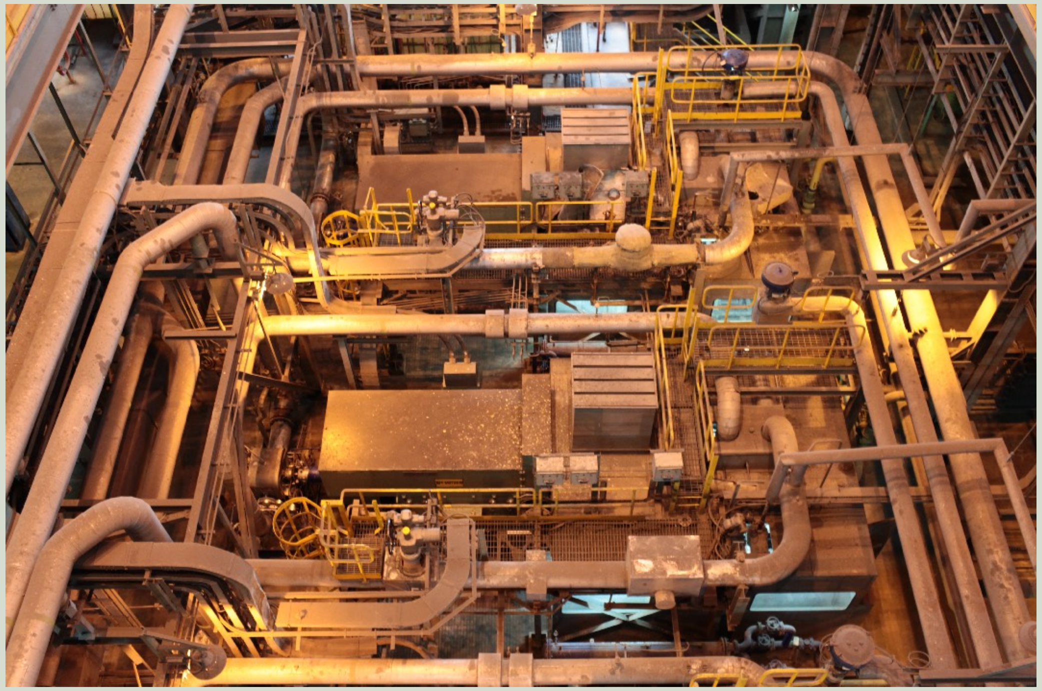
Decommissioning Thermal Power Plants in India

An Environmental & Public Health Perspective



Author: Dharmesh Shah

Advisors: Dr. Mark Chernaik, Environmental Law Alliance Worldwide - US; Shweta Narayan, Healthy Energy Initiative India

Photos: Amirtharaj Stephen, PEP Collective

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For more details contact:
Healthy Energy Initiative India
No 92, 3rd Street, Thiruvalluvar Nagar,
Besant Nagar, Chennai - 600090
India

Introduction

In 2019, the share of coal in global electricity production fell by 3%. This translates to approximately 300 terawatt hours (TWh) of reduction from coal based power sources. This is in line with the general trend of decelerating growth but a marked increase in electricity generated from non-coal sources in India and China [1].

India's fleet of 170+ thermal power plants generate around to 230,190MW of electricity (as on 29.02.2020). According to the Central Electricity Authority (CEA), 102 units of 43 thermal power plants with capacity of 10,002.88 MW have been retired between April 2014 and March 2020 [2]. Furthermore, 35949MW of power plant infrastructure is more than 25 years old [3] and are bound to be decommissioned in the near future. India has already committed to decommission 29 power plants with the combined capacity of 12000 MW by 2022 as part of its obligation towards climate change mitigation [4].

The decommissioning market in Europe and the United States is more mature given their very early use of coal based power. Between 2010 and the first quarter of 2019, U.S. power companies announced the retirement of more than 546 coal-fired power units, totaling about 102 gigawatts (GW) of generating capacity. Plant owners intend to retire another 17GW of coal-fired capacity by 2025 [5]. Decommissioning costs for a typical 500-MW coal-fired power plant range from $5 million to $15 million net of scrap [6]. Cost estimates for India are currently unavailable.

The decommissioning trend has opened up a large market for dismantling, reclamation and disposal of scrapped sites. Companies like mjunction and MSTC have stepped in to capture this market space [7]. However, in the context of regulations, decommissioning requires minimal paperwork. The power to decommission a unit vests with the board of the company which in turn is required to intimate the Central Electricity Authority (CEA) to ensure that the unit is deleted from the All India Installed Capacity database. Indian regulations do not demand environmental and social impact assessment of decommissioned power plants.

Terminology

Notably, retirement and decommissioning have different meanings. When a generating unit or an entire plant is retired, it no longer produces electricity. However, the assets of the plant, such as buildings, turbines, boilers, and other equipment, may remain in place. Decommissioning takes place only after a unit or plant retires and refers to the process of environmental remediation, dismantlement, and restoration of the site.

Several terms are often used interchangeably following the closure of a power plant, but they do have different connotations. Some common words and their meanings follow [8].

Retirement: A plant is declared inoperable, that is, neither economically nor technically feasible to continue operating. This includes interim preservation methods until decommissioning can begin.
Decommissioning: A series of activities to remove hazardous materials, such as asbestos abatement, and plant superstructure and infrastructure demolition.
Remediation: Surface and subsurface property reclamation.
Retrofitting: Attaching modern pollution control technologies or converting base fuel use (eg; coal to natural gas).
Redevelopment: Designated end-use applications.

Decommissioning should be considered as a step towards a goal - such as retrofitting or redevelopment of the site for commercial uses.

Anatomy of a Coal Power Plant

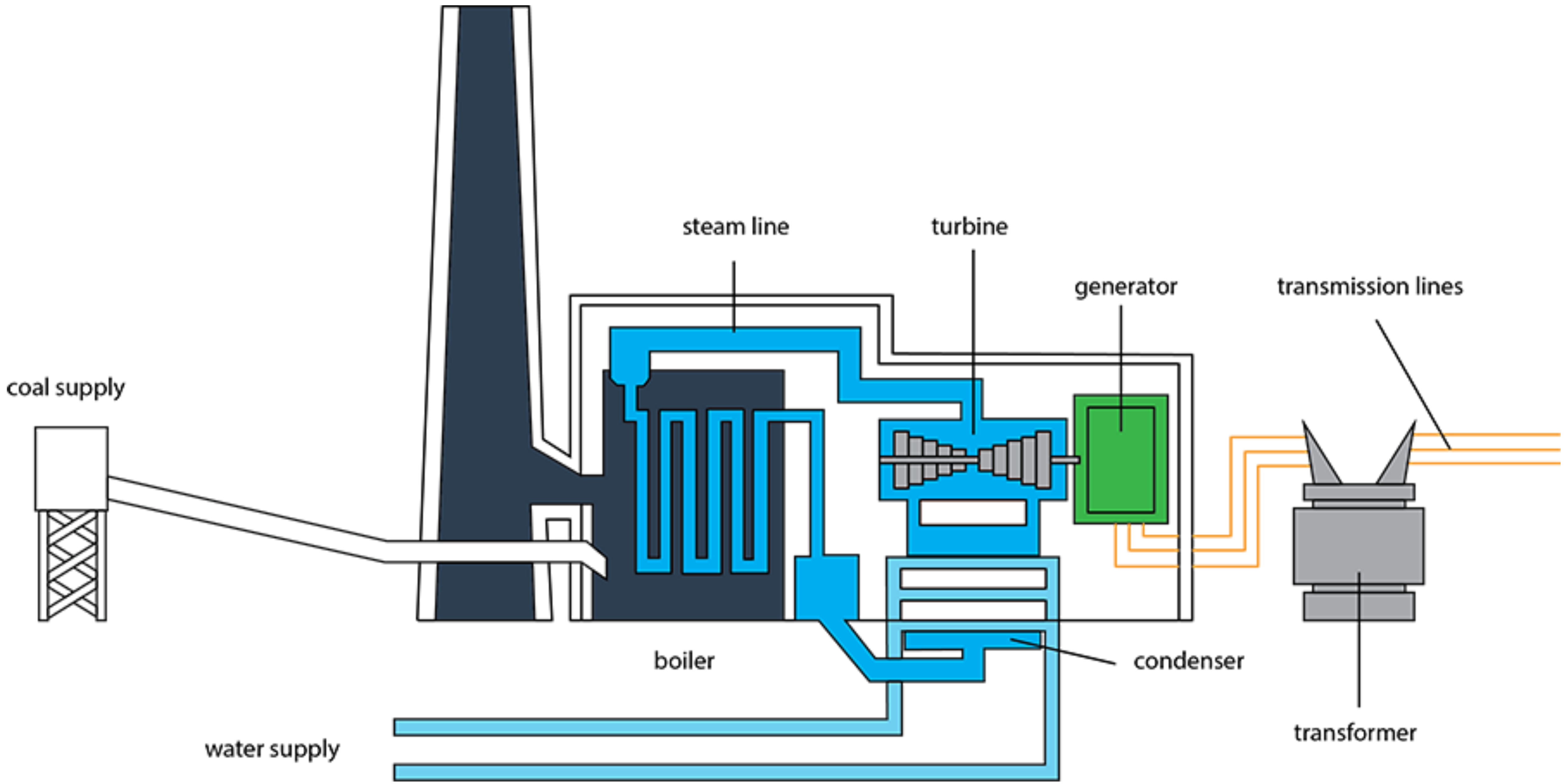

Image Source: Belluck & Fox [9]

Before proceeding into the need for regulations governing decommissioning, it is important to understand the anatomy of a power plant. A typical coal fired thermal power plant has three main sections – the coal combustion, the boiler or steam generation and the smoke stack. Interspersed among these sections, are numerous pipes, boilers, turbines, pumps, valves, transformers and transmission lines.

In order to keep these physical components operational, several hazardous substances are used for heat retention, lubrication, wear and tear prevention etc. The 'Guidance Document for Assessment and Remediation of Contaminated Sites in India' developed by the Ministry of Environment and Forests, lists **asbestos**, **arsenic**, **lead** and **polychlorinated bisphenyls (PCBs)** as UBI Tracers [10] under the coal power plant sector.

Asbestos is the substance of primary concern in this context. It is used in several areas in thermal power plants, including steel pipe insulation, in gasket joints in hot water drain pipes, in the ropes that are used for gland packing, duct insulation, as well as in safety equipment such as fire retardant gloves and curtains. Asbestos ropes and clothes are used in many of these applications. Power plants are classified as an industry "involving hazardous processes" under the Factories Act (1948) of India (Section 87, 63 of 1948) [11].

Polychlorinated Biphenyls (PCBs) are a class of highly toxic chlorinated compounds (known as congeners - chemicals which exert an effect on the body or brain) that are either oily liquids or solids. These chemicals are widely used in the power generation industry in transformers and capacitors, as hydraulic fluids, and in fire-retardant materials. The major inventory of PCBs lies in the power sector in the form of transformers and capacitors. The Indian power sector owns 71% of PCBs containing equipment followed by the steel industry at 18% [12]. The PCB disposal in India is currently being overseen collaboratively by MoEFCC and the Central Power Research Institute of Ministry of Power under a Global Environment Facility (GEF) project.

In addition to these two substances of concern, **mercury** can be found in switches, instrumentation, and pressure-vapor lighting. **Lead** can be found in paints.

Coal ash ponds are yet another significant source toxic contamination that needs to be addressed during the decommissioning process. Coal ash pond remediation could add significantly to the cost of decommissioning. According to an estimate by the US based think tank POWER, ash pond remediation can range from 70% to 75% of the total decommissioning budget. Asbestos and other hazardous material remediation can account for an additional 5% to 7% of costs, with structural demolition accounting for the rest [13].

The Indian Experience

Similar decommissioning estimates for India are not available which also points to the fact that Indian regulators do not mandate remediation as an important step in the decommissioning process. Cases reviewed for the purpose of this report did not seem to follow any remediation or handling protocols to contain hazardous substances on erstwhile power plant sites.

The proposal to decommission and replace/ redevelop the aging 450 MW Ennore Thermal Power Station is one of the cases wherein the Environmental Impact Assessment (EIA) for the replacement facility after demolishing the old structure makes no mention of handling and disposal of hazardous substances like asbestos or PCBs [14]. Similarly, the EIA for establishing a 800MW coal based supercritical thermal power plant and decommissioning of two 120MW units at Ukai Thermal Power Plant at Tapi District in Gujarat lists 6 hazardous chemicals as identified under the Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 (MSIHC). These chemicals include Light Diesel Oil, Heavy fuel Oil, Chlorine, Hydrogen, High Speed Diesel and Ammonia which are stored above the threshold quantities attracting the Major accident hazards (MAH) installations categorisation. While the MSIHC rules listing includes Asbestos, the EIA makes is no reference to it.

In the case of two of Delhi's flagship thermal power plants in Rajghat [15] and Badarpur, the government proposes to convert the sites into solar and eco parks. The project to convert the 884 acre Badarpur plant site into an eco-park [16] only proposes to bury the ash under soil cover and vegetation as part of its remediation efforts. There is no mention of heavy metal pollution mitigation strategies.

In the case Bhatinda's Guru Nanak Dev Thermal Power Plant, the proposal to dismantle the decommissioned plant only refers to the financial aspects of auctioning scrap. The management and handling of hazardous substances do not appear as part of the tender guidelines or contactor deliverables. A scrutiny of several decommissioning e-auction documents highlight a similar trend [17 18 19]. The fact that hazards posed by demolition do not feature in any decommissioning documents is a serious lapse with grave human health and environmental consequences.

The Decommissioning Journey

Once a plant is retired and scheduled to shut down, the project site will move along the subsequent stages of decommissioning, remediation and redevelopment. In order to plan clean-up assessment or remediation operations, it is best to determine site reuse/ redevelopment plans as early as feasibly possible.

During decommissioning, the electrical generating units are shut down and all operating permits are terminated and the unit is deleted from the CEA's database. The next step should include, removal of any unused coal and hazardous materials associated with both the generation process and the buildings/structures e.g., process chemicals, asbestos in the building or in equipment, polychlorinated biphenyls [PCBs], and lead.

The next stage is remediation which involves the assessment and clean-up of hazardous materials to meet regulatory standards. The site owner is responsible for ensuring that the clean-up meets all regulatory requirements and works closely with stakeholders, environmental consultants and state environmental agencies to develop and execute the remediation plan. Remediation starts with collecting soil and ground water samples to investigate and document any contamination. In case of contamination is found, future site activities and uses may be restricted.

The USEPA enlists the following hazardous items at coal-fired power plants attracting clean up [20]:

- Asbestos, PCBs and other hazardous materials are removed from the buildings.
- Coal ash disposal areas are removed or capped with a protective cover of soil to ensure the waste is not accessible.
- Fuel tanks and any associated contaminated soil are removed.
- Concrete pads and soil around old transformers and hydraulic equipment are tested for PCBs and removed if necessary.
- Surface soil is tested for mercury and other airborne contaminants and removed if necessary.
- Soil around spills and leaks is tested and removed.

Recommendations

India needs to urgently develop guidelines on decommissioning of coal fired thermal power plants in consultation with different stakeholders. The fact that hazards posed by demolition do not feature in any decommissioning documents is a serious lapse with grave human health and environmental consequences.

To mitigate against large unplanned decommissioning costs, prudent policy would require plant owners to either:
(1) provide adequate financial assurance for decommissioning before construction of a plant;
(2) accrue decommissioning funds over the life of the power plant, or both.

Overall the decommissioning should include a detailed depth and spread assessment, a public consultation to share the proposed remediation plans and finally site remediation in accordance with future land use.

In the context of remediation the comprehensive Guidance Document for Assessment and Remediation of Contaminated Sites in India developed by the Ministry of Environment and Forests must be the reference document for remediation. Environmental Impact Assessment for decommissioning and remediation / redevelopment must be made mandatory under existing environmental legislations . Oversight by CPCB must be made mandatory for scientific handling and disposal of hazardous waste in line with the provisions of the Hazardous Waste Management Rules 2016 and the Factories Act of 1948.

Toxics Fact Sheet

ASBESTOS

Asbestos mainly affects the lungs and the membrane that surrounds the lungs. Breathing high levels of asbestos fibers for a long time may result in scar-like tissue in the lungs and in the pleural membrane (lining) that surrounds the lung. This disease is called asbestosis and is usually found in workers exposed to asbestos, but not in the general public. People with asbestosis have difficulty breathing, often a cough, and in severe cases heart enlargement. Asbestosis is a serious disease and can eventually lead to disability and death.

(Source: Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, Asbestos ToxFAQs (2001) *available at* https://www.atsdr.cdc.gov/toxfaqs/tfacts61.pdf)

ARSENIC

Arsenic is a known carcinogenic to humans. It has been shown to cause skin and lung cancer; many scientists believe there is no safe level of exposure to a carcinogen. Chronic arsenic exposure has been associated with spontaneous abortions and still births. Repeated skin contact can cause thickened skin and/or patchy areas of darkening and loss of pigment. Some persons may develop white lines on the nails. Arsenic may damage the nervous system causing numbness, "pins and needles," and/or weakness in the hands and feet. Arsenic may damage the liver.

(Source: New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Arsenic *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/0152.pdf)

LEAD

Lead is a neurotoxin and is known to cause low IQ among children. Lead is a probable carcinogen in humans. There is some evidence that lead, and lead compounds cause lung, stomach, brain and kidney cancers in humans and they have been shown to cause kidney cancer in animals. Lead may decrease fertility in males and females and damage the developing fetus and the testes (male reproductive glands). Repeated exposure to lead can cause lead poisoning, symptoms include metallic taste, poor appetite, weight loss, colic, nausea, vomiting, and muscle cramps. Higher levels can cause muscle and joint pain, and weakness. Lead exposure increases the risk of high blood pressure. Lead may cause kidney and brain damage, and damage to the blood cells causing anemia.

(Source: New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Lead *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/1096.pdf)

MERCURY

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there, possibly causing damage to the developing nervous system. It can also pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk. Mercury's harmful effects that may affect the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

(Source: Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, Mercury ToxFAQs (1999) *available at* https://www.atsdr.cdc.gov/toxfaqs/tfacts46.pdf)

POLYCHLORINATED BISPHENYLS (PCBs)

PCBs are a Persistent Organic Pollutant, they do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil.

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs. Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

(Source: Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, Poly Chlorinated Bisphenyls ToxFAQs (2014) available at https://www.atsdr.cdc.gov/toxfaqs/tfacts17.pdf)

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