A. Project Objective

1. This project will identify and demonstrate environmentally-sound and cost-effective policies, procedures and techniques for safely management and disposal of China’s temporarily-stored polychlorinated biphenyls (PCBs), PCB-contaminated wastes and remaining in-use PCBs equipment. The project will also serve as a demonstration of how this objective can be achieved most cost-effectively throughout China and in other countries that face the same challenge.

B. Project Description

2. The project has six components: (1) institutional strengthening; (2) development of a policy framework for PCB management and disposal; (3) PCB management and disposal in Zhejiang Province; (4) disposal in Liaoning Province of highly-contaminated PCB wastes; (5) project monitoring and evaluation; and (6) design of a national replication program. In particular, this project will sample, test and clean up about 56 PCB temporary storage sites in Zhejiang. PCB contaminated soil and other PCB wastes with a PCB concentration between cleanup action levels to 500ppm will be decontaminated with a thermal desorption facility in Zhejiang. Highly contaminated PCB wastes (with a PCB concentration higher than 500ppm) will be stored temporarily in Zhejiang and then transported to Shenyang for final disposal in a high-temperature rotary kiln incinerator. See the attached map (Map No. IBRD 33583) for the locations of identified PCB storage sites in Zhejiang and the Shenyang incinerator.

C. Environmental Assessment

3. Environmental impacts of the project are assessed in two full environmental assessment (EA) reports – an environmental impact assessment report (EIA) for PCB management activities in Zhejiang (the Zhejiang EIA) and an EIA for PCB disposal in Shenyang (the Shenyang EIA). Mitigation measures to these potential environmental impacts are outlined in Environmental Management Plans of these two EA reports. The following two sections summarize the key findings of the Zhejiang and Shenyang EIAs.

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1 In China, the national level for site cleanup is 50 ppm. In this project, cleanup action levels for each site will be defined based on future land use and reference to the standards of other countries.
4. Three additional EAs will be prepared during project implementation - EA for the PCB storage facility to be constructed in Zhejiang; EA for the PCB storage facility to be constructed in Shenyang; and EA for the thermal desorption facility to be used for soil decontamination in Zhejiang. A feasibility study will be conducted to determine whether a mobile or fixed thermal desorption facility will be used in this demonstration project.

D. Summary of Zhejiang EIA

5. There are a total of estimated 61 PCB storage sites in Zhejiang, of which five (5) had been cleaned up by Zhejiang prior to 2003. The remaining fifty-six (56) sites are to be cleaned up in this project. Of the 61 sites, locations of 43 PCB storage sites have already been identified and the remaining sites are expected to be identified before the end of the first-year of the implementation of this demonstration project. All 56 storage sites will be cleaned up in a sequence based on their potential environmental and health threats. PCB contaminated soil and other PCB wastes with a PCB concentration between cleanup action levels to 500ppm will be decontaminated with a thermal desorption facility. Highly contaminated PCB wastes (with a PCB concentration higher than 500ppm) will be stored temporarily in Zhejiang and then transported to Shenyang for final disposal in a high-temperature rotary kiln incinerator.

Description of Actions

6. Priority Ranking. The PCB storages sites are ranked in terms of their potential environmental and health threats to assign priorities for site cleanup. A ranking system has been developed by weighing the following parameters: storage status, distance from residential areas; distance from surface water; possibility for groundwater pollution; PCB concentration level; land use history and plan. According to the characteristics of the PCBs locations in Zhejiang and the pollutants situation, the cleanup for the PCBs locations will be split into three phases: Phase 1 (2006.7-2006.12) -- clean up 14 locations; Phase 2 (2007.1-2007.10) -- clean up 30 locations; Phase 3 (2007.11-2008.4) -- clean up 12 locations.

7. Site Sampling. Some sampling methods or procedures can be adopted based on different types of PCBs storage and media. For sites where PCB concentrations have been found to be lower than the cleanup action levels and with deep ground water table, most of samples will be taken from the soil; for sites where PCB concentrations have been found to be higher than the cleanup action levels or with relatively shallow groundwater table, then “Grid Sampling Method” will be used for both soil and underground water. However, if leakage is found, the “grid sampling method” will also be considered. In addition, for the concrete slab, sampling will be conducted based on some common principles on concrete or solid mass; for industrial residue containing PCBs, then “taper sampling method” or “grid sampling method” could be adopted. Also

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2 An ongoing Sino-Italian PCB project (Development of PCB Inventory Methodology and Draft PCB Disposal Strategy) is working on identifying the remaining 18 sites. See the attached map (Map No. IBRD 33583) for the locations of the identified 43 PCB storage sites in Zhejiang.
depending on the type of the site, the level of contamination and the experience gained from practice in other sites in Zhejiang, a range of 66 to 160 samples for each site may be taken for characterization.

8. **Decontamination of PCB Contaminated Sites.** Exact locations of where the PCBs are stored in the temporary storage sites will have to be identified, sampled and tested, after which the sites will be cleaned up. Concentrated PCB wastes with PCB content of over 500ppm will be temporarily stored in Chongxian until they are transported to Shenyang for final destruction. Contaminated soil and other PCB wastes at concentrations from cleanup action levels up to 500ppm will be treated by a thermal desorption facility site by site. The highly concentrated PCB wastes generated by thermal desorption will also be sent to Shenyang for final disposal. The cleaned PCB sites will be further monitored and effectively managed until the remediation of those contaminated sites (with PCB content below cleanup action level) are within the standard set by the Chinese Government.

9. **Storage Facility for PCB Wastes.** The temporary storage facility which is proposed in Chongxian in Yuhang District of Hangzhou will store the highly contaminated PCB wastes (>500 ppm) until they are transported to Shenyang for final disposal, and some low contaminated PCB wastes (between cleanup action level and 500 ppm) to be cleaned up with the thermal desorption facility. This storage facility will be designed and operated according to the Standard for Pollution Control on Hazardous Waste Storage (GB18597-2001).

10. **Transport.** For short/provincial transportation of contaminated soil and other PCB wastes at concentrations from cleanup action level up to 500ppm from PCB sites to the thermal desorption facility, a transportation team will be established consisting of 8-10 trucks with the container of a capacity of 20 tons (180 tons capacity in total one time, about two times for each site), 1 special commanding vehicle and 1 emergency vehicle. The team will be comprised of 1 project manager, 12 drivers (including 2-4 in standby), 2 safeguard staff, and 3 staff for emergency actions. Normally in Zhejiang, the truck goes 600 km per day so the team can start in the early morning and reach Chongxian in the afternoon of the same day.

11. For long distance transportation between Chongxian of Hangzhou and Shenyang for three batches respectively from 2006 to 2008, a transportation team will be established, consisting of 5 trucks each with a 20-ton container capacity (100 tons in total each time, about 5 times for the first batch of 2006 and third batch of 2008 in about 2 month, and 10 times for the second batch of 2007 in about 3 months), 1 special commanding vehicle and 1 emergency vehicle. The team will be comprised of 1 project manager, 10 drivers (including 3 in standby), 2 safeguard staff and 3 staff for emergency actions. Drivers will attend a special training course on safe driving and transport of hazardous wastes.

12. **Thermal Desorption Facility.** Thermal desorption has been selected as the technology for decontamination of low PCBs contaminated soil (<500 ppm) after the comparative examination of other technologies like incineration, plasma, solvent extraction, base catalysed dechlorination, in situ vitrification, solvated electron. Thermal desorption is based on the principle of heating up polluted soil in a rotary kiln to desorb
PCBs and other organic pollutants from the soil. As the process is not a combustion one, but only a phase transfer enhanced by thermal energy, dioxin formation is not expected.

13. The desorption facility is the main component of the process. Waste is partially vaporised in a reductive environment under low vacuum conditions (0 to 50 Pa). The rotary reactor operates on a continuous basis. The reactor is cylindrical in shape, arranged horizontally and rotates around its axis. The operating temperature in the reactor ranges from 500 to 600 °C. The waste may be introduced directly. PCBs are vaporized and thus desorbed from the soil. And then N2 is applied to carry the desorbed PCBs to activated carbon for absorption. The gas stream is cleaned in a wet gas multi venturi scrubber prior to discharge. The scrubber process water should be treated with flocculation, precipitation and activated carbon filtration before discharged into the environment. The solid phase is cooled indirectly and is discharged for later use. All the activated carbon used for desorption and filtration should be disposed of by incineration in Shenyang.

14. **Online Decontamination for Transformers.** At the present stage, no data for PCB contaminated transformers have been found yet. Thus the online decontamination technology for PCB containing transformer will be selected after enough data on the size, location, topography, and contamination level of the transformer become available. The selection will be made between two available technologies: sodium based dehalogenation, and continuous dehalogenation process “CDP®”.

15. The equipment of the selected technology will be shipped from abroad to China; after arrival of the equipment, all the necessary permits procedures for operation will be completed. The equipment will be installed at the sites (industry, power plant sites, transformer substation sites) where the transformer(s) to be treated are located. The personnel present at the sites will be trained by the provider of the technology on the use of the equipment, in order to guarantee the safety of the decontamination procedure; moreover, the provider team responsible for the operation of the dehalogenation equipment will be trained by local experts on specific requirements for working at the site.

16. Equipment to be rented must be commercial equipment normally used in western countries (not pilot or experimental equipment). Transformers will be decontaminated following the BAT outlined in IEC regulation IEC 60422 ed. 2004 12.3.3. (Supervision and maintenance guide for insulating mineral oils in electrical equipment). The target level will be to obtain a final decontamination level between 2 and 25 ppm, determined on the basis of the IEC regulation 61619 (Insulating liquids - Contamination by polychlorinated biphenyls “PCBs” - Method of determination by capillary column gas chromatography) or equivalent methodologies.

**Impacts Assessment and Mitigation**

17. **Decontamination of PCB Contaminated Sites.** The most sensitive task to be performed at the decontamination of PCB contaminated sites is to excavate and remove contaminated soil without creating further exposure of the surrounding environment, people or workers to the PCB contaminated soil. The main risks associated with the cleaning of the site are due to: PCB oil leaking into the environment or spilling onto the
cleanup workers due to inappropriate operation; migration of the contaminant after excavation due to the heavy rain typical of the area; safeguard measures not executed completely; emergency actions not timely and completely carried out. For this purpose, a detailed procedure for operation at each contaminated sites has been developed. The procedure starts from collecting data for each site, environmental characterization, exact location of PCB wastes and sampling and analysis of contaminated media following methodologies recognized at international level; after that, a site cleanup design will be developed for each site. Specific procedure for each site and training to the operators will be provided. The procedure will cover all the aspects of site characterisation, design criteria, cleaning actions, closure actions, filing and archiving, and are grouped in five categories:

- Procedures for site preparation, covering the needs and technical specification for Infrastructure, Equipment, Leakage countermeasures, Site security, Prevention of soil collapse.
- Procedures for contaminated waste and soil removal, covering the needs and technical specification for Excavation, Packaging of PCB-contaminated soil, Removal and packaging of PCB wastes, Removal and containing of liquid PCBs, disposal of small tools and personal protective equipment.
- Environmental mitigation measures: training, review and approval of cleanup plan, establishment of guidelines;
- Evaluation and restoration of the cleaned site;
- Site documentation and filing.

18. **Storage Facility for PCB Waste.** As the storage facility is one of the facilities which if not properly designed and operated may present big risk for the environment, an environmental impact assessment has been carried out specifically for this facility. The two primary candidate site of Qiaosi and Chongxian have been compared considering an extensive set of technical, environmental and social parameters: distance from the water bodies, soil permeability, groundwater depth, position with reference of main wind direction and urbanized areas, distance from urbanized areas, distance from storage of dangerous wastes, landscape or presence of sensitive scenic spots, flora, fauna, existence of areas reserved for the protection of flora and fauna, presence of economic activities, etc. After this comparison the Chongxian site appeared to be the suitable candidate site, mainly due to the depth of the groundwater, the presence of a thick layer of low permeability clay soil, the distance from the residential area.

19. The following technical design requirements for the storage facility building must be fulfilled: it is to be designed in the light of the relevant criteria for hazard waste storage; the base of storage facility is to be impermeable; the impermeable layer that is made of clay is to be thicker than one meter (coefficient of hydraulic conductivity is less than $10^{-7}$ cm/s) or made of HDPE of 2mm thick with hydraulic conductivity less than $10^{-10}$ cm/s.; the allowable height of stack is designed according to the strength of the floor.; the impermeable layer should be laid on a base or a pedestal.; the impermeable layer should cover the entire area that can be reached by PCBs and its leachate; a leachate collection system will be built on the impermeable layer; a surface water drainage system should be built at the outskirt of the storage facility in order to prevent flow runoff into the storage facility and it is to be designed in compliance with floods with a return period.
20. The storage facility should comply with the following features: a 15-cm high continuous curb should be constructed around the floor; there should be no floor drains, drain valves expansion joints, sewer lines, or other opening that would permit liquids to flow from the curbed area; the floor and curbs are to be made of solid and leakage-proof materials. All construction materials will be compatible with PCBs and other hazardous materials stored at this facility; must be equipped with leakage collecting, gas vent and gas treatment (cleaning) devices; it must be equipped with safe lighting system and viewing window; the floor where the liquid and solid PCBs vessels are deposited should be hard, resistant to erosion, reinforced in order to avoid cracking of the surface; curbs are to be designed to prevent the spills from running out, the volume enclosed by the ground and curb should be not less than the maximum storage of maximum vessels or 1/5 of total storage.

21. Main features of the storage facility to be built will be as following: two floors building with a total area of 4464 m². The girder of the facility is 10m above the floor. The whole building is a heavy steel-structured factory house. Its roofing is of light steel and all materials used are well corrosion-proof. Its ground is watertight and involves drainage system. It is of semi-sealed structure. Each of upper and lower floor is equipped with a mobile crane. Tool rooms and watching room are designed at one side of storage facility, and lifting-hook and handling space are designed at the extended end. Moreover, the storage facility is well equipped with fire-fighting facilities. PCBs are sealed in the airtight drums and deposited in different areas depending on its contents.

22. As ref Article 8.2 of GB 18597-2001, the hazardous waste facility that will receive PCB wastes for storage will be monitored for environmental discharge in accordance with national requirements on pollution sources. A preliminary emergency plan has been presented in the EIA, outlying the most urgent tasks and safety measures to be undertaken in case of accidental release of PCBs, or in case of accident or injuries occurred to personnel or population. A preliminary closure plan with two alternatives (disassembling or reuse for other hazardous wastes) has been also included in the EIA.

23. Transportation of PCB wastes. The workers and staff involved in transportation will receive special training on (1) the physical and chemical properties of PCBs and its impact on the environmental and human health; (2) personal protection and emergency measures for PCBs; (3) character and types of PCBs wastes to be transported; (4) emergency plan for controlling the possible proliferation of PCBs contaminants during transportation; (5) the overall plan and special requirements; (6) communication equipment and its operation; and (7) training for the drivers of these trucks should cover safe driving practices, and proper completion of the hazardous waste transportation manifests.
24. The transportation route will select highways and high quality roads. The following risks control and emergency measures will be adopted to ensure the safe transportation of PCB wastes: (1) avoid transportation in night or bad weather conditions; (2) the transportation team will be well organized, and each vehicle will be equipped with communication equipment; (3) the transportation plan will identify accommodation stops at the service stations along the highway; and (4) the team will be equipped with GPS equipment to locate the exact position of the team at any time.

25. Periodical sampling and analysis on the transported vehicle will be conducted. In addition, monitoring at some sensitive sites, including sampling on soil and sediment along the transportation route, will be conducted if necessary.

26. **Thermal Desorption Facility.** The facility is operated under a reduced pressure and does not use large amounts of excess air or water during treatment. Also, the post treatment of the gas and solid phases are separate from the main process treatment. However, treatment of off-gases requires careful control and emissions treatment to minimize dioxin formation. As a conclusion, there’s little environmental impact if the off-gases from the disposal facility are properly treated. Since there was no soil or other PCB contaminated material in the facility after one site was treated, there will be little environmental risk during the transportation process between two sets of treatment.

27. **Online Decontamination for Transformers.** The main issue concerning the environmental impact assessment of the on-line dehalogenation technologies, like the CDP process or the metallic sodium processes, is that these processes are non combustion ones operating at low temperature (less than 200°C). This will prevent the formation of dioxin and other toxic compounds. Generally the online dehalogenation processes may be operated by means of transportable equipment which can be easily and quickly transported near to the transformers to be decontaminated. Thus, storage, site preparation, construction or dismantling phase is not required. All the equipment normally fit into a single truck and may be easily mobilized by forklift.

28. The chemical dehalogenation technologies do not generate emissions into the atmosphere, except for the oil degassing unit. The gasses emitted from the degassing unit are filtered on activated carbon prior to the inlet into the atmosphere. Residuals for the CDP process are potassium, calcium and magnesium salts. As far as the sodium process is considered, for each 100 kg of oil to be treated, the process requires 5 kg of clay, 20 lt/min of nitrogen (which are completely recycled), an amount of the Na emulsion which depends on the PCBs concentration of the oil; the process return 95 kg of decontaminated oil, 10 kg of a clay/oil mud containing a variable amount of NaCl, and a variable amount of light hydrocarbons and low volatile compounds. Residual from the metallic sodium process are generally sodium chloride. The noise generation of the dehalogenation unit is very limited, and generally within 80 dBA at one-meter distance away from the unit. In addition, the dehaloogenation unit do not consume water, nor generate wastewater.

**Public Consultation and Disclosure**

29. In February 2005, Zhejiang Daily, a major provincial newspaper in Zhejinag, published this project’s information, including that the Zhejiang EIA Report could be
accessed at the website of the Zhejiang Environmental Protection Bureau (EPB), at the Zhejiang Solid Waste Management Center of Zhejiang EPB, and at the Zhejiang Provincial Academy of Environmental. In addition, the Zhejiang EPB organized a public survey and found that more than half of the people investigated know something about the project and expressed their close attention to the implementation of the project. Public comments and suggestions are collected.

30. The implementation of the project will be publicized on Zhejiang Daily. The Zhejiang Solid Waste Management Center, the Zhejiang Provincial Academy of Environmental Science and the Country Implementation Office of State Administration of Environmental Protection will be available for public consultation. Specifically, three public consultation symposiums will be conducted half a year earlier before the site list for cleanup is determined. These public consultation symposiums will invite representatives from affected villages, communities and enterprises, leaders of the affected villages and neighborhood committees, representatives from the provincial electric power company and local electric power companies, representatives from the organizations in charge of project implementation and EIA of this project, and officials from the provincial EPB and local EPBs. These symposiums will introduce project implementation plans and detailed project activities to the participants with an emphasis on resettlement compensation and safety issues. Public comments and suggestions will be solicited. After a symposium, cleanup plans and compensation programs will be modified to reflect public concerns.

Conclusions

31. The PCB situation in China is somewhat different from several other countries due to the presence of a large number of storage sites where PCBs wastes have been stored for long time without proper measures for preventing the contamination of the environment. Moreover, the awareness of the problem of PCB contamination of in use equipment is still scarce. The action, development of equipment, and institutional strengthening foreseen under the “PCB management and disposal demonstration project” under which Zhejiang is the selected “demonstration province” are addressed toward the elimination of PCBs wastes in storage sites, toward the demonstration of technologies for non destructive, non combustion decontamination of electrical equipment, and toward the increase of awareness and institutional strength in PCB management. Due to the complexity and to the dangerous properties of PCB, each action (not only the technical ones, but also the institutional and managerial ones) need to be carefully designed, evaluated and supervised, in order to avoid the environmental risk associated with the highly dangerous properties of PCB.

32. The correct implementation of the project will then result in a significant improvement of the environmental quality, in a significant reduction of the risk for the health of the population, in the destruction or removal of a large amount of PCB, in the increase of the awareness of the PCB problem for “in-use” equipment, and in the transfer of know-how concerning the most effective technologies for monitoring, managing, disposal and decontamination of PCB.
E. Summary of Shenyang EIA

33. Highly contaminated PCB wastes (with PCB concentration greater than 500 ppm) collected from the storage sites in the Zhejiang Province will be transported to the Shenyang Hazardous Waste Disposal Technical Center (the Shenyang Center) and disposed of by incineration.

Background Environmental Information

34. The incineration facility of the Shenyang Center is located at the center towards north – the Gujia Forestry Section – of a government-owned forestry farm in Xinmin City, which is used to grow economic forests. The total area of the farm is 1,339 hectares, and the project occupies 10.2 hectares (about 0.8% of the total area) of the farm. There are no residents within 2 km radius of the plant, but there are farmlands next to the plant.

35. Xinmin, the location of the incineration facility of the Shenyang Center, is characterized with a flat terrain. Located in the semi-humid North Temperate Zone, it is subject to the monsoon with a continental climate. The geologic, hydrological, social and economic conditions, as well as transportation, power supply, water supply and discharging systems of Xinmin meet the construction requirements of this demonstration project. The ambient air quality, groundwater quality, surface water quality, soil quality and the noise level of the project site were monitored from April 2002 to October 2003. Detailed baseline information of the environmental quality of the project site is acquired.

36. Air quality. The dominating wind direction at the Shenyang incineration facility is near north in winter and near south in the other seasons. Except PM$_{10}$, no other parameters exceeded the standards. The location is experiencing severe PM$_{10}$ pollution because of continuous dust-raising events, as impacted by weather conditions. The daily average PM$_{10}$ of three monitoring points exceeds the Grade II Limit of the Ambient Air Quality Standard by 32%, 75% and 40%, respectively.

37. Groundwater quality. The groundwater level at the Shenyang incineration facility is at the depth of 4-5 m, and the thickness of the water layer is 10-45m. Ammonia-nitrogen in the ground water exceeds the standards by 95-225%, iron by 330-390%, and manganese by 400-1,360%. All other parameters comply with relevant standards. Analysis proves the above indexes exceed the standard primarily because of the local geological condition.

38. Surface water quality (Raoyang River). The annually average COD$_{Cr}$ of a river – Raoyang – close to the Shenyang incineration facility exceeds the standard by 150%, and petroleum exceeds by 60%. During the rainy season, BOD$_5$ exceeds the standards by 25%, and the ammonia nitrogen in low water period exceeds by 20%. The other parameters comply with the standards. The pollution in the Raoyang River is mainly caused by organic contaminants from industrial and domestic wastewaters from the upper reaches of the River.
39. **Soil quality.** The soil at the site of the incineration facility consists of multiple layers of powder clay, sands and gravels. The soil at the project site has a low concentration of heavy metals.

40. **Noise quality.** The average equivalent noise value at the project site is 37 dB (A). Noises are mainly from tractors and automobiles on a nearby road.

**Description of the Shenyang Center**

41. This project concerns a PCBs incineration line with a capacity of 15 tons/day in a hazardous waste disposal center at the Jixie Forestry Center at Gujiagong District of Xinmin, Shenyang of Liaoning province. The EIA covers all operations within the facility, including a medical waste incineration line with a capacity of 15 tons/day. The medical and PCB incineration lines are located in the same facility and share a common stack.

42. **The PCB Incineration Line.** The PCB incineration line consists of a feed system, a first stage rotary kiln, an afterburner, a flue gas quencher, a NaOH absorption column, an active carbon absorption tower, a wastewater treatment unit, a baghouse filtration unit, and a stack. After capacitors are cut and separated, they are fed into the rotary kiln for incineration. The feeding system of the PCBs incineration line is fully covered. The first stage rotary kiln, with a length of 12,000mm and an outer diameter of 2,200 mm, has a capacity of about 625 kg/h. The rotate speed could be adjusted between 0.2 – 1.0 r/min. The incineration temperature ranges from 900 to 1000 °C. As the kiln rotating, the incineration residues are discharged at the bottom of the kiln.

43. The afterburner is a cylindrical container lined with fire-resistant materials and with a dimension of 4.5m² × 5m. The combustion-supporting system of the afterburner includes an upper burner and a lower burner, with a fuel supply of 100kg/h and 250kg/h respectively, making the temperature inside the kiln meet the designed value. To make a further incineration of the flue gas so as to make the burned gas meet the destruction rate (99.9999%), the outlet temperature of the afterburner will be higher than 1200 °C and the residence time of flue gas will be controlled equal to or greater than 2 seconds.

44. The flue gas quencher cools the flue gas to a temperature below 80 °C to avoid the reverse reaction of PCDD/PCDF to a maximum extent and to remove HCl and particles. In the NaOH absorption tower, NaOH solution is spouted to contact with flue gas. The chloride ion is fully neutralized and the gas is deacidificated. After quenching and deacidification, the flue gas is heated again and enters whirlpool plate tower filled with active carbon. The mixture of carbon and lime powder will fully contact with the flue gas to remove pollutants (including DCLs) from the gas. As a result, the DCLs concentration in the flue gas will be reduced to below 0.1TEQng/m³. Baghouse filtration removes PM, and the flue gas is then released through a stack of 40 meters high.

45. The discharged incineration residues will be packed by automatic packer and transported to Shenyang Industrial Hazardous Waste Landfill to be disposed as hazardous waste. The coarse particle active carbon collected at the bottom of the whirlpool plate tower, together with the particle matters (PM) accumulated by filters, will be fed into rotary incinerator for disposal.
46. Wastewater discharged by Venturi quenching and NaOH absorption tower after the absorption of acid is treated by the wastewater treatment system. After entering the regulating reservoir, the water is cooled by heat exchanger and cooling tower. Then it passes the electro dialysis system and reverse osmosis facility. The denser solution enters double effect evaporation system while the thinner is recycled. The solid salt flocculation sediments are fed into rotary kiln together with the substituted reverse osmosis membrane after they are dehydrated. The treatment process does not generate new wastewater.

47. The key parts of the incineration line are monitored by industrial television monitoring system all the time. The monitoring and control system is controlled by PLC, and temperature, pressure, flue gas and water flux are measured continuously.

48. The Medical Waste Incineration Line. The medical incineration line consists of a container cleaning unit, a treatment unit for wastewater generated from container cleaning process, a waste feed system, a rotary kiln, a vertical afterburner, a residual heat boiler, a mist sprayer quenching unit (i.e. a semi-wet scrubber), a lime power de-acidification unit, an active carbon adsorption unit, and a baghouse filtration unit. The feeding system of this line is operated in a closed room where a wind-ducting machine pumps the gas in the closed room to the kiln as a combustion-supporting gas. The semi-dry flue gas processing technology produces no industrial wastewater.

49. The wastes are fed from the closed slideway into the rotary incinerator, which has a treatment capacity of 15MT/d. The rotary kiln is designed to make all the combustibles thermally decomposed and oxidized. The length of the incinerator is 6.5 m, its outside diameter is 1.8m, and its wall is made of 14mm-thick steel plates. The rotary incinerator uses diesel as ancillary fuel. The combustion-supporting system of the rotary kiln incinerator is a kiln burner, with a fuel supply of 55kg/h. The retention time of medical wastes in the kiln is usually 20-30 ms. The rotating speed can be 0.2-1.0 revolutions/minute. The solid metal and glass wastes that are not combustible are removed at the tail of the rotating kiln.

50. The afterburner can make a further incineration of the flue gas arising from the wastes so as to make the burned gas meet the destruction rate (99.99%). In order to ensure that combustible gas and DCLs are completely burned in the afterburner, the outlet temperature of the afterburner will be maintained higher than 850 °C, and the retention time of flue gas will be maintained longer than 2 seconds. The afterburner is a cylindric container lined with fire-resistant materials, with a dimension of 4m²×5m. The combustion-supporting system of the afterburner includes an upper burner and a lower burner, with a fuel supply of 100kg/h and 120kg/h respectively, ensuring the temperature inside the kiln meets the designed value.

51. Residual heat boiler is used to cool the high-flue gas down to below 450 °C. At the flue gas outlets of the residual heat boiler there is a water sprayer to cool the flue gas to about 170 °C. The sprayed water amounts to 3-5 t/h and is completely vaporized. Cooled flue gas enters the active carbon absorption tower. Within the tower a mixture of active carbon and pulverized lime is exposed to the flue gas. Lime will de-acidify the flue gas and the active carbon can absorb the DLCs and other toxic pollutants in the flue gas. This is the key equipment to control the emission of tail gas, which can decrease the
DLCs content to below 0.5 TEQng/m³. It adopts the solid powder spraying device and the reaction device.

52. The Baghouse filtration removes the PM, tiny active carbon and lime powder from the flue gas, making the gas meet the flue gas emission standard. Before entering the baghouse filtration, the temperature of the flue gas must be raised above the dew point in case the power should condense upon the bag filter. Purified flue gas is blown by a blower into the 40-m-high stack with a top diameter of 1.2ms (shared with PCBs incineration line) and discharged.

53. The waste treatment system for the medical waste incineration line includes container cleaning pond, wastewater collection pond, chemical precipitation tank, SBR reactor, hypo-chloride generator, deflectoxidation, sludge thickener and bag press filtration, etc. In this process, chemical precipitation tank, SBR reactor and deflect oxidation are major parts to serve the effluent treatment and recycle purposes. Chemical precipitation tank is reactor tank where related physical and chemical reaction happened in it. A SBR Reactor is a biochemical reactor used to remove organic pollutants of medical wastewater. Deflect Oxidation pond is an oxygenated baffled tank letting medical wastewater added oxidant has plenty settlement reaction time.

54. **Infrastructure and Public Utilities.** This center has a total area of 30,016 m², and consists of a primary workshop, a secondary workshop, and a complex building of 1078m². This building has a first floor used for dinning hall, multifunctional hall, medical room and bathrooms. The eastern part of the second floor is used for offices, and the western part of the second floor as well as the third floor is used as the residential area. Three rooms of the building are dedicated to chemical analysis in the auxiliary room of the incineration facility. The facility has a 920m long asphalt road with a stone foundation. The road has an 8m wide pavement and a 10m wide foundation. In the disposal facility improvement plan, 400,000 RMB was invested for the entrance path in the pretreatment units to assure that the vehicles loaded with PCBs wastes from Zhejiang could come through.

55. Two DZL (W) 2-0.7-A? steam boilers (Q=2t/h, P=1.0 Mpa) are established in the boiler room of the facility (one is used and the other standby). The stack has a height of 35 m and an upper diameter of 0.6 m. The boilers are equipped with special dust removal facility to make sure that the flue gas could meet the standards. The boilers are powered by coal, which is transported to the coal storage site of the boiler room by vehicles. And the residues of the boilers will be taken as raw materials and transported to the Shenyang Color Ground Brickyard Plant.

56. Groundwater at the project site serves as the sufficient water resource for the production and domestic uses. The water required for the project will amount to 8347.6 m³/d, among which fresh water 248.6 m³/d and recycling water 8099.0m³/d. The application for the water right was submitted to local land and resources bureau and has been approved. There is no water user within 2 km radius of the project site. Thus the project will have little impact on local water uses. Two wells were drilled 300m away from the primary workshop (one for daily use and the other for backup). The effluent flux of each well can reach 1,500 m³/d. The water is pumped to water treatment room, removed of manganese and iron by manganese sand padding tank and disinfected by
dioxide chlorine. Then it enters the supplying reservoir in the facility for production and domestic uses.

57. The domestic wastewater is treated with an underground, integrated treatment system of a capacity of 76 m$^3$/d. The biochemical treatment technology A/O is employed. The drainage during accidents and initial stage rainwater are stored in the drain basin in the facility (V=1500 m$^3$) and then enter the treatment system for treatment and recycle. Rainwater and treated domestic wastewater are channeled to a rainwater collection pond.

58. Electricity is supplied by the transmission line from the power supply substation of Liangshan, Xinmin. A distribution substation is constructed in the facility with an S10-1250/10 10/0.4 oil-immersed transformer. A quick start diesel generating set of 300 kW 0.4kv is established as emergency power source. The diesel supply system includes 2 underground diesel tanks with a volume of 50 m$^3$ each, one top diesel tank of 4 m$^3$ in the workshop, diesel pumps, diesel pipeline and control system.

Impact Assessment

59. **Discharge Loads of Major Pollutants.** The Shenyang EIA analyzes sources of all the major pollutants and their discharge loads. The flue gas volume coming from the PCB incineration line is 13,333 Nm$^3$/h, with a PCBs concentration of 1.05 mg/m$^3$, a PM concentration of 6,000 mg/m$^3$ and an HCl concentration of 31.5 mg/m$^3$. The DCLs concentration is reduced to below 0.1TEQng/m$^3$ after cleanup, and the corresponding emission amounts to 1333.3 TEQng/h.

60. The flue gas mass flow rate from the medical incineration line is 13276Nm$^3$/h. with an SO$_2$ concentration of 245.9 mg/m$^3$ and an HCl concentration of 69.3 mg/m$^3$. The estimated emissions of these two pollutants are 3.27kg/h and 0.92kg/h, respectively. The flue gas volume coming from coal-powered boilers is 4,500 m$^3$/h, with a PM concentration of 853 mg/m$^3$ and SO$_2$ of 120 mg/m$^3$. The PM and SO$_2$ emission will be 3.84kg/h and 0.54kg/h, respectively.

61. The total sewage discharge amount from the facility is 121.60 m$^3$/d. The pollutant concentration of domestic sewage is estimated to be: COD$_{cr}$ = 40mg/l, BOD$_5$ = 15mg/L, and SS = 40mg/L. The COD$_{cr}$ released from the sewage amounts to 0.91t/a, SS amounts to 0.91t/a. Treated wastewater will be used for greening, or discharge to a local channel. The cooling water is 45.60 m$^3$/d and is clean and will be used for greening.

62. The incineration ashes generation rates are as follows: 900 t/a from the PCBs incineration line, 870t/a from the medical waste incineration line, and 120t/a from boilers in heating period.

63. **Pollution Predication.** A point source dispersion model with wind presence was adopted to predict ground level concentrations of four pollutants – PCBs, HCl, SO$_2$, NO$_2$ and PM. With analysis of the pollution climate, atmospheric environment impact is predicted based on the emission load of pollutants. PCBs and HCl are identified as major prediction parameters for this assessment according to project analysis and relevant standards. With a normal emission of PCBs under unfavorable weather condition, the maximum ground concentration under Level A Stability is merely 0.0066µ g/Nm$^3$, lower
than the standard limit. The maximum ground concentrations under other stability levels are much lower than the standard limit. When there is an accident, the maximum ground concentration under unfavorable condition under Level A Stability will reach 0.0305\(\mu\) g/Nm\(^3\). Although it is below the standard value of 0.5 \(\mu\) g/Nm\(^3\), it is 0.0239\(\mu\) g/Nm\(^3\) higher than the maximum normal ground concentration. With a normal emission of PCBs, the highest average concentration by hour at all concern points is 0.0020\(\mu\) g/Nm\(^3\), which is far below the standard value. In case of an accident, the highest average concentration by hour at all concern points will rise considerably to 0.0101\(\mu\) g/Nm\(^3\), which is still lower than the standard limit. With a normal emission of PCBs, the daily average is much lower than the standard limit of 0.15\(\mu\) g/Nm\(^3\), and the maximum ground concentration is only 0.334\(\times\)10\(^{-3}\)\(\mu\) g/Nm\(^3\). Therefore, the normal emission of PCBs has limited impact on the assessed residential areas. In case of an accident, the emergency pollution discharge will raise PCBs concentration considerably, although the concentration is still below the standard limit.

64. With a normal emission of HCl under unfavorable condition, the maximum ground concentration under Level A stability is merely 0.0175\(\mu\) g/Nm\(^3\), and that under other stability levels are much lower than standard limit. In case of an accident, the HCl emission from the medical waste disposal system will exceed the concentration standard by 7 to 24 times. With a normal emission of HCl, the average concentrations by hour at all concern points are far below the standard value under unfavorable climate condition. The concentrations of 4 concern points exceed the standards under B, C, D, E and F stability levels during an accident with PCBs or the HCl emission of the medical waste disposal system. But the SO\(_2\) emission of all concern points will not exceed the standard.

65. The maximum SO\(_2\) concentrations from boilers under all stability levels are below standard limits. In case of an accident, the maximum ground concentration under unfavorable condition reaches 1.51 mg/Nm\(^3\) under Level A stability and exceeds the standard by 22 times. The ground concentrations under other stability levels exceed the standard by 6 to 20 times.

66. With normal emission of HCl, SO\(_2\), NO\(_X\) and PCBs under the normal discharge are only 17.5\(\mu\) g/Nm\(^3\), 81.6\(\mu\) g/Nm\(^3\), 22.5\(\mu\) g/Nm\(^3\), 0.0305\(\mu\) g/Nm\(^3\) respectively. All these concentrations are much lower than standard values. To sum up, it can be concluded that there is no significant impact on residential areas under normal emission of PCBs, HCl, SO\(_2\) and PM. But emergency discharges will impact all concern points significantly. Therefore, it is vital to prevent any accident from happening, or if such a discharge occurs, immediate actions must be taken to minimize the possible damage.

67. The clean cooling water from the medical waste line is separate from sewage. Sewage will be treated to meet related discharge standards before being discharged into the local main drainage channel. During low water season, water from the project flows southwards, vaporized or leaked. During high water season, water discharged from the plant may reach the downstream Raoyang area with surface runoff and reach after flowing for 40 km. Ground of all structures in the plant is treated to prevent leakage and erosion. In summary, the plant will have little impact on ground water quality.
68. The incineration residues will be packed, stored and transported to Shenyang Hazardous Waste Landfill periodically for landfill. The flying ashes will be collected and incinerated.

69. Other major equipments in the plant include induced draft fan and diesel generators which are installed outside the primary workshop. Effective measures have been taken to assure that the noise intensity will be below 90 dB (A) during normal operation.

Analysis for Alternatives

70. The major factors that have been taken into account in selecting disposal technology include: PCBs pollution in China, the limitation for using non-incineration technology in China, investment scale, disposal costs, and financial conditions of PCBs disposal facilities in China, the time required to achieve disposal capability, etc. Principles used to select PCBs waste disposal technology in China are:

- Consistent with Stockholm Convention;
- Efficient, safe and reliable;
- No secondary pollution;
- Applicable to the diversity of PCBs contaminants in China;
- Economic and reasonable disposal cost;
- Mature and reliable technology;
- Compatible with China’s first phase work and disposal plan.

71. Four disposal technologies, including high temperature incineration, gas phase chemical reduction, BCD and plasma transfer, are considered for the demonstration PCBs disposal facility. In particular, plasma transfer technology is compared with high temperature incineration. Factors considered include location selection, technical process, wastewater and gas treatment and discharge, investment and disposal costs. Because plasma technology is still a relatively new disposal technology to be understood and adopted in China and China has pilot PCBs incineration facilities and related operational experience, high temperature incineration was selected as the technology used in this demonstration project for the disposal of PCBs wastes.

Environmental Management Plan

72. An environmental management plan has been developed to address the release of solid wastes, gas, wastewater and noise, and the transportation and storage of PCBs wastes. The pollution prevention measures and strategies are proposed for operational management, greening, ecological compensation, and noise control. A monitoring plan has detailed monitoring parameters, monitoring methods and monitoring points. An emergency response plan has developed to address flue gas leakage, wastewater leakage, fires, oil tank explosion, severe earthquakes and other emergent situations. The causes, types, possible damages and impacts on equipment, personnel and environment of the accident are analyzed. This plan includes emergency measures, requirements for the
preparation and training of personnel, and responsibilities and tasks of personnel in an emergency.

**Public Participation**

73. A special meeting at the forestry farm was conducted to inform employees of the farm about the project’s purposes, possible environmental impacts and pollution control measures. A public discussion was held between the management of the plant and representatives from the farm, neighboring villages, and local government, etc. The discussion focused on issues related the construction, possible environmental impacts, pollution control measures, and possible compensations. All participants reached an agreement in the special meeting and endorsed the construction of the project. Local governments at different levels approved the construction of this project four years ago. This GEF supported demonstration project will help the plant to minimize its environmental impact to comply with stricter environmental standards.

74. In addition to the special meeting, the EIA reports of this project have been sent to libraries in Xinmin city and villages for comments. Information about the EIA reports of this demonstration was also published on Shenyang Daily, a major local newspaper, in December 2004.

**Conclusions**

75. Based on above discussion, the Shenyang EIA concludes that the final plant site of this project meets the requirements of the PCB disposal technology and environmental standards. By comparison among various PCBs disposal techniques, this EIA confirms that high temperature incineration technology used in this project is safe and reliable, and it suites China’s current situation. This is a sound selection also because China has accumulated a lot of operation and management experience in this technology.

76. Based on the predicted pollutants discharges and environmental impacts, the Shanyang EIA predicts that the pollution treatment facilities included in this project are effective enough to control and reduce the discharges of pollutants to China’s environmental standard requirements.

77. The detailed emergency plan drafted in this EIA proposes that timely emergency remedy measures must be taken in case of an accident so as to reduce the negative impacts caused by the accident to a minimum level. Also, the public consultation meeting shows that the construction of this project provokes no objections from local residents or organizations.
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