ENVIRONMENTAL MANAGEMENT FOR ELECTRONIC WASTE

1.0 Introduction

With the advent in information technology, there has been a manifold increase in the pace of all activities of our life. While on one hand electronic communication has saved environment by dramatically reducing paper usage, on the other, it has also caused widespread environmental damage due to the use of toxic materials in the manufacture of electronic goods. Almost all electronic equipments used nowadays, be it the computers, TV sets, VCRs, CD players, cellular phones, stereos, fax machines, copiers, or microwave ovens use a variety of thousands of small electronic/electrical components for their manufacture and the waste thus arising during their manufacture or disposal is of great environmental concern.

2.0 What is e Waste

The electronic waste can arise from two sources:

1. From the manufacturing of electronic components such as PCB (printed circuit board), semiconductors, capacitors, CRT (cathode ray tube) glass and picture tubes, electro galvanized audio parts, PVC/metal sheets etc.
2. From the disposal of used electronic equipments and the components used in it.

The first category may cause problem due to disposal of spent chemicals into environment in various forms whereas the second one poses threat due to unscientific destruction and disposal of expired electronic goods.

3.0 Need for e Waste Management

Almost all electronic components use persistent bio-accumulative toxins and heavy metals such as zinc, copper, cadmium, mercury, barium, asbestos, tin plates, arsenic, PVC, lead, and cadmium as one of their ingredients. Different types of hazardous solvents and chemicals such as formaldehyde, EDTA, other acids & alkalis, various gases, epoxy resin, etc. are used in the manufacturing process. The residuals of these toxins, through ground/surface water, ambient air or food chain, reach our body system and pose a far reaching impact on internal organs such as lungs, kidneys, central and peripheral nervous systems and may also cause birth defects, asthmatic bronchitis, cancer, acute and chronic effects etc. to name a few. The environmental health significance and the bodily organs affected by commonly found contaminants in electronic units are given as under:

Lead: Brain, kidney and reproductive system, convulsions in later life

Mercury: Heart, brain, CNS, kidney; known to cause Minimata Disaster in Japan
Cadmium: Kidney, flu like disorder, high BP, sterility among males; known to cause Itai-Itai disease in Japan
Barium: Muscular and Cardiovascular disorder, kidney damage
Chromium: Skin disorder, liver damage, known to be carcinogenic
Copper: Toxic to aquatic life and microorganisms
Nickel/cobalt: Carcinogenic
Silver: Darkening of the skin and eyes
Zinc: Bad taste
Solvents: Mostly Carcinogenic
Cyanide: Highly toxic

Apart from having a damaging effect on human health, it is important to realize the effects of these toxicants on the entire biological ecosystem. Accumulation of toxins in the biological systems could accelerate the extinction of species which ultimately would impact the future of the human race on earth.

4.0 Source of e Waste

The industries involved in manufacturing components for electronic industries such as semiconductors, PCB, cathode ray tube, etc. use hazardous and toxic chemicals for processing the goods. The excess, un-reacted amount of chemicals generated from process makes the e waste. Though the industries involved in making these components are in organized sector, the lack of modern manufacturing technologies, awareness among facility operators, inadequate government policies and poor enforcement of environmental regulation in the country, the untreated e-waste quite often finds its easy way into the environment.

Another type of e waste comes from electronics recycling industries. The salvage operations of used electronic equipments and in turn their inbuilt components are primarily done by unorganized & unauthorized small units in India, mainly because of cheap labour abundance. According to an estimate, India has close to 2 million obsolete computers currently and this figure counts to be 315 million for world over. The computer parts such as monitor, keyboard, CPU, floppy drive carry precious materials such as gold, silver, copper, platinum, lead, cadmium and mercury which attract the attention of recyclers for their economic value (there is predominantly lead and cadmium in PCB; lead oxide and barium in monitors and cathode ray tube; mercury in switches and flat screens; brominated fire retardants in PCB, plastic casings,

cables & PVC insulation; cadmium in batteries; PCB (polychlorinated biphenyl) in older capacitors & transformers). The salvage operations by way of hammering, burning and acid application gives rise to undesirable pollutants in liquid, gaseous and solid forms, besides exposing workers to inhumane and unsafe conditions.

In addition to the domestic production of electronic scrap, a huge quantity of used (usually obsolete) electronic equipments especially the PCs are received from some developed countries like the US and also the Middle East on pretext of charity which soon lands up as a backyard waste. The cheap quality 'use & throw' type electrical and electronic items especially from China is also compounding to the problem. According to an estimate, the average waste generation per computer is:

Lead: 1.75 kg/computer
Cadmium: 2.8 gm/computer
Mercury: 0.57 gm/computer

5.0 Legislative Framework

In India, we have a host of environmental legislation that is intended to check indiscriminate disposal of wastes into environment and ensure the well being of human and other life on the earth. The acts that could be related to electronic waste are:

Public Liability Insurance Act 1991: This Act provides immediate relief to the person(s) adversely affected from an industrial accident. According to the Act, an industry handling any of the scheduled chemicals, beyond its given threshold quantity shall take a compulsory insurance policy and the money shall be used to provide compensation to the affected person.

Factories Act 1948 (amended till 1987): This act provides for the maximum permissible limits of certain work environment pollutants that emanate from industrial activities. Accordingly there may be several contaminants arising out from manufacturing or recycling of electronic components and are listed in this Act. These listed contaminants may be ammonia, chlorine, chromic acid & chromates, copper fumes, ethylamine, fluorides, formaldehydes, HCl, hydrogen peroxide, lead, methyl alcohol, nitric acid, phosphoric acid, sodium hydroxide, sulfuric acid, toluene and trichloroethylene. However the enforcement of the rules is very poor in India and there are very few industries who really monitor these levels in their work environment.

Environment Protection Rules 1986 (amended till 2004): There is no direct standard, which can address pollutants from an electronics manufacturing or recycling industries. However certain PCB units fall in electroplating category and are therefore required to abide by the effluent disposal norms as given in schedule I of these rules. The parameters covered under these rules for their maximum permissible limits are the pH, temperature, oil & grease, suspended solids, cyanide, ammonical nitrogen, total residual chlorides, cadmium, nickel, zinc, hexavalent chromium, total chromium, copper, lead, iron and total metal.

The Hazardous Waste (Management & Handling) Rules, 2003: This deals with handling and disposal of toxic and hazardous wastes generated from electronic component manufacturing. Apart from these, there are no specific regulations for disposal of e-waste. Even the salvage and recycling operations are not regulated which is primarily responsible for the environmental damage that is caused by e-waste. Landfilling of e-waste is also unregulated which results in their being disposed off in municipal landfills which in turn leads to leaching of toxic and hazardous materials to the soil and groundwater.

International Arena: The environmental stipulations in developed world have been by and large stringent as usual. The EU's WEEE (waste from electrical and electronic equipment) directive makes for its member countries mandatory to purchase minimum 75% used electronic goods from consumers in EU only. Even countries in Asia viz. Japan, South Korea and Taiwan also have taken the similar steps. The Basel Convention signed by several countries including India prohibits the export of hazardous material from OECD (an organization of 30 rich countries) member countries to the non-member countries, India being a non-member. Lead is one such material which is extensively used in soldering for PCBs. EU has already banned the use of lead based soldering from 1 Jan 2007 and in Japan it is already in force. It also compels manufacturers to use 50-60% recycled material in electronics.

As discussed earlier, the electronic industry offers environmental threat at two stages, one during manufacture of small, tiny electronic components and the two during their 'end of life disposal'. This section therefore discusses the possible control measures that an industry can take up in order to safeguard its environment in both the stages.

6.0 Cleaner Technologies

6.1 Cleaner Technologies in Manufacturing: Most of the Indian PCB industries use electroless copper plating for plating through holes in PCB sheet. The process employs hazardous chemical like formaldehyde and EDTA (chelating agent), involves more number of chemical sub processes and hence more ware rinses. Carbon or black hole technology is one of the several environment friendly alternatives available for this process. This process does not require the use of hazardous chemicals or chelating agents, avoids multiple sub processes and thus lesser water rinses. All this makes the technology more productive and economical. In case of multi-layer PCB, the drilled holes are cleaned to prepare them for plating. Epoxy polymer smear left in the holes is then oxidized and removed with the help of permanganate solution, which generates manganese dioxide sludge. However the permanganate from this sludge can be regenerated by oxidation of manganate using electrolysis or ion transfer.

In semiconductor manufacturing, RCA 1 & 2, which is an ODS, is used as cleaning agent to remove organic impurities. This if replaced by ozonated cleaning, will save heavy amount of water and can pay back in two years.

Solder stripping is another area where lead needs to be prevented from going into the environment. The bath can be subjected to diffusion dialysis for recovery of acid contaminated with metal that enhances the bath life and reduces the pollution load. The diffusion dialysis process separates acid from its metallic contaminants.

In CRT glass industry, CRT panel contains lead, arsenic and fluorine as raw materials. A technology has now been developed which does not use these elements and moreover heavily reduces the generation of furnace slag and particulate emission.

All the industries with conventional technology use large quantity of water for rinsing operations. The metal recovery by means of ion exchange process or reverse osmosis can not only save in the cost of raw material but can also save on huge quantity of water. Similarly energy conservation also has a good opportunity in these industries. Energy efficient lamps, natural illumination, excess heat recovery, de-rating motors, using variable speed motors instead of fixed speed, optimizing process requirements etc. can save reasonable amount of energy. Thus the minor process modifications or practicing cleaner technologies in these industries can help them reduce water and power consumption both. Better technological alternatives like liquid

crystallized displays and plasma screens can further help reducing waste and save water and energy.

Close operational control also proves to be very useful in improving the efficiency of manufacturing system. Practices to be implemented include close process supervision, preventive maintenance, efficient material handling, waste segregation and pre-treatment and overall monitoring. Good design of equipment, substitution of chemicals, cleaner technologies, appropriate checklists, internal guidelines, training to staff, their motivation etc. can also prove to be very useful.

6.2 Cleaner Technologies at Disposal Stage: Several companies are involved in taking utmost care to use environment friendly technology at manufacturing stage itself and are running R&D programmes to find substitutes for hazardous substances further. At the same time there are companies like Intel, Nokia, HP who buy back the used material and send it for authorized recycling.

There are also dedicated companies now who take this menace as a business opportunity and have set up plants to recycle electronic waste. There are different technologies practiced to recycle waste. In one of the technologies, scrap is sorted manually, sheared mechanically, reacted chemically and exposed thermally to recover the useful material. The scrap is subjected to temperature upto 800 deg C so that even the tough plastics are also melting. Compatalizers are added to enable polymers make the new products. In another technology called Ultra High Shearing, the scrap is subjected to very high mechanical shearing so that the chemical bonds between different polymers are broken beyond its limit of incompatibility to form new polymers. This technology has advantage of avoiding use of chemical. The technologies are further been developed. However in any of the technology, foolproof destruction of confidential R&D information, proprietary softwares and similar type of hardware is ensured.

7.0 Suggested Measures

So far we have found that a large quantity of waste is generated during manufacturing of electronic components, which is dominated by SMEs in India. However these SMEs may not always be interested to invest in cleaner technologies or stringent operational control mainly due to the three reasons: (a) lax enforcement of environmental law in India; (b) stiff competition and rapid decline in price of white goods in market (c) lack of awareness on investment returns from

environmental management. Therefore following recommendations shall be adopted by the small, medium & large industries and the regulatory bodies:

- SMEs or industries involved in manufacturing of electronic equipments shall carry out environmental assessments of their entire system before freezing their design or starting their operations or even during the manufacturing stage to explore possibility of waste minimization and resource conservation.
- The concept of 4 R (reduce, reuse, recover and recycle) shall be popularized amongst manufacturers and consumers.
- Eco labeling of electronic components/items shall be introduced. Fiscal benefits can be given to those complying or penalty can be levied to those not complying.
- Buy back for old electronic equipments shall be made mandatory using market based instruments. Large companies should purchase the used equipments back from customers and ensure proper treatment and disposal of sludge by authorized reprocessor only. They should also give an account of the waste being generated by their 'Exchange Offers' to State Pollution Control Boards.
- Large companies, manufacturing final products such as PC, TV, refrigerators etc. are more into assembling various electronic components. They are not involved in manufacture of basic components (PCB, CRT, semiconductor etc.), which indeed is a potentially polluting process and is done by SMEs. These large industries should opt for green concepts in their supply chain and the life cycle concepts and should purchase the components from environmental friendly process/industry only.
- Environmental Tax can be levied on electronic equipments, which can be used for investing in technology up-gradation in electronic components manufacturing units (mostly SME) and developing common hazardous waste TSDF (treatment, storage and disposal facility) for them.
- Local police shall be made aware and trained on the gravity of unauthorized waste recycling.
- Importing white goods for charity or reuse in India shall be prohibited
- The expanse of pollution control technologies permitted for depreciation (for income tax purpose) shall be expanded so as to encourage industries investing more on pollution control.

7.0 How Cholamandalam MS Risk can help?

Cholamandalam MS Risk Services can partner with corporates/ E waste producers and users in identifying, inventorising and auditing the waste and suggesting suitable measures to manage/treat them in order to oblige national and international norms and also meet good governance goals. We can also assist proponents in developing an overall environmental management system (EMS) which will closely monitor the environmental performance in terms of hazardous material use, resource consumption patterns and waste handing and disposal practices.

For more information, please contact:
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