INVENTORY OF PCBs IN OLD TRANSFORMER OILS, A CASE STUDY IN VIETNAM

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Introduction

Polychlorinated biphenyls (PCBs) were widely used as coolants, insulating materials and lubricants in electrical equipment such as transformers and capacitors, and to a lesser extent in applications such as hydraulic fluids, plasticizers and surface coating. The Stockholm Convention on Persistent Organic Pollutants (POPs) entered into force on 17 May 2004 and requires its parties to submit a National Implementation Plan (NIP) to the Conference of the Parties within two years after ratification of the Convention by the country. PCBs are one of the 22 classes of POPs, which, due to their potential for damage to human health and the environment, are targeted for elimination by the Stockholm Convention. Vietnam signed the Stockholm Convention on 23 May 2001, ratified it on 22 July 2002, and submitted its NIP to the Stockholm Convention in September 2007 (MONRE, 2006). Fifteen areas of action were identified as a priority for Vietnam in meeting its obligations. PCB management was listed in Priorities No. 5 (remediation of PCB-contaminated sites) and No. 6 (elimination of PCBs in industrial uses, in particular in electrical equipment). This NIP requires eliminating the use of PCB-containing equipment by 2020 and their safe disposal by 2028.

Vietnam has never produced PCBs but imported about 27,000 to 30,000 metric tons of PCB-containing oils from late 1940s to 1985 from the former USSR, China, Rumania, and Australia (Sinh et al. 1999; MONRE, 2006). Significant amounts of PCBs still exist in Vietnam, primarily in oils used in electrical transformers and capacitors, and are still observed at relatively high concentrations in various sediment and soil samples taken around Hanoi (Toan et al., 2007; Hoai et al., 2010).

Several preliminary PCB inventories were made in Vietnam between 2003 and 2009. Since 2010, a complete PCB inventory procedure has been developed and a national PCB inventory has commenced under the GEF funded Vietnam PCB Management Project. This report summarizes the results from the preliminary PCB inventories in Vietnam in the years 2003 to 2009, and the national PCB inventory procedure presently being conducted in Vietnam.

Methodology

This report summarizes the recent PCB investigations conducted under various projects related to the PCB inventory in Vietnam:

The first inventory was conducted with the support of UNEP and the Swiss Development Cooperation Agency (SDC) from 2002 to 2004. PCB screening tests were performed with a Dexsil L2000DX PCB/Chloride Analyzer in 2005 to examine PCBs concentration in oil contained in retired equipment.

VEA supported by the SDC implemented "Environmentally sound Management and Disposal of PCB in Electrical Systems a pilot project for PCB - Elimination in Vietnam" during 2007-2008. About 2,000 transformers in four EVN subsidiaries in the south were screened under the Project. The samples were tested by a Dexsil L2000DX Analyzer for total chlorine concentration, if the potential concentration of chlorine was over 50 ppm; the sample was hereafter analyzed using GC-MS.

In addition, screening for PCBs was conducted under the project preparation that was supported by a Canadian Trust Fund and the project preparation grant. Here, a Dexsil L2000DX Analyzer was used in 2007 and 2008 to analyze a total of 289 oil samples from transformers, oil storage tanks and oil filtering machines in 42 Electricity

of Vietnam (EVN) and 43 non-EVN sites in ten demonstration provinces (Hanoi, Hai Phong, Hai Duong, Nam Dinh, Ho Chi Minh city, Dong Nai, Ba Ria – Vung Tau, Can Tho and Lam Dong).

Results and discussion

Preliminary investigations of PCB contaminated oils and equipment

Two preliminary surveys of electrical equipment, based on available records, were carried out by Vietnam Environment Protection Agency (the former name of VEA) in 2003 and 2005 and they found an estimated 9,600 metric tons of PCB-containing oils in Vietnam, primarily in about 9,000 transformers and 1,800 capacitors. These preliminary surveys were not based on actual laboratory analyses but relied solely on owners' manifests and equipment nameplates, where such information was available. In order to obtain and maintain an accurate and complete PCB inventory, it is necessary to use laboratory analysis to confirm the PCB contamination in transformers and electrical oils.

Between 2007 and 2008, the Vietnam Environment Administration (VEA) in cooperation with Electricity of Vietnam (EVN) under the Swiss Agency for Development Cooperation (SDC) fund and the Canadian Trust Fund conducted a more comprehensive PCB investigation in ten demonstration areas, comprising the provinces of Ha Noi, Hai Phong, Hai Duong, Quang Ninh, Nam Dinh, Ho Chi Minh City, Dong Nai, Ba Ria – Vung Tau, Can Tho, Lam Dong. The investigation in those demonstration provinces were mainly in charge of transformer/capacitor/cutter. The investigative results from 2003 and 2005 were used together with new information obtained in second campaign to give a clearer picture of the quantity of PCB contaminated oils and equipment. Oils and equipment were divided into three main groups (PCB containing, PCB suspect and non-PCB) for investigation.

- The total number of transformers investigated in the 10 selected demonstration provinces of the EVN and non-EVN sites was 79,221 units. Of these, 49 units contained PCBs, 63,356 units were PCB suspect and 15,816 units did not contain PCBs (see Figure 1). The total volume of the transformer oils were estimated about 41,034 tons, of which 19 tons contained PCBs, 30,800 tons were PCBs suspect and 10,215 tons did not contain PCBs;

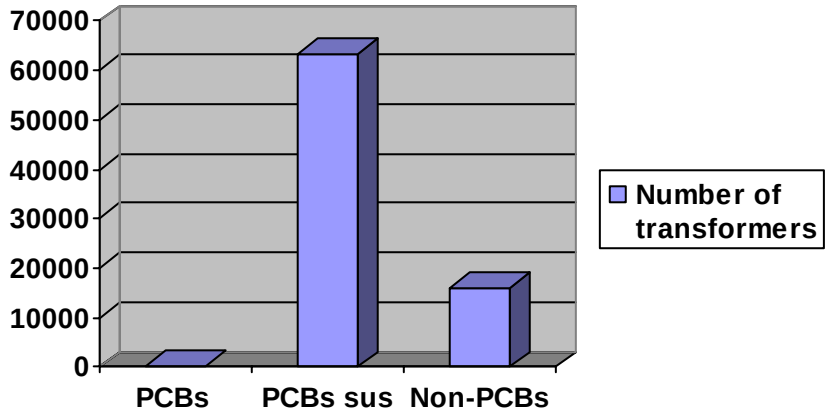

Figure 1. Number of PCB contaminated transformers

- The investigation for capacitors was conducted on more than 10,800 units; of which 9,000 units were PCB suspect capacitors and the remainder did not contain PCBs;
- The investigation of 1,600 other equipment including cutters estimated 1,300 units were PCB suspect and the remainder did not contain PCBs.

The chemical analysis was limited to 2,829 samples of transformer/capacitor oils collected at five screened sites by quick test methods (Chloride test, Dexsil L2000DX) and then verified by gas chromatography for those

samples if the total chloride concentration was over 50 ppm. The chloride test results identified 147 PCB suspect oil samples. Gas chromatograph analysis of these PCB suspect oils recognized 11 samples with PCB concentrations higher than 50 ppm, where the highest PCB concentration was 1,475 ppm (0.15% PCBs). Results from this investigation also showed that there were no significant difference in PCB quantities between the North and the South of Vietnam. Concentrated transformer oils were identified that could have caused potential PCB cross-contamination of oils during regular retrofilling or oil changes. In order to obtain and maintain an accurate and complete PCB inventory, it is necessary to use laboratory analysis to confirm the PCB contamination of transformers and electrical oils because site investigations carried out during project preparation confirmed that current servicing practices of oil-containing electrical equipment have led to cross contamination of oils.

National PCB inventory methodology

Under the methodologies applied for abovementioned investigations before 2010, there was no check for cross-contamination with PCBs, as many results were based on nameplates and records. Cross-contamination is a typical characteristic for equipment used in Vietnam; therefore, an overall national inventory of PCBs using quick test and laboratory analysis of PCBs is needed so that cross-contaminated equipment is also inventoried. Since 2010, a complete PCB inventory procedure (Figure 2) has been developed and a national PCB inventory is under implementation under the GEF funded Vietnam PCB Management Project.

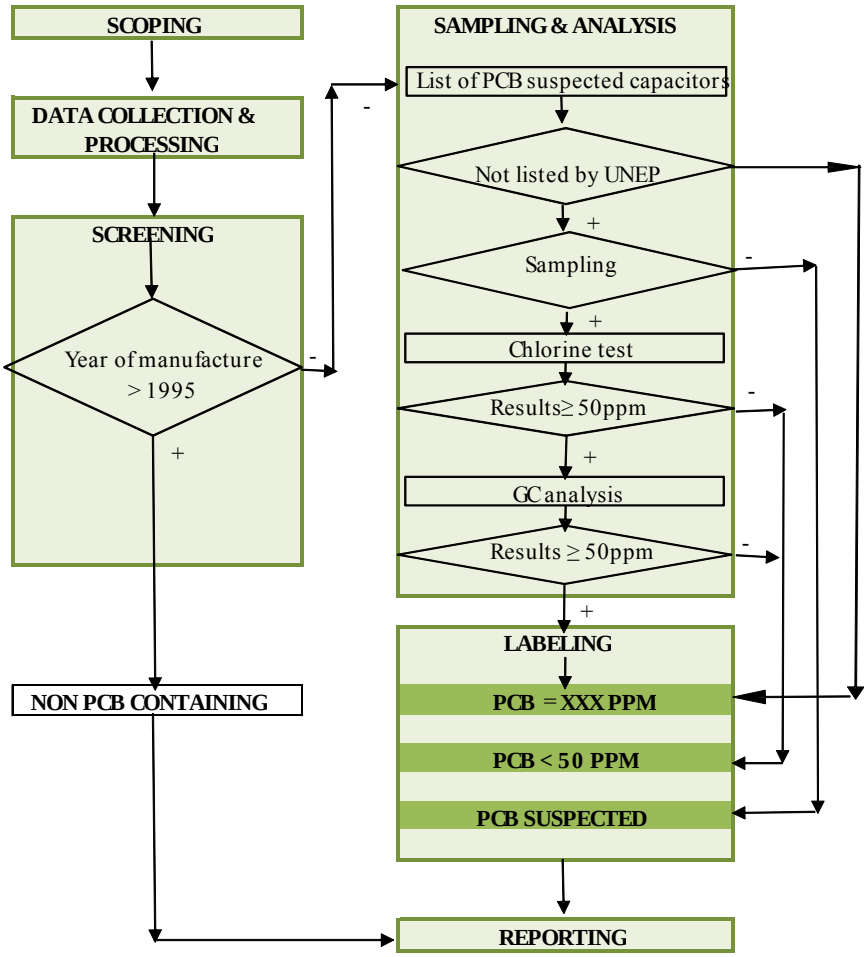

Figure 2. PCB inventory procedure for transformers and capacitors

The national PCB inventory will be conducted in 63 provinces in Vietnam on the target groups of (1) Electrical equipment that is in services; for back-up; stand-by and stored for disposal; and (2) On-site waste oils from electrical equipment under both the management of EVN and others. The chloride test of estimated 60,000 oil samples using Dexsil L2000DX Analyzers and laboratory analysis for PCBs using GC-MS will be applied. In this procedure, the preliminary scoping has given results on inventory targets, the estimated number of quick test required and number of samples that will undergo laboratory analysis. The "Data Collection" will result in an inventory that lists the owners and their IDs, covering (1) lists, records and inventory IDs of electrical equipment that is in operation, used as back-up, stand-by and stored, (2) lists, records and inventory IDs of on-site reused/recycled oil, waste oil from electrical equipment. The "Screening" will provide information on PCB suspect equipment that requires chemical analysis for PCB, including (1) list of PCB suspect electrical equipment that is under operation, used as back-up, stand-by and stored and their inventory IDs, (2) list of PCB suspect on-site reused/recycled oil, waste oil from electrical equipment and their inventory IDs. The "Sampling and Analysis" will give results on (1) list of analyzed chlorine concentrations and the associated inventory IDs (2) list of analyzed PCB concentrations and its associated inventory IDs.

It is assumed that in Vietnam a significant part of the PCBs inventory has yet to be identified. In general, the investigations of equipment's data and records are insufficient and an analysis for PCBs is required to determine that actual content of PCBs. As mentioned above, cross contamination of PCBs may have occurred and therefore available data from the previous investigations do not completely reflect the number of PCB-containing equipment and oils. The Vietnam PCB Management Project is establishing a PCB inventory that will cover all of Vietnam's provinces and that is expected to provide a complete overview of PCBs in Vietnam.

The national inventory results and associated database will be used for PCB management and disposal. To ensure that the data is current, the inventory will involve equipment owners and be integrated with the activities of the project management units, specifically:

- Development of a policy framework, penalty and reward mechanisms that govern regulations on reporting, transporting and disposing equipment and oils under inventory
- Updating the database continuously
- Sharing the database and broadly communicating about PCB-suspect equipment and oil.

Stockholm Convention requires that the threshold level of PCB in oils is 50 ppm, meanwhile the PCB limit of Vietnam's National Technical Regulation on Hazardous Waste Thresholds No. 7: 2009/BTNMH defines that anything containing 5 ppm of PCB must be considered a hazardous waste. Within this project, only inventory above the threshold of 50 ppm PCB is defined as requiring elimination under the Stockholm Convention.

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