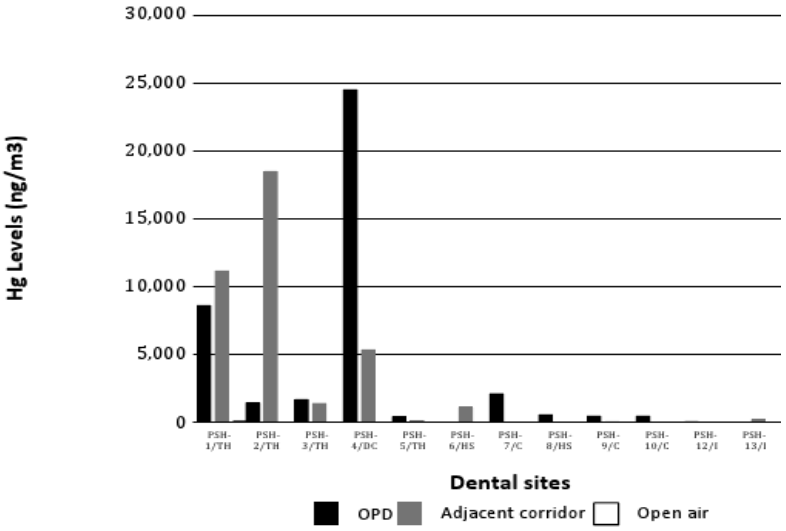
STUDY OF MERCURY LEVELS OF AIR IN AND AROUND DENTAL CLINICS, LIGHT PRODUCTS MANUFACTURING PLANTS AND MERCURY-CHLOR-ALKALI PLANT IN PAKISTAN



Project team

Dr. Mahmood A. Khwaja, Maryam Shabbir Abbasi,
Fareeha Mehmood & Sehrish Jahangir

Sustainable Development Policy Institute (SDPI)Islamabad
Pakistan

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CONTRIBUTORS:

DR. MAHMOOD A. KHWAJA
MARYAM SHABBIR ABBASI
FAREEHA MEHMOOD
SEHRISH JAHANGIR

COLLABORATION:

- ZERO MERCURY WORKING GROUP (ZMWG)
- EUROPEAN ENVIRONMENT BUREAU
- SUSTAINABLE DEVELOPMENT POLICY INSTITUTE

Sustainable Development Policy Institute (SDPI)
Islamabad Pakistan
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ABSTRACT

According to a preliminary report on mercury inventory, published in 2000, the point sources of mercury releases and emissions in Pakistan are a chlor-alkali plant, light products manufacturing units, dental clinics, incinerators and other coal based primary or secondary unit operations. Based on this reported preliminary data, the estimated maximum and minimum emission and transfer of mercury in the country is about 36,900 and 10,800 kg per year, respectively. At present, there is no mercury specific legislation in the country. However, development of a mercury management national action plan is in the making.

In the present study, mercury levels in and around mercury releasing sources and in open air are being examined, to identify "Mercury Hot Spots" in some cities of Pakistan, namely Peshawar, Rawalpindi-Islamabad and Lahore. The selected sites for measuring air mercury levels were chlor-alkali plant (1), light products manufacturing companies (2), dental clinics, teaching hospital and dental colleges (36). The selected sampling points at these sites were treatment sections, adjacent corridors and open air.

The high precision RA-915+ mercury analyzer was used to measure mercury levels in air at the selected sites. Few climatic parameters, like temperature, humidity and wind speed were measured with Kestrel® 4500 and wind direction with the help of a Field Compass, whereas geographical coordinates were taken with Garmin-eTrexGPS. Two separate questionnaires, one each for the dental and industrial sites, were developed for collecting the background relevant information regarding mercury use, waste and disposal at each sampling site. For discussion of the results, ATSDR MRL, 200 ng/m^3 and WHO/ACGIH, 25,000 ng/m^3 have been referred

Among all the visited/monitored dental sites in Lahore, Peshawar, Rawalpindi & Islamabad, eleven (11) sites were observed to be most contaminated, at the time of the visit. Among dental sites mercury contamination of air was found to be generally in the increasing order operative section > corridor > open air and teaching hospitals/dental colleges > general hospitals > private clinics. Monitoring data indicated high mercury levels, of air in and around the surroundings of the visited industrial units. The study also showed, the unawareness to the mercury handling, mishandling of the mercury/mercury amalgam, mercury containing waste, improper and inadequate ventilation system and lack of awareness regarding health hazards of mercury, being the main reasons for the observed elevated levels of mercury in air at some of the visited sites.

The data/results, findings and recommendations for releases/emissions control and phasing out of mercury use in the country is planned to be shared with all stakeholders, including policy makers and government officials, for appropriate policy interventions and an action plan to safeguard public health, specially of children and for the protection of the environment.
Details of the above investigations, results achieved and recommendations made are described and discussed in this report.

ACKNOWLEDGEMENT

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STUDY OF MERCURY LEVELS OF AIR IN AND AROUND MERCURY-CHLOR-ALKALI PLANT, DENTAL CLINICS AND LIGHT PRODUCTS MANUFACTURING PLANT IN PAKISTAN

1. INTRODUCTION

Mercury (Hg), also known as quick silver, is a toxic substance of global concern. A persistent pollutant, Mercury is not limited to its source but it travels, on time thousands of kilometers away from the source. Mercury poses risks to environment and human health, especially the health of children. Last year, in September, IUCN World Conservation Congress (WCC-2012) adopted SDPI Motion (M-169) and called upon government representatives of Intergovernmental Negotiating Committee (INC) to support a legally binding treaty on Mercury with an objective to protect human health and the environment from hazardous and toxic Mercury.[1] Early this year, in January, 140 countries in Geneva adopted a ground-breaking, world's first legally binding treaty on mercury, to be called "Minamata Convention on Mercury," limiting the use and emission of health-hazardous mercury. It shall be open for signatures at a diplomatic conference in Japan, in October 2013[2].

Mercury sources of emissions/releases are quite diverse. In Pakistan, mercury emission and transfer are mainly from extraction and use of fuels, intentional use of mercury in industrial processes, and other intentional processes such as dental mercury-amalgam fillings, medical equipment, waste deposition/land fillings and waste water-treatment[3]. A recent report has also revealed mercury releases from artisan small-scale gold mining (ASGM) in the northern areas (including Gilgit& Chitral) of Pakistan.[4] According to preliminary report on mercury inventory in Pakistan, by Ministry of Climate Change (formerly M/o Environment), estimated annual mercury inputs are maximum 30,898 & minimum 10,842 kgms[3]. Mercury and its compounds are imported from Belgium, Germany, Netherlands, Spain, Algeria, Barbados, Dubai and China.[5]

Scientific evidence, including UNEP Global Mercury report, establishes mercury as an extremely toxic substance, which is a major threat to wildlife, ecosystem and human health at a global scale[6]. It is also a major threat to fish that constitutes an all-important nutritious component of human diet. Children are more at risk from mercury poisoning which affects their neurological development and brain. Mercury poisoning diminishes memory, attention, thinking and sight. Mercuric ion reacts immediately with intracellular molecules or structures (e.g., enzymes, glutathione, tubulin, ion channels, or transporters), inhibiting their activities and interfering with normal cellular function. Mercury vapors can cause damages to central nervous system, thyroid, kidneys, lungs, immune system, eyes, gums and skin. Neurological and behavioral disorders include tremors, insomnia, memory and vision problems, neuromuscular effects and headaches. Fetuses and young children are more vulnerable to the mercury vapors.[7-10]

2. PRESENT STUDY

In view of diversified uses of mercury in the country, the resulting adverse environmental impacts and threats to public health and little reported data on mercury contamination in air or at the mercury releasing sites, the present study was undertaken by Sustainable Development Policy Institute (SDPI), with the following objectives:

1. Identification of "Mercury Hot Spots", in close proximity to near-by population and development of base line data regarding Mercury levels in ambient air.
2. Dissemination and discussion of collected data with all stakeholders, including policy makers/government officials, for appropriate policy intervention (including signing/ratifying "Minamata Convention on Mercury") and implementation in the country.
3. Policy advice/formulation of recommendations towards control measures for Mercury releases/minimization of Mercury exposure
4. Awareness raising regarding health impacts of mercury in the light of data/findings of the study.

The selected sites are in dental (teaching hospitals/dental colleges, hospitals & private clinics) and industrial sectors (Chlor-alkali and light products manufacturing plants) at Lahore, Peshawar, Rawalpindi and Islamabad.

3. METHODOLOGY:

3.1. Questionnaire/Survey:

Two separate questionnaires, one each for the dental and industrial sites, were developed for collecting the background relevant information regarding mercury use, waste and disposal at each sampling site (Annex 1 & 2). Information was collected through telephonic contacts and interviews of individuals (preferably medical/paramedical staff) at sites. Dental sites included teaching hospitals/dental colleges, general hospitals and private clinics. Industrial sites were light products manufacturing units and chlor-alkali plant. Members of SDPI monitoring team filled up questionnaires. The monitoring team also made some relevant visual observations; about the ventilation system waste generation, handling and disposal in the dental sites.

Details of the identified/visited sites at the selected cities and personnel contacted/interviewed are given in Annex 3 – 6

It is significant to clarify that as per SDPI understanding with the management of the visiting sites, the study would abstain from identifying any teaching hospital/dental colleges, hospitals, private clinics or industry with the observed/reported mercury levels

and the issue of mercury contamination of air in and around the visited sites is only broadly discussed in the report.

3.2. Sampling and Instrumental Analyses:

Preferably, monitoring was carried out at three points at each visited site on a clear dry weather during daytime. These were air (a) within operative/processing sections, (b) adjacent corridors and (c) open air. If mercury contamination levels were found below the permissible limit than open air measurements were not made. For wider sections/corridors, measurements were made at more than one point within the closed areas. Three or more than 3 measurements were taken at one sampling point and mean with standard deviations determined and reported.

Kestrel ® 4500 ***Lumex Mercury Analyzer (RA-915+)*** ***Garmin-eTrex***

Mercury was monitored in air with the help of the instrument, Lumex Mercury Analyzer (RA-915+).[11] Operational and maintenance guidelines, as described in the Lumex User's s Manual were followed throughout the fieldwork for the present study[11].
Few climatic parameters were also measured like temperature, humidity and wind speed with Kestrel® 4500 and wind direction with the help of a Field Compass whereas geographical coordinates were taken with Garmin-eTrex GPS.

All measurements at a visited site were recorded on specially designed format (Annex7).

Results are described in tables 1 – 6 & figures 1- 6 in the foregoing pages.

3.3. Mercury Exposure/Workplace Standards:

Workplace exposure standards (Annex 15) are subject to exposure time duration (8 working hours) and expected to be higher than the environmental exposure standards.
It is to be noted that the observed mercury contamination in air at the visited sites and reported in the foregoing pages are only snap values at the time of observations. For discussion of the results, ATSDR MRL 200 ng/m^3 and WHO/ACGIH 25,000 ng/m^3 have been referred (Annex 15).

4. RESULTS AND DISCUSSION:

The monitoring data and other relevant information collected in the present study are described and discussed below in two parts – dental sites and industrial sites:

4.1.Dental Sites

Mercury has been used in dental amalgams for over 160 years. These contains approximately elementary mercury 50 %, silver 30% and 20% other metals such as tin, copper & Zinc.[12, 13] Dental amalgams are also called silver fillings and amalgam fillings and are widely done because it's inexpensive, ease of use, best settling material and most importantly it is resin free which make it less allergic than composite fillings. In 2005, UNEP estimated that 362 tons of dental mercury are consumed annually worldwide.[21] These fillings gave off mercury vapors and its amount depends upon cavity size, tooth characteristics, composition, age of amalgam, time taken for filling, the number of fillings, temperature of ingested food/drinking liquids and the activities like chewing & grinding of teeth.[14, 15]

The daily intake of the vapors of mercury, from ambient air and dental fillings, through absorption into the bloodstream of adults is about 32ng Hg /2ngm^{-3} (of background air) in rural areas and about 160ng Hg/10ngm^{-3} (of background air) in urban areas. Estimated average absorbed concentrations of mercury vapors from dental fillings vary from 3,000 to 17,000ng Hg[16, 17]. As mercury vapor, it is taken up via the lungs, and 80% of it is absorbed. Due to its uncharged mono-atomic form, it is highly diffusible and lipid soluble. It crosses the blood-brain barrier easily, as well as the lipid of cells.[7 - 9].

In 2009, Sweden prohibited the use of dental amalgam for children and restricted its use for adults to cases where there is a particular medical reason for its use and where other treatments have been judged insufficient. Based on available evidence, Austria, Germany, Finland, Norway, Denmark, the United Kingdom, and Sweden have advised dentists to specifically avoid mercury-containing amalgam fillings during pregnancy. Canada, Italy & Australia have also taken step to reduce amalgam use[18, 19].

In 2010, a study in Pakistan, evaluating the amalgam use by dentists in the country and its waste management, has indicated that 92% dentists use amalgam often/always, whereas 56% of the study samples disagreed that amalgam should be phased out and replaced with non-mercury fillings. 92% dentists of the selected number of samples perceived amalgam a health risk, whereas 46% considered it an environmental hazard[20]. However, during mercury monitoring in air at dental sites, the medical doctors, staff and management were alarmed at the observed very high indoor mercury contamination at some dental sites and the dire need for taking immediate remedial/control measures, for protecting the health of the staff, patients and visitors[21].

The estimated amount of mercury consumed in dental sector in the country is reported as 65 kgs/annum[3].

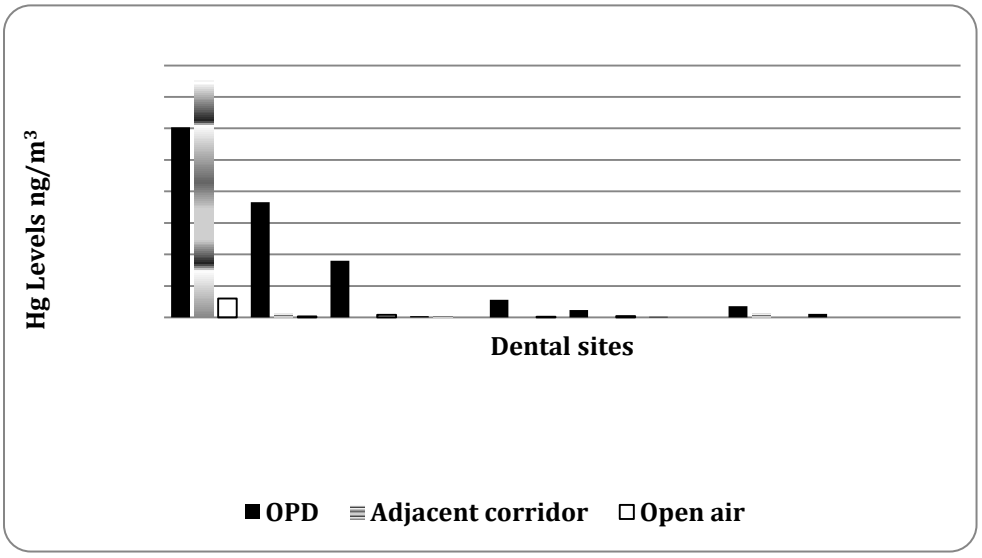
The foregoing pages describe in details the results and findings of the present study at dental sites in each of the four selected cities in the country. Through preliminary survey/contacts many sites were identified in these cities (Annex-3) but only a limited number could be visited/ monitored due to time and resources constraints, traffic density, un-familiarity with sites/locating the sites and non-cooperative & cautious attitude of management at some sites to allow monitoring work at their sites[21].

4.1.1. *Dental sites in Lahore:*

One hundred and thirty five (135) dental sites, including teaching hospitals, teaching colleges and clinics were identified in Lahore city (Annex-3A). Out of these due to constraints mentioned earlier, SDPI team could monitor only nine (9) sites for the mercury contamination in air. The results are described in Figure 1 and Annex 8. At the operative dentistry/treatment sections of four dental sites, mercury contamination in indoor air was found to be higher than the permissible limit. The lowest and the highest mercury contamination were observed at LHR-7/TH and LHR-1/TH, respectively (Annex- 8).

At LHR-1/TH daily 23 patients (average) were treated with silver fillings by 21dentists/house officers[21]. Estimated monthly requirement of bottled mercury (imported from Japan) is about nine pounds.

Figure 01: Mercury Levels (ng/m^3) at dental sampling sites of Lahore



Besides the visiting patients/visitors, staff of 41 employees (male & females) is daily at risk (six hours, five times a week) to high exposure of mercury from the use of mercury amalgam[21].

The mercury level at LHR-1 is many folds higher than the permissible AGGIH/WHO and ATSDR MRL limits (Annex 15) in the operative dentistry/treatment section (OPD) and the adjacent corridor (Figure 1 & Annex 8). This could because of a number of reasons and the most obvious seemed to be lack of cross-ventilation, as there were only two exhausts for ventilation of quite a large dental unit.
At a dental site, the treatment/operative dentistry section is always the very first space for Hg-vapors to contaminate indoor air. Being away from the source, observed values for mercury contamination in air of the adjacent corridors were lower compared to the treatment section.

Students were unaware of the proper handling of mercury/mercury amalgam while making its mixture for fillings, using it without wearing any protective masks and goggles for safety. Improper handling of mercury/mercury amalgam, caused spillage many times on the open floor, resulting in its gradual vaporization into indoor air, as there seemed no proper waste management plan/system in place by the management. A decreasing trend was observed for mercury contamination in air as OPD> treatment section > open air (Figure 1).

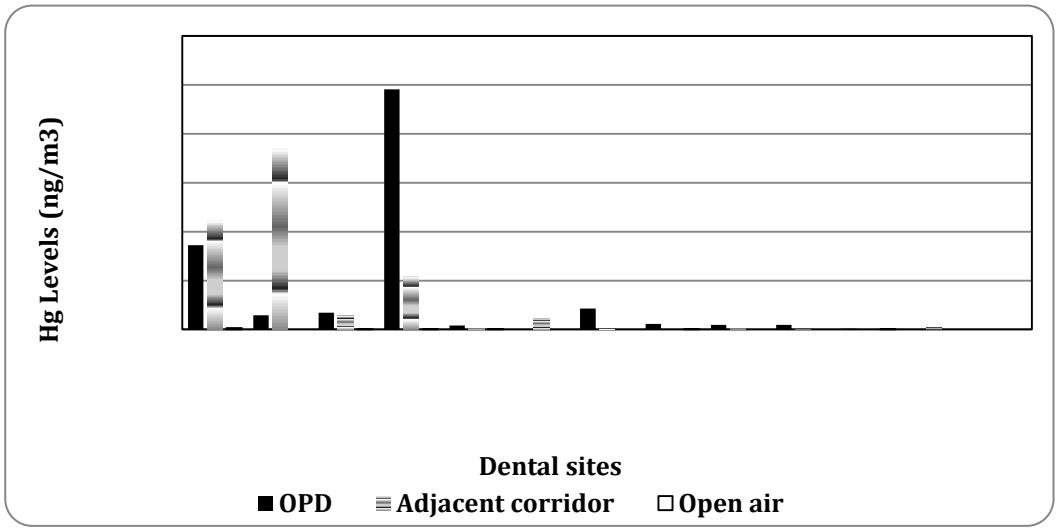
In LHR-2/*TH* same trend was observed and mercury levels were higher than the permissible limits at operative dentistry and adjacent corridors but in open air values were comparatively lower (Annex 8 & 15). At this site 42 dentists treat 54 patients and the institution has been offering service for last 75 years[21]. The reason for lower mercury levels as compared to LHR-1/TH appeared to be better cross ventilation with 11 windows and 3 doors and the use of capsulated mercury amalgam methodology for fillings, known for mercury waste reduction at source/spillage and emissions. The institution also practices waste re-use. The total number of staff exposed (six hours, five times a week) to mercury contamination in air is fifty one [21].
LHR-3/*DC* was established 50 years ago and since then offering service to dental patients. Five patients are treated daily with mercury amalgam (local purchase). No ventilation system operates in the clinic with a staff of 3 including attendant[21]. Mean value of indoor mercury contamination was observed to be 9085 +/- 148 (n = 8) ng/m^3 (Annex-8).
Mercury contamination in indoor air at LHR-4/*TC* was found to be 216 +/- 18 (n = 8) (Annex-8). Less than 3 patients were treated daily. In the treatment room of the clinic there was one exhaust, 2 windows and 3 ventilators[21].

At teaching college LHR-5/TC, values at operative dentistry section were higher 3796 +/- 517 (n = 5) than permissible limits but were much lower compared to LHR 1 – 3. Mercury levels in air at dental sites; LHR-6/*TC*, *LHR*-7/*TH*, LHR-8/ *C*, LHR-9/*C*, were also found to be comparatively lower (Annex-8) i.e. values at OPD, adjacent corridor and open air. This was either due to a small number of patients treated daily with mercury amalgam fillings or the use of capsulated material, which as explained earlier substantially, reduces mercury waste at source and mercury emissions into air.

Dental sites in Peshawar:

In Peshawar fifty-seven (57) dental sites were identified (Annex 3B) of which thirteen (13) sites could be visited/monitored by SDPI team. The results are described in Figure 2 and Table 2/Annex 9.

Figure 02: Mercury Levels (ng/m3) at Dental sites of Peshawar



At three sites mercury indoor air contamination was found to be higher than the ACGIH/WHO and ATSDR MRL (Annex 15) permissible limit, highest being observed at PSH-4/DC.

At site PSH-4/DC, mercury amalgam (imported) has been in use for the last 3 years since its establishment. Daily 4-5 patients were treated with silver fillings. As also mentioned in the preceding pages, the main reason of high value of Hg in indoor air at this site seemed to be inadequate cross-ventilation, with only two windows and one door for a large dental unit. About 15 dentists and house officers worked in the operative dentistry

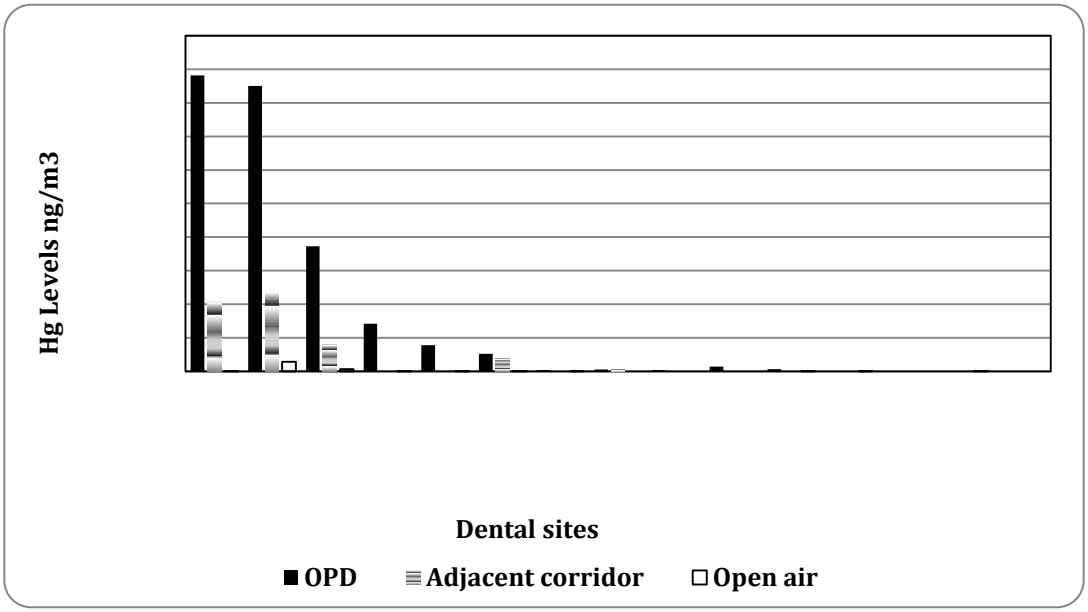
section using mercury amalgam for dental fillings[21].

For reasons given above, at site PSH-1/*TH* indoor air mercury contamination was observed to be 8,997 +/- 569 ng/m^3 (n = 7). Similarly at PSH-7, mercury indoor air level was found to be higher than the permissible ACGIH/WHO and ATSDR MRL limits (Annex 15). At the rest of 10 monitored sites monitored in Peshawar, indoor mercury levels were observed between 2068 – 470 ng/m^3(Annex 9/Table 2).

4.1.3. Dental sites in Rawalpindi and Islamabad:

At Islamabad and Rawalpindi 73 dental sites were identified (Annex-3C) and SDPI team monitored 14 sites. At five sites, indoor air mercury contamination was observed to be higher than the permissible ACGIH/WHO and ATSDR MRL limits (Annex 15), highest being at site Rwp.1/TH (Annex 10/Table 3).

Figure 03: Mercury Levels (ng/m^3) at dental sampling sites of Islamabad and Rawalpindi



At Rwp-1/TH Hg contamination in air were more than 40,000 ng/m^3 in operative dentistry section, above 11000 ng/m^3 in adjacent corridor and 20ng/m^3 in open air (Annex 10/Table 3C). Mercury amalgam has been in use at this site from the last 9 years. Daily 25-40 patients were treated with mercury amalgam (total consumption 5-6 pounds/month). Mixing of mercury amalgam has been done manually,[21] by the medical technicians, resulting in mercury releases/emission into the indoor air. and in the absence of adequate house officers don't follow the standard procedures and mercury vapors are released into the environment. Spilled over Mercury/mercury waste disposed off directly into the waste bins. For cross ventilation in the section, there were only 4 windows, one

door and one small exhaust fan. Daily 26-27 members of staff were exposed to so highly contaminated mercury vapors (6 hours for 5 days every week[21]. Similarly, very high mercury indoor air contamination was observed at Isl.1/TC (Annex 10/Table 3C).

At other dental sites ISL-2/*H,* ISL-3/*C and* ISL-4/*TH,* the observed mercury levels in indoor air were 17,772 +/- 2943 (n = 4), 7,117 +/- 436 and 3,950 +/- 82 ng/m^3, respectively (higher than the permissible ACGIH/WHO and ATSDR MRL limits (annex 15). At the remaining 4 dental sites Hg levels were observed to be comparatively lower, the lowest being 333 +/- 5 ngm^3 (n = 3) at site ISL-8/C (Annex 10/Table 3C).

At some institutions (universities, EPAs &MoCC) in Peshawar (PSH 12/I & PSH 13/I), Rawalpindi (RWP-4/I) and Islamabad (Isl-9/1 & Isl-10/I) indoor and open air monitoring for mercury contamination was also carried out. Mercury levels were observed to be comparatively lower, the highest being 64 ng/m^3(Table 2 & 3).

Among all the visited/monitored dental sites in Lahore, Peshawar, Rawalpindi & Islamabad, eleven (11) sites were most contaminated, with indoor air mercury contamination in the range 44, 067 - 3, 796 ngm^3. (Permissible ACGIH/WHO (25,000 ngm^3) and ATSDR MRL (200 ngm^3) limits (Annex 15). The observed alarming data was immediately shared with the medical staff/management of the respective institution and at most of these sites, immediate short-term measures (improved cross-ventilation and best in-house practices) were decided to be taken for mercury waste control and to reduce mercury releases/emissions[21].

4.2.Industrial Sites:

For the present study, two priority industrial sectors employing mercury in the process/products selected were light products manufacturing and chlor-alkali production. The monitoring data and other relevant information collected during monitoring and field/survey work are described and discussed below in two parts – Light Products Manufacturing sites and Chlor-Alkali site:

4.2.1. Light Products Manufacturing (LPM) Sites:

Mercury is used in variety of light bulbs. Mercury in light products is useful due to its contribution in bulb's efficiency and life expectancy. The compact fluorescent lamps (CFL) and other mercury added bulbs are generally more energy efficient and last for longer time as compared to Incandescent Lamps (ICL), [23] as more energy input is

converted in to usable light and less is converted in to heat. Thus, as a thumb rule, fluorescent lamps give more amount of visible light, use far less power and have longer life. It is estimated that fluorescent lamps use about 75% less energy than ICL. The light output of Compact Fluorescent Lamps (CFL) is roughly four times per watt as compared to ICLs [24] (Annex 11). Fluorescent lamps including both fluorescent tubes and CFL constitute the largest share in the market of all mercury containing lamps. It has been estimated that fluorescent lamps represents 80% of the total mercury use in lightening.[25]
In addition to fluorescent lamps, a number of other kinds of lamps in market also contain mercury. Many of them are considered as High Intensity Discharge Lamps (HIDs),a name commonly used for metal halide, high pressure sodium and mercury vapor lamps.[26]
The present heightened concerns on the issues of energy security, environmental degradation and climate change have also spurred the efforts to promote the energy efficient products and replace the ICLs with CFLs. To date, more than 40 countries across the world have announced to phase out incandescent lamps and CFLs are being promoted as readily available and cost effective alternative. The international market for CFLs has expanded rapidly during the past few years[27].

Mercury content in CFLs varies from product to product but generally in the range between 4 – 6 mg/ lamp[27]. It is estimated that1.2 – 6.8% of the total mercury in a CFL could be released in to the air after breakage, the enhanced rate of mercury release depending on higher surroundings temperature[27, 28].

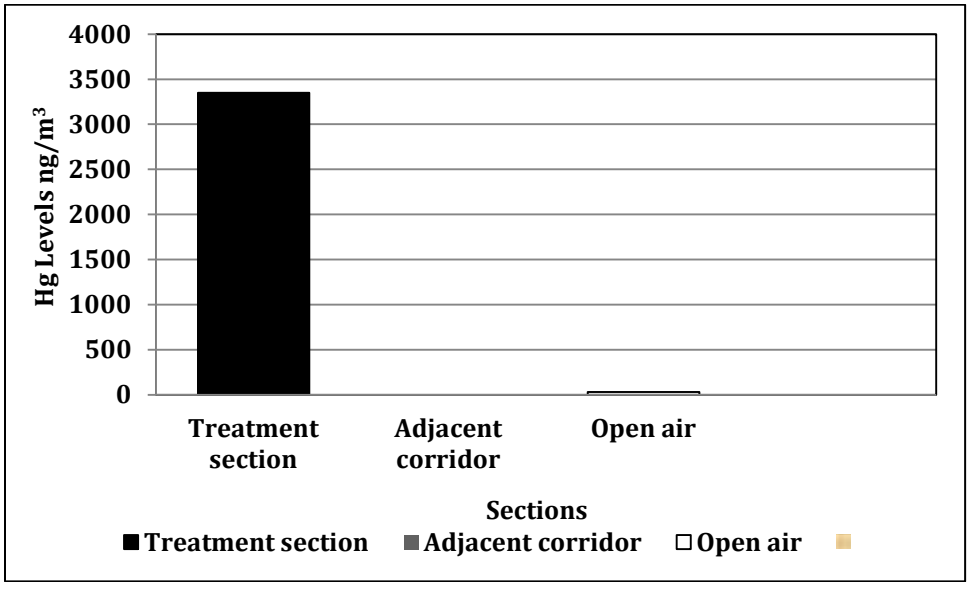
In addition to the increased mercury levels in air due to open dumping of fluorescent lamps, the rainwater can also leach the mercury bound to lamp parts or in phosphor powder within the broken lamps and transport it in to soil near or under the dumping site.
The mercury emissions may occur within the fluorescent lamp plant, from mercury liquid dosing, purification and transfer of mercury, mercury injection operation and from broken lamps, spills and waste materials. The mercury release not only causes contamination of working area but also poses serious health risks to the workers.[29, 30]
Mercury in light products in the country is estimated as 65.15 kgs/annum.[3] It is estimated that in 2009 CFL accounted for 20-25% of total demand within the country and 70% of these lamps were imported from China and Japan (estimated annual CFLs demand = 30 million; imported CFLs = 21 million).21,32
The list of light products manufacturing units in Pakistan are given in Annex 5A. The largest manufacturing unit is present in Khyber Pukhtunkhwa followed by another unit in Punjab. The major light products manufactured by these industries include: light bulbs, fluorescent tubes and CFLs.21 Mercury content in CFLs in the country is neither capped nor regulated. However, as also emphasized in the preceding pages, the increasing share

of CFLs in market in upcoming future as mentioned above, coupled with high dosing of mercury in lamps and lack of end life management of CFLs poses serious risks for environment and human health.[21]

The lighting industry in Pakistan is dominated by imported products and there are only a very few manufacturers still operating in the country (annex 5). The results of mercury monitoring in and around the air of two of these LPM units (KPK1& 2) are described in Figures 4 & 5 and Annex 12 & 13/Tables 5 & 6. For monitoring methodology, please refer to sections 3.1 & 3.2.of the preceding pages.

At light product manufacturing unit **KPK-1**, mercury (imported/locally purchased) has been in use for more than five years in energy savor bulbs. On the average KPK-1 unit consumed around 30kg mercury/month at the cost of Pak.Rs.7000/kg. 7 – 15 mg mercury/bulb is added, the amount being much higher than the generally recommended quantity.[21, 27] Because of this and other reasons described earlier (inadequate cross ventilation, improper waste management etc.) in the preceding sections, at KPK-1 indoor air mercury contamination in the manufacturing section was found to be higher (3,351 +/- 72 ng/m^3) than the permissible ACGIH/WHO and ATSDR MRL limits (Table 5/Annex 12, Annex 15). The level could have been much higher, had KPK-1 not out of production for the last few months due to energy crisis in the Khyber Pukhtunkhwa Province.[21] However, as expected, mercury contamination of open air in the surrounding of the KPK-1 building was much lower (Figure 4) compare to the manufacturing section, due to air flux and increased distance from the mercury releasing source.

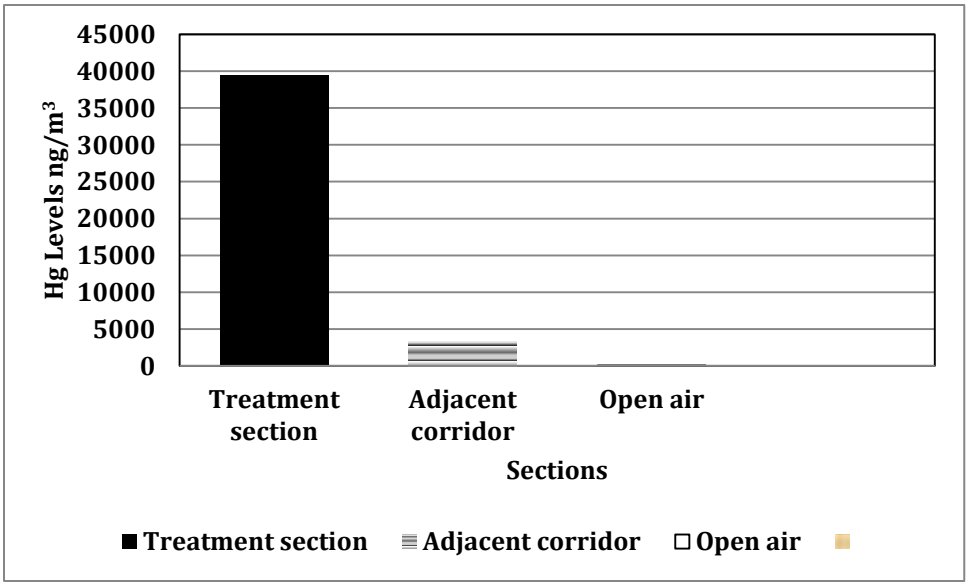
Figure 4: Mercury Levels in Air at Light Products Manufacturing Unit - (KPK-1)



At site **KPK-2**, mercury has been in use for more than 14 years. 85 mg mercury per tube or lamp is used, again, an amount much higher than the prescribed standard quantities.27

As evident by the data given in Annex 13/Table 6, Site KPK – 2 was much more polluting than KPK – 1. Indoor air mercury contamination within the manufacturing section and the adjacent corridor was observed to be higher than the permissible limit.

Figure 5: Mercury Levels in Air at Light Products Manufacturing Units - KPK-2



In the surrounding open air of KPK-2, mercury was found to be 63 +/- 16 ng/m^3 (n=3), over 30 times higher than in the air of surrounding KPK-1 (Tables 5 & 6/Annex 12 & 13). However, this difference in mercury levels could be also due to measurements taken while the production process was in full swing at KPK-2, as compared to KPK-1, where production has been stopped for the last few months.[21]

4.2.2. Chlor-Alkali Production Site:

All over the world, the chlor-alkali process is used for the production of caustic soda and chlorine which are basic building blocks for thousands of useful products. The process involves the application of direct current to brine solution that results in producing caustic soda and chlorine[32]. The mercury cell process comprises of slowly flowing layer of mercury across the cell bottom, which acts as cathode.[33] The technologies used in chlor-alkali industry vary from mercury cell to membrane and diaphragm cell. Some older chlor-alkali plants still use mercury cell process, which release large quantities of mercury in to the environment and act as potential source of global mercury pollution.[34]
It is estimated that Mercury Cell Chlor-Alkali Process (MCCAP) across the world accounts for on average 15% of the global mercury demand and acts as significant source of mercury pollution at global level.[33] Initially, mercury cell technology had a dominating

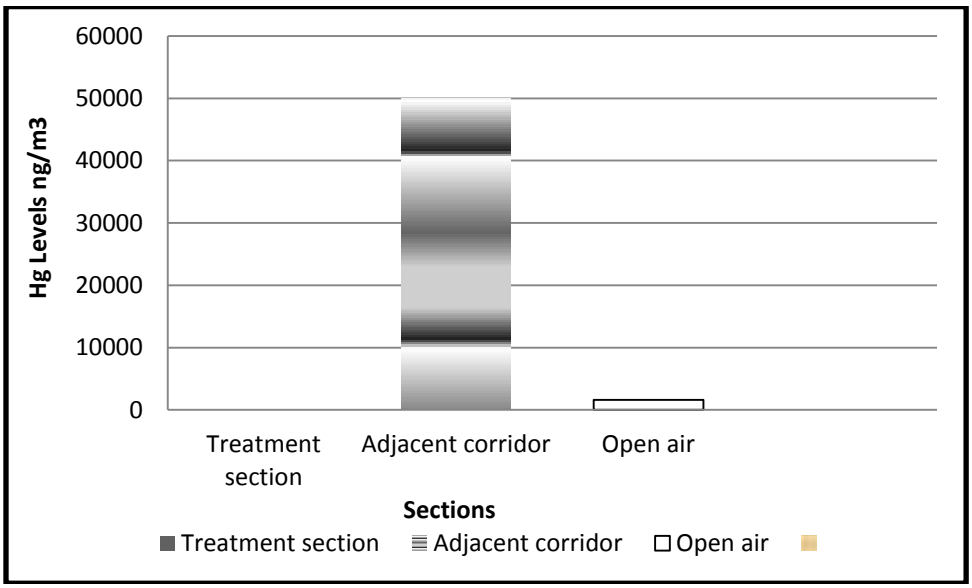
share in United States (US), however, following the mercury poisoning cases in Minamata and Niigata in Japan in 1972, there has been declining trend towards this technology.[35]

Chlor-alkali production process using mercury loses part of it during production and maintenance and it has to be replaced. Globally chlor-alkali industry uses on average 450-550 metric tons mercury/ year to replace the mercury lost during the production process[35]. Significant amount of mercury lost during the production process directly contaminate air, whereas the rest pollutes the adjacent water bodies and land.[36] The mercury emitted to the atmosphere from MCCAP, though subjected to atmospheric dispersion and long range transport, there have been reports of elevated levels of mercury observed in soils, within a few kilometers from MCCAP [37, 38].

There is only one mercury based chlor-alkali plant in operation in the country in Punjab Province. Spread over an area of 106 acres, the plant is considered to be the first one in the country for chlor-alkali industry, the mercury cell technology being employed within the plant since 1994. The average amount of annual mercury supply, from Italy, is estimated around 0.25kg/ton of caustic soda, at the cost of Rs.25000/kg. As indicated by the import data, during 2006 –7, the amount of imported mercury was 21, 735 kgm which declined to 7,100 kgms in 2007 – 8[21, 3]. During the process amount of mercury in use is estimated around 70 metric tons/day. In the mercury cell rooms, the streams involved which carry mercury, include hydrogen stream, depleted brine stream, soft water stream, solid waste stream and caustic stream[21, 3] .Among others, these steams are the likely sources of mercury emission/release to the indoor and open air mercury contamination in and around the plant.

To prevent Lumex mercury analyzer from any damage, due to very high voltage/magnetic field, measurements were not carried out within the cell rooms[21]. Perhaps due to the same reason, very high (50, 000 ng/m^3) & inconsistent readings were observed in the environment adjacent to the cell rooms (Annex 14/Table 7).

Figure 6: Mercury Levels in Air at Chlor-Alkali plant in Punjab.



Similar impact on the instrument, likely due to high voltage/magnetic field but to a lesser extent was also observed within operating section of LPM site KPK-2 in Khyber Pukhtunkhwa. (Section: 4.2.1.) . In the open surrounding, about half kilometer away from the cell rooms (close to the entrance gate), mercury contamination was observed to be 1619 +/- 472 ng/m^3 (n=3), very high compared to mercury open air contamination observed at other site in this study. Besides environmental pollution, factory workers (about 700) and visitors are directly exposed to high level of mercury with threat to their health.[24]

The management of the factory is working towards reducing mercury emissions/releases from all the streams in/from the mercury cell rooms and is committed to completely replace the mercury technology based production at the factory by 2015[21].

5. CONCLUSION AND RECOMMENDATIONS

The survey and monitoring data has shown higher level of mercury levels in air than the ACGIH/WHO and ATSDR MRL limits (annex 15), at some of the visited sites. Among dental sites mercury contamination of air was found to be generally in the increasing order operative section > corridor > open air (mostly below permissible limits) and teaching hospitals/dental colleges > general hospitals > private clinics. It was also observed that a very small number of light products manufacturing LPM units and only one mercury based chlor-alkali unit were operating in the country. Monitoring data indicated high mercury levels of air in and around the surroundings of these industrial units. The study also showed the unawareness to the mercury handling, mishandling of the mercury/mercury amalgam, mercury containing waste, improper and inadequate ventilation system and lack of awareness regarding health hazards of mercury being the

main reasons for the observed elevated levels of mercury in air, at some of the visited sites.

The following recommendations are intended to be shared and discussed with all stakeholders, including officials of ministries of health, environment and environmental protection agencies, some of these have already been shared with the staff and management of the visited sites.

- Following the best preventive approach "Waste Reduction at Source," mercury emissions/releases streams, through an environmental waste audit, be identified within dental sites and industrial units so that accordingly, control measures be designed and implemented at the earliest.
- Best in-house Environmental Practices (BEPs) and use of best environment friendly technology be encouraged, standard operating procedures for mercury handling, transport and use be developed and followed. An institutional mercury waste management plan be put in place at all mercury use sites and the same be periodically monitored and evaluated, by the management.
- Capsulated mercury amalgam use be promoted, as these effectively and substantially reduce mercury releases/emissions to the environment.
- Non-mercury dental fillings be advised to patinas by dentists.
- At the identified highly polluted dental sites (evident from the snap air contamination values, at the time of measurements) in the present study, a follow up comprehensive survey and monitoring program, including measurement of mercury levels for 9 hours exposure period, be developed and implemented at the earliest, to confirm risks to public health in general and visitors/medicals staff , at the sites in particular.
- Mercury specific legislation, including national emissions/releases standards, minimum mercury levels in products including lighting and protocols for permits/license to clinics be introduced for private clinics/teaching hospitals/dental colleges.
- Minamata Convention on mercury (2013) be signed and ratified by government of Pakistan at the earliest.

REFERENCES

1. "Legally binding global Mercury treaty to protect wildlife, ecosystems and health,"cmsdata.iucn.org/downloads/resolutions_and_recommendations_2012 pdf
2. Advance version of the Minamata Convention on mercury (2013) UNEP (DTTE)/Hg/INC.5/7 – dated 14.3.13
3. Preliminary report on Mercury Inventory in Pakistan, Government of Pakistan/UNEP Chemical Branch, Ministry of Environment, Islamabad (2000)
4. Khan, Sardar, Shah, Mohammad T., Din, Islam and Rehman, S, "Mercury Exposure of Workers and Health Problems Related with Small-Scale Gold Panning and Extraction," J.Chem. Soc. Pak., Vol. 34. No. Soc. Pak., Vol. 34. No. 4, pp. 870 – 76 (2012)
5. Federal Bureau of Statistics, Census, (2003), Government of Pakistan.
6. "Global Mercury Report," UNEP Chemicals, Geneva, Switzerland (2002)
7. Arvidson B, Arvidsson J, Johansson K (1994) Mercury de-posits in neurons of the trigeminal ganglia after insertion of dental amalgam in rats. Biometals 7, 261-263.
8. Stortebecker P (1989) Mercury poisoning from dental amalgam through a direct nose-brain transport. Lancet 333, 1207.
9. Pamphlett R, Coote P (1998) Entry of low doses of mercury vapors into the nervous system. Neurotoxicology 19, 39-48.
10. Alex Kirby, Ieva Rucevska, ValentinYemelin Christy, Cooke, Otto Simonett, Viktor Novikov and Geoff Hughes, 2013, 'Mercury- Time to Act', United Nations Environment Programme, p. 23
11. Mercury Analyzer RA-915+ User Mannual, Lumex Ltd., Russia Www.Lumex.ru
12. Hardy, James E, " Free Mercury," Gabriel Ross Press Inc., (1998)
13. "Mercury Use in Healthcare Setting and Dentistry," Module 4, UNEP Chemicals (2008)
14. The Vermont Advisory Committee on Mercury Pollution, 1998, www.mercvt.org
15. BIO Intelligence Service, 2012, Study on the potential for reducing mercury pollution from dental amalgam and batteries, Final report prepared for the European Commission- DG ENV, 11 July, p. 45
16. Clarkson, T.W. et al. Mercury. In: Clarkson, T.W. et al. eds. Biological monitoring of toxic metals, New York, Plenum, 1988 pp.199-246.
17. Skare, I. and Engqvist, A. (1994) Human exposure to mercury and silver released from dental amalgams restorations. Archives of Environmental Health, 49(5): 384-394.
18. Erdal, Serap and Oris, Peter, "Mercury in Dental Amalgam and Resin-Based Alternatives: A Comparative Health Risk Evaluation," Health Care Without Harm, June (2012)
19. Philippe Hujoel et al., "Mercury Exposure from Dental Filling Placement during Pregnancy and Low Birth Weight Risk," American Journal of Epidemiology (2005) 161 (8), p. 734-40, http://aje.oxfordjournals.org/content/161/8/734.full.
20. Mumtaz, R. et al, "Amalgam Use and Waste Management by Pak. Dentist," EMHU, 16(3) (2010)
21. Information gathered through Survey Performa (Annex 1), visual observations at site and private communication by members of SDPI team, March – April (2013)

22. Betne R, Rajankar2011, 'Toxics in that Glow: Mercury in Compact Florescent Lamps (CFLs) in India, Toxic Links, New Dehli, India
23. 'Mercury Use in Lighting', 2008, Inter State Mercury Education and Reduction Clearing House (IMERC) Fact Sheet, retrieved on April 4th, 2013. http://www.newmoa.org/prevention/mercury/imerc/about.cfm.
24. Betne R, Rajankar P 2011, 'Toxics in that Glow: Mercury in Compact Fluorescent Lamps (CFLs) in India', *Toxic Links*, New Delhi, India.
25. 'The Truth about Mercury in Lamps and Bulbs, Progress Energy Current Lines', retrieved on April 7th, 2013, http://www2.unca.edu/environment/documents/Mercury%20&%20Lighting.pdf
26. Weinberg J 2010, 'An NGO Introduction to Mercury Pollution', *International POPs Elimination Network.*
27. 'Assessment of Opportunities for Global Harmonization of Minimum Energy Performance Standards and Test Standards for Lighting Products', 2011, *Collaborative Labeling and Appliances Standard Program (CLASP) in Partnership with en.lighten.*
28. 'Mercury emissions from the disposal of fluorescent lamps' 1998, *United States Environmental Protection Agency (USEPA),* Revised Model, Final Report, Washington, D.C.
29. Aucott M Mclinden M and Winka M 2004, 'Release of Mercury from Broken Fluorescent Bulbs, Environmental Assessment and Risk Analysis Element', *Research Project Summary, Division of Science Research and Technology*.
30. 'Information on Fate of Mercury-Containing Lamps Disposed in Landfills'1994, *Tetra Tech/Frontier Geosciences*, Pasadena, CA.
31. Corazza A, Boffito C 2008, 'Mercury Dosing Solutions for Fluorescent Lamps', *J Phys D ApplPhys*, vol.41, pp.144007.
32. 'Energy Efficient Lighting: A Triple Win for Environment, People and Economy' 2009, *Presentation by Managing Director*, ENERCON, Pakistan.
33. 'Mercury in Chlor Alkali Plants', n.d., INC 2 Briefing Paper Series, Zero Mercury Working Group
34. Weinberg J 2010, 'An NGO Introduction to Mercury Pollution', *International POPs Elimination Network.*
35. Sinha S, Das K, 'Chlorine Industry: Economics of Conversion in India' 2012, *Toxic Links*, New Delhi, India
36. Lindley AA 1997, 'An Economic and Environmental Analysis of the Chlor Alkali Production Process: Mercury Cell and Alternative Technologies', European Commission.
37. 'Assessment of Mercury Releases from the Russian Federation' 2005, Arctic Council Action Plan to Eliminate Pollution of the Arctic (ACAP), *Russian Federal Service for Environmental, Technological and Atomic Supervision & Danish Environmental Protection Agency*, Copenhagen, Denmark, pp. 335.
38. Biester H, Muller G, Scholer HF 2002, ' Binding and Mobility of Mercury in Soils contaminated by Emissions from Chlor Alkali Plants', Sci.Total Environ, vol.284, pp.191-203

39. ’Compliance with Chlor Alkali Mercury Regulations’ 1986-1989, *Status Report*, Environment Canada, retrieved on April 20th, 2013, http://www.ec.gc.ca/lcpe-cepa/default. asp?lang=En&n=E7E0E329-1&offset=4&toc=show.

Annex-1

SDPI SURVEY FOR DENTAL HOSPITALS & CLINICS

A: General Information

a. City:

Rawalpindi	Islamabad	Peshawar	Lahore

Name of Unit:_____
Contact Person/In-charge:_____
Year/Duration of Establishment/ Operation: _____
Address:_____
Contact Number(s):_____

B: Specific Information:

Is Mercury Amalgam (Hg/A) Used:

Yes	**No**

(If yes, please continue)
Since when (Hg/A) is being employed(Year/ Duration:_____
Number of patients treated with Hg/A/month or year:_____
Proportion of mercury employed in Hg/A:_____

Hg/A Supplier:

Local	Imported

Contact of Supplier(s): _____
Annual Supply (Gm(s) or Kg(s)):_____
Hg/A Storage (per month or year):_____
Cost of Hg/A per capsule or gram: _____
Number of Hg/A handling staff: _____
Total employees at clinic: _____
Is there any Hg/A waste:

Yes	No

Details (If any):

_____
_____

14. How Hg/A waste is disposed off:

_____
_____

Signatures of Investigator/Surveyor: _____
Closing Date: / /2013; Place:_____

Annex-2

SDPI SURVEY FOR LIGHT PRODUCTS MANUFACTURING PLANTS

A. General Information

City:

Rawalpindi	Islamabad	Peshawar	Lahore

a. Name of Unit:_____

b. Contact Person/In-charge:_____

c. Year of Establishment / Operation: _____

d. Address:_____

e. Contact Number(s):_____

B: Specific Information:

1. Is Mercury used in any of these Products? (If yes, please continue)

Bulbs	Tubes	Others

2. Since when Hg is employed in these products (Year/ Duration):_____

3. Amount of Hg in Products:_____

4. Hg Supplier:

Local	Imported

5. Contact of Supplier(s): _____

6. Annual Supply (Gm(s) or Kg(s)):_____

7. Hg Storage (per month or year):_____

8. Cost of Hg per gm/Kg: _____

9. Number of Hg handling staff: _____

10. Total employees at Plant: _____

11. Is there any Hg waste:

Yes	No

12. Details (If any):

_____

_____

13. How Hg waste is disposed off:

_____

_____

Signatures of Investigator/Surveyor:_____

Closing Date: / /2013; Place:_____

Annex-3 (A)

List of Dental sites of Lahore

- University college of dentistry, Lahore Lat: 073.09311; Long: 33.72018
- Punjab dental hospital, Lahore Lat: 073.09311; Long: 33.72018
- Fatima Jinnah medical college for women, Lahore Lat: 073.09311; Long: 33.72018
- Mayo hospital, Lahore Lat: 073.09311; Long: 33.72018
- Sharif medical and dental college, Lahore Lat: 073.09311; Long: 33.72018
- Mid city hospital, Lahore
- Shalimar hospital, Lahore
- Farooq teaching hospital, Lahore
- AllamaIqbal medical college, Lahore
- Services institute of medical sciences, Lahore.
- Ameer-ud-Din Medical College (PGMI), Lahore.
- Sheikh Khalifa Bin Zayed Al-Nahyan Medical College, Lahore
- CMH Lahore Medical College, Lahore
- Continental Medical College, Lahore
- AkhtarSaeed Medical & Dental College, Lahore
- Lahore medical and dental college, Lahore Lat: 073.09311; Long: 33.72018
- Ghurki trust teaching hospital, Lahore Lat: 073.09311; Long: 33.72018
- FMH specialist care center, Lahore Lat: 073.09311; Long: 33.72018
- The dental cooperation, Lahore Lat: 073.09311; Long: 33.72018
- Central Parks Medical College, Lahore
- Rashid Latif Medical College, Lahore
- Shalimar Medical & Dental College, Lahore
- Avicenna Medical College, Lahore
- Azra Naheed Medical College, Lahore
- Pak Red Crescent Medical & Dental College, Lahore
- Lady Willington Hospital, Lahore
- Jinnah Hospital, Lahore
- Sir Ganga Ram Hospital, Lahore
- Lady Aitcheson Hospital, Lahore
- Wapda Hospital Complex, Lahore
- Lahore Dental Clinic, Lahore
- New Lahore dental surgery, Lahore
- Orthodontic Dental Centre, Lahore

- Shaikh Zayed Hospital, Lahore
- Arif Memorial Teaching Hospital, Lahore
- Gulab Devi Hospital, Lahore
- Khair-un-Nisa Hospital, Lahore
- Doctors Hospital, Lahore
- Nawaz Sharif Social Security Hospital, Lahore
- Al-Shafi Hospital, Lahore
- Zainab Memorial Hospital
- Aadil Hospital, Lahore
- Surgimed Hospital, Lahore
- Al-Khidmat Hospital, Lahore
- Akhtar Saeed Trust Teaching Hospital, Lahore
- Dental hospital, Lahore
- Combined Military Hospital, Lahore
- Dental Smile Specialist, Lahore
- Dental Guild, Lahore
- Naeem dental center, Lahore
- Chaudhry Dental Surgery, Lahore
- Ali Dental Surgery, Lahore
- Al-Maqsood Dental Surgery, Lahore
- Ammar Dental Clinic, Lahore
- Cheema Dental Clinic, Lahore
- Dental Surgery, Lahore
- Pakistan Dental surgery, Lahore
- Rehman Dental Clinic, Lahore
- Smile dental clinic, Lahore
- The Dental World, Lahore
- Dental Solutions, Lahore
- Dental Associates, Lahore
- International Dental Clinic, Lahore
- Denticare, Lahore
- Minhas Clinic, Lahore
- Dental Hygiene Clinic, Lahore
- Ora Dent, Lahore
- Dr. Tahir Mehmood Dental Surgeon, Lahore
- Gulberg Dental Surgery, Lahore
- H & H Denture Care, Lahore
- Smile Centre, Lahore
- Ali and Ali Dental Surgeons, Lahore
- Arcon Laser Tooth Whitening, Lahore
- Dental Expert, Lahore
- Digital Dental Imaging, Lahore
- Dr Azmat Ali Dental Surgeons, Lahore,
- Dentairecare Dental Surgery, Lahore
- Hafiz Dental Surgery, Lahore
- Medi Care Dental Clinic, Lahore
- Din Dental Clinic, Lahore
- Saeed Dental Surgery, Lahore
- Shifa Dental Surgery, Lahore

- Dr Rizwan& Associates Dental Surgeons, Lahore
- Iftikar Hunssain clinic, Lahore
- Smile n Smile Dental Clinic, Lahore
- Specialist Dental Practice, Lahore
- The Dentists, Lahore
- Dental Professionals, Lahore
- Khan Dental Care, Lahore
- Fayyaz Dental Surgery, Lahore
- Wahib Clinic, Lahore
- Saleem Dental Clinic, Lahore
- Shaker Dental & Medical Clinic, Lahore
- The Dental Care Clinic, Lahore
- Qasim Shams Dental Clinic, Lahore
- Al-Shaimaz Dental Clinic, Lahore
- Cavalry Dental Clinic, Lahore
- Dental Services, Lahore
- Ghausia Dental Clinic, Lahore
- Punjab Dental Clinic, Lahore
- Family Dental Clinic, Lahore
- Hamza Dental Clinic, Lahore
- Nishter dental clinic, Lahore
- Smile Dental Surgery, Lahore
- Happy Smiles Dental Surgery & Associates, Lahore
- Aamir Dental Surgery & Diagnostics,
- Surgi-Dent An Executive Dental Clinic, Lahore
- Ijaz Dental Clinic , Lahore
- Asim Dental Clinic, Lahore
- Umar Medical & Dental Clinic, Lahore
- Nawaz Dental Clinic, Lahore
- Aaqil's Dental, Lahore
- Rehman Dental Surgery, Lahore
- Smile Line Specialist Dental Surgery, Lahore
- Mirza Dental Clinic, Lahore
- Munir Shaheed Dental Clinic, Lahore
- Shah Dental Clinic, Lahore
- Noor Maxillofacial & Dental Surgery, Lahore
- Raza Dental Clinic, Lahore
- Ahmed Dental Clinic, Lahore
- Awais dental clinic, Lahore
- Jawad Dental Clinic, Lahore
- Ashraf Dental Clinic, Lahore
- Dental Comfort, Lahore
- Ideal dental clinic, Lahore
- jH Dental Cure, Lahore
- Rahat dental clinic, Lahore
- Reman Medical & dental clinic, Lahore

Lahore

- MS Dental Corporation, Lahore
- Shalimar Dental Services, Lahore
- Al Nisa Dental Clinic, Lahore
- Al-Fazal Dental Clinic, Lahore

Annex-4 (A)

List of stakeholders, of dental sites, interviewed- Lahore

- Dr. Shazia Naz and Dr.Salman Ashraf khan, University college of dentistry, Lahore
- Dr. Zaheer ,Punjab dental hospital, Lahore
- Dr. Zahida Ashraf, Fatima Jinnah medical college for women, Lahore
- M. Asif senior Dental Assistant, Ghurki trust teaching hospital, Lahore
- Dr. Irfan-ul-haq, FMH specialist care center, Lahore
- Dr. Aftab Ahmed, Mayo hospital, Lahore
- Dr. Uzma Shahid, Sharif medical and dental college, Lahore
- Dr. Fareeha Naz, Lahore medical and dental college, Lahore
- Dr. Farooq Nawaz, The dental cooperation, Lahore

Annex-4(B)

List of stakeholders, of dental sites, interviewed-Peshawar

- Dr. Ahmed Abdullah (Dental surgeon), Shakeel-Ur- Rehman Khattak, Dr. Shahid Khan. Sadia Hassan Khan, Dr. S Sardar Begum teaching hospital, Peshawar
- Dr. Khalid Rehman, Khyber college of dentistry, Peshawar
- Dr. Jamal Nasir, Naseer teaching hospital, Peshawar
- Dr. Tallat Anayat (Principal), Dr. M. Nisar, Peshawar medical and dental college, Peshawar
- Dr. Manzar Iqbal, Town teaching hospital, Peshawar
- Northwest general hospital and research center
- Dr. M. Nasir Shah, M.Nasir Shah clinic, Peshawar
- Dr. Fawad Khan, Fawad and associates, Peshawar
- Dr. Abdullah Hameed, Hameed Awan and associates, Peshawar
- Dr. Zia-ur-Rehman Akhoonzada, Zea dentistry center, Peshawar
- Dr. M. Bashir Khan, DG EPA Peshawar
- Prof. Dr. Imdad-ullah , head of chemistry department, Institute of Chemical sciences

Annex-4(C)

List of stakeholders, of dental sites, interviewed-Islamabad and Rawalpindi

- Dr. Nadia Awan, Dr. Yunus Jadoon (Principal)Margalla college of dentistry, Rawalpindi
- Dr. Hamza Bin Saeed (Head of Research Community) and Dr. Nida Ovais, Islamic international dental college, Islamabad
- Dr. Shahzeb Patoli, Rawal medical and dental hospital, Islamabad
- Shreen (Assistant manager) and Dr. Nadia Awan, Shifa international hospital, Islamabad
- Dr. Javed Aslam, Bilal hospital, Rawalpindi
- Dr. Abid, The art dentist, Islamabad
- Dr. Ambreen, Agha khan family health center, Islamabad
- Dr. Pakeeza Haider (Head of Dentistry Department), Polyclinic hospital, Islamabad
- Dr. Khurshaid Arshad (Head of Dentistry department) and Dr. Asma Rizwan, DHQ hospital, Rawalpindi
- Dr. Saima (Head of Dentistry Department), Islamabad medical and dental hospital, Islamabad
- Dr. Amjad Ali, Tariq dental clinic, Islamabad
- Dr. Azra Yasmeen, Fatima Jinnah women university, Rawalpindi
- Zaigham Abbas, Ministry of climate change, Islamabad
- Mr. Asif S. Khan, DG, Environmental Protection Agency, Islamabad

Annex-5(A)

List of industries in Peshawar

- Crown Lightening (Pvt) Ltd, Peshawar. (Lat=071.50056, Long=34.00214)
- Imperial Electronic Lighting (Pvt) Ltd, Peshawar. (Lat=071.48717, Long=34.00346)
- Al-Karam Lamps (Pvt) Ltd, Peshawar

Annex-5(B)

List of stakeholders interviewed at industries

- Mr Sajid Muhammad Khattak, Crown Lighting Pvt Ltd, Peshawar
- Mr Sajid, Chairman, House of Khyber Lamps, Peshawar
- Mr. Mashkoor, House of Khyber Lamps, Peshawar
- Mr. Muneeb, Managing Director, House of Khyber Lamps, Peshawar
- Mr M Nauman, Imperial Electronics Lighting Pvt Ltd, Peshawar
- Mr Syed Murtaza Ali Shah, Imperial Electronics Lighting Pvt Ltd, Peshawar

Annex-6(A)

List of industries at Lahore

- M. Khurshaid Sheikh, DGM, Lahore
- Mr Ishfaq, Pak Lamp Ltd, Lahore
- Chaudhry Basharat, Pak Lamp Ltd, Lahore
- Ghulam Mustafa, Chief Executive, Lahore
- Mr Munawar ,Lahore
- Mr Nizam-uddin, Syed Bhais Pvt Ltd, Lahore

Annex-6(B)

List of stakeholders interviewed at Lahore

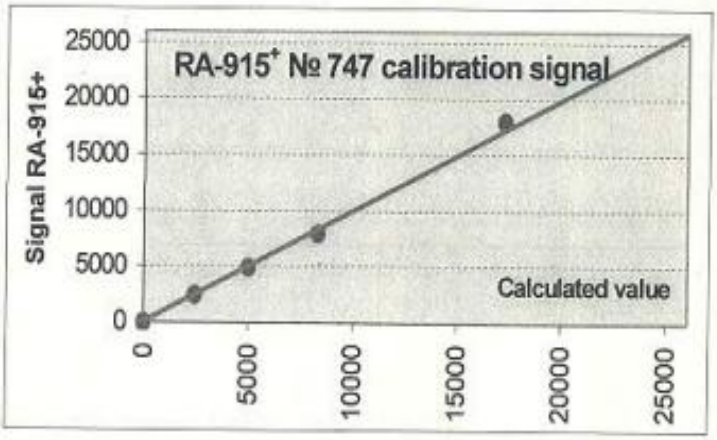
- M. Khurshaid Sheikh, DGM, Lahore
- Mr Ishfaq, Pak Lamp Ltd, Lahore
- Chaudhry Basharat, Pak Lamp Ltd, Lahore
- Ghulam Mustafa, Chief Executive, Lahore
- Mr Munawar ,Lahore
- Mr Nizam-uddin, Syed Bhais Pvt Ltd, Lahore

Annex-7(A)

Calibration certificate

Calibration Certificate
Zeeman mercury analyzer RA-915+ , serial № 747.

Standard cell #	Temp., °C	Calculated value, ng/m³	Signal, ng/m³
1	20.8	0	0
2	20.8	2460	2480
3	20.8	5000	4880
4	20.8	8340	7940
5	20.8	17300	18000
6	20.8	26300	26500
7	20.8	41500	40900



ON THE DATE CALIBRATED, THIS UNIT OPERATED WITHIN SPECIFIED TOLERANCES

CALIBRATION DATE: 26/03/2012 NEXT DUE: 26/03/2013
RA-915+ UNIT №: 747
Calibration Parameter A: **750**
Calibration Parameter B: **34000**

Instrumentation and Standards used for calibration
Digital Thermometer: "GTH175" , calibration mark 18773, due: 05.2012
Set of Calibrated Saturated Mercury Vapor Cells, due: 20.07.2012
Accuracy of the calibration set ± 10 %

Service technician: _____ V. Ryzhov

LUMEX Analytics GmbH
Wilstedter Str. 1a
D-24558 Wakendorf II
Tel.: +49 [illegible] 7756
e-mail: info@lumexanalytics.de

RECOMMENDATION NOTE: instrument should be recalibrated every 12 months, or sooner, if exposed to extreme conditions or damage is suspected.

Annex-7(B)

SDPI Monitoring Survey/Data sheet

A: General Information

a) City:

Rawalpindi	Islamabad	Peshawar	Lahore

b) Type:

A	B	C	D	E

A: Dental Clinics **B:** LPM Units **C:**Chlor Alkali Plants **D:** Cement Plants **E:** Others/Specify

a. Name of Unit:_____

b. Contact Person/In-charge:_____

c. Year/Duration of Establishment/ Operation: _____

d. Address:_____

e. Contact Number(s):_____

h. Date of monitoring: _____

B: Measurements with KESTREL & GPS

S. No	**Parameters**	**Reading # 1**	**Reading # 2**	**Reading #3**	**Average**
1	Temperature (°C)				
2	Humidity (%)				
3	Wind Direction				
4	Wind Speed (m/sec)				
5	Coordinates (°): Latitude				
	Longitude				
6	Time				

C. Measurements (ng/cm^3) with LUMEX

S. No	**Hg Concentration**	**Reading # 1**	**Reading # 2**	**Reading # 3**	**Reading #4**	**Reading # 5**	**Average**
1	S						
2	Si						
3	Average						
Mean Value (+/- SD)							

Signatures of Investigator: _____

Closing Date: / /2013;

Place & time: _____

Annex-8

Table 1: Mercury Levels in and around dental sites of Lahore

Sr. No	Dental site(s)	Treatment section/ Operative dentistry	Adjacent corridor	Open air
1	**LHR-1/***TH* **Date=**08-03-2013 **Time=** 12:35- 1:56pm	**S**=30192±498 (n=5) **Si**=30156±516 (n=5**)** **T=**26.6 **H=**70.8	***S=**37633±1270 (n=4) ***Si=**37768±1373 (n=4) **T=**27 **H=** 72.6	***S=**2990±887 (n=6) ***Si=**3040±710(n=6) **T=**28.6 **H=**57 **W.D=**N-E **W.S=**0.4
2	**LHR-2/***TH* **Date=**09-03-13 **Time=** 12:00pm-12:52pm	***S=**18312±3009 (n=5) **Si=**17494±3114 (n=5) **T=**28 **H=**45	***S=**704±30 (n=3) ***Si=**726±156 (n=3) **T=**27.2 **H=** 44.6	**S=**156± 96 (n=3) **Si=**216± 176 (n=3) **T=**28.4 **H=**43 **W.D=**W-E **W.S=**0.57
3	**LHR-3/***DC* **Date=**08-03-2013 **Time=** 09:51-10:21pm	**S=**9003±99 (n=5) **Si=**9027±143 (n=5) **T=**23.9 **H=**73.4	**NIL**	**S=**440±174 (n=4) **Si=**347±135 (n=5) **T=**23.9 **H=**73.4 **W.D=**N-W **W.S=**0.8
4	**LHR-4/***TC* **Date=**09-03-13 **Time=** 09:40-10:15am	**S=**221±15 (n=4) **Si=**219±17 (n=4) **T=**27 **H=**61.7	**S=**171±11 (n=3) **Si=**158±25 (3) **T=**25.4 **H=**60.4	**NIL**
5	**LHR-5/***TC* **Date=**09-03-2013 **Time=** 02:25-3:00pm	**S=**2798±542 (n=9) **Si=**2833± 595 (n=9) **T=**29.3 **H=**47.6	**S=**121± 38 (n=4) **Si=**97± 49 (n=4) **T=**28 **H=**59.8	**NIL**
6	**LHR-6/***TC* **Date=**06-03-2013	**S=**1177±128 (n=7)	**NIL**	**S=**213±16 (n=4)

	Time= 11:45- 1:00pm	**Si=**1203±116 (n=7) **T=**25 **H=**65		**Si=**193±35 (n=4) **T=**23.5 **H=**64.5 **W.D=**S-E **W.S=**0.45
7	**LHR-7/***TH* **Date=**06-03-2013 **Time=** 02:17-02:30pm	**S=**105±7 (n=4) **Si=**118±6 (n=4) **T=**26.4 **H=**58	**NIL**	**NIL**
8	**LHR-8/***C* **Date=**08-03-2013 **Time=** 06:19-06:27pm	**S=**1800±37 (n=3) **Si=**1803±21 (n=3) **T=**28.4 **H=**59	**S=**703±22 (n=3) **Si=**706±29 (n=3) **T=**29 **H=**56.7	**NIL**
9	**LHR-9/***C* **Date=**06-03-2013 **Time=** 04:16-04:46pm	**S=**551±23 (n=3) **Si=**547±41 (n=3) **T=**27.5 **H=**60.3	**NIL**	**NIL**

*****Average value of Hg (ng/m^3) at two points within same sections; **S**= Current value of Hg (ng/m^3); **Si**= Mean value of Hg (ng/m^3); **T**=Temperature (°C); **H**= Humidity (%); **W.D**= Wind Direction (%); **W.S**= Wind Speed (m/sec); ***TH****= Teaching Hospitals;* ***TC****=Teaching Colleges;* ***C****=Clinics;* ***HS****= Hospitals*; All measurements were made with Lumex Mercury Analyzer at R (Deviation) ≤ 25% and S≅Si

Annex-9

Table 2: Mercury Levels in and around dental sites of Peshawar

Sr. No	Dental site(s)	Operative dentistry	Adjacent corridor	Open air
01	**PSH-1/***TH* **Date=** 19-03-13 **Time=** 10:11-11:45am	****S**=8627±85 (n=4) ****Si=**8568±225 (n=4**)** **T=**23.8 **H=** 63.5	**S**=11180±496 (n=4) **Si=**11437±1930 (n=4**)** **T=**24.4 **H=**63.5	**S=** 132±8 (n=4) **Si=**173±35 (n=4) **T=**27.7 **H=**55.1 **W.D=**N-E **W.S=**0.4
02	PSH-2/*TH* **Date=**19-03-13 **Time=1:45-2:15pm**	***S**=1447±171 (n=4) ***Si=**1617±162 (n=4**)** **T=**26 **H=**59.8	**S**=18517±436 (n=3) **Si=**16237±1790 (n=3**)** **T=**26 **H=**55.4	**NIL**
03	PSH-3/*TH* **Date=**20-03-13 **Time=**10:53-11:23am	**S**=1711±35 (n=5) **Si=**1705±30 (n=5**)** **T=**26.6 **H=**65.9	**S**=1413±94 (n=5) **Si=**1432±83 (n=5**)** **T=**26.5 **H=**65.5	**S=**22±2 (n=3) **Si=**40±7 (n=3) **T=**26**H=**56.3 **W.D=**N-S **W.S=**0.6
04	PSH-4/*DC* **Date=**01-03-13 **Time=**09:56-	**S**=24539±2483 (n=5) **Si=**28808±1476 (n=5**)**	**S**=5378±402 (n=3) **Si=**4950±212 (n=3**)**	**S=**15±1 (n=3) **Si=**22±12 (n=3)

	10:46am	**T=**24.7 **H=**58.4	**T=**23.4 **H=**62.5	**T=**22.9 **H**=59.5 **W.D=**NIL**W.S=**0.0
05	PSH-5/*TH* **Date=**20-03-13 **Time=**01:01-01:25pm	**S**=422±61 (n=3) **Si=**408±72 (n=3**)** **T**=27.6 **H=**59.5	**S**=118±15 (n=3) **Si=**116±10 (n=3**)** **T=**25.7 **H=**60.4	**S=**8±2 (n=3) **Si=**9±2 (n=3) **T=**25 **H**=60.3 **W.D=** NIL **W.S=0.0**
06	PSH-6/*HS* **Date=**20-03-13 **Time=**06:24-06:33pm	**NIL**	***S**=1136±39 (n=6) ***Si=**1144±25 (n=6**)** **T=**25.8 **H=**62.9	**NIL**
07	PSH-7/*C* **Date=**20-03-13 **Time=**05:15-05:35pm	**S**=2147±66 (n=3) **Si=**2247±99 (n=3**)** **T=**26 **H=**59.8	**S**=23±2 (n=2) **Si=**28±2 (n=2**)** **T=**25.8 **H=**60.7	**NIL**
08	PSH-8/*HS* **Date=**19-03-13 **Time=**05:29-05:45pm	**S**=585±132 (n=3) **Si=**547±147 (n=3**)** **T=**27 **H=**60.5	**NIL**	**S=**48±17 (n=3) **Si=**45±12 (n=3) **T=**25.6 **H**=56 **W.D=**N-S**W.S=**0.3

09	PSH-9/*C* **Date=**19-03-13 **Time=**06:06-06:35pm	**S**=471±47 (n=3) **Si=**430±16 (n=3**)** **T=**25.8 **H=**58.8	**S**=64±18 (n=3) **Si=**64±43 (n=2**)** **T=**26.3 **H=**62.5	**NIL**
10	PSH-10/*C* **Date=**18-3-13 **Time=**06:13-06:38pm	***S**=470±4 (n=5) ***Si=**470±4 (n=5**)** **T=**26.6 **H=**59.7	***S**=42±22 (n=3) ***Si=**41±23 (n=3**)** **T=**25.7 **H=**48.5	**NIL**
11	PSH-11/*C* **Date=**18-3-13 **Time=**07:24pm-07:37pm	***S**=791± 14(n=5) ***Si**=790±12(n=5) ***S=**2076±129(n=5) ***S**=2068±131 (n=5) **T**=24.5 **H**=67.2	**NIL**	**S=**16±6 (n=5) **Si=**14±8 (n=5) **T=**23.5 **H**=59.9 **W.D=**NIL **W.S=**0.0
12	PSH-12/*I* **Date=**20-3-13 **Time=**02:45-3:00pm	**S**=64±0.0 (n=3) **Si=**64±2 (n=3**)** **T=**26.7 **H=**66.3	**NIL**	**S=** 10±2 (n=3) **Si=**9±1 (n=3) **T=**24.9**H**=55.9 **W.D=**N-S**W.S=**0.4
13	PSH-13/ *I* **Date=**21-3-13 **Time=**08:07-	**S**=14±5 (n=3) **Si=**14±6	**S**=234±33 (n=3) **Si=**203±46	**NIL**

	08:20am	(n=3**)** **T=**18.7 **H=**70	(n=3**)** **T=**20 **H=**68	

Average value of Hg (ng/m^3) at *two/**three points within same sections; **S**= Current value of Hg (ng/m^3); **Si**= Mean value of Hg (ng/m^3); **T**=Temperature (°C);
H= Humidity (%); **W.D**= Wind Direction (%); **W.S**= Wind Speed (m/sec); ***TH****= Teaching Hospitals;* ***TC****=Teaching Colleges;* ***C****=Clinics;* ***HS****= Hospitals;* ***I****=Institutions*; All measurements were made with Lumex Mercury Analyzer at R (Deviation) ≤ 25% and S≅Si

Annex-10

Table 3: Mercury Levels in and around dental sites of Islamabad and Rawalpindi

Sr.No	Dental site(s)	Treatment section/ Operative dentistry	Adjacent corridor	Open air
01	**Rwp-1/** *TH* **Date=**05-04-13 **Time=**10:13-10:57am	**S=**44067±6314 (n=3) **Si=**43130±5433 (n=3) **T=**26.2 **H=**48.1	**S=**10333±316 (n=3) **Si=**10987±1008 (n=3) **T=**26.6 **H=**41.8	**S=**24±1.7 (n=3) **Si=**21±2 (n=3) **T=**26.4 **H=**39.8 **W.D=**S-E **W.S=**0.8
02	**Isl-1/** *TC* **Date=**04-04-13 **Time=**12:22pm-01:37pm	***S=**42490±1457 (n=5) ***Si=**41754±809 (n=5) **T=**26.7 **H=**45.5	**S=**11897±774 (n=3) **Si=**11170±773 (n=3) **T=**25.9 **H=**42.5	**S=**1434±220 (n=3) **Si=**4100± 5049 (n=3) **T=**26.1 **H=**37.5 **W.D=**N-E **W.S=**0.3
03	**ISL-2/***H* **Date=**04-04-13 **Time=**10:28-11:22am	**S=**18636±371 (n=3) **Si=**17382±2043 (n=3) **T=**25.9 **H=**50.5	**S=**3923±690 (n=3) **Si=**3674±1074 (n=3) **T=**25.6 **H=**46.5	**S=**356±90 (n=3) **Si=**373±96 (n=3) **T=**25.1 **H=**43.5 **W.D=**N-S **W.S=**0.6
04	**ISL-3/***C* **Date=**08-4-13 **Time=**12:38-01:00pm	**S=**7117±436 (n=3) **Si=**6326±500 (n=3) **T=**29.1 **H=**53.6	**NIL**	**S=**38±7 (n=3) **Si=**40±3 (n=3) **T=**29.5 **H=**41.5 **W.D=**S-W **W.S=**0.3
05	**ISL-4/***TH* **Date=**08-4-13 **Time=**11:49-12:13pm	**S=**3930±79 (n=4) **Si=**3969±24 (n=4) **T=**26.7 **H=**53.4	**NIL**	**S=**62±6 (n=3) **Si=**80±8 (n=3) **T=**27 **H=**40

				W.D=0.3 **W.S**=N-E
06	**Rwp-2**/*H* **Date**=28-3-13 **Time**=01:28-02:08pm	**S**=2631±132 (n=4) **Si**=2510± 203 (n=4) **T**=25.4 **H**=66	**S**=1845± 98 (n=3) **Si**=1820±52 (n=3) **T**=25.3 **H**=62.8	**S**=5±0.8 (n=4) **Si**=5± 1.7 (n=4) **T**=24.9 **H**=61.6 **W.D**=N-S **W.S**=0.3
07	**ISL-5**/*H* **Date**=08-04-13 **Time**=10:24-11:04am	**S**=203±1.5 (n=3) **Si**=206±5 (n=3) **T**=26.7 **H**=57.7	**NIL**	**S**=11± 0.5 (n=4) **Si**=11±0.5 (n=4) **T**=26.2 **H**=51.2 **W.D**=N-W **W.S**=0.5
08	**ISL-6**/*H* **Date=0**2-4-13 **Time**=3:29-4:10pm	**S**=296±60 (n=4) **Si**=278± 78 (n=4) **T**=28.4 **H**=47.4	**S**=221±10 (n=3) **Si**=208±23 (n=3) **T**=28.2 **H**=49.4	**NIL**
09	**Rwp-3**/*H* **Date**=28-3-13 **Time**=3:04-3:12pm	**S**=179±12 (n=3) **Si**=163±3 (n=4) **T**=26.2 **H**=61.1	**NIL**	**NIL**
10	**ISL-7**/*C* **Date**=4-4-13 **Time**=3:30-3:37	**S**=714±102 (n=3) **Si**=631±16 (n=3) **T**=29.6 **H**=65.3	**NIL**	**NIL**
11	**ISL-8**/*C* **Date**=8-4-13 **Time**=1:56-2:15pm	**S**=333±5 (n=3) **Si**=312±41 (n=3) **T**=29 **H**=40.7	**NIL**	**S**=15±5 (n=3) **Si**=14±2 (n=3) **T**=28.8 **H**=41.2 **W.D**=N-E

				W.S=0.3
12	**Rwp-4/***I* **Date=**28-3-13 **Time=**10:44-11:30am	**S=**51±1.7 (n=4) **Si=**51±4 (n=4) **T=**24.4 **H=**57.2	**NIL**	**S=**16±4 (n=4) **Si=**13±3 (n=4) **T=**24.6 **H=**61.5 **W.D=**N-S **W.S=**0.7
13	**ISL-9/***I* **Date=**9-4-13 **Time=**12:12-12:24pm	**S=**18±2 (n=4) **Si=**17±3 (n=4) **T=**27.9 **H=**62.5	**NIL**	**NIL**
14	**ISL-10/***I* **Date=**11-4-13 **Time=**3:13-3:55pm	**S=**8±1 (n=3) **Si**= 8±3 (n=3) **T**=25.6 **H**=55.8	**NIL**	**S=**4±3 (n=3) **Si**=3±2 (n=3) **T**=27.8 **H**=46.4 **W.D=**N-E **W.S**=0.5

*****Average value of Hg (ng/m^3) at two points within same sections; **S**= Current value of Hg (ng/m^3); **Si**= Mean value of Hg (ng/m^3); **T**=Temperature (°C); **H**= Humidity (%); **W.D**= Wind Direction (%); **W.S**= Wind Speed (m/sec), ***TH****= Teaching Hospitals;* ***TC****=Teaching Colleges;* ***C****=Clinics;* ***HS****= Hospitals,* ***I****=Institutions*, All measurements were made with Lumex Mercury Analyzer at R (Deviation) ≤ 25% and S≅Si

Annex-11

Table 4: Electric Power Equivalents for Different Lamps-

Electrical power Consumption Watts(W)		**Minimum Light Output Lumens(lm)**
Compact Fluorescent Lamps(CFL)	**Incandescent Lamps(ICL)**	
9-13	40	450
13-15	60	800
18-25	75	1,100
23-30	100	1,600
30-52	150	2,600

Source of information: Reference 22

Annex-12

Table 5: Levels of Mercury in and around KPK-1

Sr.No	**Industry**	**Treatment section**	**Adjacent corridor**	**Open air**
1	**KPK-1** Date=18-3-13 Time=3:27-3:47pm	**S**=3351±72 (n=3) **Si**=3321±139 (n=3) **T**=26 **H**=57	NIL	**S**=32±4 (n=3) **Si**=47±10 (n=3) **T**=24, **H**=54 **W.D**=N-E W.S=0.7

S= Current value**; Si=** Mean value**; T=** Temperature**; H=** Humidity**; W.D=** Wind Direction
W.S= Wind Speed

Annex-13

Table 6: Levels of Mercury in and around KPK-2

Sr.No	Industry	Treatment section	Adjacent corridor	Open air
1	KPK-2 Date=21-3-13 Time=1:43-1:57pm	S=39426±6035 (n=3) Si=43337±4617 (n=3) T=28 H=51	S=3381±1364 (n=3) Si=4881±565 (n=3) T=28 H=50	S=63±16 (n=3) Si=53±17 (n=3) T=28 H=47 W.D=N-E W.S=0.6

S= Current value**; Si=** Mean value**; T=** Temperature**; H=** Humidity**; W.D=** Wind Direction

W.S= Wind Speed

Annex-14

Table 7: Mercury Levels in and around industry LHR-10

Sr.No	Industry	Treatment section	Adjacent corridor	Open air
1	LHR-10 **Date**=7-3-13 **Time**=2:10-3:19pm	*NIL	**S**=>50000 (n=5) **Si**=>50000 (n=5) **T**=29; **H**=59	**S**=1619±472 (n=3) **Si**=1362±241 (n=3) **T**=29;**H**=55;**W.D**=S-W; **W.S**=0.7

S= Current value**; Si=** Mean value**; T=** Temperature**; H=** Humidity**; W.D=** Wind Direction**, W.S=** Wind Speed; ***NIL**= Monitoring wasn't carried out because of high magnetic effect.

Annex-15

Table 8: Environmental and Occupational health standards for inhalation exposure to mercury vapor

Sr. No	Agency	Hg µg/m^3/ (ng/m^3)
1	***OSHA**	100/100,000
2	***NIOSH REL**	50/50,000
3	***ACGIH/ WHO****	25/25,000/ ** 0.025mg/m^3
4	***ATSDR MRL**	0.2/200
5	***ATSDR ALIE**	1.0/1000
6	***EPA Rfc**	0.3/300

*www.newmoa.org/preventation/mercury/mercuryindoor.Pdf

**World Health Organization (WHO) (1980): Technical Report Series 647, recommended health-based limits in occupational exposure to heavy metals. World Health Organization, Geneva

Annex-16

List of student's trainees, Institute of Chemical Sciences, Peshawar University

- Qindeel hayat, BS Hons. Semester –IV, ICS
- Sidra Munir, BS Hons. Semester –IV, ICS
- Ammara Gul, BS Hons. Semester –IV, ICS
- Salma Nawaz, M.Sc final, ICS
- Arifa Mehmood, M.Sc final, ICS
- Luqman, M.Sc final, ICS
- Abdul Wakeel, M.Sc final, ICS
- Iqra Aridi, M.Sc final, ICS
- Hafeez-ur-Rehman, M.Sc final, ICS
- Abdul-haq Khan, M.Sc final, ICS
- Sundus Syed, M.Sc final, ICS
- Muhammad Sohail, M.Sc final, ICS
- Rana Gul, M.Sc final, ICS
- Naheed Bibi, M.Sc final, ICS

Annex-17

Press Coverage in Pakistan

- First mercury pollution measurement initiative launched in Pakistan, Pakistan Times, Wednesday, 6th March, 2013
- Mercury pollution measurement sys launched, Technology Times, Monday, 11th March, 2013
- Pollution study, Dawn, Friday, 22nd March 2013
- Project launch to measure mercury pollution in air, The Nation, Saturday, 23rd March 2013
- Students of UoP to detect mercury pollution in air, The Frontier Post, Sunday, 24th March 2013
- Mercury levels: UoP SDPI to study twin cities, air, The Express Tribune, Sunday, 24th March, 2013
- Medical staff sensitized on mercury system, Weekly Technology Times Vol. 04, No.14, Monday, 1st April, 2013
- Mercury pollution exceeds safe levels inside dental hospitals in Rawalpindi, Islamabad, The Lahore Times, Wednesday, 10th April, 2013
- Hazardous element: dental hospitals have 20 times higher indoor mercury levels than permissible limit, International HeraloTrinune, 11th April, 2013
- Mercury pollution inside dental hospitals quite high, The News International - Apr 12, 2013
- Mercury Pollution exceeds safety level at dental clinics, Weekly Technology Times, Vol. 04, No. 16, April 15-21, 2013
- Mercury pollution exceeds safety level at dental clinics , Technology Times at April 19, 2013

Annex-18(A)

Support from Pakistan Environmental Protection Agency

Government of Pakistan
Pakistan Environmental Protection Agency
(Ministry of Climate Change)
311-Margallah Road, F-11/3, Islamabad
****

F. No. 1(8)/2013-DG Dated: 18-02-2013

Subject: **Monitoring of Mercury Contamination.**

You would agree that mercury contamination is becoming a serious environment and health issue due to its consumption in industrial products and wastes.

2. With a view to quantifying release of mercury in the environment, Pak-EPA and SDPI have obtained special portable equipment from European Environment Bauru on loan basis for the period of three months ending in April, 2013. It will provide a good opportunity to identify source of mercury at different locations and in different products for which cooperation of your organization will be necessary to conduct the survey. I would be grateful if you could kindly extend your cooperation for conducting the survey and designate a focal person who could coordinate and assist:

Dr. Mahmood Khwaja
Senior Advisor,
Sustainable Development Policy Institute (SDPI)
38 Embassy Road, G-6/3 Islamabad (New Address)
Pakistan
Postal Code: 44000
Tel: +92-51-2278134
Fax:+92-51-2278135

18-2-2013
(Asif S. Khan)
Director General

1. **Secretary, Environmental Protection Department, Lahore.**
2. **Secretary, Environment Alternate Energy Department, Karachi.**
3. **Secretary, Environment Department, Peshawar.**
4. **Chlor-Alkali Plant, Ittehad Chemical, Lahore.**
5. **Dental Clinics Incharge**
6. **Light Products Manufacturing Industry.**

Copy for information to:

- P.S to Secretary, M/o Climate Change
- Joint Secretary (I.C), M/o Climate Change
- Dr. Mahmood Khwaja, Senior Advosor, SDPI, Islamabad.

Annex-18(B)

Support from Environmental Protection Agency, Peshawar

Office of the Director General
Environmental Protection Agency
Environment Department
Government of Khyber Pakhtunkhwa

No. EPA/001/MMC/1085 Date: 20.3.2013

The Executive Director,
SDPI, Islamabad.

Subject: **Monitoring of Mercury Contamination in Air.**

With reference to your letter No Nil dated 28/02/2013 on the subject, with the regard to survey work on Mercury contamination in air, we appreciate and extend our fullest support to this activity and research work.

Director General 20.3.13

CC to:-

1. Dr. Mahmood Khwaja, SDPI, Islambad.

3rd Floor, (SDU) Old Courts Building, Khyber Road, Peshawar Cantt,
Khyber Pakhtunkhwa, Pakistan.
Tel: 92(91) 9210263-9210148, Fax: 92 (91) 9210280

Annex-18(C)

Support from Ministry of climate change

Government of Pakistan
Ministry of Climate Change
(International Cooperation Wing)
LG&RD Complex, 4th Floor, G-5/2, Islamabad
*****

F.No.3(5)/12/DD(Chem) Islamabad the, 13th February, 2013

Subject: **Mercury Monitoring in Ambient Air.**

Please find enclosed a letter received from Sustainable Development Policy Institute (SDPI), Islamabad on the subject cited above, the contents of which are self-explanatory.

2. The mercury analyzer for air monitoring is a useful device for measuring possible mercury releases/emission sources.

3. SDPI may be approached in this regard for utilizing this facility as and when required.

(ZAIGHAM ABBAS)
Deputy Director (Chemical)
Tel: 051-9245536

1. The Secretary, EPD-Punjab, Lahore.
2. The Secretary, EPA-Sindh, Karachi.
3. The Secretary, EPD-Balochistan, Quetta.
4. The Secretary, EPD-KPK, Peshawar.
5. Director General (Pak-EPA), Islamabad.

Copy to:

1. Dr. Mahmood A. Khawaja, SDPI, Islamabad
2. Joint Secretary (IC), M/o Climate Change, Islamabad

Annex-19

ACROYNMS

ASTDR	Agency for Toxic Substances and Disease Registry
ACGIH	American Conference of Governmental Industrial Hygienists
AS/NZS	Australian and New Zealand National Standards
BEP	Best in-house Environmental Practices
C	Clinic
CFL	Compact Fluorescent Lamps
DC	Dental College
EU	European Union
EPA	Environmental Protection Agency
EEB	European Environmental Bureau
GPS	Global Positioning System
Hg/A	Mercury amalgam
HID	High Intensity Discharge lamp
I	Institute
INC	Intergovernmental Negotiation Committee
ISL	Islamabad
IMERC	Interstate Mercury Education and Reduction Clearing House
IFC	International Finance Corporation
IEC	International Electro technical Commission
ICL	Incandescent Lamps
ICS	Institute of Chemical Sciences
LED	Light Emitting Diode
LCD	Liquid Crystal Display
LPM	Light Products Manufacturing
LHR	Lahore
MCCAP	Mercury Cell Chlor Alkali Process
MRL	Minimal Risk Level
NIOSH	The National Institute for Occupational Safety and Health
NEMA	National Electric Manufacturers
OPD	Operative Dentistry
OSHA	Occupational Safety and Health Administration
PSH	Peshawar
RWP	Rawalpindi
Rfc	Reference concentration
REL	Recommended Exposure Limit
SDPI	Sustainable Development Policy Institute, Islamabad
TC	Teaching College
TH	Teaching hospital
TWA	Time Weighted Average
TLV	Threshold Limit Value
UV	Ultra Violet
WHO	World Health Organization
ZMWG	Zero Mercury Working Group