgam. The estimated amount of non-contact amalgam is 16 tons, which is explained as follows:

T_{ANC} = TAC * 32.5%

= 49.6 T * 0.325

= 16 tons

The contact amalgam (generated due to the removal of old fillings or polishing of new ones) and the residual non-contact amalgam (the amalgam which has been prepared but never gets filled) is thrown into bins or goes to the sewer or is emitted into the air during the procedure of dental restoration. Cremation is also an important source of mercury emissions into the air.

16 Mercury in our Mouth, Toxics Link, 2011
17 Mercury in our Mouth – An estimation of mercury usage and release from the Dental Sector in India

The total quantity of contact and non-contact amalgam generated in dentistry practices in India is estimated at 49 tons and 16 tons, respectively, thereby reaching a total mercury use of about 65 tons in dental practices of India.

According to the study:[18]

- The estimated amount of mercury used by dentists in India is approximately 65 tons per year;
- Out of these 65 tons, 49 tons is the dental filling while 16.2 tons is non-contact amalgam.

The quantum of total mercury placed in the mouth of Indian population can be as high as 396 tons. Dental amalgam accounts for significantly high consumption of mercury though the survey suggests that increasing number of younger dentists are now practicing mercury-free dentistry and there is a demand from patients for alternates to amalgam.

2.1.1.3 Compact Fluorescent Lamp (CFL)

A Compact Fluorescent Lamp (CFL) – also known as a compact fluorescent light or energy saving light – fits into most of the existing light fixtures used for incandescent lamps. CFLs, as compared to an incandescent lamp, give the same or more volume of visible light, uses far less energy and have a longer rated life. There are many types of CFLs with each constructed differently, but using similar technology. Their wattage typically ranges between 5 and 50 watts and they generally come in U-bar or spiral shapes.[19]

CFLs use about 75% less energy than conventional incandescent light bulbs. They also have a much longer life as compared to a conventional bulb. A good quality CFL would last between 6,000-15,000 hours –8 to 15 times higher to that of a conventional incandescent lamp.[20]

Mercury is integral to CFLs like all fluorescent lamps. The mercury is in liquid form when the lamp is not operating and the lamp is at room temperature. The mercury vaporises when the electrical flow through the argon gas starts and the presence of gaseous mercury greatly increases the ultraviolet light produced. Mercury also helps increasing the amount of current that can flow through the gas and, in turn, helps in generating even more ultraviolet (UV) light. This ultraviolet light strikes a layer of phosphor that coats the inner part of the fluorescent lamp that blocks most of the ultraviolet light. Because of the ultraviolet light, the phosphor emits various frequencies of visible light.

18 Mercury in our Mouth, Toxics Link
19 http://en.wikipedia.org/wiki/Compact_fluorescent_lamp
20 The National Energy Foundation: Low Energy Lighting – How to Save with CFLs, http://www.nef.org.uk/energysaving/lowenergylighting.htm

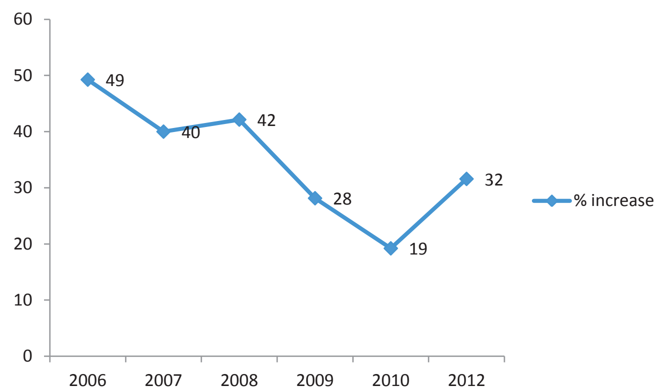
The CFL market share in India is growing rapidly (about 36% in the past half-a-decade). India's growing energy dependency and concerns about the climate change impacts have forced successive governments to promote energy-saving schemes. Further, due to a strong manufacturing base in India, CFL manufacturing enjoys significant economies of scale thus helping it to rapidly replace the ICLs. The quantum of mercury in CFLs in India is neither capped nor regulated. With an increased market share coupled with unregulated mercury dosing, the overall quantum of mercury consumption would be high.

In 2012, the CFLs production in India was calculated to be at 400 million units[21]. The average annual penetration (or growth) rate of CFLs in the Indian lighting market has been 35% in the last six years (Table 2-1 and Figure 2-1).

TABLE 2-1: GROWTH RATE OF CFL IN INDIAN LIGHTING MARKET

Year	2005	2006	2007	2008	2009	2010	2012
CFL (in million units)	67	100	140	199	255	304	400
Growth rate (in %)		49	40	42	28	19	32

FIGURE 2-1: PERCENTAGE GROWTH RATE OF CFL IN INDIAN LIGHTING MARKET



This growing market of Indian CFL is majorly catered by locally manufactured products. However, there is import of some of the units from other countries as well with China being the topmost exporters to India with a market share of 64% of total import figure. According to the DGFT figure, the import of CFL to India in 2012 is 17.68 million units.

21 ELCOMA Report, Lighting Industry & ELCOMA Activities

Rest of the demand for the CFL is met by local manufacturing in India. According to government estimation, the CFL units available in India normally contain mercury in the range of 3-12 mg[22]. However, a recent study conducted by Toxics Link revealed mercury dosing in the range of 2.27 mg to 62.56 mg per CFL[23]. Therefore, an average of 21.21 mg of mercury per CFL has been considered for calculation purpose. Here's an estimate of the total mercury consumption by Indian CFL manufacturing industries:

CFL manufactured in India in 2012	:	400 million units
Mercury content per CFL	:	21.21 mg
Total mercury consumption	:	8.5 tons annually (approx.)

2.1.1.4 Button cell batteries

Button cells batteries account for the bulk of mercury use in the battery sector. There are three common expertise or chemistries for mercury-added miniature batteries –zinc air, silver oxide and alkaline. These three battery types can contain 0.1% to 2.0% mercury. Generally, mercury oxide, which had a mercury content of 30-50%, was also used but this battery type is no longer manufactured in large quantities.[24]

The miniature batteries have different usage across various products. The zinc air batteries are mostly used in hearing aids and ear implants, but can also be found in pagers. Silver oxide batteries are most frequently used in watches, clocks, calculators, games and cameras. Alkaline batteries are often used in applications, such as toys, key chains and remote controls.

As part of our recent study, a primary survey was conducted to understand the button cell battery market in India. Interactions with various groups of users revealed that there is no local manufacturing of button cell batteries in India; all the procurement by end users is done through imports only. What emerged during the discussions with end users in India was that mercury-free button cell batteries are used in key application areas, such as watches, hearing aids, healthcare instruments, children's toys, etc. The cell batteries are mainly composed of common materials—steel, zinc and manganese – that do not pose a health or environmental risk in normal use or disposal.

However, there is no inventory regarding the mercury contained button cell batteries' usage in India –a requirement from the waste generation point of view in our country. Absence of information in public domain either by industry/trade bodies or government sources makes it very hard to get estimates on the total quantum of batteries used and the consumption of mercury in such products.

22 *Guidelines for Environmentally Sound Mercury Management in Fluorescent Lamp Sector, Central Pollution Control Board, Ministry of Environment & Forests, Government of India, November 2008*

23 *Toxics in that Glow, Toxics Link, 2011*

24 http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/INC4/Submissions%20from%20NGOs/ZMWG_Button%20Cell_INC4_final.pdf

2.1.1.5 Mercury In Electrical, Electronics & other Products

Mercury has vast use in industrial applications. Its use in electrical appliances, certain pharmaceutical and agricultural products account for additional consumption of mercury. Chief uses of mercury include tilt switches and relays, lamps, pigments, batteries, reagents and barometers.

Mercury is used in temperature-sensitive switches and in mechanical switches. These are used in products like thermostats and silent switches. Mercury tilt switches have been used in thermostats for more than 40 years. A small electrical switch may contain 3,500 milligrams of mercury; whereas the industrial switches may contain as much as eight pounds of mercury. Mercury is also used in various components of the automobile sector. According to a study by UNEP[25], mercury is used in varying amounts in different components of electrical application (Table 2-2).

TABLE 2-2: MERCURY IN SWITCHES & ELECTRICAL APPLICATIONS

Switch	Quantity of mercury
Tilt switch	
Thermostats	3000-6000 mg
Float control(septic tank and sump pumps	2000 mg
Freezer light	2000 mg
Washing machine	2000 mg
Thermo-electrical applications	
Accustat ("mercury in glass thermostat"– a calibrated device resembling a thermometer – is used to provide precise temperature control for specialized applications).	1000 mg
Flame sensor (used in residential and commercial gas ranges; mercury is in a capillary tube which when heated vaporizes mercury and opens the gas valve or operates the switch; used for both electrical and mechanical outputs).	2500 mg
Source: Guidance &awareness raising materials under new UNEP mercury programmes – Indian scenario (http://www.chem.unep.ch/MERCURY/2003-gov-sub/India-submission.pdf)	

The country, at present, does not have any inventory prepared for these sectors as this sector is widely distributed among medium and small scale sector and it is quite difficult to get an estimate of the same.

25 http://www.chem.unep.ch/MERCURY/2003-gov-sub/India-submission.pdf

2.1.1.6 Mercury in Cultural Products, Traditional Medicines, Jewellery & other Products

Mercury is widely used in cultural and religious practices. In Hindu practice, mercury is used in "Parad", a material from which religious relics are made. Parad is an amalgamation of mercury and other metals that is used to make relics for worship. It is traditionally made of silver and mercury, but it is now often made of mercury and tin, with trace amounts of other metals. Toxics Link had conducted a study on "Parad Shivling" in the year 2006. However this sector being completely informal and unorganised in nature, it is difficult to create an inventory of mercury usage by this sector.

It is also used in medicines, jewellery and for other cultural practices. People may keep mercury in containers, such as pots or cauldrons, to purify the air. In some cultures, people sprinkle mercury on the floor of a home to protect its occupants. Some use it with water and a mop to spiritually clean a dwelling. Some even add mercury to oil lamps and candles to ward off evil spirits – to bring good luck, love or money.

Apart from these, cosmetics including skin lightening soaps & creams, pesticides, biocides & topical antiseptics also contain certain amount of mercury.

However, it is extremely difficult to make an inventory of mercury usage by these sectors.

2.1.2 Manufacturing Processes Using Mercury / Mercury Compounds

2.1.2.1 Chlor-Alkali Process

The Chlor-alkali process is used for producing caustic soda and chlorine all over the world. The processes use electrolysis to produce caustic soda and chlorine or sometimes potassium hydroxide and hydrogen gas. Three types of technologies are prevalent, one of which is the mercury cell technology process. In this process, the mercury cell cathode comprises of a slowly flowing layer of mercury across the cell bottom. Sodium ions at the cathode are converted into sodium, which forms an amalgam with the mercury at the cathode there by using large quantities of mercury.

Chlor-alkali plants in India dates back to 1959 and progressively till 2003 there were all together 36 plants with a total production capacity of approximately 3.2 MTPA of caustic soda. However with the adoption of the Charter on Corporate Responsibility for Environmental Protection (CREP) initiative in 2003 (after an understanding was reached between the government and the industry), the plants started shifting to membrane cell technology. Currently there are only two plants which are operating partly on the mercury cell technology with a total capacity of 14,800 tons/year of caustic soda. The average mercury usage per ton of caustic soda production per year is 200 gm.[26] On the basis of these, the following figure is obtained:

Total capacity on mercury cell process	: 14,800 tons/yr of caustic soda
Mercury used/ton of caustic soda per yr	: 200gm
Total mercury usage per yr	: (200 * 14800 tons/yr) = 2960000gm/yr
	: 2.96 tons/yr

The following table (Table 2-3) gives a snapshot of how much mercury is being used by different sectors in the country.

TABLE 2-3: MAJOR CONSUMERS OF MERCURY IN INDIA (2010-2013)

Mercury	Consumers	Amount (estimated through primary study) (tons/annum)
Elemental Mercury	Clinical thermometer	21.82
	Blood pressure	
Elemental Mercury/ Mercury Oxides	Dental amalgams	65
	Compact fluorescent lamps	8.5
Mercury	Chlor-alkali industries in 2013	2.96
	Total	98.28

The figure of 98.28 tons per annum consumption of mercury is only from few known sectors where data has been available hence does not represent the total inventorisation of mercury consumption in India. Other sectors such as cultural usage, Ayurveda medicines, soaps, cosmetics, fungicides, switches relays and other electronic products would also account for significant mercury consumption.

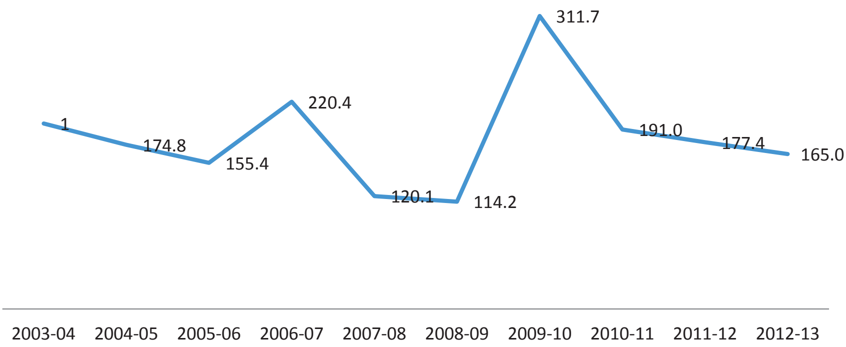
2.2 Mercury Supply & Trade

Mercury is not mined in India; it is imported to meet the demand of domestic use. Currently there are no domestic or international laws governing mercury trade hence this commodity is freely traded within and between countries. However, a few countries have since announced an export ban on mercury in order to reduce the total mercury availability in global circulation. The European Union and the USA have both declared a ban on any export of mercury from their respective countries. The commencement of treaty negotiations also has been responsible for it to be under focus and, as a consequence, the overall supply of mercury has reduced.

26 *http://www.cseindia.org/dte-supplement/who-responsible.htm*

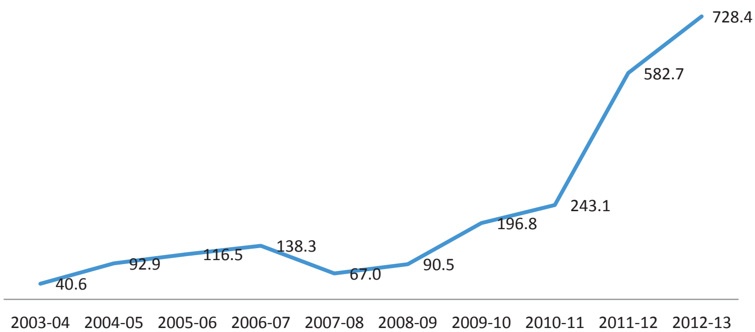
Directorate General of Foreign Trade maintains records of import and export of mercury. The current import quantity of elemental mercury stands at 165 tons. This quantity reflects a gradual reduction at a CAGR of -2% during the period 2003-04 to 2012-13.

FIGURE 2-2: IMPORT QUANTITY OF ELEMENTAL MERCURY (IN TONS)



Source: Ministry of Commerce, Import Export Data

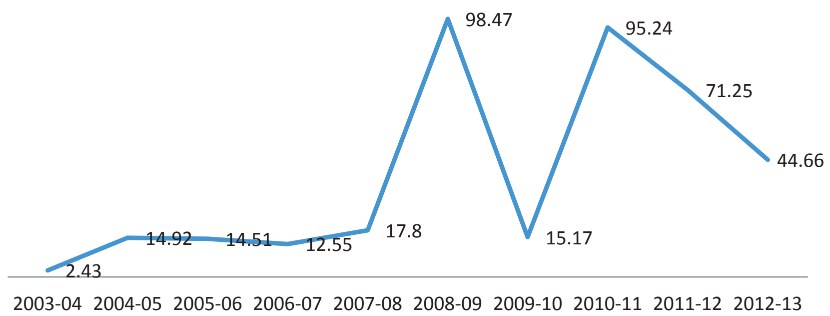
FIGURE 2-3: IMPORT VALUE OF ELEMENTAL MERCURY (IN MILLION INR)



Source: Ministry of Commerce, Import Export Data

A close scrutiny of the graph (Figure 2-2) reflects a gradual downtrend in mercury imports; however, the graph also shows a few sharp peaks suggesting increase in import quantities in years 2006-07 and 2009-10. Figure 2-3 reflects a gradual percentage increase in the per ton mercury import cost of more than 100% (about 457.06%) from 2008-09 to 2012-13. The gradual increase in the price of mercury could be attributed to reduced availability of mercury in global markets.

FIGURE 2-4: EXPORT QUANTITY OF ELEMENTAL MERCURY (IN TONS)



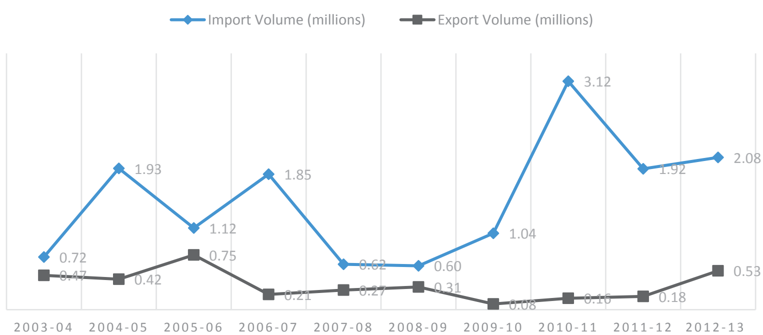
Source: Ministry of Commerce, Import Export Data

The export trend of India is also showing significant ups and downs over the last ten years. The highest export of 98.47 tons of mercury took place in 2008-09, followed by 95.24 tons in the year 2010-11. The lowest export of elemental mercury took place in the year 2003-04 (only 2.43 tons). This suggests that mercury trading is being practiced here in India; however, there is no set trend for export of elemental mercury.

In addition to the import of elemental mercury, the country is also importing mercury-based clinical thermometer and sphygmomanometer in order to meet the domestic demand.

- Total import of clinical thermometer is 2.08 million units as against 0.53 million units of exports of clinical thermometers from India (represented graphically in Figure 2-5);
- The import of mercury based sphygmomanometers is nil at 2012, whereas the import of the same was 0.008 million units in 2011 **(explained in Annexure I).**

FIGURE 2-5: IMPORT AND EXPORT VOLUME OF CLINICAL THERMOMETER FOR THE LAST TEN YEARS



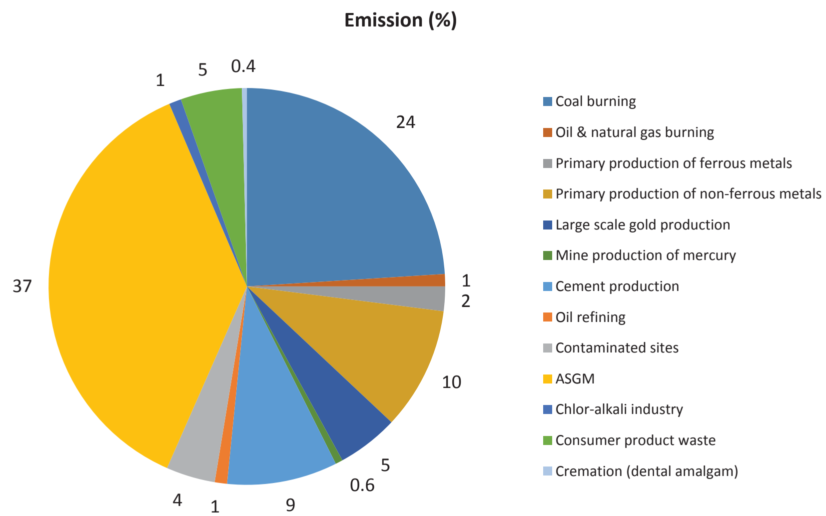
Source: Department of Commerce, Government of India
Note: 2012-13 correspond to the period of April to December 2012

2.3 Emissions

Mercury is a naturally occurring element which remains liquid at room temperature. It occurs naturally and is found in very small amounts in oceans, rocks and soils. It becomes airborne when rocks erode, volcanoes erupt and soil decomposes. It then circulates in the atmosphere and is redistributed throughout the environment. Apart from these natural sources, mercury emissions into the atmosphere can also take place from various anthropogenic activities. The various anthropogenic activities include primary production of ferrous and non-ferrous metals, cement production, pig iron & crude steel production, artisanal and small scale gold mining (ASGM), large scale gold mining, oil and natural gas burning, oil refining, mercury mining, contaminated sites and incineration of mercury containing waste. The cremation of bodies having past mercury filling also causes mercury emission to the atmosphere.

The following figure exhibits the percentage of mercury emission into air from various activities at global level. As per the UNEP estimation of 2010, artisanal and small scale gold mining accounts for the highest amount of mercury emission to the atmosphere. Emissions from coal burning accounts for 24% of the total global emissions, while primary production of non-ferrous metal and cement manufacture accounts for approximately 10% and 9% emission to the atmosphere, respectively. The details of other sources of emissions with percentages are represented graphically in Figure 2-6.

FIGURE 2-6: UNEP ESTIMATION OF GLOBAL MERCURY EMISSION IN 2010 FROM DIFFERENT ANTHROPOGENIC SOURCES



Source: http://www.unep.org/PDF/PressReleases/GlobalMercuryAssessment2013.pdf

In India, the major contributor of mercury emission to the atmosphere is coal burning in thermal power plants. Apart from this, non-ferrous metal production, cement production, pig iron & crude steel production, incineration of mercury containing waste are also some of the sources of mercury emission to the atmosphere. The cremation of bodies with dental mercury filling also causes mercury emission to the atmosphere.

The coal fired power plants are the major contributors of mercury emission to the atmosphere. According to the report[27],emission from the stationary combustion dominates Indian inventory by and large (Table 2-4). As part of the UNEP work towards establishing national emission inventories, AMAP (2008) has prepared an inventory of emission for 2005.

The mercury emission factor, used in the AMAP 2008 report for UNEP was 0.1-0.3 g/ton for coal combustion in power plants and 0.3g/ton for coal combustion in residential and commercial boilers.

The AMAP (2008) global inventory for 2005 estimated total "by product" emissions (including emission to all media) from India at 161.05 tons/year.[28] The stationary combustion (all fuels) is leading in mercury emission in India amounting to almost 140 tons/yr. This is followed by emission of about 11.4 tons/yr from cement production industries and 4.3 tons/yr from non-ferrous metal production and 4.0 tons/yr from caustic soda production, respectively. However, the estimate of emissions from coal combustion in India is extremely dependent on the mercury content of the coal, i.e. the mercury emission factor. Table 2-4 shows a sector-wise inventory of mercury emission into air.

TABLE 2-4: MERCURY BY PRODUCT EMISSIONS FROM ANTHROPOGENIC SOURCES IN 2005 IN INDIA (IN KG)

Stationary combustion	Non-ferrous metal production	Pig iron & crude steel production	Cement production	Large scale gold production	Caustic soda production	Total (in kg)
139659.5	4330.3	1523.3	11416.0	124.8	4002.5	161056.4

AMAP, in the above calculation, has taken the emission factor of 0.3 g/tons, along with a coal consumption total of 404.7 Mt of hard coal (anthracite &bituminous), 60 Mt soft coal (lignite and brown coal) and 38.1 billion m^3 natural gas. The air pollution control devices fitted with these plants hardly help in mercury emission reduction because these plants are only fitted with basic ESP (Electrostatic Precipitator), which does not go well with the general Indian coals that have very high ash content.

Indian coals are reported to have higher mercury content than coal from other countries, with values cited in the literatures ranging from 0.11-0.80 mg/kg. However, there is no specific data available regarding the mercury emission factor.

27 *Source:* Mercury Emissions from India and South East Asia, 2012 *by Lesley Sloss, AMAP (the Arctic Monitoring and Assessment Programme) under the auspices of UNEP*

28 *http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/coal/Lesley%20Sloss-Mercury%20Emissions%20from%20India%20and%20South%20East%20Asia.pdf*

The country currently has 111 coal-fired power plants with a total generation capacity of 121GW. The 12th (2012-2017) and 13th (2017-2022) five year plan are expected to add an additional 76 GW and 93 GW, respectively. AMAP in its study has predicted a probable emission of mercury from anthropogenic sources for the year 2020, which is presented in Table 2-5[29]. The emission scenario for 2020 reflects a significant jump from 2011 figure of 140 metric tons to 231 tons – a significant increase of approximately 90 tons per annum. This is a matter of serious concern and requires immediate attention.

TABLE 2-5: MERCURY BY PRODUCT EMISSIONS FROM ANTHROPOGENIC SOURCES IN 2020 IN INDIA (IN KG)

Stationary combustion	Non-ferrous metal production	Pig iron & crude steel production	Cement production	Large scale gold production	Total (in kg)
208842.3	4330.3	1523.3	17124.0	124.8	231944.7

2.4 Mercury Waste Generation in India

All products and processes which use mercury in their manufacture generate waste that contains mercury and this is extremely hazardous to the environment. Mercury has a very long half-life period, hence any waste laden with mercury will not deteriorate or break down but will continue to exist in the environment and impact the environment adversely. This will eventually increase mercury pollution load in the environment and can be globally transported.

According to the definition of Minamata Convention, the mercury wastes mean substances or objects consisting of mercury or mercury compounds, containing mercury or mercury compounds or contaminated with mercury or mercury compounds – in a quantity above the relevant thresholds defined by the Conference of the Parties (CoP), in collaboration with the relevant bodies of the Basel Convention in a harmonized manner – that are to be disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law or this Convention.

However, this definition excludes overburden, waste rock and tailings from mining, except from primary mercury mining, unless they contain mercury or mercury compounds above thresholds defined by the Conference of the Parties.

In India, there are several sectors which use mercury in products and processes that result in generation of waste laden with mercury. The current study talks about a few of them, and it is estimated that India generates significant quantities of waste which requires specialised treatment and handling. An effort is made to ascertain and estimate the total waste generation in India and the details are placed in the following pages.

29 *http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/coal/Lesley%20Sloss-Mercury%20Emissions%20from%20India%20and%20South%20East%20Asia.pdf*

2.4.1 Mercury Waste from Healthcare Instruments

The mercury containing medical devices (thermometer & sphygmomanometer) become a part of the solid waste stream, when obsolete. If these wastes are disposed of with regular trash then mercury can contaminate the environment and endanger health through two of its very typical property of bio-accumulation and bio-magnifications.

Mercury instruments in the healthcare industry are also being slowly and gradually replaced by alternates and the global mercury treaty is likely to hasten this process. This shift is creating a new kind of waste which contains mercury captured into products, thereby increasing the quantum of total mercury bearing waste in products. Most healthcare facilities are currently storing these products within their facilities which will eventually be part of the waste stream and will require to be disposed of appropriately.

However, the total weight of such waste could not be quantified due to lack of accurate information from healthcare facilities. This is likely to create a new situation of storing such large number of products which contain mercury.

Mercury waste is also generated within healthcare facilities due to spillage of waste and breakages of products which eventually land up in landfills and effluents generated from hospitals.

2.4.2 Mercury Waste from Dental Sector

Dental sector is a significant contributor to mercury waste. The dental mercury enters the environment through a range of pathways. Mercury is released into the environment through handling and preparation of amalgamation. Mercury emission occurs through the cremation of bodies having mercury filling and also as a waste stream during the removal of old dental fillings.

Mercury release due to removal of old fillings: This is the bulk component of mercury waste from the dental sector. According to the study:[30]

Estimated number of dental restorations performed in India/year	:	251 million (approx.)
Percentage of removal of old filling	:	70%
Removed old mercury fillings	:	176 million
Percentage loss of mercury during use over the years	:	50%
Amount lost to 0.75g mercury in each filling	:	0.375 g
Generated mercury waste	:	176 * 0.375g
	:	66 tons/yr

30 Mercury in Our Mouth by Toxics Link, 2012

We have assumed here that all the fillings removed were mercury fillings because the average life of a mercury filling is around 8-10 years and, around year 2000, most of the fillings were done using mercury. However, according to some dentists in Delhi, the usage of alternatives started since 2000. If we assume that 75% of the removed fillings were mercury fillings, the releases come to around 49.5T.

2.4.3 Mercury Waste from CFL Handling

CFL is another major source of mercury waste generation in India as it contains small amounts of mercury. The most important fact with CFL is that mercury might leak out from broken or burnt-out lamps. This has a high chance of toxic mercury getting into the waste stream posing dangers to local inhabitants and waste handlers. The mercury content in the CFL does not reduce over the usage period of CFL, which means the quantum of mercury used by CFL industries in India will evidently slip into the environment as waste stream, until and unless proper management measures are adopted.

The quantum of mercury waste from CFL usage in India has been calculated based on the attrition rate of the CFL. The attrition rate again varies between commercial and residential sector.

Attrition rate of CFL & mercury waste generation: The attrition rate refers to the time period during which a unit of CFL would get entirely exhausted. The attrition rate for CFL units in India has been calculated at two levels – household level and commercial level. The annual mercury waste generation from the household and the commercial sector is 0.3 tons and 8.0 tons, respectively.

The average life per piece of CFL in household sector is 2.7 years and that of a CFL in commercial sector is 1.0 years. The detailed calculation and explanation is given in **Annexure II**.

The quantity of mercury waste generation has been calculated by considering the conservative figure of 2.7 years and 1 year of attrition rate per CFL in the household sector and commercial sector, respectively. These calculations are based taking into consideration 21.21 mg of mercury contained in each CFL. On the basis of these assumptions, the annual potential mercury waste generation from Indian household sector and commercial sector has been calculated and explained.

Case A: Household section

At present (2012), CFL penetration in household	:	42 million
Life of a CFL in household	:	2.7 years

Indian situation

After 2.7 years, Hg waste generation by 42 million units	: 42 million * 21.21 mg
	: 0.9 tons
Each year mercury waste generation by 42 million units	: 1.0 tons/2.7
	: 0.3 tons (approx.)

Case B: Commercial section

At present (2012), CFL penetration in commercial area	: 376 million
Life of a CFL in commercial area	: 1 year

Indian situation

Each year Hg waste generation by 376 million units	: 376*21.21 mg
	: 8.0 tons (approx.)
Total annual waste (Case A + Case B)	**: 8.3 tons (approx.)**

The above calculations of waste generation are best estimates. However, it is important to mention here that the above calculation does not present the total waste generated from CFL but only estimates the total elemental mercury being released into the environment from CFL lamps. The rest of the CFL also becomes contaminated with mercury thereby increasing the quantum of potential mercury bearing waste. Considering the current number of CFL in Indian market – which is 400 million units – and the weight of each CFL unit, the quantum of mercury bearing waste will be significantly large and geographically spread out.

2.4.4 Mercury Waste from Chlor-Alkali Industries

According to our recent study on Chlor-alkali industries – Economics of Conversion in India –it was observed that for each ton of caustic soda produced, approximately 20kg of mercury waste, named sludge is generated[31]. Currently, in Indian Chlor-alkali industries, the total production capacity on mercury cell technology is 14,800 tons/year. However, this quantity of waste generation is expected to be completely eliminated due to conversion/closure of the two existing plants.

Total production capacity in India	: 14,800 tons/year
Mercury waste generation	: 20kg/tons of caustic soda
Total mercury bearing sludge generation	: (14,800*20)/1000 tons/year
	: 296 tons/year

31 *Source: Interview with Alkali Manufacturers Association of India*

2.5 Mercury Release in India

The word mercury release refers to any form of release of mercury or mercury compound into land and/or water. Minamata Convention concerns about controlling and, where feasible, reducing releases of mercury and mercury compounds – often expressed as "total mercury" – to land and water from relevant point sources was not addressed in other provisions of this Convention.

For the purpose of this Convention, the "Releases" mean discharge of any mercury or mercury compounds to land or water. "Relevant Source" means any significant anthropogenic point source of releases as identified by the country that is not addressed in other provisions of this Convention.

2.5.1 Mercury Release from Healthcare Instruments

Healthcare instruments are majorly responsible for the mercury release into the environment. The tendency of breakage of mercury thermometer and sphygmomanometer and the mercury spillage from the sphygmomanometer leads to the huge quantum of mercury release into the environment because of the poor or zero spill collection mechanism in healthcare facilities.

- According to the study Lurking Menace in 2004 by Toxics Link, the average monthly breakage rate of thermometer in a 300 bedded hospital is around 70;
- 1/3rd of the total amount of mercury (60 gms) in sphygmomanometer is spilled and 2 BP spills occur in a month;
- Occurrence of approximately 480 gms of annual mercury release into land or water from BP instruments;
- Only thermometer and sphygmomanometer breakage and/or spillage from a single hospital can cause environmental mercury burden of 1320 gms/year;
- An average sized hospital with a dental wing can release conservatively around 3 kgs of elemental mercury in the environment in a year;
- Indian healthcare sector including both the government and private sector releases approximately 8 tons of mercury/year from the usage of thermometer and sphygmomanometer.

This mercury waste, on account of leakages and breakages of instruments, is generally mixed with municipal waste and finds its way into municipal dumps and landfills. However, these 8 tons of mercury will be difficult to account as release because certain percentage of it will be emitted into air as well.

2.5.2 Mercury Release from Dental Sector

The dental sector releases mercury in the form of non-contact amalgam and contact amalgam (during polishing of the new filling). The cremation of the dead leads to mercury emission into air.

- The average non-contact amalgam generated per year in India is about 16 tons;
- India would emit around 1.4 tons of mercury from dental amalgam fillings during cremations annually;
- Leaching of mercury from amalgam fillings in the Indian Population is 1 ton annually.[32]

TABLE 2-6: MERCURY WASTE, RELEASE AND EMISSION FROM DIFFERENT USAGE

Sl. No.	Sector	Waste/year (tons)	Release per year (tons)	Emission per year (tons)
1	Healthcare instruments	-	8	
2	Dental sector			
	Non-contact amalgam		16	
	Cremations			1.4
	Leaching from amalgam filling		1	
3	CFL			
	Household sector	0.3		
	Commercial sector	8.0		
4	Chlor-alkali Sector	296*		
	Total	**304.3**	**25**	**1.4**

**This waste is likely to be eliminated in 2013, as the only two facilities currently operating on mercury are to be phased out or converted to be mercury-free thus substantially reducing the total waste generation.*

2.6 Mercury Contaminated Sites in India

In India, the prevalence of mercury contamination is expected to be widespread because of the uncontrolled use of elemental mercury/mercury compounds by various sectors. The various product manufacturing sites including healthcare instruments, CFL and tube lights industries, and industrial processes – where mercury or mercury compounds are being used – are some of the probable sites which may have mercury contamination.

However, there is no standard operating procedure for identification of such sites which have been exposed to prolonged and significant usage of mercury. These sites are located across the length and breadth of the country and are placed under the regulatory jurisdiction of various State Pollution Control Boards, but in the absence of any norm or procedure these sites have not been investigated or reported upon. However there have been some recent reports and studies on some of these sites in India. One of the reported sites in India has been the thermometer

32 *Mercury in Our Mouth, Toxics Link, 2012*

factory at Kodaikanal. The site is approximately 85,000 m^2 and is located in a notified industrial area –on top of a cliff at an elevation of approximately 2,180 m above sea level. A former mercury thermometer factory was located on this site which ceased manufacturing operations in March 2001. There were reports of mercury laden waste and sludge being disposed off down the hill slopes thus contaminating large area around the plant. However, most of the mercury contaminated equipment and soil has been removed from the site[33] though current status on clean up still continues to be in doubt.

Although the Chlor-alkali plants in India have shifted technology from mercury to membrane cell process, there is no clear evidence or record to suggest and confirm whether the site has been cleaned and completely decontaminated of mercury. Hence, these sites would fall in the category of potentially contaminated sites demanding further investigation and confirmation. The list of such sites is placed below in Table 2-7.

TABLE 2-7: CHLOR-ALKALI PLANTS – PROBABLE SITES OF MERCURY CONTAMINATION

S. No.	Name of the unit	Location
A. Eastern region		
1	Bihar Caustic & Chem.	Jharkhand
2	Durgapur Chem. Ltd.	Durgapur, WB
3	Hindustan Heavy Chem.	Kolkata
4	Hindustan Paper (Nagaon & Cachar)	Assam
5	HJI-Prop: GMMCO Ltd.	Amlai, MP
6	Jayshree Chemicals Ltd.	Ganjim, Orissa
7	Kanoria Chemicals Ltd.	Renukoot, UP
B. Western region		
8	Atul Ltd.	Valsad, Gujarat
9	Ballarpur Industries Ltd.	Ballarshah
10	Century Rayons Ltd.	Thane, Maharashtra
11	Grasim Industries	Nagada, MP
12	Gujarat Alkaliesand Chem.	Dahej& Baroda, Gujarat
13	Indian Rayon	Veveral, Gujarat
14	NRC Ltd.	Thane, Maharashtra
15	Reliance (IPCL)	Dahej, Gujarat
16	Standard Industries Ltd.	Mumbai, Maharashtra
17	Shriram Alkali & Chemicals	Jhagadia, Gujarat
18	Tata Chemicals	Jamnagar, Gujarat
19	United Phosphorus Ltd.	Bharuch, Gujarat

33 http://moef.nic.in/downloads/public-information/BioremediationBook.pdf

S. No.	Name of the unit	Location
C. Northern region		
20	Lords Chloro Alkali Ltd.	Alwar, UP
21	Punjab Alkarlies & Chem. Ltd.	NayaNangal, Punjab
22	Shriram Vinyl & Chemical Industries	Kota, Rajasthan
23	Siel Chemicals Complex	Rajpura, Punjab
D. Southern region		
24	Chemplast Sanmar Ltd. (Mettur)	Mettur Dam, Tamil Nadu
25	Chemplast Sanmar (Karaikal)	Karaikal
26	Chemfab Alkalis Ltd.	Pondicherry
27	DCW Ltd.	Sahupuram, Tamil Nadu
28	Solaris Chem Tech.	Karwar, Karnataka
29	Sreee Rayalaseema Alkalies & Allied Chemicals Ltd.	Kurnool, AP
30	Tamilnadu Petroproducts Ltd.	Chennai, Tamil Nadu
31	Andhra Sugars Ltd.	Kovvur & Saggonda, AP
32	Travancore-Cochin Chem. Ltd.	Kochi, Kerala

Rushikulya river of South Orissa flows through two districts of Orissa – Phulabani and Ganjam – before entering into the sea. It touches the Bay of Bengal near Ganjam town of Ganjam district of Orissa. This place is well known as Rushikulya estuary (locally called as Rushikulya Muhana). This has been identified as the hotspot of mercury when the fish and hair samplings were conducted because of the presence of a 33 year old Chlor-alkali plant named Jayshree Chemicals.[34] The plant was following the principle of "solution to pollution is dilution" and was releasing the mercury containing liquid effluents of the plant into the Rushikulya estuary. Although the plant started draining the liquid effluents into two guard ponds built by the plant authority close to the estuary, one of it was found to be in dilapidated condition. During the rainy season, the liquid waste oozed out from the guard ponds and drained into the estuary. Also the mercury bearing solid waste release from the industry was dumped in open land which was close to the estuary. These are the probable indicators that will require complete study to understand the level of contamination.[35]

Coal fired power plants and surrounding areas are again some probable sites which could potentially be contaminated with mercury. One such site is Singrauli, the powerhouse of India with massive coal reserves and many thermal power plants. There were a number of studies conducted by CPCB, IITR, Lucknow, about mercury toxicity; however, the place is not yet recognized as one of the major mercury hot spots in the country.

34 *Hot spots report by Toxics Link, 2012*
35 http://www.appliedgeochemistsindia.org.in/pdf/abstracts/5.%20H.%20Kariyanna.pdf

In 2011, people of the area approached the Centre for Science and Environment, a Delhi based environmental group,to study the pollution and health problems in Sonbhadra. Nineteen people facing health problems were selected for blood, hair and nail samples from Sonbhadra. CSE collected samples of water, soil, cereals and fish from the district, in addition to blood, hair and nails of people living there.

Twenty-three samples of water, a mix of groundwater, surface water and effluent, were collected from different places in the district. Seven soil samples were taken. Five samples of rice, wheat and pulses grown in the area were collected from different houses. Three fish samples were collected from different places in the Gobind Ballabh Pant Sagar (GBPS) reservoir on the Rihand. Results showed that high levels of mercury did make way into the environment. Nothing at all in Sonbhadra has been spared the devastating effect of mercury.

Laboratory tests revealed the presence of an average 34.3 parts per billion (ppb) mercury in the blood samples of twelve women and seven men whose age ranged between 8 and 63 years. This was six times the safe limit of 5.8 ppb set by the United States Environment Protection Agency (USEPA).This indicates that the population living in close vicinity of such facilities are exposed to mercury from various pathways. Such sites are likely candidates of contamination and will require a detailed investigation.

HIGHLIGHTS

Mercury Trading – Import-Export

- Mercury is not mined or produced in India, but imported completely.
- Mercury is also exported from India.
- Total import & export of elemental mercury is 165 tons & 45 tons, respectively, in 2012-13.
- Mercury-containing instruments, mercury compounds, batteries containing mercury and mercury compounds, etc. are also imported in large quantities.
- Total import of clinical thermometer is 2.08 million units & export is 0.53 million units.
- Mercury traders in India are engaged in trading this commodity from India.

Mercury Usage Inventory in Products & Processes

- Major consumer of mercury is healthcare instrument, dental amalgam, electronic device, batteries, CFLs & other lighting equipment, paints & cosmetics, traditional Ayurveda & Siddha medicines & in cultural products.
- Current manufacturing of thermometer & sphygmomanometer in India is 8.32 million and 0.225 million units per year, respectively.
- Total mercury usage in healthcare instruments is 21.82 tons (8.32 tons in thermometer and 13.50 tons in sphygmomanometer).
- Total mercury used in dental amalgam including contact & non-contact amalgam is 65 tons, as on 2011.
- Total CFL production in India is 400 million units & mercury usage is approximately 8.5 tons annually with an average of 21.21 mg mercury per CFL.
- Button cell batteries contain mercury; however, there is neither production of the same in India nor any inventory of usage of button cell batteries.
- Two numbers of Chlor-alkali plants with an annual production capacity of 14800 tons of caustic soda use 2.96 tons of mercury per year.

Mercury Emission, Waste & Release into Environment

- Total mercury emissions from anthropogenic sources in India is 161.05 tons/yr with stationary combustion (coal fired thermal power plant) being the major contributor (140 tons/yr).
- Annual mercury waste generation from CFL and Chlor-alkali sector is 8.3 tons and 296 tons, respectively, totalling to 304.3 tons/yr (approx.).
- Annual mercury release is approximately 25 tons/yr.
- Annual mercury emission from cremation is 1.4 tons/yr.

ISSUES WITH MERCURY IN INDIA

3.1 Mercury Supply Sources & Trade

In India, mercury is not mined; rather it is imported for meeting its domestic requirements. While trade between countries is unregulated, trade within the country is also not regulated or controlled as the imported mercury is freely traded among end users without any records or inventory. The Directorate General of Foreign Trade (DGFT) maintains record of all imports and exports of mercury; it is unable to provide any additional information on the subsequent movement of mercury due to the absence of any reporting mechanism. The data so maintained by the DGFT is only from an economic perspective and has details on total imports, countries of import and valuation of imports and exports. Mercury as a product is freely traded in Indian markets and there are no definite requirements for storage and sale in markets. This could be a matter of concern as this commodity has the potential of moving into black-markets also because of the treaty which is now in place. Since there are no licences for trade or any reporting requirements for mercury usage, any accidental releases or movement from any sector to another cannot be tracked. Mercury, being an extremely toxic metal, is a huge environmental risk.

There is very little awareness among the traders and the users of mercury on some of the health impacts of this metal. While, in trade, there are no specific rules on their storage and transportation, it's extremely dangerous to be traded openly.

3.2 Mercury–Added Products

Mercury added products are still in use in India and this includes products like healthcare instruments (thermometer and sphygmomanometer), dental amalgam, CFL, batteries etc. There are several concerns, associated with the usage of these products; however, the issues vary.

3.2.1 Healthcare Instruments

The major problems lie with the manufacturing of mercury containing healthcare instruments as it uses elemental mercury. Mercury thermometer manufacturing is largely in small sector units, which are multiple in numbers and geographically spread out making it difficult for the regulators to monitor handling of such a hazardous material. Mercury-based instruments and mercury usage in healthcare facilities will require to be shifted to alternates and experiences suggest the following challenges in making this shift possible:

- Scarcity of good quality mercury alternate products at affordable prices is one of the major issue;
- Standardization of alternate instrument also comes as a barrier to this shift;
- Financial implications is another barrier of such shift from mercury to non-mercury products because of the huge cost differential of these products;
- The training of healthcare staffs for using these alternate products;
- There are also issues of healthcare professionals' mind-set on shifting from mercury to alternates. Most regard mercury instruments as gold standards and oppose move for shift to alternates;
- In the downstream side, the issue is with the handling of end products, i.e. mercury waste produced from these instruments and also the product waste which becomes obsolete on introduction of alternates.

3.2.2 Dental Amalgam

Mercury usage in dentistry also poses serious challenges, which are explained here:

- Cost differential for alternate dental fillings pose financial challenge;
- Non-contact mercury amalgam from dental filling increases environmental pollution load in the absence of proper collection mechanism;
- Senior dentists who have had long years of dentistry practice find it difficult to make the shift to alternates;
- Mercury emission from crematorium.

3.2.3 CFL

In India, the major problems lie with the handling of CFL both at the upstream and downstream levels:

- Upstream issue: Absence of any standard for mercury dosing in CFL;
- Downstream issue: End-of-life management of the spent CFL.

Mercury dosing in CFL: In the absence of any standards for mercury dosing in CFL lights, most manufacturers have continued to dose excessive quantities of mercury in lamps. This way they have introduced much higher quantities of mercury through the products into the market and subsequently into the environment. Currently, the Bureau of Indian Standards (BIS) is in the process of finalising mercury dosing standards for the lighting industry in India.

End-of-life management: The country is lacking adequate mechanism for CFL management – once its life ends and becomes obsolete. Absence of collection mechanism, indifferent attitude of the manufactures, their unwillingness to work on EPR principals and general lack of know how among regulators are some of the major factors responsible for the mismanagement of spent CFLs. Due to this mismanagement, CFLs are still going into the household municipal garbage to be ultimately dumped onto landfills. Lighting products are also not part of the recently notified Electronics waste rules, hence movement of this waste into landfills and performing informal sector recyclers of waste compromises human and environmental health.

3.3 Manufacturing Process using Mercury/Mercury Compounds

3.3.1 Chlor-Alkali Industries

In India, CREP initiative has led these industries to shift majorly with only two plants left. But there is hardly any mechanism of post closure handling of excess mercury. India does not have any regulation for site remediation at present.

Traces of mercury in the soil and water can be found near the Chlor-alkali plants which used to operate with mercury cell technology. The change of technology may leave a few quantum of discarded and excess mercury which can go for reselling into the open market; however, there is no such mechanism of tracking this excess mercury at present.

3.4 Mercury Emissions

India does not have any regulatory mechanism to control and handle air emission of mercury from thermal power plants, smelting industries and various other processes, which emits mercury as a by product. The country also does not have any standard for mercury emission from the power plant sector and other industrial processes including smelting, cement production, primary production of ferrous and non-ferrous metal, etc. The mercury emission from such industrial processes is significantly large and there is a need to not only control such emissions but also reduce it. The requirement to identify the Best Available Technology (BAT) and the Best Environmental Practices (BEP) is needed to be put in place.

This is one of the most critical areas and poses enormous challenge to the policy makers and regulators as any control mechanism will require significant technological and financial inputs.

Any intervention in this direction will require a decision at the highest levels of government. Once the country signs the treaty, it will be mandatory for the national government to initiate action to control and reduce the levels of emissions and protect human health and environment.

3.5 Mercury Releases

Industrial and manufacturing processes, which use mercury as a raw material and/or use mercury bearing compound, can release/discharge mercury and mercury compounds in the waste stream through effluents. This release ultimately finds its way into the soil, water and air, thus posing grave environmental challenge.

- The country lacks any release limit values of mercury for industrial effluents;
- The country at present does not have any mechanism for inventorisation of this mercury effluent as there is a lack of sound tracking mechanisms of such releases;
- There is no concept of Best Available Techniques (BAT) and Best Environmental Practices (BEP) availability in India for reduction of releases in environment from concerned sources;
- The country at present does not have any pollution control strategies for control of mercury release.

3.6 Environmentally Sound Interim Storage of Mercury other than Waste Mercury

Waste from mercury or mercury containing waste can pose a serious challenge due to large volumes and dispersed location of generation. Absence of a regulatory framework and appropriate and sound infrastructure also adds to the challenges of dealing with such waste.

Mercury stored at a dispersed location can be potentially problematic as creation of multiple appropriate storage infrastructures and monitoring of such storage sites can be excessively resource centric. This also creates multiple hot spots with a need to place adequate care and security at such dispersed locations. These locations may also be prone to natural disasters and climatic variations. The current situation on mercury storage appears to be highly compromised as the guidelines issued attempts to address storage of mercury containing products from healthcare sector only. There is a requirement to address the issue of interim and long-term storage of mercury and this would require more in depth study and deliberations among stakeholders and experts in order to identify such locations and create appropriate infrastructure and systems for storage in the country.

3.7 Mercury Wastes

The total estimated quantity of mercury related waste generated from various sectors in India is approximately 304.3 tons (*refer Chapter 2*) which is expected to be significantly reduced on conversion of the Chlor-alkali plants. However, there is an urgent requirement to conduct a detailed estimation of waste generation due to the obsolescence of mercury-based healthcare measuring instruments as this will eventually add to waste volumes and possibly surplus mercury, which might require safe disposal or long term storage.

The country is currently lacking any appropriate measures to keep and/or to manage and dispose of the mercury waste in an environmentally sound manner. There is a need to dispose of such waste in an environmentally sound manner through the adoption of appropriate technology. There is also the need for short term and long term storage of waste and surplus mercury.

Central Pollution Control Board had issued a guideline on environmentally sound management of mercury from healthcare sector (*Section 4.1.4, Chapter 4*); the implementation of the same, however, has not proven to be successful.

3.8 Contaminated Sites

In India, there are various industrial processes, which use mercury as a raw material, or generate mercury emission and releases to air and water or soil, respectively. However, there are no processes or systems of identifying a site contaminated with mercury and assessing the impact on environment and human health. Henceforth, it is very important to have some regulatory mechanisms in place. The technology and tools will also require to be developed for identifying such sites. It can also be a complex decision as the polluter may not be easy to locate making it a legacy site. There are a few experiences in dealing with contamination of sites including identification and remediation, in addition to addressing health concerns of impacted population close to such sites. Health issues due to contamination of site are also critical and will require different levels of surveillance and treatment options. There could also be a need for compensating victims of such contamination.

3.9 Capacity Building, Technical Assistance and Technology Transfer

There is a lack of understanding and incapacity to deal with mercury in the country and this is true for all sectors. Policy makers, regulators, users and emitters of mercury are all either ill-informed or have poor knowledge of the issue. An inadequacy of suitable technology, a lack of knowledge in manufacturing of alternate products, lack of individual capacity of handling mercury-free alternate products, absence of BAT and BEP to control and reduce emissions and releases are some of the critical issues which requires to be dealt with.

3.10 Lack of Public Information, Awareness and Education

India seriously lacks in an information sharing system for public at present. People in India are hardly aware of mercury toxicity and its ill effects on human health. Neither do they know the mechanism of handling any mercury spillage (at household level or sometimes at healthcare facilities) nor do they have any knowledge about the very existence of mercury in a regular household item like CFL. So these end-of-life products, which contain mercury, finally end up in the waste stream releasing significant volumes of mercury into the environment.

Common public are not even familiar with mercury issues in dental amalgams; it is the doctors who can push for alternative filling at individual patient level as well as in the market thereby indicating their key role as influencers.

As regards the barriers to adoption, it emerged that lack of awareness among the common populace and total absence of any governmental intervention to implement effective information Education Communication (IEC) initiatives to spread awareness about the issue are major barriers to universal adoption of alternatives in India.

Given the current trend and the upcoming adoption of the Minamata Convention on Mercury, it is assumed that the use of amalgam will continue to decline. People will prefer natural color tooth fillings and there will be an increased awareness of the need to reduce mercury pollution. Along with this fact there is also a growing emphasis on the dental hygiene and preventive dental care leading to improved dental health, and an overall reduction in invasive treatment. It will ultimately result in reducing the usage of amalgam and mercury in dentistry.

"When we talk about the barrier towards adoption of mercury-free technology, we can consider lack of knowledge of people and less Government initiatives to make people aware about it.

Dr. Rohit Kochhar, MD and Professor, ITS Dental College

3.11 Research, Development, Environmental Monitoring and Health Aspects

In India, there is no such mechanism of continuous and regular research and development progress, specifically in making inventory of use, consumption and anthropogenic emissions of mercury and mercury compounds to air and releases to water and land. The country also lacks in any major database regarding the use of mercury, mercury compounds or mercury containing products and processes. Neither there is any documented paper on the environmental and health impacts of its usage, thereby generating the urgent need to develop protocol and system for environmental and health monitoring.

Another important issue is methyl mercury contamination of fish and fish-eating mammals, which is a global public health concern. The risk is not only highest for populations whose per capita fish consumption is high, but also in areas where environmental pollution has elevated the average mercury content of fish. Nevertheless, the methyl mercury hazard also exists where per capita fish consumption and average mercury levels in fish are comparatively low. Therefore, monitoring the mercury level in fish that people consume frequently is a significant part in assessing the health impact of mercury. Toxics Link in 2009 had participated in a study of monitoring mercury levels in fish eating states of West Bengal and few data has come up.[36]

This type of study requires further extension beyond any particular state and must spread across the other states of India, where majority of the population depend on fish consumption.

36 http://mercurypolicy.org/wp-content/uploads/2009/02/MercuryInFishFullReportFinal021009.pdf

HIGHLIGHTS

Mercury Supply & Trade

- Unregulated trading of mercury between countries and within the country.
- Mercury is freely traded among end users in India without any records or inventory. There is an absence of any reporting requirement.

Mercury in Products

- Lack of good quality alternates, absence of standardization and certification of products & huge cost difference are some of the barriers of shifting from mercury to alternative healthcare instruments and dental amalgam.
- Absence of standard for mercury dosing and end-of-life management of discarded CFL are the two issues to be dealt with.

Mercury Waste Disposal, Emission and Release into Environment

- Absence of regulatory standard for mercury emission from the power plant & other industrial process including smelting, cement production, primary production of ferrous and non-ferrous metal, etc.
- Critical requirement for setting up country specific Best Available Technology and Best Environmental Practices to be identified and adopted for use in industry emitting mercury.
- Requirement of setting mercury standards in effluents and creating a monitoring mechanism for mercury releases in effluents.
- Presence of dispersed location of mercury storage is highly compromised without due precautionary measures to prevent some dangers, posed by such storage.
- India lacks any appropriate measures, needed to manage mercury waste in an environmentally sound manner. Neither does it have any mechanism to keep and manage or dispose of the mercury laden waste, i.e. the substance or objects consisting of mercury or mercury compounds, containing mercury or mercury compounds and/or contaminated with mercury or mercury compounds.

Mercury Contaminated Sites

- India hardly has any appropriate strategies for identifying a site contaminated with mercury, as well as identifying and assessing the impact of mercury on environment and human health.
- Training, Capacity Building & Knowledge Sharing
- Policy makers, regulators, the users and emitters of mercury are all either ill-informed or have inadequate knowledge of the issue.
- India hardly has any information sharing mechanism among the common mass about the toxicity of mercury.

ACHIEVEMENTS ACROSS INDIA

4.1 Legislative Framework

The current legislative framework does not deal with mercury and its health and environmental impacts adequately. While there is mention of mercury laden waste in Hazardous Wastes (Management, Handling & Transboundary Movement) Rules 2008, it does not address other aspects of mercury toxicity and its overall environmental concerns. India's National Environment Policy 2006 also does not refer to the mercury usage and handling across different sectors. However, the Central Pollution Control Board have issued guidelines for storage of mercury products and on shifting.

4.1.1 Existing Environment Policy – Emergence of National Environment Policy 2006

Broad Objectives of NEP

- Conservation of critical environmental resources;
- Intra-generational equity, livelihood security for the poor;
- Inter-generational equity, integration of environmental concerns in economic and social development;
- *Efficiency in environmental resource use, environmental governance, enhancement of resources for environmental conservation.*

The need for conservation and sustainable use of natural resources has been stated in Indian scriptures and is reflected in the constitutional, legislative and policy framework as also in the international commitments of the country. Prior to India's independence in 1947, several environmental legislations existed, but the real impetus for bringing about a well-developed framework came only after the UN Conference on the Human Environment (Stockholm, 1972). Under the influence of this declaration, the National Council for Environmental Policy and Planning within the Department of Science and Technology was set up in 1972, which later evolved into the Ministry of Environment, Forests & Climate Change. This is the apex administrative body in the country for regulating and ensuring environmental protection.

The present policies for environmental management are contained in the National Forest Policy, 1988; the National Conservation Strategy and Policy Statement on Environment and Development, 1992; Policy Statement on Abatement of Pollution, 1992; the Wildlife Conservation Strategy 2002, and; the National Environment Policy, 2006. Some sector policies – such as the National Agriculture Policy, 2000; National Population Policy 2000, and; National Water Policy, 2002 – have also contributed towards environmental management. All of these policies have recognized the need for sustainable development in their specific contexts and formulated necessary strategies to give effect to such reorganization.

In 2006, India adopted the National Environment Policy (NEP) as a comprehensive policy to mainstream environmental concerns in all development activities. The policy outlines strategies for addressing the key environmental challenges facing the country. It promotes economic competence for environmental conservation and internalization of the costs of environmental damages. The dominant theme of NEP is that while conservation of environmental resources is necessary to secure livelihoods and welfare of all, the utmost safe basis for conservation is to ensure that people dependent on specific resources obtain better livelihood through the conservation of natural resources rather than its degradation. The objective of NEP, which relates to the current perceptions of the key environmental challenges are conservation of critical environmental resources, intra-generational equity, livelihood security for the poor, inter-generational equity, integration of environmental concerns in economic and social development, efficiency in environmental resource use, environmental governance and enhancement of resources for environmental conservation.

4.1.2 Existing Legislation & Regulations Addressing Mercury

The Environment (Protection) Act, 1986, in India is an umbrella legislation, which provides a complete framework for the protection and improvement of the environment and is designed to provide a structure for the co-ordination of central and state authorities established under the Water (Prevention and Control of Pollution) Act, 1974, and Air (Prevention and Control of Pollution) Act, 1981. Under this act, the central government is empowered to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of environment and preventing, controlling and abating environmental pollution and also taking measures necessary to protect and improve the quality of the environment by setting standards for emissions and discharges; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. From time to time the central government makes rules and issues notifications and guidelines for the various environment related matters under this Act.

Table 4-1 gives a brief on the few aspects of Hazardous Waste (Management, Handling, and Transboundary Movement) Rules, 2008, as this is the only rule in India which talks about a few aspects of mercury and its management & handling in one or the other way.

TABLE 4-1: HAZARDOUS WASTE (MANAGEMENT, HANDLING, AND TRANSBOUNDARY MOVEMENT) RULES, 2008

Provision of rules	Type of process/waste (hazardous)
Process generating hazardous waste (Rule 3 (l) (schedule 1)	Mercury bearing sludge; Brine sludge containing mercury.
Waste constituent with concentration limit: 50 mg/Kg Rule 3 (l) (schedule 2)	Class A: Mercury and mercury compounds; Class E: Regardless of conc. limit, the waste containing or contaminated with established toxic or eco-toxic constituent is covered under hazardous waste.
Hazardous waste applicable for import with prior informed consent (of the country from where it is imported and exported to) Rule 3, 14 (2-i) (schedule 3- part A & C)	Mercury switches; electrical and electronic assembles or scrap contaminated with mercury to an extent that they exhibit hazard characteristics (poisons, liberation of toxic gases in contact with air or water, toxic, eco-toxic, capable of lechate).
Hazardous waste applicable for import without prior informed consent of the country from where it is imported (import permitted by the actual user with Ministry of Environment, Forests & Climate Change permission and DGFT license) Rule 3 (L-iii), 14 (2-ii) (schedule 3- part B & C)	i) Waste batteries conforming to a standard of battery specification, excluding those made with lead, mercury, Cd.; ii) Mercury switches; electrical and electronic assembles or scrap not contaminated with mercury from which they have been removed to an extent that they do not possess constituents with conc. limit mentioned in schedule 2.
Hazardous waste prohibited for import and export Schedule VI, Rule 13 (4)	Mercury bearing wastes; waste having mercury compounds as constituents or contaminants.
Categories of hazardous waste: Waste Category No.4 (Hazardous Waste Management Rules 1989; notification 29th July)	Regulatory quantity: 5 kg per year (The sum of the specified substance calculated as pure metal).

4.1.3 Chlor-Alkali Industries – CREP Initiatives

It is of critical importance to move towards compliance through the adoption of clean technologies and improvement in management practices. Commitment and voluntary initiatives of industry for responsible care of the environment can help in building a partnership for pollution control.

With this objective, the Ministry of Environment, Forests & Climate Change in India initiated the Charter on Corporate Responsibility for Environmental Protection (CREP) – a thirteen point time bound Action Plan for phasing out the use of mercury from the Chlor-alkali sector.

The formation of CREP was one such step, which was agreed by Indian Chlor-alkali Industries. CREP came into force in 2003 and, right from the beginning, this initiative proved to be an instrument for reducing mercury consumption in industry.

This CREP initiative suggested a time-bound shift from mercury cell to membrane cell technology for all the Chlor-alkali plants in India by 2012. Currently, in India, this process has mainly shifted to membrane cell technology except for two plants.

In addition to the CREP recommendation, there were some more reasons for shifting to membrane cell technology, which are as follows:

- Reduction in energy consumption & its cost;
- Capacity expansion of existing plant;
- Addressing the environmental benefits.

Reduction in energy consumption & its cost: Since the Chlor-alkali production relies on energy intensive electrochemical technology, approximately 70-75% of the production cost primarily comprised of energy costs in case of mercury cell-based technology. On the contrary, there is a significant reduction in energy consumption by membrane cell technology with the total energy cost constituting just 60% of the production cost. The study[37] has shown a net savings of approximately 24% in energy consumption through the shifting of technology. This has reduced the cost considerably by Rs. 3670 per ton.

Capacity expansion of existing plant: In India, most of the Chlor-alkali plants are a source of raw material for the associated industries; therefore an increase in market demand for end products, like chlorine caustic soda, establishes the need for increased production of either chlorine or alkalis. However, due to the age factor of plants, the government refused to sanction the use of mercury cell technology on account of environmental concerns. This, therefore, remained a major factor of technology shifting.

Addressing environmental benefits: The Chlor-alkali plants in India have achieved huge benefits through this technology shift, which includes:

- The membrane cell plant is an environment friendly and energy efficient technology. Henceforth any end product from this plant is mercury free with no chances of mercury contamination to the soil or water;
- The membrane cell-based plant would ensure no emission of mercury into the air;
- No negative impacts on human health as well as the environment remains;
- Net energy savings of approximately 24%, thereby reducing the amount of carbon footprint.

37 Chorine Industry: Economics of Conversion in India

4.1.4 Healthcare Sector

In India, the healthcare sector has experienced various national level and state specific order to phase out mercury-based instruments, specially thermometer and sphygmomanometer, from their respective healthcare facilities.

4.1.4.1 mercury phase out orders

In India, Delhi was the first state to shift from mercury to mercury-free equipment when Toxics Link published first of its kind research report –"Lurking Menace"– in the year 2004. After the release of this report, 5 major hospitals in Delhi started the shift to mercury-free equipment voluntarily.

In 2007, Toxics Link did another study on the mercury content in hospital indoor air. It found dangerous levels of mercury in the indoor air of two hospitals indicating persistent exposure of healthcare staffs and visitors to this toxic element. The results also found an astonishingly 5 times higher mercury exposure to the newborn in maternity ward. In the same year, DPCC issued a first-of-its-kind mercury phase out order in Delhi that instructed all hospitals to shift from mercury to alternative instruments.

In 2010, the Directorate General of Health Services (DGHS) issued a national level guideline to reduce environmental pollution due to mercury and e-waste in central government hospitals and health centers. In the same year, Hubli-Dharwad Municipal Corporation (HDMC), Karnataka also came up with a similar kind of mercury phase out order applicable to all the hospitals under the ambit of HDMC. The two states of Punjab and Manipur have also issued mercury phase out orders in 2011 and 2012 in the healthcare facilities of the state.

Initially the healthcare facilities had to confront and deal with some of the perceived barriers of accuracy and cost of the instruments however slowly and gradually these constrains were being resolved. Though this barrier has been reduced to a great extent and the alternates are easily accepted by the healthcare professionals, the issue is yet to be completely resolved.

There are now many hospitals across the country, which have successfully shifted from mercury instruments to alternates. The practice of such a shift has been a rich experience in itself and provides answers to many of the perceived barriers and challenges of shifting. These hospitals are both in government and private sector. The knowledge, experience and the ground work done in making this shift happen is of immense value to the country and this paves the way for additional drive in this regard.

4.1.4.2 CPCB storage guidelines

Once the hospital started shifting from mercury to mercury-free alternatives, the major problem was to manage the mercury waste – generated from the discarded products – its handling and disposal mechanism. The Central Pollution Control Board (CPCB) in 2012 came up with guidelines specifying environmentally sound management of mercury and mercury-bearing waste from the healthcare sector. According to this guideline, the mercury bearing waste is one that is generated because of accidental breakage of mercury base instruments, obsolete medical instruments containing mercury (which are no longer in use) or items contaminated with mercury including mercury spill and residual mercury base dental amalgam.

This guideline refers to the environmentally sound management of thermometer, sphygmomanometer, dental amalgam, esophageal dilator, feeding tubes, gastrointestinal tubes, intraocular pressure devices, etc. which are being used in any healthcare setup.

This guideline proposes the following strategies for better management of mercury bearing waste that is generated from healthcare setup:

i. Segregation of reusable and non-reusable mercury containing products;

ii. Recycling mercury-containing products when they can no longer be used;

iii. Proper handling and disposal of mercury waste, mercury-containing equipment, collected mercury spill, residual mercury base dental amalgam and laboratory chemicals;

iv. Establishing protocols for proper clean-up of spills involving mercury;

v. Enforcing compliance with suggested or institutional policies;

vi. Using alternatives for products that contain mercury.

This guideline also talks about the safe storage of mercury base medical instruments and also suggests precautionary measures necessary to be taken during their maintenance.

HIGHLIGHTS

- **CREP initiative of 2003 has helped Indian Chlor-alkali plants to shift from mercury to membrane cell technology.**
- **Healthcare sector of Delhi was the first to become mercury free.**
- **Issuance of national level guidelines by DGHS to reduce environmental pollution due to mercury and e-waste in central government hospitals & health centres.**
- **CPCB in 2012 has come up with a guideline detailing the environmentally sound management of mercury and mercury bearing waste from healthcare sector.**

PLANNING RECOMMENDATION

5.1 Commitments at International Level

India has been a signatory to various international environmental agreements relevant directly or indirectly to sustainable development. India was among the first countries to enshrine environment protection in its Constitution. This Constitution mandates has, over the years been, translated into series of statutes in the realm of environment.

Likewise, India has actively participated in the negotiation process of Minamata Convention which has since been adopted by the global community in October 2013. It will take some time for it to be implemented by member states since 50 countries are required to ratify the treaty, which will happen sometime after 2013. In the interim, India needs to do the ground work, recognize priority uses, allocate resources and formulate an action plan for easy and smooth implementation of the treaty. The treaty has set firm deadlines for phase out of various products and processes that currently use mercury. This mandates countries to stop manufacture of such products & processes, and also places control for export-import of such products.

5.2 Need for a National Implementation Plan

The issues around mercury and its toxicity are complex and require serious consideration at highest levels of governments. Such decisions have significant economic, social and political impacts hence dependant on critical and credible inputs and data and intensive consultations among stakeholders. There is also an important requirement of clear roadmap and what needs to be achieved.

An implementation plan is a detailed roadmap of decisions, activities, deliverables and the resources which becomes an important tool in all the decision making process. The need of a good and comprehensive Implementation plan is fundamental and critical for governments and the overall impacts of such plan can be substantial. It's a document that helps the departments and functionaries to continue to sustain the implementation and push the agenda over a long period.

The Minamata convention does encourage countries to work towards preparations of such a plan but it does not mandate such a process. According to the Article 20 of the Minamata Convention, each Party may develop and execute an implementation plan taking into account its domestic circumstances for meeting the obligations under this Convention and, if in case a plan is developed it should be conveyed to the Secretariat at the earliest. However, this is solely optional and not mandatory in nature.

While the treaty will only become operative on ratification by fifty countries – which could take another two years or so – in the interim period the country would require taking some actions and preparing ground for its effective and smooth implementation, all of which can be brought under the ambit of a National Implementation Plan.

This plan can broadly cover aspects of national issues around mercury and the need to address these issues. The issue of prioritising action and intervention in sectors is also expected to get well-articulated through a detailed plan. Any plan of action will best serve its purpose if prepared with extensive consultation with stakeholders and experts, and is drawn upon others' experiences. This exercise could be taken up prior to the date of implementation of the treaty. The country has a previous experience of preparing such a plan for the Stockholm Convention though there will be requirement of further adding to the previous experience and making this a practical and functional document. The plan should be able to deal with sector wise action plans, timelines for such actions, involvement of respective departments/ministries and identification and allocation of adequate resources for such actions.

- The country can cover various aspects of the treaty for its effective compliance when developing such a plan and this will include:
- Regulation on mercury supply & trade;
- Manufacture of products, import or export of mercury-added products;
- Restriction on the use of mercury or mercury compounds in the manufacturing processes;
- Emission control from point sources;
- Control and, where feasible, reduce releases of mercury and mercury compounds to land and water from the relevant point sources not addressed in other provisions of this Convention;
- Environmentally sound management and handling of mercury waste consisting of/containing mercury or mercury compounds and/or contaminated with mercury or mercury compounds;
- Address all issues related to site contamination and its impacts on human health;
- Start the final disposal of surplus mercury.

5.3 Regulate Mercury Supply Sources & Trade

According to Article 3 of the Convention, each Party shall not allow the export of mercury, except to a Party that has provided the exporting Party with its written consent and only for the purpose allowed under the Convention. Each Party shall not allow the import of mercury from a non-Party to whom mit will provide its written consent unless the non-Party has provided certification that the mercury is not from sources identified as not allowed under paragraph 3 of the Convention. The treaty also has a very strict reporting requirement which will help nations and secretariat to track mercury movement across the globe.

Likewise India will require regulating and controlling its supply sources and preventing it from becoming a source of trading. Considering the enormous usage of mercury (*refer Chapter 2*) and the uncontrolled trading of mercury within the country, one of the objectives of this treaty is to reduce demand & supply of mercury and also control on the usage of mercury and track its movements. Hence the treaty has a strict reporting structure in place.

India will also be required to follow this reporting regimen and ensure that there is complete transparency and record of mercury movement both within the country and outside. This could be done through a regulatory framework for control of mercury and a system for trade and consumption reporting by various industries and other users. This will also be helpful in receiving data on mercury usage by various sectors and keeping track of any spillage and releases into the environment.

5.4 Mercury-Added Products

5.4.1 Healthcare Instruments

On becoming party to the Minamata Convention India requires adoption of certain measures to fulfil its commitments:

- Control & regulate import of mercury contained healthcare instruments: The treaty clearly stipulates a phase out of mercury-added products including healthcare instruments by 2020, which suggests that healthcare instruments will not be mass-produced post 2020. The ban will adversely affect the healthcare manufacturing industry and the healthcare industry will be required to shift to alternates and setup protocols & systems to address all issues related with such shifts.
- Ensure availability of mercury-free alternatives: India needs to ensure accessibility of safer, accurate and economically viable alternate products, keeping in mind the demand from the medical fraternity. There are products available as an alternative to the mercury-based instruments that include thermometer and sphygmomanometer; however, a cost differential exists due to the higher cost of alternates. Therefore the government must allocate adequate

budget for shifting from mercury to alternate products in all the healthcare facilities under its control. The current experience of no future procurement of mercury instruments in many states has been a good example and perhaps one of the ways forward for other states to emulate.

- Arrange for training: There will also be training needs for healthcare professionals and paramedic staff for the use of alternate instruments.
- Safeguard quality: The availability of quality products in domestic market also requires to be ensured; the system for product standardisation through BIS/QCI will be helpful in the shift.

There are various instances in different states on the shift from mercury to alternate instruments in healthcare settings. All the required groundwork has been successfully accomplished, thus making it extremely smooth for such shift to be achieved by the entire country well before the 2020 deadline.

CASE STUDY: POTENTIAL BUSINESS FOR DIGITAL THERMOMETER

In order to create a market potential for in-house manufacturing of mercury-free alternates, a definite business case scenario is being presented here in order to encourage the manufacturers of mercury-based healthcare instruments to shift to alternates.

a. Thermometer

The thermometer market in India is mainly driven by import; there is little percentage of current demand and this is met by in-house production.

- Current import of digital thermometer in India was 3.30 million units in 2012;
- The export of digital thermometer was 0.15 million units in 2012;
- A net consumption of these digital thermometers in India is approximately 3.15 million units (3.30 – 0.15);
- The current market demand for digital thermometer from public & private hospital IPD, individual household, hospital OPD and from doctors' clinics has been estimated at 3.20 million units in 2011-12;
- A projected demand for digital thermometer from these sectors has been calculated at 60.09 million units by 2020, though it is a conservative figure and based on few assumptions;
- A best case scenario with 100 percent adoption projection by 2020 has also been calculated. This gives a probable demand figure of approximately 143.4 million units thermometer.

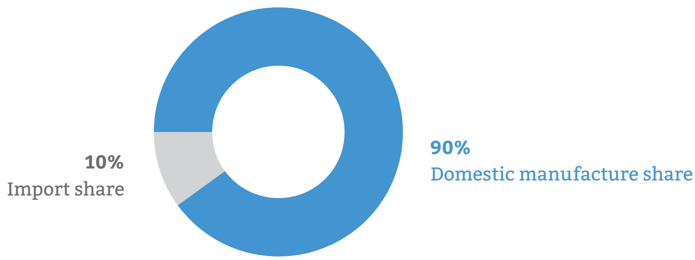
(Detailed calculation is attached as *Annexure III*)

CASE STUDY: POTENTIAL BUSINESS FOR ANEROID SPHYGMOMANOMETER

Survey findings reveal that the demand of aneroid sphygmomanometers in India is largely met through imports. There is only one manufacturer of aneroid sphygmomanometers and that is based in Pune.

- Current market volume of aneroid sphygmomanometers is pegged at 0.775 million units per year;
- Out of this market, imports account for the 90% of volume, i.e. 0.7 million;
- Remainder 0.075 million is attributed to domestic manufacturing.

FIGURE 5-1: MARKET SHARE OF ANEROID SPHYGMOMANOMETERS IN INDIA



Future projected demand for aneroid sphygmomanometers has been calculated for the year 2020 keeping household sectors largely in mind, wherein its adoption is gaining traction. The projected demand from the household sectors is approximately 6.7 million units by 2020 (a detailed methodology for calculation is given in Annexure IV).

This is more than double of the total current volume of sphygmomanometers in India. This huge demand from the household segment alone presents a credible business case for mercury-based sphygmomanometer manufacturers to shift to aneroid sphygmomanometer manufacturing. The total demand would be further increased if the requirements of hospitals and clinics are included.

This presents an optimum business condition for manufacturers to come up with a new setup for alternate products manufacturing. The government must also encourage more manufacturers to setup their units for manufacturing such instruments.

5.4.2 Dental Amalgam

In India, the demand for restorative materials is met by the following three segments:

- Domestic manufactured products by 8-10 manufacturing units;
- Imported products from China and also from Europe and America, respectively;
- Imported from China but repacked in India and sold by the brand name of local traders and business houses.

The treaty envisages a phase down approach for mercury amalgam and this will require efforts on multiple fronts for it to be a success. Government hospital with dental facilities can start to reduce the use of amalgam in their clinics. The role of government (various ministries), the dental association and the dental practitioners will be critical in making this shift possible. This can be achieved through the following:

- Encourage usage of alternate restorative materials and gradually increase the percentage of alternate fillings;
- Inclusion of mercury-free dentistry training in the dental education curriculum can change the attitudes and mind-set of fresh dentists;
- Awareness among consumers seeking medical treatment on the harmful effects of amalgam can make the shift easy;
- Implementation of national programme for prevention of dental caries to minimise need for dental restoration;
- Increasing tariff or taxes of mercury amalgam to decrease consumption;
- Encouraging the use of encapsulated amalgams to avoid spillage or to control non-contact amalgam from moving freely;
- Setting targets for such shifts in government dental facilities;
- Encourage manufacturers to setup production facilities for alternative restorative materials in the country to ensure availability of affordable and quality restorative products for the dentist and citizens.

5.4.3 CFL

In order to ensure safe handling and management of CFL, the country will be required to create standards for mercury dosing in consonance with the treaty text. This could possibly be achieved through a directive or mandatory standards for CFL; it can also be accomplished through a voluntary initiative by the industry. However, requirement for testing of new standards will also need to be recognized and a process to ensure compliance of the standards must be in place.

CASE STUDY: POTENTIAL BUSINESS FOR DENTAL RESTORATIVE MATERIALS

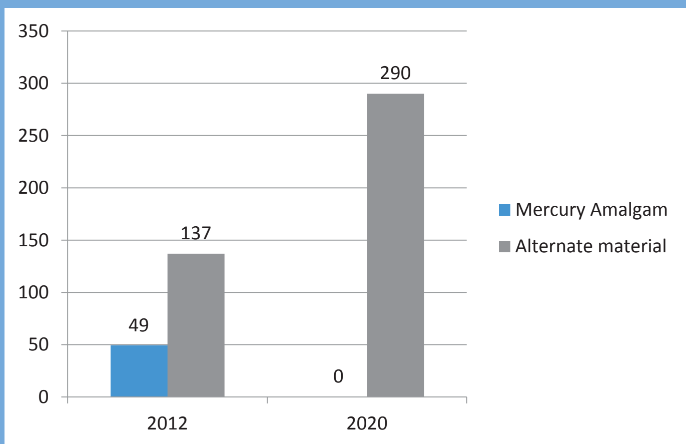
In order to create market potential for in-house manufacturing of mercury free alternative restorative materials, a definite business case scenario is being presented here to encourage the manufacturers to produce more of such alternates:

- Current market for alternative restorative materials in India is 137 tons;
- Out of this, 81 tons is met by the remaining tons after the import and export (import 179 tons & export 98 tons, i.e. 179 tons – 98 tons = 81 tons) (DGFT data on import & export);
- This shows a hypothesis that balance requirement of 56 tons is being provided by local manufacturing units.

Projected demand for total dental restorative material by 2020 has been estimated to the tune of 290 tons (a detailed calculation is presented in Annexure V).

Considering the treaty provision, this demand will be met by alternative dental restorative material.

FIGURE 5-2: SUMMING UP THE UTILIZATION OF DENTAL RESTORATIVE MATERIALS (2012 V/S 2020)



- Based on the calculations, the utilization of alternatives would increase from 137 tons in 2012 to 290 tons in 2020, indicating an increase of more than hundred percent by the treaty identified period;
- It appears to be lucrative and appropriate for some of the Indian business houses and entrepreneurs to grab this opportunity.

Bringing standards would also boost the new technology where the mercury spillage would be much lower and there will be a check on the low quality import materials in addition to reducing the exposure risk downstream.

The need for suitable label on CFL packaging for mercury is also considered crucial and essential, and demands immediate implementation by the manufacturers. The regulators will need to be proactive in dealing with some of the concerns arising from the lighting industry, and these can be put in place well before the treaty comes into implementation.

The issue of downstream mercury-laden waste, generated from these end-of-life lamps, need to be addressed as this poses a grave environment and human health risk. This can be best addressed by the lighting industry through the setting up of a collection mechanism and a recycling facility for these lamps. The government role in defining mechanisms of Extended Producers Responsibility will be important and this would require regulatory framework with industry participation.

5.4.4 Other Mercury Containing Products

In order to comply with the treaty provisions, the country needs to come up with strategic plans for phasing out all products containing mercury:

- At the very outset, an inventory of mercury usages in various products including switches, relays, thermostats, cultural products and traditional medicines, topical medicines, jewellery, etc. is to be prepared;
- Preservative value of topical antiseptics and cosmetics would require a regulation in sustaining low levels of mercury in them;
- Mercury in biological products, antiseptics & other drugs, vaccines, cosmetics, and AYUSH drugs should be reviewed by the DCG(I);
- Mercury containing beauty creams, hair treatment creams and other cosmetics may cause significant exposures, hence they should be regulated;
- It is important to identify globally acceptable alternatives to these mercury containing products and the cost differential associated with it;
- There is a need to identify alternate materials and technology for manufacturing of such products. Participation of the industry in such process will be important;
- The country needs to come up with strategies for encouraging the use of alternative products;
- Finally, a national level notification may be issued to industries and/or to the individual manufacturer asking for complete ban on production and use of mercury-based products by 2020.

5.5 Manufacturing Process using Mercury/Mercury Compounds

5.5.1 Chlor-Alkali Industries

Initially, mercury was used in the Chlor-alkali industry for the production of chlorine and caustic soda; however with the adoption of the CREP initiation, all plants, except two, have shifted to alternate technology.

The country should fast track the conversion and/or closure of two of its existing plants. It will be important to carry out site surveillance of some of these closed or converted facilities to reduce the risk from mercury contaminated sites. If such sites need any further efforts for remediation, then an action plan for the same can be drawn.

5.6 M6

According to the Article 8 of Minamata Convention, any country or a Party with relevant sources shall take measures to control emissions and may prepare a national plan setting out the measures to be taken to control emissions and its expected targets, goals and outcomes. Any plan shall be submitted to the Conference of the Parties within four years of the date of entry into force of the Convention for that Party. If a Party develops an implementation plan in accordance with Article 20, the Party may include in it the plan prepared pursuant to this paragraph.

India for its new sources, will be required to adopt best available techniques and best environmental practices to control and, where feasible to reduce mercury emissions, as soon as practicable but no later than five years after the date of entry into force of the Convention for it. It may also use emission limit values that are consistent with the application of best available techniques hence the need to identify appropriate technology for controlling emissions.

For its existing sources, India shall include in any national plan, and shall implement, one or more of the following measures, taking into account its national circumstances, and the economic and technical feasibility and affordability of the measures, as soon as practicable but no more than ten years after the date of entry into force of the Convention for it:

a. A quantified goal for controlling and, where feasible, reducing emissions from relevant sources;
b. Emission limit values for controlling and, where feasible, reducing emissions from relevant sources;
c. The use of best available techniques and best environmental practices to control emissions from relevant sources;

d. A multi-pollutant control strategy that would deliver co-benefits for control of mercury emissions;
e. Alternative measures to reduce emissions from relevant sources;

Apart from the allotted list of measures, the country needs to adopt following steps, so as to ensure successful implementation of set targets:

- India shall establish, as soon as practicable and no later than five years after the date of entry into force of the Convention for it, and maintain thereafter, an inventory of emissions from relevant sources;
- India needs to develop the methodology for preparing inventories of emissions;
- It must setup an expert committee/task force to ascertain requirements for mercury control measures;
- The committee or the task force should report to the highest levels in government so that the recommendations are handled at the highest echelon of the government;
- The country needs to adopt regular monitoring system for incinerators emission levels and emission from cremation of bodies with dental fillings and also emission from relevant point sources;
- The country must allocate resources for such technologies;
- There should be set targets and time frames for such reduction in emissions;
- India shall also include information on its implementation of this Article 8 in its reports – to be submitted pursuant to Article 21 in particular information – concerning the measures it has taken and the effectiveness of the measures.
- The country shall setup regular monitoring mechanism of mercury in various mediums, such as water, soil, air and for the people living around the power plants. This can be done by the concerned SPCB;
- India needs to monitor the quality control measures taken by industries or by the accreditation system to reduce mercury emission.

5.7 Mercury Releases

Mercury in effluents is considered as a pollutant release to the land and/or soil. This needs to be tracked in an environmentally sound way. The country does not have any mechanism of such tracking; henceforth it is important to take relevant measures to monitor mercury releases.

According to the Article 9 of the Minamata Convention, each Party should control and, where feasible, reduce releases of mercury and mercury compounds – often expressed as "total mercury" – to land and water from the relevant point sources, which includes any significant anthropogenic point source of release as identified by a Party.

India must adhere to this Article of the Convention, according to which:

- It shall, no later than three years after the date of entry into force of the Convention for it and on a regular basis thereafter, identify the relevant point source categories;
- India with relevant sources shall take measures to control releases and may prepare a national plan setting out the measures to be taken to control releases and its expected targets, goals and outcomes. Any plan shall be submitted to the Conference of the Parties within four years of the date of entry into force of the Convention for it. If it develops an implementation plan in accordance with Article 20, it may include in it the plan prepared pursuant to this paragraph.
- For the compliance of the above, India shall include one or more of the following measures, as appropriate:
  a. Release limit values to control and, where feasible, reduce releases from relevant sources;
  b. The use of best available techniques and best environmental practices to control releases from relevant sources;
  c. A multi-pollutant control strategy that would deliver co-benefits for control of mercury releases;
  d. Alternative measures to reduce releases from relevant sources;
- India shall establish, as soon as practicable and no later than five years after the date of entry into force of the Convention for it, and maintain thereafter, an inventory of releases from relevant sources;
- India also needs to develop the methodology for preparing inventories of releases;
- The country shall, as soon as practicable, adopt guidance on best available techniques and on best environmental practices, taking into account any difference between new and existing sources and the need to minimize cross-media effects;

  There is a need to create a national estimate for such releases into different mediums;
- The country needs to ensure proper reporting, covering the various information related to the implementation of several procedures which is to be submitted as per the Article 21 of the Convention. The information shall include the measures it has taken for creating inventories and monitoring the release and effectiveness of the measures.

5.8 Mercury Wastes

According to the Article 11 of the treaty, the mercury waste generated from the countries which are parties to this Convention has to be managed in an environmentally sound manner taking into account the guidelines developed under the Basel Convention and in accordance with requirement that the CoP shall adopt in an additional annex in accordance with Article 27 of the treaty. In developing requirements, the Conference of the Parties shall take into account Parties' waste management regulations and programmes.

Mercury can only be recovered, recycled, reclaimed or directly re-used for a use allowed to a Party under this Convention or for environmentally sound disposal; however, for Parties to the Basel Convention it is not transported across international boundaries except for the purpose of environmentally sound disposal in conformity with Article 11 of mercury treaty and with that Convention.

No corporate or polluter responsibility is identified in the article, however national governments may wish to make use of these economic instruments. In developing waste management guidelines, the national level waste management programs and regulations should be in place.

There are several mechanisms for management and handling of mercury waste from different sectors. However, as a step towards better management of mercury waste the country needs to come up with an action plan, which takes into account the following:

- Development of an inventory of different types of mercury waste generation from various usages and processes;
- An inventorization of surplus and/or excess mercury from all the usages so as to measure the volume of mercury and the specificity of storage facility required;
- Safe collection of mercury waste from various usages;
- Adoption of strategies or mechanism for recovery, purification and recycling of waste;
- Transformation of mercury waste into a more physically and chemically stable form (if in case the waste is in liquid form) so as to transfer it without causing environmental damage during transportation;
- Identification of a suitable location for permanent storage of mercury waste;
- Authorize an agency to collect, recover and recycle mercury waste;
- Develop, finalise and adopt a regulation/framework for sound handling and disposal of mercury and mercury waste;
- Identify appropriate technology for processing of mercury waste.

The following section talks about the handling of mercury waste generated from various sectors in an environmentally sound manner.

5.8.1 Healthcare Sector Waste and Spill Clean-up & Disposal

The mercury containing medical devices (thermometer & sphygmomanometer) becomes a part of the solid waste stream when it is obsolete and hence these waste products and spilled mercury will require to be handled with due precaution. The country must ensure the following steps for better management of mercury waste from the healthcare sector:

- Proper and timely employment of existing guidelines, meant by CPCB, for environmentally sound management of mercury waste from the healthcare sector;
- Assure a take-back system for discarded mercury containing devices by the manufacturers through the issuance of an order or a guideline;
- Ensure the use of common biomedical waste treatment facilities for incineration, rather than being done by the individual hospital;
- Placement of mercury spill management kit in healthcare facilities so as to ensure better collection of spilled mercury thereby preventing the same from entering the municipal waste streams;
- Use of mercury spill management kits only by trained personnel to prevent further exposures;
- Inventorization and quantification of cumulative weight of medical devices and mercury itself;
- Identification of interim as well as final storage for disposal of products and the collected mercury.

5.8.2 Mercury Waste Management in CFLs – What are the Options?

The downstream mercury management in CFL is the most critical issue. Though there is a guideline for safe handling[38] of mercury in the CFL, the execution of the same is hardly present across the country. Currently there are no systems in the country to collect and manage this waste from the consumers and, henceforth, the waste so generated finally ends up in landfills. This is a serious challenge and will require multiple methods to find solutions. The major waste stream generated from the CFL sector includes:

- Mercury emission through the vent attached to Hg dosing machine (during manufacture);
- Used/broken lamps/cut glass tubes used in dosing of Hg in the process (during manufacture);
- Glass waste (with & without mercury);
- Waste phosphor powder;
- Waste mercury (in liquid &vapour phase);
- Waste electronic & plastic components;
- Residue from mercury distillation facility;
- Waste from air pollution control system.

While collection of used CFLs is a major challenge, identification of appropriate technology to manage such waste will be another task. The geographical spread of the country will also be an

38 Guideline for environmentally sound mercury management in Fluorescent lamp sector, CPCB

important factor to be considered while taking any decision on mercury management from CFLs. Here are a few steps that might help in better management of waste from the lighting sector:

- The principle of Extended Producers Responsibility (EPR) will be highly advisable for any intervention on waste from lighting products;
- The producers to come out with a mechanism for collection, transportation, storage and recycling along with a reverse logistics plan and financial mechanism (for setting plants, transportation, incentives, etc.). This can also create space for civic and town bodies, the local waste pickers, etc. for better recovery of lamp waste;
- Engaging the informal sector in pre-crushing/recycling operation, like door-to-door collection and transportation of CFL waste to storage/recycling site;
- Detailed financial mechanism will need to be identified and implemented for operation of reverse logistics and the final treatment and disposal of waste.

5.9 Contaminated Sites

In India, there have been several reports on site contamination from mercury usage in production processes and facilities. Even though these incidences have been reported, there are no closure reports to such contaminated sites – the details of these having been remediated and responsibilities fixed.

According to the Article 12 of Minamata Convention, the country must follow the guidance on managing contaminated sites adopted by the Conference of the Parties.

Those may include methods and approaches for:

- Site identification & characterisation;
- Engaging the public;
- Human health and environmental risk assessments;
- Options for managing the risks posed by contaminated sites;
- Evaluation of benefits & costs, and;
- Validation of outcomes.[39]

In consideration of the above mentioned facts India will be required to finalise a framework in line with the guidance documents adopted by the Conference of Parties with an objective to identify and notify such contaminated sites.

- The country must develop strategies and implement activities for identifying, assessing, prioritizing, managing and, as appropriate, remediating contaminated sites;

39 *Article 12 of the UNEP treaty text*

- The country must identify agencies responsible for actions and start measures to build such capacities;
- The country shall attempt to develop suitable strategies for assessing sites contaminated by mercury or mercury compounds;
- The country shall act in order to evaluate the risks to human health and the environment from mercury or mercury compounds;
- The country needs to conduct detailed epidemiological study in human population in order to measure the health effect through early sub clinical signs;
- The country requires training and capacity of healthcare professionals to assess such impacts on human health;
- It shall develop mechanisms to address the health concerns arising out of site contamination.

CPCB recently published a list of 88 industrial clusters where the extent of ecological damage is being evaluated and effective remedial action plan is foreseen. A similar kind of activity is the call of the hour so as to identify places contaminated with mercury. For defining the same, a standard operating procedure needs to be established as a basic step to it.

5.10 Capacity Building, Technical Assistance and Technology Transfer

India needs to develop an in-house capacity for successful implementation of the Convention. The capacity building can be in terms of getting technical help or alternative technology transfer from developed countries for effective implementation of mercury phase out programme&environmentally sound management and handling of mercury. This is to be followed by a regular evaluation of progress in adopting the technology or technical assistance (*ref: Article 14 of UNEP treaty text*). In addition to this:

- The country should integrate provision for capacity building and training of the environmental regulators and ensure further development and innovation of design in order to deliver the best possible capacity-building programme for environmental regulators on mercury toxicity issue, its handling, disposal, knowledge sharing on its alternatives etc.;
- Identification and selection of such institutions which can deliver such multidisciplinary capacity for the country;
- A provision or arrangement should be made with medical colleges for monthly training of healthcare professionals and para medical staffs under the existing and/or newly planned training component;
- The hospital staff must be trained on the handling mechanism of mercury spillage in case of breakage of a thermometer and sphygmomanometer;
- The country must ensure the training of dentists and dental assistants on ways to handle and dispose of mercury after use in dental fillings;

- Environmental education program should focus on the core aspects of mercury hazards and poisoning;
- Building of capacity and knowledge sharing from countries that have technology and experience of storage, transportation, monitoring and assessment of contaminated sites will add value.

The lack of clues and capacity is starker among planners, pollution mitigating agencies and municipalities who are at the helm of affairs to manage such things. This needs to be addressed in a manner so that necessary steps can be taken from experiences and knowledge sharing.

5.11 Creation of Public Information, Awareness and Education

The country needs to come up with a different mechanism for information distribution and spreading public awareness, as this is very vital for the successful implementation of the treaty.

- The government bodies like Ministry of Environment, Forests & Climate Change, Ministry of Power, Ministry of Health, CPCB, producers of products should take the onus of building mass awareness on mercury;
- The facts on the health and environmental effects of mercury and mercury compounds and the alternatives to mercury and mercury compounds should be available for public;[40]
- Concerned body must ensure information reach out among public and various industrial forums about the accessibility of technically and economically viable alternatives for manufacturing processes in which mercury or mercury compounds are used and also for activities and processes that emit or release mercury or mercury compounds;
- Dietary advice can be developed for people, especially pregnant women and children, exposed to mercury contamination. Assistance can be given to states/UTs for counselling pregnant & lactating women and children of the population about the dangers and benefits of fish consumption, thereby specifying the type of fish that can be consumed and how frequently can it be consumed. Breastfeeding can be strongly advised, since the presence of methyl mercury in breast milk is not sufficient to outweigh its benefits;
- Information related to health and environmental risks, economic & social costs of mercury usage and benefits of alternatives at the same time[41] must be available in general.

For the purpose of the dental sector awareness generation:

- National programme for prevention of dental caries, as part of oral health and school health, must be implemented which will also reduce amalgam filling and subsequently reduce emissions during cremation;

40 *Article 18, treaty text of Minamata Convention*
41 *Article 17, treaty text of Minamata Convention*

- Private and public sector health centres providing dental services should deploy patient educators who would educate the visiting dental patients about the mercury issues in amalgams and positively implement adoption of alternatives for filling dental cavities;
- Relevant government bodies should initiate IEC material distribution through different platforms (print & electronic) to spread awareness about the issue.

In addition to this, India needs to adopt two or more measures from the following list as part of the treaty provisions for "phasing down" dental amalgam:

- Setting national objectives aimed at dental caries prevention and health promotion, thereby minimizing the need for dental restoration;
- Setting national objectives aimed at minimizing its usage;
- Encouraging the use of cost-effective and clinically effective mercury-free alternatives for dental restoration;
- Reducing costs on import of alternate filling materials;
- Promoting research and development of quality mercury free materials for dental restoration;
- Encouraging representative professional organizations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on endorsing best management practices;
- Limiting the use of dental amalgam to its encapsulated form;
- Promoting the use of best environmental practices in dental facilities to lessen the releases of mercury and mercury compounds to water and land.

Appropriate public policy with information on products and the toxics substances contained in them must be taken into consideration during the policy implementation. Henceforth, there is a need for a proactive mass awareness campaign to inform people about toxic hazards and their various pathways.

A thorough roadmap for this type of mass awareness campaign has to be drawn up by various agencies and implemented over a specific time frame. Necessary resource must be allocated for this. NGOs can play an important role to support the task of mass awareness campaign.

The Ministry of Environment, Forests & Climate Change should maintain a Management Information System (MIS) to ensure a similar reporting format for activities taking place in different states and Union Territories.

5.12 Research & Development, Environmental Monitoring & Health

The constant need for research and generation of new data on mercury related issues is a critical need for protecting the citizens of India. While the health aspect is important, there is also a need to invest in technology and processes for production of mercury-free products. Both the industry and government are important stakeholders and they should find opportunities for investing in research and finding solutions.

- Encourage international agencies to work with the national manufacturers to develop and make inexpensive mercury-free products;
- Research & development activities in industry and health are also required to be strengthened in order to identify & study alternative substance as preservative/catalyst/amalgam;
- There is an urgent need for a separate scientific body to look at some of the critical scientific research aspects related to mercury and work as a knowledge centre. The government will need to allocate resources and also tap into global resources for supporting research and new data;
- A major area where India is lacking is the research on the technical and economic availability of mercury-free products & processes, and on the Best Available Techniques (BAT) and Best Environmental Practices (BEP) to reduce & monitor emissions and releases of mercury and mercury compounds. This research will help in advocating locally accessible products, which might help various Indian sectors to shift more rapidly;
- A regional field investigation team is recommended to conduct a detailed investigation on the unusual cases of renal failure, memory impairment, termer, erethism (red Plam), acrodynia (painful extremities), cases of psychomotor retardation, blindness, deafness, seizures, etc. reported among infants for possible mercury poisoning; its impact on human beings and the environment can also be studied;
- National apex lab and at least five regional labs should be assigned for testing mercury levels in food, blood, hair, exhaled air and urine;
- Mercury levels in water, air and soil should be identified and their capacity should be developed;
- Long-term monitoring (including biological measurements of exposure) and programs to reduce occupational exposure needs to be promoted;
- Water-based foods, like fish, should be reviewed by FSSAI; however, the mercury levels in biocide, pesticides, insecticides, etc. should be reviewed by ICAR.

HIGHLIGHTS

Highlights

- A national level action plan, covering all aspects of the treaty, is recommended in consultation with national & regional stakeholders for effective compliance of the treaty by stakeholders.
- India must regulate and control its mercury supply sources, so as to prevent it from becoming a hotspot of trading.
- A strict reporting system of mercury movement must be in place.

Mercury-based Products

- Manufacturing of mercury added products will not be allowed post 2020.
- India to ensure availability of safer, accurate and economically viable alternate products to meet the demand of medical fraternity.
- Import of alternate products must be restricted so as to encourage Indian manufacturers to come up with more production internally.
- Government needs to allocate fund for shifting from mercury to alternate products.
- Training and capacity building of healthcare professionals on the use of alternates is the need of the hour.
- Mercury dosing standard in CFL must be put in place.
- End-of-life management of CFL in an environmentally sound manner with safe disposal is required.

Mercury Emission, Release & Waste Handling

- Country to come up with a mercury emission standard for air.
- Adoption of BAT & BEP for new plant & retrofitting of existing plants to reduce the level of current emission.
- Identification of relevant point sources of mercury releases and adoption of control measures to reduce such release.
- The country to come up with a standard of mercury release into different environmental medium.
- India to develop an inventory of various forms of mercury waste & quantification of such waste as well as surplus mercury from different sources.
- The country to adopt a strict mechanism for environmentally sound disposal of mercury waste through collection, distillation & purification and solidification for permanent storage of mercury waste.

COST ESTIMATES

6.1 Financial resources and mechanisms

According to Article 13 of the Minamata Convention, the overall success of implementation of this Convention by developing countries (Parties) lies in the effective implementation of the financial mechanism. Each Party needs to provide, within its capabilities, resources in respect of those national activities that are proposed to implement this Convention in accordance with its national policies, priorities, plans and programmes. Such resources may lead to domestic funding by the country itself through relevant policy adaptation, development strategies and budget allocation at national and/or regional levels. In addition to multilateral, regional and bilateral sources of financial and technical assistance, capacity building and technology transfer are also encouraged to enhance and increase the activities on mercury with the implementation of this Convention.

According to Article 13 of UNEP Treaty text, it was decided that the Global Environment Facility (GEF) trust shall provide new, predictable, adequate and timely financial resources to parties to meet the cost in support of treaty implementation for activities as agreed by the COP. The Conference of Parties shall provide guidance strategies and policies, program priorities and eligibility for access and utilisation of this fund.

While there is some funding support as envisaged in the treaty for select activities in developing countries, it will be imperative for these countries to allocate resources to meet the defined obligations. Hence there is a need to plan for these resources and then identify what the nation can sustain and where will it require external support. At this stage it is difficult to estimate the total cost for treaty implementation as this would include both hardware and software interventions and the details are yet to evolve; however some cost calculations are being worked out and they could be best estimates that serve as guidance for the development of any action plan.

The following section describes the details of financial estimates for sector wise shifting and/or management of mercury waste generated from various usages in India.

6.2 Financial requirements for phasing out mercury containing health care instruments

Mercury-based thermometers and sphygmomanometers used in the health sector will be shifted to alternates by 2020 as per the treaty mandate and this requires dedicated funds. It will be comparatively easier for private healthcare facilities to assign funds and make this shift, but, in case of public healthcare facilities, the government will need to estimate the fund requirement and allocate such resources.

6.2.1 Shifting of Thermometers in Government Health Setup

- The cost of shifting from the mercury thermometer has been calculated taking into account the total number of sub-centers, PHC, CHC, district hospitals as given in Data Portal, India 2011;
- The number of thermometers is as specified by IPHS.

It has been found that in case the government needs to shift to mercury-free thermometer in the entire public setup of the country, they need to invest approximately 69.2 million INR in a year.

As reflected in Table 6-1 (on a yearly basis), there are 0.49 million clinical thermometers and 0.4 million sphygmomanometers in use across different levels of public healthcare in India. State-wise breakup of these healthcare facilities are given in *Annexure VI*.

TABLE 6-1: NUMBER OF THERMOMETERS & SPHYGMOMANOMETERS

Type of public health facility	Thermometers per facility *	Sphygmoma-nometers *	Numbers of HCFs in India **	Total thermometers	Total sphygmomanometers
Sub-centers	2	2	14,7838	2,95,676	2,95,676
PHC	4	3	23,790	95,160	71,370
CHC	11	1	4,761	52,371	4,761
District & sub divisional hospitals	37	40	1,372	50,764	54,880
Total				4,93,971	4,26,687

HCF: Health Care Facilities
**As per IPHS standards, the number of thermometer/sphygmomanometer to be present at any time in a year.*
*** As per Data Portal, India 2011*

As per Table 6-2, 4 clinical thermometers would be mandatory as against each thermometer in any public health facility in a year (considering the average lifespan of a clinical thermometer to be 3 months). The average lifespan has been assumed by factoring the breakage aspect.

TABLE 6-2: YEARLY REQUIREMENT OF CLINICAL THERMOMETER

Life of a thermometer (clinical) considering breakage	3 months
No. of months in a year	12 months
No. of thermometers required in a year	4 pieces

As per UNDP GEF global healthcare waste project (2009) report, 80 thermometers (digital or clinical) are required in a model hospital and 840 clinical thermometers are broken in a year. This indicates that each clinical thermometer sustains for a period of nearly one month, assuming a positive scenario of 3 months of lifespan for each clinical thermometer.

6.2.2 Requirement of Healthcare Instruments in Public Health Sector

Considering the 1:4 ratio for thermometer requirement, the normative figures – as mentioned in Table 6-1 – have been multiplied by 4 to arrive at estimates for a number of thermometers necessary per facility per annum (shown in Table 6-3).

TABLE 6-3: TOTAL NON-MERCURY HEALTHCARE INSTRUMENTS REQUIRED PER ANNUM (CONSIDERING BREAKAGE)

Type of public health facility	Thermometers required per facility per annum**	Sphygmomanometers required per facility per annum	Numbers of health facilities in India	Total thermometers	Total sphygmomanometers
Sub-centers	8	2	1,47,838	11,82,704	2,95,676
PHC	16	3	23,790	3,80,640	71,370
CHC	44	1	4,761	2,09,484	4,761
District level & sub divisional hospitals	148	40	1,372	2,03,056	54,880
Total				**19,75,884**	**4,26,687**

*** Figures of Table 6-1 is multiplied by 4*

On the basis of discussion with doctors, it has been assumed that the life of a digital thermometer is 12 months. Therefore, in case of digital thermometer, no yearly replacement is required and the total number of digital thermometers will be 4,93,971 (Table 6-1).Table 6-4 explains the cost of shifting all clinical thermometers (D) to digital thermometers (B).

TABLE 6-4: COST OF REPLACING ALL CLINICAL THERMOMETERS WITH DIGITAL THERMOMETERS

A	Total digital thermometers required per annum as per IPHS standards (see Table6-1)	4,93,971
B	Total cost for digital thermometers per annum (unit cost of digital thermometer @140 INR)*	69.2 million
C	Total clinical thermometers required per annum (see Table 6-3)	19,75,884
D	Total cost for clinical thermometers per annum (unit cost of clinical thermometer@50 INR)*	98.79 million
E	Cost differential of shifting (B-D)	-29.59 million

**Information shared by Maa Durga Medical Store & New Anand Medical Store in Ghaziabad*

The table reflects that the shift from mercury thermometer to a digital one is actually leading to a net profit of about 29.59 million INR for the government enterprise.

6.2.3 Shifting of Sphygmomanometers in Government Health Setup

- The cost of shifting the sphygmomanometer has been calculated taking into account the total number of sub-centers, PHC, CHC, district hospitals as given in Data Portal, India 2011;
- The number of sphygmomanometers is as specified by IPHS.

It has been found that if the government wants to shift to mercury-free sphygmomanometer in the entire public setup of the country (Table 6-5), they have to invest approximately 512.05 million INR additionally in a year (E).However, the increasing demand and changing market scenario will lead to the gradual fall in the unit cost of digital sphygmomanometer and this will automatically bring down the government's investment for shifting.

TABLE 6-5: COST OF REPLACING ALL CLINICAL SPHYGMOMANOMETERS WITH DIGITAL SPHYGMOMANOMETERS

A	Total digital sphygmomanometers required per annum (Table 6-3)	4,26,687
B	Total cost for digital sphygmomanometers per annum (unit cost @2000 INR)**	853.4 million
C	Mercury based sphygmomanometers required per annum (Table 6-1)	4,26,687
D	Total Cost for mercury based sphygmomanometers per annum (unit cost @ 800 INR) **	341.35 million
E	Cost differential of shifting(B-D)	512.05 million

***Information shared by Maa Durga Medical store & New Anand Medical Store in Ghaziabad. The detailed methodology for calculating the state-wise investment is given in Annexure VI.*

The cost in both the cases – thermometer and sphygmomanometer – only talks about the public healthcare sector in states. However a number of health facilities under the central government, such as the CGHS, Railways, Defence, will require financial allocation for such a shift. The total financial estimates for shifting of mercury-based measuring instruments in public health facilities in the states is approximately 922.6 million INR and they need to be made available by the respective state governments. One of the surveys in 2008 claims that the ratio of the public-private sector is 60:40 in rural areas as compared to 10:90 in the urban sector[42]. So the private healthcare setup also needs to go for an investment for shifting to mercury-free alternatives, however,in most cases, this cost will be passed on to the consumers.

6.3 Comparative Cost of Mercury & Alternative Dental Filling Materials

Dentists were queried about the comparative unit costing of filling for mercury-based amalgams and alternatives. Interactions with the dentists revealed a wide difference between the unit costs as mentioned in the Table 6-6.

TABLE 6-6: COMPARATIVE COST OF MERCURY AND AMALGAM FILLING

Type of filling	Unit cost (INR)
Mercury Amalgam filling	350
Filling with Alternatives	600 -1000

Dentists reported that the overall pricing trend of the alternatives filling is witnessing an upward trajectory since the last 4 to 5 years.

Cost calculation for dental filling with alternate restorative materials (as on date) is explained in Table 6-7.

TABLE 6-7: COST OF SHIFTING (MERCURY-BASED TO NON-MERCURY BASED DENTAL FILLING) [43]

A	Total amount of mercury utilized in mercury fillings	49 tons
B	Amount of mercury used per filling	750 mg
C	Number of mercury-based dental fillings (A/B)	65.33 million
D	Average end user charges per mercury filling (Table 6-6)	Rs. 350
E	Total cost of mercury filling (C*D)	22,867 million INR
F	Average end user charges per alternative based filling (Table 6-6)	Rs. 800
G	**Total cost of filling with alternate restorative materials (C*F)**	**52,267 million INR**

42 http://www.nihfw.org/WBI/docs/PPP_SessionBriefs/PPP%20Course%20sessions/Need%20and%20Scope%20for%20PPP/Private%20Sector%20in%20Health%20Care%20Delivery%20in%20India.pdf

43 Toxic Links Report; Mercury in Mouth

Since this estimate for shifting includes the public and private dental facilities, the cost of shifting will be borne by both the governments and individual consumers.

> "Per unit cost of mercury filling is Rs. 300 as against Rs. 1000 of composite (alternative) fillings"
>
> "Educated people do not want to have black color dental amalgam filling inside their teeth, so composites are preferred"
>
> Dr. Gauravjit Singh Ratra, Dentist in Noida

It also emerged during the discussions that the average lifespan of mercury amalgams (10 years) is double than that of alternatives (5 years). Nevertheless alternatives are preferred on grounds of better aesthetics against the discoloration experienced by users in case of mercury amalgams.

6.4 Cost incurred in safe disposal of discarded Cfl

The country presently produces approximately 400 million CFLs and an enormous number of tubes laden with mercury that require environmentally safe handling and disposal. This will need identification of appropriate technology suited to the needs of the country and the cost of logistics in collection and transportation of such end-of-life lights. This cost estimation would require multiple inputs and a more in-depth study. Nevertheless it is vital to discuss some technologies that can serve this purpose along with the related costs in order to get an idea of the total investment required. The cost of the two widely acceptable technologies has been discussed here in order to arrive at national estimates for the disposal of spent CFLs.

6.4.1 Bulb Eater

The bulb eater or drum crusher has been demonstrated at certain events in India and it has also been used to deal with the production waste. This technology has the capacity to reduce volumes and capture mercury in carbon filters; however these carbons filters, laden with mercury, further requires treatment in order to recover mercury from these filters. This technology can be placed at static locations or can be mobile depending on the requirements.

Cost of one bulb eater is Rs.0.5 million. One drum of 200 L can hold and crush upto 1750 lamps/hr. This technology can be effectively used in bringing down volumes and capturing mercury, but will require thorough assessments in order to get a better understanding on its cost and handling capabilities. The numbers required to be installed at various locations can also be determined after due trials and assessments.

6.4.2 MRT System

Mercury Recovery Technology (MRT) system offers a variety of lamp recycling equipment for all types and dimensions of spent fluorescent lamps in the market. The plant ranges from small to large capacity based on market requirements.

- Cost of one MRT system is 45 million INR (capacity in excess of 10 million pieces per year);
- A mercury distiller, worth 20 million INR, is required to purify the mercury.

The above cost is exclusive of operating cost (manpower and electricity) and the transportation cost of CFL to the plant site. These needs to be further evaluated and substantiated with authentic documents. Apart from these costs, there will be a logistics cost for collection of CFL, interim storage mechanism, public awareness creation and reverse supply of CFL into the market.

According to a technology expert from MRT system, a small-sized machine, worth rupees 180-200 million with a capacity of 150kg/hr (exclusive of Hg distiller)is also available, which they can bring to the market depending on the financial feasibility.

6.5 Cost of Environmentally Safe Disposal & Handling of Mercury Waste

Chapter 5 (*section 5.8*) has already explained the various steps required to be followed for safe handling and disposal of mercury in an environmentally safe way. The entire process demands financial aid for:

- Interim storage of mercury collected from various sources;
- Distillation of mercury;
- Solidification of mercury;
- Final & permanent disposal in secured landfill sites.

However, these stated processes may vary on case-to-case basis depending on the quantum of waste and the likely adopted processes.

6.5.1 Cost of Interim Storage

The interim storage of mercury refers to the temporary storage of mercury collected from several usages. This stored mercury will either go for final disposal or for pre-treatment before disposal. The cost of such storage is not calculated here, as it depends on various factors like quantum of the material, physical form of the substance collected, location & infrastructure required, assigned monitoring & surveillance mechanism, etc.

However, a case study of such storage in USA refers to a tentative cost of mercury storage which is 2848 USD/per ton/per year. However, this cost will vary in the Indian scenario as the one time investment cost and the annual operational cost will be different.[44]

6.5.2 Cost of Distillation of Mercury

The distillation process of mercury helps to purify the mercury waste generated from various usages in order to make it more pure in nature. This process leads to the recovery of 99% pure mercury.

According to an interview conducted with MRT system expert, this technology has the capacity to perform distillation of impure mercury.

Capacity of mercury distillation by each unit	= 4 kg/day
Cost of one distillation unit	= 20 million INR

However, the total distillation cost will depend on the quantum of mercury extracted from the generated waste, plant establishment & operating cost, etc.

6.5.3 Cost of Mercury Stabilization

This is a newly identified technique, which converts waste into a product with higher physical and chemical stability that meets regulatory standards and can be utilized or stored without further treatment.

Stabilization processes are employed to convert elemental mercury and mercury compounds into compounds with inherently more favourable chemical and physical properties (e.g. low leachability of mercury and low mercury vapour pressure). Such compounds may pose a smaller risk to human health and the environment and, could be handled and stored more safely.

A recent study conducted in the year 2011[45] speaks of the stabilization of elemental mercury as an established technology. This study talks about the various processes of mercury stabilization. One of the processes is stabilization of mercury waste by addition of sulphur containing compounds and then its further solidification by mixing with clay or Portland cement. For the stabilization of mercury mixed waste, costs were projected to be around 0.4 USD/kg at 1200 lb./h or 2.40 USD/kg at 100 lb./h. In addition to this, the expected cost for disposal was 1.91 USD/kg (2002). However, several other technologies exist for converting mercury to a more stabilised form.
The total cost of mercury solidification process again depends on various factors like site

44 Analysis of options for the environmentally sound management of surplus mercury in Asia and the Pacific, April 2011
45 Gesellschaftfür Anlagen-und Reaktorsicherheit (GRS) mbH and Asian Institute of Technology/ Regional Resource Centre for Asia and the Pacific, *http://www.unep.org/hazardoussubstances/Portals/9/Mercury/Documents/PartneshipsAreas/grs_252_stabmerc.pdf*

selection, plant setup, operating costs including manpower, electricity tariff, etc. However, the cost and feasibility of its implementation may be on site specific basis.

Thus stabilization/solidification methods may also be a means to facilitate national and (sub) regional efforts to manage, store and dispose mercury waste and mercury containing wastes in an environmentally sound manner.

6.6 Cost of Controlling Mercury Emission into Air

Reduction and control of mercury emission from various point sources is cost intensive as this would require technology interventions that might require design and development. Some of these technologies may also not be present within the country, hence the need to import at a cost.

Many of these plants are both in public sector and private sector implying that some of this cost will have to be borne by the government and in others the private sector will have to bear this additional cost. The immediate fallout of such measures is the cost of technology integration that will hike up the product cost. This will have to be borne by end consumers.

Any new technology for emission control will also require advanced monitoring mechanism incurring cost in capacity building and technology. The government will require to allocate resources for incorporation of such technology and such estimates can only be drawn up on the identification of commercially viable and robustness of technology.

However, it is difficult to estimate a budget for these measures at this point of time because of the uncertainty of the actions to be adopted.

6.7 Cost incurred in Awareness Generation & Capacity Building across the Country

Mass awareness campaign and capacity building activities will require fund allocation; however, this will vary from one state to another. Currently no estimation has been given for this expenditure.

6.8 Sourcing of Funds for Successful Implementation of the Convention

India, being a developing nation, may require financial assistance for effective implementation of the treaty text. This could be from multilateral/bilateral agencies, Ministry of Environment, Forests & Climate Change, Central and State Governments through various schemes. At the very outset, India needs to frame a strategy so as to allocate funds through diverse schemes for the successful replacement of mercury containing products with available alternatives.

India may also need multilateral, regional and bilateral funding along with technical assistance in support of the activities, planned for successful implementation of the Convention. Various capacity-building activities and technology transfer from the developed countries are also encouraged in order to adopt BAT and BEP in various industrial processes that are currently using mercury or mercury compounds in India. Additionally, India may benefit from funding through the "special programme".

HIGHLIGHTS

- Shifting from mercury-based to alternate thermometer in government healthcare setup will incur a net benefit of approximately 29 million INR for the government.
- Shifting from mercury based to alternate sphygmomanometer in government healthcare setup will lead to an additional investment of approximately 512 million INR by government.
- Environmentally sound disposal of mercury waste demands huge investments on the interim storage of mercury, mercury distillation & solidification, and final & permanent disposal in secured landfill sites.

ROLE OF INSTITUTIONS

7.1 Leading organizations in Mercury Management in India

Since the adoption of the treaty in October 2013 and its legal implementation after the signature of 50 countries, India will have to come up with a national level regulatory framework comprising of sector specific strategies. In India, the Ministry of Environment, Forests & Climate Change is the nodal agency for planning, promoting and coordinating any environmental programmes across the country. Other important ministries and organisations critical for successful implementation will be the Ministry of Power, the Ministry of Health, the Ministry of Consumer Affairs, Central Pollution Control Board and State Pollution Control Boards.

FIGURE 7-1: LEADING ORGANIZATIONS CRITICAL FOR SUCCESSFUL IMPLEMENTATION

Apart from this ministerial division, there will be other organizations/institutions which will be directly or indirectly involved with better mercury management in place.

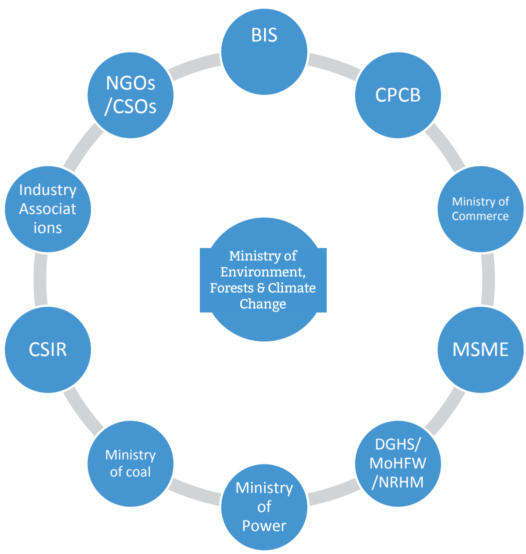
7.2 Framework Approach & Role of Organizations

A national level action plan (*refer Chapter 5*) demands commitment from each and every individual stakeholder and regulatory agency associated with the specific sector so as to ensure environmentally sound management and handling of mercury in order to stop the use of any mercury containing products and/or mercury compounds in our country.

FIGURE 7-2: STRATEGIES TO BE ADOPTED TO MAKE INDIA MERCURY FREE

Drawing up of National Implementation Plan	National regulation on mercury management and handling	Plans for reducing mercury consumption in dentistry	Standardization of Hg free healthcare devices & mercury dosing in CFL
Chlor-alkali plant (tracking of excess mercury)	End-of-life management of CFL & batteries	Management need for Mercury from effluent & mercury waste from healthcare sector	Thermal power plant (improvement of BAT & BEP)
Encouraging R&D activities for Hg free products & processess	Provision for regular monitoring of environment polllution & health surveillance	Training need & capacity building of regulators, individual & industrial bodies/associations	Mass awareness generation campaign & mandatory labelling of products containing Hg

FIGURE 7-3: ORGANIZATION/INSTITUTIONS TO BE PART OF TO MAKE INDIA MERCURY FREE



7.2.1 Healthcare Sector to Become Mercury Free

In India, the shifting from mercury to mercury-free instruments has already gained momentum as the healthcare setup across the country has started moving towards becoming mercury free. The shifting of healthcare sector in Delhi was completely voluntary in nature and it started since 2005 (*refer Chapter 4*). This helped in evaluating the role of numerous institutions in achieving the same. Figure 7-4 shows the various strategies to be adopted for making the healthcare sector mercury free.

FIGURE 7-4: STRATEGIES TO BE TAKEN FOR MAKING HEALTHCARE SECTOR IN INDIA MERCURY FREE

The role of various organizations/institutions, directly or indirectly involved with the above set agenda are discussed below.

7.2.1.1 The Ministry of Environment, Forests & Climate Change

The Ministry of Environment, Forests & Climate Change is the focal point in Government of India for all matters relating to the environment and also for the forthcoming Minamata Convention on Mercury and Global Environment Facility (GEF). As the nodal Ministry, its first and foremost responsibility is to ensure coordination with all other Ministries that come into the picture. The Ministry is also the nodal agency at the Central level for planning, promoting and coordinating the environmental programs in addition to policy formation. The Ministry needs to come up with a national level regulatory framework covering mercury movements and control its handling and management.

The Ministry of Environment, Forests & Climate Change is empowered to promulgate rules under the Environment Protection Act (EPA) and is responsible for ensuring effective implementation of the concerned legislation.

7.2.1.2 The Central Pollution Control Board (CPCB)

Central Pollution Control Board at the central level is a statutory authority attached to the Ministry of Environment, Forests & Climate Change and is accountable for the industrial pollution prevention and control. The CPCB had recently come up with a guideline for environmentally sound management of mercury from the healthcare sector. Henceforth, it is important that the CPCB safeguard the compliance of this guideline at national level through their counterparts in respective states and Union territories, i.e. state pollution control boards and pollution control committees. It is the standard setting body for environmental norms and its role will be critical in developing various standards for presence of mercury in air, water and soil. It is also responsible for developing guidelines for contaminated sites and data collection and inventory preparation.

7.2.1.3 The State Pollution Control Boards (SPCBs)/Pollution Committee (for UTs)

They are the designated agencies to protect India's land, air and water systems at the state level. The SPCBs monitor emission levels are responsible for enforcement, including initiating legal action against defaulters of the provisions of the Water and Air Pollution Acts, and the Environmental Protection Act, the Public Liability Act and other relevant acts. The SPCBs or the Pollution Control Committee also give authorization to establish hospital or any other healthcare facilities under the Bio Medical Waste (Management &Handling) Rules, 1998.

The SPCBs can also issue state specific order/notifications/notices concerning the usage and control of mercury in the healthcare scheme of respective states. In order to comply with CPCB, the concerned SPCBs should be responsible for successful implementation of the national guideline and/or state specific mercury phase out orders.

The State Pollution Control Boards/Committees will be finally accountable for the effective implementation of the norms and standards established by national regulation for the industries related to mercury.

7.2.1.4 Ministry of Health and Family Welfare (MoHFW)

This ministry ensures the availability of quality and toxic-free products in healthcare setup in India. Likewise, this department needs to monitor the implementation of any guideline or notification related to health issues in various states through the respective state health departments under its ambit. Secondly, India is a federal country and, health being a state subject, the respective state health departments are responsible for executing any order related to its respective state healthcare system. The role of this ministry will be critical in making the healthcare industry mercury free by bringing in regulatory frameworks and effective implementation of such regulations through training and participation of all stakeholders.

7.2.1.5 Bureau of Indian Standard (BIS)

This is the standard setting body for products that will have a key role in creating ethics for many products which use mercury, such as CFL lamps, cosmetics, soaps, batteries, etc. It also creates standards for products that replace mercury-based products, such as digital thermometers, sphygmomanometers, etc. Creation of necessary standards for products will be an important responsibility of this agency.

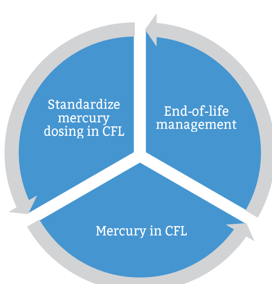
7.2.1.6 Directorate General of Foreign Trade (DGFT)

This directorate has been the part of Ministry of Commerce and Industry and GOI, and is accountable for the formulation of EXIM guidelines and principles for Indian importers and exporters. Therefore in controlling the movement and the export-import of mercury or mercury compounds and/or mercury bearing products, DGFT needs to impose strict guidelines on the import-export issue of mercury in India. The DGFT also has to play an important role in regulating the illegal dumping of mercury containing products in India.

7.2.2 Lighting Sector

The lighting sector in India, which mainly shifted to CFL industries, needs to have two structural steps – upstream and downstream. In the upstream, dosing of mercury in CFL needs to be mandatory; whereas the downstream management of CFL lamps will require to be placed with the lamp manufacturers under the Extended Producers Responsibility. The lamp manufacturers will need to setup systems across the country for an effective system of collection, transportation and disposal of such spent lamps.

FIGURE 7-5: STRATEGIES TO BE TAKEN FOR MERCURY MANAGEMENT IN CFL IN INDIA



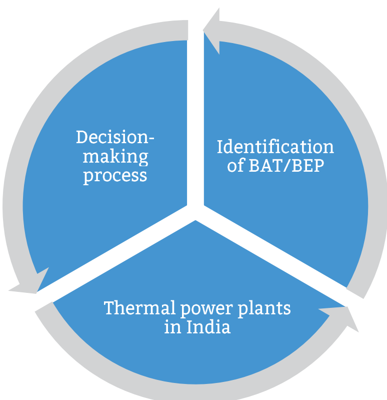
7.2.3 Thermal Power Sector

7.2.3.1 The Ministry of Power

This ministry is mainly responsible for the development of electrical energy and concerned with perspective planning, policy formation, processing of projects for investment decision, monitoring of the implementation of power projects, training and manpower development, and the administration and enactment of legislation with regard to thermal and other power generation, transmission and distribution.

Role of this ministry is significantly important in controlling and reducing mercury emission from coal-based plants. There is a need to create an assessment of mercury emission for the country, set standards for mercury emission from such plants and then identify Best Available Techniques (BAT) and Best Environmental Practices (BEP) to efficiently reduce the total mercury emission. The ministry will, in close coordination with other agencies, setup a monitoring mechanism which can generate regular data on mercury emission levels. Areas around such power plants will require surveillance for mercury pollution in close coordination with the State Pollution Control Boards.

FIGURE 7-6: STRATEGIES TO BE TAKEN FOR CONTROLLING MERCURY EMISSION FROM TPP IN INDIA



7.2.3.2 The Council of Scientific and Industrial Research (CSIR)

The CSIR aids the Government of India and has 38 research and development laboratories in various disciplines where they conduct several of their activities related to chemical safety and environmental management.

These organizations may be active in promoting schemes to introduce BAT and BEP into various processes using mercury or mercury compound and/or mercury containing products.

HIGHLIGHTS

- In India, the Ministry of Environment, Forests & Climate Change is the nodal agency for planning, promoting and coordinating any environmental programmes across the country.
- Ministry of Health and Family Welfare (MoHFW) ensures the availability of quality and toxic-free products in healthcare setup in India.
- Central Pollution Control Board is a statutory authority attached to the Ministry of Environment, Forests & Climate Change and is accountable for the industrial pollution prevention and control.
- The State Pollution Control Boards (SPCBs)/Pollution Committee (for UTs) are the designated agencies to protect India's land, air and water systems at the state level.
- Bureau of Indian Standard (BIS) is the standard setting body for products that will have a key role in creating ethics for many products which use mercury, such as CFL lamps, cosmetics, soaps, batteries, etc.
- Directorate General of Foreign Trade (DGFT) is accountable for the formulation of EXIM guidelines and principles for Indian importers and exporters.
- The Ministry of Power is mainly responsible for the development of electrical energy and concerned with perspective planning, policy formation, processing of projects for investment decision, monitoring of the implementation of power projects, training and manpower development, and the administration and enactment of legislation with regard to thermal and other power generation, transmission and distribution.
- The Council of Scientific and Industrial Research (CSIR) conduct several of their activities related to chemical safety and environmental management.

ANNEXURES

ANNEXURE I

IMPORT TREND OF SPHYGMOMANOMETERS

TABLE ANNX I-1: IMPORT DATA ANALYSIS OF MERCURY & NON-MERCURY SPHYGMOMANOMETERS

Year	Non-mercury based sphygmomanometers		Mercury sphygmomanometers	
	Million Units	Million INR	Million Units	Million INR
2008	0.2	141.1	0.003	4.65
2009	0.2	184.7	0.002	1.62
2010	0.2	175.2	0.000	0.00
2011	0.3	214.6	0.008	3.11
2012	0.7	504.6	0.000	0.00
Total	**1.6**	**1220.2**	**0.013**	**9.38**

Source: International Business Information Services

The total number of non-mercury based sphygmomanometers imported during 2008 to 2012 is pegged at 1.6 million units. In 2012, 0.7 million units of sphygmomanometers were imported. The imports of non-mercury based sphygmomanometers have grown at a CAGR of 36% during the period of 2008 to 2012. Table Annx I-2 reflects the country-wise import for the year 2012.

TABLE ANNX I-2: IMPORT SOURCE OF NON-MERCURY SPHYGMOMANOMETERS

Country	Million units	% share	Million INR	% share
China	0.3448	49.43	210.42	41.70
Germany	0.0020	0.28	9.13	1.81
Japan	0.0300	4.30	29.79	5.90
Korea REP	0.0003	0.04	0.34	0.07
Singapore	0.1163	16.68	94.48	18.72
Switzerland	0.0002	0.03	11.42	2.26
Taiwan	0.0132	1.90	11.35	2.25

Country	Million units	% share	Million INR	% share
USA	0.0047	0.67	14.94	2.96
Vietnam	0.1855	26.60	116.01	22.99
Others	0.0004	0.05	6.73	1.33
Total	**0.6974**	**99.98% ≈100.00%**	**504.61**	**99.99% ≈ 100.00%**

Source: International Business Information Services

China is the principal import source country, both in terms of volume and value, followed by Vietnam and Singapore as represented in the Table Annx I-2.

ANNEXURE II

ATTRITION RATE OF CFL

TABLE ANNX II-1: CALCULATION OF CFL ATTRITION RATE

S. No.	Particulars	Units
A	Total CFLs units (2012) (import + domestic manufacturing)	418 million
B	Percentage penetration of CFLs in household segment[46]	10%
C	Percentage of CFLs in commercial segment	90%
D	Number of CFLs in household segment	42 million
E	Number of CFLs in commercial segment	376 million
F	Average life per piece	6000 hours[47]
G	Average per day utilization in household segment	6 hours per day
H	Average per day utilization in commercial segment	16 hours per day
I	Number of days in a year	365 days
J	Per year utilization in household sector	2190
K	Per year utilization in commercial sector	5840
L	Average life per piece in household sector(F/J)	2.7 years
M	Average life per piece in commercial sector (F/K)	1.0 years

Methodology for calculation

A. Total number of CFL units taken from ELCOMA report.

B. & C Penetration figures for year 2008 in household sector are in the range of 5%-10%, while in commercial sector the penetration level is 90%.

D. 10% of 418 million units are in household sector.

E. 90% of 418 million units are in commercial sector.

F. To qualify for ENERGY STAR, CFLs must have a rated lifetime of 6,000 hours or greater (here we are considering the lifespan to be 6000 hours for our calculation).

G. & H. Assumptions based on primary survey in household and commercial unit by consultant.

46 Bachat Lamp Yojana Report by Bureau of Energy Efficiency, Ministry of Power, Government of India
47 http://www.energystar.gov/index.cfm?c=cfls.pr_crit_cfls

J. When 6 hours per day is multiplied by 365 days of year, we arrive at per year utilization of CFLs in household sector.

K. When 16 hours per day is multiplied by 365 days of year, we arrive at per year utilization of CFLs in commercial sector.

L. Average lifespan in household sector has been calculated by dividing average lifespan per unit of 6000 hours by per year utilization hours in household sector.

M. Average lifespan in commercial sector has been calculated by dividing average lifespan per unit of 6000 hours by per year utilization hours in commercial sector.

ANNEXURE III

METHODOLOGY – DEMAND PROJECTION OF MERCURY-FREE THERMOMETER

According to our analysis, the in-house demand for mercury-free digital thermometer was 2.93 million units in the year 2011. This has been projected to a future figure of 60.15 million units by the year 2020. Witnessing the household section being predominant among the users,the demand calculation for digital thermometers has been calculated keeping in view the following three segments:

- Hospitals (OPD + IPD)
- Doctor's clinics
- Households using digital thermometers

The different segment-wise total in-house demand is presented in Table Annx III-1.

TABLE ANNX III-1: IN-HOUSE DEMAND FOR DIGITAL THERMOMETER

Segment	2011	2020	2020* (best case scenario)
In-Patient Department segment	0.55	46.5	116.3
Out-Patient Department segment	0.04	2.28	4.56
Doctor's clinic segment	0.02	0.22	0.44
Household users segment	2.32	11.20	22.40
Total units (millions)	**2.93**	**60.15**	**143.7**

** The "best case scenario" presents the demand of digital thermometers when there is a 100 percent adoption across the user segments to include IPD, OPD, doctor clinics & household segment. This is keeping in mind the mandatory adoption of mercury-free products by 2020 as an implementation plan followed in the Minamata Convention.*

In case of 100 percent adoption – best case scenario – the demand for the alternatives will further go up to 143.4 million units. This presents a positive business case for manufacturers of mercury-based thermometers in order to shift to alternative technology.

The following tables – Table Annx III-2 to Table Annx III-5 – give a break-up of the segment-wise quantification of the demand for the digital thermometer.

In-Patient Department (IPD) Segment

The calculation for demand of digital thermometers for IPD section is presented in Table Annx III-2.

TABLE ANNX III-2: DEMAND CALCULATION FOR IPD SEGMENT

S No	Particulars	2011 (in million)	2020 (in million)	2020 (best case scenario, in million)
A	Total number of hospital beds (public + private)	1.5 [48]	3	3 5[49]
B	No. of beds provided with digital thermometers	0.01	0.6	1.5
C	Total annual bed days provided with digital thermometers (B x 365)	3.65	219	547.5
D	Average number of bed days with provision of digital thermometers annually (based on occupancy rates)	2.74	186.1	465.37
E	Average length of stay per patient (days)	5	4	4
F	Number of patients occupying beds provided with digital thermometers	0.55	46.5	116.3

Calculation methodology and assumptions

A. Central Pollution Control Board report was referred to ascertain the number of hospital beds in 2011. As per Technopak Advisors, an additional 2 to 2.5 million hospital beds would be required in 2020 to meet the healthcare needs of burgeoning population of the country. Nevertheless, as a conservative approach, a double fold increase of another 1.5 million additional beds has been considered for 2020 and thus arrived at the figure of 3 million beds.

B. Our primary research reveals that IPD patients are being provided with digital thermometers on an individual basis across many hospitals, particularly in Delhi/NCR region. Delhi state is leading in the country as far as phasing out of mercury from healthcare centre is concerned. In other states of India, mercury phase out in healthcare facilities is either at the inception stage or has yet to begin. As per CPCB figures, Delhi constitutes 3% of the total bed strength of the entire country. Considering Delhi state as the representative of the country in providing digital thermometers to IPD patients, a conservative figure of one-third of the beds – occupied by the patients who are being provided with digital thermometers – has

48 Annual Report Information on Bio-medical Waste Management for the year 2011, Central Board of Pollution Control
49 http://pharmabiz.com/NewsDetails.aspx?aid=68928&sid=1

been taken. This one-third of the hospital beds in Delhi translates to 1% of total countrywide beds that are being provided with digital thermometers. Therefore, we gather that 1% of hospital beds were provided with digital thermometers in 2011. By 2020, assuming that the mercury phase out in healthcare facilities would gain high traction, 20% of IPD beds would be provided with digital thermometers. However, the best case scenario for 2020 will be at best when 50% of IPD patients can be provided with the digital thermometer. Multiplying the percentage rates with total number of beds would translate into the number of beds provided with digital thermometers.

C. Total annual bed days provided with digital thermometers have been calculated by multiplying the total number of hospital beds provided with digital thermometers by 365 days of the year.

D Annual average number of beds days with the facility of digital thermometers has been calculated on the basis of hospital bed occupancy rates. For 2011, the bed occupancy rate has been considered as 75%, while for 2020 the same has been assumed as 85% to work out the figures.

E. As per the Investor Presentation of Apollo Hospitals, the average span of patient stay in Apollo hospital is 5 days (average of last 5 years). We are considering this as a national representative figure. For the year 2020, the same has been kept at a conservative period of 4 days bearing in mind that the progress in healthcare facilities would lead to a quicker pace of treatment resulting in lesser average span of stay in the hospital.

F. Number of patients occupying beds and provided with digital thermometers has been calculated by dividing annual average number of bed days with provision of digital thermometers with per patient stay duration in IPD.

Out-Patient Department (OPD) Segment

The calculation for demand of digital thermometers for OPD section is presented in Table Annx III-3.

TABLE ANNX III-3: DEMAND CALCULATION FOR OPD SEGMENT

S.No.	Particulars	2011	2020	2020 (best case scenario)
A	Total number of healthcare facilities using digital thermometers	2,607	1,52,012	3,04,023
B	Digital thermometers per hospital (based on primary research)	15	15	15
C	Total digital thermometers used (A x B)	39,105	22,80,180	45,60,345
D	Number of digital thermometers	0.0391 million	2.28 million	4.56 million

A. Delhi and Kerala are the two states where shifting to mercury-free alternatives have gained traction. Therefore, we consider these two states as the representative constituencies having healthcare facilities using digital thermometers in OPD. Bearing in mind that none of the HCFs in other states are using digital thermometers, the calculations for 2011 (on PAN India basis) are based on Delhi and Kerala only as explained:

Number of Healthcare Facilities(HCFs) in Delhi(2011): 3854..(1)
Considering 50% HCFs are using digital thermometers: 50% of 3854= 1927........................(2)
Number of HCFs in Kerala (2011): 3399...(3)
Considering 20% HCFs are using digital thermometers: 20% of 3399= 680..........................(4)
Total number of HCFs using digital thermometers: (2) + (4) = 2607

VIS-À-VIS 2020, THE CALCULATIONS ARE AS FOLLOWS:

a	Total number of HCFs in 2011*	1,51,507 (0.15 million)
b	Total number of hospital beds in 2011*	1.5 million
c	Beds per HCF (2011)	9.8
d	Number of additional beds required in 2020	1.5 million (conservative estimates based on Technopak Report)
e	Number of additional HCF required in 2020 (d/c)	1,52,516 (0.15 million)
f	Total number of HCFs in 2020 (a+e)	3,04,023 (0.30 million)
g	Number of HCFs using digital thermometers (2020)*	50% of (f) = 50% of 3,04,023 = 1,52,012
h	Number of HCFs using digital thermometers (2020) best case scenario*	100% of (f) = 100% of 3,04,023= 3,04,023

** CPCB report, 2011*

Percentage figures have been assumed bearing in mind that utilization of alternatives would penetrate across HCFs at PAN India level once the treaty will be in place.

B. MIC assumption.

C. Figures calculated by multiplying values of rows A & B of Table Annx III-3.

Doctor's Clinic Segment

The calculation for demand of digital thermometers for doctor's clinic segment is presented in Table Annx III-4.

TABLE ANNX III-4: DEMAND CALCULATION FOR DOCTOR'S CLINIC SEGMENT

S. No.	Particulars	2011	2020	2020 (best case scenario)
A	Total number of doctors	0.59 million[50]	1.39 million[51]	1.39 million
B	Number of doctors in private sector (80% of total)	0.47 million	1.11 million	1.11 million
C	Doctors having clinics	0.09 million	0.22 million	0.22 million
D	Clinics using digital thermometers	0.01 million	0.11 million	0.22 million
E	Digital thermometers used per clinic	2	2	2
F	Number of digital thermometers in the clinic segment(D x E)	0.02 million	0.22 million	0.44 million

Calculation methodology and assumptions

A. Secondary sources (as mentioned in the India Indicators Report by US Commercial Service in India) have been referred to determine the figures on the number of doctors. As per Technopak, in 2020, a surplus 0.8 million doctors are needed. Therefore the number of doctors in 2020 is 1.39 million.

B. As per The World Bank estimates in 2008, 80-85 percent of doctors in India are in private sector. Hence, we are considering 80% of doctors to be in private sector in 2011 and 2020.

C. Here it is assumed that 20% of the doctors have their own clinics in 2011 and 2020.

D. While 15% of the doctors who have their own clinics used digital thermometers in 2011, it has been assumed that at least 50% of clinic owning doctors would be using digital thermometers in 2020. Vis-à-vis the best case scenario in 2020, MIC is considering that 100% clinic owning doctors would use digital thermometers.

E. It has been assumed that doctors should be having 2 pieces of digital thermometers in their clinics – one for use and another as an inventory.

F. Multiplication between clinics using digital thermometer and the number of digital thermometers per clinic.

50 India Indicators Report by US Commercial Service in India
51 http://pharmabiz.com/NewsDetails.aspx?aid=68928&sid=1

Household Segment

The calculation for the demand of digital thermometers for household segment is presented in Table Annx III-5.

TABLE ANNX III-5: DEMAND CALCULATION FOR HOUSEHOLD USER SEGMENT

S. No.	Particulars	2011	2020	2020 (best case scenario)
A	Total population of 6 metros of India	47.9 million	89.4 million[52]	89.4 million
B	Number of households	11.6 million[53]	22.4 million	22.4 million
C	Digital thermometer using households	2.32 million	11.2 million	22.4 million
D	Digital thermometers per household	1	1	1
E	Total number of digital thermometers (C x D)	2.32 million	11.2 million	22.4 million

Calculation methodology and assumptions

A. The data is sourced from census 2011 and from UN Habitat website.

B. The number of households for 2011 is as per Census 2011. While for 2020, the average family members are considered as 4. Hence the population figure in row A is divided by 4.

C. While 20% of the households in 6 metros (in 2011) were having digital thermometers, 50% of the households in 2020 would be using digital thermometers. In best case scenario, 100% of the households would be using digital thermometers.

D. This is after ground check and discussion with families.

E. The total number of digital thermometers in the household segment has been calculated by multiplying values in row C and D.

52 www.unhabitat.org
53 Census 2011

ANNEXURE IV

DETAILED METHODOLOGY FOR DEMAND PROJECTION OF SPHYGMOMANOMETER BY 2020

The total market size of sphygmomanometers in India is 1.0 million units inclusive of mercury-based and non-mercury based (aneroid) instruments. The current market volume is presented in the Table Annx IV-1.

TABLE ANNX IV-1: MARKET VOLUME OF SPHYGMOMANOMETERS IN INDIA (2012)

Type of sphygmomanometer	Market volume
Mercury-based sphygmomanometers	0.225 million units[54]
Aneroid sphygmomanometers (imported)	0.7 million units[55]
Aneroid sphygmomanometers (domestic manufacturing)*	0.075 million units
Total	**1.0 million units**

* *Industrial Electronic & Allied Products (Diamond brand) is the only manufacturer of aneroid sphygmomanometers in India. Therefore the per annum production of aneroid sphygmomanometers by Diamond is considered to be representative of the total domestic manufacturing of aneroid sphygmomanometers in India.*

The current market volume of 1.0 million units is consumed by different segments including hospitals, clinics, household segment, etc.

The upcoming demand of aneroid sphygmomanometers for the year 2020 largely centers on the household segment, wherein the acceptance of aneroid sphygmomanometers is swiftly gaining traction. For the purpose of demand calculation for 2020, we are considering the household segment only (Table Annx IV-2).

54 Primary research: As reported by representative of Industrial Electronic & Allied Products (Diamond brand)
55 International Business Information Services

TABLE ANNX IV-2: DEMAND CALCULATION FOR SPHYGMOMANOMETERS IN 2020

S. No.	Household users	2020	2020 (best case scenario)
A	Total population of 6 metros of India	89.4 million[56]	89.4 million
B	Number of urban households	22.4 million	22.4 million
C	Aneroid sphygmomanometer using households	6.7 million	11.2 million
D	Aneroid sphygmomanometer per household	1	1
E	Total number of aneroid sphygmomanometer (C x D)	6.7 million	11.2 million

A. Data from the UN Habitat website.

B. An average family size of 4 members was considered as the number of households & the population figure in row A was divided by 4.

C. Market Insight Consultants (MIC) considers 30% of the households in 6 metros to be having aneroid sphygmomanometers, while,in best case scenario, 50% of the metro households would be using aneroid sphygmomanometers.

D. MIC hypothesis.

E. The total number of aneroid sphygmomanometer in the household segment has been calculated by multiplying the values in row C and D.

56 www.unhabitat.org

Table Annx V-1 presents the current consumption of dental restorative materials of approximately 186 tons, which includes mercury-based and alternatives. Out of this, the mercury-based amalgams account for marginally more than one-fourth (26.3%) of the utilization tonnage as compared to close to three-fourth (73.7%) of utilization tonnage accounted by alternatives.

TABLE ANNX V-1: QUANTITY OF RESTORATIVE DENTAL MATERIALS UTILIZED (2011)

Type of dental restorative material	Quantity per annum (tons)	Percent Utilization
Mercury based[57]	49	26.3%
Alternatives	137	73.7%
Total	**186 tons**	**100%**

FIGURE ANNX V-1: PERCENTAGE OF MERCURY FILLING TO ALTERNATE FILLINGS IN INDIA

Projection of Tonnage of Dental Restorative Materials by 2020

The quantity of restorative dental materials for 2020 has been calculated on the basis of population forecasts for 2020, number of dentists by 2020 and the number of fillings completed by each dentist per day.

TABLE ANNX V-2: QUANTITY OF DENTAL RESTORATIVE MATERIALS

S. No.	Particulars	2020
A	Total population by 2020	1,330 million
B	Total number of doctors by 2020	1,77,333
C	Total working days/year (seen as similar to 2011)	313
D	Per day filling by each doctor (seen as similar to 2011)	6.65
E	Per day mercury filling by each doctor (considering reduction to 10% of total filling, due to growing awareness & gradual phase down of mercury-based dental amalgam as a result of treaty implementation)	0.7

57 Toxic Links Report – Mercury in Mouth

A. Population statistics by 2020 from Planning Commission report (http://planningcommission.gov.in/reports/genrep/pl_vsn2020.pdf).

B. Based on the WHO recommendation of a dentist to population ratio of 1:7500 dentists.

C & D. Survey findings during 2011 study.

E. Bearing in mind the implication of the treaty in India, the number of mercury filling by each doctor will be only 10% of total filling of 6.65, i.e. 0.7 per day per doctor.

Total quantum of mercury usage by year 2020	: (1,77,333*0.7*313*0.75g)
	: 2,91,40,245 gm
	: 29 tons
Total dental filling including mercury & alternate	: (29*10)
	: 290 tons
Total amount of alternate filling (90%)	: (290*0.9) tons
	: 261 tons

ANNEXURE V

DETAILED METHODOLOGY FOR CALCULATING THE COST OF SHIFT IN HEALTH CARE SECTOR BY 2020

Table Annx VI-1 reflects the state-wise cost participation and subsequent savings from the shift of clinical thermometers to digital thermometers. The methodology for calculating the cost investment factor is as reflected in *Table 6-1* to *Table 6-4* in Chapter 6.

TABLE ANNX VI-1: STATE-WISE COST OF THERMOMETER REPLACEMENT (IN MILLIONS)

Name of the state	Total digital thermometer/ annum	Total cost of digital thermometer	Total clinical thermometer/ annum	Total cost of clinical thermometer	Cost differential
Andaman & Nicobar Islands	459	0.1	1836	0.09	-0.03
Andhra Pradesh	37406	5.2	149624	7.48	-2.24
Arunachal Pradesh	518	0.1	2072	0.10	-0.03
Assam	15517	2.2	62068	3.10	-0.93
Bihar	30426	4.3	121704	6.09	-1.83
Chhattisgarh	15466	2.2	61864	3.09	-0.93
Dadra-Nagar Haveli & Daman-Diu	332	0.05	1328	0.07	-0.02
Delhi	114	0.016	456	0.02	-0.01
Goa	555	0.1	2220	0.11	-0.03
Gujarat	24245	3.4	96980	4.85	-1.45
Haryana	9671	1.4	38684	1.93	-0.58
Himachal Pradesh	6782	0.9	27128	1.36	-0.41
Jammu-Kashmir	7129	1.0	28516	1.43	-0.43
Jharkhand	12451	1.7	49804	2.49	-0.75
Karnataka	35509	5.0	142036	7.10	-2.13
Kerala	16441	2.3	65764	3.29	-0.99
Lakshadweep	151	0.021	604	0.03	-0.01
Madhya Pradesh	29947	4.2	119788	5.99	-1.80

Name of the state	Total digital thermometer/ annum	Total cost of digital thermometer	Total clinical thermometer/ annum	Total cost of clinical thermometer	Cost differential
Maharashtra	36259	5.1	145036	7.25	-2.18
Manipur	1632	0.2	6528	0.33	-0.10
Meghalaya	1935	0.3	7740	0.39	-0.12
Mizoram	1437	0.2	5748	0.29	-0.09
Nagaland	1934	0.3	7736	0.39	-0.12
Odisha	24581	3.4	98324	4.92	-1.47
Puducherry	235	0.03	940	0.05	-0.01
Punjab	11138	1.6	44552	2.23	-0.67
Rajasthan	34880	4.9	139520	6.98	-2.09
Sikkim	558	0.1	2232	0.11	-0.03
TamilNadu	36120	5.1	144480	7.22	-2.17
Tripura	2182	0.3	8728	0.44	-0.13
Uttar Pradesh	61475	8.6	245900	12.30	-3.69
Uttarakhand	6497	0.9	25988	1.30	-0.39
West Bengal	28176	3.9	112704	5.64	-1.69
Total	-	69.12	-	98.46	29.55

Assumption[58]

Life of mercury-based and digital sphygmomanometers is nearly same (2 years each as per the discussion with doctors and nurses of SGRH, Delhi and ESI hospital Kerala, respectively). Therefore, same numbers of mercury-free digital sphygmomanometers are required to replace mercury-based sphygmomanometers. Chapter 6 explains the cost differential of mercury-based and mercury-free sphygmomanometers. This means that the Government would have to spend an additional 512.05 million INR for shifting all the mercury-based sphygmomanometers to digital sphygmomanometers.

Table Annx VI-2 represents the state-wise cost of shifting from mercury to mercury-free sphygmomanometers. The methodology for calculating the cost investment factor is as reflected in Table 6-1, Table 6-3 and Table 6-5, respectively in Chapter 6.

58 Primary interactions with nurses of select hospitals.

TABLE ANNX VI-2: STATE-WISE COST OF SPHYGMOMANOMETER REPLACEMENT (IN MILLIONS)

Name of the state	Total digital sphygs/annum	Total cost of digital sphyg	Total clinical sphygs/annum	Total cost of clinical sphyg	Cost differential
Andaman & Nicobar Islands	409	0.8	409	0.33	0.49
Andhra Pradesh	33197	66.4	33197	26.56	39.84
Arunachal Pradesh	560	1.1	560	0.45	0.67
Assam	13610	27.2	13610	10.89	16.33
Bihar	28091	56.2	28091	22.47	33.71
Chhattisgarh	13279	26.6	13279	10.62	15.93
Dadra-Nagar Haveli & Daman-Diu	302	0.6	302	0.24	0.36
Delhi	106	0.2	106	0.08	0.13
Goa	492	1.0	492	0.39	0.59
Gujarat	20222	40.4	20222	16.18	24.27
Haryana	8295	16.6	8295	6.64	9.95
Himachal Pradesh	5569	11.1	5569	4.46	6.68
Jammu-Kashmir	5968	11.9	5968	4.77	7.16
Jharkhand	10334	20.7	10334	8.27	12.40
Karnataka	31930	63.9	31930	25.54	38.32
Kerala	13521	27.0	13521	10.82	16.23
Lakshadweep	123	0.2	123	0.10	0.15
Madhya Pradesh	25779	51.6	25779	20.62	30.93
Maharashtra	31112	62.2	31112	24.89	37.33
Manipur	1416	2.8	1416	1.13	1.70
Meghalaya	1566	3.1	1566	1.25	1.88
Mizoram	1320	2.6	1320	1.06	1.58
Nagaland	1631	3.3	1631	1.30	1.96
Odisha	19757	39.5	19757	15.81	23.71
Puducherry	181	0.4	181	0.14	0.22
Punjab	9567	19.1	9567	7.65	11.48
Rajasthan	29741	59.5	29741	23.79	35.69
Sikkim	526	1.1	526	0.42	0.63
TamilNadu	31849	63.7	31849	25.48	38.22
Tripura	2032	4.1	2032	1.63	2.44
Uttar Pradesh	52633	105.3	52633	42.11	63.16
Uttarakhand	5822	11.6	5822	4.66	6.99
West Bengal	23787	47.6	23787	19.03	28.54
Total	-	849.40	-	339.78	509.67

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