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FINAL REPORT

ENVIRONMENTALLY SOUND MANAGEMENT AND DISPOSAL OF OBSOLETE POPS PESTICIDES AND OTHER POPS WASTES IN CHINA

UNIDO Project No: GF/CPR/08/002

Contract No. 16001649

Foreign Economic Cooperation Office of the Ministry of Environmental Protection

Beijing, China

November 2009

CONTENTS

1 PROJECT BACKGROUND

The Chinese government acceded to the Stockholm Convention on May 23, 2001. The Tenth National People's Congress Standing Committee ratified the Stockholm Convention on June 25, 2004. Under Article 6(1) (c), China is required to manage POPs wastes in an environmentally sound manner. However, surveys and reports have shown that lack of institutional, technical, and financial capacity inhibits the sound management of obsolete POPs pesticides and associated wastes.

The absence of adequate capacity and infrastructure for environmentally sound management (ESM) and disposal of POPs pesticide wastes in China poses significant risks to human health and the environment. In most POPs pesticide manufacturing plants and end user sites, there are no storage facilities specifically designed for obsolete pesticides and pesticide wastes. Large amounts of obsolete POPs pesticides are therefore often stored in improper conditions, such as outdoor storage, simple enclosure, or open-air disposal with municipal solid waste, all of which constitute a serious threat to human health.

For decades obsolete and unwanted POPs pesticide stockpiles have been building and accumulating. Based on a limited audit of a sample of sites, the total quantity of pesticide POPs waste in China is in the order of 10,000 tons. In addition, it is estimated that fly ash containing high level of dioxin from incineration of hazardous wastes and medical waste amounts to 11,000 tons per annum, which are commonly received no adequate management and disposal, thereby increasing the potential POPs pollution risk to water resources.

2 OBJECTIVE OF THE FULL SIZE PROJECT

The project will enable environmentally sound management (ESM) and disposal of targeted obsolete POPs pesticides and associated wastes in fulfilment of China's commitments under the Stockholm Convention. The project will directly provide for treatment according to Stockholm Convention and Basel Convention guidelines of a minimum of 10,000 tons of identified targeted POPs pesticide wastes and 1,000 tons of PCDD/PCDFs rich fly ash. The project will also introduce regulatory reforms and strengthen national capacity to identify, assess, manage, and treat other such wastes in an environmentally sustainable manner by use of new analytical and organizational techniques such as qualitative environmental risk assessment and public-private partnerships (PPP).

The Full-Size Project includes inter alia, the following main elements:

- ✓ Strengthened legal and regulatory framework for environmentally sound management (ESM) and disposal of POPs waste by modify existing laws and regulations and, where necessary, develop new regulatory approaches to specifically address POPs pesticide wastes and dioxin-rich fly ash
- ✓ Improved institutional capacity at all levels of POPs waste disposal management through training, supported by regulatory and market-based measures that provide waste generators and owners with both the capability and the inventive to manage POPs waste in an environmentally sound manner.

- ✓ Environmentally sound management and disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash, including packaging, handling, collecting, transporting, temporary storage and development and commissioning of disposal facilities. In regard to disposal facilities, Environmental Impact Assessment, technology evaluation and selection, development of technology specifications and guidance documents, site preparation shall be carried out ,
- ✓ Qualitative environmental risk assessment (QERA) site prioritization is carried out by training and technical assistance to establish an inventory of contaminated sites, prepare human health and ecological risk assessment, site surveys, identify POPs exposure scenarios and concentrations, and complete a quantitative environmental risk assessment.
- ✓ Project management, monitoring and evaluation include establishment of a Steering Group, establishment and staffing of the project management team at the national and local levels, execution of a management training program for project staff, and ongoing monitoring and reporting of project activities.

3 PURPOSE OF PROJECT PREPARATION GRANT

Foreign Economic Cooperation Office, Ministry of Environmental Protection(FECO/MEP) delivered management, organization, recruitment and other services required to develop the full size project documents assisted by UNIDO:

In general terms, FECO/MEP has delivered the following activities step by step:

3.1 Current status of obsolete POPs pesticides and feasibility study of special management;

- ✓ Updating inventory data of OPP and establishment of archives for all the sites where the quantity of OPP is over 50 tons.
- ✓ Carry out a survey by means of site visit where obsolete POPs pesticide are stored, desk studies in association with counterparts at local administration level, sampling and analysis of some source and ecosystem receptors for obtaining inventory data on nature, type, package description, site description with photos, magnitude, and geographic dispersion of stockpiled POPs pesticide waste.
- ✓ Analyzing and assessing POPs waste management policies, laws, regulations and standards regarding to POPs wastes identification, labeling, package, handling, temporary storage, transportation and disposal;
- ✓ Propose corresponding plan in regarding to the weakness existed in current legislation framework for POPs waste management and the requirement of Environmental sound management.
- ✓ The policy demand for OPP Environmental Sound Management(ESM) and disposal, and mechanism to guarantee the project implementation, concerning proposal on necessary policy framework,guaranting mechanism,project implementation mechanism,disposal fee assigned under the basis of respective responsibility and proposal on solution
- ✓ Necessity and feasibility study on centralized disposal of OPP in national wide, in respect with necessity study, the following points should be concerned: features of OPP, disposal technology, management and project support, incorporating with the National Program for hazardous and medical waste disposal facilities construction(2003);

3.2 Nature and magnitude of dioxins rich fly ash; contextual analysis of Qualitative Environmental Risk Assessment (QERA); disposal technologies feasibility study

- ✓ Investigate current status of management of dioxins rich ash generated in incineration plants in China;
- ✓ Assess the current practice for dioxins rich ash management;
- ✓ Propose the corresponding requirement for management and disposal of such typical POPs waste as well as selection criteria of enterprise running business of waste management and disposal.
- ✓ Carry out the survey on the nature and magnitude of dioxins rich ash which are generated in typical incinerator(stoke-furnace, fluidized bed, rotary kiln) through field investigation;
- ✓ characterize the physical-chemical features through sampling and lab analysis,.
- ✓ Contextual analysis of QERA application to the project,
- ✓ Identify and assess the contextual parameters potentially including the source waste, potential pathways, vulnerable receptors, elements of geology and hydrology.
- ✓ Field visits to a number of sites.
- ✓ Investigate the technical and economical features of commercialized disposal technologies for POPs waste in home and abroad,
- ✓ Propose a feasible technology study for obsolete POPs pesticide disposal and dioxins rich ash based on the requirement of the project, in which,
- ✓ Specify selection criteria for available disposal technologies for obsolete POPs pesticide and fly ash, including plasma, rotary kiln, stationary and mobile disposal facility .

3.3 Feasibility study and proposal on Stakeholder and public-private partnerships

- ✓ Investigate current available practice of Public-private partnerships(PPPs)
- ✓ Assess the candidate PPPs mechanism based on this project.
- ✓ Carried out barrier analysis based on our ongoing project,
- ✓ Propose the practical action plan of PPP to settle the potential barriers

3.4 Complete necessary work prior to the approval of the Project Document:

- ✓ Calculate the incremental cost;
- ✓ Formulate the work plan;
- ✓ Draft the Project Brief and Project Document; and Request for CEO endorsement
- ✓ Obtain endorsement of all stakeholders; etc..

3.5 Establish an integrated system for managing the project,

- ✓ Establish project management office and project steering committee group; and
- ✓ Support parallel coordination with local governments, and stakeholders representing public, industry, academic and other groups.

4 EXECUTIVE SUMMARY

Since the signature of the contract, the planned activities have been carried out in line with the TOR of the contract. Whereas considerable efforts were made to establish project management units and coordination mechanisms including the development of terms of references, recruitment of a national project consultant and procurement and fulfillment of three subcontracts, draft and polishing the PD, feedback the comment to the PD from GEF, inception meeting of PPG program and a series of meetings for project coordination.

The final report covers the period from July 17,2008 to April 30th,2009 when the Project Document was finally approved by CEO of GEF. The main activities of the contract were stated in Annex 2 of A Chronology of Main Activities.

5 PROGRESS MADE AND OUTPUTS ACHIEVED

5.1 Project Management and Technical Coordination Group(PMTCG)

Considerable efforts were made to establish PMTCG and coordination mechanism-including negotiations with national counterparts and the development of terms of references, reviewing of project documentation.

5.2 PPG Coordination Meetings

PPG Coordination Meetings were held eight times, which were respectively dealing with the inception of PPG program and progress report and discussion on the response to GEF-SEC comments and project coordination. Among the meetings, some of them was provided minutes in Annex 3

5.3 Practices and technologies for ESM of POPs wastes

A subcontract on characterization of dioxins rich fly ash, contextual anaysis of qualitative environmental risk assessment and feasibility study on disposal technology for POPs waste have been awarded to the Shenyang Research Academy of Environmental Science(SRAES) on Oct.14th ,2008. to carry out the tasks scheduled in the Terms of Reference. The public bidding process of this subcontract was taken place in Sept.-Oct.,2008

SRAES is a technical supporting unit for the National Environmental Protection Hazardous Wastes Disposal Engineering Technical Center. Currently, it is on the process of constructing the research center identified during development of the project on National Plan for Hazardous Wastes and Medical Wastes Disposal Facility Construction.

SRAES has completed the final Report of practices and technologies for environmentally sound management and disposal of POPs waste.The major issues in the report are the following:

- ✓ Investigation and assessment on management of dioxins rich ash in China;
- ✓ Proposal of requirement for ESM and disposal of dioxins rich ash
- ✓ Survey report on the nature and magnitude of dioxins rich ash.
- ✓ Study of QERA application to the project
- ✓ Technologies feasibility study for POPs waste disposal

5.4 POPs waste status survey and policy framework for POPs waste management

A subcontract on current status investigation on obsolete pops pesticides and feasibility study of management policy framework of obsolete pops pesticides have been awarded to the Chinese Research Academy of Environmental Science(CRAES) on Oct.24th ,2008. to carry out the tasks scheduled in the Terms of Reference. The public bidding process of this subcontract was taken place in Sept.-Oct.,2008

CRAES was established on Dec.31, 1978. As a national institution for environmental protection, carries out innovative basic scientific research on environmental protection, taking national strategy of sustainable development as the center. The Institute of Solid under the CRAES had completed the sub-project entitled the strategy of POPs waste and contaminated sites under the project of drafting of National Implementation Plan during 2005-2007.

CRAES has completed the final Report of the status of POPs wastes in China and final Report of policy framework for POPs waste management. The major issues in the report are the following:

- ✓ Report on updating inventory data of OPP and establishment of archives for all the sites where the quantity of OPP is over 50 tons
- ✓ Assessment report on the current status of legislation system and management and disposal technologies for obsolete POPs pesticide in China;
- ✓ Study on the policy demand for OPP ESM and disposal, and mechanism to guarantee the project implementation
- ✓ Necessity and feasibility study on unified disposal of OPP in national wide

5.5 Investment options for POPs waste disposal

A subcontract on feasibility study and proposal on stakeholder and public-private partnerships on POPs waste management has been awarded to the EnviSolve Consultation Co. (ESCC)on Sep.23rd ,2008. to carry out the tasks seheduled in the Terms of Reference. The public bidding process of this subcontract was taken place in Aug.-Sept.

ESCC is a specialized institution which provides consulting service in gathering the data on environmental status and issues at global, regional and local levels, and providing technically feasible, economically viable, socially acceptable, and managerially innovative solutions to planning and management of ecological environment.

ESCC has completed final Report of viable investment options for POPs waste disposal. The major issues in the report are the following:

- ✓ Investigation and assessment on current practice of PPPs in public facilities for environmental protection ;
- ✓ Feasibility study and proposal on stakeholder and public-private partnerships on POPs waste management

5.6 Project Document (including request for CEO endorsement)

Final project Document on Environmentally sound management and disposal of obsolete POPs pesticides and other POPs waste in China. The public bidding process of the formulating and drafting project document subcontract was taken place in June-July, 2008. Dr. Zhu Jianxin is the subcontractor undertakes this subcontract. The zero draft project document was formulated based on the report completed in activities 4.1 to 4.5. To formulate the zero draft, the coordinating meetings participated by all the subcontractors was held in Beijing for five times. The draft PD was continually improved by combined efforts of PMTCG. The final PD has been completed at Feb. 2009 (See Annex)

5.7 Feedback to the comment on Project Document (including request for CEO endorsement)

Receiving the GEF Secretariat review on PD, two meetings was quickly convened for drafting feedback to the review, and correspondingly revised the PD and its relevant document.

5.8 Mobilization of Co-financing

According to the co-financing requirement on the project raised by GEF, Foreign Economic Cooperation Office of Ministry of Environmental Protection(FECO/MEP) has made great efforts to raise co-financing contributions from related stockholders, and received commitment for co-financing with a total of 32.0 million US$ in-kind and in-cash as counterpart funding during the project implementation period (2009-2013)from various of entities, including: some provincial waste management centers, waste treatment plants and research institutes.

6 PROJECT BALANCE

Project Expenditures(July 2008-April. 2009)		
Project budget-first tranche in place	13,960	
Project budget-second tranche	104,700	
Project budget-third tranche		
Subcontract with SRAES		54000
Subcontract with CRAES		30000
Subcontract with ESCC		20000
Workshops&seminars		31306
SUBTOTAL	118,660	135,306
BALANCE- April.2009	-16,646	

7 SUMMARIZATION

FECO/MEP delivered management, organization, recruitment and other services required to develop the full size project documents with the assistance of UNIDO during the fulfillment period from July 17,2008 to April 30th,2009.Whereas considerable efforts were made to establish project management units and coordination mechanisms including the development of terms of references, recruitment of a national project consultant and procurement and fulfillment of three subcontracts, draft and polishing the PD, feedback the comment to the PD from GEF, inception meeting of PPG program and a series of meetings for project coordination.The Project Document was finally approved by CEO of GEF on 30th April,2009.

ANNEX

Annex 1 Project Document required by GEF and UNIDO

Annex 2 Request for CEO endorsement

Annex 3 A Chronology of Main Activities

Annex 4 Minutes on PPG Coordination Meetings

Annex 5 Report of the status of POPs wastes in China

Annex 6 Report of Disposal Technologies Selection and Environment Risk Evaluation

Annex 7 Report of Necessity & Feasibility Study Report on Special Management & Centralized Disposal for Pesticide POPs Wastes in China

Annex 8 Feasibility study and proposal on stakeholder and public-private partnerships on POPs waste management

Annex 1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Project of the People's Republic of China

PROJECT DOCUMENT

Project number:	GF/CPR/08/X01
Project title:	Environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes in China
GEFSEC Project ID:	2926
Starting date:	January 2009
Duration:	5 years
Project site:	China
Government Co-ordinating agency:	China Ministry of Environmental Protection (MEP)
Executing Agency/ cooperating agency:	MEP/Foreign Economic Cooperation Office (FECO)
Project Inputs:	
GEF grant:	**US$ 9,959,000** excluding PPG of US$ 231,000
	US$ 10,190,000 including PPG
Support costs (10%):	*US$ 1,019,000*
***UNIDO inputs** (in-kind):*	*US$ 100,000*
Counterparts input:	
MEP (cash & in-kind)	*US$ 7,750,000*
Local EPBS (cash & in-kind)	*US$ 7,310,000*
Pesticides owners and other private/public sectors (cash & in-kind)	*US$ 16,940,000*
Total co-financing	***US$ 32,100,000***
Grand Total:	**US$ 42,059,000 (excluding support costs)**

Brief description:

The project will enable environmentally sound management (ESM) and disposal of targeted obsolete POPs pesticides and associated wastes in fulfillment of China's commitments under the Stockholm Convention. The presence of geographically dispersed stockpiles of obsolete POPs pesticide waste and PCDD/PCDFs rich incinerator fly ash presents an ongoing pollution source and pathway risk to environmental receptors, especially groundwater and surface water resources. The scale of this risk and its global consequences make it a uniquely Chinese issue with significant trans-boundary impact. The project will directly provide for treatment in accordance with Stockholm Convention and Basel Convention guidelines of a minimum of 10,000 tons of identified targeted POPs pesticide wastes and 1,000 tons of PCDD/PCDFs rich fly ash. The project will also introduce regulatory reforms and strengthen national capacity to identify, assess, manage, and treat other such wastes in an environmentally sustainable manner by use of new analytical and organizational techniques such as qualitative environmental risk assessment and public-private partnerships (PPP).

Approved:	**Signature:**	**Date:**	**Name and title:**
On behalf of			
The Government of the People's Republic of China:	____________	______	____________
UNIDO:	____________	______	____________

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LIST OF ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AIDS	Acquired Immure Deficiency Syndrome
APCD	Air pollution control device
APCS	Air pollution control system
APR	Annual Project Report
AQSIQ	Administration of Quality, Supervision, Inspection and Quarantine
BAT	Best available techniques
BEP	Best environmental practices
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
CAS	Chinese Academy of Sciences
CCCEPI	China Certification Centre of Environmental Protection Industry
CEMS	Continuous Emission Monitoring System
CICG	Convention Implementation Coordinating Group
CIO	Convention Implementation Office
COP	Conference of Parties
CSC	China Standard Certification Centre
CTA	Chief Technical Advisor
DEHP	Diethylhexylphthalate
EMS	Environmental Management System
EPA	US Environmental Protection Agency
EPB	Environmental Protection Bureau
EIA	Environmental Impact Assessment
ESM	Environmental Sound Management
EU	European Union
FECO	Foreign Economic Cooperation Office
GAC	General Administration of Customs
GEF	Global Environment Facility
HWDC	Hazardous Waste Disposal Centre
MW	Medical waste
IHB	Institute of Hydrobiology
IR	Inception Report
MI	Medical Institution
MOA	Ministry of Agriculture
MEP	Ministry of Environmental Protection
MOHURD	Ministry of Housing and Urban-Rural Development
MOF	Ministry of Finance
MOFA	Ministry of Foreign Affairs

LIST OF ACRONYMS AND ABBREVIATIONS

MOFCOM	Ministry of Commerce
MOH	Ministry of Health
MOST	Ministry of Science and Technology
NCG	National Coordination Group
NDRC	National Development and Reform Commission
Ng	Nanogram
NGOs	Non-governmental Organizations
NIP	National Implementation Plan
NHMWP	National Hazardous and Medical Waste Disposal Facility Construction Program
NTA	National Technical Advisor
OP	Operational Program
OPP	Obsolete POPs pesticides
PW	POPs waste
PPW	POPs pesticide waste
PCDD/PCDFs	Polychlorodibenzo-para-dioxins and Polychlorodibenzofurans
PPP	Public-private partnership
PIR	Annual Project Implementation Review
PM	Particulate matter
PMO	Project Management Office
POPs	Persistent Organic Pollutants
SARS	Severe Acute Respiratory Syndrome
SC	Stockholm Convention
SERC	State Electrical Regulation Commission
SAWS	State Administration of Work Safety
TCDD	Tetrachlorodibenzo-p-dioxin
TCG	Technical Coordination Group
TEQ	Toxic Equivalent (dioxin emissions)
TOT	Transfer-Operate-Transfer
TTR	Terminal Tripartite Review
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNIDO	United Nations Industrial Development Organization
UP-POPs	Unintentionally produced POPs
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound
WB	The World Bank
WHO	World Health Organization

SECTION A. CONTEXT

A.1 Context/History

a. Overview

1. China has urgent need of an on the ground program for managing stockpiles of obsolete POPs pesticides and associated contaminated wastes in an environmentally sound manner. China's large agricultural sector with its heavy dependence on agro-chemicals resulted in about 574,000 tons of POPs pesticides being manufactured up to 2004 when production was banned. Although POPs pesticides production has been prohibited by domestic regulations, lack of a targeted national program providing capacity building and technical assistance to manage these chemicals has resulted in significant stockpiling of obsolete POPs pesticides.

2. Based on the research and surveys conducted in conjunction with the preparation of this project, obsolete POPs pesticide and associated wastes have been identified in 44 POPs pesticide manufacturing plants and a number of distribution and end user sites. In the past, plant owners and end users have been largely unregulated and responsible for managing their own POPs pesticides, which have resulted in stockpiles of obsolete pesticides and associated wastes, the distribution and scope of which has been unknown to central and local environmental protection agencies.

3. The absence of adequate capacity and infrastructure for environmentally sound management (ESM) and disposal of POPs pesticide wastes in China poses significant risks to human health and the environment. In most POPs pesticide manufacturing plants and end user sites, there are no storage facilities specifically designed for obsolete pesticides and pesticide wastes. Large amounts of obsolete POPs pesticides are therefore often stored in improper conditions, such as outdoor storage, simple enclosure, or open-air disposal with municipal solid waste, all of which constitute a serious threat to human health. This serious risk of environmental contamination and human exposure is further exacerbated by natural disaster, such as the flooding and earthquakes, which China has recently experienced.

4. Current practices for hazardous waste disposal have been dominated by incineration and therefore generate secondary pollution such as dioxins and furans. It is estimated that fly ash containing a high level of dioxin from incineration of hazardous wastes and medical wastes amounts to 11,000 tons per annum. Incineration plants generally dispose of this dioxin rich fly ash in open dumps or non-sanitary landfills mixed with municipal wastes, thereby increasing the potential POPs pollution risk to water resources.

5. The Chinese government acceded to the Stockholm Convention on May 23, 2001. The Tenth National People's Congress Standing Committee ratified the Stockholm Convention on June 25, 2004. Under Article 6(1) (c), China is required to manage POPs wastes in an environmentally sound manner. However, surveys and reports have shown that lack of institutional, technical, and financial capacity inhibits the sound management of obsolete POPs pesticides and associated wastes.

b. Obsolete POPs pesticides

6. China has historically produced six of the nine POPs pesticide in Annex A and B of the Convention, including toxaphene, hexachlorobenzene, chlordane, heptachlor, mirex and DDT. Accumulated output of those pesticides was about 574,000 tons through the end of 2004. Aldrin, dieldrin and endrin were never produced industrially. Production and use of toxaphene and heptachlor ceased in the 1970's, and production and use of hexachlorobenzene in 2004. Small scale production of chlordane, mirex and DDT still exits in China but is expected to completely stop in 2009 given that China has not re-applied for exemption for these chemicals.

7. Obsolete POPs pesticides refer to unusable pesticides stored or abandoned by manufacturers, distributors and end-users, with no remaining market value. Obsolete POPs pesticides and

associated wastes are generated when new products render old ones obsolete, when stocks exceed market demand and as a result of waste generated during the production process.

8. In conjunction with the development of this project, MEP initiated a survey program for production, consumption, stockpile and disposal of POPs pesticides. The program updated initial manufacturer and distributor surveys conducted during the preparation of the NIP, and expanded upon the NIP by inclusion of additional distributor sites. To date, the program has identified 3840~4380 tons of obsolete pesticides in the production field, including about 2400~2800 tons of DDT, 60~70 tons of HCB/PCP-Na and 1380~1510 tons of chlordane and mirex. Distributor surveys and follow-up site visits were conducted nationwide during preparation of China's NIP, identifying 13 POPs pesticide waste sites in 13 provinces. Additional detailed survey work completed during the preparation of this project has focused on three target provinces (Chongqing, Jilin and Jiangsu), identifying 29 additional sites in Chongqing. The 42 sites identified to date have 4219~5713 tons of obsolete pesticides (mostly DDT). Table 1 below is given for further details regarding sites information currently collected and Table 6 in Annex 8 – Baseline Analysis for POPs pesticides and fly ash for detailed listing of identified sites and site data.

Table 1. Identified Obsolete POPs Pesticides Sites

Area		DDT	Chlordane/Mirex	HCB	Sub-total
Production	Pesticide manufactures	2400~2800	1380~1510	60~70	3840~4380
Distributors	Agriculture	4164~5640			4164~5640
	Healthcare	55~73	-	-	55~73
	Subtotal	4219~5713			4219~5713
Total		**6,619~8,513**	**1380~1510**	**60~70**	**8,059~10,093**

9. Among the pesticide manufacturers with obsolete POPs pesticides and contaminated workshops in the production sites, one will be covered by the GEF funded Termite Project (WB) and three by the GEF funded Dicofol Project (UNDP). The remaining sites (18 manufacturers and 42 distributors) and additional sites identified during project implementation will form the project's target universe, neutralizing a minimum of 10,000 tons of obsolete pesticides and associated wastes. Figure 1 below shows the geographic distribution of major target sites.

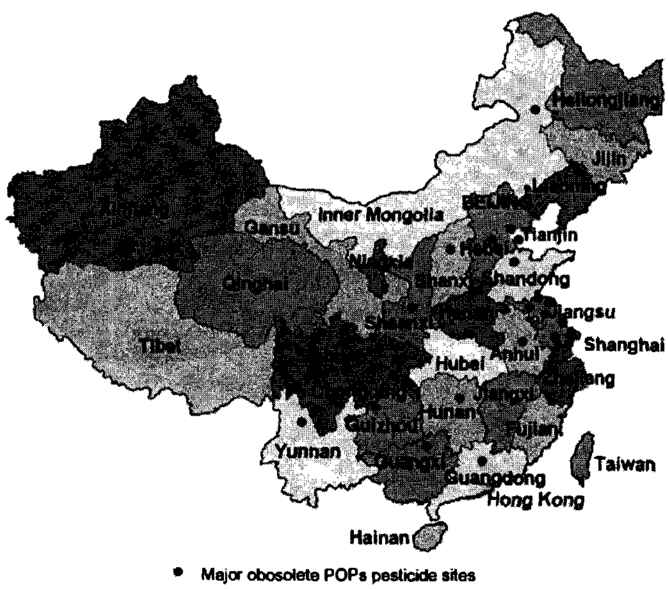


Figure 1: Geographic Distribution of targeted obsolete POPs pesticides

10. Obsolete pesticides and associated wastes are hazardous wastes. Owing to the absence of environmentally sound disposal facilities in China, the quantity of obsolete pesticides and associated wastes are constantly on the increase. Most waste sites are located in areas with high population density where obsolete POPs pesticides were dumped in the vacant buildings, abandoned water towers and caves. Storage conditions rarely meet internationally accepted standards. Chemical drums are often stored in the open, exposed to harsh weather conditions which accelerate their deterioration and leak their contents to the soil, severely contaminating groundwater and the environment, while powdered chemicals in bags and cardboard boxes are dispersed by wind and rain as their containers deteriorate. Most sites are located in or near population centres and/or bodies of water. This high degree of environmental contamination is demonstrated by one manufacturing site in which chemical analysis of contaminated soils was undertaken, identifying 18,000 tons of highly polluted soil (DDT>50 ppm). Annex 8 – Baseline analysis for POPs pesticides and fly ash and China NIP give additional information regarding the current and historical production and use of POPs pesticides.

c. *Regulatory context*

11. The Stockholm Convention entered into force in China on 11 November 2004. Article 6 of the Convention requires Parties to take measures to ensure that POPs wastes are handled, collected, transported, stored and disposed of in an environmentally sound manner; to identify POPs-contaminated sites; and to ensure that any remediation of contaminated sites is undertaken in an environmentally sound manner. Article 5 of the Convention requires the Parties to take measures to reduce or eliminate releases of unintentionally produced POPs in Part I from sources listed in Parts II and III of Annex C of the Convention, including reduction/elimination of dioxin releases from incineration of POPs pesticides and risks posed by dioxin-rich fly ash resulting from incineration processes.

12. China has also acceded to the Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal in 1991 and will continue to adhere to its requirements controlling management of hazardous waste exports to Basel Convention countries and prohibiting exports to non-Basel countries. In implementing this project, China will also draw on Basel Convention "*Technical guidelines on environmentally sound management of persistent organic pollutants*" with respect to processes for destruction and irreversible transformation of POPs wastes in response to the request by the Open Ended Working Group of the Basel Convention in September 2007 (OEWG-VI/6).

13. According to the current hazardous waste management licensing system, a license must be obtained for collection, transport, and storage, and/or disposal of hazardous waste. For treatment of hazardous waste streams over 10,000 tons per year or involving transporting hazardous materials across provincial lines, central government approval by MEP is required. For treatment facilities under these thresholds, provincial or municipal approval is adequate. A special MEP-issued license is also required for PCB or mercury contaminated waste or "other toxic substances highly dangerous to the environment and human health." The special license required for PCB waste management and treatment has enabled China to better control and dispose of those wastes. Currently, processing of obsolete POPs pesticide and other POPs contaminated wastes does not include a clear approval requirement for a special operating license by MEP or Local Environmental Protection Bureaus (EPBs), which constitutes a barrier to the implementation of ESM in POPs pesticide waste. The project will therefore support work within MEP to develop and implement such a licensing system for the treatment of obsolete POPs pesticides and associated POPs contaminated wastes.

14. China does not currently have any take-back requirements for obsolete or otherwise unusable pesticides and contaminated used pesticide containers, which often results in improper disposal of these wastes by end-users. The project will therefore work with legislative and regulatory authorities to develop such a requirement so that pesticide suppliers (manufacturers and/or distributors) would be required to take back such contaminated wastes, which could then more efficiently and effectively be channeled into the hazardous waste management system. The

project will also consider implementation of a buy-back requirement for both obsolete and unused pesticides, which would tend to result in reduced pesticide use by end-users. While such a requirement may appear to be in conflict with supplier interests, take-backs can benefit suppliers in the long term since they improve customer relations, and are significantly less expensive than the clean-up costs, which the supplier can potentially become wholly or partially responsible for if unused or obsolete pesticides are not properly managed and disposed of.

15. Table 2 below list the key laws, regulations and standards related to obsolete POPs pesticides and associated wastes.

Table 2. Key Laws, Regulations and Standards related to Obsolete POPs Pesticides and Associated Waste

Law/regulation/standard		Issued by	Date of issuance
Laws	Environmental Protection Law of China	SCNPC	December 1989
	Law of China on the Prevention and Control of Environmental Pollution Caused by Solid Waste	SCNPC	April 2005
Policies	National Implementation Plan for POPs Convention in China	State Council	April 2006
	Technical Policy for the Prevention and Control of Pollution Caused by Hazardous Waste	SEPA	December2001
	Circular Concerning Implementation of Charging System for Disposal of Hazardous Wastes to Promote Industrialization of Hazardous Waste Disposal	NDRC, SEPA, MOH, MOF, MOC	April 2005
Regulations	Pesticide Management Rules	State Council	July 2001
	Regulation on Safe Use of Pesticides	MOA, MOH, etc	October 1982
	National Catalogue of Hazardous Waste	SEPA, the former SETC, the former MOFTEC	July 1998
	Measures for the Administration of Operating Licenses for Hazardous Waste	State Council	May 2004
	Measures for Manifest Management on Transfer of Hazardous Waste	SEPA	October 1999
	Measures for the Prevention and Control of Environment Pollution by Discarded Hazardous Chemicals	SEPA	October 2005
	National Programme for Hazardous and Medical Waste Disposal Facilities Construction	State Council	January 2004
Standards	Standard on Identification of Hazardous Waste	SEPA	October 2007
	Pollution Control Standard for Hazardous Waste Incineration	SEPA	January 2002
	Standard for Pollution Control on Hazardous Waste Storage	SEPA	July 2002
	Standard for Pollution Control on the Safe Landfill for Hazardous Waste	SEPA	July 2002
	Technical Requirements on Engineering Construction for Safe Landfill and Disposal of Hazardous Waste	SEPA	January 2004

* See Annex 9 for additional laws, regulations and standards related to POPs pesticides and contaminated sites.

e. *Institutional settings*

16. As designated hazardous wastes (category "HW04" in the *National Catalogue of Hazardous Wastes*), obsolete pesticides are managed under China's solid waste management system, as shown in the Figure 2 below.

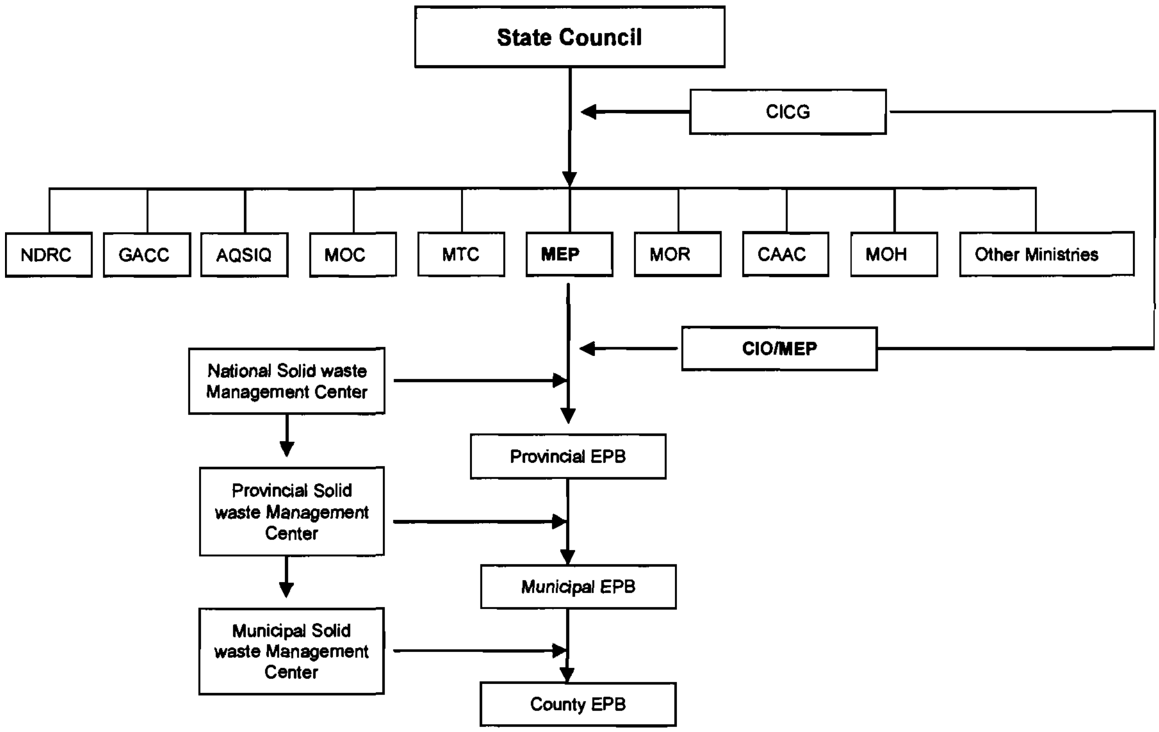


Figure 2: Institution settings concerned with solid waste management

17. The Ministry of Environmental Protection (MEP) is the national level authority for environmental protection and pollution prevention. MEP's Solid Waste Division under the Department of Pollution Control is responsible for solid waste management, including obsolete POPs pesticides. MEP also has a National Solid Waste Management Centre, which provides technical and policy support to MEP. At the provincial, municipal, and county levels, solid waste is managed by the EPB's Pollution Control section or Solid Waste Management Centre. Other government ministries such as the NDRC, MOHURD and AQSIQ work with MEP to support implementation of the Solid Waste Law within each ministry's sphere of responsibility.

f. *Disposal of POPs wastes*

18. At present, high-temperature incinerators are the most common facilities used for treatment of hazardous wastes because there are few disposal alternatives with regulatory approval. Incinerators are generally designed to accept consistent waste feedstocks with low chlorine content in order to achieve the current national emission standard (0.5 ngTEQ/Nm^3) and are not capable of meeting ESM requirements.

19. Cement kiln co-processing of hazardous waste provides high temperature, long residence time, surplus oxygen, good mixing, and an alkaline environment for high efficiency destruction of POPs. For China, co-processing of POPs in rotary cement kilns has been used in limited applications and is still at the demonstration stage, although it has been practiced for more than 30 years in developed countries. As rule of thumb, chlorine should be limited to 350 to 500g/t

cement clinker for a kiln without by-pass and 400-750 g/t for a kiln with by-pass, and the feeding ratio has to be controlled carefully to avoid the high-level dioxin emission. In most cases, the cement kiln must be equipped with a special feeding system, flue gas treatment equipment, and a continuous environmental monitoring system for treatment of POPs emissions. The quench process is also an essential step to achieve lower PCDD/Fs emissions.

20. Limited research and pilot demonstration have been undertaken in the application of plasma technology for treatment of POPs in China. China's first facility using domestically manufactured plasma treatment technology with a capacity of 3 tons/day was constructed in late 2006 for disposal of PCB by-products and residues from a chemical plant in Sichuan Province. The flue-gas system was designed to recover HCl; the natural gas-fueled secondary combustion chamber is placed directly after the plasma pyrolysis furnace. Carbon and combustible gases are incinerated with natural gas; hydrochloric acid is recycled through a three-stage acid gas scrubber/recycling tower and then recovered. A pilot 3 ton/day plasma system for fly ash treatment has also been demonstrated in Anhui province, achieving PCDD/Fs emissions levels of 0.02 ngTEQ/Nm^3.

g. Private-Public Partnership (PPP) in the management of obsolete POPs pesticides

21. China will need to invest billions of dollars for identification, collection, transportation, treatment, and disposal of obsolete POPs pesticides and associated wastes. The Chinese government is facing both a "capital bottleneck" and low efficiency in the existing government-run system for developing the necessary infrastructure to address environmental pollution. Investment needs will further increase as new POPs are included under the auspices of the Stockholm Convention. A long term and sustainable financial strategy is therefore needed. To meet this need, the project will introduce and develop PPP.

22. PPPs are innovative mechanisms for delivery of new or improved facilities and services. Traditionally, local government own facilities are responsible for providing services, procuring support services on a piecemeal basis from the private sector as needed. With PPP, a single private sector provides the complete range of services to build and operate a facility under a long term contract. The PPP approach has often been adopted in other countries, but is relatively new in China. This approach allows the private sector to contribute its expertise and for both sectors to harness their energies in finding innovative and cost-effective solutions.

23. PPP will be applied in this project through a Special Purpose Company (SPC), which will build the hazardous waste disposal facility and then operate it through provision of technology transfer, in-plant training, environmental monitoring, maintenance, and other necessary services. The SPC will be responsible to the procuring government agency in meeting contractual targets and other requirements, and will be required to follow relevant environmental protection and other regulations. Beyond that, the SPC will have a high degree of independence in managing its internal operations and providing services. In return, the SPC will receive contractual payments and/or revenue sharing.

24. The project will provide additional incentives and legislative support for the PPP mechanism through a variety of measures, potentially including:

    a) Introduction of fee-based system for disposal of obsolete POPs pesticides and pesticide wastes;
    b) Implementation of shared savings bonuses to SPCs for successful implementation of new, cost-effective approaches;
    c) Subsidize capital investment costs of introducing environmentally sound disposal technologies; and
    d) Introduction of tax incentives for new facilities, technologies and jobs in the hazardous waste treatment industry.

A.2 Barrier Analysis

25. The proposed project has been designed to address a variety of barriers in order to ensure its successful implementation and the achievement of project objectives. These barriers, listed in the order of project outcomes, include:

a) Existing laws and regulations related to hazardous wastes are too general and their implementation is not supported by detailed regulations and technical guidelines.

26. In order to prevent POPs-contaminated wastes from polluting the environment, the Chinese government has promulgated *Measures on Prevention and Control of Environmental Pollution Caused by Abandoned Hazardous Chemicals.* China has also formulated and implemented a series of standards, including the *Standard on Hazardous Wastes Identification,* the *Standard for Pollution Control on Hazardous Waste Storage,* the *Pollution Control Standard for Landfilling of Hazardous Wastes,* and the *Pollution Control Standard for Hazardous Wastes Incineration.* The implementation of these Standards plays a very important role in promoting and regulating hazardous wastes management of the country.

27. Though China has established a basic regulatory framework for hazardous waste management and treatment, existing laws and regulations are too general and their implementation is not supported by detailed orders and technical guidelines. The project will address this issue through technical support, policy support, and capacity building for regulatory development. Regulatory development will also be coordinated in both content and timing with other project activities in order to provide a nurturing and sustainable policy environment.

Operating license for hazardous wastes

28. Issuing operating licenses for hazardous waste management is an important administrative tool for supervision of hazardous wastes disposal facilities. According to the *Measures for the Administration of Operating Licenses for Hazardous Wastes* promulgated on 1 July 2004, hazardous wastes disposal facilities must first demonstrate that its facility meets national and/or local environmental protection standards in order to obtain an operating license.

29. The *Measures for the Administration of Operating licenses for Hazardous Wastes* contain general provisions relating to the basic resource requirements for hazardous waste disposal facilities, but lack specifications for POPs pesticide wastes. In practice, due to application backlogs and lack of enforcement, many facilities are still operating without a license. There is no detailed guidance for processing POPs pesticides, transportation of waste across provincial boundaries, or use of mobile facilities. The project will address these deficiencies by supporting development of detailed implementation rules for licensing POPs pesticide wastes treatment and disposal facilities.

Hazardous waste consignment

30. The generation, collection, transports and disposal of PW forms a complex system involving multiple economic actors. Implementation of a consignment system for PW is an important means to organize this process so as to prevent loss of wastes and ensure that wastes are treated and disposed of safely and properly at each stage of the process. Aspects of China's current system comprise a barrier in reaching this goal.

31. According to the *Measures for Manifest Management on Transfer of Hazardous Wastes*, the present PW transfer manifest system requires a hazardous waste transfer manifest in quintuple copies, which is overly complicated for management of PW waste transfers. Some provinces modified shipment requirements and changed the manifest to three copies, which greatly reduced the system's effectiveness. The manifest system is not implemented in some regions increasing the possibility of unaccountable loss and unauthorized disposal of PW is increased with the consequent potential health and environmental pollution risk.

32. To bring the role of the PW transfer manifest system into full operation, the project will develop and introduce a dedicated PW transfer manifest that should be formulated based on the present hazardous waste transfer manifest. This new PW transfer manifest system should clearly define responsibilities of waste generation units, transport units and disposal units in the management

on transfer of waste, explicitly specify information required to be filled in, establish data reporting and archiving systems, and make use of advanced information technology tools.

Legal Liability System

33. While the *Environmental Protection Law* stipulates the "polluter pays" principal, China does not currently have a well-developed system for establishing the legal and financial liability for environmental contamination and health impacts due to improperly disposed of pesticides and pesticide wastes. This lack of clear accountability reduces the deterrent impact of legal prohibitions, leading to a greater incidence of improperly managed wastes, and reduces national, provincial, and local government ability to finance waste management and clean-up operations, thereby compounding the problem and increasing health and environmental impacts. The lack of clear legal and financial liability is particularly pronounced for "orphaned" obsolete POPs pesticides, where the owner or other party responsible for the wastes either can not be determined or no longer exists.

b) Existing standards for hazardous waste pollution control are too broad and specific standards for POPs pesticides do not exist

34. The Government of China has not yet established a system of standards for PW. Such a system is crucial to assure appropriate management and disposal of PW, and its absence constitutes a barrier to environmentally sustainable management.

35. Current environmental legislation was developed prior to China's accession to the Stockholm Convention. This led to an inadequate consideration of the requirements of ESM for all aspects of POPs wastes.

Lack of standards for alternative treatment technologies

36. Standards for testing and assessing alternative disposal technologies have not yet been developed in China due to lack of knowledge and technical support regarding those technologies. This lack of prescribed standards makes it difficult for China's environmental protection departments to identify, apply and regulate alternative technologies and their application.

Loose standards for the incineration pollution control

37. China's *Pollution Control Standard for Hazardous Wastes Incineration* establishes 0.5 ng TEQ/Nm^3 as the emission limit of PCDD/PCDFs in flue gas from incineration, while most countries in the world have adopted a PCDD/PCDFs emission below 0.1 ng TEQ/Nm^3 through application of best available techniques and best environmental practices (BAT/BEP) under the Stockholm Convention. China's high incineration emission limits allows prolonged use of outdated incineration equipment and acts as a barrier to implementation of new and improved equipment, technologies and techniques, and consequently impedes China's fulfillment of its obligations under the Stockholm Convention.

c) China's Nationwide Hazardous Waste Treatment Facility Construction Program has been developed without considering technology and knowledge transfer of ESM measures particularly in considering alternative technologies

38. The National Hazardous and Medical Waste Disposal Facility Construction Program (NHMWP) commenced in 2003, when China has not yet acceded to the Stockholm Convention. It was developed based on environmental protection and health standards in force at that time, which adopted incineration technology as the primary disposal technology. The Program principally emphasized elimination of the health and safety threats posed by medical hazardous wastes, and gave less consideration to the application of ESM to total process management of POPs wastes and minimization of unintentionally produced POPs (UP-POPs) and other pollutants.

39. Article 5 of the Convention requires the Parties to take measures to reduce or, where feasible, eliminate releases of UP-POPs, and to apply BAT for new sources and existing sources listed in Part II: Source categories of Annex C of the Stockholm Convention. In the NIP of China, the on-

going management and incremental disposal of identified POPs pesticide wastes is also listed as a specific action (Table 3-14, Specific action 16) and, pursuant to the "*action plan for identification and disposal of POPs stockpiles, wastes and contaminated sites*" priority should also be given to demonstration activities for ESM application.

40. However, the application of ESM in the whole process of management and disposal of obsolete POPs pesticides and POPs pesticide wastes in China still faces a series of barriers.

41. The project will address this omission in the NHMWP by working closely with national, provincial, and local officials responsible for the implementation of the NHMWP to provide capacity building and technical assistance in the development of waste management plans and in technology selection. This support will allow selection of the most cost-effective, environmentally beneficial technologies, coupled with the implementation of the ESM to minimize overall system costs, inefficiencies, and POPs emissions.

d) Lack of policy instruments promoting adoption of ESM in a market economy

42. Technical policies for environmental protection are technical guidelines formulated by governments to guide industries to take self-regulatory actions in choosing and upgrading their technologies in light of the principles of sustainable development. ESM recommended by the Convention should be incorporated into a country's technical policy.

43. Economic policies for environmental protection make use of economic instruments such as pricing, taxation, credit and insurance. They are designed to regulate or influence the behavior of market players in favour of sustainable develop. The United Nation's Rio Declaration on Environment and Development states that countries should adopt economic policies to internalize environmental costs into the production and consumption processes.

44. In 2001, China promulgated the *Technical policy for the prevention and control of pollution caused by hazardous wastes*. This policy is applicable to technology selection for the total process of pollution prevention and control from the generation, collection, transport, segregation, testing, packing, recycling, storage, treatment, and disposal of hazardous wastes, and can be used to provide guidance on the planning, project justification, location selection, design, construction, operation and management of relevant facilities.

45. China promulgated waste fees and taxation preference policies for the operation of hazardous wastes facilities. In November 2003, the National Development and Reform Commission (NDRC), MEP, Ministries of Health, Finance and Construction jointly promulgated the Advice Concerning Implementing Fee Charging System to Promote Industrialization of Hazardous Waste Disposal, which includes provisions on implementation of the fee system for hazardous waste disposal. However, the fee-based system has not yet been applied to obsolete pesticide disposal.

46. However, a variety of deficiencies remain in technical and economic policies. Current technology selection standards promoting incineration as the preferred disposal method are outdated and do not reflect current international trends or Stockholm Convention ESM requirements. Economic policies are also incomplete, and limited in their ability to promote market-based operation of obsolete pesticides management and disposal. Tax preferences have not been provided to reflect the public goods nature of pesticide waste management, nor are government agencies equipped to employ special funds, subsidies, or other economic incentives to encourage enterprises to carry out environmentally safe disposal of obsolete pesticides.

e) Historical pesticides manufacturing sites that stopped production long ago might not have production records based on which the size of contaminated areas and level of contamination can be estimated

47. Prior to the *Measures on Prevention and Control of Environmental Pollution Caused by Abandoned Hazardous Chemicals* in 2005, pesticides manufacturing companies were not obliged to rehabilitate contaminated sites when they stopped production and therefore often did not keep historical records regarding the location and size of contaminated areas within their facility perimeters. Hence detailed field surveys must be carried out to obtain this information.

f) Weak institutional capacities for supervision and inspection of POPs waste owners' sites and dedicated disposal facilities in the areas of pollution monitoring, environmental impact assessment, and risk assessment of disposal operations

48. During completion of the NIP, development of this project, and through undertaking related bilateral projects, the Ministry of Environmental Protection has begun to strengthen its capacity for supervision of POPs pesticides manufacturing companies and dedicated hazardous wastes disposal facilities in the areas of pollution monitoring, environmental impact assessment, and risk assessment of disposal operations. However, much additional work needs to be done to enhance monitoring, assessment, and enforcement capabilities, both at the national and local levels.

49. Currently, environmental protection departments at various levels of government suffer from inadequate guidelines for supervision. As a result, pesticides management varies from official to official and region to region, giving rise to confusion on what constitutes proper waste management practice. It is therefore necessary to formulate guidelines for obsolete pesticides and associated waste supervision and management in order to regularize and strengthen management and supervisory activities.

50. Because the manifest system for pesticides transfer has not been implemented effectively, such important basic data as source, type, composition, and quantity of obsolete pesticides and associated wastes is unavailable for many stockpiles throughout the country. This lack of data restricts the ability of environmental protection departments to supervise pesticides management, and develop programs and policies for obsolete pesticides disposal. It is therefore necessary to establish a more comprehensive data reporting system requiring regular reporting by pesticides manufacturers, distributors, and transporters. Use of advanced information management techniques can both increase the system's effectiveness and usefulness, and reduce the administrative burden, which the system imposes on reporting entities, particularly when compared to the more cumbersome aspects of the current reporting system.

Weak capacity for pollution monitoring of dedicated disposal facilities

51. The supervision and monitoring of pollutant releases constitute an important means to ensure ESM application and adequate emission controls in the pesticides management and disposal sector. Work is required to establish online monitoring systems directly linked to the government's environmental protection supervision departments. Without such data, the departments are unable to monitor the operating status of obsolete pesticide waste incineration facilities.

52. The Chinese Government has moved fast to issue initial regulations and standards for pollution control at pesticide waste disposal facilities and capability exists to monitor emissions of general pollutants. However, gaps still exist in supervising and monitoring implementation of these regulations and standards, including:

- Lack of technical specifications and instruments for supervision and monitoring;
- Lack of capacity building and training for enforcement personnel;
- Lack of capacity to monitor POPs pollutants such as PCDD/PCDFs from incineration; and
- Lack of continuous emissions monitoring systems (CEMS).

Insufficient environmental impact assessment (EIA)

53. Environmental impact assessment is one of China's basic environmental protection requirements. In 1998, the Chinese Government promulgated the *Management Regulations for Environmental Protection of Construction Projects*, which sets forth the system of environmental impact assessment. In 2003, it promulgated the *Chinese Environmental Impact Assessment Law* and the *Technical Guidelines for Environmental Impact Assessment.* China has a certification system for EIA engineers, of which a large pool has been established.

54. In 2003, in order to address EIA for construction of hazardous wastes disposal facilities in conjunction with the NHMWP, MEP formulated the *Technical Principles for Environmental*

Impact Assessment of Construction of Hazardous Waste and Medical Waste Disposal Facilities. These guidelines specify environmental management requirements for pollutants emission, technology selection and provide other guidance on EIA for hazardous waste disposal facilities.

55. To date, EIA has been carried out for a majority of hazardous waste disposal facilities in accordance with the guidelines, but problems remain:

- Incomplete contents. The *Technical Principles* focus on incineration and do not consider alternative technologies, making their adoption more difficult.
- Insufficient follow-up assessments and post-assessments. Though the present EIA system includes requirements for follow-up assessment and post-assessment, they are either given inadequate emphasis or not executed in practice. This inhibits implementation of environmental impact mitigation measures proposed by the EIA during facility construction.
- Professional development of EIA personnel. In spite of the certification system, many EIA agencies and personnel still lack expertise and experience.

Lack of risk assessment of disposal operations

56. Ensuring effective operation of hazardous wastes disposal facilities is one of the key requirements for achieving ESM of obsolete POPs pesticides. Experience in other developed countries reveals that strengthening risk assessment at hazardous waste disposal facilities is an effective measure to ensure their safe operation. China currently does not undertake such risk assessment.

57. Inappropriate operation of disposal technologies can increase risks to the environment. For example, inappropriate control of incineration technical parameters and pollution caused by tail gases leads to higher PCDD/PCDFs releases, with concomitantly greater risks to public health and the environment. It is difficult to identify these problems through routine site inspections. By using risk assessment methodologies, inspectors can identify otherwise unknown problems and require new procedures, modification, or shut down for non-compliant facilities.

g) Lack of effective personnel training systems to provide qualified human resources for ESM based lifecycle management of POPs pesticides

58. Experience of developed countries proves that effective training is necessary to improve managerial and operating personnel capabilities in ESM based lifecycle pesticides management. The Stockholm Convention requires each Party to promote such training of workers, scientists, and technical and managerial personnel. China has no such training system, and it is therefore important that an effective system be established, particularly given the training needs that implementation of the Stockholm Convention requirements entails. Most disposal facility operators lack the knowledge and capabilities to comply with these requirements and require training in correct operation of equipment, emergency response, record keeping and reporting.

h) Lack of stakeholder awareness raising and education

59. ESM of obsolete pesticides in China involves the following groups:

i) Governmental personnel from multiple agencies, whose role is to carry out effective regulation and management of waste treatment and disposal through regulatory, administrative, economic and other instruments;

ii) Professional bodies and individuals including scientific and technological research personnel for obsolete pesticides treatment and disposal, waste disposal equipment manufacturers, and disposal facility operators;

iii) End-users, including small scale agricultural end-users who often resort to open burning or other improper methods to dispose of unused POPs pesticides; and

iv) Members of the general public who, if properly educated, are in a position to reduce contamination risk and exercise public supervision over treatment and disposal facilities.

60. *While members of these groups play a crucial role in ESM, their awareness and knowledge are* currently inadequate. For example, due to lack of knowledge about the secondary pollution from uncontrolled incineration of obsolete pesticides and the availability of alternative technologies, many government officials wrongly believe that incineration is the only way to treat obsolete pesticides. They actively promote incineration technologies and neglect the research, development, and application of alternatives. As a result, inappropriate incineration disposal has generated considerable amounts of toxic and hazardous substances such as PCDD/PCDFs.

61. Public information materials for those without a professional or scientific background are few and inadequate. Little has been invested in public information and educational campaigns through radio, TV, and other effective ways to reach the general public.

i) Lack of effective mechanism to promote research, development, and application of technically feasible and locally affordable processes, techniques and equipment

62. Some researches about the disposal of PW received international financial assistances. For example, the Institute of Hydrobiology (IHB) and Chinese Academy of Sciences (CAS) received funding from the Volkswagen Foundation and established China's first dedicated laboratory complying with international standards for the testing and research of PCDD/PCDFs-like compounds.

63. Overall, China's research and development in PW processes, technologies and equipment mainly focus on incineration technologies, particularly the pyrolysis incineration technology, and there are only very few studies on alternative technologies.

64. However, centralized disposal of hazardous wastes only started recently in China, and the country's capacity for research and development of disposal processes, technologies, and equipment remains in its infancy. The project preparatory phase surveys found the following gaps in incineration technologies of China compared with the international advanced level:

- The automation level of incineration disposal facilities is low in the waste feeding system. Many facilities are incapable of automatic feeding resulting in poor sealing at the feed inlet.
- Neither the furnace body design nor the manufacturing technology of rotary kilns and pyrolysis furnaces are up to international standards. Furnace walls are frequently overheated, which consequently damages the seals of incinerators, affects temperature control and severely shortens the service life of furnace body.
- The state of pyrolysis and combustion is not stable enough. The automatic control system cannot respond to the fluctuation of combustion conditions in time.
- The design of the principal body and nozzles of quenching tower is inappropriate, which influences the effect of quick quenching.
- Design technologies for selective catalytic reaction equipment and catalysts associated are still missing in China.
- The continuous emission monitoring system (CEMS) is not up to standard, incapable of real-time monitoring of pollutant releases in the combustion process.
- Poor integration of related individual technologies into system.

65. With the technological gaps in incineration, China cannot fulfill the international achievable limits for PCDD/PCDFs emissions from the hazardous waste incinerators, below the standard value of 0.1ngTEQ/Nm^3. The severely inadequate supply of various alternative technologies makes them difficult to adopt as recommended by the Convention. Therefore, China needs to properly introduce, digest and absorb foreign advanced technologies to close up these technological gaps. A long-term strategy on independent or joint research and development has to ensure that equipment in demand is locally available, thus reducing costs for the implementation of the Convention.

66. Based on the above analysis, a strategy should be put in place to mobilize the needed fund for research and development by means of:

- Divert investment of the national scientific research funds to research and development activities of this project by establishing a policy dialogue mechanism with the fund management authorities;
- Tap resources from enterprises for research and development of disposal equipment in need by creating and regulating domestic market; and
- Encourage joint research and development among international technology vendors and domestic enterprises by establishing a mutually equitable benefit sharing mechanism

j) Lack of POPs waste disposal capacity

67. Incineration is the principal technology for hazardous waste treatment in China. Compared to developed countries, China lacks environmentally sound management (ESM)-qualified incineration facilities and operating experience. Most of the facilities have a capacity less than 10 tons per day, but are still unable to consistently operate at full capacity level. Some facilities are capable of incinerating POPs wastes under the current national dioxin emission standard (0.5 ngTEQ/Nm^3). Such operations always have very high operating costs and require regular government subsidies. At the current stage of hazardous waste disposal industry development, it would not be technically feasible to dispose of the identified 10,000 tons of stockpiled POPs pesticides according to international BAT/BEP standards (0.1ngTEQ/Nm^3). China also has limited knowledge of and experience with co-processing of hazardous waste in cement kilns, which constitutes a barrier in considering this disposal option and implementing it in accordance with the ESM guidelines.

68. For POPs wastes, only PCB is identified as special hazardous waste in the Technical Policy for the Prevention and Control of Pollution Caused by Hazardous Wastes and other regulations and required to be treated at 1200 °C for at least 2 seconds according to the Pollution Prevention Standard of Hazardous Waste Incineration, as requires very complex equipments, sophisticated controls and dangerous processes.

69. Although two POPs treatment centres have been planned in NHMWP approved in 2004, their construction has started with some delays. The only incineration facility that will meet the Convention operating standards is located in northeast China and dedicated to PCBs disposal at the unit cost of 2,000 Euros per ton. This facility has not yet been commissioned, and when operational, the demand on this facility will be beyond its capacity hence will not be available for this project. No other incineration facility that is currently in operation in China meets the Convention's standards for the disposal of POPs waste.

70. In addition, it is not economically feasible to export the POPs stockpiled pesticides and other POPs waste to other countries for final disposal in hazardous waste incinerators within the EU that meet the Convention's standards. In addition, the assembly and in-country transport costs of the waste and other pre-disposal activities including packaging to international standards, shipment cost, and compliance with transboundary with shipment regulations impose significant costs. On one side, the amount of POPs wastes is too big to transport to other countries, e.g. more than 110,000 tons POPs wastes were found from 2 typically high contaminated sites of pesticides of the total 44 POPs pesticide plants already closed. On the other side, relying on this option will delay or prevent the development of China's own capability to dispose of stockpiled pesticides and other POPs wastes in an environmentally sustainable manner. An analogue comparison would be the in-country unit transport cost to the dedicated PCB disposal incinerator in northeast China.

k) Slow commercial application of innovative POPs waste disposal technologies

71. Toxic emissions and the related health risks resulting from incineration have given rise to increasing concerns in China. Incineration is a major source of dioxins in China, and the risk of dioxin generation will increase significantly when additional POPs wastes are treated via incinerator. Demonstration and promotion of alternative technologies for the treatment of POPs contaminated waste is therefore a high priority.

72. Surprisingly, the commercial application of novel POPs disposal technologies in China has not been as successful as in other countries. Recently, several alternative technologies for POPs wastes disposal have been studied and applied in China such as pyrolysis, plasma arc technologies, supercritical water oxidation and molten salt technologies. Out of these technologies, plasma arc has been deeply researched and developed, such as the Plasma pyrolysis gasifying apparatus (Institute of Mechanics, Chinese Academy of Sciences – CAS-IMECH), High Power Plasma Technology for Hazardous Waste Treatment (Institute of Plasma Physics of CAS) and Plasma Medical Waste Treatment System (Research Institute of Tsinghua University in Shenzhen). However, the spread of these technologies are quite limited in the area of POPs waste treatment.

73. CAS-IMECH began its plasma research as early as 1960's. In 2002, the chemical warfare agent destruction experiment was taken in this furnace for Chemical Defense Institute of PLA. In 2003, it developed its plasma arc technology for medical wastes treatment sponsored by National Hi-Tech Project 863 and completed plasma-arc pyrolysis system with reductive atmosphere in the laboratory. The load capacity is 60 kg/h and the vitrified slag with very stable physio-chemical property was obtained. Furthermore, it was also used to treat PCBs and HFC23 at Zhonghao Chenguang Research Institute of Chemical Industry (ZCRICI), Sichuan Province. Tests showed the destruction efficiency (DE) is higher than 99.99%. PCBs content in the residue was lower than 1.28 mg/kg PCBs.

74. The operating cost for PCBs treatment for a plasma facility with the capacity of 5 ton/day was much lower than the PCB disposal fee by high temperature incineration (about 20,000 RMB/ton). However, the technology has not been widely used for other POPs and in other plants till now because the high temperature incineration was regarded as the only authorized technology for PCBs wastes based on a national standard.

l) Distribution and properties of obsolete pesticides and dioxin-rich fly ash

75. According to the current inventory of obsolete pesticides, the owners namely 20 pesticide manufacturers, 8 pesticide dealers for agricultural used and 5 disease control centres for vector control distributed in 14 provinces. POPs wastes include obsolete pesticides, solid residues, liquid wastes, soil and sediment of DDT, HCB, PCP-Na, toxaphene, chlordane, mirex and dicofol. The large number of pesticide sites, great disparity of waste amount at each site, the matrices contaminated with wastes makes their collection, packaging, transportation, storage and disposal a serious challenge for China having relatively little experience in hazardous waste management.

76. In addition, the handling, transportation, storage and disposal of PCDD/PCDFs rich fly ash is also a very new issue to be addressed since in most of the cases, they were disposed at landfill. The high content of PCDD/PCDFs and heavy metals make the disposal more difficult than the normal POPs wastes. The project requires broad-spectrum of highly efficient disposal technologies to be able to treat effectively many kinds of POPs wastes that would make the technology selection and cost control difficult. For a description and analysis of environmentally sound technologies for fly ash management, see Annex 3 – Environmentally sound technologies for fly ash management.

m) Lack of experience in operating mobile disposal facilities

77. For widely dispersed distribution of obsolete POPs pesticides and associated wastes it is a reasonable choice to select mobile POPs disposal facilities. Although the stationary disposal units are the optimal choice of selection for POPs waste, mobile units of low capacity are more economic due to their lower costs and are acceptable by the public due to their "temporary outfit".

78. New alternative technologies can be installed as mobile or semi-mobile units. The main processing plant and control room are constructed within two standard 40 foot ISO containers. These ISO containers have been issued with CFC plates for all modes of transportation. Various support facilities required for the operation of the mobile unit are located adjacent to the processing plant. As for a semi-mobile units concerned, it takes 2-3 months to dismantle, move and re-erect them somewhere else with a capacity of 3,000 tons/year. The cost of re-location is in the range of 15-25% of initial capital costs with additional costs required for sampling, analysis, and transportation. For Plasma Arc (PLASCON), the footprint of the skid is 12 m^2. The height is

2 m, allowing transportation via shipping containers. Site preparation costs are approximately US$100,000 and accounts for 10% of equipment price. The Startech Plasma's footprint of 5, 10, 20 TPD converter is 10.47m^2; height is 3m, again allowing transportation via shipping container.

79. Although wide experience had been accumulated in developed countries, designing, manufacture, operation and maintenance are still a challenge in China. It should be noted that the mobility of the unit and its effectiveness required to be well balanced.

n) Lack of cooperative and coordinated ESM for POPs waste disposal

80. In China, the hazardous waste management is based at provincial level and each province has a solid waste management centre and at least one hazardous waste disposal centre, which are responsible for the management and disposal nearly all the hazardous waste in that particular province. However, the disposal of obsolete POPs pesticides requires a regional mechanism and coordination. The frequent transboundary movement for POPs waste among provinces and operating a mobile disposal facility in several provinces (actually in 14 provinces) requires a strong policy and regulatory support.

81. With the aim to complete the construction of PW disposal facilities across the country as fast as possible and to set up a suitable framework of administrative rules, the NHMWP defined the scheme for the construction of disposal facilities focusing on incineration technology in cities at the prefecture level. In addition, the Program during its implementation has put in its agenda disposal facilities applying alternative technologies pointing out that disposal of different types of PW must be evaluated with demonstration projects.

82. The efficient use of waste disposal equipment capacities during maintenance period can be secured by strengthening cooperation among regional hazardous waste disposal centres. The cooperative disposal of hazardous wastes involving disposal facilities in adjacent cities can have significant benefits. Apart from the economies of scale and the breakdown of administrative barriers, the concept reinforces regional planning and coordination. At a practical level regional facilities including incineration and alternative technologies that can deal with the various waste streams of POPs wastes may provide an ideal model to improve environmental benefits and to ensure environmental safety within the region. The integrated regional capacity allows for the maintenance time without loss of service, the capacity to deal with a variety of specialized hazardous wastes and an enhanced capacity to deal with emergencies.

83. As mentioned above, the promotion of the cooperative disposal of POPs wastes has multiple economic, social and environmental benefits. However, to achieve these benefits, it is required to remove the present administrative barriers to establish a regional cooperation mechanism aiming at overall optimization of the facility resources in the region.

o) Lack of certification program to provide open, reliable and comparable information for reviewing technical and environmental performance of POPs waste treatment and disposal facility owners

84. The certification of environmental protection products (including POPs wastes disposal equipment) is conducted by an independent certification agency to certify that equipment and instruments preventing and controlling environmental pollution used specially for environmental monitoring comply with relevant standards or technical requirements. To carry out independent, objective and fair certification of environmental protection products has the following benefits:

- Lift the market threshold for environmental protection products to prevent inferior products to enter the market so that users can choose and buy good quality products.
- An environmental product manufacturer may promote the label issued by a certification agency among consumers to show and prove its products in compliance with related technical requirements. This helps to improve the environmental image of the enterprise and promote sales of its products.
- The inspection and survey during the certification help to find defects and problems of the environmental protection product and urge the manufacturer to improve the manufacturing technology and product performance.

85. A complete organizational system for the certification of PW disposal equipment should include

an accreditation authority, an accredited certification agency and accredited testing institutes or laboratories.

86. At present, the China Certification Centre of Environmental Protection Industry (CCCEPI) and China Standard Certification Centre (CSC) are certification agencies accredited for certification of hazardous wastes disposal equipment. CCCEPI is accredited by MEP and Certification and Accreditation Administration of the People's Republic of China to carry out certification of environmental protection products. It can perform certification for a variety of products for PW disposal including industrial waste incinerators and dust removal devices. CSC is subordinate to China National Institute of Standardization. It is a third-party certification agency accredited to carry out certification of products for energy conservation, water conservation and environmental protection. So far, only incinerators and a few types of dust precipitator have been included in the list of products subject to certification.

87. Presently, 28 testing agencies such as the Quality Supervision and Testing Centre for Environmental Monitoring Instruments under MEP and the National Flue Gas Control Engineering and Technical Centre of Environmental Protection Industry have been examined and approved by CCCEPI as qualified testing agencies. However, incinerator has not been included in their testing capacity.

88. Most hazardous waste disposal facility owners do not fully understand the significance of buying certified equipment. To reduce purchase cost, they generally choose to buy cheap equipment that cannot meet the certification requirements. For facilities currently in operation, great majority have significant quality problems. For example, most pyrolysis furnaces cannot operate in an uninterrupted way; the quenching tower cannot be installed and run and equipment service life is extremely short. These have severely affected effective operation of disposal facilities and make them difficult to achieve the safe disposal of PW.

89. In order to establish a certification and labeling programme for PW disposal equipment, the following work has to be undertaken:

- Develop technical requirements for the certification of PW disposal equipment;
- Strengthen the existing certification agencies to include PW disposal equipment into their certification catalogue;
- Develop certification procedures and criteria;
- Strengthen the existing testing agencies to include PW disposal equipment into their testing catalogue; and
- Encourage the manufacturers to apply for the certification and promote the facility owners to buy certified equipment.

p) Lack of inter-ministerial mechanism to provide coordination and guidance upon cross-sectoral policy and implementation issued

90. An inter-departmental coordination mechanism is often used as an effective means to address comprehensive environmental protection issues by many countries in the world in their work on environmental protection. Like most other comprehensive environmental protection work, disposal of POPs wastes is also cross-sectoral. Various aspects such as construction of POPs waste disposal facilities, management of facility operation, and development of charging policy involve the responsibilities among different departments of environmental protection, development, agriculture, health, safe production, communications, construction, industry and commerce, and pricing.

91. In China, various departments are responsible for the environmental protection work within their jurisdictions, and the environmental protection department carries out unified supervision and management. Due to administrative barriers existing among different departments and lack of a cross-sectoral coordination mechanism in place, the process of PW disposal is constrained. For example, coordination efforts have long been needed in such key segments as charging policy, facility construction, validation and market-based operations in order to achieve the goal of sustainable environmental management of PW.

92. To meet the obligations under the Convention as well as addressing ESM of PW, cross-sectoral coordination mechanism composed of relevant departments is required to provide guidance and coordination in the development of unified national and local policies and programs for PW management and disposal. To date, China has no inter-ministerial mechanism to provide this coordination among ministries at the national level and with local agencies. The project will rectify this problem through creation of inter-agency supervisory and working bodies to ensure communication and coordination between ministries and governmental levels.

q) Stakeholder conflict of interests

93. The waste management sector includes a large number of stakeholders, many of which have diverging (and sometimes conflicting) interests. For example, at the most basic level, hazardous waste treatment facilities may prefer high waste treatment fees in order to maximize revenues, while POPs wastes owners prefer low fees in order to reduce their costs. The project will attempt to address such risks by developing and implementing approaches that minimize total system costs, and then distribute those costs equitably among stakeholders in order to allow operation of the waste management programs in an environmentally sound manner.

94. Other conflicting interests that may pose a particular threat to the project is when local waste management agencies may resist alternative technologies because they are heavily invested in or committed to incineration technologies and believe that alternative technologies would be implemented outside their sphere of influence. This perception might be particularly true for introducing innovative technologies to treat and dispose dioxins rich fly ash generated from hazardous and medical waste incinerators. The project will address such risks by working with stakeholders to develop win-win approaches, including PPP and alternative ownership and operating approaches that will give all parties the incentives to select the most economically and environmentally sound technologies.

A.3 Local, Regional and Global Benefits

95. Obsolete POPs pesticides are a class of toxic chemicals that resists degradation, bio-accumulates and with potential for long-range transport. Their release into the environment therefore constitutes a significant risk, impacting human and ecosystems locally, regionally, and globally. Numerous studies have confirmed that exposure to DDT, HCB, and other POPs pesticides can result in cancer, reproductive impacts (such as decreased fertility and reduced sperm counts), and developmental problems such as birth defects, inability to maintain pregnancy, and lowered testosterone levels.

96. ESM based lifecycle management of hazardous obsolete POPs pesticides and associated wastes have not yet been achieved in China. Lax enforcement of pesticide waste management regulations and disposal facility standards have resulted in continuous increase in the amount of improperly managed POPs pesticide wastes. Most obsolete POPs pesticides are just dumped untreated on pesticide manufacturer property or in the surrounding area, or mixed with municipal wastes.

97. Where obsolete pesticides are collected, they are generally either disposed of in landfill isolation without measures to prevent leachate infiltration into soils and ground water, or treated in incinerators without effective pollution controls or emissions monitoring to minimize the potential for adverse environmental impacts. Many incinerators are equipped only with out-of-date APCDs that are unable to adequately control release of air pollutants such as particulate matters (PMs), PCDD/PCDFs, heavy metals (Pb, Hg and Cd), acid gases (HCl and SO_2), CO, and NO_x, all of which result in serious adverse impacts to worker safety, public health, and the environment.

98. With GEF support, the proposed project will address these issues through regulatory enhancement, capacity building, technology transfer, a novel PPP mechanism, and direct treatment of obsolete POPs pesticides and associated wastes. The combination of these approaches will not only address the immediate, high priority need to mitigate the imminent local, regional, and global environmental risk posed by the obsolete pesticides identified during the project preparation, but will also provide for the regulatory framework, institutional capacity, and technical capacity to improve management of POPs pesticides on a long-term sustainable basis, with concomitant benefits to local communities, China, the region, and the world.

99. In summary, the project will generate significant local, regional and global benefits, including:

- Safe disposal of a minimum of 10,000 tons of obsolete POPs pesticides and 1,000 tons of dioxin-rich fly ash, which in and of itself is of significant local, regional, and global significance.
- Avoided emissions of 8.97 gTEQ PCDD/PCDFs releases into the water and atmosphere through improved emissions control technology and direct destruction of 30.67 gTEQ of dioxins.
- Additional local, regional, and global environmental benefits accruing from long-term capacity building and regulatory reform activities.
- Innovative approaches providing a model for sustainable management of obsolete POPs pesticides and other POPs both in China and in other developing countries.

A.4 Special Features

100. The proposed project is the first one in China to directly address the issue of accumulated obsolete POPs pesticides and associated wastes. The project will directly provide for cleanup of at least 10,000 tons of these wastes, plus 1,000 tons of dioxin-rich fly ash, and will develop national capacity to identify, manage, and treat other such wastes in an environmentally sustainable manner in the future.

101. The project is a national priority project addressing an important Stockholm Convention requirement, which it does in a highly cost-effective manner. A novel PPP mechanism will be introduce to mobilize resources from both the public and private sectors and encourage innovation.

102. The cost to the GEF for treatment of obsolete POPs pesticides and associated wastes directly addressed by the project will be under US$1000/ton, which is similar to treatment cost in the European Union and compares favorably to cost figures from other POPs waste treatment projects in China. Given that GEF funds are leveraged at 1:3 ratio and considering the additional long-term capacity building and other benefits which the project will provide, the project's cost effectiveness from a GEF perspective is even greater.

103. Given the high risk to public health that POPs contaminated waste entails, the project will also provide significant health benefits to such vulnerable populations as women and children, which international research shows are often exposed to POPs pesticide contaminants and contaminated containers at a higher incidence.

104. The project will coordinate with and draw on the lessons learned from other bilateral and multilateral projects in the POPs pesticides and related areas, including in particular the Sino-German pesticides project. The project has also benefited from input received from Germany and Japan at the GEF Council meeting in response to the PIF submission, from comments and technical information provided by industry experts from Germany, Italy, and the Netherlands, and from comments and other project developmental support being provided by the Netherlands Soil Partnership, the Sino-Dutch Centre for the Management and Remediation of Contaminated Land, and the International HCH & Pesticides Association.

SECTION B: REASONS FOR UNIDO ASSISTANCE

105. UNIDO is committed to assist its developing country Member States in accordance with Article 12 of the Stockholm Convention. The GEF has approved Enabling Activities proposals submitted by UNIDO for about 43 countries, including China and India that have opted to undertake the NIP development through GEF full project cycle. In addition, UNIDO is executing or developing a range of demonstration and capacity building projects geared to support Stockholm Convention implementation in a wide range of developing countries and countries with economies in transition. These activities are compatible with UNIDO's mandate and corporate strategy and will lead towards the Millennium Development Goals.

106. UNIDO has significant past experience with environmentally sound waste management projects in China. The municipal solid waste management project that resulted in the formulation of a nationwide municipal solid waste management strategy had of particular significance. Recently UNIDO took the lead in implementing BAT/BEP measures in several industrial source categories (iron and steel industry, medical waste incineration and production of pulp and paper) of the potential for comparatively high formation and release of UP-POPs to the environment. Based on the favourable experience gained, MEP jointly with UNIDO formulated and submitted for GEF funding a full sized BAT/BEP project on environmentally sustainable medical waste management in China. This project was approved and its Inception Workshop was held in Beijing in March 2008.

107. China is UNIDO's largest recipient of technical cooperation assistance. Activities undertaken by UNIDO in China include a range of measures related to investment, industrial efficiency and waste management. It is noteworthy to mention that China, through the National Pesticide Centre (NPC) in Nantong, which deals with the formulation technologies of pesticide, is a participating country in UNIDO RENPAP programme (Regional Network for Pesticides Formulations in Asia and the Pacific) that has a strong element of pesticide waste management. Close cooperation between NPC and UNIDO POPs unit on promotion of alternatives to POPs pesticides will be established. The experience gained in these projects will be of relevance in the proposed project in China.

108. UNIDO's in-kind contribution to the project will comprise the establishment of a project focal point and the provision of the part-time assistance of senior staff within its Environmental Management Branch to ensure the effective implementation of the project and to support project implementation.

109. In addition, UNIDO will continue to seek co-financing or associated financing for activities that further the objectives of the project and of implementation of the Stockholm Convention in China.

SECTION C: THE PROJECT

C.1 OBJECTIVE OF THE PROJECT

Overall Objective of the Project

110. The project's overall objective is to implement environmentally sound management (ESM) and disposal of 10,000 tones of accumulated POPs pesticide wastes and 1,000 tones dioxin rich incinerator fly-ash in fulfillment of China's obligations under the Stockholm Convention. If not addressed, the presence of these geographically dispersed accumulations of POPs wastes constitutes a significant source and ongoing pathway risk to environmental receptors, particularly groundwater and surface water resources, with concomitant negative impact on human and ecosystem health.

111. The objective will be achieved through a combination of strategies, including legislative and regulatory development, capacity building, public education, technology transfer, training, technical support, and introduction of new advanced environmental risk assessment tools. For additional detail, see Annex 1: Project Logical Framework. For a graphic illustration of this conceptual framework, see Figure 3 below.

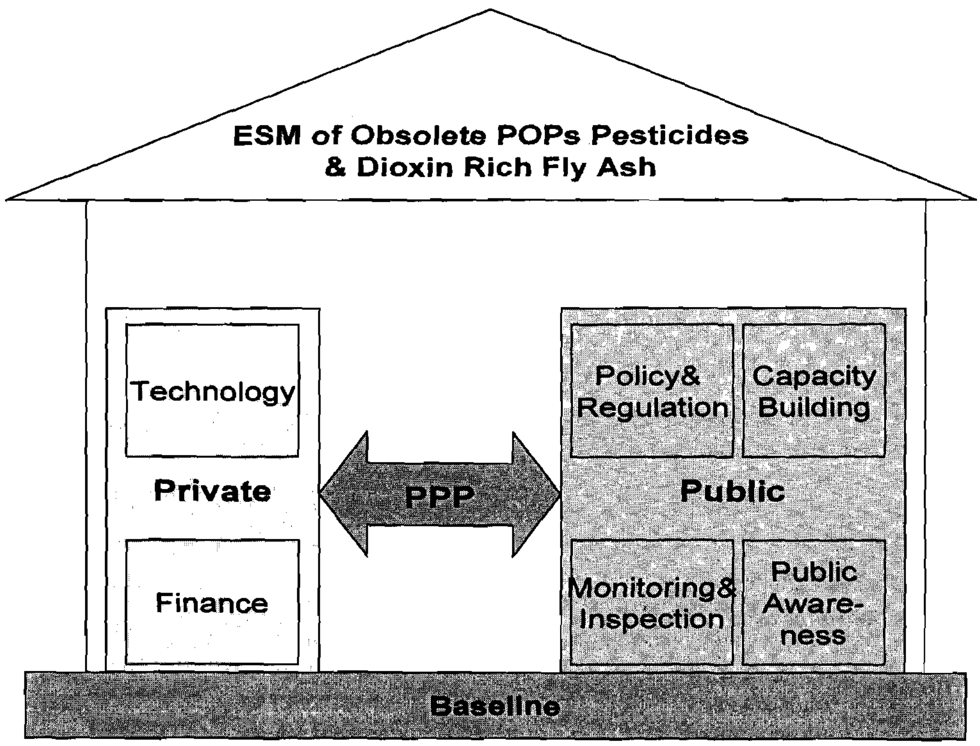


Figure 3: Project Conceptual Framework

112. The full participation of stakeholders is required to properly characterize the pesticide stockpiles and to ensure that appropriate disposal technologies are used. PPP mechanisms will be introduced to promote technology transfer. National and international experts will be recruited to facilitate the technology transfer process by expanding the scope of technology selection and candidate vendors. Owners of facilities and technology vendors will be selected through an open bidding process. The experts will also help to clarify and define the participation models of the relevant and in particular the waste disposal business models

113. Transparency and competitiveness in the ownership and modus operandi of facilities will be guaranteed by two rounds of transparent and open tendering processes. The first round is for the national selection of the owners/operators of suitable host facilities through important criteria assessment including, but not limited to operating license, co-finance, relationship with local government (to satisfy PPP criterion) and previous experiences in hazardous waste business. The second round is the international tendering process for the technology selection. The

selected national host entities will participate in the technical evaluation of the bids for the technology selection. The process will then be completed by opening the commercial bids and equipment procurement. All processes will be jointly organized, executed and supervised by UNIDO and MEP/FECO through the above mentioned national and international open bidding processes.

Immediate Objective of the Project

114. The immediate objectives of the project are to:

   a. Strengthen the legal and regulatory framework for environmentally sound management (ESM) and disposal of POPs waste
   b. Improve institutional capacity at all levels of POPs waste disposal management
   c. Remove POPs pesticide wastes dioxin rich incinerator fly ash from targeted contaminated sites, and transport them to disposal unit
   d. Dispose of wastes in an environmentally sound manner
   e. Complete qualitative environmental risk assessment (QERA) site prioritization.

C.2 THE UNIDO APPROACH

Project Implementation Arrangements

115. UNIDO will be the GEF Implementing Agency (IA) for the project. A project focal point will be established within UNIDO to assist with project execution. This focal point will consist of dedicated core staff, supplemented by support from professional and support staff colleagues on a part-time as needed basis, including in particular senior staff engaged in the management and coordination of UNIDO's POPs program. UNIDO will make these services available as part of its in-kind contribution to the project.

116. ESM of obsolete pesticide wastes and dioxin rich fly ash involves a wide spectrum of stakeholders both vertically and horizontally distributed throughout China's administrative framework. While the principal responsibilities will be undertaken by environmental sector stakeholders, a variety of stakeholders from other sectors will play an important role in the project. Annex 5 lists these stakeholders and describes their mandates, providing the administrative context under which these mandates will be translated into specific responsibilities. The project management structure is given in Figure 4 below.

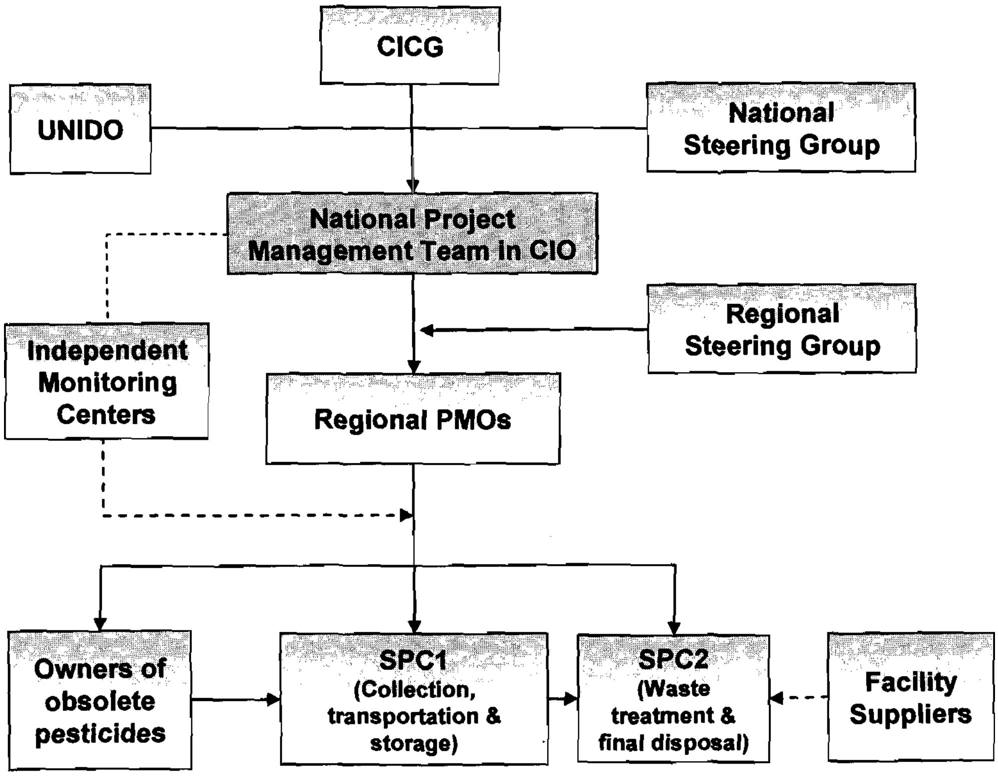


Figure 4: Project Organogram

117. **Convention Implementation Coordination Group (CICG)**. China established the National NIP Development Leading Group in September 2003. This Group became the National Leading Group for Implementation of the POP Convention when China ratified the Convention on 13 August 2004, which was formally approved by State Council in April 2005 and renamed the National Technical Coordination Group (TCG) for Implementation of the Stockholm Convention, or Convention Implementation Coordination Group (CICG). The CICG will provide (i) review of significant policies related to POPs management and control, (ii) guidance and coordination for POPs management activities and Convention implementation. The CICG consists of the following 13 agencies:

i. Ministry of Environmental Protection (MEP)
ii) Ministry of Foreign Affairs (MOFA)
iii) National Development and Reform Commission (NDRC)
iv) Ministry of Finance (MOF), which is the GEF Focal Point in China
v) Ministry of Commerce (MOCom)
vi) Ministry of Science and Technology (MOST)
vii) Ministry of Agriculture (MOA)
viii) Ministry of Public Health (MOH)
ix) Ministry of Housing and Urban-Rural Development (MOHURD)
x) General Administration of Customs (GAC)
xi) State Electricity Regulatory Commission (SERC)
xii) General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ)
xiii) State Administration of Work Safety (SAWS)

118. UNIDO is coordinating all POPs activities of all UN, multi- and bilateral POPs activities in the country, jointly with the Ministry of Environmental Protection (MEP) through the annual Technical Coordination Group (TCG) meetings. This includes World Bank, UNDP, UNITAR, UNEP and others.

119. **Convention Implementation Office (CIO)**. The CIO is part of MEP and is responsible for coordinating the day-to-day management of the Stockholm Convention implementation in China. The CIO's responsibilities include: (i) provision of technical support for international negotiations and policy studies on the Stockholm Convention, (ii) provision of support for development and implementation of POPs-related policy and regulations, as well as coordination of key governmental stakeholders, (iii) mobilization of co-financing from bilateral, international, and national sources, (iv) collecting data and information, compiling reports, organizing training activities, and publishing information. The CIO will provide guidance to ensure the successful implementation of the project, including regular monitoring and enforcement inspections. As the CIO is not an independent legal entity, **Foreign Economic Cooperation Office (FECO)** will be the national executing agency (NEA) and will represent MEP and the CIO in the management and completion of contracts for project implementation.

120. **National, Provincial and Municipal Steering Groups**. The project will establish a national steering group by drawing upon resources from related ministries or commissions in charge of development and reform, environment, health, construction, and pricing to provide the project team with political guidance and inter-ministerial coordination support. To facilitate the extensive demonstration and replication activities at provincial and municipal levels, the National Steering Group will encourage and assist provincial and municipal governments in the establishment and operation of their own corresponding steering groups.

121. **National Project Management Team (NPMT)** will be composed of staff from MEP, NDRC, MOHURD and other relevant agencies. MEP will designate a coordinator/team leader. The Project Management Team will be responsible for the day-to-day management and execution of the project, and will oversee local project management offices. The NPMT's responsibilities will include (i) assignment and supervision of project activities; (ii) recruitment of national consultants; (iii) providing guidance to local PMOs; (iv) coordination with stakeholders, donors, the IA, relevant national agencies and the private sector; (v) preparation of terms of reference (TORs) for project activities, (vi) review of project progress reports submitted by the local PMOs, (vii) supervising project procurement and financial resources in accordance with UNIDO procedures, (viii) organizing and convening project coordination stakeholder meetings, and (ix) review of project outputs. Detailed description of the work to be performed by the NPMT is given in Annex 5 - Terms of References.

122. **Project Expert Team (PET)**. The project will recruit an international **Chief Technical Advisor (CTA)**, a **National Technical Advisor (NTA)**, policy experts, waste management industry experts, chemists, monitoring & evaluation experts and other technical experts. These experts will form a Project Expert Team to assist the CIO and NPMT through the following activities:

- i) Introduction of successful experiences gained from foreign countries;
- ii) Management and coordination of all project activities;
- iii) Provision of technical support for policy framework, institutional strengthening, demonstration activities, technology selection, market promotion, awareness raising and education, results and experience dissemination, project monitoring and evaluation, replication program development, and project management;
- iv) Periodic project implementation progress appraisal;
- v) Support for development of training materials; and
- vi) Liaison for international symposia and field research.

Detailed description of the work to be performed by the project expert team is given in Annex 5 - Terms of References.

123. **Regional Project Management Offices (PMOs)** will be responsible for coordination of project activities that transcend provincial boundaries. The project will involve a large number of

obsolete pesticides owners, incinerator fly ash owners and dedicated treatment and disposal facilities operating across municipal and provincial lines. Extensive awareness promotion and training activities will be conducted in coordination with local officials. Implementation of new regulations will rely on local administrative agencies. Treatment of obsolete POPs pesticides and dioxin rich fly ash and disposal at provincial hazardous waste disposal centres will be regionally optimized to improve efficiencies, reduce costs, and reduce environmental risk. In addition there will be extensive demonstrations of BAT/BEP for integrated waste management that will cluster obsolete POPs pesticides, associated wastes, and incinerator fly ash generators and waste treatment and disposal facilities.

124. Regional PMOs will be composed of staff from relevant provincial governmental agencies. Their responsibilities will include (i) management of the provincial level activities; (ii) oversight of provincial and municipal implementation; (iii) dissemination of the experience emanating from demonstration sites; (iv) coordinating treatment activities with the mobile treatment facility and base stations; (v) coordinating transportation of waste materials over provincial lines; and (vi) collecting information and preparing progress reports. Their specific responsibilities will be defined by the NPMT supported by the PET after the inception workshop.

125. Private sector stakeholders and other potential project participants will be actively recruited and integrated into the project, as follows:

- Waste owners will be provided with technical assistance and financial support on a cost-sharing basis to adopt ESM in obsolete pesticides management and to treat existing stocks of obsolete POPs pesticides and associated wastes;
- Waste transporters and treatment and disposal facilities will be provided with technical assistance and capacity building support to ensure implementation of obsolete POPs pesticide waste management requirements, and provided with targeted incentives to adopt ESM practices beyond current regulations;
- Private sector contractors selected under the PPP program to provide facilities and services will form an integral part of the project;
- End-users will be educated in proper pesticides management and risk minimization/ avoidance, supported by new policies and programs (e.g., possible manufacturer/distributor take-back requirements) to encourage ESM practices.

C.3 RATIONALE FOR GEF INTERVENTION

126. Storage of obsolete pesticide wastes containing POPs constitutes a major problem in China. These wastes have been accumulating for decades and are estimated at over 10,000 tons, including approximately 6,000 tons of DDT and approximately 4,000 tons of HCB, chlordane, and mirex.

127. Obsolete POPs pesticide wastes are widely distributed throughout China. High priority locations identified during development of China's NIP and preparation of this project include 44 POPs pesticides manufacturing plants and a number of distributor sites. Unsound storage conditions at these sites entail high risk of POPs release, with concomitantly high risk of POPs contamination of ground water and soil. Capacity does not currently exist to dispose of these contaminated wastes in an environmentally sound manner. Current regulatory requirements and waste disposal facilities do not take ESM practices and Stockholm Convention requirements into consideration.

128. Where disposal does take place, current disposal practices are dominated by direct incineration without consideration of Stockholm Convention requirements, resulting in secondary pollution such as dioxin and furan formation and release into the atmosphere. In addition, incineration of hazardous and medical waste results creates large amounts of fly ash (an estimated 11,000 tons per annum) containing high levels of dioxin. While current regulations require that fly ash resulting from these wastes be either destroyed or de-contaminated prior to landfill, incineration plants lack the understanding and technology to do so, and hence generally either store the resulting fly ash or landfill it without treatment, thereby increasing the risk of POPs releases.

129. In May 2001, the Stockholm Convention on Persistent Organic Pollutants (POPs) was adopted with the aim of protecting human health and the environment from POPs. The GEF became the principal financial mechanism by the decision of the Conference of Parties (COP). In October 2002, the GEF Assembly approved the addition of POPs as a new GEF focal area, and in November 2003, the GEF Council approved a GEF Operational Program on POPs – OP 14.

130. Article 5 of the Convention requests that Parties shall take measures to reduce releases of unintentionally produced POPs listed in Part I Annex C with the goal of their continuing minimization and, where feasible, ultimate elimination. Part II of Annex C is a list of source categories that "have the potential for comparatively high formation and release of these chemicals (i.e. dioxins) to the environment" and the "Waste incinerators, including co-incinerators of municipal, hazardous or MW or of sewage sludge is the first source in the list.

131. For new sources listed in Part II (including any new or any substantially modified facility for treatment of POPs contaminated wastes), Parties are required to use best available technology. This requirement is to be "*phased in as soon as practicable but no later than four years after entry into force of the Convention for the Party.*" The Convention entered into force for China on 11 November 2004, which means that waste treatment facilities built or modified on or after 10 November 2005 will be required to adopt BAT/BEP by 10 November 2008. Furthermore, in all existing facilities, China is required by the Convention to promote BAT and BEP.

132. During the implementation of the project, GEF contribution is needed to remove the barriers in particular in the area of technology selection and promotion as well as the need to improve policy and institutional defects. GEF contribution will play a catalytic role in the selection and promotion of technologies in compliance with the Stockholm Convention and other international environmental agreements. GEF contribution is also necessary to initiate national concern and awareness for ESM of POPs pesticide and other POPs wastes and to leverage co-finance of other major stakeholders to demonstrate a fee charge system that defines the roles and responsibilities of each player (government, private companies and the GEF) and supports the related disposal market. GEF grant will be used to ensure adequate interests and participation of the private sectors to construct and operate the facility during the project implementation.

133. When a Party implements this obligation, it should assure that priority consideration is given to alternative processes, techniques or practices that have similar usefulness but which avoid the formation and release of chemicals listed in Part I of Annex C. Subparagraph (f) in Para. A Part V Annex C provides: "*When considering proposals to construct new waste disposal facilities, consideration should be given to alternatives such as activities to minimize the generation of municipal and MW, including resource recovery, reuse, recycling, waste Separation and promoting products that generate less waste. Under this approach, public health concerns should be carefully considered.* "

134. Open burning of waste, including burning of landfill sites, is included in Part III Annex C as a source from which UP-POPs may also be formed and released. In China's rural and remote rural areas the common practice of open burning of obsolete POPs pesticides should therefore be banned.

135. Pursuant to Strategic Programs 2 and 3 in the POPs focal area for GEF-4, the GEF will co-finance investments needed for NIP implementation in order to reduce POPs production, use and releases, and reduce the stress on human health and the environment caused by POPs, including promotion of the use of alternative practices that prevent or reduce generation and/or release of POPs. The project will support this work by application of ESM in the management and disposal of obsolete POPs pesticides and associated POPs wastes.

136. For a detailed review of the project rationale and approach, please see Annex 1 (Project Logical Framework). The project will facilitate assessment of POPs waste stockpiles and systematically manage integrated predisposal activities and processes such as waste characterization, collection, packaging, labeling, storage and transportation. The ultimate generic disposal options are illustrated in the tables below where the relative environmental risks, feasibility and costs of each option are weighted. Within each generic disposal option, there are many individual technologies. For example more than 30 technologies can be identified as non-combustion by USEPA and UNEP. However the commercially available ones suitable for transformation and irreversible destruction of the POPs waste matrices mentioned above, needs to be closely verified.

137. The project will strengthen the overall management and disposal of POPs containing products and wastes in an environmentally sound manner and eliminate the risk of POPs to human health and the environment in China and globally. Methodologies for POPs waste site risk assessment, handling, clearance, collection, labeling, packaging, transportation, disposal, and emergency response procedures will be developed according to strict internationally accepted technical standards and guidelines including those developed by COP to the Basel Convention. The emphasis will be put on the cost-effectiveness and sustainability of the proposed measures.

138. The expected global environmental benefits to be delivered include the complete irreversible destruction and transformation of a minimum of 10,000 tons of obsolete POPs pesticides and POPs pesticide wastes and 1,000 tons of dioxin rich fly ash from waste incinerators in an environmentally sound and cost-effective manner.

139. The GEF4 Strategy in POPs focal area also states that coordination and synergies with countries' responses to related multilateral environmental agreements addressing chemicals issues will be encouraged. The design of activities regarding BAT/BEP demonstration and replication has taken into account Technical Guidelines on Environmentally Sound Management of Persistent Organic Pollutants issued by the Secretariat of Basel Convention.

140. The GEF intervention can be justified as follows:

i. Project objectives, outcomes and outputs meet the goals and objectives of GEF Strategic Programs 2 and 3 in POPs focal area for GEF-4;

ii. The leverage ratio of the project financing is 1:3;

iii. Project outcomes are in line with the requirements of the Stockholm Convention and follow Basel Convention Technical Guidelines;

iv. Project applies ESM and BAT/BEP in management and disposal of POPs wastes that poses a major public health and environmental threat;

v. Opportunity to apply project results and capabilities created to new POPs pesticides (e.g., linden) currently under consideration for inclusion under the Stockholm Convention;

vi. Project will significantly reduce UP-POPs releases into the atmosphere; and

vii. Project will ensure the sustainability and replicability of its outputs, significantly increasing global environmental benefits.

Table 3. Risk assessment matrix

Generic management options	Handling	Collection	Packaging	Labeling	Storage	Transportation	Disposal	Overall risk rating
Baseline scenario	NA	NA	NA	NA	NA	NA	NA	H
Temporary engineering containment	H	H	M	L	M	M	M	M
Incineration as recommended by National HW Program	H	H	M	L	M	M	M	M
Export for treatment abroad	H	H	M	L	M	H	L	M-H
Non-combustion based alternative scenario	H	H	M	L	M	M	L-M	L-M

Legend: Risk level symbol H = High, M = Moderate, L = Low, NA = Not Applicable.

Table 4. Conceptual illustration/Feasibility assessment matrix

Generic management options	Convention requirement	National policy and institutional support	Infrastructure	Stakeholder transaction cost	Pre-disposal cost	Disposal cost	Application potential through innovation, R&D, and joint ventures	Global environmental benefit	Overall feasibility and cost
Baseline scenario	1	1	1	3	1	1	1	1	10
Temporary engineering containment and landfill	1	2	2	3	2	2	2	2	16
Incineration as recommended by National HW Program	3	4	3	4	4	4	5	2	29
Export for treatment abroad	4	1	3	1	2	1	1	4	17
Non-combustion based alternative scenario	5	3	2	3	4	4	5	5	31

Legend: 1 = Least feasibility, 5 = Highest feasibility

C.4 RBM CODE AND THEMATIC AREA CODE

RBM code: CE17 Stockholm Convention

Thematic Area code: FG50

C.5 EXPECTED OUTCOMES

141. Five substantive outcomes have been developed to achieve the project objectives.

Outcome 1 will result in a stronger legal and regulatory framework for environmentally sound management (ESM) and disposal of POPs waste. Current laws and regulations do not specifically address POPs pesticide wastes and dioxin-rich fly ash, and were not designed in view of China's obligations under the Stockholm Convention. The project will work with legislative and regulatory agencies to modify existing laws and regulations and, where necessary, develop new regulatory approaches to specifically address POPs pesticide wastes and dioxin-rich fly ash.

142. Relevant international regulations, standards, guidelines or tools, which have been established internationally, will be fully reviewed during the regulation development to avoid conflicts with them. Since a variety exits in environmental quality, management system, supervision and monitoring and engineering capacity in the world as a country has its own political, economic, technical, social, historical and cultural orientation, which resulted in different environmental regulations, policies and guidelines adopted. Those international technical documents can be used as reference and be adapted to fit with the current situation and future development in China.

Outcome 2 will result in improved institutional capacity at all levels of POPs waste disposal management. POPs pesticide waste and dioxin-rich fly ash generators and contaminated site owners are often unaware of the potential environmental, legal, and human health risks that their current and past operations entail. In addition, waste generators and owners lack the managerial and technical capacity to manage POPs wastes in an environmental sound manner.

143. The foundational chemical management will also be strengthened by the project as ESM system design is just based on the current framework of foundational chemical management and hazardous waste management, including the laws, regulations, policies and standards and institutional settings. Although the targeted pesticide wastes are mainly composed of obsolete POPs pesticide and associated wastes, the establishment of ESM strategy for both POPs and non-POPs pesticide will be considered in the following aspects in the project (a) life cycle management system based on ESM covers both categories, including collection, packaging, labeling, transportation and disposal; (b) selection and utilization of wide-spectrum of disposal technologies capable of destructing mixed pesticides; (c) PPP mechanism established in the project will facilitate ESM of pesticide waste including new-POPs chemicals.

144. The project will address the above through training, supported by regulatory and market-based measures that provide waste generators and owners with both the capability and the incentive to manage POPs waste in an environmentally sound manner. In addition, a mass media based public education program will be designed and implemented in order to raise public awareness of the risks posed by POPs contaminated wastes, and educate members of the public in ways to reduce exposure risks. The project will also hold hearings and establish a hotline to field POPs waste related questions and reports.

Outcome 3 will support the clean-up of POPs pesticide wastes and their transportation from targeted POPs-contaminated hot spots to new waste disposal facilities in compliance with Stockholm Convention requirements. Activities under this outcome will include training and technical support for identification and characterization of POPs wastes at target sites, collection of those wastes, containment for safe storage and transportation, transportation of wastes to designated treatment facilities, and survey of hot spot sites to confirm their successful remediation. Through technology investigation and consultation with international consultants, it was noted that some non-combustion technologies are being commercially used and some are still in a premature stage. Technology choice will be implemented according to a detailed feasibility study during the project implementation.

145. The project will also directly support development and commissioning of one stationary and one mobile disposal facility and development of PPPs for construction and operation of these facilities, including but not limited to such PPP approaches as Build-Operate-Transfer (BOT),

Build-Operate-Own (BOO), and other such cooperative forms of development and operation not currently in common use in China. Activities to establish these new facilities will include Environmental Impact Assessment (EIA) for the facilities, technology evaluation and selection, development of technology specifications and guidance documents, site preparation, installation of facilities at the disposal sites, and technical support for disposal of targeted POPs wastes in an environmentally sound manner at the new facilities. In this manner, activities under this outcome will mitigate the high risk of POPs releases from the target cleanup sites and allow for the treatment of wastes from the target sites at Stockholm Convention compliant facilities. The project's ultimate direct outcome will be environmentally sound disposal of at least 10,000 tons of POPs pesticide wastes and 1,000 tons of dioxin rich fly ash. As an important global environmental co-benefit, the project will also seek to identify and make use of technical processes to extend POPs waste disposal capacity to CFCs destruction, so that the facilities can be made dual capable at little or no additional cost in order to enable their future use for CFC destruction.

146. The project while addressing ESM of obsolete POPs pesticide, will also seek for possibilities to extend POPs waste disposal capacity to CFCs destruction, thus creating co-benefits for compliance of both Stockholm Convention and Montreal Protocol.

147. In December 2004, the China refrigeration servicing sector CFC phase-out plan (CRSSP) was approved to help the said sectors to recover, reclaim and recycle CFC while maintaining and disposing of CFC containing equipment. A component of the plan is to destroy contaminated CFC, which needs application of high temperature thermal destruction technology. The project designs an activity to conduct a feasibility study on dual capability of destruction unit to treat both CFC and POPs wastes.

Outcome 4 will support completion of qualitative environmental risk assessment (QERA) site prioritization. Activities under this outcome will include training and technical assistance to establish an inventory of contaminated sites, prepare human health and ecological risk assessment, carry out site surveys, identify POPs exposure scenarios and concentrations, perform GIS analysis, collect necessary data, and complete a quantitative environmental risk assessment, and train CIO staff to maintain the system and transfer it to EPBs. The result of China's first soil pollution survey jointly launched in July 2006 by MEP and the Ministry of Land and Resources will be fully considered in the QERA.

148. In addition to the above substantive activities, project owners will provide ongoing project management, monitoring, and evaluation under Outcome 5, including establishment of a Steering Group composed of national and local stakeholder agencies, establishment and staffing of the project management team at the national and local levels, recruitment of national and international consultants, execution of a management training program for project staff (particularly at the local level), and ongoing monitoring and reporting of project activities.

Innovativeness of Approach

149. Collection and treatment of dioxin rich fly ash represents a new and innovative project approach. Fly ash is generally not collected in China, but is instead emitted in flue gases, the danger of which to human health is significantly increased when the particulate matter is contaminated with dioxin. The project approach will be to recover dioxin rich fly ash through electro-static precipitation and other abatement technologies and treat it in order to remove dioxin contamination. The treated fly ash can then be used as a valuable construction material additive, thus avoiding a serious airborne public health risk or hazardous solid waste residue requiring sanitary landfill.

150. The project will support technological innovation in treatment of POPs pesticides and other POPs contaminated waste. The project will promote environmentally sound alternative technologies not currently in use in China, which has historically relied predominantly on incineration, often without air pollution abatement controls.

151. The project will also introduce and support an innovative approach for hazardous waste management through a Public Private Partnership (PPP) mechanism for construction and operation of new hazardous waste management and treatment facilities, including but not limited to such PPP approaches as Build-Operate-Transfer (BOT), Build-Operate-Own (BOO),

and other such cooperative forms of development and operation not currently in common use in China.

152. PPP is an innovative method of procuring public services and infrastructure combining the strengths of both the public and private sectors. With PPP, the government moves from being the direct infrastructure and service provider to being market creator, promoter, supervisor and manager. The government focuses on creating the regulatory framework, setting up the necessary institutional structures, establishing fee levels, and providing subsidies and guarantees. Private-sector partners take primary responsibility for financing, designing, building, operating and maintenance.

153. The primary objective of introducing PPP into this project is to create opportunities for enhanced private sector involvement in constructing and operating facilities and delivering the services needed for environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes. The project will use PPP structures to create streams of revenue for private companies to recover investments through collection of disposal fees from POPs waste producers in accordance with the polluters pay principle, or from other responsible parties when it is impossible to identify the owners of the wastes. The project will also consider development of revenue streams in the form of subsidies and/or incentives.

154. Finally, the flexible, non-regulatory nature of the PPP approach will encourage private-sector partners to improve technologies and/or develop new technologies in order to meet current and future market needs in a more efficient, cost effective, and environmentally sustainable way. See Figure 5 below on a graphic illustration of the PPP approach and its function within the project.

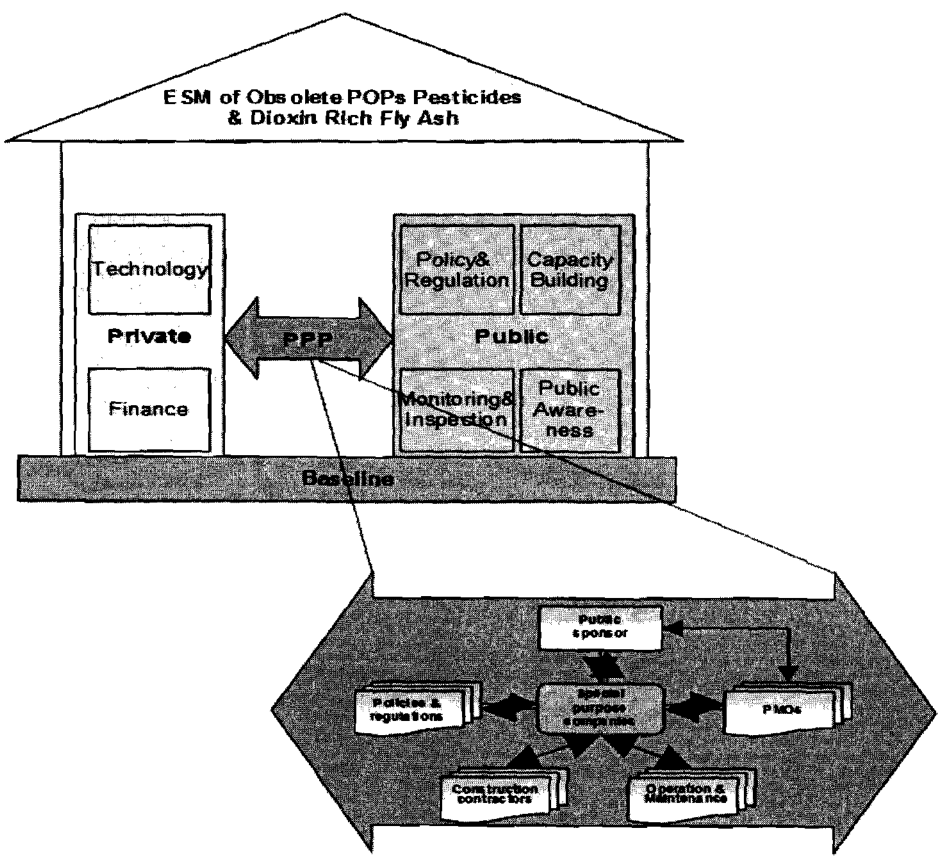


Figure 5: Public-Private Partnership for Environmentally Sound Management of Hazardous Waste

Methodological Approach

155. The project's objective of implementing environmentally sustainable management of POPs pesticides and other POPs contaminated waste will be achieved through a combination of strategies, including legislative and regulatory development, capacity building, public education, *technology transfer, training, technical support, and introduction of new advanced* environmental risk assessment tools.

156. The project will develop and implement regulatory reforms, coupled with the innovative approaches described above (public-private partnerships), so as to create an enabling environment for POPs pesticides treatment facilities to operate on a sustainable basis.

157. The project will deliver extensive training programs to enhance technical competencies, establish and promote the achievement of project objectives. Principal training activities include:

- Management training classes for national and local project management staff
- Training on new technological and economic policies, guidelines, standards, and specifications so as to implement ESM for provincial EPB managerial staff
- Training to provincial HWDCs staff concerning collection, packaging, and transportation of POPs pesticide wastes
- *Staff training for safe disposal of POPs pesticides and dioxin rich fly ash to the* managerial, technical and operational staff in the selected province.

158. The project will also undertake extensive stakeholder awareness raising and education activities, including:

- Develop TV and broad broadcasting program to disseminate knowledge of POPs
- Prepare articles and reports for dissemination in national and local newspapers
- Develop and produce brochures for awareness raising regarding health and safety protection from POPs pesticide wastes and dioxin rich fly ash
- Hold public hearings regarding POPs waste stockpile reporting, emergency response, and health and safety protection
- Establish hotline to allow reporting of POPs related health and safety issues.

159. Figure 6 below further illustrates the project methodology, focusing in particular on the relationship between private and public sector participants. For additional detail on the project methodology, see Annex 1: Project Logical Framework.

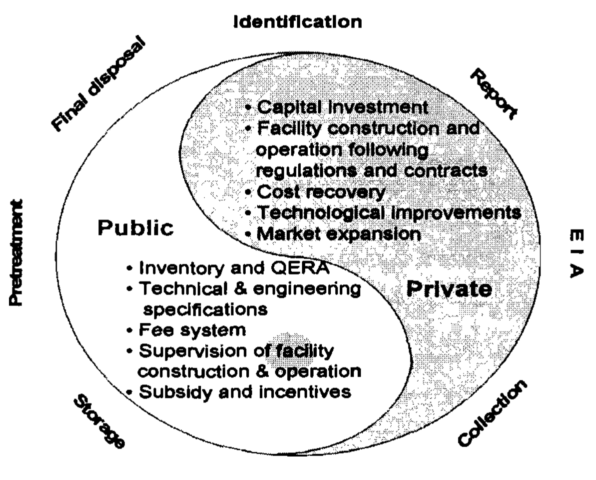


Figure 6: Project Methodology Graphic

C.6 Outcomes, outputs and Activities

160. The table below lists project outcomes, outputs, and activities, along with responsibility for each activity, under each project outcome.

Outcome 1: Strengthened legal and regulatory framework for environmentally sound management (ESM) and disposal of POPs waste

Output/Activity	Responsibility
Output 1.1 Technological and economic policies and regulations in place for promoting environmentally sustainable management and disposal of POPs wastes	
1.1.1 Develop and formulate technological and economic policies through inter-departmental coordination, public awareness raising, public hearings, and NGO outreach	MEP, UNIDO
1.1.2 Provide training on new technological and economic policies for managerial staff from provincial EPBs	FECO/MEP, UNIDO
1.1.3 Raise awareness of new technological and economic policies and enforcement mechanisms	FECO/MEP, UNIDO
Output 1.2 Technical standards and guidelines developed for ESM of POPs waste	
1.2.1 Develop and formulate guidelines, standards and specifications for ESM of POPs waste	FECO/MEP, UNIDO
1.2.2 Provide training on guidelines, standards and specifications for managerial staff from provincial EPBs	FECO/MEP, UNIDO
1.2.3 Develop standard operation procedures for analysis and monitoring	FECO/MEP, UNIDO

Outcome 2: Improved institutional capacity at all levels of POPs waste disposal management

Output/Activity	*Responsibility*
Output 2.1 Communication and coordination sustained between stakeholders in waste management and disposal	
2.1.1 Establish national, regional, and local coordination framework for integrated POPs waste management	FECO/MEP, Local EPBs, UNIDO
2.1.2 Periodically review stakeholder recommendations and action proposals related to POPs wastes ESM	FECO/MEP, Local EPBs,UNIDO
2.1.3 Hold periodic fora for public and private stakeholders, NGOs, and the general public to promote good governance and increased effectiveness	FECO/MEP, Local EPBs, UNIDO
Output 2.2 Institutional capacity enhanced for POPs waste management at local level	
2.2.1 Enhance overall institutional capacity for program development	FECO/MEP, Local EPBs, UNIDO
2.2.2 Adapt and implement national policy and regulatory framework at local level	FECO/MEP, Local EPBs,
2.2.3 Develop trial local-level responsibility system for obsolete POPs pesticide management and disposal	FECO/MEP, Local EPBs, UNIDO
2.2.4 Develop and test pricing mechanisms for POPs waste disposal	FECO/MEP, Local EPBs, UNIDO

Output/Activity	Responsibility
2.2.5 Establish and implement reporting system to collect and analyze data on creation, transport, and treatment of POPs waste	FECO/MEP, UNIDO
2.2.6 Establish inspection and prosecution system for discarded POPs wastes and contaminated sites	FECO/MEP, Local EPBs
2.2.7 Promote widespread local participation through increasing local input of personnel and financial resources	FECO/MEP, Local EPBs, UNIDO
2.2.8 Incorporate ESM principles, norms and requirements into current EIA guidelines	FECO/MEP, UNIDO
2.2.9 Prepare ESM inspection manuals, including: (a) Evaluation, registration and authorization of facility operating licenses for POPs waste treatment, (b) Monitoring of POPs waste disposal facility operation	FECO/MEP, UNIDO
2.2.10 Provide training for local solid waste management centres to implement ESM	FECO/MEP, Local EPBs, UNIDO
Output 2.3 Public awareness on POPs activities undertaken	
2.3.1 Develop TV and other mass media programs to disseminate knowledge of POPs	FECO/MEP, UNIDO, Local EPBs
2.3.2 Publish articles or reports for public education in national and local newspapers.	FECO/MEP, UNIDO
2.3.3 Develop and produce brochures to raise awareness regarding health and safety protection from POPs pesticide wastes and dioxin rich fly ash	FECO/MEP, UNIDO
2.3.4 Hold public hearings regarding POPs waste stockpile reporting, emergency response, and health and safety protection	FECO/MEP, Local EPBs, UNIDO
2.3.5 Hotline established for POPs related health and safety issues	FECO/MEP, Local EPBs, UNIDO

Outcome 3: Environmentally sound disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash

Output/Activity	Responsibility
Output 3.1 Safe and effective collection, packaging, and transportation of POPs pesticide wastes for disposal adopted	
3.1.1 Identify location, type, status of POPs pesticide wastes and associated waste matrices at targeted hot spots	FECO/MEP, Local EPBs, UNIDO
3.1.2 Develop operating manual for collection, packaging, and transportation of the POPs pesticide waste	FECO/MEP, Local EPBs, UNIDO
3.1.3 Prepare detailed terms of reference and contracts for the provincial HWDCs according to expertise in the fields of waste management and occupational health and safety.	FECO/MEP, Local EPBs, UNIDO
3.1.4 Provide training to staff from the provincial HWDCs concerning the collection, packaging, and transportation of the POPs pesticide wastes	FECO/MEP, Local EPBs, UNIDO
3.1.5 Collect, package, and transport POPs pesticide wastes from hot spots	FECO/MEP, Local EPBs, UNIDO

Output/Activity	Responsibility
3.1.6 Store POPs pesticide wastes safely to prevent release of POPs contaminants to the environment	FECO/MEP, Local EPBs, UNIDO
Output 3.2 Assessment of technologies for POPs waste disposal carried out	
3.2.1 Detailed feasibility study for final disposal units based on the waste type, destruction efficiency, emissions, residues, energy/material requirements, portability, state of commercialization, and site selection	FECO/MEP, Local EPBs, UNIDO
3.2.2 Preparation of detailed Terms of Reference for technology selection and Request for Proposal from vendors	FECO/MEP, UNIDO
Output 3.3 Technology transfer promoted through PPP mechanisms	
3.3.1 Identify potential PPP arrangements for design, construction and operation of POPs waste treatment infrastructure	FECO/MEP, Local EPBs, UNIDO
3.3.2 Promote cooperative relationship among technology vendors and facility designers, constructors, and operators to achieve cost-effective options	FECO/MEP, Local EPBs, UNIDO
Output 3.4 Construction, certification, operation, and supervision of stationary and mobile treatment facilities arranged	
3.4.1 Environmental Impact Assessment (EIA) for one stationary and one mobile unit	FECO/MEP, Local EPBs, UNIDO
3.4.2 Invite bids from potential vendors to transport POPs wastes, construct stationary and mobile units and operate disposal facilities	FECO/MEP, Local EPBs
3.4.3 Prepare disposal sites for deployment of selected technology, including construction of storage facility and commissioning of equipment	FECO/MEP, Local EPBs, UNIDO
3.4.4 Installation of the stationary unit at the selected site and mobile unit at selected base stations	FECO/MEP, Local EPBs, UNIDO
3.4.5 Transportation of POPs wastes to the POPs treatment locations in an environmentally sound manner	FECO/MEP, Local EPBs, UNIDO
3.4.6 Final disposal of POPs pesticide wastes in an environmentally sound way	FECO/MEP, Local EPBs, UNIDO
3.4.7 Monitoring during facility construction and operation	FECO/MEP, Local EPBs, UNIDO
3.4.8 Establishment of equipment ownership arrangements	FECO/MEP, Local EPBs, UNIDO
Output 3.5 Dioxin rich fly ash disposal implemented	
3.5.1 Target province selected for non-landfill pilot disposal of dioxin rich fly ash	FECO/MEP, Local EPBs, UNIDO
3.5.2 Development of operating manual for non-landfill disposal of dioxin rich fly ash	FECO/MEP, UNIDO
3.5.3 Staff training for safe disposal of dioxin rich fly ash in the selected province	FECO/MEP, Local EPBs, UNIDO
3.5.4 Implementation of pilot for safe disposal of dioxin rich fly ash by non-landfill options	FECO/MEP, Local EPBs, UNIDO
Output 3.6 Exploration of the feasibility to extend POPs waste disposal capacity to CFCs destruction undertaken	
3.6.1 Complete technical and policy review	FECO/MEP, UNIDO

Output/Activity	*Responsibility*
3.6.2 Identify potential technical processes and arrangements for the extension of POPs wastes disposal capacity to CFCs destruction	FECO/MEP, UNIDO
3.6.3 Treatment of CFCs contaminants in the POPs destruction unit to demonstrate feasibility of the dual capability of the facility at little or no additional cost	FECO/MEP, UNIDO

Outcome 4: Qualitative environmental risk assessment (QERA) site prioritization

Output/Activity	*Responsibility*
Output 4.1 Inventory of contaminated sites prioritized	
4.1.1 Review existing national and international best practice guidelines for human health and ecological risk assessment	FECO/MEP, Local EPBs, UNIDO
4.1.2 Develop a project-fit methodology, including QA/QC procedures for quantitative environmental risk assessment (QERA)	FECO/MEP, UNIDO
4.1.3 Train staff in provincial solid waste management centres	FECO/MEP, Local EPBs, UNIDO
4.1.4 Carry out on-site surveys following removal activities, focusing on identification of exposure scenarios	FECO/MEP, Local EPBs, UNIDO
4.1.5 Qualitatively predict POPs concentrations in identified exposure scenario and characterize risks by comparing target POPs risk factors	FECO/MEP, UNIDO
4.1.6 Analyze information needs for quantitative environmental risk assessment	FECO/MEP, UNIDO
Output 4.2 Establishment and maintenance of an Internet-based information processing, display and dissemination system in place	
4.2.1 Design Internet-based system to process and display QERA results and facilitate modeling of environmental risks and remediation decision-making	FECO/MEP, UNIDO
4.2.2 Purchase, install, and test system, maximizing use of existing hardware, software, and topographic data from the current POPs MIS	FECO/MEP, UNIDO
4.2.3 Input data and operate, maintain and update system	FECO/MEP
4.2.4 Conduct internet-based training and software dissemination	FECO/MEP, UNIDO

Outcome 5: Project management, monitoring and evaluation

Output/Activity	*Responsibility*
Output 5.1 Project management structure established	
5.1.1 Establish Project Steering Group	FECO/MEP, UNIDO
5.1.2 Establish the National Project Management Team under CIO	FECO/MEP, UNIDO
5.1.3 Recruit Chief Technical Advisor (CTA), a National Technical Advisor (NTA) and other local personnel	FECO/MEP, Local EPBs, UNIDO
5.1.4 Establish local project management offices in target provinces	FECO/MEP, Local EPBs, UNIDO

Output/Activity	*Responsibility*
5.1.5 Hold management training classes for national and local project management staff	FECO/MEP, Local EPBs, UNIDO
Output 5.2 An M&E mechanism designed and implemented according to GEF M&E procedures	
5.2.1 Hold the Inception Workshop	FECO/MEP, UNIDO
5.2.2 Prepare Inception Report	FECO/MEP, UNIDO
5.2.3 Measure impact indicators on an annual basis	FECO/MEP, UNIDO
5.2.4 Prepare Annual Project Reports and Project Implementation Reviews	FECO/MEP, Local EPBs, UNIDO
5.2.5 Hold annual tripartite review meetings	FECO/MEP, UNIDO
5.2.6 Hold biannual Project Steering Group meetings	FECO/MEP, UNIDO
5.2.7 Carry out mid-term external evaluation	UNIDO
5.2.8 Carry out final external evaluation	UNIDO
5.2.9 Complete the Terminal Report	FECO/MEP, Local EPBs, UNIDO
5.2.10 Carry out annual project financial audits	FECO/MEP, UNIDO
5.2.11 Carry out biannual visits to selected field sites	FECO/MEP, Local EPBs, UNIDO
5.2.12 Establish a project management information system (MIS), including a project website to disseminate information to stakeholders	FECO/MEP, UNIDO

C.7 ACTVITIES TIMELINE

Year	1				2				3				4				5			
Outcome/Output/Activity Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Outcome 1: Strengthened legal and regulatory framework for *environmentally sound management* (ESM) and disposal of POPs waste																				
Output 1.1 Technological and economic policies and regulations in place for promoting environmentally sustainable management and disposal of POPs wastes																				
1.1.1 Develop and formulate technological and economic policies through inter-departmental coordination, public awareness raising, public hearings, and NGO outreach																				
1.1.2 Provide training on new technological and economic policies for managerial staff from provincial EPBs																				
1.1.3 Raise awareness of new technological and economic policies and enforcement mechanisms																				
Output 1.2 Technical standards and guidelines developed for ESM of POPs waste																				
1.2.1 Develop and formulate guidelines, standards, and specifications																				
1.2.2 Provide training on guidelines, standards and specifications for managerial staff from provincial EPBs																				
1.2.3 Develop standard operation procedures for analysis and monitoring																				
Outcome 2: Improved institutional capacity at all levels of POPs waste disposal management																				
Output 2.1 Communication and coordination sustained between stakeholders in waste management and disposal																				
2.1.1 Establish national, regional, and local coordination framework for integrated POPs waste management																				
2.1.2 Periodically review stakeholder recommendations and action proposals related to POPs wastes ESM																				
2.1.3 Hold periodic fora for public and private stakeholders, NGOs, and the general public to promote good governance and increased effectiveness																				

Outcome/Output/Activity Year	1				2				3				4				5			
Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Output 2.2 Institutional capacity enhanced for POPs waste management at local level																				
2.2.1 Enhance overall institutional capacity for program development																				
2.2.2 Adapt and implement national policy and regulatory framework at local level																				
2.2.3 Develop trial local-level responsibility system for obsolete POPs pesticide management and disposal																				
2.2.4 Develop and test pricing mechanisms for POPs waste disposal																				
2.2.5 Establish and implement reporting system to collect and analyze data on creation, transport, and treatment of POPs waste																				
2.2.6 Establish inspection and prosecution system for the discarded POPs wastes and contaminated sites																				
2.2.7 Promote widespread local participation through increasing local input of personnel and financial resources																				
2.2.8 Incorporate ESM principles, norms and requirements into current EIA guidelines																				
2.2.9 *Prepare* ESM inspection manuals, including: (a) Evaluation, registration and authorization of facility operating licenses for POPs waste treatment, (b) Monitoring of POPs waste disposal facility operation																				
2.2.10 Provide training for local solid waste management centers to implement ESM																				
Output 2.3 Public awareness on POPs activities undertaken																				
3.2.1 Develop TV and other mass media programs to disseminate knowledge of POPs																				
3.2.2 Publish articles or reports for public education in national and local newspapers.																				
3.2.3 Develop and produce brochures to raise awareness regarding health and safety protection from POPs pesticide wastes and dioxin rich fly ash																				
3.2.4 Hold public hearings regarding POPs waste stockpile reporting, emergency response, and health and safety protection																				
3.2.5 Hotline established for POPs related health and safety issues																				

Outcome/Output/Activity — Year	1				2				3				4				5			
Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Outcome 3: Environmentally sound disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash																				
Output 3.1 Safe and effective collection, packaging, and transportation of POPs pesticide wastes for disposal adopted																				
3.1.1 Identify location, type, status of POPs pesticide wastes and associated waste matrices at targeted hot spots																				
3.1.2 Develop operating manual for collection, packaging, and transportation of the POPs pesticide waste																				
3.1.3 Prepare detailed terms of reference and contracts for the provincial HWDCs according to expertise in the fields of waste management and occupational health and safety.																				
3.1.4 Provide training to staff from the provincial HWDCs concerning the collection, packaging, and transportation of the POPs pesticide wastes																				
3.1.5 Collect, package, and transport POPs pesticide waste from hot spots																				
3.1.6 Store POPs pesticide waste safely to prevent release of POPs contaminants to the environment																				
Output 3.2 Assessment of technologies for POPs waste disposal carried out																				
3.2.1 Detailed feasibility study for final disposal units based on the waste type, destruction efficiency, emissions, residues, energy/material requirements, portability, state of commercialization, and site selection																				
3.2.2 Preparation of detailed Terms of Reference for technology selection and Request for Proposal from vendors																				
Output 3.3 Technology transfer promoted through PPP mechanisms																				
3.3.1 Identify potential PPP arrangements for design, construction and operation of POPs waste treatment infrastructure																				
3.3.2 Promote cooperative relationship among technology vendors and facility designers, constructors, and operators to achieve cost-effective options																				

Year	1				2				3				4				5			
Outcome/Output/Activity Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Output 3.4 Construction, certification, operation, and supervision of stationary and mobile treatment facilities arranged																				
3.4.1 Environmental Impact Assessment (EIA) for one stationary and one mobile unit																				
3.4.2 Invite bids from potential vendors to transport POPs wastes, construct stationary and mobile units and operate disposal facilities																				
3.4.3 Prepare disposal sites for deployment of selected technology, including construction of storage facility and commissioning of equipment																				
3.4.4 Installation of the stationary unit at the selected site and mobile unit at selected base stations																				
3.4.5 Transportation of POPs waste to the POPs treatment locations in an environmentally sound manner																				
3.4.6 Final disposal of POPs pesticide wastes in an environmentally sound way																				
3.4.7 Monitoring during facility construction and operation																				
3.4.8 Establishment of equipment ownership arrangements																				
Output 3.5 Dioxin rich fly ash disposal implemented																				
3.5.1 Target province selected for non-landfill pilot disposal of dioxin rich fly ash																				
3.5.2 Development of operating manual for non-landfill disposal of dioxin rich fly ash																				
3.5.3 Staff training for safe disposal of dioxin rich fly ash in the selected province																				
3.5.4 Implementation of pilot for safe disposal of dioxin rich fly ash by non-landfill options																				
Output 3.6 Exploration of the feasibility to extend POPs waste disposal capacity to CFCs destruction undertaken																				
3.6.1 Complete technical and policy review																				

Year	1				2				3				4				5			
Outcome/Output/Activity Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
3.6.2 Identify potential technical processes and arrangements for the extension of POPs waste disposal capacity to CFCs destruction																				
3.6.3 Treat of CFCs contaminants in POPs destruction unit to demonstrate feasibility of making facilities dual capable at little/no additional cost																				
Outcome 4 Qualitative environmental risk assessment (QERA) site prioritization																				
Output 4.1 Inventory of contaminated sites prioritized																				
4.1.1 Review existing national and international best practice guidelines for human health and ecological risk assessment																				
4.1.2 Develop a project-fit methodology, including QA/QC procedures for quantitative environmental risk assessment (QERA)																				
4.1.3 Train staff in provincial solid waste management centers																				
4.1.4 Carry out on-site surveys following removal activities, focusing on identification of exposure scenarios																				
4.1.5 Qualitatively predict POPs concentrations in identified exposure scenario and characterize risks by comparing target POPs risk factors																				
4.1.6 Analyze information needs for quantitative environmental risk assessment																				
Output 4.2 Establishment and maintenance of an Internet-based information processing, display and dissemination system in place																				
4.2.1 Design Internet-based system to process and display QERA results and facilitate modeling of environmental risks and remediation decision-making																				
4.2.2 Purchase, install, and test system, maximizing use of existing hardware, software, and topographic data from the current POPs MIS																				
4.2.3 Input data and operate, maintain and update system																				
4.2.4 Conduct internet-based training and software dissemination																				

Outcome/Output/Activity — Year	1				2				3				4				5			
Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Outcome 5. Project management, monitoring and evaluation																				
Output 5.1 Project management structure established																				
5.1.1 Establish Project Steering Group																				
5.1.2 Establish the National Project Management Team under CIO																				
5.1.3 Recruit Chief Technical Advisor (CTA), a National Technical Advisor (NTA) and other local personnel																				
5.1.4 Establish local project management offices in target provinces																				
5.1.5 Hold management training classes for national and local project management staff																				
Output 5.2 An M&E mechanism designed and implemented according to GEF M&E procedures																				
5.2.1 Hold the Inception Workshop																				
5.2.2 Prepare Inception Report																				
5.2.3 Measure impact indicators on an annual basis																				
5.2.4 Prepare Annual Project Reports and Project Implementation Reviews																				
5.2.5 Hold annual tripartite review meetings																				
5.2.6 Hold biannual Project Steering Group meetings																				
5.2.7 Carry out mid-term external evaluation																				
5.2.8 Carry out final external evaluation																				
5.2.9 Complete the Terminal Report																				
5.2.10 Carry out annual project financial audits																				
5.2.11 Carry out biannual visits to selected field sites																				
5.2.12 Establish a project management information system (MIS), including a project website to disseminate information to stakeholders																				

C.8 RISKS, SUSTAINABILITY AND REPLICABILITY

Possible Risks

161. The risks are identified with reference to project objectives as follows:

Outcomes	Risks	Level	Mitigation measures
Strengthened legal and regulatory framework for environmentally sound management (ESM) and disposal of POPs waste	➢ Government at national, provincial, and local levels, as appropriate, would not endorse and adopt the required standards, guidelines and specifications according to the project timeline	Low	Ensure laws, regulations, standards, guidelines and specifications are practical and enforceable and support with institutional capacity building and training
	➢ Key stakeholders could not be effectively involved throughout the process	Low	Arise public awareness and enforce monitoring and inspection
Improved institutional capacity at all levels of POPs waste disposal management	➢ NGOs and enterprises might not be willing to actively participate.	Low	Focus on stakeholder awareness raising as a priority
	➢ Key agencies might not attach sufficient importance and allocate sufficient resources to POPs waste management supervision	Low	Arise public awareness, enforce monitoring and inspection, and provide enough trainings
Environmentally sound disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash	➢ Vendors and other parties might not be willing to cooperate	Low	A policy for POPs disposal fee will be issued and a proper price mechanism will be introduced to allow suitable revenue for the contractors.
	➢ Health and environmental risks that POPs removal, transport, and destruction entail	Low	The following activities will be implemented to reduce the risks related: (a) Hire specialized and licensed waste treatment companies to implement the waste clean, transport and destruction. (b) Prepare detailed guidelines and operation manuals. (c) Strengthening capacity and training for the staff in those activities (d) Pre- and post-monitoring and evaluation by independent institutions.
Qualitative environmental risk assessment (QERA) site prioritization	➢ Adequate data could not be obtained to complete analyses	Low	Carefully design the investigation program and enforce monitoring and inspection during the implementation

Sustainability and Replicability

162. The continuously increasing demands for disposal of high chlorine containing and toxic pesticide waste will create a broad waste market for the facilities to be constructed in the project. China has a big pesticide industry for its agriculture development and a large amount of pesticide wastes are produced each year in the pesticide production and use. The treatment of high toxic pesticide wastes is a serious and unresolved problem, especially for the organochlorine and high toxic pesticides, such as: heptachlor epoxide, endosulfan, endosulfan sulfate and HCH, although they are still not classified as POPs. The disposal facilities to be constructed through the project will extend their special advantages in the above area. Also, the increasing amount of dioxin containing fly ash will be another direct waste source to ensure the continuous operation of the facilities in the future.

163. According to the latest promulgated standard for pollution control on the landfill site in China, wastes with dioxins content of > 3ng-TEQ/g is prohibited to landfill. So there is a growing market for disposal of high dioxin content waste such as rich fly ash, which cannot be treated by landfill. In addition, landfill of dioxin rich waste is an intermediate way, which cannot make the waste destroyed or irreversibly transformed.

164. The project will help to mainstream the disposal of POPs wastes into implementation of national programs that will be supported by national governmental funding sources. The project also has a close linkage to the current government study that will lead to the development of a program for the treatment of contaminated soils. Through the QERA process, the project will identify and prioritize POPs contaminated sites. The government of China has allocated a budget to undertake a national survey of contaminated land and land use. This survey, if altered and intervened by the project may catalyze a nationwide soil remediation program, which will surely sustain the outreach of the project results and bring more global environmental benefits.

165. The sustainability of the project outputs will be also ensured by the following:

- Strengthening and adaptation of policies, laws, and regulations related to POPs waste management and more specifically POPs pesticide waste management will ensure the sustainability of the regulatory environment. By assuring the practicality of laws and regulations, enforcement will also be improved if supported by adequate and targeted capacity building.
- Market-based mechanism established by the project will have the polluters and beneficiaries pay to internalize the incremental cost. Legal responsibility of POPs owners and price regulation for POPs waste treatment will be enacted and implemented in and after the project. The disposal fee from the newer pesticide waste producers will cover the cost of facility operators.
- Compliance with ongoing monitoring and reporting requirements under the Stockholm Convention will be improved by increasing the capacity to collect and process data and to formulate reports to fit to the format and to meet the standards required by the Convention.
- The momentum generated by the mobilization of stakeholders at national and local levels becomes self-sustaining given the critical mass of project activities both at the levels of nationwide dissemination and the location-specific treatment activities.
- The relevance of the project in the context of environmental and public health issues resulting from unsafe storage of obsolete POPs pesticides and POPs pesticide wastes guarantees the sustainability of the project outputs.
- Experience gained through successful application of the BAT/BEP requirements for collection, storage, transport and disposal of POPs pesticide wastes will provide a solid base for introducing sustainable life-cycle management for a wide range of hazardous wastes.
- Experience gained through BAT/BEP treatment of dioxin-rich fly ash will ensure the sustainability of ongoing disposal of this particular type of hazardous waste on a larger scale.

166. In addition, the sustainability will be a dynamic process evolving during and after the project. During the implementation of the project, GEF grant is needed because of the barriers to remove. The GEF contribution, together with sufficient co-financing leveraged from other major stakeholders, including central and local governments and facility owners will build up necessary disposal facility, which will create a pilot and demonstration effect and stimulate the replication of same practice nationally.

167. The project will draw special attention to infant and emerging local efforts in building up a pesticide like waste disposal market, where different funding sources from central and local governments, private sectors, BOT and BOO business could be pooled in. It is expected that the charge system for waste disposal and the related practices would mature during the implementation of the project.

168. The emergence of industrial and service sectors dedicated to the technical and technological support of ESM in POPs waste management will generate economic activity and employment. The development and promotion of different commercial models (e.g. BOT, BOO, TOT, etc.) for construction and operation of POPs waste treatment and disposal facilities will assure continuing capital investment in the sector.

169. After the end of the project, the capital investment and equipment will be handed over to the government to enable new arrangements for a PPP to continue in a sustainable manner. The commitment from the government and the co-financing used to subsidize the initial stage of the project will be factorize for the new business plan to offset the remaining costs of disposal of stockpiles that are still under the custody of the government, public and private enterprises.

170 The project also offers potential replicability of the project results will be ensured by benefits, including but not limited to:

- ESM will be introduced in life-cycle management of other types of POPs wastes and hazardous wastes;
- Successful implementation of incentives for POPs pesticides disposal will, wherever feasible, be extended to other hazardous wastes disposal;
- BAT will be introduced in waste disposal of other types of POPs wastes;
- BAT will be introduced in waste disposal of dioxin-rich fly ash at nationwide;
- Successfully introduced and demonstrated alternative technologies will be applied for disposal of other types of POPs and chemical wastes;
- Replication of project results to new POPs pesticides (e.g., linden) currently under consideration for inclusion under the Stockholm Convention;
- The experience and lessons learned through this project will be applied for other ESM projects in the region outside China, particularly in comparable large countries such as India; and
- Whenever feasible and reasonable the lessons learned through this project will be applied globally in developing countries and countries with economies in transition.

SECTION D: INPUTS

D.1 COUNTERPARTS INPUTS

171. The GEF, as the financial mechanism for the Stockholm Convention, will provide a proposed US$9.959 million incremental cost funding for the project. The Government of China has committed to provide US$ 7.75 million where US$ 3.9 million is cash and US$ 3.85 million (in-kind) from MEP. In addition, local EPBs will contribute US$ 7.31 million (cash & in-kind) co-financing, and obsolete pesticides owners and other private/public sectors will contribute a projected US$16.94 million (cash & in-kind), for a total co-funding of US$32.0 million.

Baseline

172. In the absence of this project, the POPs pesticides waste disposal sector in China is characterized as follows:

- A regulatory framework is not focused on the particular features of POPs pesticide waste management and disposal.
- Under-developed institutional capacities, in terms of both hardware (infrastructure) and software (skills and expertise) for supervision and inspection of owners and storage sites of POPs pesticide waste and POPs waste disposal facilities in terms of pollution control and monitoring, environmental impact assessment, and operation risk evaluation.
- Incinerators continue to play the predominant role in the disposal of POPs waste and generate unintentional POPs releases that significantly exceed BAT performance levels.
- Alternative technologies, which can avoid formation of PCDD/PCDFs have not been adopted.
- Integration and coordination of POPs waste management, treatment and disposal systems have not been explored to achieve optimal social, economic and environmental benefits.
- National debts and local government investments remain the principal financial source for construction of dedicated hazardous waste disposal facilities, but are unsustainable.
- Stakeholder awareness regarding secondary pollution from POPs waste disposal is insufficient.
- The fee-based system supporting POPs pesticide waste management, treatment and disposal systems has not yet been developed.

173. Incineration is the major method for hazardous waste treatment in China and the disposal cost for the common hazardous waste that has low chlorine content and low toxicity is US$ 700/tone. These incinerators are required to operate in line with national emission limit of PCDD/Fs of 0.5 ng/Nm^3 (GB18484-2001) but many of them could not meet the requirements in the day-to-day operation.

174. The only incineration facility that will meet the Convention operating standards is located in the northeast of China, and is dedicated to PCB disposal at a unit cost of US$ 2,930/tone. This facility is not yet commissioned, and when operational, the demand on this facility will be beyond its capacity, and in practice will not be available for this project. No other incineration facility currently in operation in China meets the Convention's standards for the disposal of POPs waste.

175. The baseline cost is US$ 700/t for common hazardous waste destruction with the national emission limit of PCDD/Fs of 0.5 ng/Nm^3 and US$ 2,930/tone for PCBs wastes.

Global Environmental Objective

176. Obsolete POPs pesticides refer to pesticide POPs listed in Annexes A and B of the Stockholm Convention and stored for long periods by producers, sales sites and users, which have already lost their original value, basically have no market value and are discarded or abandoned, not in condition for distribution and use. Due to their unique properties, obsolete

POPs pesticides are easy to entire into the food chain and pose a serious eco-environment and human health risk. POPs pesticides such as DDTs are endocrine disruptors, which can cause severe reproductive and developmental internal disorders and damage the immune system and interfere with hormonal systems.

177. Obsolete POPs pesticides and associated wastes are hazardous wastes. Owing to the absence of environmentally sound disposal facilities in developing countries, the quantity of obsolete pesticide stocks is constantly on the increase. Storage conditions rarely meet internationally accepted standards and drums are often stored in the open exposed to harsh weather conditions which accelerate the wear and tear of containers. Many containers deteriorate and leak their liquid contents into the soil, eventually severely contaminating groundwater and the environment while the powder contents of worn or torn bags and cardboard boxes are often dispersed into the environment by wind or rain. Most stores are in the centres of populated urban areas or close to public dwellings or bodies of water.

178. The overall objective of the project is to constitute a regulation platform and finance mechanism for the environmental sound management obsolete pesticide and POPs wastes, install necessary waste treatment capacity for POPs waste, safely dispose the obsolete POPs pesticides and associated wastes, destruct the high content PCDD/PCDFs fly ash generated during the hazardous waste and medical waste incineration, reduce and ultimately eliminate the release in the treatment process into environment of PCDD/PCDFs from the obsolete POPs pesticides and associated wastes, and to assist China in implementing its obligations under the Stockholm Convention.

Alternative

179. Through the project, obsolete POPs pesticides and POPs pesticide waste owners will adopt ESM for POPs pesticides waste management. It will achieve great reduction of air pollutant emission from POPs pesticide waste incineration through the application of ESM and through application of innovative alternative technologies to avoid unintentional PCDD/PCDFs formation.

180. The capacity incubated through interaction with NPDFCHWMW can lay a foundation for upgraded life cycle management of hazardous waste, which would further encourage central and local government to develop and implement more projects and programs to address the needs of environmentally sound management of hazardous waste. China has a rapid economic growth and a rapidly increasing input on environmental protection and the project will make its contribution to the trend by guiding the right direction of the related environmental protection input.

181. The technology selection and facility construction will fully follow the BAT/BEP of Stockholm Convention and technical guidelines of Basel Convention to meet the international environmental standards and project requirements. In summary, the basic criteria are:

- PCDD/Fs 0.1 ng/Nm^3
- DRE >99.9999%
- Comparable disposal cost with incineration technology (US$1000-1500/t)
- Appropriate for the overall hazardous waste management system in China
- Enough co-finance for the potential technology and equipment providers

182. Experiences from other countries showed that the unit costs of non-combustion technology are about US$1000 and US$1500 for common and high-strength POPs wastes (see Annex 2). Considering that low-strength takes major part of the POPs stockpile and wastes, US$1000 is preliminarily determined as the alternative disposal cost

183. The project will significantly contribute to the POPs focal area as follows:

- Safe management of obsolete POPs pesticides and associated wastes to avoid the release of those pollutants to local and global environment;
- Disposal of 10,000 tons of POPs waste in an environmental sound way to avoid the formation and releases of about 8.97 gTEQ PCDD/PCDFs;

- Destruction of 1,000 tons of dioxin-rich fly ash by means of BAT/BEP demonstration and adoption of alternative treatment processes to reduce releases of 30.67 gTEQ PDCC/PDCFs.

184. In addition, the project has a close linkage with the ongoing National Program of Disposal Facilities Construction for Hazardous Wastes and Medical Wastes, which was approved in 2004 as a pure engineering construction program in which 31 hazardous waste treatment and disposal centers will be constructed to dispose of hazardous waste by incinerators. The project will interact with and influence the Program by:

- Introducing life cycle management into current hazardous waste management systems, including qualitative site environmental risk assessment, waste characterization, and pre-disposal treatment involving handling, collection, packaging, labeling, transportation, and storage of stockpiled POPs pesticides;
- Mainstreaming relevant Stockholm Convention requirements for ESM of POPs stockpiles and wastes into current legal and institutional management structure; and
- Expanding technology selection for destruction of stockpiled obsolete POPs pesticide waste thereby generating global environmental benefits.

185. The project could also have a close linkage to the current government study eventually aimed at developing a program for the treatment of contaminated soils. Through the QERA process the project will identify and prioritize POPs contaminated sites. The government of China has allocated a budget to undertake a national survey of contaminated land and land use. This survey, if altered and intervened by the project may catalyze a nationwide soil remediation program, which will surely sustain the outreach of the project results and bring more global environmental benefits.

Table 5. Summary Incremental Cost Matrix in US$

	Baseline	Increment	Alternative
Outcome 1: Strengthened legal and regulatory framework for environmentally sound management (ESM) and disposal of POPs waste	1,214,500	852,400	2,066,900
Outcome 2: Improved institutional capacity at all levels of POPs waste disposal management	1,725,000	924,000	2,649,000
Outcome 3: Environmentally sound disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash	27,790,000	7,063,600	34,853,600
Outcome 4 Qualitative environmental risk assessment (QERA) site prioritization	660,000	642,500	1,302,500
Outcome 5. Project management, monitoring and evaluation	710,500	476,500	1,187,000
Total	**32,100,000**	**9,959,000**	**42,059,000**

D.2 UNIDO INPUTS

186. UNIDO will provide an in-kind contribution of US$100,000 for Outcomes 3 and 5, in particular, providing advice on UNIDO previous experience in implementing Slovakia and Philippines projects; providing training course on contracts and purchase procedures to nationals in line with the component of technology transfer; monitoring of overall project activities specially equipment procurement and dissemination of lessons learnt in the region.

SECTION E: BUDGET

E.1 Project Budget in US$

GEF Outputs	Budget lines	Description	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
			US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m
Output 1.1: Technological and economic policies and regulations in place for promoting environmentally sustainable management and disposal of POPs wastes	11-01	Chief Technical Advisor	17,200	1.0									17,200	1.0
	11-50	Short-term consultants	68,800	4.0									68,800	4.0
	15-00	Project travel	5,000										5,000	
	21-00	Subcontracts	166,400										166,400	
	51-00	Printing/translation	2,000										2,000	
	Sub-total		***259,400***	***5.0***									***259,400***	***5.0***
Output 1.2 : Technical standards and guidelines developed for ESM of POPs waste	11-01	Chief Technical Advisor	10,300	0.6									10,300	0.6
	11-50	Short-term consultants	17,200	1.0									17,200	1.0
	15-00	Project travel	3,000		2,000								5,000	
	17-01	National Technical Advisor	3,100	0.6	3,100	0.6							6,200	1.2
	17-50	National experts	5,100	1.0	5,100	1.0							10,200	2.0
	21-00	Subcontracts	320,000		216,100								536,100	
	51-00	Printing/translation	4,000		4,000								8,000	
	Sub-total		***362,700***	***3.2***	***230,300***	***1.6***							***593,000***	***4.8***
TOTAL Outcome 1			**622,100**	**8.2**	**230,300**	**1.6**							**852,400**	**9.8**
Output 2.1 : Communication and coordination sustained between stakeholders in waste management and disposal	11-01	Chief Technical Advisor	1,700	0.1	1,700	0.1	1,700	0.1	1,700	0.1	1,700	0.1	8,500	0.5
	11-50	Short-term consultants	1,700	0.1	1,700	0.1	1,700	0.1	1,700	0.1	1,700	0.1	8,500	0.5
	15-00	Project travel	3,000		3,000		3,000		3,000		3,000		15,000	
	17-01	National Technical Advisor	1,500	0.3	1,500	0.3	1,500	0.3	1,500	0.3	1,500	0.3	7,500	1.5
	17-50	National experts	2,100	0.4	2,100	0.4	2,100	0.4	2,100	0.4	2,100	0.4	10,500	2.0
	35-00	Workshop/meetings	12,000		12,000		12,000		12,000		12,000		60,000	
	Sub-total		***22,000***	***0.9***	***22,000***	***0.9***	***22,000***	***0.9***	***22,000***	***0.9***	***22,000***	***0.9***	***110,000***	***4.5***

GEF Outputs	Budget lines	Description	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
			US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m
Output 2.2: Institutional capacity enhanced for POPs waste management at local level	11-01	*Chief Technical* Advisor	12,000	0.7	12,000	0.7							24,000	1.4
	11-50	Short-term consultants	16,000	0.9	16,000	0.9							32,000	1.8
	15-00	Project travel	18,,000		17,000								35,000	
	17-01	National Technical Advisor	7,200	1.4	7,200	1.4							14,400	2.8
	17-50	National experts	8,300	1.6	8,300	1.6							16,600	3.2
	21-00	Subcontracts	43,600		43,600								87,200	
	33-00	In-service training	220,000		220,000								440,000	
		Sub-total	***325,100***	***4.6***	***324,100***	***4.6***							***649,200***	***9.2***
Output 2.3 Public awareness	17-01	National Technical Advisor			2,100	0.4	2,100	0.4	2,100	0.4			6,300	1.2
	17-50	National experts			4,100	0.8	4,100	0.8	4,100	0.8			12,300	2.4
	15-00	Project travel			10,000		10,000		5,000				25,000	
	21-00	Subcontracts			10,400		10,400		10,400				31,200	
	35-00	Workshop			25,000				25,000				50,000	
	45-00	Equipment			20,000				20,000				40,000	
		Sub-total			***71,600***	***1.2***	***26,600***	***1.2***	***66,600***	***1.2***			***164,800***	***3.6***
TOTAL Outcome 2			**347,100**	**5.5**	**417,700**	**6.7**	**48,600**	**2.1**	**88,600**	**2.1**	**22,000**	**0.9**	**924,000**	**17.3**
Output 3.1: Safe and effective collection, packaging, and transportation of POPs pesticide wastes for disposal adopted	11-01	Chief Technical Advisor			10,300	0.6	10,300	0.6					20,600	1.2
	11-50	Short-term consultants			32,500	1.9	32,500	1.9					65,000	3.8
	15-00	Project travel			4,000		4,000						8,000	
	17-01	National Technical Advisor			6,100	1.2	6,100	1.2					12,200	2.4
	17-50	National experts			19,000	3.7	19,000	3.7					38,000	7.4
	21-00	Subcontracts			474,000		473,800						947,800	
	33-00	In-service training			10,400								10,400	
		Sub-total			***556,300***	***7.4***	***545,700***	***7.4***					***1,102,000***	***14.8***

GEF Outputs	Budget lines	Description	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
			US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m
Output 3.2 Assessment of technologies for POPs waste disposal carried out	11-01	Chief Technical Advisor	1,700	0.1	3,400	0.2							5,100	0.3
	11-50	Short-term consultants	1,700	0.1	3,400	0.2							5,100	0.3
	15-00	Project travel	1,300		2,700								4,000	
	21-00	Subcontracts	10,000		20,000								30,000	
	Sub-total		***14,700***	***0.2***	***29,500***	***0.4***							***44,200***	***0.6***
Output 3.3: Technology transfer promoted through PPP mechanisms	11-50	Short-term consultants			8,600	0.5	8,600	0.5					17,2000	1.0
	15-00	Project travel			1,500		1,500						3,000	
	17-50	National experts			8,700	1.7	8,700	1.7					17,400	3.4
	Sub-total				***18,800***	***2.2***	***18,800***	***2.2***					***37,600***	***4.4***
Output 3.4: Construction, certification, operation, and supervision of stationary and mobile treatment facilities arranged	11-01	Chief Technical Advisor	3,400	0.2	12,000	0.7	5,100	0.3	5,100	0.3	3,400	0.2	29,000	1.7
	11-50	Short-term consultants	5,100	0.3	22,300	1.3	10,300	0.6	10,300	0.6	5,100	0.3	53,100	3.1
	15-00	Project travel	5,000		5,000								10,000	
	17-01	National Technical Advisor	1,500	0.3	6,700	1.3	3,600	0.7	3,600	0.7	1,500	0.3	16,900	3.3
	17-50	National experts	3,100	0.6	12,900	2.5	6,700	1.3	6,700	1.3	3,100	0.6	32,500	6.3
	21-00	Subcontracts	343,300		1,373,000		686,600		686,600		343,300		3,432,800	
	35-00	Workshop	18,000										18,000	
	45-00	Equipment			2,000,000								2,000,000	
	Sub-total		***379,400***	***1.4***	***3,431,900***	***5.8***	***712,300***	***2.9***	***712,300***	***2.9***	***356,400***	***1.4***	***5,592,300***	***14.4***
Output 3.5 Dioxin rich fly ash disposal implemented	11-01	Chief Technical Advisor					3,400	0.2	3,400	0.2			6,800	0.4
	11-50	Short-term consultants					3,400	0.2	3,400	0.2			6,800	0.4
	15-00	Project travel					4,000		4,000				8,000	
	17-01	National Technical Advisor					1,000	0.2	1,000	0.2			2,000	0.4
	17-50	National experts					2,100	0.4	2,100	0.4			4,200	0.8

GEF Outputs	Budget lines	Description	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
			US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m
	21-00	Subcontracts					114,700		114,700				229,400	
	33-00	In-service training					14,600						14,600	
		Sub-total					***143,200***	***1.0***	***128,600***	***1.0***			***271,800***	***2.0***
Output 3.6 **Exploration of the feasibility to extend POPs waste disposal capacity to CFCs destruction undertaken**	11-01	Chief Technical Advisor							6,800	0.4			6,800	0.4
	11-50	Short-term consultants							3,400	0.2			3,400	0.2
	15-00	Project travel							4,000				4,000	
	17-01	Nat. Technical Advisor							1,000	0.2			1,000	0.2
	17-50	National experts							500	0.1			500	0.1
		Sub-total							***15,700***	***0.9***			***15,700***	0.9
TOTAL Outcome 3			**394,100**	**1.6**	**4,036,500**	**15.8**	**1,420,000**	**13.5**	**856,000**	**4.8**	**356,400**	**1.4**	**7,063,600**	**37.1**
Output 4.1 Inventory of contaminated sites prioritized	11-01	Chief Technical Advisor			3,400	0.2	3,400	0.2	3,400	0.2	3,400	0.2	13,600	0.8
	11-50	Short-term consultants			3,400	0.2	3,400	0.2	3,400	0.2	3,400	0.2	13,600	0.8
	15-00	Project travel			10,000		10,000		7,100		7,000		34,100	
	17-01	National Technical Advisor			2,100	0.4	2,100	0.4	2,100	0.4	2,100	0.4	8,400	1.6
	17-50	National experts			2,600	0.5	2,600	0.5	2,600	0.5	2,600	0.5	10,400	2.0
	21-00	Subcontracts			47,200		35,000		34,000		30,000		146,200	
	35-00	Workshop			20,000		20,000		20,000		20,000		80,000	
	33-00	In-service training			80,000								80,000	
		Sub-total			***168,700***	***1.3***	***76,500***	***1.3***	***72,600***	***1.3***	***68,500***	***1.3***	***386,300***	***5.2***
Output 4.2 Establishment and maintenance of an Internet-based information processing, display and dissemination system in place	11-01	Chief Technical Advisor							1,700	0.1	1,700	0.1	3,400	0.2
	11-50	Short-term consultants							1,700	0.1	1,700	0.1	3,400	0.2
	15-00	Project travel							5,000		5,000		10,000	
	17-01	Nat. Technical Advisor							1,000	0.2	1,000	0.2	2,000	0.4
	17-50	National experts							1,000	0.2	1,000	0.2	2,000	0.4

GEF Outputs	Budget lines	Description	Year 1		Year 2		Year 3		Year 4		Year 5		Total	
			US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m	US$	w/m
	21-00	Subcontracts							47,700		47,700		95,400	
	33-00	In-service training									60,000		60,000	
	35-00	Workshop/meetings							30,000		30,000		60,000	
	45-00	Equipment							20,000				20,000	
	Sub-total								***108,100***	***0.6***	***148,100***	***0.6***	***256,200***	***1.2***
TOTAL Outcome 4					**168,700**	**1.3**	**76,500**	**1.3**	**180,700**	**1.9**	**216,600**	**1.9**	**642,500**	**6.4**
Output 5.1 Project management structure established	11-01	Chief Technical Advisor	8,600	0.5			8,600	0.5					17,200	1.0
	15-00	Project travel	4,000		2,000		4,000						10,000	
	17-01	National Technical Advisor	15,400	3.0	15,400	3.0	15,400	3.0	15,400	3.0	15,400	3.0	77,000	15.0
	17-50	National experts	10,300	2.0	10,300	2.0	10,300	2.0	10,300	2.0	10,300	2.0	51,500	10.0
	45-00	Equipment			38,300								38,300	
	51-00	Printing/translation	500		500								1,000	
	Sub-total		***38,800***	***5.5***	***66,500***	***5.0***	***38,300***	***5.5***	***25,700***	***5.0***	***25,700***	***5.0***	***195,000***	***26.0***
Output 5.2 An M&E mechanism designed and implemented according to GEF M&E procedures	11-01	Chief Technical Advisor	3,400	0.2	3,400	0.2	3,400	0.2	3,400	0.2	3,400	0.2	17,000	1.0
	11-50	Short-term consultants	3,400	0.2	24,000	1.4	3,400	0.2	3,400	0.2	20,600	1.2	54,800	3.2
	15-00	Project travel	7,000		7,000		7,000		7,000		5,000		33,000	
	17-01	National Technical Advisor	1,000	0.2	1,000	0.2	1,000	0.2	1,000	0.2	1,000	0.2	5,000	1.0
	21-00	Subcontracts			40,700								40,700	
	35-00	Workshop/Meetings	69,400		14,400		14,400		14,400		14,400		127,000	
	51-00	Printing/translation	800		800		800		800		800		4,000	
	Sub-total		***85,000***	***0.6***	***91,300***	***1.8***	***30,000***	***0.6***	***30,000***	***0.6***	***45,200***	***1.6***	***281,500***	***5.2***
TOTAL Outcome 5			**123,800**	**6.1**	**157,800**	**6.8**	**68,300**	**6.1**	**55,700**	**5.6**	**70,900**	**6.6**	**476,500**	**31.2**
GRAND TOTAL			**1,487,100**	**21.4**	**5,011,000**	**32.2**	**1,613,400**	**23.0**	**1,181,600**	**14.4**	**665,900**	**10.8**	**9,959,000**	**101.8**
PPG													***231,000***	
TOTAL PROJECT COSTS (incl. PPG)													**10,190,000**	

E.2 Co-financing budget in US$

Outcome/Output/Activities	Co-financing in cash (US$)			Co-financing In-kind (US$)				Total (US$)
	MEP	Local EPB	Private/public sectors	MEP	Local EPB	Private/public sectors	UNIDO	
Outcome 1: Strengthened legal and regulatory framework for *environmentally sound management* (ESM) and disposal of POPs waste								**1,214,500**
Output 1.1 Technological and economic policies and regulations in place for promoting environmentally sustainable management and disposal of POPs wastes				***280,000***	***597,000***			***877,000***
1.1.1 Develop and formulate technological and economic policies through inter-departmental coordination, public awareness raising, public hearings, and NGO outreach				50,000				
1.1.2 Provide training on new technological and economic policies for managerial staff from provincial EPBs				200,000	562,000			
1.1.3 Raise awareness of new technological and economic policies and enforcement mechanisms				30,000	35,000			
Output 1.2 Technical standards and guidelines developed for ESM of POPs waste				***319,500***	***18,000***			***337,500***
1.2.1 Develop and formulate guidelines, standards, and specifications				104,500				
1.2.2 Provide training on guidelines, standards and specifications for managerial staff from provincial EPBs				200,000				
1.2.3 Develop standard operation procedures for analysis and monitoring				15,000	18,000			
Outcome 2: Improved institutional capacity at all levels of POPs waste disposal management								**1,725,000**
Output 2.1 Communication and coordination sustained between stakeholders in waste management and disposal				***140,000***				***140,000***
2.1.1 Establish national, regional, and local coordination framework for integrated POPs waste management				40,000				

Outcome/Output/Activities	Co-financing in cash (US$)			Co-financing In-kind (US$)				Total (US$)
	MEP	Local EPB	Private/public sectors	MEP	Local EPB	Private/public sectors	UNIDO	
2.1.2 Periodically review stakeholder recommendations and action proposals related to POPs wastes ESM				50,000				
2.1.3 Hold periodic fora for public and private stakeholders, NGOs, and the general public to promote good governance and increased effectiveness				50,000				
Output 2.2 Institutional capacity enhanced for POPs waste management at local level					***1,465,000***			***1,465,000***
2.2.1 Enhance overall institutional capacity for program development					180,000			
2.2.2 Adapt and implement national policy and regulatory framework at local level					95,000			
2.2.3 Develop trial local-level responsibility system for obsolete POPs pesticide management and disposal					100,000			
2.2.4 Develop and test pricing mechanisms for POPs waste disposal					100,000			
2.2.5 Establish and implement reporting system to collect and analyze data on creation, transport, and treatment of POPs waste					165,000			
2.2.6 Establish inspection and prosecution system for the discarded POPs wastes and contaminated sites					190,000			
2.2.7 Promote widespread local participation through increasing local input of personnel and financial resources					100,000			
2.2.8 Incorporate ESM principles, norms and requirements into current EIA guidelines					145,000			

Outcome/Output/Activities	Co-financing in cash (US$)			Co-financing In-kind (US$)				Total (US$)
	MEP	Local EPB	Private/public sectors	MEP	Local EPB	Private/public sectors	UNIDO	
2.2.9 Prepare ESM inspection manuals, including: (a) Evaluation, registration and authorization of facility operating licenses for POPs waste treatment, (b) Monitoring of POPs waste disposal facility operation					200,000			
2.2.10 Provide training for local solid waste management centers to implement ESM					190,000			
Output 2.3 Public awareness on POPs activities undertaken				***120,000***				***120,000***
2.3.1 Develop TV and other mass media programs to disseminate knowledge of POPs				30,000				
2.3.2 Publish articles or reports for public education in national and local newspapers.				35,000				
2.3.3 Develop and produce brochures to raise awareness regarding health and safety protection from POPs pesticide wastes and dioxin rich fly ash				25,000				
2.3.4 Hold public hearings regarding POPs waste stockpile reporting, emergency response, and health and safety protection				20,000				
2.3.5 Hotline established for POPs related health and safety issues				10,000				
Outcome 3: Environmentally sound disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash								**27,790,000**
Output 3.1 Safe and effective collection, packaging, and transportation of POPs pesticide wastes for disposal arranged				***320,000***	***900,000***	***1,200,000***		***2,420,000***
3.1.1 Identify location, type, status of POPs pesticide wastes and associated waste matrices at targeted hot spots				50,000				
3.1.2 Develop operating manual for collection, packaging, and transportation of the POPs pesticide waste				130,000				

Outcome/Output/Activities	Co-financing in cash (US$)			Co-financing In-kind (US$)				Total (US$)
	MEP	Local EPB	Private/public sectors	MEP	Local EPB	Private/public sectors	UNIDO	
3.1.3 Prepare detailed terms of reference and contracts for the provincial HWDCs according to expertise in the fields of waste management and occupational health and safety.				50,000				
3.1.4 Provide training to staff from the provincial HWDCs concerning the collection, packaging, and transportation of the POPs pesticide wastes				90,000				
3.1.5 Collect, package, and transport POPs pesticide waste from hot spots						1,200,000		
3.1.6 Store POPs pesticide waste safely to prevent release of POPs contaminants to the environment					900,000			
Output 3.2 Assessment of technologies for POPs waste disposal carried out				***90,000***			***20,000***	***110,000***
3.2.1 Detailed feasibility study for final disposal units based on the waste type, destruction efficiency, emissions, residues, energy/material requirements, portability, state of commercialization, and site selection				70,000				
3.2.2 Preparation of detailed Terms of Reference for technology selection and Request for Proposal from vendors				20,000			20,000	
Output 3.3 Technology transfer promoted through PPP mechanisms			***150,000***	***590,000***				***740,000***
3.3.1 Identify potential PPP arrangements for design, construction and operation of POPs waste treatment infrastructure				500,000				
3.3.2 Promote cooperative relationship among technology vendors and facility designers, constructors, and operators to achieve cost-effective options			150,000	90,000				

Outcome/Output/Activities	Co-financing in cash (US$)			Co-financing In-kind (US$)				Total (US$)
	MEP	Local EPB	Private/public sectors	MEP	Local EPB	Private/public sectors	UNIDO	
Output 3.4 Construction, certification, operation, and supervision of stationary and mobile treatment facilities arranged	***3,900,000***	***850,000***	***6,000,000***	***570,000***	***3,000,000***	***8,650,000***	***25,000***	***22,995,000***
3.4.1 Environmental Impact Assessment (EIA) for one stationary and one mobile unit				20,000		200,000		
3.4.2 Invite bids from potential vendors to transport POPs wastes, construct stationary and mobile units and operate disposal facilities				50,000			15,000	
3.4.3 Prepare disposal sites for deployment of selected technology, including construction of storage facility and commissioning of equipment						700,000		
3.4.4 Installation of the stationary unit at the selected site and mobile unit at selected base stations	3,900,000		3,500,000	500,000	1,500,000	6,800,000		
3.4.5 Transportation of POPs waste to the POPs treatment locations in an environmentally sound manner						200,000		
3.4.6 Final disposal of POPs pesticide wastes in an environmentally sound manner		850,000	2,500,000		1,500,000	600,000		
3.4.7 Monitoring during facility construction and operation						150,000	10,000	
3.4.8 Establishment of equipment ownership arrangements								
Output 3.5 Dioxin rich fly ash disposal implemented		***230,000***	***600,000***	***70,000***	***250,000***			***1,150,000***
3.5.1 Target province selected for non-landfill pilot disposal of dioxin rich fly ash				30,000				
3.5.2 Development of operating manual for non-landfill disposal of dioxin rich fly ash			55,000					

Outcome/Output/Activities	Co-financing in cash (US$)			Co-financing In-kind (US$)				Total (US$)
	MEP	Local EPB	Private/public sectors	MEP	Local EPB	Private/public sectors	UNIDO	
3.5.3 Staff training for safe disposal of dioxin rich fly ash in the selected province			150,000					
3.5.4 Implementation of pilot for safe disposal of dioxin rich fly ash by non-landfill options		230,000	395,000	40,000	250,000			
Output 3.6 Exploration of the feasibility to extend POPs waste disposal capacity to CFCs destruction undertaken				***25,000***		***340,000***	***10,000***	***375,000***
3.6.1 Complete technical and policy review						170,000		
3.6.2 Identify potential technical processes and arrangements for the extension of POPs waste disposal capacity to CFCs destruction						170,000	10,000	
3.6.3 Treatment of CFCs contaminants in POPs destruction unit to demonstrate feasibility of the dual capability of the facility with little or no additional cost				25,000				
Outcome 4 Qualitative environmental risk assessment (QERA) site prioritization								**660,000**
Output 4.1 Inventory of contaminated sites prioritized				***370,000***				**370,000**
4.1.1 Review existing national and international best practice guidelines for human health and ecological risk assessment				30,000				
4.1.2 Develop a project-fit methodology, including QA/QC procedures for quantitative environmental risk assessment (QERA)				50,000				
4.1.3 Train staff in provincial solid waste management centers				90,000				
4.1.4 Carry out on-site surveys following removal activities, focusing on identification of exposure scenarios				110,000				

Outcome/Output/Activities	Co-financing in cash (US$)			Co-financing In-kind (US$)				Total (US$)
	MEP	Local EPB	Private/public sectors	MEP	Local EPB	Private/public sectors	UNIDO	
4.1.5 Qualitatively predict POPs concentrations in identified exposure scenario and characterize risks by comparing target POPs risk factors				60,000				
4.1.6 Analyze information needs for quantitative environmental risk assessment				30,000				
Output 4.2 Establishment and maintenance of an Internet-based information processing, display and dissemination system in place				***290,000***				***290,000***
4.2.1 Design Internet-based system to process and display QERA results and facilitate modeling of environmental risks and remediation decision-making				90,000				
4.2.2 Purchase, install, and test system, maximizing use of existing hardware, software, and topographic data from the current POPs MIS				100,000				
4.2.3 Input data and operate, maintain and update system				50,000				
4.2.4 Conduct internet-based training and software dissemination				50,000				
Outcome 5. Project management, monitoring and evaluation								**710,500**
Output 5.1 Project management structure established				***465,000***				***465,000***
5.1.1 Establish Project Steering Group				70,000				
5.1.2 Establish the National Project Management Team under CIO				100,000				
5.1.3 Recruit Chief Technical Advisor (CTA), a National Technical Advisor (NTA) and other local personnel				100,000				
5.1.4 Establish local project management offices in target provinces				100,000				

Outcome/Output/Activities	Co-financing in cash (US$)			Co-financing In-kind (US$)				Total (US$)
	MEP	Local EPB	Private/public sectors	MEP	Local EPB	Private/public sectors	UNIDO	
5.1.5 Hold management training classes for national and local project management staff				95,000				
Output 5.2 An M&E mechanism designed and implemented according to GEF M&E procedures				***200,500***			***45,000***	***245,000***
5.2.1 Hold the Inception Workshop				35,000				
5.2.2 Prepare Inception Report				500				
5.2.3 Measure impact indicators on an annual basis				500				
5.2.4 Prepare Annual Project Reports and Project Implementation Reviews				2,500			10,000	
5.2.5 Hold annual tripartite review meetings				30,000				
5.2.6 Hold biannual Steering group meetings				16,000				
5.2.7 Carry out mid-term external evaluation				3,000			20,000	
5.2.8 Carry out final external evaluation				3,000			15,000	
5.2.9 Complete the Terminal Report								
5.2.10 Carry out annual project financial audits				15,000				
5.2.11 Carry out biannual visits to selected field sites				25,000				
5.2.12 Establish a project management information system (MIS), including a project website to disseminate information to stakeholders				25,000				
GRAND TOTAL CO-FINANCING	3,900,000	1,080,000	6,750,000	3,850,000	6,230,000	10,190,000	100,000	32,100,000

187. Co-financing leverage will be secured covering almost all project activities, including but not limited to:

- Real estate value the operating site of stationary disposal unit
- Real estate value the operating sites at the four base stations of the mobile disposal unit
- Costs of disposal sites preparation for stationary and mobile disposal units
- Cost of collecting, packaging and transport of POPs pesticide wastes to temporary storage facilities at POPs waste owner site
- Cost of special transport vehicles for POPs pesticide wastes
- Costs of improving current storage facilities for obsolete POPs pesticides and POPs pesticide wastes
- Costs of constructing environmentally sound storage facilities for obsolete POPs pesticides and POPs pesticide wastes
- Costs of carrying out further surveys at polluted sites
- Project administration expenses.

188. The co-financing from the public and private sectors will be ensured through the national selection of host entities. The whole process of disposal facility construction and operation, including the co-finance, will be under the supervision and inspection of the local government.

Co-funding Source Breakdown in US$

Co-financing source	**Cash**	**In-kind**	**Total co-financing**
Central Government (MEP)	3,900,000	3,850,000	***7,750,000***
Local EPBs: - Chongqing Solid Wastes Management Center - Shan'Xi Solid Wastes Management Center	1,080,000 *730,000* *350,000*	6,230,000 *3,660,000* *2,570,000*	***7,310,00***
Private/public sectors: - Shan'Xi Maikerui Environmental Science & Technology Management Co. Ltd. - Anhui Julong Environmental Science & Technology Co. Ltd. - Shenyang Academy of Environmental Sciences - Research Centre for Eco-Environmental Sciences Chinese Academy of Sciences	6,750,000 *5,220,000* *1,460,000* *70,000*	10,190,000 *6,820,000* *2,490,000* *660,000* *220,00*	***16,940,000***
UNIDO		100,000	***100,000***
Total Co-financing	**11,730,000**	**20,370,000**	**32,100,000**

SECTION F: MONITORING AND EVALUATION, REPORTING AND LESSONS LEARNED

Monitoring and Evaluation

189. Monitoring of project activities and evaluation of their results in the project will serve a dual function. First, it will facilitate tracking implementation progress toward the outcomes and objectives. Second, it will facilitate learning, feedback, and knowledge sharing on results and lessons among the primary stakeholders to improve knowledge and performance.

190. This section of the project document presents a concrete and fully budgeted monitoring and evaluation plan of this project (see table below).

Table 6: Monitoring and evaluation plan

Type of M&E activity	Responsible Parties	Budget US$ (Excluding project team staff time)	Time frame
Hold the Inception Workshop	CIO	55,000	Within 3 months after GEF CEO approval
Prepare Inception Report	CIO with support of CTA and NTA	4,000	Within 6 months after the IW
Measure impact indicators on an annual basis	CIO with support of CTA and NTA	9,000	Annually
Prepare Annual Project Reports and Project Implementation Reviews	CIO and UNIDO	9,000	Annually
Hold annual tripartite review meetings	CIO and UNIDO	47,500	Annually, upon receipt of APR and PIR
Hold biannual Steering group meetings	CIO and UNIDO	24,500	Biannually
Carry out mid-term external evaluation	Independent consultants	20,600	At the mid-point of the project implementation
Carry out final external evaluation	Independent consultants	17,000	Within 12 months after the completion of the project implementation
Complete the Terminal Report	CIO, UNIDO with support of NTA and CTA	4,000	
Carry out annual project financial audits	Independent audit entity	17,200	Annually
Carry out biannual visits to selected field sites	CIO and UNIDO	33,000	Biannual
Establish a project management information system (MIS), including a project website to disseminate information to stakeholders	CIO supported by subcontractor	40,700	Throughout the project implementation
Total		**281,500**	

Project Inception Phase

191. A Project Inception Workshop (IW) will be conducted with the full project team, relevant government counterparts, co-financing partners, UNIDO and representative from the UNIDO Country Office (CO), as appropriate.

192. The fundamental objective of this Inception Workshop will be to assist the project team in understanding and assimilating the goals and objectives of the project, as well as to finalize the preparation of the project's first annual work plan on the basis of the project's logical framework matrix. This work will include reviewing the logical framework (indicators, means of verification, assumptions), imparting additional detail as needed, and completing an Annual Work Plan (AWP) for the first year of project implementation, including measurable performance indicators.

193. Additionally, the IW will: (i) introduce project staff to the UNIDO team, which will support the project during its implementation; (ii) delineate the roles, support services, and complementary responsibilities of UNIDO staff vis-à-vis the project team; (iii) provide a detailed overview of UNIDO reporting and Monitoring & Evaluation (M&E) requirements, with particular emphasis on Annual Project Implementation Reviews (PIRs), the Annual Project Report (APR), Tripartite Review (TPR) meetings, as well as mid-term and final evaluations. Equally, the IW will provide an opportunity to inform the project team on UNIDO project related budgetary planning, budget reviews and mandatory budget rephrasing.

194. The IW will also provide an opportunity for all parties to understand their roles, functions, and responsibilities within the project's decision-making structures, including reporting and communication lines and conflict resolution mechanisms. The Terms of Reference (TOR) for project staff and decision-making structures will be discussed, as needed, in order to clarify each party's responsibilities during the project's implementation phase.

Monitoring responsibilities and events

195. A detailed schedule of project review meetings will be developed by the project management team in consultation with the project implementation partners and stakeholder representatives and incorporated in the Project Inception Report. The schedule will include: (i) tentative time frames for Tripartite Reviews, Steering Committee Meetings, and (ii) project related Monitoring and Evaluation activities.

196. Day to day monitoring of project implementation progress will be the responsibility of the National Project Manager based on the project's Annual Work Plan and its indicators. The Project Team will inform UNIDO of any delays or difficulties faced during implementation so that the appropriate support or corrective measures can be adopted in a timely and remedial fashion. In order to avoid risk of duplication or overlapping, the project would seek reporting of major milestones to UNIDO country office for information.

197. The Project Manager, the NTA and the CTA will fine-tune the progress and performance/impact indicators for the project in consultation with the full project team at the Inception Workshop. Specific targets for the first year implementation progress indicators together with their means of verification will be developed in this workshop. These will be used to assess whether implementation is proceeding at the intended pace and in the right direction and will form part of the Annual Work Plan. Targets and indicators for subsequent years will be reviewed annually as part of the internal evaluation and planning processes undertaken by the project team. Local/regional PMOs will also take part in the IW.

198. SMART indicators for impacts and results related to global environmental benefits are identified with baseline and target at Year 5 defined in the table below. All these impact indicators will be monitored annually at specific locations with effective means of verification. These will be undertaken through subcontracts or retainers with relevant institutions or through specific studies that are to form part of the projects activities. Indicators of project goal, progress and performance will be continuously monitored and evaluated throughout the whole project life.

Table 7: Key Impact Indicators

Key Impact Indicator	Baseline	Target (at Year 5)	Means of Verification	Sampling frequency	Location
Metric tons of POPs pesticide waste and associated high-strength waste matrices collected and disposed of in an environmentally sound manner	0	10,000	Check manifests for hazardous waste transportation	Annually	hot spot sites
Metric tons of dioxin rich incineration fly ash collected and disposed of in an environmentally friendly manner	0	1,000	Check manifests for hazardous waste transportation	Annually	1 target province
Avoided production and release of PCDD/F in TEQ attributable to adoption of non-combustion destruction of POPs pesticide waste	0	8.97	On-site monitoring of facility operation	Annually	Provincial hazardous waste management centers
Grams of PCDD/F in TEQ *contained in incineration* fly ash destructed	0	30.67	HRGC-MS monitoring	Annually	Solid hazardous waste management centre in 1 target province
Increase of POPs concentration in adjacent soil and water body, including surface water and underground water	To be determined in 1st year of implementation	0	Supervisory monitoring by local environmental authorities	Annually	hot spot sites

199. As the primary objective of this project is to carry out environmentally sound management and disposal of obsolete POPs pesticide waste and dioxin rich incineration fly ash, the most direct indicators to characterize the impacts of this project should include:

- Metric tons of POPs pesticide waste and associated high-strength waste matrices collected and disposed of in an environmentally sound manner, and
- Metric tons of dioxin rich incineration fly ash collected and disposed of in an environmentally friendly manner should be.

200. Consequential impacts from the clearance and disposal of the aforementioned POPs waste could be indicated by

- the avoided production and release of PCDD/F in TEQ attributable to adoption of non-combustion destruction of POPs pesticide waste, and
- grams of PCDD/F in TEQ contained in incineration fly ash destructed and increase of POPs.

201. The ultimate result of the project should be the decrease or stabilization of POPs concentrations in adjacent soil and water body, including surface water and underground water, following the clearance of the POPs waste stockpile sites due to the removal of sources.

202. UNIDO through quarterly meetings with project counterparts or as frequent as deemed necessary will undertake periodic monitoring of the project implementation progress. This will allow parties to troubleshoot any problems pertaining to the project in a timely fashion to ensure the smooth implementation of project activities.

203. UNIDO and/or UNIDO Country Office will conduct periodic visits based on agreed schedule to be detailed in the project's Inception Report / Annual Work Plan to assess project progress. Other members of the Steering Committee may also accompany these visits. A Field Visit Report will be prepared by UNIDO and will be circulated to the project team and all Project Steering Committee members no less than one month after the visit.

204. Annual Monitoring will occur through Tripartite Review (TPR) meetings, which will take place at least once every year. The first such meeting will be held within twelve months of the start of the full project implementation. The PMOs will prepare an Annual Project Report (APR) and submit it to UNIDO at least two weeks prior to the TPR for review and comments.

205. The TPR has the authority to suspend funds disbursement if project performance benchmarks are not met.

Terminal Tripartite Project Review

206. The terminal tripartite project review (TTPR) meeting will be held in the last month of project operation. The project proponent is responsible in the preparation of the Terminal Report and its submission to UNIDO. It will be prepared in draft at least two months in advance of the TTPR in order to allow more time for its review. This will serve as the basis for discussions in the TTPR meeting. The TTR considers the implementation of the project as a whole, paying particular attention to whether the project has achieved its stated objectives and contributed to the broader environmental objective. It decides whether any actions are still necessary, particularly in relation to sustainability of project results and acts as a means, which lessons learned can be captured for use in other projects under implementation or formulation.

Project Monitoring Reporting

207. The national project team in conjunction with the UNIDO focal point will be responsible for the preparation and submission of the following reports that form part of the monitoring process. Items (a) through (f) are mandatory and are specifically related to monitoring, while items (g) through (h) have a broader function and the frequency and nature are to be defined throughout implementation.

(a) Inception Report

208. A Project Inception Report (IR) will be prepared immediately following the IW. It will include a detailed First Year Annual Work Plan divided into quarterly timeframes, which detail the activities and progress indicators that will guide the implementation during the first year phase of the project. The Work Plan will include the dates of specific field visits, support missions from UNIDO and/or UNIDO consultants, as well as timeframes for meetings of the project's decision-making structures. The report will also include the detailed project budget for the first full year of implementation, prepared on the basis of the Annual Work Plan, and including any monitoring and evaluation requirements to effectively measure project performance during the targeted 12 month timeframe.

209. When finalized, the report will be circulated to project counterparts, who will be given a period of one calendar month in which to respond with comments or queries. Prior to this circulation of the IR, UNIDO will review the document.

(b) Annual Project Report

210. The Annual Project Report (APR) is a UNIDO requirement and part of UNIDO central oversight, monitoring, and project management. It is a self-assessment report by project management to UNIDO, as well as a key input to the TPR. The APR will be prepared on an annual basis prior to the TPR to reflect the progress achieved in meeting the project's Annual Work Plan and assess performance of the project in contributing to the intended outcomes through outputs and partnership work.

211. The format of the APR is flexible but should include the following:

- Analysis of project performance over the reporting period, including outputs produced and information on the status of the outcome
- Constraints experienced in the progress towards results and the reasons for these
- Expenditure reports
- Lessons learned
- Recommendations to address key problems in lack of progress, if applicable.

(c) Project Implementation Report

212. The Project Implementation Report (PIR) is an annual monitoring process mandated by the GEF. It is an essential management and monitoring tool for project managers and offers the main vehicle for extracting lessons from ongoing projects. Once the project will be under implementation for a year, the project team shall complete the PIR. The PIR can be prepared any time during the year (July-June) and ideally immediately prior to the TPR. The PIR should then be discussed at the TPR so that the result would be a PIR that has been agreed upon by project staff, the national executing agency and UNIDO.

(d) Quarterly Progress Reports

213. Short reports outlining the main updates in project progress should be provided quarterly to UNIDO by the project team.

(e) Periodic Thematic Reports

214. As and when called for by UNIDO, the project team will prepare Specific Thematic Reports, focusing on specific issues or areas of activity. The request for a Thematic Report will be provided to the project team in written form by UNIDO and will clearly state the issue or activities that need to be reported on. These reports will be used as a form of lessons learned exercise, specific oversight in key areas, or as troubleshooting exercises to evaluate and overcome obstacles and difficulties encountered.

(f) Project Terminal Report

215. During the last three months of the project, the project team will prepare the Project Terminal Report (PTR). This comprehensive report will summarize all activities, achievements and outputs of the project, lessons learned, objectives met (or not met), and structures and systems implemented. The PTR will be the definitive statement of the Project's activities during its lifetime. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the project's activities.

(g) Technical Reports

216. Technical Reports are detailed documents covering specific areas of analysis within the overall project. As part of the Inception Report, the project team should prepare a draft Reports List, detailing the technical reports that are expected to be prepared on key areas of activity during the course of the Project, and tentative due dates. Where necessary, this Reports List will be revised and updated and included in subsequent APRs. Technical Reports may also be prepared by external consultants and should be comprehensive, specialized analyses of clearly defined areas of research within the framework of the project and its sites. These technical reports will represent, as appropriate, the project's substantive contribution to specific areas and will be used in efforts to disseminate relevant information and best practices at local, national and international levels.

(h) Project Publication

217. Project Publications will form a key method of crystallizing and disseminating the results and achievements of the Project. These publications may be scientific or informational texts on the activities and achievements of the Project in the form of journal articles, multimedia publications or other forms of distribution. Publications can be based on Technical Reports or may be summaries or compilations of a series of Technical Reports and other research. The project team will determine if Technical Reports merit formal publication and will also (in consultation with UNIDO, the government and other relevant stakeholder groups) plan and produce these publications in a consistent and recognizable format.

Independent Evaluations

218. The project will be subjected to at least two independent external evaluations as follows:

(a) Mid-term Evaluation. An independent Mid-Term Evaluation will be undertaken at the end of the second year of project implementation. The Mid-Term Evaluation will measure progress made towards the achievement of outcomes and will identify corrections if needed. The evaluation will focus on the effectiveness, efficiency, and timeliness of project implementation; highlight issues requiring decisions and actions; and present initial lessons learned on project design, implementation and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the second half of the project's term. The organization, terms of reference and timing of the mid-term evaluation will be decided after consultation between the parties to the project document. The Terms of Reference for this mid-term evaluation will be prepared by UNIDO in accordance with the generic TORs developed by the GEF Evaluation Office.

(b) Final Evaluation. An independent Final Evaluation will take place within 12 months after the completion of the project implementation, and will focus on the same issues as the mid-term evaluation. The final evaluation will also review impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental goals. The Final Evaluation should also provide recommendations for follow-up activities. The Terms of Reference for this evaluation will be prepared by the UNIDO in accordance with the generic TORs developed by the GEF Evaluation Office. Though the evaluation activities in China have not yet been completed, the reporting formats will be used as soon as produced by the evaluation branch of UNIDO.

219. A Project Management Information System will be established to support the Project Manager and the project management team to ensure that all the project activities be completed on time, in quality and within budget. The MIS will keep baseline records of Annual Work Plans and contracts with consultants and subcontracts with performance indicators, result reports, responsibilities and budgets, and compare them with the progresses of the activities. A project website will be established to disseminate project information to the primary stakeholders and the general public.

Audit Clause

220. The Government will provide UNIDO with certified periodic financial statements and with an annual audit of financial statements relating to the status of the GEF funds according to the established procedures set out in the Programming and Finance manuals. The audit will be conducted by a legally recognized Government auditor, or by a commercial auditor engaged by the Government.

SECTION G: PRIOR OBLIGATIONS AND PREREQUISITES

221. The Project Document will be signed by UNIDO and the Government of the People's Republic of China. GEF assistance will be provided subject to UNIDO being satisfied that obligations and pre-requisites listed below have been fulfilled or are likely to be fulfilled. When fulfillment of one or more of these prerequisites fails to materialize, UNIDO may, at its discretion, either suspend or terminate its assistance.

G.1 Prior to Project Effectiveness

222. Legally binding co-financing agreements are signed for the private/public sector participation in the project.

G.2 During project implementation

223. Quarterly Progress reports, annual Project Reports and Project Implementation Review reports as well as measure impact indicators should be prepared. The project work plan and consequently the budget will be updated annually.

G.3 Within one year of start of project implementation

224. Annual audited financial reports should be prepared and submitted to GEF.

SECTION H: LEGAL CONTEXT

225. The project document shall be the instrument referred to the Standard Basic Agreement between the Government of the People's Republic of China and UNIDO. The project objectives shall be in line with the objectives of the Policies of the Government of the People's Republic of China.

226. The following types of revisions may be made to this Project Document with the signature of the Project Manager, provided he or she is assured that the other signatories of the Project Document have no objection to the changes as follows:

- Revision in, or addition of, any of the annexes of the Project Document; and
- Revisions that do not involve significant changes in the immediate subcomponents, objectives, outcomes or activities of the project, but are caused by rearrangement of the inputs already agreed to or by cost increases due to inflation.

ANNEXES:

Annex 1: Project Logical Framework

Project Strategy	Objectively verifiable indicators		
Goal	Continuously minimize and, where feasible, ultimately eliminate the releases of obsolete POPs pesticides and dioxin rich fly ash into the environment; assist China in implementing its obligations under the Stockholm Convention to protect the global environment and human health.		
Interventions	**Objectively Verifiable Indicators**	**Sources of Verification**	**Assumptions and Risks**
Objectives Environmentally sound management (ESM) and disposal of obsolete stockpile POPs pesticides associated waste matrices, and PCDD/PCDFs rich incinerator fly-ash in fulfillment of China's commitments under the Stockholm Convention (SC) and National Strategy for Hazardous Waste.	➢ At least 10,000 tons POPs pesticides stockpile and associated wastes at targeted hot spots have been identified, processed, safely transported, and disposed of in an environmentally sound manner. ➢ At least 1000 tons of incinerator fly ash produced in 1 target province collected and disposed in an environmentally friendly manner. ➢ Avoidance of release of 7.5 gTEQ dioxin from pesticide incineration and destruction of 0.9 gTEQ dioxin from fly ash; ➢ One stationary (capacity 10 tons/day) and one mobile unit (5 tons/day) will be *constructed and installed for destruction of* POPs pesticide wastes and dioxin rich fly ash on a national scale. ➢ Identification of potential PPP arrangements and feasibility study of private involvement in POPs destruction facilities ➢ Level of soil and underground water contamination with POPs reduced	➢ Texts of revised or new regulations, standards, and policies ➢ Bidding documents for purchase of technical services and equipment ➢ TORs for consulting services ➢ Service contracts ➢ Work plans ➢ Thematic study reports ➢ M&E reports	➢ Necessary provincial, local, and industry support is received ➢ Barriers can be successfully removed with effective interventions from this project ➢ POPs waste treatment will be an economically viable option ➢ The regulatory and policy framework established by the project will be maintained and adequately resourced after the project's completion

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
Outcome 1: Strengthened legal and regulatory framework for environmentally sound management (ESM) and disposal of POPs waste			
Output 1.1 Technological and economic policies and regulations in place for promoting environmentally sustainable management and disposal of POPs wastes			
1.1.1 Develop and formulate technological and economic policies through inter-departmental coordination, public awareness raising, public hearings, and NGO outreach 1.1.2 Provide training on new technological and economic policies for managerial staff from provincial EPBs 1.1.3 Raise awareness of new technological and economic policies and enforcement mechanisms	➢ Technical and economic policies to promote ESM for disposal of POPs wastes, including but not limited to: – technical policy for construction and operation of disposal units to dispose POPs waste in a cost effective and environmental friendly way; – licensing requirement for management and disposal of POPs pesticides and other POPs contaminated wastes; – legal responsibility and financial mechanism for treatment of POPs waste by operating and non-operating enterprises; – price considerations for POPs waste disposal; and – possible suppliers take back requirements. ➢ New regulations to promote ESM, including but not limited to: – Administrative and regulatory requirements for POPs waste disposal and cost effective disposal options – Licensing requirements for mobile facilities for hazardous waste, including POPs waste disposal - Development of technical specifications for mobile disposal facilities – Development of monitoring guidelines for new technologies and mobile disposal facilities – 4000 managerial and technical staff receiving ESM training	➢ Reports on regulations and policies developed, proposed and adopted. ➢ Regular project reports on training, coordination, outreach, and awareness-building activities. ➢ Training minutes and reports. ➢ News and articles in papers, TV programs, internet, and other media fora. ➢ Community activity reports.	➢ Government at national, provincial, and local levels, as appropriate, will endorse and adopt required policies and measures according to the project timeline.

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
	➢ Training materials developed ➢ Participation by 20 news media outlets and 100 communities	➢	➢
Output 1.2 Technical standards and guidelines developed for ESM of POPs waste			
1.2.1 Develop and formulate guidelines, standards, and specifications 1.2.2 Provide training on guidelines, standards and specifications for managerial staff from provincial EPBs 1.2.3 Develop standard operation procedures for analysis and monitoring	➢ Compilation of ESM guidelines for POPs waste management in line with requirements of Stockholm and Basel conventions; technological and operating guidelines for the following POPs treatment technologies: - Collection, storage, and transportation technologies - Destruction technologies including but not limited to: Incineration, Plasma Arc, Pyrolysis/gassifiers and chemical destruction technologies ➢ Risk assessment and emergency response guidelines for POPs waste disposal ➢ Technology certification standards for disposal of POPs wastes ➢ Audit manuals for the operation of disposal facilities formulated ➢ Supervision and Management Technological Specifications for cost effective options ➢ Monitoring specifications for POPs waste disposal and contaminated sites ➢ 500 specialized managerial and monitoring staff receiving training ➢ Training material ➢ 2 operational program models for monitoring of POPs waste and contaminated sites	➢ Reports on standards, guidelines, and specifications developed, proposed, and adopted ➢ Training minutes and reports ➢ Operational program model documentation	➢ Government at national, provincial, and local levels, as appropriate, will endorse and adopt the required standards, guidelines and specifications according to the project timeline ➢ Key government agencies accept and promulgate new guidelines ➢ Key stakeholders can be effectively involved throughout the process
Outcome 2: Improved institutional capacity at all levels of POPs waste disposal management			
Output 2.1 Communication and coordination sustained between stakeholders in waste management and disposal			
2.1.1 Establish national, regional, and local coordination framework for integrated POPs waste management	➢ National, regional and provincial POPs waste management committees established and in operation	➢ Meeting minutes	➢ Coordination and cooperation can be achieved among stakeholders

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
2.1.2 Periodically review stakeholder recommendations and action proposals related to POPs wastes ESM 2.1.3 Hold periodic fora for public and private stakeholders, NGOs, and the general public to promote good governance and increased effectiveness	➢ Number of recommendations/proposals related to POPs wastes ESM ➢ Local cross cutting managerial and operational coordination mechanism for integrated POPs waste management ➢ Potential conflicts of interest or disputes identified and resolved ➢ Number of NGOs and other stakeholders involved in process ➢ Stakeholder feedback and comments received	➢ Committee decisions, suggestions, and recommendations ➢ Reports on proposals submitted and reviewed ➢ Reports on resolution of conflicts and disputes ➢ Reports on stakeholder feedback and comments	➢ NGOs and enterprises are willing to actively participate.
Output 2.2 Institutional capacity enhanced for POPs waste management at local level			
2.2.1 Enhance overall institutional capacity for program development 2.2.2 Adapt and implement national policy and regulatory framework at local level 2.2.3 Develop trial local-level responsibility system for obsolete POPs pesticide management and disposal 2.2.4 Develop and test pricing mechanisms for POPs waste disposal 2.2.5 Establish and implement reporting system to collect and analyze data on creation, transport, and treatment of POPs waste 2.2.6 Establish inspection and prosecution system for the discarded POPs wastes and contaminated site 2.2.7 Promote widespread local participation through increasing local input of personnel and financial resources 2.2.8 Incorporate ESM principles, norms and requirements into current EIA guidelines 2.2.9 Prepare ESM inspection manuals, including:	➢ Creation of trial responsibility assignment system for obsolete POPs pesticide management and disposal ➢ Pricing program for POPs waste disposal demonstrated ➢ POPs waste disposal data reporting system established ➢ Prosecution and inspection system for the discarded POPs waste and contaminated site established ➢ Increasing local input of personnel, finance and resources ➢ EIA guidelines adopted ➢ ESM inspection manuals developed	➢ New or revised local policies and regulations ➢ Report on local policy establishing responsibility of obsolete POPs pesticide management and disposal ➢ Report on waste disposal pricing ➢ Report of reporting system database creation and use ➢ Report on prosecution and inspection system ➢ Training workshop reports ➢ Training materials ➢ Guidance documents ➢ Manual text	➢ Key agencies attach sufficient importance and allocate sufficient resources to POPs waste management supervision

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
- Evaluation, registration and authorization of facility operating licenses for POPs waste treatment - Monitoring of POPs waste disposal facility operation. 2.2.10 Provide training for local solid waste management centers to implement ESM			
Output 2.3 Public awareness on POPs activities undertaken			
2.3.1 Develop TV and other mass media programs to disseminate knowledge of POPs 2.3.2 Publish articles or reports for public education in national and local newspapers. 2.3.3 Develop and produce brochures to raise awareness regarding health and safety protection from POPs pesticide wastes and dioxin rich fly ash 2.3.4 Hold public hearings regarding POPs waste stockpile reporting, emergency response, and health and safety protection 2.3.5 Hotline established for POPs related health and safety issues	➢ 2 TV and/or other mass media programs to disseminate the knowledge of POPs ➢ 60 articles in national and/or local newspapers ➢ 10,000 brochures prepared to raise awareness of POPs waste related health and safety protection issues ➢ 4 hearings held ➢ At least 200 attendees at hearings ➢ Number of hotline calls/reports ➢ 3-5 hot line staffers	➢ Copies of videos and recordings ➢ Copies of newspaper articles published ➢ Copies of brochures ➢ Hearing report and participant list/ summary ➢ Report on hotline activity	➢ TV programs effectively reach target population ➢ Newspaper articles effectively reach target population
Outcome 3: Environmentally sound disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash			
Output 3.1 Safe and effective collection, packaging, and transportation of POPs pesticide wastes for disposal arranged			
3.1.1 Identify location, type, status of POPs pesticide wastes and associated waste matrices at targeted hot spots 3.1.2 Develop operating manual for collection, packaging, and transportation of the POPs pesticide waste	➢ Localization of POPs pesticide wastes and associated waste matrices at targeted hot spots ➢ Operation manual for the collection, packaging, and transportation of the POPs pesticides and associated waste matrices, including emergency response plan for obsolete POPs pesticide wastes	➢ Report of waste localization and type for each hot spot targeted ➢ Training manual text ➢ Copies of TORs and contracts	➢ Provincial HWDCs represent a sufficient business opportunity to attract contractual interest

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
3.1.3 Prepare detailed terms of reference and contracts for the provincial HWDCs according to expertise in the fields of waste management and occupational health and safety. 3.1.4 Provide training to staff from the provincial HWDCs concerning the collection, packaging, and transportation of the POPs pesticide wastes 3.1.5 Collect, package, and transport POPs pesticide waste from hot spots 3.1.6 Store POPs pesticide waste safely to prevent release of POPs contaminants to the environment	➢ Terms of reference and contract templates for the provincial HWDCs ➢ Number of trained staff from the provincial HWDCs ➢ Safe collection, packaging, and transportation of identified obsolete POPs pesticides ➢ 10000 tons of pesticide wastes and associated waste matrices safely stored in designated storage facilities. ➢ inventory of pesticide wastes at storage sites created and maintained	➢ Implementation plan for collection, packaging, and transportation of POPs pesticide wastes ➢ Training materials and list of trainees ➢ Detailed implementation reports for collection, packaging, and transportation of obsolete POPs pesticides ➢ Storage implementation report ➢ Evaluation report	
Output 3.2 Assessment of technologies for POPs waste disposal carried out			
3.2.1 Detailed feasibility study for final disposal units based on the waste type, destruction efficiency, emissions, residues, energy/material requirements, portability, state of commercialization, and site selection 3.2.2 Preparation of detailed Terms of Reference for technology selection and Request for Proposal from vendors	➢ Feasibility study report of POPs destruction technologies and site selection ➢ Specifications of the stationary and mobile final disposal unit ➢ List of potential vendors for technology and equipment ➢ Terms of Reference ➢ Request for Proposal (RFP)	➢ Evaluation report for POPs destruction technologies ➢ Feasibility report ➢ TOR and RFP documents	➢ Contracts are commercially attractive to vendors
Output 3.3 Technology transfer promoted through PPP mechanisms			
3.3.1 Identify potential PPP arrangements for design, construction and operation of POPs waste treatment infrastructure 3.3.2 Promote cooperative relationship	➢ Identification report for the potential PPP arrangements for POPs destruction infrastructures in China ➢ Workshop held to introduce technology transfer/	➢ Proposal report on potential PPP arrangements for POPs waste treatment ➢ Workshop materials and report ➢ Joint venture certification	➢ Vendors and other parties are willing to cooperate

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
among technology vendors and facility designers, constructors, and operators to achieve cost-effective options	PPP concepts and promote dialogue between public and private sector groups regarding potential POPs PPP projects. ➢ Joint venture or comparable cooperative relationship established	➢ Bidding documents	
Output 3.4 Construction, certification, operation, and supervision of stationary and mobile treatment facilities arranged			
3.4.1 Environmental Impact Assessment (EIA) for one stationary and one mobile unit 3.4.2 Invite bids from potential vendors to transport POPs wastes, construct stationary and mobile units and operate disposal facilities 3.4.3 Prepare disposal sites for deployment of selected technology, including construction of storage facility and commissioning of equipment 3.4.4 Installation of the stationary unit at the selected site and mobile unit at selected base stations 3.4.5 Transportation of POPs waste to the POPs treatment locations in an environmentally sound manner 3.4.6 Final disposal of POPs pesticide wastes in an environmentally sound way 3.4.7 Monitoring during facility construction and operation 3.4.8 Establishment of equipment ownership arrangements	➢ Assessment of the environmental impact of the construction of stationary unit for POPs treatment ➢ Assessment of the environmental impact of installation and operation of mobile unit with four base stations ➢ Qualified vendors identified and contracted to transport POPs wastes and operate disposal facilities ➢ Site preparation for disposal facilities ➢ Storage facility construction and commissioning ➢ Stationary unit installed at selected site ➢ Mobile unit commissioned at four base stations. ➢ 10,000 tons of pesticide wastes safely transported to designated stationary unit or mobile base stations ➢ 10,000 tons of pesticide wastes disposed of in an environmentally sound manner ➢ Equipment purchase, infrastructure construction, facility installation, and operation ➢ Terms of Reference for post-project equipment ownership and operation ➢ Transfer of equipment title	➢ 5 EIA reports ➢ Contracts signed ➢ Progress report ➢ Monitoring reports ➢ Progress report ➢ Monitoring report ➢ Hazardous waste transportation manifests ➢ Operation report ➢ Monitoring reports ➢ Terms of reference ➢ Copies of signed contracts	➢ Contracts are commercially attractive to vendors Infrastructure and water/electric power supply at selected sites are suitable for construction of the stationary and mobile POPs treatment facilities

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
Output 3.5 Dioxin rich fly ash disposal implemented			
3.5.1 Target province selected for non-landfill pilot disposal of dioxin rich fly ash 3.5.2 Development of operating manual for non-landfill disposal of dioxin rich fly ash 3.5.5 Staff training for safe disposal of dioxin rich fly ash in the selected province 3.5.5 Implementation of pilot for safe disposal of dioxin rich fly ash by non-landfill options	➢ Report on target province selection ➢ Operating manual ➢ Number of staff trained in selected province ➢ Training materials developed ➢ Capacity created for disposal of at least 300 tons per year of dioxin rich fly ash safely by non-landfill technology	➢ Report on province selection ➢ Manual text ➢ Training materials ➢ List of trainees ➢ Disposal reports	
Output 3.6 Exploration of the feasibility to extend POPs waste disposal capacity to CFCs destruction undertaken			
3.6.1 Complete technical and policy review 3.6.2 Identify potential technical processes and arrangements for the extension of POPs waste disposal capacity to CFCs destruction 3.6.3 Treat of CFCs contaminants in POPs destruction unit to demonstrate feasibility of making facilities dual capable at little/no additional cost	➢ Evaluation of technical and economic feasibility to destroy CFCs in the POPs disposal facility ➢ Technical processes developed for destruction of CFCs in POPs disposal facilities ➢ Evaluation of economic feasibility to destroy CFCs in POPs disposal facility ➢ Amount of CFCs contaminants disposed in the pilot project	➢ Evaluation report ➢ Technical report	
Outcome 4 Qualitative environmental risk assessment (QERA) site prioritization			
Output 4.1 Inventory of contaminated sites prioritized			
4.1.1 Review existing national and international best practice guidelines for human health and ecological risk assessment 4.1.2 Develop a project-fit methodology, including QA/QC procedures for quantitative environmental risk assessment (QERA) 4.1.3 Train staff in provincial solid waste management centers 4.1.4 Carry out on-site surveys following	➢ Report of international experience and applicability to QERA of POPs contaminated sites in China ➢ Copy of project-fit methodology for QERA ➢ Training agenda, course materials, trainer list, trainee list, list of qualification certificates ➢ Filled out questionnaires ➢ Report of qualitative description of exposures to POPs via environmental medias	➢ Report of international experience and applicability to QERA of POPs contaminated sites in China ➢ Copy of project-fit methodology for QERA ➢ Training agenda, course materials, trainer list, trainee list, list of qualification certificates	Adequate data can be obtained to complete analyses

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
removal activities, focusing on identification of exposure scenarios 4.1.5 Qualitatively predict POPs concentrations in identified exposure scenario and characterize risks by comparing target POPs risk factors 4.1.6 Analyze information needs for quantitative environmental risk assessment	➢ Prioritized site inventory ➢ Report of information needs for quantitative environmental risk assessment system	➢ Filled out questionnaires ➢ Report of qualitative description of exposures to POPs via environmental medias ➢ Prioritized site inventory ➢ Report of information needs for quantitative environmental risk assessment system	
Output 4.2 ***Establishment and maintenance of an Internet-based information processing, display and dissemination system in place***			
4.2.1 Design Internet-based system to process and display QERA results and facilitate modeling of environmental risks and remediation decision-making 4.2.2 Purchase, install, and test system, maximizing use of existing hardware, software, and topographic data from the current POPs MIS 4.2.3 Input data and operate, maintain and update system 4.2.4 Conduct internet-based training and software dissemination	➢ Number of data sets for Internet-based system ➢ Bug reports ➢ Number of data entries ➢ Number of thematic maps derived by system ➢ Number of persons within CIO and local EPBs able to maintain the system	➢ Design report ➢ Specifications and TORs for system installation and testing ➢ System test report ➢ TOR for system operation and maintenance ➢ System specifications and user instructions ➢ Web pages	
Outcome 5. Project management, monitoring and evaluation			
Output 5.1 ***Project management structure established***			
5.1.1 Establish Project Steering Group 5.1.2 Establish the National Project Management Team under CIO	➢ Steering group established with representatives from national and local stakeholder agencies ➢ National Project Management Team established ➢ Necessary office equipment procured ➢ National project expert team established ➢ 3 local project management offices established	➢ Report on establishment and operation of Steering group ➢ TORs for project management staff ➢ National and international expert recruitment notices and TORs	Project will be nationally executed by MEP/FECO.

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
5.1.3 Recruit Chief Technical Advisor (CTA), a National Technical Advisor (NTA), policy experts, and technical experts in POPs waste management, evaluation, and program development 5.1.4 Establish local project management offices in target provinces 5.1.5 Hold management training classes for national and local project management staff	➢ Training workshops held on contractual management, project management tools, and basics of POPs waste management and disposal	➢ TORs of the local project management offices ➢ *Training materials*	
Output 5.2 An M&E mechanism designed and implemented according to GEF M&E procedures			
5.2.1 Hold the Inception Workshop 5.2.2 Prepare Inception Report 5.2.3 Measure impact indicators on an annual basis 5.2.4 Prepare Annual Project Reports and Project Implementation Reviews 5.2.5 Hold annual tripartite review meetings 5.2.6 Hold biannual Steering group meetings 5.2.7 Carry out mid-term external evaluation 5.2.8 Carry out final external evaluation 5.2.9 Complete the Terminal Report 5.2.10 Carry out annual project financial audits 5.2.11 Carry out biannual visits to selected field sites 5.2.12 Establish a project management information system (MIS), including a project website to disseminate information to stakeholders	➢ Inception Workshop held ➢ Detailed work plans prepared ➢ Data and information against indicators input into the MIS ➢ Non-compliances identified and corrected ➢ Technical and political guidance from the Steering group ➢ Experience summarized and recommendations raised ➢ Problems identified and recommendations provided by field visits ➢ MIS established and made functional ➢ Project information, experience and lessons disseminated through website	➢ Inception workshop meeting minutes ➢ Inception Report ➢ Annual Project Reports and Project Implementation Reviews ➢ Biannual Steering group meeting minutes ➢ Mid-term and terminal external evaluation reports ➢ Terminal Report ➢ Annual project financial audit reports ➢ Field inspection reports ➢ MIS development documentations and reports generated by properly retrieving data and information from the MIS ➢ Project website development and maintenance documentation	

ANNEX 2: ENVIRONMENTALLY SOUND DISPOSAL TECHNOLOGIES FOR POPs WASTE AND PESTICIDE DISPOSAL

CONSIDERATION FOR ADAPTATION OF DISPOSAL TECHNOLOGIES IN CHINA

1.1 Status of Pesticides POPs in China

According to the project design, 11,000 tons of POPs pesticide stockpiles and related wastes and 1000 tons of fly ash from hazardous/medical waste incineration will be disposed within 3 years (2 of the 5 years for facility preparation and installation). There is spatially uneven distribution of POPs pesticide wastes in China r. Eight provinces or regions including Jiangsu, Hunan, Sichuan, Shandong, Tianjin, Shanxi, Hebei and Liaoning are the major distribution region, which accounts for 70~80% of total amount, while the distribution in other regions of China is dispersive.

The ingredient and quality of Pesticide POPs wastes in China have greatly changed because of being stockpiled for many years and lacking of supervision.. In most condition, they were immingled with other wastes and their ingredients are very complex, the existing status varies site by site. Simple store or direct discharge of POPs wastes have posed a big environmental and healthy threat to the communities around.

Disposal capacity building was triggered after China government promulgated the *National Construction Planning of Hazardous Waste and Medical Waste Disposal Facilities* (the National Plan) in 2004 and now it is in implementation.

Technology selection consideration

Selection of pesticide POPs wastes disposal technologies should consider those features as below based on those conditions:

- ***Broad-spectrum technology.*** The ingredient and configuration of Pesticide POPs in China are quite complex, which requires a broader technology application range that are able to accommodate and address wasted containing soil, sands, stone, sediment, metal, woods and bio-matrix etc. Moreover, the moisture content in waste should not greatly affect the final disposal efficiency.
- ***Requirement of BAT/BEP.*** The technology should be an environmental sound technology that is *in compliance* with BAT/BEP under the Stockholm and Basel Conventions. The disposal effect should also comply with the further requirements consistent with BAT/BEP, for instance, POPs emission, destruction efficiency, etc.
- ***Inventory and current disposal capacity***. The disposal plan for China pesticide POPs should well consider the distribution of pesticide POPs and cooperate to the extent possible the current disposal capacity.
- ***Cost-effectiveness and co-financing requirements***. The option of technologies must be based on the budget of the whole project including disposal cost and co-financing.

2. CANDIDATE DISPOSAL TECHNOLOGIES FOR ESM OF PESTICIDE POPS

Over the past ten years, intensive evaluation and investigation focus on POPs waste disposal technologies have been completed by some international organizations or research institutions, including UNEP-GEF/STAP, USEPA, BASEL convention secretariat and IHPA etc. In this report, the main candidate technologies are likely to be considered in the implementation phase of the project shall be briefly introduced. Please referred to Review of emerging, innovative technologies for the destruction and decontamination of pops and the identification of promising technologies for use in developing countries for comprehensive evaluation information.

2.1 BCD

The BCD technology was developed on the basis of earlier APEG dechlorination methodologies by EPA's Risk Reduction Engineering Laboratory from 1988 to 1993, in cooperation with the National Facilities Engineering Services Center (NFESC) of US Navy to remediate liquids, soils, sludge and sediments contaminated with chlorinated organic compounds, especially PCBs, PCDD/PCDFs.

A broad range of POPs, from PCB liquids to organochlorine pesticides can be treated by BCD technology. The treatment can be direct or by 2 separate steps, depending on the type of the feed. The first step is the indirect thermal desorption (in case of solids and contaminated matrices), which is a continuous flow process, and the second step is the intrinsic BCD reaction of POPs (condensates from the first step or liquid POPs which can be fed directly), which is a batch process.

2.2 Alkali metal reduction (sodium reduction SR)

SR was practically the first widely adopted alternative solution of PCB treatment and has been applying for nearly 20 years, being very simple in operation, requiring almost no infrastructure, and easy to transport and install on site. The process is based on the reduction of organic compounds by the use of dispersed metallic sodium, which removes the halide from the alkyl halide molecule to produce a sodium halide and a saturated aliphatic hydrocarbon. The reaction is suitable both for destruction of aliphatic and aromatic and of course of mixed aliphatic-aromatic chlorinated compounds as well.

2.3 Supercritical water oxidation

SCWO treats wastes in an enclosed system, using an oxidant (e.g. oxygen, hydrogen peroxide, nitrite, nitrate, etc.) in water at temperatures and pressures above the critical point of water (374°C and 218 atmospheres). Under these conditions, organic materials become highly soluble in water and are oxidized to produce carbon dioxide, water and inorganic acids or salts.

2.4 Ball Milling

This type of technology is represented by two similar processes that is the MCD process by Environmental Decontamination Ltd (EDL), New Zealand and the DMCR process by Tribochem, Germany.

The Ball milling process employs the mechanochemical energy for the initiation of a reduction reaction between a chlorinated substrate (PCBs, pesticides) and a reagent.

2.5 GCPR

The technology was developed and commercialized by ELI Eco Logic International Inc. in Canada. The process can treat all types of chlorinated waste in different forms, such as bulk organic solids and liquids, high-strength PCB oils and mixed solid materials, aqueous waste, contaminated soils and sediments.

The Eco Logic's GPCR technology is based on the gas-phase thermochemical reduction of organic compounds by hydrogen at temperatures of 875°C and low (atmospheric) pressures. The reaction between waste and hydrogen occurs only in the gaseous phase, therefore solid and liquid materials need to be pre-treated.

2.6 Plasma

Generally, plasma arc technologies can be classified as thermal destruction process ranging from pyrolysis to combustion that use heat generated by a plasma arc to destroy the organic waste content and to melt and vitrify the inorganic material.

Various plasma reactors have been developed for the thermal destruction of hazardous waste, mainly in Australia (Plascon, Parcon, Startech), USA (PACT, and PWC) Japan, Switzerland (Thermoselect) and Italy (CSM, Material Development Centre).

2.7 Incineration

High-temperature hazardous-waste incinerators are the most common facilities used for the treatment by complete oxidation of wastes consisting of, containing or contaminated with any POPs, because they are very effective and because there are few alternatives with regulatory approval.

It must be pointed out that the Stockholm Convention in Annex C, Part II identifies waste incineration as a potential source of unintentionally produced POPs. Moreover, recent studies suggest that incinerators achieve destruction efficiencies that are lower than those achieved by certain non-combustion technologies. Therefore each incinerator must be assessed very carefully for its ability to destroy contaminants and its gaseous, liquid and solid emissions.

2.8 Pyrolysis and gasification

In general these methods have been applied to selected waste streams and on a smaller scale than incineration. In addition to municipal wastes and sewage sludge, gasification can be used for some hazardous waste, while pyrolysis for contaminated soils. Specifically developed pyrolysis/gasification technologies, standard incineration technologies (i.e. grates, fluidized beds, rotary kilns, etc) may be adapted to be operated under pyrolytic or gasifying conditions i.e. with reduced oxygen levels (sub-stoichiometric), or at lower temperatures. In addition to the normal targets of waste incineration the waste), the additional aims of gasification and pyrolysis processes are to convert certain fractions of the waste into process gas (called syngas, which can be used as feedstock for other processes) and reduce gas cleaning requirements by reducing flue-gas volumes. The reduced oxygen content implies a lower formation of PCDD/PCDFs.

2.9 Cement Kilns

The primary fuel used in cement kilns is coal. A wide range of other fuels is or has been also used, including petroleum coke, natural gas and oil and it is not uncommon for kilns to be capable of multi-fuelling and for fuels to be changed from time to time based on the prevailing costs of different fuels.

In addition to conventional fuels, the cement industry uses various types of waste as a fuel, including hazardous waste, thus contributing to their destruction. This may be done at the request of national governments or in response to local demand. This co-processing can only be done if certain requirements with respect to input control (for example of heavy metal content, heating value, ash content, chlorine content), process control and emission control are met.

3 STATUS OF DISPOSAL TECHNOLOGY APPLICATION IN CHINA

3.1 Incineration technologies

High temperature incineration

About 30 hazardous waste treatment plants have the ability to treat hazardous wastes, and their total incineration capacity is about 120,000 ton/a. There are few regulations for the POPs wastes incineration in China. Only the pollution control of PCB wastes incineration is regulated. According to the technical policy for the pollution prevention of hazardous waste, PCB wastes should be incinerated in assigned incineration facilities, which should meet the requirements of the Chinese Standard for Hazardous Waste Incineration Pollution Control (GB 18482001)', related policies and regulations.

In the Chinese Standard for PCBs Waste Pollution Prevention (GB 13015-91), it was pointed out that the PCBs waste with a concentration between 50 and 500 mg/kg should be treated by safe landfilling or high temperature incineration; the PCBs waste and PCBs containing impregnator from scrap power capacitors with a concentration higher than 500 mg/kg must be treated by high temperature incineration. The requirements of PCB waste incineration were regulated by Chinese Standard for Hazardous Waste Incineration Pollution Control (GB 18482001), the temperature in high temperature zone ≥1200°C, combustion gas residence time in high temperature zone ≥2.0 s, combustion efficiency ≥ 99.9%, DRE ≥ 99.9999% and Heat Loss of residues <5%.

Currently, Shenyang Incineration Center is the only authorized plant for the incineration of PCBs wastes. It is located at Gujia section of Guoyingjianxian forestry center, Xinming, Shenyang. The project was applied to the former State Planning Committee of China by Shenyang Academy of Environmental Sciences, and the construction started in May 2002. The capacity of the incinerator is 15 ton/day for PCBs wastes. The construction project has passed the environmental risk assessment and the examination of Development and Reform Committee of Liaoning Province. To ensure the safe disposal of PCBs transported from Zhejiang Province in the PCBs Management Demonstration Project, a PCBs storage warehouse, a pretreatment workshop and a waste characterization discriminating unit will be added in the west part of the incineration center.

Cement kiln co-processing

In 2004, there are more than 5000 enterprises producing cement, among them 1900 enterprises have to reduce products or be shot down. The number of enterprises with annual cement output of 200,000-60,000 tons (output 550-1650 tons/day), has increased from 565 in year 2000 to 973 in year 2004. The number of enterprises, with annual cement output more than 60,000 tons (including enterprises that produce clinker), increased from 102 to 265, and the number of oversized enterprises increased from 32 to 87, with annual cement output more than 1.2 million tons (daily output 3300 tons) at the same time. Hence, when choosing kiln for POP wastes disposal, cement plants, which have production capacity over 1000t/d and better management situation for production facilities can be chosen (enterprises that have passed ISO9000/14000 authentication should be paid priority consideration).

According to statistic data from SEPA, about 40 cement plants can dispose hazardous wastes during Tetramethylene Disulfotetramine (a kind of raticide) renovation action in 2003.

As far as the literature reviewed, 3 enterprises namely Hubei Huaxin cement kiln plant, Shanghai Wanan Group Ltd., Beijing cement factory group have conducted pilot incineration. Hereinto pilot incinerations of Shanghai Wanan are most on hazardous wastes and no work has been done on POPs waste. Besides that, Suzhou Huaxin cement kiln plant is reported to conduct pilot incineration soon.

Plasma incineration

Plasma Medical Waste Incineration Technology – SWIP

Southwestern Institute of Physics (SWIP) applied DC plasma torch to develop experimental facility for chemical warfare agent treatment (1kg/h), but no industrialized application. In 2002, cooperated with some engineers of SWIP, Zhen Gao Ke Industry Co., Ltd. (Shenzhen, China) developed a plasma wastes incinerator (2 ton/day), using SWIP technology and key components (plasma torch and power supply).

Actually, the capacity of the furnace cannot achieve 2 ton/day (SWIP now announced that it is only 1 ton/day) and built up a set of 1 ton/day medical wastes facility in Pingshan People's Hospital, Longgang District, Shenzhen. It was said that the incinerator can reach 2000°C or even more in reaction area and decompose effectively the virulent materials, which make great harm to human beings. It also can be used for environmental-friendly treatment of municipal solid wastes, medical wastes, asbestos, battery, waste tire, PVC, and other hazardous industrial wastewater or waste gas. This furnace has no flue gas treatment equipment, so the flue gas is directly discharged. Furthermore, the technology uses air as plasma gas, the excess air ratio is above 5. The system is an oxidative system, like a combustion system, the energy supplied by plasma is not enough to pyrolyze waste. According to SWIP, they have started marketing promotion, but do not offer any examples except the furnace in Pingshan People's Hospital, which was donated by SWIP.

3.2 Pyrolysis

The Thermal Power Engineering and Thermal Science Key Laboratory, Department of Thermal Engineering, Tsinghua University studied the mass and energy balances of quasi-stable state continuous pyrolysis process. Based on their study, the reactor design principle and calculation procedure ware set up. Subsequently the greasy dirt waste taken as the example, the system quality and the energy balance calculation was introduced. The system mass loss is 7.93% — 19.15%. Energy balance calculation can determine not only the energy requirement of the endothermic pyrolysis process, but also the energy recovery efficiency. The experimental equipment can be taken as the prototype reactor of rotary kiln, grate furnace and all other waste incineration process.

Guangzhou Institute of Energy. The Chinese Academy of Science, has applied chromatograph technology to study pyrolysis and gasification mechanism of municipal solid waste.

China Zhongjian Nuclear Fuel Corporation developed the inflammable radioactive solid waste pyrolytic incinerator. The company has done research in middle of 1970s on the processing technology of inflammable solid waste, which contains uranium. The research has been stopped due to funding and resource limitation. In middle of 1980s, Chinese Radiological Protection Academy (Taiyuan, Shanxi Province) has done research with consideration over the property of the radioactive waste in China and focus on the common solid waste. After laboratory testing, the bench test, pilot scale test and industrial scale test of main equipments, prototype of radioactive solid waste pyrolysis-incinerator is developed. Based on the prototype furnace, multi-function radioactive waste incineration testing facility is established and carried engineering test. China Zhongjian Nuclear Fuel Corporation and Chinese Radiological Protection Academy have jointly established the first combustible radioactive solid waste pyrolysis-incineration industrial facility in Oct. 1995. The facility has been tested with different material content discontinuously and continuously. In 2003 the original equipments have been upgraded and improved. The facility realizes the industrial scale processing of radioactive waste and processed more than 100 tons in last 8 years. The facility solves the storage problem and meets the national standard off gas emission.

The Chinese Radiological Protection Academy developed a multi-purpose radioactive waste incineration system and technical process. This systematic technical process mainly includes waste pretreatment, incineration and flue gas purification, etc. The wastes can be processed are solid combustible waste, waste resin and used oil. Solid wastes (include resin) take pyrolysis and used oil spray into furnace to burn the solid wastes. The flue gas purification system uses the combination of dry dust removal and wet acid absorption. The entire system is operated under negative pressure in normal operating mode and the maximum working pressure is ≤ 20 000 Pa. In this case, the system can be fabricated as conventional equipments. The high temperature oxidation and low temperature corrosion at the same time should be well considered during the design period for major equipments and purchasing. The major operating parameters are: for combustor, temperature 850~1100°C, vacuum 1000~1500 Pa, furnace volume 0.36 m3; flue gas ~1260 m3/h, resident time 1 second, preheating from oil burning; for cool air dilutor, temperature 1000~500°C, vacuum 1500-1800 Pa, diluting air 130~150 m3/h; and for water spray cooler, temperature 500~200 °C, vacuum 1800~2500 Pa, water injection volume 80~100 liters/h, compressed air flow rate ~15 m3/h, compressed air pressure 0.3~0.4 MPa, flue gas resident time ~1 second, water spray injector is external air mixing nozzle.

One of the Fengquan's products is two-circuit vertical pyrolyzing furnace. The furnace only uses the inherited heating value of waste (actually is starved air incineration process) Primary combustion chamber does not need any additional fuel to sustain the incineration of municipal solid waste. Hence it can be used to process waste in wide range. The heat preservation and non-adhesion wall technology of the furnace body is a domestic leading technology. The furnace has high thermal efficiency and makes the most of heat recovery. The fine heat resistant technology guarantees waste to be burnt out thoroughly under high temperature and can utilize the high temperature flue gas energy (T ≥ 850 ℃) through a waste heat boiler to produce steam, which can be used according to actually need of customers.

Fengquan has developed 'vertical discontinuous feeding pyrolyzing furnace' to process medical waste, to gasify medical waste in starved air combustion, and then burn out the off gas with controlled air input. Fengquan keeps continuous pyrolysis with two or more furnaces in turn, and apply PLC or DCS system to control entire process, and monitor the pyrolysis and emission conditions on-line, which is connected to local EPA. Since waste resident time relatively longer in vertical furnace, it can be burnt out thoroughly with lower heat loss rate. During the gasification process, the heat from the burning waste in bottom dries the waste in upper layer, which can utilize the inherited heating value and decrease the fuel consumption.

Zhengzhou Wangu Machines Co. Ltd. developed an FSL-150 pyrolyzing furnace (actually, a starved air incinerator), which is mainly used in small and medium size city and towns for medical waste processing. The FSL series furnaces include a furnace body, an auxiliary combustor, flue gas processing system and an automatic control system. Its working principle is the waste first incinerated in primary combustion chamber (600°C-850°C) in oxygen-lean condition to gasify most part of the waste and then the off gas is incinerated in secondary chamber (1000°C -1200°C). Afterwards, the bottom ash is removed from primary chamber.

3.3 Plasma arc technologies

CAS-IMECH plasma arc pyrolysis

CAS-IMECH plasma arc pyrolysis system is developed by the Institute of Mechanics, Chinese Academy of Sciences (CAS-IMECH). The technology is based on Chinese patents such as 3-phase AC plasma metallurgy furnace (ZL 96119824.9) and DC arc technology (listed in table 3), etc., it uses Hydrogen or Argon as plasma gas to get reductive atmosphere, its feasibility is confirmed by using the pyrolysis treatment experiments of various wastes such as chemical warfare agents, chemical wastes, and electronic wastes.

CAS-IMECH built up the plasma-arc medical wastes treatment system, with the capacity of 3 to 5 ton/day, is a full-scale demonstration and can be used to destruct gases, liquids and solid wastes. Since using graphite as furnace liner and electrodes, the system can be used to treat strong-corrosive CFCs wastes containing fluorine.

The system introduces H2 to form reductive atmosphere, consumes less plasma gas and produces low volume off-gas of 200 to 300 Nm^3/hr.

It includes a simplified pre-treatment subsystem, a plasma pyrolysis reactor, a plasma power supply, and an off-gas treatment subsystem, a monitoring/controlling subsystem and a cooling subsystem, etc. The pre-treatment subsystem consists of a hydraulic ram feeder and a guillotine-door, the entire medical wastes pre-treatment subsystem also includes a crusher, a conveyer an additives storage tank, an additives screw feeder and a seal system. The plasma pyrolysis reactor includes an AC plasma-arc generator, a reactor tank, a set of electrode driving machine, a feed-in system, a cooling system and a taphole system etc. The temperatures can attain above 7000°C in arc zone, 1000-1500°C in reaction zone and 900-1100°C at off-gas port, the output of the slag forms vitreous slag. Plasma power subsystem with power capacity of 250kW includes a transformer, an electric reactor and a controlling system, which is obligated for the capacity of 5 ton/day. The integrated off-gas subsystem in the lab is a full system, which involves an off-gas fast heat exchange cooler (to about 600°C), an air pre-heater (heat fresh air to 150°C, while the temperature of the off-gas reduces to around 500°C), and then off gas enters into a carbon-fiber adsorber box to remove dioxins and furans. The fabric filter is not fixed in the system, because of small amount of off-gas taking little particles in it. However, a fabric baghouse is built up in this position in order to catch more fine particles in industrial system. The off-gas after removal of particles is turned into a wet acid gas scrubber where the acid gas in the off-gas is removed, then heated to 150°C by hot air from air pre-heater, and then discharged to a combustor. The off-gas combustor is fixed at the end of the subsystem, and the system before the combustor is designed as sealed and explosion-resistant system.

The combustible gas recycling and syngas producing technique are not employed in this system, thus the technical process and facilities are rather simpler and the system and control strategy is much easier. The shoot diameters produced by pyrolysis progress is around 50 nm and can be collected by fabric filter, which is determined by its purity, the unrecycled shoot will be returned to the feed-in side and then re-treated.

3.4 Tio2 -Based V2O5/WO3 Catalyst Dechlorine

Northwest Research Institute of Chemical Engineering is the only domestic institution, which has researched and developed the technology to clean up dioxin from the flue gas of the medical waste incineration plant with V2O5/TiO2 as catalyst. This process uses vanadium, tungsten and other transition metal as the active ingredients of the catalyst, the titanium dioxide as the carrier, the metavanadic acid ammonium, the ammonium tungstate as the source of active ingredients. The impregnation method produces the catalyst of titanium dioxide carrying vanadium. The off gas of waste incinerator cooled down and removes dust first, and then goes through catalyzing reactor. When the air speed is 5,000 ~ 6000 m3/h, the bed temperature is 250 ~ 450°C, the decomposition efficiency achieves 95% ~ 99%. The pilot scale equipment was installed in a hospital waste incinerator with capacity of 400 kg per day in Beijing. From Dec. 2002 to Jan. 2003, a test has been done in a MSW power plant in southern China. According to the analysis of National Environmental Analysis and Testing Center, the dioxin DME is 95~99%. After passing through the catalyzing reactor, the dioxin concentration drops lower than 0.1 ng TEQ/m3. This technology has applied for domestic invention patent.

Catalyzed dechlorination is a commonly used chemical process, widely applied in crude oil refining, synthetic ammonia and oil refining, etc. The chlorine is the common poison to catalyst, it has very high electron affinity and migratory aptitude, easily react with the metallic ion, also often migrate along with the processing gas to the downstream process and poison the catalyst permanently. In the reforming and processing stage, the organic chloride will be converted into the hydrogen chloride after raw material goes through the hydrogenation pretreatment. The hydrogen chloride and water or ammonia forms the hydrochloric acid and the ammonium chloride separately, which will create the serious corrosion of the equipment and block the pipeline. Furthermore, in some serious condition, the facilities should be cause shutdown to be maintained, which leads to huge economic loss to the plant.

The catalyzed dechlorination technology is a relatively matured technology in existing dechlorination technology and applied widely. The organic chlorine desorption technology mainly have 2 kinds: the catalytic hydrogenation dechlorination and the catalytic hydrogen transfer dechlorination.

The reaction mechanism of catalytic hydrogenation dechlorination has 4 steps: the first, hydrogen adsorption in catalyst surface; the second, the organic chloride adsorbed on the catalyst carrier surface; the third, surface reaction – the adsorbed hydrogen and the organic chloride produce HCl and corresponding hydrocarbon compound; the last, product desorption – produced hydrocarbon compounds and hydrogen chloride detach from dechlorination catalyst surface.

The reaction mechanism of catalytic hydrogen transfer dechlorination is as follows: in the first step, the catalyst and the hydrochloric hydrocarbon to form the complex compounds via contact; in the second step, the hydrogen donor transfers hydrogen to complex compounds to take the place of chloride ion and forms new complex compounds, and the chloride ion leave complex compounds as free-stuff; in the third step, the new complex compounds decompose and then forms new complex compounds; in the last step, after the new complex compounds decompose and form catalyst and corresponding hydrocarbon compounds.

Generally, the dual-metal catalyst as dechlorination catalyst is applied for the organic chloride. At present, the iron contained compounds are used as the main catalyst, with other noble metal and corresponding ion as the auxiliary catalyst. The carrier normally is selected according to the hydrogen source, for example, when take methane series hydrocarbon as hydrogen source, normally the activated carbon, the activated carbon fiber or the activation carbonization resin are used as the carrier. When choosing Al2O3 or PVP (polyethylene base pyrrolidone) as the carrier, gaseous hydrogen is taken as the hydrogen source. Regarding to the aromatic chloride catalytic dechlorination, generally, reaction is taken in the aqueous phase and catalytic hydrogen transfer dechlorination agent is often used. There are many research about this exist in China.

The State Engineering Research Center for Urban Pollution Control, College of Environmental Science and Engineering, Tongji University, studied the technology and mechanism of catalytic reduction dechlorination of chloralkane in aqueous solution, taking the substances as the carbon tetrachloride and the tetrachloroethane as the examples. The Environmental Science Research Institute, Xi'an University of Technology, studied the technology use nickel/iron dual-metal catalytic degrade atrazine and parachlorophenol in the water body. The Henan Hsinhsiang Medical College has studied catalytic dechlorination of PCBs in isopropanolin water solution under mild condition. The Chengdu Institute of Organic Chemistry, Chinese Academy of Science, has studied the Pt/ZSM - 5 catalytic carbon tetrachloride with gas phase hydrogenation dechlorination technology. The Research institute of Environmental Chemistry and Application Technology, Hanshan Normal School, has studied the dechlorination technology for pentachlorophenol with null valence metal in soil.

Although catalytic dechlorination is a relatively matured technology in existed dechlorination technology, few POPs processing experiences have been obtained and not finish laboratory test yet.

4 COST ANALYSIS ON THE POTENTIAL DISPOSAL TECHNOLOGIES.

4.1 Economic analysis on existing disposal technologies

Incineration

Specific costs for PCB treatment (UNEP report on destruction capacity, 2004)

Technology	Type of PCB treated	EUR/ton of waste
rotary kiln + afterburning	bulk liquid, oils	50-500
	bulk packed material	750
high temp incineration	liquids, paper, wood	400-900
	capacitors	800-1500
pretreatment +incineration+ efficient APCDs	solid PCB	600-1500
	liquid PCB	250-1500
	capacitors	depend on size

Low cost mobile incinerators

Prices of mobile incinerators range from US$1,500,000 to $15,000,000 depending on capacity and capabilities. Some companies provide mobile incineration services that can be contracted.

It may take up to six months to get a mobile incinerator on location (preparation, shipment, in-country transport, assembly and testing) and mobilization costs may exceed US$1,000,000 (transport, assembly, testing, disassembly, and transport).

Additional operating costs range from US$600 to $2,000 per tonne, depending on the model of incinerator and the type of waste.

Pyrolysis/gasification

The general costs for these facilities are:

Small plants =3000-4000 t/year; investment costs = $250,000 - $1,000,000 depending on applied APCDs and energy/chemical recovery

Cement kiln

Little information is available on costs for POP treatment.

The capital investment can be maintained parallel with the hazardous waste incineration. The main additional costs mainly come from retrofitting with APCD systems (dedusting or scrubbers). Generally costs are strongly dependent on pretreatment and kind of wastes.

Specific cost for chlorinated and PCB co-incineration are reported from US$1,000 up to US$ 5,000.

Plasma

Plasma technologies generally have lower capital and maintenance costs than incineration

Capital cost can vary in a large extent depending upon the configuration and upon factors such as:

- Waste feed – molecular structure, weight and concentration;
- Electricity costs;
- Argon and oxygen costs;
- Geographic location and site specific issues;
- Caustic costs; and
- Required emission limits.

BCD

Capital costs range from US$800,000 to US$1,400,000 for a 2,500 gallon BCD liquid reactor; and

Operating costs range from US$728 to US$1,772 per tonne depending on the POP concentration (10% POP) and on the design and configuration of the system for either mobile or stationary use, as reported by the vendor.

Alkali metal reduction (SR)

Different operation costs are reported for different SR technologies. Including labour and amortization costs can reach US$ 1,500 (information on BDS process from vendor). However, several other vendors report costs of less than US$1,000 per ton of pure POPs.

The SR plant costs are usually in the range of several hundred thousand USD and can be less than US$ 300,000.

Molten salt

No data are reported for installation costs. Minimum treatment cost is US$ 1,200

4.2 Determination of baseline price for POPs waste disposal

Incineration is the major method for hazardous waste treatment in China and the disposal cost for the common hazardous waste that has low chlorine content and low toxicity is US$700/t. Those incinerators are required to operate in line with the national emission limit of PCDD/Fs of 0.5 ng/Nm3 according to the current Pollution control standard for hazardous waste incineration (GB18484-2001) in China but many of them could not meet the requirement in the day-to-day operation.

The only incineration facility that will meet the Convention operating standards is located in northeast China, and is dedicated to PCB disposal at the unit cost of US$2,930/t. This facility is not yet commissioned, and when operational, the demand on this facility will be beyond its capacity, and in practice will not be available for this project. No other incineration facility currently in operation in China meets the Convention's standards for the disposal of POPs waste.

The baseline cost is US $700/t for common hazardous waste destruction with an emission of PCDD/Fs of 0.5 ng/Nm3 and US$2,930/t for PCBs wastes.

5. CONCLUSION

The considerations mentioned above will help to select the best available technology with a base of comprehensive comparison and analysis on local and international technology. However the final technologies used have to consider a number of technique parameters and performance levels.

ANNEX 3: ENVIRONMENTALLY SOUND TECHNOLOGIES FOR FLY ASH MANAGEMENT

General description

During combustion processes and flue gas polishing, solid wastes may be generated.

The amount and nature of these wastes varies, mainly according to the types of waste or materials being incinerated or combusted and the technology that is employed. These residues contain concentrated amounts of pollutants (e.g. hazardous compounds and salts) and therefore normally are not considered appropriate for recycling purposes.

The following main waste streams are commonly produced during the combustion process:

- ashes and/or slag
- boiler ashes
- filter dust
- other residues from the flue-gas cleaning (e.g. calcium or sodium chlorides)
- sludge from waste water treatment.

In some cases, the above waste streams are segregated; in other cases, they are combined within or outside the process.

The main part of the solid waste is typically called 'ashes'. Two types are usually present; one called 'bottom ash', typically recovered at the bottom of the combustion chamber and another called 'fly ash' that is smaller and flows with the combustion fumes. This latter one is usually recovered with flue-gas cleaning equipment. Other type of ashes come in a lesser extent come from the boiler or heat recovery sections.

In municipal waste incineration bottom ashes are generally produced in the largest quantities and depending on their characteristics can be sometimes used as for re-cycling as an aggregate replacement and construction materials. In modern well-operated plants the TOC (Total organic carbon) in bottom ashes can be below 1 wt %. The relative partitioning of elements into bottom ash depends mainly on the composition of the MSW fed to the incinerator, the volatility of the elements it contains, the type of incinerator and grate system applied and the operation of the combustion system. The mass and volume reduction of waste incineration causes an enrichment of a number of heavy metals in the bottom ashes compared to their concentration in the waste feed. It is important to note that the risks associated with bottom ash are not indicated only by the presence or absence of substances but by the fact that they can be possible emissions sources of pollutants to the environment.

Residues from dry and semi-wet flue-gas treatment are a mixture of calcium and/or sodium salts, mainly as chlorides and sulphites/sulphates. There are also some fluorides and unreacted reagent chemicals (e.g. lime or sodium carbonate). This mixture also includes some fly ash that has not been removed by any preceding dust removal step. It can, therefore, also include polluting heavy metals and PCDD/PCDFs. The normal way of disposal is landfilling as hazardous waste, provided that tests of leaching are carried out

Residues from hazardous waste incineration are not fundamentally different from those of municipal waste incineration plants. However, the following differences can be observed:

- in the case of ash and slag: the incineration of hazardous waste in drums is usually performed at temperatures higher than those used for municipal waste incineration. This can result in different metal partitioning
- owing to variations in waste type and content, the specific amount of bottom ash can be subject to variations much greater than those in municipal waste incineration plants. These variations can be seen within the same plant according to the wastes fed, as well as between different plants and technologies
- in the case of filter dust/FGT residues, as the concentration of heavy metals is normally higher in hazardous waste, the solid residues produced may also contain considerably higher concentrations of heavy metals.

The fly ash produced from the burning of pulverized coal in a coal-fired boiler is a fine-grained, powdery particulate material that is carried off in the flue gas and usually collected from the flue gas by means of electrostatic precipitators, baghouses, or mechanical collection devices such as cyclones. When pulverized coal is combusted in a dry-ash, dry-bottom boiler, about 80 percent of all the ash leaves the furnace as fly ash, entrained in the flue gas. When pulverized coal is combusted in a wet-bottom (or slag-tap) furnace, as much as 50 percent of the ash is retained in the furnace, with the other 50 percent being entrained in the flue gas. In a cyclone furnace, where crushed coal is used as a fuel, 70 to 80 percent of the ash is retained as boiler slag and only 20 to 30 percent leaves the furnace as dry ash in the flue gas.(1) A

In the next table some typical data on residues from municipal waste incineration plants are summarized:

Types of waste	Specific amount (dry) (kg/t of waste)
Slag/ash (including grate siftings/riddlings)	200 – 350
Dust from boiler and de-dusting	20 – 40
FGC residues, reaction products only: Wet sorption Semi-wet sorption Dry sorption	 8 – 15 15 – 35 7 – 45
Reaction products, and filter dust, from: Wet sorption Semi-wet sorption Dry sorption	 30 – 50 40 – 65 32 – 80
Loaded activated carbon	0.5 – 1
Note: wet sorption residue has a specific dryness (e.g. 40 – 50 % d.s.) [74, TWGComments, 2004]	

Source: EU BREF on waste incineration

The table below gives the mass streams of solid residues for various substances per tonne of MSW incinerated. (Flanders Region of Belgium in 1999)

Type of solid residue	Percentage (%)
Bottom ash	21
Fly ash + gas cleaning residue + sludge from wet scrubbers	4.2
Scrap recuperated from bottom ash	1.2

In the table below data from a European survey of merchant Hazardous waste incinerators are provided concerning the total production of various residues:

	Residue production (kg/t waste input)			(Tonnes)
	Minimum	Maximum	Average	Total annual amount (recorded)
Bottom ash	83	246	140	193372
Boiler ash + fly ash + solid flue-gas cleaning residue	32	177	74	79060
Filter cake from ETP	9	83	30	16896

POP content in ashes

PCDD/PCDFs can be found at levels of the order of ng/g in fly ashes or pg/g in other ashes, depending on the source of production. It must be pointed out that as pollution equipment becomes more effective in removing particulate matter, the toxicity of the any kind of ash increases. This has deep consequences in the method of disposal. Some ash is treated as hazardous waste, but sometimes, especially in developing countries, they are disposed of as ordinary waste in dumping sites.

Typical concentrations of organic compounds in the various solid residues in some modern facilities are compiled in the table shown below. (Source: EU IPPC BREF on waste incineration, 2006)

Parameter	Bottom ash	Boiler ash	Filter ash
PCDD/F (I-TEQ)	<0.001 – 0.01	0.02 – 0.5	0.2 – 10
PCB	<5 – 50	4 – 50	10 – 250
PCBz	<2 – 20	200 – 1000	100 – 4000
PCPh	<2 – 50	20 – 500	50 – 10000
PAH	<5 – 10	10 – 300	50 – 2000
All values in ng/g			

Residue	Average value in ng/kg I-TEQ	Max value in ng/kg I-TEQ	Number of samples	Total amount in 2003/tonnes
Bottom ash	46	46	1	1100000
Fly ash	2946	16900*	34	82200
Boiler ash	42	86	3	2900
Wet FGC salts	636	5400	16	25500
Filter cake	17412	66000*	30	8300
* This is a relatively old installation with modern FGT-equipment that prevents dioxin emissions to air. The residue is land filled on a hazardous waste landfill site.				

In the Dioxin Toolkit edited by UNEP four classes of emission factors for hazardous waste incinerators are defined. The highest content of PCDD/PCDFs in hazardous waste incinerators are caused by the batch-type operations, which commonly lead to a long warming and cooling phase of the furnace resulting in pyrolytic conditions in the furnace over an extended period of time.

Classification	Emission Factors - µg TEQ/t HW Burned	
	Air	Residue (Fly Ash Only)
1. Low technology combustion, no APCS	35,000	9,000
2. Controlled combustion, minimal APCS	350	900
3. Controlled combustion, good APCS	10	450
4. High technology combustion, sophisticated APCS	0.75	30

Ashes Disposal Methods

Introduction

Bottom and boiler ashes are disposed of in dumping sites in many countries but may be reused in construction and road-building material following pre-treatment. However, an assessment of content and leachability tests of persistent organic pollutants and heavy metals should be conducted. The disposal in lined and dedicated dumping sites is preferable to mixed waste facilities.

Because of the differences in pollutant concentration, the mixing of bottom and boiler ash with fly ash from filters should be avoided and is forbidden in many countries, but in developing countries still there is a lack of regulation for this kind of problem.

Combustion ashes and flue-gas treatment (FGT) residues can be treated by conditioning, stabilization and solidification processes, either in the combustion plant (e.g. in some incinerators), or on waste treatment facilities. Other methods are vitrification, purification and recycling of some components (e.g. salts).

In particular the following processes are described:

Conditioning

The substances that can only be incinerated or landfilled are conditioned by means of aggregates. Depending on the final disposal plant (e.g. incineration or landfill); diatomite, sawdust or other appropriate aggregates are added to the waste.

Wastes with certain resource contents may be passed on to the downstream plant for the recovery of recyclable substances. If necessary, the wastes may be run over a one step crushing and transferred via a conveyor system to the facility for recovery of recyclable material. Wastes that are delivered in large capacity containers are pretreated.

For dusty wastes, a third fully encapsulated two-shaft shredder is available. In the freefalling mixer, the pretreated wastes may be mixed with aggregates to produce a batch. A homogeneous mixture is prepared in a container and the abrasive forces in the mixing drum cause a quasi-dry cleaning of metal and plastic components in the waste. Then, the conditioned waste is conveyed towards the facility for the recovery of recyclable substances.

Cement solidification

On of the application of cement in waste management is for solidification/stabilization treatment of waste. This treatment of waste involves mixing cement into contaminated media or waste to immobilize contaminants within the treated material.

By mixing portland cement into a waste containing free liquids, the waste gains physical integrity or become more solid. The chemical properties of hydrating portland cement are used to lower the solubility of toxic contaminants in the waste and are some cases, to also lower the toxicity of hazardous constituents. Indeed, cement supplies a large amount of alkaline that stabilizes the heavy metals. On the other hand, it produces the reaction of cohesive, absorption, block, and fixation. Moreover, it is possible, under the condition of strong alkaline, converting heavy metals into hydroxide or carbonate compounds, through a series of physical-chemical processes, hence, retaining at solid. The cement achieves a final strength, after maturation for a certain period of time, through the formation of crystal silicate and hydrate. However, the method usually increases the pH and alkaline capacity of the mixture, therefore improving the leaching behavior of the product.

Cement solidification is used to treat industrial waste to make it safe for land disposal. It is also used to treat contaminated soil, sediment or sludge at clean-up (remediation) sites. At remediation projects, the treatment can be applied to a variety of contaminated media (ex. soil and sediment) with a variety of contaminants (ex. heavy metals, PCBs, and oil). In-situ treatment can have the added benefit of improving soil conditions for construction of structures and pavements.

Thermal treatments

Thermal treatment of FGT waste from combustion processes is used extensively in a few countries, mainly to reduce the volume and to improve their leaching properties. Most commonly, FGT wastes are treated thermally in combination with bottom ashes.

Regardless of the process, the thermal treatment of FGT waste in most cases results in a more homogeneous, denser product with improved leaching properties. The thermal treatment of FGT waste requires substantial off gas treatment, thus creating a new solid residue to be treated...

High temperature treatments use heat in order to melt waste and initiate vitrification and ceramisation processes. They can be grouped into three categories: vitrification, smelting and sintering. The differences between these processes chiefly relate to the characteristics and properties of the final material

Vitrification is a proven technique in the disposal and long-term storage of nuclear waste or other hazardous wastes. It is a process where wastes are mixed with glass precursor materials and then combined at high temperatures to form a single-phase amorphous molten glass that then solidifies immobilizing the waste. Typical vitrification temperatures are 1300 to 1500 °C. The retention mechanisms are chemical bonding of inorganic species in the waste with glass-forming materials, such as silica, and encapsulation of the constituents by a layer of glassy material. The final waste form resembles obsidian and is a non-leaching, durable material that effectively traps the waste inside. The waste can be stored for relatively long periods in this form without concern for air or groundwater contamination. Bulk vitrification uses electrodes to melt soil and wastes where they lay buried.

Melting is similar to vitrifying, but this process does not include the addition of glass materials and results in a multiple-phased product. Often several molten metal phases are generated. It is possible to separate specific metal phases from the melted output and recycle these metals, possibly after refinement. Temperatures are similar to those used in vitrifying.

Sintering involves heating the waste to a level where a bonding of the particles occurs and chemical phases in the wastes reconfigure. This leads to a denser output with less porosity and a higher strength than the original waste. Typical temperatures are around 900 °C. Temperatures for sintering bottom ash from MSW incinerators can be up to 1200 °C.

Incineration

Residues from flue-gas polishing depend on the adsorbent used (activated carbon, cokes, lime, sodium bicarbonate, zeolite). The residue of activated carbon from fixed bed reactors is sometimes permitted to be incinerated in the waste incineration plant itself, if certain process conditions are fulfilled. The residue of entrained bed systems can also be incinerated, if the applied adsorbent is activated carbon or oven cokes only. If a mixture of other reagents and activated carbon is used, the residue is generally sent for external treatment or disposal, since there might be risks of corrosion. If zeolite is used, there are in principle possibilities to recover the mercury, but these techniques are not yet available in practice.

Innovative Technologies

The commercial non-combustion technologies already described in Annex 3 can be positively used for fly ashes treatment and for the removal of the POP content. The main application can be found with plasma or similar high-temperature technologies, such as GPCR (Gas Phase Chemical Reduction) or BCD (base catalytic dechlorination/decomposition). Other application are found with Molten salt technology and

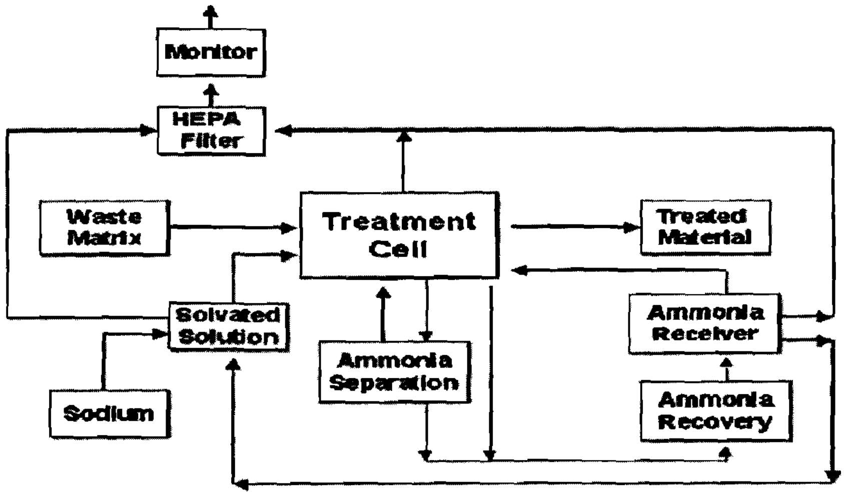
There are other promising technologies which can be used for solid waste treatment. They are as follows:

Solvated electron process

The SET process is a method of reducing halogenated hydrocarbons in a mixture of sodium or other alkali metal in liquid ammonia. Anhydrous sodium or potassium is added to liquid ammonia at nearly 100°C that results in a blue colored solution, due to the solvated electrons. The solvated electrons are powerful reducing agents that can strip chlorine atoms, giving rise to the dechlorinated hydrocarbons and sodium chloride. The organic radicals and ions formed as result of electron and sodium attack can give rise to a variety of polymerization products. When treating concentrated solutions of chlorinated compounds, especially of polychlorinated ones, the polymerization processes might lead to a decrease of efficiency of dechlorination. Therefore, the method is only applicable to low concentrations of chlorinated organics. Full strength POPs, such as concentrated liquids or bulk solid organochlorines should be added in corresponding amounts to reach necessary concentration.

The technology is configured for treating soils, sludges, PCB oils, pesticides, and other organics. The reduction of halogenated materials from soils, oily wastes, sludge, and sediments requires almost complete removal of moisture through pre-drying, because liquid ammonia reacts quickly with water to form ammonium hydroxide, which is not only exothermic, but also inhibits production of solvated electrons. The sodium metal also has affinity for water to form sodium hydroxide. Moreover, water within debris and other inert materials prevents penetration of ammonia.

The SET technology was commercialized and patented by Commodore Solution Technologies, Inc., Marengo, Ohio.



Catalyzed Electrochemical oxidation

At low temperature and atmospheric pressure, electrochemically generated oxidants react with organo-chlorines to form carbon dioxide, water and inorganic ions with high destruction efficiencies. All emissions and residues can be captured for assay and re-processing.

An electrochemical cell is used to generate oxidizing species at the anode in an acid solution, typically nitric acid. These oxidizers and the acid then attack any organic compounds, converting most of them to carbon dioxide, water and inorganic ions at low temperature (<80 °C) and atmospheric pressure. Compounds that have been destroyed by this process include aliphatic and aromatic hydrocarbons, phenols, organophosphorous and organosulphur compounds, and chlorinated aliphatic and aromatic compounds.

This techniques uses electrochemical cells for the generation of the active oxidant at the anode, a liquid phase reactor for primary organic destruction, a gas phase reactor to destroy any fugitive emissions from the liquid reactor and an acid gas scrubber for removal of acid gases prior to venting to the air. The processes operate at low temperature (90 – 95 °C) and at atmosphere pressure.

Mediated electro-chemical oxidation

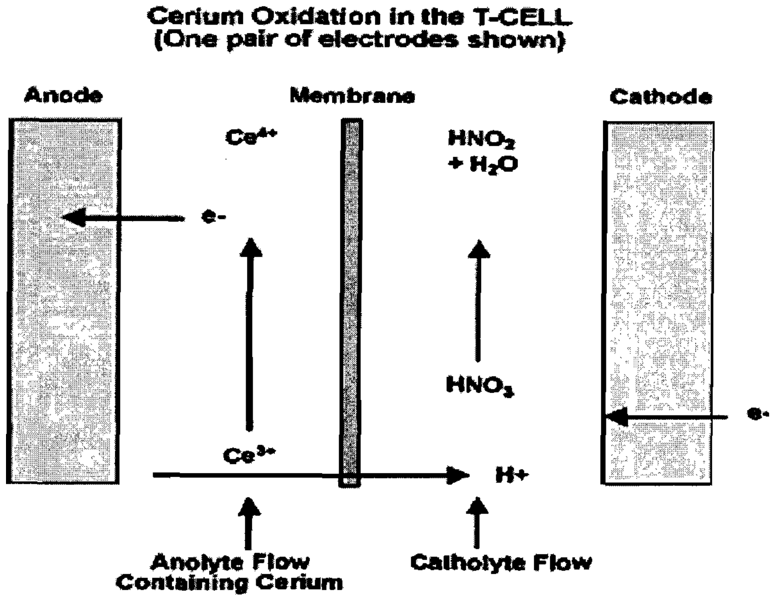
There are two main processes, not fully commercialized yet.

Mediated electro-chemical oxidation by cerium and mediated electro-chemical oxidation by silver

According to the principle of MEO, an electrochemical mediator is being brought to its higher oxidation state via electrochemical reaction, and is then being put in contact with an organic compound to be oxidized; the mediator, now in a lower oxidation state, is brought back to the electrochemical cell.
This techniques uses electrochemical cells for the generation of the active oxidant Ce^{4+} or Ag^{2+} at the anode, a liquid phase reactor for primary organic destruction, a gas phase reactor to destroy any fugitive emissions from the liquid reactor and an acid gas scrubber for removal of acid gases prior to venting to the air. The process operates at low temperature (90 – 95 °C) and at atmosphere pressure

The Cerium technology can process only liquid or liquidized waste. Solids and sludges should be homogenized and pumped as slurries in water. No special pre-treatment equipment is provided other than sonicator mentioned above, the latter needed to further break up the particles of solids in the sludge or emulsify the organic liquids.

The applications of Silver II to POP are limited; however, the reported pilot/lab scale tests with several chlorinated organic substances (trichlorobenzene, chlorobenzene, chlorofluorobenzoic acid, methylene chloride, chloroform, chloroethylethyl sulphide) have been performed including several tests on the full scale plant. The results confirm the possibility of using the technology for destruction of polychlorinated POP waste, such as pesticides and PCBs, which is believed to become one of the future Silver II applications.



Recycling of Fly Ash, in construction materials

Fly ash is useful in many applications because it is a pozzolan, meaning it is a siliceous or alumino-siliceous material that, when in a finely divided form and in the presence of water, will combine with calcium hydroxide (from lime, Portland cement, or kiln dust) to form cementitious compounds.[4]

Portland Cement Concrete (PCC)

Fly ash has been successfully used as a mineral admixture in PCC for nearly 60 years. This is the largest single use of fly ash. It can also be used as a feed material for producing Portland cement and as a component of a Portland-pozzolan blended cement.

Fly ash must be in a dry form when used as a mineral admixture. Fly ash quality must be closely monitored when the material is used in PCC. Fineness, loss on ignition, and chemical content are the most important characteristics of fly ash affecting its use in concrete. Fly ash used in concrete must also have sufficient pozzolanic reactivity and must be of consistent quality.

Asphalt Concrete – Mineral Filler

Fly ash has been used as substitute mineral filler in asphalt paving mixtures for many years. Mineral filler in asphalt paving mixtures consists of particles that fill the voids in a paving mix and serve to improve the cohesion of the binder (asphalt cement) and the stability of the mixture. Most fly ash sources are capable of meeting the gradation (minus .075 mm) requirements and other pertinent physical (nonplastic) and chemical (organic content) requirements of mineral filler specifications.

Fly ash must be in a dry form for use as mineral filler. Fly ash that is collected dry and stored in silos requires no additional processing. It is possible that some sources of fly ash that have a high lime (CaO) content may also be useful as an antistripping agent in asphalt paving mixes.

Other innovative technologies:

Hitachi Zosen has developed a comprehensive exhaust gas / ash treatment system that removes toxic gas and dust efficiently. The equipment consists mainly of a gas cooler, a bag filter, a gas re-heater and a catalytic reduction reactor. Combustion gas from the incinerator is rapidly cooled by a water spraying process to a temperature suitable for exhaust gas treatment. As exhaust gas is rapidly cooled, the generation of PCDD/PCDFs is limited. This equipment is designed to prevent corrosion and dust obstruction by adopting a perfect evaporation cooling system. Cooled exhaust gas is introduced to the bag filter together with injected special agent and slaked lime. HCl and SOx react efficiently with the slaked lime. PCDD/PCDFs and dust absorbed by the special agent are also removed efficiently. Filter cloth material and filtering speed appropriate to the composition of exhaust gas are selected to provide high efficiency and compact filtering system.

Exhaust gas treated in the bag filter is sent to the catalytic reduction reactor with ammonia gas after it has been heated to a temperature suitable for the denitrification reaction using the gas re-heating device. The reactor, using a titanium catalyst, removes very small amounts of PCDD/PCDFs that were not removed by the bag filter. Activated carbon adsorption tower to eliminate PCDD/PCDFs more efficiently, an activated carbon adsorption tower is applied.

The residues (hereafter fly ash) generated in the above flue gas treatment system contain toxic and harmful substances such as PCDD/PCDFs and water-soluble heavy metal compounds. The following systems are designed and installed so that any problem does not occur after their final disposal:

PCDD/PCDFs thermal destruction equipment

Hitachi Zosen has developed a comprehensive exhaust gas / ash treatment system that removes toxic gas and dust efficiently.

2. Features

a. Exhaust gas treatment equipment

The equipment consists mainly of a gas cooler, a bag filter, a gas re-heater and a catalytic reduction reactor.

Gas cooler
Combustion gas from the incinerator is rapidly cooled by a water spraying process to a temperature suitable for exhaust gas treatment. As exhaust gas is rapidly cooled, the generation of dioxin is limited. This equipment is designed to prevent corrosion and dust obstruction by adopting a perfect evaporation cooling system.

Bag filter
Cooled exhaust gas is introduced to the bag filter together with injected special agent and slaked lime. HCl and SOx react efficiently with the slaked lime. Dioxin and dust absorbed by the special agent are also removed efficiently.
Filter cloth material and filtering speed appropriate to the composition of exhaust gas are selected to provide high efficiency and compact filtering system.

Catalytic reduction reactor
Exhaust gas treated in the bag filter is sent to the catalytic reduction reactor with ammonia gas after it has been heated to a temperature suitable for the denitrification reaction using the gas re-heating device. The reactor, using a titanium catalyst, removes very small amounts of dioxin that were not removed by the bag filter.

Activated carbon adsorption tower to eliminate dioxin more efficiently, an activated carbon adsorption tower is applied.

b. Ash processing equipment

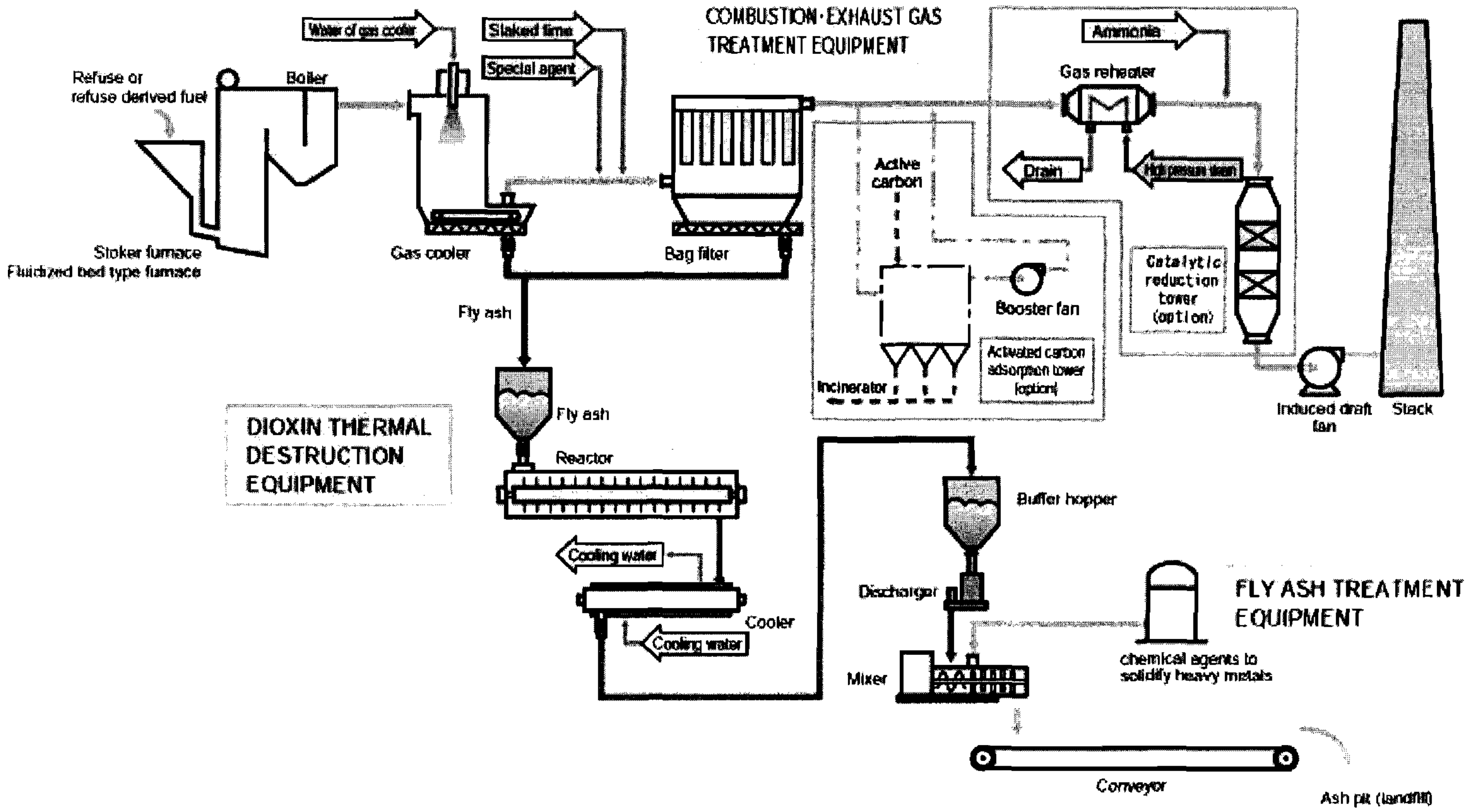
The residues (hereafter fly ash) generated in the above flue gas treatment system contain toxic and harmful substances such as dioxins and water-soluble heavy metal compounds. The following systems are designed and installed so that any problem does not occur after their final disposal:

Dioxins thermal decomposition

The fly ash is heated up to a temperature of 350-450°C for 1hr in condition of very low oxygen concentration, and then cooled down to approx. 60°C promptly. Dioxins' decomposition and elimination takes place in this thermal treatment. This system operates automatically without any full-time operator, is compacted and requires low operating cost.

Heavy metals stabilization

The fly ash is mixed and kneaded with moistening water and chemical agent in a twin-axle type of kneading machine which is specially designed for this use. Water soluble heavy metals react with the agent and alter into insoluble compounds.



System Flow

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Catalytic Decomposer of Dioxins in Flue Gas

1. Outline

We offer the catalytic decomposer of dioxins as reduction system of dioxins in flue gas. This system decomposes dioxins in flue gas by Titania-Vanadium catalyst. We carry out the engineering work including layout planning, design, procurement and construction.

2. Advantages

- The device is compact and suitable to install at existing incinerator. It requires short construction period.
- The catalyst has high dioxins decomposition performance at lower temperature range of 180-200°C, therefore reheating is not required.
- The catalyst decomposes dioxins into harmless substances such as water, carbon dioxide and hydrogen chloride.
- No additional operation is required.
- Expected life of the catalyst is 3 to 10 years, and no maintenance is required in that period.
- Since the catalyst does not adsorb dioxins but decomposes them, no secondary treatment is required.

3. *Performance*

	Gas flow rate (㎥N/h)	Temp. (℃)	Dioxins conc. In inlet gas (ng-TEQ/㎥ N)	Dioxins conc. In outlet gas (ng-TEQ/㎥ N)	Conv. ratio (%)	Start up
A	1740	189	6.3	0.066	99	1999
B	5	200	0.6	0.04	94	1999
C	74000	225	0.3	0.03	90	1996

4. *Application*

Decomposition/Removal of dioxins and NOx as below mentioned in flue gas exhausted from the following facilities.

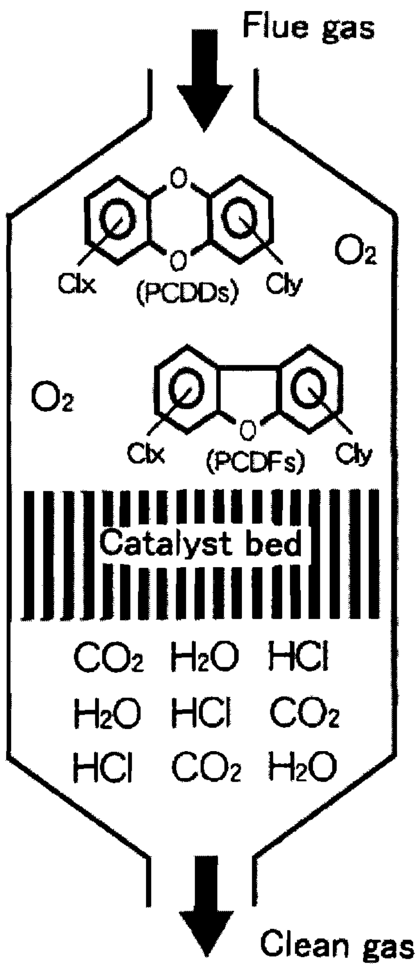
- MSW incinerator
- Industrial waste incinerator
- Production facilities in various fields
- Boiler
- Gas turbine
- Cremator

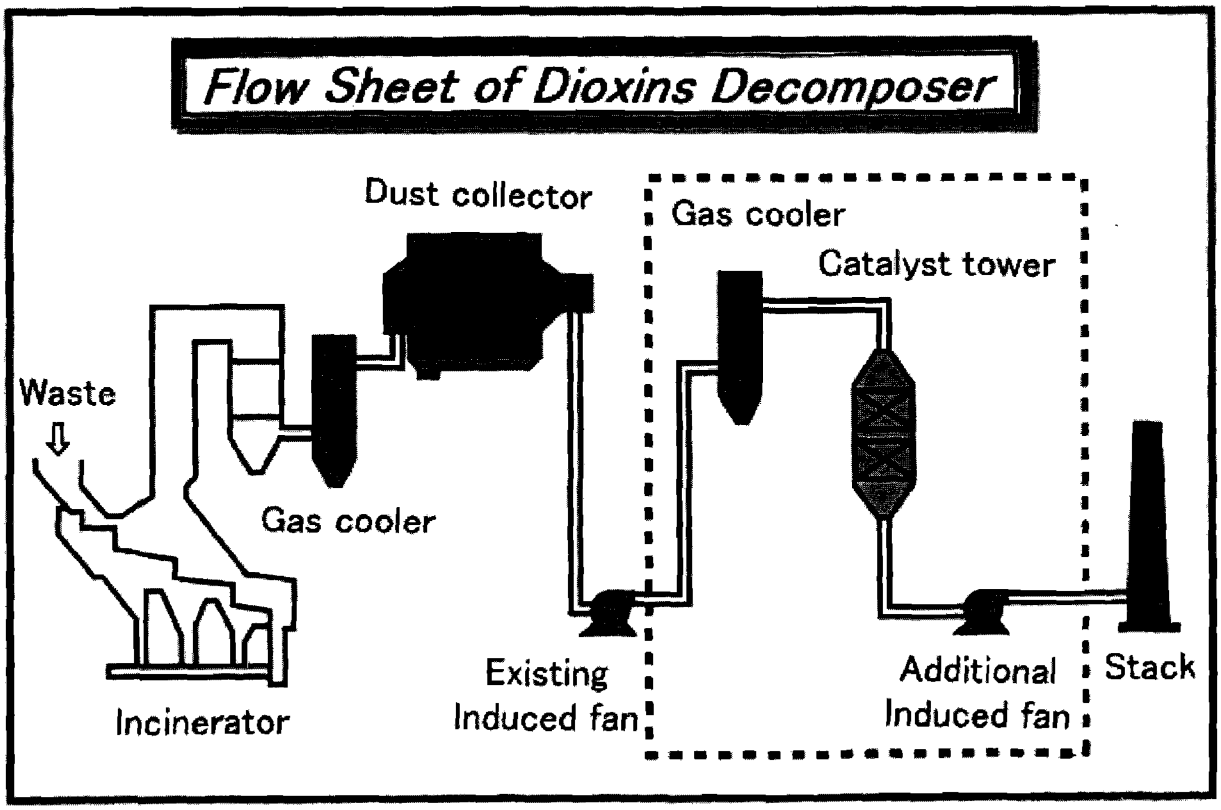
5. *Others*

The catalyst adapted to this device has been developed for de-NOx and then dioxins removal by a certain improvement, and has the following advantages.

- High conversion efficiency
- Applicable for dirty gas
- High resistance to Sox
- High resistance to alkali metals
- Long life
- De-NOx can be carried out simultaneously by injection of reductant agent such as ammonia.

Principle of Dioxins Decomposition





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http://www.tecnofrontier.co.jp/

TSK Dioxin Destruction System

1. Outline

The TSK Dioxin Destruction System consists of a high active catalyst and a special type of reactor called a Lateral Flow Reactor, or LFR. The so-called Lateral Flow Reactor (LFR) is a system of gas channels and catalysis slabs (see attached figure 1). The flue gas enters the reactor through a gas channel that is open on only one side of the reactor. The gas then passes through a thin catalyst slab in a direction to enter a further gas channel that is only open on the opposite side of the reactor through which the gas leaves the system. The fact that the gas only passes through a thin catalysis layer is reason for the very low-pressure drop possible with this system.

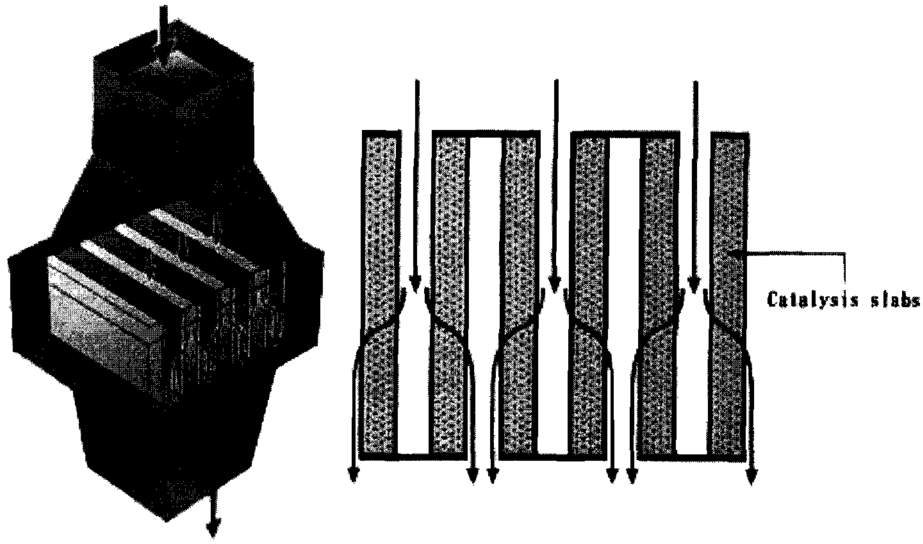

Figure 1

2. *Features*

The TSK catalyst system has the following features.

a. High destruction removal performance

TSK catalyst has the dioxin destruction efficiency of 99% or more. Even if the concentration of dioxin in the flue gas is so high, it is possible to meet the strict regulation value.

b. Wide range of available temperature

A high destruction rate is obtained within the range of the temperature of 160-380°C. Therefore, extra facilities such as cooling, heating, etc. of exhaust gas need not be considered.

c. Long catalyst life

Generally, a high destruction rate can be maintained for three years or more. Therefore, the exchange frequency of the catalyst can be minimized.

d. Space-saving

Because TSK catalyst has a very wide internal surface area, space required for installation is smaller than other catalysts. In addition, there is no limitation in the direction of the gas flow.

3. Performance

a. Temperature dependency

Figure 2 shows the temperature dependency of TSK catalyst. The catalyst has the high dioxin destruction ability compared with the honeycomb type catalyst. In addition, the catalyst has high performance of 95% or more at the temperature of about 150°C.

b. Space velocity

The space velocity does not significantly affect the destruction ability (99.5-97%) in the range of 3000-12000 [h^{-1}].

c. Pressure drop

TSK catalyst is granular type, and standard slabs thickness is 100mm, which has pressure drop of 0.5 kPa. When the allowable pressure drop is less than that volume, the slab thickness of 20-65mm can be designed. In this case, size of the reactor becomes slightly bigger and the volume of the catalyst does not change.

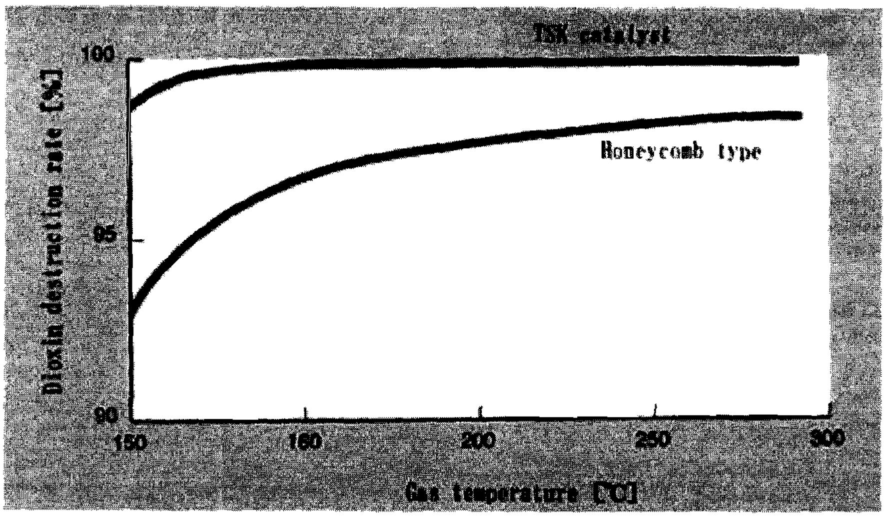

Figure 2

4. Application

This catalyst can be applied to the incineration plant for municipal wastes, industrial wastes as well as the gas from the chemical plant.

It has also an excellent De-NOx performance, so the simultaneous destruction of dioxin and NOx is possible.

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ANNEX 4: FEE-BASED WASTE MANAGEMENT SYSTEM

Current Situation

According to recent estimates over 10 million tons of hazardous wastes are annually produced in China. Strong economic development and the lack of strict enforcement of hazardous waste management regulations has resulted in continuous increase in the amount of wastes created. Only an estimated 24.2 percent of these wastes have been disposed of, and only one third is stored in environmentally sound storage facilities. Between 1996 and 2004, it is estimated that 26.34 million tons of hazardous wastes were disposed of in dumpsites.

As hazardous waste has toxic, reactive, flammable, corrosive and/or infectious properties, it poses a direct hazard to both human and environmental health. Of total hazardous wastes generated in China, 40 percent was produced by the chemical industry. The majority of hazardous waste consists of waste alkali, waste acid, inorganic fluoride waste, copper waste, and inorganic cyanide waste. In total, 44% of this hazardous waste was recycled, 27% was stored, 13.5% was treated and disposed of, and 15.4% was discharged into the environment untreated.

Legislative framework for hazardous wastes management

Since the 1990s, China has promulgated a series of solid waste management laws, regulations and standards. Since 2000, China passed and implemented new laws and policies that have specifically addressed the management of hazardous wastes. The legislative framework for hazardous waste management has 5 levels that among others include:

First Level: National People Congress/Central Government

Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and Their Disposal, ratified on 4 September, 1991

Law on Prevention and Control of Environmental Pollution Caused by Solid Waste, adopted on 30 October, 1995, amended on 12 December, 2004.

Second Level: State Council Regulations

- Regulation on Medical Waste Management, effective as of 16 June, 2003.
- Procedure for Applying for a Hazardous Waste Operating License, effective as of July 1, 2004.

Third Level: National Standards from Ministries

- Identification Standard on Hazardous Waste GB5085.1-3-1996
- Standard on the Pollution Control of Incineration of Hazardous Waste GB 18484-2001
- Standard on the Pollution Control in the Storage of Hazardous Waste GB 18597-2001
- Standard on the Pollution Control in Landfilling Hazardous Waste GB 18598-2001
- Rule on Tracking the Manifest of Hazardous Waste, effective as of 1 October, 1999
- National Catalogue of Hazardous Waste, promulgated by MEP, Ministry of Public Security, former Ministry of Foreign Economy and Trade, and former State Economic and Trade Committee, effective as of 1 July, 1998

Fourth Level: National Policy for Construction and Treatment Facilities

- Construction Plan on Hazardous Waste and Medical Waste Facilities, approved by State Council, issued by MEP, NDRC (National Development and Reform Commission) on 19 January, 2004
- Technical Requirement for the Construction of Facility Incinerating Hazardous Waste, issued by MEP in 2004, amended in 2005

Fifth Level Local Regulations: Provincial People's Congresses

- Shanghai's Regulation on Prevention and Control of Environmental Pollution Caused by Hazardous Waste, adopted in 1995 and amended in 2002.

Penalties for illegal disposal of hazardous wastes

In the Regulations Governing the Management of Urban Construction Waste came into force on 1 June 2005, heavy fines will be imposed on units and individuals that fail to dispose of construction waste according to relevant regulations.

Under the new regulations, waste generator units may be fined up to RMB 3,000 and individuals up to RMB 200 if they mix construction waste with household garbage or mix hazardous waste with construction waste. Units may be fined between RMB 5,000 and RMB 10,000 and individuals may be fined up to RMB 3,000 if they set up dumping grounds for construction waste without authorization. Construction waste treatment facilities that handle industrial waste, household garbage or toxic or hazardous waste may be fined between RMB 5,000 and RMB 10,000. Construction units that fail to dispose in a timely manner of construction waste produced in the course of construction, resulting in environmental pollution, may be fined RMB 5,000 to RMB 50,000. Construction units that ask individuals or unauthorized units to dispose of construction waste on their behalf may be fined between RMB 10,000 and RMB 100,000. Waste treatment facilities handling the disposal of construction waste may be fined between RMB 5,000 and RMB 50,000 for discarding or scattering construction waste in the course of transportation. Fines of between RMB 5,000 and RMB 20,000 may be imposed on acts of tampering with, illegal selling, renting out, lending or other forms of illegal transfer of urban construction waste disposal approval documents. Construction units may be fined RMB 10,000 to RMB 100,000, and project developers and construction waste transportation units may be fined RMB 5,000 to RMB 30,000 for unauthorized disposal of construction waste or disposal of construction waste over and above the approved limits. Units or individuals that dump, discard or stack construction waste randomly will be warned by the environmental and health departments and ordered to take remedial measures within a stated time. In addition, waste generator units may be fined RMB 5,000 to RMB 50,000 and individuals may be fined up to RMB 2,000.

Construction waste mentioned in the regulations refers to spoil, waste and other materials discarded by developers or construction units in new construction, reconstruction or expansion projects, or in the dismantling of buildings, structures or pipe networks, or by people decorating or refurbishing their homes.

Fee-based hazardous waste management

According to national regulations on hazardous and medical waste management, treatment facilities are permitted to charge hazardous waste generators for treatment of the wastes they generate. However, national regulations do not specify the basis for these fees, nor how they should be collected. As a result, different approaches have been adopted. For example, for hospitals generating hazardous medical waste, charges may be assessed:

- Flat fee based on number of hospital beds
- Charge based on actual hazardous and medical wastes treated, by weight

Ideally, fee-based systems can significantly improve the efficiency and effectiveness of hazardous and medical waste management system operation, as well as providing incentives to stakeholders to minimize waste. However, given the haste with which these systems have been implemented, little attention has been paid to maximizing efficiency and minimizing waste. In many cases, systems adopted may in fact reduce efficiency and provide no incentive for waste minimization. In addition to system design issues, fee systems may also be incompletely implemented and/or poorly managed, resulting in further inefficiencies, disincentives and negative financial impacts to stakeholders.

Flat fee system

As the flat fee system is mainly relevant to the medical waste management, it is not discussed in this project document. However, it may be relevant and can be considered when used as an enduser-based charge.

Weight-based system

For hazardous wastes of obsolete pesticides and particularly POPs pesticides, a weight-based fee system seems to be the most appropriate and feasible to adopt. In a simple situation the hazardous waste treatment facilities transport and treat the pesticide wastes, and then charge the waste generators and/or owners based on the weight of the waste treated. The disposal process may, however, be more complex depending on the ownership of the waste, particularly if the entity that originally generated the waste could not be hold liable for its ownership. There could be several reasons for such a situation, e.g. the entity was shut down and does not exist any more but the wastes have remained on site. It should also be noted that the hazardous waste disposal facility and the transport service provider may belong to different entities that might particularly be the case in the private sector.

This approach has advantage and disadvantages. It gives an incentive to the waste generators to reduce the amount of wastes by reuse and recycling, but can result in illegal discharges at the manufacturing sites particularly if the penalty fees were lower than the disposal costs. A strictly weight-based approach has at least two further drawbacks:

- It does not consider physical waste volume, which is an more important determinant of total waste treatment cost, since waste transportation is often the largest cost factor and transport costs are based on physical volume rather than weight; and
- When waste volumes vary significantly, unit-based fees do not reflect total treatment costs, given that total treatment costs have both fixed and variable cost components. While the variable cost can easily be incorporated into a unit charge, allocation of fixed costs requires an estimate of total annual volume. If actual volume differs significantly from physical volume, unit costs will then vary significantly, and the unit charge will either over or under-state costs.

To address these drawbacks the weight-based approach should be refined and taken into account not only the actual quantity of the obsolete pesticides and/or pesticide wastes but also the specific medium or matrix in which the POPs pesticides are dissolved, absorbed or carried in addition to their contaminating pesticides concentrations.

Why the current fee-based system does not work

The regulations establishing the current hazardous waste disposal fee system are in the form of guidance documents, and are not mandatory. This lack of mandatory enforcement and the regulations' vagueness regarding approaches has inhibited development of consistent and optimal systems. Because of the lack of specific guidance and requirements, the decision on which fee approach to adopt is often made by the local price setting bureau based on factors not related to the ultimate efficiency and sustainability of the system.

An additional factor contributing to disfunctionality in the current approach is the difficulty of coordination among various local stakeholders in determining fee levels. Conflicting interests among the local EPB (waste disposal), the local Price Setting Bureau, the Department for Industry and Business, and other stakeholders make it difficult to arrive at an efficient outcome.

Global market prices

The global market prices may be used as a benchmark when introducing a fee-based system or amending an existing system for hazardous waste disposal in China. Without transport costs the current international market price for hazardous waste disposal falls in the range of US$ 500 to US$ 1,000.

Dedicated fund approach

One option for structuring China's hazardous waste management system is to draw on the experience of the United States' Superfund system. Under Superfund, industries that have been historically responsible for creation of hazardous waste (principally the chemical and petrochemical sectors) are assessed fees based not on their generation of hazardous waste, but on their overall physical output. Three excise taxes were established by the program: (1) a per barrel tax on refinery crude oil and imported petroleum products, (2) a per ton tax on designated chemicals; and (3) a per ton tax on imports containing or derived from those chemical feed stocks. The special income tax on corporations is an additional income tax on relatively large corporations based on their alternative minimum taxable income.[1]

[1] In addition to excise taxes, a special environmental tax of 0.12% of profits was assessed on large corporations, the proceeds of which went directly into the Superfund.

This approach has several potential benefits: (1) easier administration, since total output is easier to track and verify than hazardous waste generation; (2) creation of a wider fee base, which allows for a lower fee rate per unit of output and significant collection of funds (Superfund collects over $300 million/year); and (3) removal of the possible incentive to under-report (and hence illegally and dangerously dispose of) hazardous wastes, since fees are not directly based on generation of those wastes. While other aspects of the Superfund program have been criticized, this fee-based approach should be considered, since each of these benefits might prove advantageous in China as well. If desired, the approach could be modified to take into account differing average levels of hazardous waste generation in different sectors and sub-sectors (e.g., a sector with lower levels of hazardous waste generation could be assessed a lower rate). This approach could also easily be combined with alternate approaches for select sectors, e.g., a output-based fee system for the chemical industry, with a weight or volume based approach for medical waste generators. Given the potentially high ultimate cost of remediation of contaminated sites, a special transfer tax could also be levied on real estate transfers (e.g., 1-2% of total sales price), the proceeds of which would then be used to remediate contaminated sites nationwide. As a further revenue source, the Fund could assume ownership of highly contaminated land (potentially purchasing land use rights at a reduced cost to reflect clean-up costs), and could remediate and then redevelop that land, with sales proceeds flowing back into the Fund to finance remediation work.

It should be noted that the US Superfund program generally operates according to the "polluter pays" principal, whereby the program first seeks to require those responsible for a contaminated hazardous waste site to bear the financial and legal responsibility for site clean-up. However, where no responsible party can be identified or held legally responsible, clean-up funds are drawn from funds generated by the above fee based system (the "Superfund"). As a further program option, the China hazardous waste fee could be structured to pay for either (1) only those sites for which responsible parties were not identified (or did not have the necessary funds), as with Superfund, (2) to pay for clean-up of all targeted sites, or (3) to pay all costs without solvent responsible parties and a fixed portion of costs at other sites.

Project approach

In order to maximize efficiency, equity and sustainable funding, the project will undertake to train officials and POPs pesticide waste generators/owners in fee-based waste disposal systems and their benefits, and will work with them to promote approaches, as described above, that are both efficient, equitable, and provide strong incentives to minimize waste generation, reduce overall treatment costs, reduce PCDD/PCDFs intensity in the resulting waste generated, and develop and implement systems to efficiently and effectively administer the fee program.

[1] The current international market price for hazardous waste disposal falls in the range of US$ 500 to US$ 1,000 (not including transport)

ANNEX 5: IDENTIFICATION AND RESPONSIBILITIES OF STAKEHOLDERS

With regard to hazardous waste, the National Development and Reform Commission (NDRC), Ministry of Environmental Protection (MEP), the Ministry of Finance (MOF), and the Ministry of Housing and Urban-Rural Development (MOHURD) issued a Plan for Construction of Hazardous Waste and Medical Waste Treatment Facilities in late 2003. All government-financed hazardous waste treatment projects need to go through a technology review by the Chinese Academy for Environmental Planning which is affiliated with MEP.

National Development and Reform Commission (NDRC): As a department under the State Council for macro control of national economic operation, the NDRC is responsible for advancing the sustainable development strategy, carrying forward adjustments on strategic as well as upgrading of the industrial structure and providing guidance on national industrial development policies. It plays a significant role in the comprehensive planning of the construction of dedicated disposal facilities for hazardous wastes. Pursuant to the arrangement by the State Council, the NDRC and MEP jointly formulated the NHMWP, which is an important measure to implement the Regulations on Management of hazardous wastes and ensure the realization of the goal of safe disposal of hazardous wastes.

Ministry of Finance (MOF): The MOF assumes the responsibility for foreign negotiation and consultation with regard to loans from foreign governments, the World Bank, Asian Development Bank (ADB) and banks of developed countries and joint international financial organizations on behalf of the Chinese government; supervises the implementation of guidelines, policies, laws and regulations on finance and taxation; examines and reflect material problems in government revenue and expenditure management; and propose policy suggestions on strengthening the financial administration.

Ministry of Housing and Urban-Rural Development (MOHURD): In December 2002, MOHURD ruled that the administrative departments in charge of the municipal public sector should (i) further transform the system of governmental management from direct management to macro-management; and (ii) encourage other public and private funding and foreign capital to invest in the construction of municipal public facilities to form a diversified investment pattern and consequently promote the market-based operation of the municipal public sector. Consequently, in 2003 MOHURD took part of issuance of NHMWP.

Ministry of Science and Technology (MOST): The MOST is responsible for studying major issues on science and technology promoting economic and social development; studying and deciding on key arrangements and priorities for scientific and technological development; promoting construction of the national scientific and technological innovation system and improving national capacity for scientific and technological innovation. Some topics relating to hazardous wastes management have been listed into the national program for scientific and technological development. With the implementation of this project, the Ministry will be consulted to include new topics of needs in the national program for scientific and technological development.

General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ): The General AQSIQ is a department directly under the State Council in charge of national work on quality, metrology, entry-exit commodity inspection, certification and accreditation, standardization, etc. It can formulate standards and rules for accreditation to relevant agencies and for certification of hazardous wastes treatment equipment.

Ministry of Environmental Protection (MEP): The MEP is responsible for the regulation of environmental pollution from HW management and disposal. Its primary duties for hazardous wastes management are as follows:

- Organize drafting and formulation of rules and regulations related to safe disposal of hazardous wastes and review technical standards on safety of hazardous wastes;
- Organize supervision and assessment of the safety performance of hazardous waste disposal facilities, and issue or revoke operating licenses of hazardous waste disposal facilities;
- Undertake the responsibility to investigate and solve safety accidents on hazardous wastes;
- Guide and supervise the formulation and implementation of contingency plans for hazardous waste disposal facilities, in coordination with related departments;

- Organize departments concerned to carry out scientific research, publicity and education, and liaison of international organizations with regard to safety and management of hazardous waste; and
- Organize departments concerned to carry out assessment of hazardous waste disposal technology and related technical trainings in dedicated disposal facilities.

Local Environmental Protection Bureaus (EPB) at the county level and above: The local EPBs conduct unified supervision and management on the environmental pollution prevention and control in collection, transport, storage and disposal of hazardous wastes; and in the event of any environmental pollution accidents resulting from mismanagement of hazardous wastes, or in the event that there is evidence that such accidents are likely to occur, take provisional control measures, evacuate people, control the accident site, and order to stop operations leading to or likely to lead to such environmental pollution accidents.

Pricing Bureaus: Pricing Bureaus are assisted by environmental protection departments determine and promulgate levy standards for the treatment of hazardous wastes, and coordinate pesticides manufacturing and pesticide wastes owning enterprises in reaching the agreements for the collection and transfer of the levy for hazardous wastes treatment and disposal.

Other government functional departments: Land planning departments make the planning of land used for hazardous wastes disposal facility construction. Departments in charge of urban construction are responsible for the construction and management of municipal landfills, which receive treated hazardous wastes residues. Departments for industry and commerce examine and approve business licenses for hazardous wastes disposal units.

Technical support institutions: The technical support units under the direction or designation of MEP and the scientific research institutes in the academic community undertake technological development for hazardous waste management and disposal, introduce and assess advanced technology, carry out environmental impact assessment on facility construction, provide technical trainings, and make recommendations for improvement and revision of related policies, laws, regulations and standards. All government-financed hazardous waste treatment projects need to go through a technology review by the Chinese Academy for Environmental Planning which is affiliated with MEP.

Non-governmental organizations (NGOs): NGOs are established within the scope of national laws, policies and regulations in China. Typically dependent on a governmental department or focusing on a sector, a non-governmental organization specializes in information collection and dissemination, public and stakeholder awareness raising, and promoting the implementation of environmental sound management among enterprises. In general, all the aforementioned institutions have important and indispensable roles to play in realizing the ESM of hazardous wastes. In reality, their capacities for hazardous waste management are generally low and are at an early stage of development due to the very short time since China has formally started to regulate hazardous wastes management. There is also a great disparity of capacity among different institutions. Therefore, top priorities should be given to institutional strengthening.

ANNEX 6: TERMS OF REFERENCE FOR CONSULTANTS/EXPERTS

1. Post: Chief Technical Advisor

The objectives of this assignment are to:

i. Transfer international experience in the lifecycle management of obsolete POPs pesticides and other POPs pesticide waste (PPW) through NTA and other local experts to the managerial and technical staff of PPW owners and PPW disposal facilities. Provide technical advice for the reduction of PCDD/PCDFs emission from POPs pesticides disposal, including establishing training manual and program in technical matters as well as monitoring and evaluation;

ii. Assist CIO in overall technical support of other project activities, including institutional strengthening, policy development, , technology assessment and selection, monitoring and evaluation, and inspection for enforcement and compliance;

iii. Review TORs for individual experts and implementation of project activities;

iv. Monitor progress against milestones and indicators set for the project implementation, and formulate reports for workshops of Technical coordination.

v. Advise CIO on project monitoring, evaluation, including providing comments and finalizing the English version of semi-annual progress reports on the ongoing activities, and annual action plan;

vi. Troubleshoot technical and implementation issues that may emerge.

DURATION

9.5 working months over a period of five years including regular missions to China. The number and duration of missions will be determined in the course of the project in accordance with the work plan. Additional time may be added to the contract if considered necessary by the CIO.

SCOPE OF WORK

The Chief Technical Advisor (CTA) will assist CIO, together with national experts, to oversee all technical components of the Project. The Grant Agreement, Project Appraisal Document, the Project Implementation Manual and the Annual Work Plan are the basic documents describing the project and guiding its implementation. Through continuous project monitoring, the CTA will assist CIO to provide corrective measures for problems that may arise. The CTA will work together with the National Technical Advisor and a number of other individual technical experts. The CTA will report directly to the Project Manager in the MEP CIO and UNIDO.

1. The CTA will provide overall technical assistance in the following aspects:
   a. Support to workshops and trainings: including participating in all important project workshops, introducing relevant international experience in the workshops, and reviewing and commenting all relevant deliverables of the workshops. This will include the following workshops:
      - inception workshops (national and regional inception workshops)
      - technologies and techniques evaluation workshop
      - policy and regulatory framework reform workshop
      - 4 annual project implementation review meetings
      - the technical consultation and institutional coordination workshops among project stakeholders
      - the project results publicity and dissemination workshop
   b. Support to ESM of obsolete POPs pesticide including:

- ➢ providing assistance in developing R&D competition
- ➢ reviewing and finalization of training manual and training programs
- ➢ participating in the training for researchers and trainers to transfer of technologies to domestic equipment manufacturers and PPW disposal facilities
- ➢ drafting technical specifications of equipment procurement
- ➢ guiding and supervising local experts of enterprises on specific issues concerning equipment installation, operation, and monitoring

c. Monitoring and Evaluation for the whole process of the project. At this level the CTA will

- ➢ review and finalize the TORs for selection of experts and implementation of project activities in order to guarantee TORs are prepared in compliance with the requirement of the project and the principles of Stockholm Convention.
- ➢ review and finalize all key project reports as follows:
  - review draft of the 2nd, 3rd, 4th, and 5th annual work plan of the project
  - review the quarterly progress reports on the ongoing activities
  - draft the substantive terms of references for technology acquisition
  - finalize the English version of all project reports and deliverables before dissemination to relevant stakeholders

d. Provide technical advice on establishment of MIS including:

- ➢ Assist in the selection of public information
- ➢ provide corrective measures for accidental issues that may arise and provide advice on miscellaneous project matters as requested by CIO

QUALIFICATIONS:

- Extensive practical experience with reduction of PCDD/PCDFs emission from PPW disposal implementation;
- Extensive knowledge of international situation of disposal technologies, especially the new cost-effective ones;
- Experience in a field directly related to POPs pesticides management and disposal;
- Experience with implementation of international projects; and
- Good communication and writing skills in English; preferably in Chinese

The following qualifications will be helpful:

- knowledge of the Stockholm Convention on POPs;
- experience of working in China.

2. Post: National Technical Advisor

OBJECTIVES

The objectives of this assignment are to:

- ➢ Assist CIO in overall technical support of other project activities, including institutional strengthening, policy development, technology assessment and selection, monitoring and evaluation, and inspection for enforcement and compliance;
- ➢ Transfer international experience in the lifecycle management of obsolete POPs pesticides and POPs pesticide waste from CTA and other local experts to the managerial and technical staff in PPW owners and PPW disposal facilities. Provide technical advice for the reduction of PCDD/PCDFs emission from PPW disposal, including establishing training manual and program in technical matters as well as monitoring and evaluation;

- Project monitoring and evaluation, including preparation of TORs for project activities and project reports, and providing solutions to project critical tasks of the project implementation;
- Monitor the progresses against milestones and indicators set for the project implementation, and formulate reports for workshops of technical coordination.
- Help CIO with the preparation of technical aspects of workshops.

DURATION:

19 working months over a period of five years including 9 months for the field visit to participating provinces. *The number and duration of missions will be determined in the course of the project in* accordance with the work plan.

SCOPE OF WORK

NTA will assist CIO, working in a team with the CTA and other individual technical experts, in charge of all technical components of the Project. The Grant Agreement, Project Appraisal Document, the Project Implementation Manual and the Annual Action Plan are the basic documents to be referred to. Through continuous project monitoring, the NTA will assist CIO to provide corrective measures for accidental issues that may arise. The NTA will be the leader of the National Experts Group for the project, and will collaborate with the CTA. The NTA will report directly to the CIO and UNIDO.

The NTA will provide overall technical assistance in the following aspects:

a) Support to workshops: including participating in all important project workshops, making presentations on project progress in the workshops, and preparing, reviewing and commenting all relevant deliverables of the workshops. The workshops are specified as:
    - inception workshops (national and regional inception workshops)
    - technologies and techniques evaluation workshop
    - policy and regulatory framework reform workshop
    - 4 annual project implementation review meetings
    - the technical consultation and institutional coordination workshops among project stakeholders
    - market promotion workshop
    - the project results publicity and dissemination workshop

b) Support to ESM of obsolete POPs pesticide including:
    - draft the questionnaires for participants before trainings on managerial, technical staff
    - review and commenting on training manual and training programs,
    - participation in the training for managers, researchers, trainers and operators to give a presentation on PPW disposal technologies
    - *making presentations to national and local hazardous wastes management experts in* the trainings
    - assistance in preparing Request for Proposal (RFP) of equipment procurement, including TOR, Letter of Invitation (LOI), draft contract
    - guiding the local experts and enterprise technical staff on specific issues concerning equipment installation, operation, and monitoring
    - prepare annual evaluation report on ESM of obsolete POPs pesticides and PCDD/PCDFs emission reduction implementation
    - provide technical advice for the development of R&D competition.

c) Monitoring and Evaluation of the project. At this level the NTA will prepare, review and finalize all reports include:

- ➢ Review the outputs related to ESM of obsolete POPs pesticides and reduction of PCDD/PCDFs emission from PPW disposal
- ➢ Review and give comments on 2nd, 3rd, 4th, and 5th annual work plans of the project
- ➢ Review and give comments on the semi-annual progress reports on the ongoing activities.
- ➢ Review the evaluation report on national and provincial policies and regulations submitted by subcontractor
- ➢ Provide technical support and guidance for technology transfer from the R&D communities to enterprises

d) Supervision of procurement, installation, and operation of demonstration facilities, the NTA will:

- ➢ assist CIO in the preparation of subcontracts' substantive terms of references
- ➢ assist CIO in the preparation of a monitoring plan

e) Provide technical advice on establishment of MIS including:

- ➢ draft parameters for ESM of obsolete POPs pesticides and PCDD/PCDFs emission reduction monitoring
- ➢ Transfer the international information from CTA on advanced technologies to the technical and managerial staff in the field

f) Besides above assistance, the NTA will also provide corrective measures for accidental issues that may arise.

QUALIFICATIONS OF THE CONSULTANT

The consultant will have:

- Extensive practical experience with reduction of PCDD/PCDFs emission from PPW disposal implementation;
- Extensive knowledge of international situation of disposal technologies, especially the new cost-effective ones;
- Excellent communication and writing skills in English and Chinese
- Experience with management and coordination of international cooperation projects
- Excellent interpersonal skills

The following qualifications will be helpful:

- Knowledge of the Stockholm Convention on POPs
- Experience of working on POPs related projects in China

3. Post: Project Expert Team (PET)

1. To ensure the successful implementation of project, an obsolete POPs pesticides and POPs pesticide waste project team within CIO/MEP will be established. The team will be in charge of the daily operations and implementation of the Project under the guidance of the CIO, implementing activities assigned to CIO, supervision and monitoring of all activities implemented under the project, provide technical advice and support, financial management for all aspects of the project and reporting within MEP and to UNIDO.
2. Initially, the team consists of one project team leader and two project officers of MEP. Additional officers may be added, such as from Ministry of Housing and Urban-Rural Developments. The project team will receive technical support from various experts (including CTA, NTA, and other consultants) as necessary. The existing CIO financial and procurement staff will provide financial and procurement management support to the project team.

Responsibilities

The project team's responsibilities are to:

- Prepare quarterly Financial Monitoring Reports (FMR) and review FMR submitted by Local PMOs;
- Manage project procurement and financial resources for activities managed by CIO with in accordance with the UNIDO's procedures and the agreed procurement plan;
- Organize and convene project coordination and review meetings among stakeholders;
- Review project outputs;
- Collect project and national data and information and input them into project MIS and prepare FMR to the UNIDO using MIS;
- Organize training, education, and information dissemination activities;
- Provide direction to local local PMOs;
- Incorporate project quarterly financial reports from its component, and provincial components and submit withdrawal application to MOF for replenishment;
- Recruit international and national consultants in CIO-managed components;
- Prepare Annual Work Plan and Procurement Plan for the activities managed by CIO and review the Annual Work Plan and Procurement Plan submitted by local PMOs; and
- Coordinate with stakeholders, including GEF, donors, the UNIDO, and relevant domestic ministries and agencies.

The key responsibility of the team leader and each of the existing three project officers are as follows.

Team Leader: report to the UNIDO

Key qualifications:

- sufficient project management skill and experience;
- capacity in team management;
- familiarity with the project;
- familiarity with UNIDO procedures;
- excellent written and spoken ability of both Chinese and English.

Responsibilities:

a. overall management of the project implementation to ensure the quality and timeliness of project implementation;
b. communication with the UNIDO and donors concerning project implementation;
c. communication within MEP, national agencies and local PMOs;
d. organization of staff resources to ensure coordination and harmony of the team;
e. monitoring the use of counterpart and GEF funds.

Project Officer 1: responsible for MIS, M&E, and NRP, report to the team leader, demonstration and adoption of BAT/BEP

Key qualifications:

- project management experience;
- good knowledge on environmental monitoring and PPW management in China;
- knowledge or experience of information management;
- knowledge on requirement of UNIDO and China on EIA;
- good written and spoken ability of both Chinese and English.

Responsibilities:

- communication with CTA and NTA, as well as review the outputs of CTA and NTA;
- organize the bidding processes to select and acquire services and goods;
- organize the trainings on managerial and technical staff;
- organize the bidding processes to set up the training system;
- organize the implementation of EIAs supported with the newly developed guidelines and specifications for BAT/BEP adoption in the lifecycle management of obsolete POPs pesticides and PPW;
- organize M & E according to GEF guidelines;
- communication with UNIDO and local PMOs concerning above issues.

Project Officer 2: responsible for general activities, report to the team leader

Key qualifications:

- project management experience;
- experience in organization of workshops;
- comprehensive knowledge on procurement guideline of UNIDO;
- good written and spoken ability of both Chinese and English.

Responsibilities:

- routine communication and coordination with local PMOs;
- organize the workshops and training managed by CIO;
- organize procurement of the activities managed by CIO and monitor the procurement of the activities managed by local PMOs;
- responsible for the procedure on payment of contracts and assist Finance Division of FECO to draft the finance report of FMR;
- updated the information in POPs pesticides website and MIS;
- draft the FMR concerning activities managed by CIO and consolidate the FMR;
- update annual Work Plan related to the activities managed by CIO and consolidate the annual Work Plan submitted by local PMOs;
- update the procurement plan related to the activities managed by CIO and consolidate the procurement plan submitted by local PMOs;
- Routine communication with the UNIDO and local PMOs concerning above issues.

4. International expert on POPs pesticides policies and regulations

Duration: 5.6 working months over a period of 5 years

Main duties:

1.1 Review requirements of ESM for obsolete POPs pesticides and PPW management and arising from obligations of the Stockholm Convention and other related multilateral environmental agreements.

1.2 Review laws, regulations, policies, and strategies to promote ESM for disposal of POPs wastes, including but not limited to

- technical policy for construction and operation of disposal units to dispose POPs waste in a cost effective and environmental friendly way
- licensing requirement for management and disposal of POPs pesticides and other POPs contaminated wastes

- legal responsibility and financial mechanism for treatment of POPs waste by operating and non-operating enterprises
- price considerations for POPs waste disposal
- possible supplier takeback requirements.
- Administrative and regulatory requirements for POPs waste disposal and cost effective disposal options
- Licensing requirements for mobile facilities for hazardous waste, including POPs waste disposal

1.3 Analyze the implications and applicability of international best practices and experience to China taking into account the actual technological and economic status in China.

1.4 Provide preliminary findings and recommendations for China to control PCDD/PCDFs emission from PPW disposal consistent with the Stockholm Convention.

ANNEX 7: TERMS OF REFERENCE FOR SUBCONTRACTS

Subcontract 1 Technological and economic policies and regulations promoting environmentally sustainable management and disposal of POPs waste

1. General background information

In order to prevent POPs-contaminated wastes from polluting the environment, the Chinese government has promulgated Measures on Prevention and Control of Environmental Pollution Caused by Abandoned Hazardous Chemicals. China has also formulated and implemented a series of standards, including the Standard on Hazardous Wastes Identification, the Standard for Pollution Control on Hazardous Waste Storage, the Pollution Control Standard for Landfilling of Hazardous Wastes, and the Pollution Control Standard for Hazardous Wastes Incineration. The implementation of these Standards plays a very important role in promoting and regulating hazardous wastes management of the country.

Though China has established a basic regulatory framework for hazardous waste management and treatment, existing laws and regulations are too general and their implementation is not supported by detailed orders and technical guidelines. The project will address this issue through technical support, policy support, and capacity building for regulatory development. Regulatory development will also be coordinated in both content and timing with other project activities in order to provide a nurturing and sustainable policy environment.

Operating license for hazardous wastes

Issuing operating licenses for hazardous waste management is an important administrative tool for supervision of hazardous wastes disposal facilities. According to the Measures for the Administration of Operating Licenses for Hazardous Wastes promulgated on 1 July 2004, hazardous wastes disposal facilities must first demonstrate that its facility meets national and/or local environmental protection standards in order to obtain an operating license.

The Measures for the Administration of Operating licenses for Hazardous Wastes contain general provisions relating to the basic resource requirements for hazardous waste disposal facilities, but lack specifications for POPs pesticide wastes. In practice, due to application backlogs and lack of enforcement, many facilities are still operating without a license. There is no detailed guidance for processing POPs pesticides, transportation of waste across provincial boundaries, or use of mobile facilities. The project will address these deficiencies by supporting development of detailed implementation rules for licensing POPs pesticide wastes treatment and disposal facilities.

Hazardous waste consignment

The generation, collection, transports and disposal of PW forms a complex system involving multiple economic actors. Implementation of a consignment system for PW is an important means to organize this process so as to prevent loss of wastes and ensure that wastes are treated and disposed of safely and properly at each stage of the process. Aspects of China's current system comprise a barrier to reaching this goal.

According to the Measures for Manifest Management on Transfer of Hazardous Wastes, the present PW transfer manifest system requires a hazardous waste transfer manifest in quintuple copies, which is overly complicated for management of PW waste transfers. Some provinces modified shipment requirements and changed the manifest to three copies, which greatly reduced the system's effectiveness. The manifest system is not implemented in some regions increasing the possibility of unaccountable loss and unauthorized disposal of PW is increased with the consequent potential health and environmental pollution risk.

To bring the role of the PW transfer manifest system into full operation, the project will develop and introduce a dedicated PW transfer manifest should be formulated based on the present hazardous waste transfer manifest. This new PW transfer manifest system should clearly define responsibilities of waste generation units, transport units and disposal units in the management on transfer of waste explicitly specify information required to be filled in, establish data reporting and archiving systems, and make use of advanced information technology tools.

Legal liability system

While the Environmental Protection Law stipulates the "polluter pays" principal, China does not currently have a well-developed system for establishing the legal and financial liability for environmental contamination and health impacts due to improperly disposed of pesticides and pesticide wastes. This lack of clear accountability reduces the deterrent impact of legal prohibitions, leading to a greater incidence of improperly managed wastes, and reduces national, provincial, and local government ability to finance waste management and clean-up operations, thereby compounding the problem and increasing health and environmental impacts. The lack of clear legal and financial liability is particularly pronounced for "orphaned" obsolete POPs pesticides, where the owner or other party responsible for the wastes either can not be determined or no longer exists.

2. Aim of the project

The objective of this subcontract is to formulate and issue technological and economic policies and regulations promoting environmentally sustainable management and disposal of POPs waste

3. Activities

- Develop and formulate technological and economic policies through inter-departmental coordination, public awareness raising, public hearings, and NGO outreach
- Provide training on new technological and economic policies for managerial staff from provincial EPBs
- Raise awareness of new technological and economic policies and enforcement mechanisms

4. Outputs

- Technical and economic policies to promote ESM for disposal of POPs wastes, including but not limited to:
  - technical policy for construction and operation of disposal units to dispose POPs waste in a cost effective and environmental friendly way
  - licensing requirement for management and disposal of POPs pesticides and other POPs contaminated wastes
  - legal responsibility and financial mechanism for treatment of POPs waste by operating and non-operating enterprises
  - price considerations for POPs waste disposal
  - possible supplier takeback requirements.
- New regulations to promote ESM, including but not limited to:
  - Administrative and regulatory requirements for POPs waste disposal and cost effective disposal options
  - Licensing requirements for mobile facilities for hazardous waste, including POPs waste disposal

5. Qualifications

The contractor must:

- Have experience in drafting policies and regulations,
- Be familiar with POPs wastes management and disposal;
- Have experience in working with stakeholders in the POPs wastes disposal sector.

6. Language requirement

All reports should be in Chinese and translated to English

7. Estimated budget US$ 166,400

Subcontract 2: Technical standards and guidelines for ESM of POPs waste

1. General background information

In order to prevent POPs-contaminated wastes from polluting the environment, the Chinese government has promulgated Measures on Prevention and Control of Environmental Pollution Caused by Abandoned Hazardous Chemicals. China has also formulated and implemented a series of standards, including the Standard on Hazardous Wastes Identification, the Standard for Pollution Control on Hazardous Waste Storage, the Pollution Control Standard for Landfilling of Hazardous Wastes, and the Pollution Control Standard for Hazardous Wastes Incineration. The implementation of these Standards plays a very important role in promoting and regulating hazardous wastes management of the country.

Though China has established a basic regulatory framework for hazardous waste management and treatment, existing laws and regulations are too general and their implementation is not supported by detailed orders and technical guidelines. The project will address this issue through technical support, policy support, and capacity building for regulatory development. Regulatory development will also be coordinated in both content and timing with other project activities in order to provide a nurturing and sustainable policy environment.

The Government of China has not yet established a system of standards for PW. Such a system is crucial to assure appropriate management and disposal of PW, and its absence constitutes a barrier to environmentally sustainable management. Current environmental legislation was developed prior to China's accession to the Stockholm Convention. This led to an inadequate consideration of the requirements of ESM for all aspects of POPs wastes.

2. Aim of the project

The project's overall objective is to implement ESM and disposal of accumulated POPs pesticide wastes and dioxin rich incinerator fly-ash in fulfillment of China's obligations under the Stockholm Convention. This objective will be achieved through a combination of strategies, including legislative and regulatory development, capacity building, public education, technology transfer, training, technical support, and introduction of new advanced environmental risk assessment tools.

3. Scope of the contracting services

The objective of this subcontract is to strengthen the legal and regulatory framework for environmentally sound management (ESM) and disposal of POPs waste

Activities

The contractor shall undertake the following activities:

- Analyze and assess current POPs waste management policies, laws, regulations and standards regarding to POPs wastes identification, labeling, package, handling, temporary storage, transportation and disposal
- Propose corresponding plan in regarding to the weakness existed in current legislation framework for POPs waste management and the requirement of Environmental sound management
- Investigate the technical and economical features of commercialized disposal technologies for POPs pesticide in home and abroad
- Develop and formulate guidelines, standards, and specifications
- Provide training on guidelines, standards and specifications for managerial staff from provincial EPBs
- Develop standard operation procedures for analysis and monitoring

Outputs

- ESM guidelines for POPs waste management in line with requirements of Stockholm and Basel conventions, covering: identification, handling, packaging, labeling, Collection, storage, and transportation technologies
- Technological and operating guidelines for the following POPs treatment technologies: including but not limited to: Incineration, Plasma Arc, Pyrolysis/gassifiers and chemical destruction technologies
- Risk assessment and emergency response guidelines for POPs waste disposal
- Technology certification standards for disposal of POPs wastes
- Audit manuals for the operation of disposal facilities formulated
- Supervision and Management Technological Specifications for cost effective options
- Monitoring specifications for POPs waste disposal and contaminated sites
- 500 specialized managerial and monitoring staff receiving training and training materials

4. Qualifications

- Must have experience in drafting standards and/or norms;
- Must be familiar with POPs wastes management and disposal;
- Experience in working with stakeholders in the PPW disposal sector is strongly preferred.

5. Language requirement

All reports should be in Chinese and translated to English

6. Estimated budget US$ 536,168

Subcontract 3: Institutional capacity enhanced for POPs waste management at local level

1. General background information

Currently, environment protection departments at various levels of government suffer from inadequate capacity for hazardous waste management. Especially, POPs pesticides management varies from official to official and region to region, giving rise to confusion on what constitutes proper waste management practice. It is therefore necessary to formulate guidelines for obsolete pesticides and associated waste supervision and management in order to regularize and strengthen management and supervisory activities.

The Chinese Government has moved fast to issue initial regulations and standards for pollution control at pesticide waste disposal facilities and capability exists to monitor emissions of general pollutants. However, gaps still exist in supervising and monitoring implementation of these regulations and standards, including:

- Lack of technical specifications and instruments for supervision and monitoring;
- Lack of capacity building and training for enforcement personnel;
- Lack of capacity to monitor POPs pollutants such as PCDD/PCDFs from incineration; and
- Insufficient environmental impact assessment (EIA).

2. Aim of the project

The project's overall objective is to implement ESM and disposal of accumulated POPs pesticide wastes and dioxin rich incinerator fly-ash in fulfillment of China's obligations under the Stockholm Convention. This objective will be achieved through a combination of strategies, including legislative and regulatory development, capacity building, public education, technology transfer, training, technical support, and introduction of new advanced environmental risk assessment tools.

3. Scope of the contracting services

The objective of this subcontract is to enhance overall institutional capacity for POPs waste management at local level through

Activities

The contractor shall undertake the following activities:

- Enhance overall institutional capacity for program development
- Adapt and implement national policy and regulatory framework at local level
- Develop trial local-level responsibility system for obsolete POPs pesticide management and disposal
- Develop and test pricing mechanisms for POPs waste disposal
- Establish and implement reporting system to collect and analyze data on creation, transport, and treatment of POPs waste
- Establish inspection and prosecution system for the discarded POPs wastes and contaminated sites
- Promote widespread local participation through increasing local input of personnel and financial resources
- Incorporate ESM principles, norms and requirements into current EIA guidelines
- Prepare ESM inspection manuals, including:

Outputs

- Trial responsibility assignment system for obsolete POPs pesticide management and disposal
- Pricing program for POPs waste disposal demonstrated
- POPs waste disposal data reporting system established
- Prosecution and inspection system for the discarded POPs waste and contaminated site established
- Increasing local input of personnel, finance and resources
- EIA guidelines adopted
- ESM inspection manuals developed

Qualifications

- engineering monitoring and supervision
- *engineering cost auditing*
- pricing setting and the related negotiation and organization for projects of public services
- Must be familiar with POPs wastes management and disposal;
- Experience of working with stakeholders in the sector of PPW disposal is strongly preferred.

4. Language requirement

All reports should be in Chinese and translated to English

5. Estimated budget US$ 87,200

Subcontract 4: Public awareness raising

1. General background information

ESM of obsolete pesticides in China involves the following three groups:

i) Governmental personnel from multiple agencies, whose role is to carry out effective regulation and management of waste treatment and disposal through regulatory, administrative, economic and other instruments;

ii) Professional bodies and individuals including scientific and technological research personnel for obsolete pesticides treatment and disposal, waste disposal equipment manufacturers, and disposal facility operators;

iii) Endusers, including small scale agricultural endusers who often resort to open burning or other improper methods to dispose of unused POPs pesticides; and

iv) Members of the general public who, if properly educated, are in a position to reduce contamination risk and exercise public supervision over treatment and disposal facilities.

While members of these groups play a crucial role in ESM, their awareness and knowledge in are currently inadequate. For example, due to lack of knowledge about the secondary pollution from uncontrolled incineration of obsolete pesticides and the availability of alternative technologies, many government officials wrongly believe that incineration is the only way to treat obsolete pesticides. They actively promote incineration technologies and neglect the research, development, and application of alternatives. As a result, inappropriate incineration disposal has generated considerable amounts of toxic and hazardous substances such as PCDD/PCDFs.

Public information materials for those without a professional or scientific background are few and inadequate. Little has been invested in public information and educational campaigns through radio, TV, and other effective ways to reach the general public.

2. Aim of the project

The objective is to raise the public awareness and mobilize the public participation in the ESM of POPs wastes.

3. Activities

- Develop TV and other mass media programs to disseminate knowledge of POPs
- Publish articles or reports for public education in national and local newspapers.
- Develop and produce brochures to raise awareness regarding health and safety protection from POPs pesticide wastes and dioxin rich fly ash
- Hold public hearings regarding POPs waste stockpile reporting, emergency response, and health and safety protection
- Hotline established for POPs related health and safety issues Outputs

4. Outputs

- 2 TV and/or other mass media programs to disseminate the knowledge of POPs
- 60 articles in national and/or local newspapers
- 10,000 brochures prepared to raise awareness of POPs waste related health and safety protection issues
- 4 hearings held
- At least 200 attendees at hearings
- Number of hotline calls/reports
- 3-5 hot line staffers

5. *Qualifications*

- Experience in reproducing project results into easy-to-understand formats for dissemination among the public
- Experience and resources to mobilize volunteers to impart knowledge about environmental issues

6. Language requirement

All reports should be in Chinese and translated to English

7. Estimated budget US$ 31,200

Subcontract 5: Safe and effective collection, packaging, and transportation of POPs pesticide wastes for disposal

1. Scope of the contracting services

   The objective of this subcontract is to collect the obsolete POPs pesticides from all the hot hits and transport the wastes to the corresponding hazardous waste disposal centers (HWDCs) for safe storage. A special purpose company will be hired under the PPP mechanism to provide the services required in this TOR

Activities

The contractor of the subcontract shall undertake the following activities:

- Identify location, type, status of POPs pesticide wastes and associated waste matrices at targeted hot spots

Develop operating manual for collection, packaging, and transportation of the POPs pesticide waste

- Prepare detailed terms of reference and contracts for the provincial HWDCs according to expertise in the fields of waste management and occupational health and safety.
- Provide training to staff from the provincial HWDCs concerning the collection, packaging, and transportation of the POPs pesticide wastes
- Collect, package, and transport POPs pesticide waste from hot spots
- Store POPs pesticide waste safely to prevent release of POPs contaminants to the environment

Outputs:

- Localization of POPs pesticide wastes and associated waste matrices at targeted hot spots
- Operation manual for the collection, packaging, and transportation of the POPs pesticides and associated waste matrices, including emergency response plan for obsolete POPs pesticide wastes
- Terms of reference and contract templates for the provincial HWDCs
- Number of trained staff from the provincial HWDCs
- Safe collection, packaging, and transportation of identified obsolete POPs pesticides
- 10000 tons of pesticide wastes and associated waste matrices safely stored in designated storage facilities.
- inventory of pesticide wastes at storage sites created and maintained

Qualifications

The contractor of the subcontract:

- Must be familiar with the related international and national regulations and requirements for hazardous waste collection, packaging, and transportation;

- Must have proven experiences on safe collection, packaging, and transportation of toxic and hazardous wastes;
- Must own enough waste treatment facilities and abilities for the safe collection and storage of 10,000 tons obsolete POPs pesticide in the required timeline;
- Experience of working with stakeholders in the sector of pesticide production and hazardous waste management is strongly preferred.
- Must have proven experiences to work effectively with provincial hazardous waste disposal centers and strong abilities to coordinate the project partners.

2. Language requirement

All reports should be in Chinese and translated to English

3. Estimated budget US$ 947,800

Subcontract 6: Evaluation of technologies for POPs waste disposal

1. Scope of the contracting services

   The objective of this subcontract is to evaluate the existing POPs waste disposal technologies and study the technical, social and economic feasibilities to apply the suggested technology and facility for the disposal of 10,000 tons obsolete POPs pesticides in the required time schedule.

Activities

The contractor of the subcontract shall undertake the following activities:

- Review the international and domestic current situation for POPs and hazardous waste disposal, including the incineration, thermal destruction, plasma arc, oxidation, reduction, catalysis and bio-degradation remediation;
- Detailed feasibility study for final disposal units based on the waste type, destruction efficiency, emissions, residues, energy/material requirements, portability, state of commercialization, and site selection;
- Preparation of detailed request for Proposal from vendors

Outputs

- Feasibility study report of POPs destruction technologies and site selection
- Specifications of the stationary and mobile final disposal unit
- List of potential vendors for technology and equipment
- Request for Proposal (RFP)

Qualifications

Familiar with the current situation of incineration and non-combustion technologies for hazardous waste disposal

Knowledge of the requirement of BAT/BEP under Stockholm Convention

Knowledge of ESM under Basel Convention

2. Language requirement

All reports should be in Chinese and translated to English

3. Estimated budget US$ 30,000

Subcontract 7: Construction, certification, operation, and supervision of stationary and mobile treatment facilities

1. Scope of the contracting services

The objective of this subcontract is to install the stationary and mobile disposal facilities, transport the 10,000 tons of obsolete POPs pesticides from hazardous waste disposal centers (HWDCs) to the corresponding disposal facilities and destruct the wastes in an environmentally friendly manner. A special purpose company will be hired under the PPP mechanism to provide the services required in this TOR.

2. Activities

The contractor shall undertake the following activities:

- Environmental Impact Assessment (EIA) for one stationary and one mobile unit
- Invite bids from potential vendors to transport POPs wastes and operate disposal facilities
- Prepare disposal sites for deployment of selected technology, including construction of storage facility and commissioning of equipment
- Installation of the stationary unit at the selected site and mobile unit at selected base stations, the installed facilities should achieve at least the following requirements for applicability, performance and cost-effectiveness:

  a) *Applicability*
    - suitable for the treatment of POPs stockpile and highly contaminated soil and substances;
    - suitable for the destruction of organic pollutants and stabilization the heavy metals of the dioxin-rich fly ash; and
    - suitable for the safe disposal of contaminated CFCs.

  b) *Destruction efficiency*
    - Avoid POPs disposal methods which are non-destructive (e.g landfilling, recycling, deep - well injection, etc.).
    - In general, destruction efficiency (DE) higher than 99.99% is thought to be the lowest requirement for POPs waste treatment. According to the Pollution prevention standard of hazardous waste incineration, the DRE should be higher than 99.9999%.

  c) *By products*
    - Prevent the release of dioxins/furans and other by-product POPs.
    - Not generate any wastes with POPs characteristics.

  d) *Completeness and safety*
    - Suitable pre- and post- treatment process and facilities
    - Good portability and can be configured as fixed or transportable
    - Good safety for the whole operating process

  e) *Cost effectiveness*
    - less than USD5300/ton for high strength POPs wastes,
    - less than USD 1000/ton for medium and low concentration POPs wastes.

  f) *Monitoring requirements for the disposal facility*
    - flue gas: O2, degree of blackness, soot, PM10, CO, CO2, HF, HCl, NO2 at least once a month; heavy metals contents at least once a quarter; dioxin at least twice a year
    - wastewater: pH, CODcr, SS, NH3-N at least once a quarter; POPs pesticides at least once a quarter; heavy metals twice a quarter

- slag and residual: POPs pesticides and LOI twice a month
- noise: sound level(Leq) once a month (24h/d)

g) *Monitoring requirements for the disposal plant*

- air quality: PM10, NO2, CO, SO2 twice a year (7 days each time)
- soil quality: POPs pesticides twice a year
- surface water: CODcr, SS, NH3-N, PCBs once a year (3 days each time)
- noise: sound level(Leq) once a quarter (24h/d)

- Transportation of POPs waste to the POPs treatment locations in an environmentally sound manner
- Final disposal of POPs pesticide wastes in an environmentally sound way
- Monitoring during facility construction and operation
- Establishment of equipment ownership arrangements

3. Outputs

- Assessment of the environmental impact of the construction of stationary unit for POPs treatment
- Assessment of the environmental impact of installation and operation of mobile unit with four base stations
- Qualified vendors identified and contracted to transport POPs wastes and operate disposal facilities
- Site preparation for disposal facilities
- Storage facility construction and commissioning
- Stationary unit installed at selected site
- Mobile unit commissioned at four base stations.
- 10,000 tons of pesticide wastes safely transported to designated stationary unit or mobile base stations
- 10,000 tons of pesticide wastes disposed of in an environmentally sound manner
- Equipment purchase, infrastructure construction, facility installation, and operation
- Terms of Reference for post-project equipment ownership and operation
- Transfer of equipment title

4. Qualifications

The contractor must:

- Be familiar with the related international and national regulations and requirements for hazardous waste transportation and final disposal;
- Have proven experiences on safe transportation an final disposal of toxic and hazardous wastes;
- Own enough waste treatment facilities and abilities for the safe disposal of 10,000 tons obsolete POPs pesticide in the required timeline;
- Have experience in working with stakeholders in the hazardous waste management sectors strongly preferred.
- Have proven experiences to work effectively with provincial hazardous waste disposal centers and strong abilities to coordinate the project partners.

5. Language requirement

All reports should be in Chinese and translated to English

6. Estimated budget US$ 3,432,800

Subcontract 8: Demonstration non-landfill technologies for safe disposal of Dioxin rich fly ash

1. Scope of the contracting services

The objective of this subcontract is to implement a pilot demonstration for safe disposal 1000 tons of dioxin rich fly ash by non-landfill options in the target province

2. Activities

The contractor shall undertake the following activities:

- Target province selected for non-landfill pilot disposal of dioxin rich fly ash
- Development of operating manual for non-landfill disposal of dioxin rich fly ash
- Staff training for safe disposal of dioxin rich fly ash in the selected province
- Implementation of pilot for safe disposal of dioxin rich fly ash by non-landfill options

3. Outputs

- Report on target province selection
- Operating manual
- Number of staff trained in selected province
- Training materials developed
- Capacity created for disposal of at least 300 tons per year of dioxin rich fly ash safely by non-landfill technology

4. Qualifications

The contractor:

- Must be familiar with the related international and national regulations and requirements for hazardous waste disposal;
- Must have proven experiences on safe final disposal of hazardous wastes;
- Must own enough waste treatment facilities and abilities for the safe disposal of 1,000 tons dioxin-rich fly ash in the required timeline;
- Experience of working with stakeholders in the hazardous waste management sectors in the target province is strongly preferred.

5. Language requirement

All reports should be in Chinese and translated to English

6. Estimated budget US$ 229,400

Subcontract 9: Prioritized inventories of contaminated sites

1. General background information

China has urgent need of an on the ground program for managing stockpiles of obsolete POPs pesticides and associated contaminated wastes in an environment sound way. China's large agricultural industry and heavy dependence on agro-chemicals resulted in about 574,000 tons of POPs pesticides production through the end of 2004. Although POPs pesticides production has been prohibited by domestic regulations, lack of a targeted national program providing capacity building and technical assistance to manage these chemicals has resulted in significant stockpiling of obsolete POPs pesticides.

Based on the research and surveys conducted in conjunction with preparation of this project, obsolete POPs pesticide and associated wastes have been identified in 44 POPs pesticide manufacturing plants and a number of distribution and end user sites. In the past, plant owners and end users have been responsible for managing their own POPs pesticides, which have resulted in stockpiles of obsolete pesticides and associated wastes, the distribution and scope of which has been unknown to central and local environmental protection agencies.

With the clean-up and removal of these POPs wastes, the contaminated sites should be inventoried with risks to human health and the environment ranked to determine the priority for future remediation.

2. Aim of the project

The objective is to establish a prioritized inventory of contaminated sites associated with obsolete POPs pesticides

3. Activities

- Review existing national and international best practice guidelines for human health and ecological risk assessment
- Develop a project-fit methodology, including QA/QC procedures for quantitative environmental risk assessment (QERA)
- Train staff in provincial solid waste management centers
- Carry out on-site surveys following removal activities, focusing on identification of exposure scenarios
- Qualitatively predict POPs concentrations in identified exposure scenario and characterize risks by comparing target POPs risk factors
- Analyze information needs for quantitative environmental risk assessment

4. Outputs

- Report of international experience and applicability to QERA of POPs contaminated sites in China
- Copy of project-fit methodology for QERA
- *Training agenda, course materials, trainer list, trainee list, list of qualification certificates*
- Filled out questionnaires
- Report of qualitative description of exposures to POPs via environmental medias
- Prioritized site inventory
- Report of information needs for quantitative environmental risk assessment system

5. Qualifications

- *Necessary equipment for personal safety protection*
- Able to organize a team with multidisciplinary background in environmental risk assessment

6. Language requirement

All reports should be in Chinese and translated to English

7. Estimated budget US$ 57,000

Subcontract 10: Establishment and maintenance of an Internet-based information processing, display and dissemination system

1. General background information

China has urgent need of an on the ground program for managing stockpiles of obsolete POPs pesticides and associated contaminated wastes in an environment sound way. China's large agricultural industry and heavy dependence on agro-chemicals resulted in about 574,000 tons of POPs pesticides production through the end of 2004. Although POPs pesticides production has been prohibited by domestic regulations, lack of a targeted national program providing capacity building and technical assistance to manage these chemicals has resulted in significant stockpiling of obsolete POPs pesticides.

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With the clean-up and removal of these POPs wastes, the contaminated sites should be inventoried with risks to human health and the environment ranked to determine the priority for future remediation. All the data and information from the above processes should be input into an information system which can be accessed by various stakeholders to facilitate the future remediation actions.

2. Aim of the project

The objective is to establish and maintain an Internet-based information processing, display and dissemination system based on data from environmental risk assessment

3. Activities

- Design Internet-based system to process and display QERA results and facilitate modeling of environmental risks and remediation decision-making
- Purchase, install, and test system, maximizing use of existing hardware, software, and topographic data from the current POPs MIS
- Input data and operate, maintain and update system
- Conduct internet-based training and software dissemination

4. Outputs

- Design report
- Specifications and TORs for system installation and testing
- System test report
- TOR for system operation and maintenance
- System specifications and user instructions
- Web pages

5. Qualifications

- Be able to organize a team with expertise in cartography, GIS, and hardware and software configuration.
- Having experience in establishing and maintaining environmental information systems.
- Having necessary hardware and software for system test.

6. Language requirement

All reports should be in Chinese and translated to English

7. Estimated budget US$ 35,400

Subcontract 11: Establish a project management information system (MIS), including a project website to disseminate information to stakeholders

1. General background information

A Project Management Information System will be established to support the Project Manager and the project management team to ensure that all the project activities be completed on time, in quality and within budget. The MIS will keep baseline records of Annual Work Plans and contracts with consultants and subcontracts with performance indicators, result reports, responsibilities and budgets, and compare them with the progresses of the activities. A project website will be established to disseminate project information to the primary stakeholders and the general public.

2. Aim of the project

The project's overall objective is to implement ESM and disposal of accumulated POPs pesticide wastes and dioxin rich incinerator fly-ash in fulfillment of China's obligations under the Stockholm Convention. This objective will be achieved through a combination of strategies, including legislative and regulatory development, capacity building, public education, technology transfer, training, technical support, and introduction of new advanced environmental risk assessment tools.

3. Activities

The contract or shall undertake the following activities:

- Review preliminary MIS requirements arising from obligations of the Stockholm Convention and from available guidance relevant to multilateral environmental agreements;
- Review likely sources of data in China and prepare a detailed plan for transmission to FECO/MEP,
- Agree technical requirements for MIS with national counterpart and subcontractors
- define user requirements, identify software options and develop hardware specifications compatible with existing IT infrastructure;
- Present, with national counterparts, draft findings and recommendations to MEP and relevant stakeholders
- Procure hard- and software and establish information management systems within existing national IT architectures;
- Install and operate the MIS and build capacity to operate the information management system;
- gather, compile, manipulate, and disseminate potentially sensitive public information; and
- design and develop a user-friendly website providing products from or access to some or all of the data and information in the management system.

4. Outputs

- MIS development documentations and reports generated by properly retrieving data and information from the MIS
- Project website development and maintenance documentation
- Report of short English briefing for the development and operation of the MIS

5. Qualifications

- Familiar with the data and Management information system and reporting requirements of the Stockholm Convention,
- Familiar with the related guidance from multilateral environmental agreements,
- Familiar with the project management requirements of international agencies,
- Previous experiences in project development and implementation are assets.

6. Language requirement

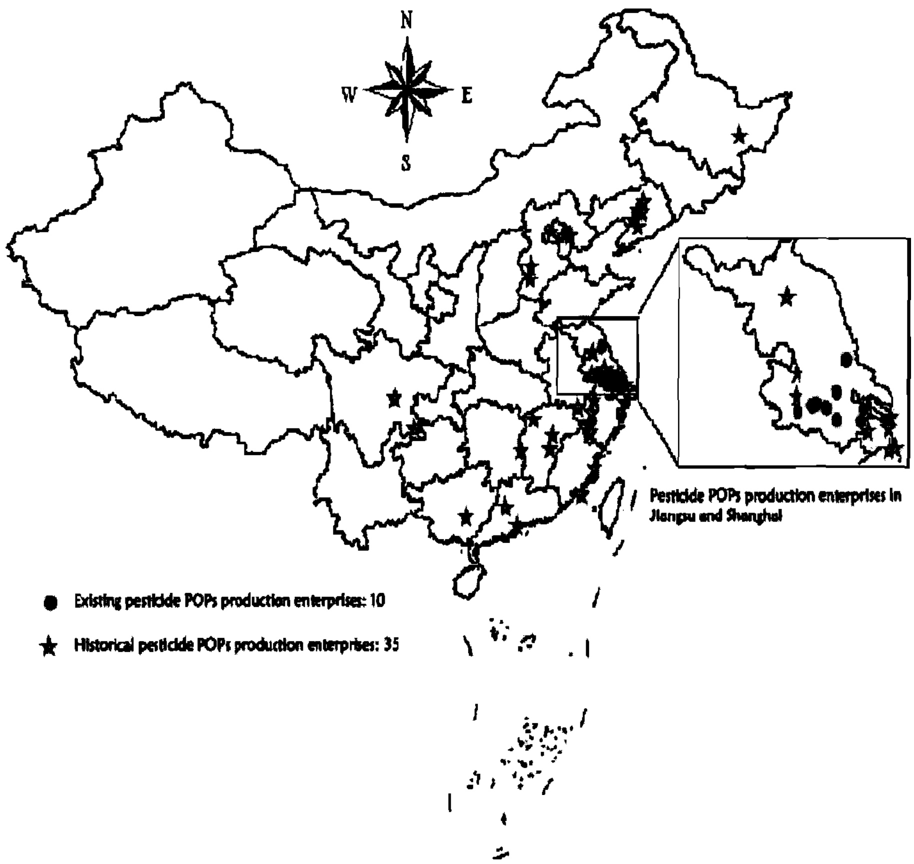
All reports should be in Chinese with short briefing translated to English

Estimated budget US$ 58,000

ANNEX 8: BASELINE ANALYSIS FOR POPS PESTICIDES AND FLY ASH

a) Obsolete POPs Pesticide and associated wastes

POPs pesticides in Stockholm Convention Annex A include: aldrin, chlordane, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex and toxaphene. China used to produce toxaphene, hexachlorobenzene, chlordane, heptachlor and mirex. There are 58 enterprises in China that produced the POPs pesticides mentioned in Annex A of the Convention (including primary production and formulation plants), which are located in 18 provinces and municipalities of China. Production and use of toxaphene and heptachlor were stopped in the 1970's, and the production and use of hexachlorobenzene were stopped in 2004. The chlordane and mirex production and use for termite prevention and control will be stopped in the near future following the Demonstration of Alternatives to Chlordane and Mirex in Termite Control Project.



Distribution of historical and existing POPs pesticides production enterprises

By the end of 2004, China has produced a total of 110,000 tons of POPs pesticides mentioned in Annex A of the Convention, of which about 30,000 tons were directly used in fields as agricultural pesticides for pest prevention and control, in termite prevention and control and in disease vector control, and about 80,000 tons of hexachlorobenzene were used as raw materials in the production of pesticides (sodium pentachlorophenate (Na-PCP) and pentachlorophenol (PCP)) and some was exported.

There exist a total of 58 enterprises involved in production of POPs pesticides, including 14 existing units. 20 enterprises have been identified and surveyed, including all existing production enterprises as well as enterprises with larger historical volumes of production. Because the production and use of toxaphene and heptachlor was completely stopped in the 1970's, and large-scale production of dieldrin, endrin and aldrin has never been started, their chemical wastes have not been found in China. At present, the identified POPs pesticide wastes are mainly DDT, chlordane, mirex and HCB and for the latter, the production was stopped in 2004. POPs pesticide wastes in China are mainly located in Jiangsu, Hunan, Sichuan, Shandong, Tianjin, Shanxi, Hebei and Liaoning provinces, accounting for 70-80% of the total waste quantity. At present, the storage methods of the above wastes are dominantly outdoor storage and simple enclosure.

Insufficient supervision and implementation of pesticides have lead to the complex flow patterns to the users and resulted in serious loss of POPs wastes locations. There is also no systemic sorting or collection, no specific packaging and containers for POPs wastes, and no specially designed POPs wastes transport vehicle. The consequence of that is the simple storage that leads to direct release of POPs wastes in the surrounding areas, which directly affect the environmental safety and public health. Also, many pesticide manufacturers had changed the origin of production areas and production lines for new products and other purposes. At most of the time, the obsolete pesticides and associated wastes are mixed with construction debris and municipal wastes that were simply treated or dumped in uncontrolled landfills.

POPs pesticides contaminated sites, in proximity to the stockpile locations, are also a serious issue, including highly polluted soil found at pesticides manufacturing sites, warehouses and at waste pesticide storage. According to the survey, there are about 44 polluted sites and four of them have been investigated. It was found there were about 18,000 tons of highly polluted soil (DDT>50 ppm) normally concentrated in top layer of soil around a single historic production plant, which is more than 100 times of the original amount of the obsolete pesticides.

Among the pesticide manufactures with obsolete POPs pesticides and contaminated workshops in the production sites, one (Liyang Guanghua Chemical Ltd. Co.) will be covered by the GEF funded Termite Project (WB) and three (Zhanjiakou Greatwall Agricultural Chemical Group, Shangdong Dacheng Pesticides Ltd. Co. and Jianshu Yangnong Chemical Ltd. Co.) by the GEF funded Diocofol Project (UNDP). 10 enterprises with obsolete POPs pesticides remained in production field (enterprises that have only contaminated sites is NOT included), 7 pesticide suppliers in agricultural fields, 5 vector control centres, and 1 hazardous waste temporary storage centre in Chongqing that has about 30 tons of DDT wastes are the main objective and focus of this project. They are located in 14 provinces including: Tianjin, Sanxi, Hebei, Yunnan, Jangsu, Anhui, Shanghai, Congqing, Shan'xi, Nimenggu, Guangdong, Hunan, Guangxi and Jiangxi.

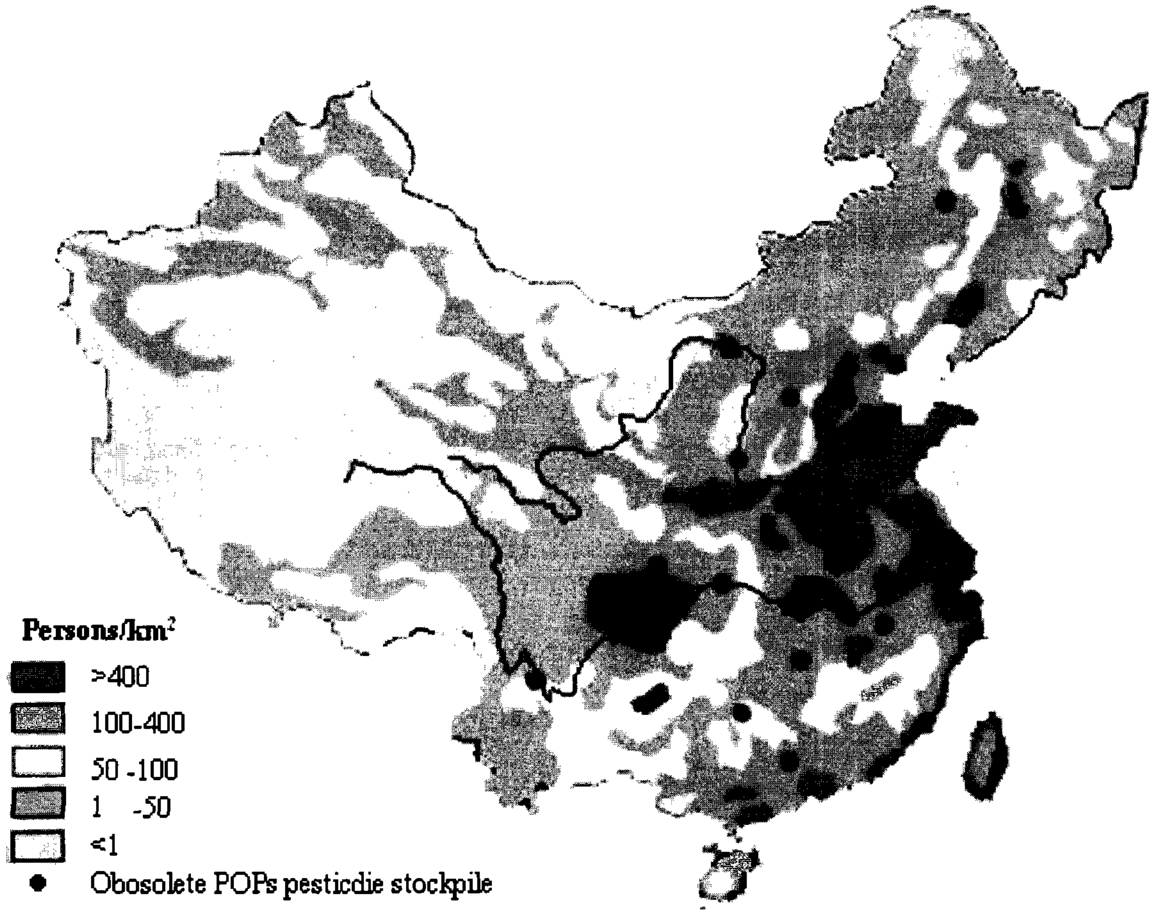
In conjunction with development of this project, MEP initiated a survey program for production, consumption, stockpile, and disposal of POPs pesticides. The program updated initial manufacturer and distributor surveys of conducted during preparation of the NIP, and expanded upon the NIP by inclusion of additional distributor sites. To date, the program has identified 3840~4380 tons of obsolete pesticides in the production field, including about 2400~2800 tons of DDT, 60~70 tons of HCB/PCP-Na and 1380~1510 tons of chlordane and mirex. Distributor surveys and follow-up site visits were conducted nationwide during preparation of China's NIP, identifying 13 POPs pesticide waste sites in 13 provinces. Additional detailed survey work completed during preparation of this project has focused on three target provinces (Chongqing, Jilin, and Jiangsu), identifying 29 additional sites in Chongqing. The 42 sites identified to date have 4219~5713 tons of obsolete pesticides (mostly DDT). Please see the table below for further details regarding sites information collected to date.

Table 1. Identified Obsolete POPs Pesticides Sites

Area		DDT	Chlordane/Mirex	HCB	Sub-total
Production	Pesticide manufactures	2400~2800	1380~1510	60~70	3840~4380
Distributors	Agriculture	4164~5640			4164~5640
	Healthcare	55~73	-	-	55~73
	Subtotal	4219~5713			4219~5713
Total		6,619~8,513	1380~1510	60~70	8,059~10,093

The release and transfer of obsolete pesticides and associated waste is potentially a major source of the soil pollution in a wide spread territory because of their semi-volatile properties. It was reported that the concentration is still higher than 1mg/kg in some areas even after 20 years of the prohibition of DDT and HCH usage in farmlands. In addition, the chemicals may be transferred into the water bodies and finally to the food chain from soil. Many organic chlorine compounds could be detected in the underground water in Beijing, Tianjin, Hebei and Sanxi Provinces. The POPs was also found in the sediments at 5 sites at Eastern Sea coast. The concentration of DDT in the sediment samples of Zhujiang River in southeast China is 0.1~44µg/kg which is distinctively higher than the global average level

Based on the survey of pesticides residues in food stuff, DDT and HCH was detectable in 90.9% of the wheat, corn and rice samples and the concentration of DDT and HCH was about 3~138µg/kg. Those chemicals could be found in eggs, milk and plant oils even after 10 years of the usage prohibition. The concentration of HCH is about 57µg/kg in fish products.



Locations of major POPs pesticide sites and the population distribution in China

At present, the identified POPs wastes storage sites are mostly located in the coastline provinces of eastern China or the areas with high population. The storage methods of these wastes are outdoor storage and simple enclosure from where POPs release poses a great risk to global environment and human health. If these wastes are to be mainly disposed by incineration without appropriate air pollution control devices, according to the common practice, additional large amount of dioxins and furans might be released. The project will identify and adopt cost-effective and environmentally sound alternative technologies to deal with the POPs stockpiles and wastes problem.

b) Fly ash of medical and hazardous waste incineration

According to the national survey on hazardous waste treatment facilities there are 106 centralized treatment facilities and 43 emergency incineration centres constructed for eliminating SARS outbreaks in 2003. There are 85, 33 and 31 facilities located in eastern, central and western parts of China, taking a share of about 56.7%, 22.1% and 21.2% of the total number. As for the disposal capacity, 52 facilities have a capacity higher than 10 ton/d, 38 facilities have a capacity about 5-10 ton/d and 59 facilities have lower than 5 tons/d. As for the hazardous waste incineration, there are 79 incinerators with a capacity of 5.2×10^5 t/a.

About 8.14×10^5 tons of medical wastes and 2.71×10^5 tons of hazardous wastes were incinerated in 2004. It is estimated that fly ash containing a high level of dioxin from incineration of hazardous wastes and medical waste amounts to about 11,000 tons per annum, that dioxin release in ash and residue from hazardous and medical incineration of waste is about 748.9g and 186 gTEQ accounting for 19% of the total estimated dioxins release in ash and residue and above 16% of the total releases to air from all sources in China (see table 2). According to the plan of hazardous waste processing facility construction, every province should have at least one centralized hazardous waste treatment centre. So it is expected that without the transfer of alternative technologies, the amount of dioxin fly ash will increase largely in the coming years.

Table 2: Identified Sources of POPs Wastes Containing Dioxins

Type of pollution source	Dioxin release in ash and residue (g-TEQ)
Incineration of waste	1,171.4
Metal smelting	2,167.2
Chemical production and use	68.9
Electricity and heat production	588.1
Outdoor incineration	940
Total	4,911.3

According to current regulations, fly ash should be managed as hazardous waste, i.e., stabilized before disposal at sanitary landfill or irreversibly destroyed and transformed into environmentally harmless substances. Because the safe disposal of fly ash from combustion is a recent issue, there is inadequate research or development in this field in China and consequently relevant technology and equipment is lacking. The high pollutant content in fly ash (shown in table 3) will also increase the requirements of pre-treatment and disposal costs. New and highly effective technologies for destruction of POPs have emerged in recent years and some have been commercialized with competitive price compared with conventional technologies and practices such as safe and controlled landfills. This provides a good opportunity to demonstrate new models of fly ash treatment in China. Despite the fact that landfilling is a common practice in China, there is a need to find out alternatives for disposal because the costs of building well controlled landfills have become expensive and convenient landfill sites are readily not available in many areas, especially the eastern costal areas.

Table 3: Heavy metal and leachate concentration of incineration ash

ash	amount	Cu	Pb	Zn	Cd	Cr	Ni	Hg	As
FA1	Concentration ($mg\cdot kg^{-1}$)	898.5	1147.1	10761.2	47.1	110.3	1427.5	7.7	18.4
	Leachate concentration ($mg\cdot L^{-1}$)	1.06	6.50	377.93	2.96	0.09	1.11	-	0.01
FA2	Concentration ($mg\cdot kg^{-1}$)	253.3	14.9	4519.0	3.7	59.0	1009.5	-	-
	Leachate concentration ($mg\cdot L^{-1}$)	0.05	0.02	0.33	0.00	0.25	0.00	-	-
BA	Concentration ($mg\cdot kg^{-1}$)	788.7	40.0	2788.3	14.9	174.7	1176.5	0.6	2.8
	Leachate concentration ($mg\cdot L^{-1}$)	0.02	0.03	0.20	0.02	0.07	0.04	-	-
Leachate toxicity evaluation standard value ($mg\cdot L^{-1}$)		50	3	50	0.3	10	10	0.05	1.5
Hazardous waste allowed to go to landfill ($mg\cdot L^{-1}$)		75	5	75	0.5	12	15	0.25	1.5

The fly ash dioxin content of different types of waste incinerators is shown in Table 3 and 4.

Table 4 Dioxin concentration of fly ash from Rotary-fluidized bed incinerator of medical waste

	[PCDDs] ng/g	[PCDFs] ng/g	[PCDF]/[PCDD]	TEQ-Conc. ng-ITEQ/g
HFA-1	155.3	870.5	5.16	13.5
HFA-2	440.	1652.1	3.65	25.5
HFA-3	561.4	1635.0	2.93	25.5
HFA-4	372.6	1265.4	3.36	17.5
HFA-5	71.8	368.3	4.89	6.9
HFA-6	993.1	2806.5	2.89	44.7
HFA-7	452.2.	1935.4	4.28	67.3
HFA-8	141.8	723.8	5.5	13.1

Samples HFA-1~8 were taken at the outlet of Bag filter during operation including start up, stable condition and shut down, but the specific operating conditions of the numbered samples were not available.

Table 5 Dioxin concentration of fly ash of number of typical waste incinerators in China

No.	Type of Incinerator	Capacity	Type of Waste	Flue gas cleaning system	Dioxin (ng-TEQ/g)
HFA-1	Rotary kiln- fluidized bed incinerator	10T/d	MW (oil)	Semi-dry+ACI+BF	26.8
HFA-2	Incinerator of Simple stoke	10T/d	MW (oil)	Wet scrubber+cyclon	15.6
MFA-1	Circulating fluidized bed incinerator	800T/d	MSW Coal(20/80)	Semi-dry+ BF	0.37
MFA-2	Martin stoke incinerator	1100T/d	MSW (oil)	Semi-dry+ ESP in filtering way	0.65
MFA-3	Reciprocal mechanical stoke incinerator	900T/d	MSW (oil)	Semi-dry+BF	0.75

H: Hospital; M: Municipal; MW: medical waste; MSW: Municipal Solid Waste; ACI: Activated Carbon Injection; ESP: Electro-static precipitator BF: Bag filter
Source: Unpublished research data.

Table 6 POPs Pesticide waste Site Status[2]

Site #	**Chemical**	**Obsolete pesticides (tons)**	**Site size**	**Status**
PM-1	Toxaphene	none	Workshop: 250m^2	Historical enterprise
PM-2	Chlordane/Mirex	Chlordane Residue: 2t Mirex Residue: 8t	Workshop: 300 m^2; The site of stocking wastes: 100 m^2	Historical enterprise
PM-3	Chlordane	Waste water: 1600t, Sediment: 1000t	1500m^2	Historical enterprise
PM-4	Chlordane	50-60	Workshop: 100m^2; The site of stocking	Historical enterprise

[2] For business confidentiality purposes, exact site location and ownership indicators have been replaced with identification numbers, e.g. PM-1 = Pesticide manufacturer #1, AD-2 = Agricultural distributor # 2, HD-3 = Healthcare distributor # 3. Additional identification or location information can be made available upon request.

Site #	Chemical	Obsolete pesticides (tons)	Site size	Status
			wastes: $60m^2$	
PM-5	DDT/Dicofol	none	Workshop:$1000m^2$	Existing enterprise
PM-6	DDT reagent	none	Workshop:$32m^2$	Historical enterprise
PM-7	Chlordane/Mirex	none	Workshop:$13000m^2$	Existing enterprise
PM-8	Chlordane/Mirex	none	Workshop: $5300m^2$	Existing enterprise
PM-9	DDT/Dicofol	none	Workshop:$12000m^2$	
PM-10	Chlordane/Mirex	Chlordane none	Workshop: 80 m^2	Existing enterprise
PM-11	HCB/PCP-Na	none	Workshop: $2500m^2$	Historical enterprise
PM-12	Chlordane	none	Workshop: 400 m^2	Historical enterprise
PM-13	DDT/HCB/PCP-Na	30-50	Workshop:$6466m^2$; Contaminated site:10000 m^2	Historical enterprise
PM-14	Chlordane/Mirex	100-150	Workshop: $3000m^2$; The site of stocking wastes: 200m2	Existing enterprise
PM-15	Chlordane	Emulsion:2t; Raw material:2t; Residue: 3t	Workshop: 1000-$1500m^2$	Historical enterprise
PM-16	DDT	500-600	$4km^2$	Has produced DDT for many years and is the only plant producing DDT in China now.
PM-17	HCB/PCP-Na	50-100	area of stocking contaminated soil:3000 m2, Workshop:75000m2	Has produce HCB for many years and the only plant producing HCB until 2003 in China
PM-18	DDT reagent	60-100	$2km^2$	Existing enterprise
PM-19	DDT/Dicofol	10; raffinate 400 m3	$15000m^2$	Historical enterprise
PM-20	Toxaphene	none	Workshop: $250m^2$	Historical enterprise
PM-21	DDT			
PM-22	Chlordane, Mirex, Heptachlor and Dieldrin			
PM-23	PCP-Na			
PM-24	DDT			
PM-25	Toxaphene			
PM-26	Toxaphene/Mirex			
PM-27	HCB/ PCP-Na			
PM-28	Toxaphene			
PM-29	Toxaphene			
PM-30	DDT			
PM-31	Toxaphene			
PM-32	Toxaphene			
PM-33	DDT			
PM-34	Chlordane			
PM-35	Chlordane			
PM-36	HCB			
PM-37	HCB			

Site #	Chemical	Obsolete pesticides (tons)	Site size	Status
PM-38	DDT			
PM-39	Toxaphene			
PM-40	Toxaphene			
PM-41	Toxaphene			
PM-42	Toxaphene			
PM-43	Toxaphene			
PM-44	Toxaphene			
Total Pesticides manufacturers	**Mixed**	**3840~4380**		
AD-1	DDT	12		Simple landfilling, deeply buried under the storehouse, with the Depth 4m. The ground covered by cement
AD-2	DDT		300 m^2	Storing in storehouse where no measure to defend leakage
AD-3	DDT	0.002		Storing special site
AD-4	DDT	0.3		During 1972-1976 there were 300kg DDT in stock and buried as wastes since then.
AD-5	DDT/HCB	2		It is stored in special storehouse and waited to be disposed.
AD-6	Dicofol			
AD-7	Dicofol	2		It has a large amount from a questionnaire and need to be verified on site
AD-8	Chlordane/Mirex			Storing in storehouse where no measure to defend leakage
AD-9	DDT			
AD-10	DDT			
AD-11	DDT			
AD-12	DDT			
AD-13	PCP			
AD-14	Toxaphene			
AD-15	HCB			
AD-16	Chlordane			
AD-17	Mirex			
AD-18	Mirex			
AD-19	Mixed			
AD-20	Mixed			
AD-21	Mixed			
AD-22	Mixed			
AD-23	Mixed			
AD-24	Mixed			
AD-25	Mixed			
AD-26	Mixed			
AD-27	Mixed			

Site #	Chemical	Obsolete pesticides (tons)	Site size	Status
AD-28	Mixed			
AD-29	Mixed			
AD-30	Mixed			
AD-31	Mixed			
AD-32	Mixed			
AD-33	Mixed			
AD-34	Mixed			
AD-35	Mixed			
AD-36	Mixed			
AD-37	Mixed			
Total Agricultural distributors	**Mixed**	**4164~5640**		
HD-1	DDT	9.6		It is put into plastic bottle, sealed by wooden box, and stored in special storehouse where have cement ground.
HD-2	DDT	0.2		There are 20 boxes of waste pesticide approximated to 200kg.It is stored in sealed storehouse where have cement ground, no aeration and light. 14 of them are sealed up, others are stored dispersedly.
HD-3	DDT			The plant plans to consume until it is used up
HD-4	DDT, Chlordane/Mirex			The company has a strict stock management and plans to use until it's exhausted.
HD-5	Mirex			The company has a strict stock management and plans to use until it's exhausted.
Healthcare distributors	**Mixed**	**55~73**		
Subtotal distributors	**Mixed**	**4219~5713**		
Total	**Mixed**	**8059~10093**		

Note: PM = Pesticide manufacturer, AD = Agricultural distributor, HD = Healthcare distributor.

Table 7 Current Laws, Regulations, and Standards Related to POPs Pesticides

Law/Regulation/Standard	Description
Law on the Prevention and Control of Environmental Pollution from Solid Waste	Umbrella law stipulating general pollution control requirements, including production, collection, storage, and transport of hazardous wastes
National Catalogue of Hazardous Wastes	Listing of regulated hazardous wastes and waste categories (POPs pesticides listed in Category 4)

Law/Regulation/Standard	Description
Administration of Report and Registration of Pollutants Discharge	Requirement that producers of solid wastes register and regularly report releases
Measures for the Administration of Operating License for Hazardous Wastes	Requires that those engaged in collection, storage, and/or treatment of hazardous wastes obtain a hazardous waste operating license
Measures on the Management of Duplicated Form for Transfer of Hazardous Wastes	Generators of hazardous wastes must submit duplicate hazardous waste transfer plans for approval by regional authorities at source and destination
Measures for the Prevention and Control of Environment Pollution by Discarded Hazardous Chemicals	Regulates process for remediation of contaminated sites
Principles for the Environmental Impact Assessment Technology on Hazardous Waste Treatment Facility Construction Projects	Regulations regarding location, treatment technologies, environmental impact, environment protection measures, public disclosure, and other issues
Standard on Identification of Hazardous Wastes	Standards for analysis of POPs containing hazardous wastes
Pollution Control Standards for Hazardous Waste Incineration (GB18484-2001)	Incineration standards
Standard for Control of Hazardous Waste Secure Landfill (GB18598-2001)	Landfill standards
Standard for Pollution Control of Hazardous Waste Storage (GB18597-2001)	Waste storage standards
General Appellation of Pesticides (GB4839-1998)	HCB, chlordane, mirex, aldrin, dieldrin, endrin, and heptachlor listed as controlled substances
Name List of Hazardous Goods (GB12268-2005)	Listing of hazardous POPs (item 1 toxic goods in category 6)
Regulation on Management of Import of Chemicals for the First Time and Import and Export of Poisonous Chemicals	Pesticides POPs listed in Annex I (Poisonous Chemicals Banned or Strictly Restricted, Group 1)
Guiding Catalogue of Industrial Structure Regulation (2005)	HCB, chlordane, and mirex in "elimination category" as obsolete products
Regulation on Safe Use of Pesticides (1982)	Classifies toxaphene and chlordane as medium toxicity pesticides, prohibiting use on fruit trees, vegetables, tea plants, traditional Chinese medicine, tobacco, coffee, pepper and citronella; chlordane allowed only for cereal feedstuff, and to prevent and control underground pests
Ministry of Agriculture Public Notice No. 199	bans toxaphene, aldrin, and endrin
Regulation on Termite Prevention and Control in Urban Houses (amended 2004)	regulates prevention and control of termites in urban houses
Pesticide Varieties Banned and Strictly Restricted from Use in China	Regulation regarding banned or restricted pesticides, including POPs pesticides
Notification of the General Administration of Customs on Issues Related to Exemption of the Value Added Tax in Import of Pesticides (2001)	Regulates import and export of pesticides

Law/Regulation/Standard	Description
Ministry of Environmental Protection (MEP) Notifications No. 29 and No. 65	Regulates import and export of pesticides
Classification and Indication of Hazardous Chemicals in Common Use (GB13690-92)	Dieldrin listed as category 6 poisonous good
Guideline on Construction of Diseases Prevention and Control Center Laboratories at the Province, Prefecture and County Levels	lists heptachlor as a pesticide monitoring item
Maximum Pesticide Residue Limit in Foods (GB2763-2005	stipulates residual limits of aldrin, dieldrin, and heptachlor in grains, vegetables, meat and eggs.
Measures for the Administration of Operating Licenses for Hazardous Chemicals (SETC 2002)	Management of business licenses related to POPs
Implementation Measures for Safety Production License of Hazardous Chemical Production Enterprises, State Administration of Work Safety and State Administration of Coal Mine Safety 2004	Management of the qualifications of enterprises engaged in POPs production
Management Measures on Production of Packages and Containers for Hazardous Chemicals in Designated Enterprises (SETC 2002)	Management of designated manufacturers of packaging and containers for hazardous chemicals
Measures for Management on Registration of Hazardous Chemicals (SETC 2002)	POPs registration management
Detailed Rules for Registration of Hazardous Chemicals (Trial) (SETC 2000)	POPs registration management
Implementation Measures for Safety License of Hazardous Chemicals Construction Projects (State Administration of Work Safety, State Administration of Coal Mine Safety 2006)	Safety check of POPs production and storage enterprises
Regulations on Environmental Management of the First Import of Chemicals and the Import and Export of Toxic Chemicals (MEP, General Administration of Customs, Ministry of Foreign Trade and Economic Cooperation, 1994)	Import and export management related to POPs
Provisions on Safe Use of Chemicals in Workplaces (Ministry of Labor, Ministry of Chemical Industry 1996)	Safety management related to POPs production sites
Measures for Management on Production license of Industrial Products (State Bureau of Quality Supervision and Inspection 2002)	Production license management related to POPs
Regulations for the Safe Use of Pesticides (Ministry of Agriculture, Animal Husbandry and Fishery, Ministry of Health, 1982)	Management related to the use of POPs
Regulations on Prevention of Termites in Urban Housing (Ministry of Housing and Urban-Rural Development 1999)	Management related to the use of POPs
Management Regulations on Railway Transportation of Hazardous Goods (Ministry of Railways 1996)	Management related to the transportation of POPs

Law/Regulation/Standard	Description
Regulations on Waterway Transportation of Hazardous Goods (Ministry of Communications 1996)	Management related to the transportation of POPs
Regulations on Road Transport of Hazardous Goods (Ministry of Communications 1993)	Management related to the transportation of POPs
List of Chemicals with Severe Toxicity (2002)	Includes POPs
List of Hazardous Chemicals (State Administration of Work Safety 2003)	Includes POPs
Reference No. of Dangerous Goods and Classification GB6944-2005 (MEP 2005)	Includes POPs
List of Dangerous Goods GB 12268-90 (MEP, the State Standardization Commission 2005)	Includes POPs
Environmental Quality Standard for Soils (GB15618-1995)	Applicable to POPs contaminated sites
Environmental Quality Risk Assessment Benchmark for Soils at Industrial Facilities (HJ/T25-1999)	Applicable to POPs contaminated sites
Identification Standard for Hazardous Waste - Identification for Extraction Toxicity GB 5085.3-1996	Applicable to POPs contaminated sites
Technological Specifications of Environmental Monitoring of soils (HJ/T164-2004)	Applicable to POPs contaminated sites
Measures for Manifest Management on Transfer of Hazardous Wastes	Includes POPs hazardous wastes

Annex 9: International and national experts consulted during Project Document development

Name	Position and Specialty
International Experts	
Dr. Csizer, Zoltan	UNIDO Consultant for Environmental projects and programs development, environmental management and policy
Dr. Roland Weber	POPs Environmental Consulting
Mr. Donal O'Laoire	UNIDO Consultant, environmental policy and management
Dr. John Vijgen	International HCH & Pesticides Association
Mr. Ray Phillips	Environmental projects and program development expert, International Program Director, RP Consulting, Inc.
Dr. Andrea Sbrilli	UNIDO consultant, Environmental Monitoring and Technology
Dr. Carlo Lupi	Chief Technical Advisor, Sino-Italian Cooperation Program for Environmental Protection
Dr. Luciano A. Gonzalez	Kinectrics
Mr. John Janse	Netherlands soil partnership
Dr. Jan Japenga	Sino-Dutch Center for the Management and Remediation of Contaminated Land
Dr. Martin Murin	Ekotoxikologicke centrum, Bratislava
Dr. Stephanie W.Y.Ma	Environmental Protection Department, Cross-Boundary and International Group
Marcus Gludinca	Regional Director, Environmental Decontamination (HK) Ltd.
Dr. Mohamed Eisa	UNIDO Deputy to the Director, Environmental Management Branch
Mr. Zengyou Peng	UNIDO, Industrial Development Officer, Stockholm Convention Unit
Ms. Erlinda P. Galvan	UNIDO Project Assistant, Stockholm Convention Unit
Mr. Jesse David Wilson	Wilson Global Environmental Consultations
Mr. John Johnston	Managing Director, Ecosafe Systems
Mr. Tore Laugerud	Senior Advisor, Nordic Consulting Group
Ms. Lida Tan	China Coordinator, Region 9, USEPA
Dr. Andrea Critto	Department of Environmental Sciences, University of Venice Ca'Foscari
National Experts	
Dr. Yu Gang	Professor, Director of Department of Environmental Science & Engineering, Tsinghua University, co-Chair of BAT/BEP Expert Group under POPs Convention
Dr. Zheng Minghui	Research Center for Eco-environment Sciences, Chinese Academy of Science, member of TWG for POPs monitoring and Toolkit Expert Group under POPs Convention
Dr. Hu Jianxin	Professor, College of Environmental Sciences, Peking University, member of POPs Review Committee under POPs Convention
Dr. Tian Honghai	Professor, National Research Center for Environmental Analysis & Measurement, POPs monitoring
Mr. Wang Qi	Professor, Chinese Research Academy of Environmental Science, Solid Waste Management

Name	Position and Specialty
Dr. Huang Qifei	Research Institute of Solid Waste Management, Chinese Research Academy of Environmental Science,
Dr. Li Li	Research Institute of Solid Waste Management, Chinese Research Academy of Environmental Science,
Dr. Cai Mulin	Research Institute of Solid Waste Management, Chinese Research Academy of Environmental Science,
Prof. Sheng Hongzhi	Department of Engineering Science, Institute of Mechanics, Chinese Academy of Sciences
Dr. Yang Hangsheng	Depart Mater. Sci. Eng. College Mater. Sci. Chem.Eng., Zhejiang University
Dr. Zhu Jianxin	Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences
Dr. Zhang Xiaobin	Depart Mater. Sci. Eng. College Mater. Sci. Chem.Eng., Zhejiang University
Dr. Li Xiaodong	Professor, Institute of Thermal Power Engineering, Zhejiang University, Dioxin Monitoring and Reduction
Prof. Li Baoshan	Depart of Chemistry, College of Science, Beijing University of Chemical Technology
Dr. Huang Jun	Department of Environmental Science& Engineering, Persistent Organic Pollutants Research Center
Mr. Bai Rong	Deputy General Engineer, Chengguang Research Institute of Chemical Industry
Ms. Li Jia	Senior Engineer , Chengguang Research Institute of Chemical Industry
Dr. Cai Linli	Global-green Plasma Technology Co., Ltd
Mr. Luo Zhihai	Engineer, CASIMECH-GREEN PLASMA RESEARCH CO.,LTD
Mr. Zhang Jiancan	Engineer, CASIMECH-GREEN PLASMA RESEARCH CO.,LTD
Mr. Ai Shengbing	Deputy General Engineer, CHENGDU DONGFANG KWH Environmental Protection Catalysts Co. Ltd.
Mr. Leng Hongchuan	General Manager, CHENGDU DONGFANG KWH Environmental Protection Catalysts Co., Ltd.
Dr. Lin Ronghua	Center of Agrochemicals for Biological and Environmental Technology, Institute for the Control of Agrochemicals, Ministry of Agriculture
Mr.Li Lixin	Deputy Director, Beijing Municipal Environmental Protection Bureau, Beijing Municipal Solid Waste Management Center
Dr. Liu Yangsheng	Department of Environmental Engineering, Peking University
Mr. Xie Jinyu	Chief Engineer, Chongqing Solid Wastes Management Center
Dr. Wang Guoqin	Center for Assessment and Remediation of Contaminated Sites/Soils, Nanjing Institute of Environmental Science
Dr. Ni Yuwen	Dalian Institute of Chemical Physics, Chinese Academy of Sciences
Dr. Jin Dengchao	Department of Electromechanical Engineering, Tianjin Agricultural University

REQUEST FOR CEO ENDORSEMENT/APPROVAL

PROJECT TYPE: Full-sized Project
THE GEF TRUST FUND

GEF

Annex 2

Submission Date: PIF: 25/09/2005
FSP: 1/08/2008
Re-submission Date: PIF: 15/10/2007; 21/01/2008; 11/02/2008

PART I: PROJECT INFORMATION

GEFSEC PROJECT ID: 2926
GEF AGENCY PROJECT ID: GF/CPR/08/X01
COUNTRY(IES): People's Republic of China
PROJECT TITLE: Environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes in China
GEF AGENCY(IES): UNIDO
OTHER EXECUTING PARTNER(S): Ministry of Environmental Protection (MEP)
GEF FOCAL AREA(S): Persistent Organic Pollutants,
GEF-4 STRATEGIC PROGRAM(S): POPs SP2 and SP3
NAME OF PARENT PROGRAM/UMBRELLA PROJECT:

Expected Calendar	
Milestones	**Dates**
Work Program (for FSPs only)	April 2008
Agency Approval date	August 2008
Implementation Start	January 2009
Mid-term Evaluation (if planned)	February 2011
Project Closing Date	February 2013

A. PROJECT FRAMEWORK (Expand table as necessary)

Project Objective: The project will enable environmentally sound management and disposal of targeted obsolete POPs pesticides and associated wastes in fulfillment of China's commitments under the Stockholm Convention. The presence of geographically dispersed stockpiles of obsolete POPs pesticide waste and PCDD/PCDF rich incinerator fly ash presents an ongoing pathway risk to environmental receptors, especially groundwater and surface water resources. The scale of this risk and its global consequences make it a uniquely Chinese issue with significant transboundary impact. In accordance with the Stockholm Convention and Basel Convention guidelines, the project will directly provide treatment of a minimum of 10,000 tonnes of identified targeted POPs pesticide wastes and 1,000 tonnes of PCDD/PCDF rich fly ash. The project will also introduce regulatory reforms and strengthen national capacity to identify, assess, manage, and treat other such wastes in an environmentally sustainable manner by use of new analytical and organizational techniques such as qualitative environmental risk assessment and public-private partnerships.

Project Components	Indicate whether Investment, TA, or STA**	Expected Outcomes	Expected Outputs	GEF Financing*		Co-financing*		Total ($) c=a+ b
				($) a	%	($) b	%	
1. Formulation of regulations and policies consistent with relevant requirements of Stockholm Convention for life-cycle management of POPs wastes	TA	Strengthened legal and regulatory framework for ESM and disposal of POPs wastes	1.1 Technological and economic policies and regulations in place for promoting environmentally sustainable management and disposal of POPs wastes 1.2 Technical standards and guidelines developed for ESM of POPs waste	852,600	29	2,069,650	71	2,922,250

2. Strengthening of institutional structures at national and local levels for life-cycle management including site inspection, QERA, handling, collection packaging, labeling, transportation and disposal	TA	Improved institutional capacity at all levels of POPs waste disposal management	2.1 Communication and coordination sustained between stakeholders in waste management and disposal 2.2 Institutional capacity enhanced for POPs waste management at local level 2.3 Public awareness raising on POPs activities undertaken	953,100	34	1,841,175	66	2,794,275

Project Components	Indicate whether Investment, TA, or STA**	Expected Outcomes	Expected Outputs	GEF Financing*		Co-financing*		Total ($)
				($) a	%	($) b	%	c=a+ b
3. Environmentally sound disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash	TA	The central outcome will be the removal for disposal of 10,000 tonnes of POPs stockpiled pesticides and 1,000 tonnes of dioxin-rich fly ash as source contaminants for the vulnerable local ecosystem receptors.	3.1 Safe and effective handling, packaging, transportation of obsolete POPs pesticides for disposal adopted 3.2 Assessment of technologies for POPs disposal carried out 3.3 Technology transfer promoted through PPP mechanisms 3.4 Construction, certification, operation, and supervision of stationary and mobile treatment facilities arranged 3.5 Dioxin rich fly ash disposal implemented 3.6 Exploration of the feasibility to extend POPs waste disposal capacity to CFCs destruction undertaken	7,074,000	21	26,400,825	79	33,474,825
4. Qualitative environmental risk assessment (QERA) site prioritization	TA	Qualitatively assessment and prioritization of the residual environmental risks remaining on the sites.	4.1 Inventory of potentially contaminated sites prioritised 4.2 Establishment and maintenance of an Internet-based information processing, display and dissemination system in place	584,700	36	1,051,100	64	1,635,800
5. Project management, monitoring and evaluation				508,600	41	737,250	59	1,245,850
Total Project Costs				**9,973,000**		**32,100,000**		**42,073,000**

* List the $ by project components. The percentage is the share of GEF and Co-financing respectively to the total amount for the component.
** TA = Technical Assistance; STA = Scientific & technical analysis.

B. Financing Plan Summary For The Project ($)

	Project Preparation a	*Project Grant b*	*Total c = a + b*	*Agency Fee*	*For the record: Project Grant at PIF*
GEF	231,000	9,973,000	10,204,000	1,020,400	11,304,900
Co-financing	545,000	32,100,000	32,645,000		31,470,000
Total	**776,000**	**42,073,000**	**42,849,000**	**1,020,400**	**42,774,900**

C. Sources of Confirmed Co-financing for Project Preparation and Project

(expand the table line items as necessary)

Name of co-financier (source)	*Classification*	*Type*	*Project Preparation*	*Project*	*Total*	*%**
Central government (MEP)	Nat'l Gov't	cash		220,000	220,000	0.7%
		In-kind	545,000	6,180,000	6,725,000	19.0%
Central government (MOF)	Nat'l Gov't	cash		3,900,000	3,900,000	12.0%
Local EPBs	Local Gov't	cash		1,030,000	1,030,000	3.0%
		in-kind		6,370,000	6,370,000	20.0%
Pesticide owners and Private Sectors	Private Sector	cash		5,980,000	5,980,000	19.0%
		In-kind		8,320,000	8,320,000	26.0%
GEF Agency (UNIDO)	Impl. Agency	In-kind		100,000	100,000	0.3%
Total Co-financing			545,000	**32,100,000**	32,645,000	100%

* Percentage of each co-financier's contribution at CEO endorsement to total co-financing.

D. GEF Resources Requested by Agency(ies), Focal Area(s) and Country(ies)

GEF Agency	*Focal Area*	*Country Name/ Global*	*(in $)*			
			PPG (a)	*Project (b)*	*Agency Fee (c)*	*Total d=a+b+c*
(select)	(select)					
(select)	(select)					
Total GEF Resources						

* No need to provide information for this table if it is a single focal area, single country and single GEF Agency project.

E. Project Management Budget/Cost

Cost Items	*Total Estimated person weeks/months*	*GEF ($)*	*Other sources ($)*	*Project total ($)*
*Local consultants**	858.0	130,000	900,000	**1,030,000**
*International consultants**	4.3	17,200	-	**17,200**
*Office facilities, equipment, printing and communications**		39,300	42,300	**81,600**
*Travel**		10,000		**10,000**
Total	**862.3**	**196,500**	**942,300**	**1,138,800**

* Details to be provided in Annex C.

F. Consultants Working for Technical Assistance Components:

Component	*Estimated person weeks*	*GEF($)*	*Other sources ($)*	*Project total ($)*
*Local consultants**	1,358	230,400	1,399,600	1,630,000
*International consultants**	127	508,000	-	508,000
Total	**1,485**	**738,400**	**1,399,600**	**2,138,000**

* Details to be provided in Annex C.

G. Describe the Budgeted M&E Plan:

Type of M&E activity	**Responsible Parties**	**Budget US$ (excluding project team staff time)**	**Time frame**
Hold the Inception Workshop	CIO	55,000	Within 3 months after GEF CEO approval
Prepare Inception Report	CIO with support of CTA and NTA	4,000	Within 6 months after the IW

Type of M&E activity	Responsible Parties	Budget US$ (excluding project team staff time)	Time frame
Measure impact indicators on an annual basis	CIO with support of CTA and NTA	9,500	Annually
Prepare Annual Project Reports and Project Implementation Reviews	CIO and UNIDO	9,500	Annually
Hold annual tripartite review meetings	CIO and UNIDO	47,500	Annually, upon receipt of APR and PIR
Hold biannual Steering group meetings	CIO and UNIDO	24,500	Biannually
Carry out mid-term external evaluation	Independent consultants	20,600	At the mid-point of the project implementation
Carry out final external evaluation	Independent consultants	17,200	Within 12 months after the completion of the project implementation
Complete the Terminal Report	CIO and UNIDO	4,600	
Carry out annual project financial audits	Independent audit entity	20,000	Annually
Carry out biannual visits to selected field sites	Independent consultants, UNIDO	44,000	
Establish a project management information system (MIS), including a project website to disseminate information to stakeholders	CIO supported by subcontractor	54,700	Throughout the project implementation
Total		**312,100**	

PART II: PROJECT JUSTIFICATION:

A. DESCRIBE THE PROJECT RATIONALE AND THE EXPECTED MEASURABLE GLOBAL ENVIRONMENTAL BENEFITS:

1. China has urgent need of an on the ground program for managing stockpiles of obsolete POPs pesticides and associated contaminated wastes in an environment sound way. China's large agricultural industry and heavy dependence on agro-chemicals resulted in about 574,000 tonnes of POPs pesticides production through the end of 2004. Although POPs pesticides production has been prohibited by domestic regulations, lack of a targeted national program providing capacity building and technical assistance to manage these chemicals has resulted in significant stockpiling of obsolete POPs pesticides.

2. Based on the research and surveys conducted in conjunction with preparation of this project, obsolete POPs pesticide and associated wastes have been identified in 44 POPs pesticide manufacturing plants and a number of distribution and end user sites. In the past, plant owners and end users have been responsible for managing their own POPs pesticides, which have resulted in stockpiles of obsolete pesticides and associated wastes, the distribution and scope of which has been unknown to central and local environmental protection agencies.

3. The absence of adequate capacity and infrastructure for environmentally sound management (ESM) and disposal of POPs pesticide wastes in China poses significant risks to human health and the environment. In most POPs pesticide manufacturing plants and end user sites, there are no storage facilities specifically designed for obsolete pesticides and pesticide wastes. Large amounts of obsolete POPs pesticides are therefore often stored in improper conditions, such as outdoor storage, simple enclosure, or open-air disposal with municipal solid waste, all of which constitute a serious threat to human health. This serious risk of environmental contamination and human exposure is further exacerbated by natural disaster, such as the flooding and earthquakes, which China has recently experienced.

4. Current practices for POPs waste disposal are dominated by incineration and therefore generate secondary pollution such as dioxins and furans. It is estimated that fly ash containing a high level of dioxin from incineration of hazardous wastes and medical waste amounts to 11,000 tonnes per annum. Incineration plants generally dispose of this dioxin rich fly ash in open dumps or non-sanitary landfills mixed with municipal waste, thereby increasing the potential POPs pollution risk to water resources.

5. China acceded to the Stockholm Convention on Persistent Organic Pollutants (POPs) on 23 May 2001. The Tenth National People's Congress Standing Committee ratified the Convention on 25 June 2004. Under Article 6(1) (c), China is required to manage POPs wastes in an environmentally sound manner. However, surveys and reports have shown that lack of institutional, technical and financial capacity inhibits the sound management of obsolete POPs pesticides and associated wastes.

6. The project concept is illustrated in Appendix 1: Project logical framework. The proposed project will strengthen the overall management and disposal of POPs obsolete pesticides and associated wastes in an environmentally sound manner in China and eliminate the risk of POPs to human health and the environment globally. Methodologies for POPs waste site risk assessment, handling, clearance, collection, labeling, packaging, transportation, disposal and emergency response procedures will be developed according to strict internationally accepted technical standards and guidelines including those developed by COP to the Basel Convention. The emphasis will be put on the cost-effectiveness and sustainability of the proposed measures.

7. The proposed project has been designed to address a variety of barriers in order to ensure its successful implementation and the achievement of project objectives. These barriers, listed in the order of project outcomes, include:

   - Existing laws and regulations related to hazardous wastes are too general and their implementation is not supported by detailed regulations and technical guidelines;
   - Existing standards for hazardous waste pollution control are too broad and specific standards for POPs pesticides do not exist;
   - China's Nationwide Hazardous Waste Treatment Facility Construction Program has been developed without considering technology and knowledge transfer of ESM measures particularly in considering alternative technologies;
   - Lack of policy instruments promoting adoption of ESM in a market economy;
   - Historical pesticides manufacturing sites that stopped production long ago might not have production records based on which the size of contaminated areas and level of contamination can be estimated;
   - Weak institutional capacities for supervision and inspection of POPs waste owners' sites and dedicated disposal facilities in the areas of pollution monitoring, environmental impact assessment and operational risk assessment;
   - Lack of effective personnel training systems to provide qualified human resources for BAT/BEP based lifecycle management of POPs waste;
   - Lack of stakeholder awareness raising and education;
   - Lack of effective mechanism to promote research, development and application of technically feasible and locally affordable processes, techniques and equipment;
   - Lack of POPs wastes disposal capacity;
   - Slow commercial application of innovative POPs wastes disposal technologies;
   - Distribution and properties of obsolete pesticides and PCDD/PCDF rich fly ash;
   - Lack of experience in operating mobile disposal facilities;
   - Lack of regionally cooperative and coordinated ESM for POPs waste disposal;
   - Lack of certification program to provide open, reliable and comparable information for reviewing technical and environmental performance of POPs waste treatment and disposal facility owners;
   - Lack of inter-ministerial mechanisms to provide coordination and guidance upon cross-sectoral policy and implementation issues; and
   - Stakeholder conflict of interests.

8. With GEF support, the proposed project will address these issues through regulatory enhancement, capacity building, technology transfer, a novel PPP mechanism, and direct treatment of obsolete POPs pesticides and associated wastes. The combination of these approaches will not only address the immediate, high priority need to mitigate the imminent local, regional, and global environmental risk posed by the obsolete pesticides identified during project preparation, but will also provide for the regulatory framework, institutional capacity, and technical capacity to improve management of POPs pesticides on a long-term sustainable basis, with concomitant benefits to local communities, China, the region, and the world.

9. The proposed project will help China to fulfill its obligation under the Convention. In summary, the project will generate significant global benefits, including:

- Safe disposal of a minimum of 10,000 tonnes of obsolete POPs pesticides and 1,000 tonnes of dioxin-rich fly ash, which in and of itself is of local, regional and global significance.
- Avoided emissions of 8.97 gTEQ PCDD/PCDF releases into the water and atmosphere through improved emissions control technology and direct destruction of 30.67 gTEQ of dioxins.
- Additional global environmental benefits accruing from long-term capacity building and regulatory reform activities.
- Innovative approaches providing a model for sustainable management of obsolete POPs pesticides and other POPs both in China and in other developing countries.

B. DESCRIBE THE CONSISTENCY OF THE PROJECT WITH NATIONAL PRIORITIES/PLANS:

10. The National Program of Disposal Facilities Construction for Hazardous Wastes and Medical Wastes Treatment was approved in 2004. It is a pure engineering construction program in which 31 hazardous waste treatment and disposal centres will be constructed to dispose of hazardous waste by incinerators. The proposed project will interact with and influence the Program through:
    - Introduction of life cycle management into current hazardous waste management systems, including qualitative site environmental risk assessment, waste characterization, and ESM involving handling, collection, packaging, labeling, transportation, and storage of stockpiled POPs pesticides;
    - Mainstreaming relevant Stockholm Convention requirements for ESM of POPs stockpiles and wastes into current legal and institutional management structure; and
    - Expansion of technology selection for destruction of stockpiled obsolete POPs pesticide waste thereby generating global environmental benefits.
11. The Chinese National Implementation Plan (NIP) requires the development of comprehensive strategies, including characterization, management and disposal of wastes consisting of, containing, or contaminated by POPs, and requires the demonstration of cost-effective and environmentally sound technologies, including but not exclusively incineration and non-combustion options, as well as capacity building for their commercial application. ESM of POPs wastes is also one of the important elements set in the National 11th Five-Year Plan on Economic and Social Development of China.
12. According to the NIP, China shall:
    - Establish a preliminary system for the ESM of POPs stockpiles and wastes by 2010;
    - Complete the ESM and disposal of 30% of pesticide POPs wastes identified nationwide by 2010;
    - Begin to achieve the ESM and disposal of pesticide POPs wastes across the country by 2015;
    - Fulfill the ESM and disposal of identified dioxin wastes released by key industries by 2015; and
    - Update the lists of POPs wastes and POPs contaminated sites, and gradually eliminate contamination caused by them as the long-term objective.
13. The proposed project will play a vital role in supporting China in fulfilling the objectives.

C. DESCRIBE THE CONSISTENCY OF THE PROJECT WITH GEF STRATEGIES AND STRATEGIC PROGRAMS:

14. Obsolete POPs pesticide wastes are widely distributed throughout China. High priority locations identified during development of China's NIP and preparation of this project include 44 POPs pesticides manufacturing plants and a number of distributor sites. Unsound storage conditions at these sites entail high risk of POPs release, with concomitantly high risk of POPs contamination of ground water and soil. Capacity does not currently exist to dispose of these contaminated wastes in an environmentally sound manner. Current regulatory requirements and waste disposal facilities do not take ESM practices and Stockholm Convention requirements into consideration.
15. Where disposal does take place, current disposal practices are dominated by direct incineration without consideration of Stockholm Convention requirements, resulting in secondary pollution such as dioxin and furan formation and release into the atmosphere. In addition, incineration of hazardous and medical waste results creates large amounts of fly ash (an estimated 11,000 tons per annum) containing high levels of dioxin. While current regulations require that fly ash resulting from these wastes be either destroyed or de-contaminated prior to landfill, incineration plants lack the understanding and technology to do so, and hence generally either store the resulting fly ash or landfill it without treatment, thereby increasing the risk of POPs releases.

16. Article 13.2 of the Stockholm Convention on POPs provides that developing country Parties and Parties with economies in transition will have access to new and additional financial resources to enable them to meet the agreed full incremental costs of implementing measures that fulfill their obligations under the Convention. Therefore, insofar as a Party is obliged to require best available techniques under the well-defined circumstances specified in the Convention, the Party should receive access to the agreed full incremental costs of implementing this obligation.

17. Article 5 of the Convention addresses measures that Parties shall take measures to reduce releases of unintentionally produced POPs listed in Part I Annex C with the goal of their continuing minimization and, where feasible, ultimate elimination. Part II of Annex C is a list of source categories that "have the potential for comparatively high formation and release of these chemicals (i.e. dioxins) to the environment" and the "Waste incinerators, including co-incinerators of municipal, hazardous or MW or of sewage sludge is the first source in the list.

18. For new sources listed in Part II (including any new or any substantially modified facility for treatment of POPs contaminated wastes), Parties are required to use best available technology. This requirement is to be *"phased in as soon as practicable but no later than four years after entry into force of the Convention for the Party."* The Convention entered into force for China on 11 November 2004, which means that waste treatment facilities built or modified on or after 10 November 2005 will be required to adopt BAT/BEP by 10 November 2008. Furthermore, in all existing facilities, China is required by the Convention to promote BAT and BEP.

19. When a Party implements this obligation, it should assure that priority consideration is given to alternative processes, techniques or practices that have similar usefulness but which avoid the formation and release of chemicals listed in Part I of Annex C. Subparagraph (f) in Para. A Part V Annex C provides: *"When considering proposals to construct new waste disposal facilities, consideration should be given to alternatives such as activities to minimize the generation of municipal and MW, including resource recovery, reuse, recycling, waste Separation and promoting products that generate less waste. Under this approach, public health concerns should be carefully considered.* "

20. Open burning of waste, including burning of landfill sites, is included in Part III Annex C as a source from which unintentional POPs may also be formed and released. In China's rural and remote rural areas the common practice of open burning of obsolete POPs pesticides should therefore be banned.

21. Project activities eligible for funding under GEF OP 14 include: building waste management capabilities; strengthening policy and regulatory frameworks; strengthening monitoring capacity; developing capacity to assess technologies and management practices; developing and implementing public awareness, information and environmental education programs; facilitating dissemination of experiences and lessons learned and promoting information exchange; promoting access to, and the transfer of, clean and environmentally sound alternative technologies; and demonstrating viable and cost-effective alternatives to the processes and practices that lead to the release of POPs.

22. Pursuant to Strategic Programs 2 and 3 in the POPs focal area for GEF-4, the GEF will co-finance investments needed for NIP implementation in order to reduce POPs production, use and releases, and reduce the stress on human health and the environment caused by POPs, including promotion of the use of alternative practices that prevent or reduce generation and/or release of POPs. The project will support this work by application of ESM in the management and disposal of obsolete POPs pesticides and associated POPs wastes.

23. The project will strengthen the overall management and disposal of POPs containing products and wastes in an environmentally sound manner and eliminate the risk of POPs to human health and the environment in China and globally. Methodologies for POPs waste site risk assessment, handling, clearance, collection, labeling, packaging, transportation, disposal, and emergency response procedures will be developed according to strict internationally accepted technical standards and guidelines including those developed by COP to the Basel Convention. The emphasis will be put on the cost-effectiveness and sustainability of the proposed measures.

24. The expected global environmental benefits to be delivered include the complete irreversible destruction and transformation of a minimum of 10,000 tons of obsolete POPs pesticides and wastes and 1,000 tons of dioxin rich fly ash from waste incinerators in an environmentally sound and cost-effective manner.

25. The GEF4 Strategy in POPs focal area also states that coordination and synergies with countries' responses to related multilateral environmental agreements addressing chemicals issues will be encouraged. The design of activities regarding BAT/BEP demonstration and replication has taken into account Technical Guidelines on Environmentally Sound Management of Persistent Organic Pollutants issued by the Secretariat of Basel Convention.

D. OUTLINE THE COORDINATION WITH OTHER RELATED INITIATIVES:

26. The proposed project will ensure close cooperation and coordination with the GEF projects on phase out and substitution of POPs pesticides and medical waste incineration to enhance the sustainability relevant to POPs waste disposal. The project will

monitor the progress of the non-combustion projects in Slovakia and the Philippines and will incorporate results as appropriate when available. The project will also seek to achieve synergies with the on-going efforts under Montreal Protocol implementation framework. The project will explore the possibility of CFCs disposal using the experience and facilities generated.

27. The proposed project will coordinate with and draw on the lessons learned from other bilateral and multilateral projects in the POPs pesticides and related areas, including in particular the Sino-German pesticides project. The proposed project has also benefited from input received from Germany and Japan at the GEF Council meeting in response to the PIF submission, from comments and technical information provided by industry experts from Germany, Italy, and the Netherlands, and from comments and other project developmental support being provided by the Netherlands Soil Partnership, the Sino-Dutch Center for the Management and Remediation of Contaminated Land, and the International HCH & Pesticides Association.

E. DESCRIBE THE INCREMENTAL REASONING OF THE PROJECT:

Baseline

28. In the absence of the proposed project, the POPs pesticides waste disposal sector in China could be characterized as follows:
    - A regulatory framework is not focused on the particular features of POPs pesticide waste management and disposal.
    - Under-developed institutional capacities, in terms of both hardware (infrastructure) and software (skills and expertise) for supervision and inspection of owners and storage sites of POPs pesticide waste and POPs waste disposal facilities in terms of pollution control and monitoring, environmental impact assessment, and operation risk evaluation.
    - Incinerators continue to play the predominant role in the disposal of POPs waste and generate unintentional POPs releases that significantly exceed BAT performance levels.
    - Alternative technologies, which can avoid formation of PCDD/PCDF could not be adopted.
    - Integration and coordination of POPs waste management, treatment and disposal systems could not be explored to achieve optimal social, economic and environmental benefits.
    - National debts and local government investments remain the principal financial source for construction of dedicated hazardous waste disposal facilities, but are unsustainable.
    - Stakeholder awareness regarding secondary pollution from POPs waste disposal is insufficient.
    - The fee-based system supporting POPs pesticide waste management, treatment and disposal systems would not be developed.

Global Environmental Objective

29. Obsolete POPs pesticide refer to pesticide POPs listed in Annexes A and B of the Stockholm Convention, stored for long periods by producers, sales sites and users, which have already lost their original value and basically have no market value, discarded or abandoned and not in condition for distribution and use. Due to their unique properties, obsolete POPs pesticides easily enters the food chain and poses a serious eco-environment and human health risk. POPs pesticides such as DDT are endocrine disruptors, which can cause severe reproductive and developmental interdisorders and damage the immune system and interfere with hormonal systems.

30. Obsolete POPs pesticides and associated wastes are hazardous waste. Owing to the absence of environmentally sound disposal facilities in developing countries, the quantity of obsolete pesticide stocks is constantly on the increase. Storage conditions rarely meet internationally accepted standards and drums are often stored in the open exposed to harsh weather conditions, which accelerate the wear and tear of containers. Many containers deteriorate and leak their liquid contents into the soil, eventually severely contaminating groundwater and the environment while the powder contents of worn or torn bags and cardboard boxes are often dispersed into the environment by wind or rain. Most stores are in the center of populated urban areas or close to public dwellings or bodies of water.

31. The overall objective of the project is to constitute a regulatory platform and finance mechanism for the ESM of obsolete POPs pesticide and associated wastes, install necessary waste treatment capacity for POPs waste, safely dispose of the obsolete POPs pesticides and associated wastes, destruct the high content of PCDD/PCDFs fly ash generated during the hazardous waste and medical waste incineration, reduce and ultimately eliminate the release of PCDD/PCDFs during the treatment process of obsolete POPs pesticides and associated wastes, and to assist China in implementing its obligations under the Stockholm Convention.

Alternative

32. Through the proposed project, obsolete POPs pesticides and POPs pesticide waste owners will adopt ESM for POPs pesticides waste management. It will achieve great reduction of air pollutant emission from POPs pesticide waste incineration through the application of ESM and through application of innovative alternative technologies to avoid unintentional PCDD/PCDFs formation.

33. The proposed project will significantly contribute to the POPs focal area as follows:

- Safe management of obsolete POPs pesticides and associated wastes to avoid the release of those pollutants to local and global environment;
- Disposal of 10,000 tones of POPs waste in an environmental sound manner to avoid the formation and releases of about 8.97 g TEQ PCDD/PCDFs;
- Destruction of 1,000 tones of dioxin-rich fly ash by means of BAT/BEP demonstration and adoption of alternative treatment processes to reduce releases of 30.67 g TEQ PCDDs/PCDFs.

E. INDICATE RISKS, INCLUDING CLIMATE CHANGE RISKS, THAT MIGHT PREVENT THE PROJECT OBJECTIVE(S) FROM BEING ACHIEVED AND OUTLINE RISK MANAGEMENT MEASURES:

34. The risks are identified with reference to project objectives as follows:

Outcomes	Risks	Level	Mitigation measures
Strengthened legal and regulatory framework for ESM and disposal of POPs waste	➢ Government at national, provincial, and local levels, as appropriate, would not endorse and adopt the required standards, guidelines and specifications according to the project timeline	Low	Ensure laws, regulations, standards, guidelines and specifications are practical and enforceable and supported with institutional capacity building and training
	➢ Key stakeholders could not be effectively involved throughout the process	Low	Public awareness raising and enforce monitoring and inspection
Improved institutional capacity at all levels of POPs waste disposal management	➢ NGOs and enterprises might not be willing to actively participate. ➢ Key agencies might not attach sufficient importance and allocate sufficient resources to POPs waste management supervision	Low	Focus on stakeholder awareness raising as a priority Arise public awareness, enforce monitoring and inspection and provide sufficient trainings
ESM and sound disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash	➢ Vendors and other parties might not be willing to cooperate	Low	A policy for POPs disposal fee will be issued and a proper price mechanism will be introduced to allow suitable revenue for the contractors.
	➢ Water/electric power supply at selected sites might not be suitable for construction of the stationary and mobile POPs treatment facilities	Low	Careful selection of sites coupled with comprehensive capacity building
Qualitative environmental risk assessment (QERA) site prioritization	➢ Adequate data could not be obtained to complete analyses	Low	Carefully design the investigation program and enforce monitoring and inspection during the implementation

G. EXPLAIN HOW COST-EFFECTIVENESS IS REFLECTED IN THE PROJECT DESIGN:

35. The proposed project is the first one in China to directly address the issue of accumulated obsolete POPs pesticides and associated wastes. The project will directly provide for cleanup of at least 10,000 tones of these wastes, plus 1,000 tones of dioxin-rich fly ash, and will develop national capacity to identify, manage, and treat other such wastes in an environmentally sound manner in the future.

36. The project is a national priority project addressing an important Stockholm Convention requirement, which it does in a highly cost-effective manner. A novel PPP mechanism will be introduce to mobilize resources from both the public and private sectors and encourage innovation.

37. The cost to the GEF for treatment of obsolete POPs pesticides and associated wastes directly addressed by the project will be under US$1,000/ton, which is similar to treatment cost in the European Union and compares favorably to cost figures from other POPs waste treatment projects in China. Moreover, the implementation will avoid the 8.97 g TEQ PCDD/PCDF releases into the water and atmosphere through improved emissions control technology and directly destruct 30.67 g TEQ of dioxins. Given that GEF funds are leveraged at 1:3 ratio and considering the additional long-term capacity building and other benefits, which the project will provide, the project's cost effectiveness from a GEF perspective is even greater.

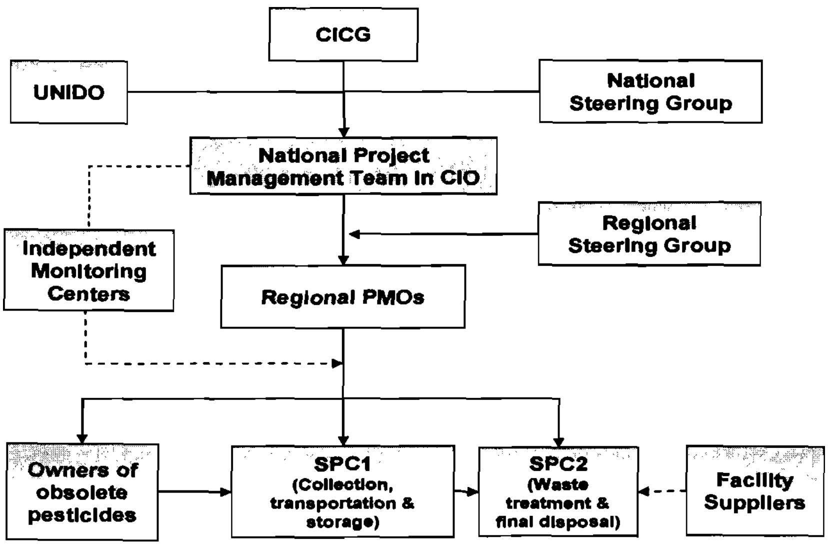
38. Given the high risk to public health that POPs contaminated waste entails, the project will also provide significant health benefits to vulnerable populations such as women and children, which international research shows are often exposed to POPs pesticide contaminants and contaminated containers at a higher incidence.

PART III: INSTITUTIONAL COORDINATION AND SUPPORT

A. PROJECT IMPLEMENTATION ARRANGEMENT:

39. UNIDO will be the GEF Implementing Agency (IA) for the project. A project focal point will be established within UNIDO to assist with project execution. This focal point will consist of dedicated core staff, supplemented by support from professional and support staff colleagues on a part-time as needed basis, including in particular senior staff engaged in the management and coordination of UNIDO POPs program. UNIDO will make these services available as part of its in-kind contribution to the project.

40. ESM of obsolete pesticide wastes and dioxin rich fly ash involves a wide spectrum of stakeholders both vertically and horizontally distributed throughout China's administrative framework. While the principal responsibilities will be undertaken by environmental sector stakeholders, a variety of stakeholders from other sectors will play an important role in the project. Annex 5 lists these stakeholders and describes their mandates, providing the administrative context under which these mandates will be translated into specific responsibilities. The project management structure is given in the graphic below.



41. **Convention Implementation Coordination Group (CICG).** China established the National NIP Development Leading Group in September 2003. This Group became the National Leading Group for Implementation of the POP Convention when China ratified the Convention on 13 August 2004, which was formally approved by State Council in April 2005 and renamed the National Technical Coordination Group (TCG) for Implementation of the Stockholm Convention, or Convention Implementation Coordination Group (CICG). The CICG will provide (i) review of significant policies related to POPs management and control, (ii) guidance and coordination for POPs management activities and Convention implementation. The CICG consists of the following 13 agencies:

    i) Ministry of Environmental Protection (MEP)
    ii) Ministry of Foreign Affairs (MOFA)
    iii) National Development and Reform Commission (NDRC)
    iv) Ministry of Finance (MOF), which is the GEF Focal Point in China.
    v) Ministry of Commerce (MOCom)
    vi) Ministry of Science and Technology (MOST)
    vii) Ministry of Agriculture (MOA)
    viii) Ministry of Public Health (MOH)
    ix) Ministry of Housing and Urban-Rural Development (MOHURD)
    x) General Administration of Customs (GAC)
    xi) State Electricity Regulatory Commission (SERC)
    xii) General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ)
    xiii) State Administration of Work Safety (SAWS)

42. **Convention Implementation Office (CIO).** The CIO is part of MEP and is responsible for coordinating the day-to-day management of the Stockholm Convention implementation in China. The CIO's responsibilities include: (i) provision of technical support for international negotiations and policy studies on the Stockholm Convention, (ii) provision of support for development and implementation of POPs-related policy and regulations, as well as coordination of key governmental stakeholders, (iii) mobilization of co-financing from bilateral, international, and national sources, (iv) collecting data and information, compiling reports, organizing training activities, and publishing information. The CIO will provide guidance to ensure the successful implementation of the project, including regular monitoring and enforcement inspections. As the CIO is not an independent legal entity, **Foreign Economic Cooperation Office (FECO)** will be the national executing agency (NEA) and will represent MEP and the CIO in the management and completion of contracts for project implementation.

43. **National, Provincial and Municipal Steering Groups.** The project will establish a national steering group by drawing upon resources from related ministries or commissions in charge of development and reform, environment, health, construction, and pricing to provide the project team with political guidance and inter-ministerial coordination support. To facilitate the extensive demonstration and replication activities at provincial and municipal levels, the National Steering Group will encourage and assist provincial and municipal governments in the establishment and operation of their own corresponding steering groups.

44. **National Project Management Team (NPMT)** will be composed of staff from MEP, NDRC, MOHURD and other relevant agencies. MEP will designate a coordinator/team leader. The Project Management Team will be responsible for the day-to-day management and execution of the project, and will oversee local project management offices. The NPMT's responsibilities will include (i) assignment and supervision of project activities; (ii) recruitment of national consultants; (iii) providing guidance to local PMOs; (iv) coordination with stakeholders, donors, the IA, relevant national agencies and the private sector; (v) preparation of terms of reference (TORs) for project activities, (vi) review of project progress reports submitted by the local PMOs, (vii) supervising project procurement and financial resources in accordance with UNIDO procedures, (viii) organizing and convening project coordination stakeholder meetings, and (ix) review of project outputs.

45. **Project Expert Team (PET).** The project will recruit an international **Chief Technical Advisor (CTA)**, a **National Technical Advisor (NTA)**, policy experts, waste management industry experts, chemists, monitoring and evaluation experts and other technical experts. These experts will form a Project Expert Team to assist the CIO and NPMT through the following activities:

    - Introduction of successful experiences gained from foreign countries;
    - Management and coordination of all project activities;
    - Provision of technical support for policy framework, institutional strengthening, demonstration activities, technology selection, market promotion, awareness raising and education, results and experience dissemination, project monitoring and evaluation, replication program development, and project management;
    - Periodic project implementation progress appraisal;

- Support for development of training materials; and
- Liaison for international symposia and field research.

46. **Regional Project Management Offices (PMOs)** will be responsible for coordination of project activities that transcend provincial boundaries. The project will involve a large number of obsolete pesticides owners, incinerator fly ash owners and dedicated treatment and disposal facilities operating across municipal and provincial lines. Extensive awareness promotion and training activities will be conducted in coordination with local officials. Implementation of new regulations will rely on local administrative agencies. Treatment of obsolete POPs pesticides and dioxin rich fly ash and disposal at provincial hazardous waste disposal centers will be regionally optimized to improve efficiencies, reduce costs, and reduce environmental risk. In addition there will be extensive demonstrations of BAT/BEP for integrated waste management that will cluster obsolete POPs pesticides, associated wastes, and incinerator fly ash generators and waste treatment and disposal facilities.

47. Regional PMOs will be composed of staff from relevant provincial governmental agencies. Their responsibilities will include (i) management of the provincial level activities; (ii) oversight of provincial and municipal implementation; (iii) dissemination of the experience emanating from demonstration sites; (iv) coordinating treatment activities with the mobile treatment facility and base stations; (v) coordinating transportation of waste materials over provincial lines; and (vi) collecting information and preparing progress reports. Their specific responsibilities will be defined by the NPMT supported by the PET after the inception workshop.

48. Private sector stakeholders and other potential participants will be actively recruited and integrated in the project as follows:
    - Waste owners will be provided with technical assistance and financial support on a cost-sharing basis to adopt ESM in obsolete pesticides management and to treat existing stocks of obsolete POPs pesticides and associated wastes;
    - Waste transporters and treatment and disposal facilities will be provided with technical assistance and capacity building support to ensure implementation of obsolete POPs pesticide waste management requirements, and will also be provided with targeted incentives to adopt ESM practices beyond current regulations;
    - Private sector contractors selected under the PPP program to provide facilities and services will form an integral part of the project;
    - End-users will be educated on proper pesticides management and risk minimization/avoidance, supported by new policies and programs (e.g. possible manufacturer/distributor take-back requirements) to encourage ESM practices.

PART IV: EXPLAIN THE ALIGNMENT OF PROJECT DESIGN WITH THE ORIGINAL PIF:

	PIF	CEO ENDORSEMENT
Global environmental benefits	The expected global environmental benefits to be delivered include the complete irreversible destruction and transformation of thousands tones of obsolete POPs pesticides and dioxin rich fly ash from waste incinerators in an environmentally sound and cost-effective manner.	**Same as PIF.** Moreover, the quantitative objective was clarified, such as: (1) safe disposal of a minimum of 10,000 tones of obsolete POPs pesticides and 1,000 tones of dioxin-rich fly ash; (2) avoided emissions of 8.97 g TEQ PCDD/PCDF releases into the water and atmosphere through improved emission control technology and direct destruction of 30.67 g TEQ of dioxins; and (3) innovative approaches providing a model for sustainable management of obsolete POPs pesticides and other POPs both in China and in other developing countries.
Co-financing	US$ 31,350,000 ($4,050,000 USD in cash and $27,420,000 in kind)	**Basically same as PIF.** Total co-financing fund is US$ 32,100,000 where US$ 11,130,000 is cash and 20,970,000 in kind. The share of co-finance in cash increased, which improved the operability and flexibility of the project.
GEF grant requested	US$ 9,959,000	**Basically same as PIF,** funds requested is slightly more (US$ 9,973,000)
Incremental reasoning	Without GEF support a large country like China would not be able to access the sustainable approaches for environmentally sound management and disposal of the large amounts of POPs stockpiles and other hazardous wastes and will continue to adopt unsustainable POPs waste management, treatment and disposal practices with possible negative impact on the global environment. With GEF support and technical assistance of UNIDO, China will be able to fully access new and innovative destruction technologies and therefore comply with disposal requirements set by the Stockholm Convention.	**Same as PIF.**

PART V: AGENCY(IES) CERTIFICATION

This request has been prepared in accordance with GEF policies and procedures and meets the GEF criteria for CEO Endorsement.	
Name & Signature *Mr. Dimitri Piskounov* *Managing Director* GEF Agency Coordinator	*Project Contact Person* *Mr. Mohamed Eisa* *Chief & Deputy to Director*
Date: 1 August 2008	Tel: +43 1 26026 4261 Email: M.eisa@unido.org

ANNEX A: PROJECT RESULTS FRAMEWORK

Project Strategy	Objectively verifiable indicators		
Goal	Continuously minimize and, where feasible, ultimately eliminate the releases of obsolete POPs pesticides and dioxin rich fly ash into the environment; assist China in implementing its obligations under the Stockholm Convention to protect the global environment and human health.		
Interventions	**Objectively Verifiable Indicators**	**Sources of Verification**	**Assumptions**
Objectives Environmentally sound management (ESM) and disposal of obsolete stockpile POPs pesticides, associated waste matrices and PCDD/PCDF rich incinerator fly-ash in fulfillment of China's commitments under the Stockholm Convention (SC) and National Strategy for Hazardous Waste.	➢ At least 10,000 tones POPs pesticides stockpile and associated wastes at targeted hot spots have been identified, processed, safely transported, and disposed of in an environmentally sound manner. ➢ At least 1,000 tones of incinerator fly ash produced in 1 target province collected and disposed in an environmentally friendly manner. ➢ Avoidance of release of 8.97 g TEQ dioxin from pesticide incineration and destruction of 30.67 g TEQ dioxin from fly ash; ➢ One stationary (capacity 10 tones/day) and one mobile unit (5 tones/day) will be constructed and installed for destruction of POPs pesticide wastes and dioxin rich fly ash on a national scale. ➢ Identification of potential PPP arrangements and feasibility study of private involvement in POPs destruction facilities ➢ Level of soil and underground water contamination with POPs reduced	➢ Texts of revised or new regulations, standards, and policies ➢ Bidding documents for purchase of technical services and equipment ➢ TORs for consulting services ➢ Service contracts ➢ Work plans ➢ Thematic study reports ➢ M&E reports	➢ Necessary provincial, local, and industry support is received ➢ Barriers can be successfully removed with effective interventions from this project ➢ POPs waste treatment will be an economically viable option ➢ The regulatory and policy framework established by the project will be maintained and adequately resourced after the project's completion

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions and Risks
Outcome 1: Strengthened legal and regulatory framework for environmentally sound management (ESM) and disposal of POPs waste			
Output 1.1 Technological and economic policies and regulations in place for promoting environmentally sustainable management and disposal of POPs wastes			
1.1.1 Develop and formulate technological and economic policies through inter-departmental coordination, public awareness raising, public hearings, and NGO outreach 1.1.2 Provide training on new technological and economic policies for managerial staff from provincial EPBs 1.1.3 Raise awareness of new technological and economic policies and enforcement mechanisms	➢ Technical and economic policies to promote ESM for disposal of POPs wastes, including but not limited to: – technical policy for construction and operation of disposal units to dispose POPs waste in a cost effective and environmental friendly way – licensing requirement for management and disposal of POPs pesticides and other POPs contaminated wastes – legal responsibility and financial mechanism for treatment of POPs waste by operating and non-operating enterprises – price considerations for POPs waste disposal – possible supplier take back requirements. ➢ New regulations to promote ESM, including but not limited to: – Administrative and regulatory requirements for POPs waste disposal and cost effective disposal options – Licensing requirements for mobile facilities for hazardous waste, including POPs waste disposal – development of technical specifications for mobile disposal facilities – development of monitoring guidelines for new technologies and mobile disposal facilities ➢ 4000 managerial and technical staff receiving ESM training ➢ Training materials developed ➢ Participation by 20 news media outlets and 100 communities	➢ Reports on regulations and policies developed, proposed, and adopted ➢ Regular project reports on training, coordination, outreach, and awareness-building activities ➢ Training minutes and reports ➢ News and articles in papers, TV programs, internet, and other media fora ➢ Community activity reports	➢ Government at national, provincial, and local levels, as appropriate, will endorse and adopt required policies and measures according to the project timeline

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
Output 1.2 Technical standards and guidelines developed for ESM of POPs waste			
1.2.1 Develop and formulate guidelines, standards, and specifications 1.2.2 Provide training on guidelines, standards and specifications for managerial staff from provincial EPBs 1.2.3 Develop standard operation procedures for analysis and monitoring	➢ Compilation of ESM guidelines for POPs waste management in line with requirements of Stockholm and Basel conventions; technological and operating guidelines for the following POPs treatment technologies: - Collection, storage, and transportation technologies - Destruction technologies including but not limited to: Incineration, Plasma Arc, Pyrolysis / gasifiers and chemical destruction technologies ➢ Risk assessment and emergency response guidelines for POPs waste disposal ➢ Technology certification standards for disposal of POPs wastes ➢ Audit manuals for the operation of disposal facilities formulated ➢ Supervision and Management Technological Specifications for cost effective options ➢ Monitoring specifications for POPs waste disposal and contaminated sites ➢ 500 specialized managerial and monitoring staff receiving training ➢ Training materials ➢ 2 operational program models for monitoring of POPs waste and contaminated sites	➢ Reports on standards, guidelines, and specifications developed, proposed, and adopted ➢ Training minutes and reports ➢ Operational program model documentation	➢ Government at national, provincial, and local levels, as appropriate, will endorse and adopt the required standards, guidelines and specifications according to the project timeline ➢ Key government agencies accept and promulgate new guidelines ➢ Key stakeholders can be effectively involved throughout the process
Outcome 2: Improved institutional capacity at all levels of POPs waste disposal management			
Output 2.1 Communication and coordination sustained between stakeholders in waste management and disposal			
2.1.1 Establish national, regional and local coordination framework for integrated POPs waste management	➢ National, regional and provincial POPs waste management committees established and in operation ➢ Number of recommendations/proposals related to POPs wastes ESM	➢ Meeting minutes ➢ Committee decisions, suggestions and recommendations ➢ Reports on proposals submitted and reviewed	➢ Coordination and cooperation can be achieved among stakeholders ➢ NGOs and enterprises are willing to actively participate

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
2.1.2 Periodically review stakeholder recommendations and action proposals related to POPs wastes ESM 2.1.3 Hold periodic fora for public and private stakeholders, NGOs, and the general public to promote good governance and increased effectiveness	➢ Local cross cutting managerial and operational coordination mechanism for integrated POPs waste management ➢ Potential conflicts of interest or disputes identified and resolved ➢ Number of NGOs and other stakeholders involved in process ➢ Stakeholder feedback and comments received	➢ Reports on resolution of conflicts and disputes ➢ Reports on stakeholder feedback and comments	
Output 2.2 Institutional capacity enhanced for POPs waste management at local level			
2.2.1 Enhance overall institutional capacity for program development 2.2.2 Adapt and implement national policy and regulatory framework at local level 2.2.3 Develop trial local-level responsibility system for obsolete POPs pesticide management and disposal 2.2.4 Develop and test pricing mechanisms for POPs waste disposal 2.2.5 Establish and implement reporting system to collect and analyze data on creation, transport, and treatment of POPs waste 2.2.6 Establish inspection and prosecution system for the discarded POPs wastes and contaminated sites	➢ Creation of trial responsibility assignment system for obsolete POPs pesticide management and disposal ➢ Pricing program for POPs waste disposal demonstrated ➢ POPs waste disposal data reporting system established ➢ Prosecution and inspection system for the discarded POPs waste and contaminated site established ➢ Increasing local input of personnel, finance and resources ➢ EIA guidelines adopted ➢ ESM inspection manuals developed	➢ New or revised local policies and regulations ➢ Report on local policy establishing responsibility of obsolete POPs pesticide management and disposal ➢ Report on waste disposal pricing ➢ Report of reporting system database creation and use ➢ Report on prosecution and inspection system ➢ Training workshop reports ➢ Training materials ➢ Guidance documents ➢ Manual text	➢ Key agencies attach sufficient importance and allocate sufficient resources to POPs waste management supervision

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
2.2.7 Promote widespread local participation through increasing local input of personnel and financial resources 2.2.8 Incorporate ESM principles, norms and requirements into current EIA guidelines 2.2.9 Prepare ESM inspection manuals, including: - Evaluation, registration and authorization of facility operating licenses for POPs waste treatment - Monitoring of POPs waste disposal facility operation 2.2.10 Provide training for local solid waste management center o implement ESM			
Output 2.3 Public awareness on POPs activities undertaken			
2.3.1 Develop TV and other mass media programs to disseminate knowledge of POPs 2.3.2 Publish articles or reports for public education in national and local newspapers. 2.3.3 Develop and produce brochures to raise awareness regarding health and safety protection from POPs pesticide wastes and dioxin rich fly ash	➢ 2 TV and/or other mass media programs to disseminate the knowledge of POPs ➢ 60 articles in national and/or local newspapers ➢ 10,000 brochures prepared to raise awareness of POPs waste related health and safety protection issues ➢ 4 hearings held ➢ At least 200 attendees at hearings ➢ Number of hotline calls/reports ➢ 3-5 hot line staffers10,000 brochures prepared to raise awareness of POPs waste related health and safety protection issues ➢ 4 hearings held with at least 200 attendees in each hearings	➢ Copies of videos and recordings ➢ Copies of newspaper articles published ➢ Copies of brochures ➢ Hearing report and participant list / summary ➢ Report on hotline activity	➢ TV programs effectively reach target population ➢ Newspaper articles effectively reach target population

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
2.3.4 Hold public hearings regarding POPs waste stockpile reporting, emergency response, and health and safety protection 2.3.5 Hotline established for POPs related health and safety issues	➢ Number of hotline calls/reports ➢ 3-5 hot line staffers		
Outcome 3: Environmentally sound disposal of targeted POPs pesticide waste and dioxin rich incinerator fly ash			
Output 3.1 Safe and effective collection, packaging, and transportation of POPs pesticide wastes for disposal adopted			
3.1.1 Identify location, type, status of POPs pesticide wastes and associated waste matrices at targeted hot spots 3.1.2 Develop operating manual for collection, packaging, and transportation of the POPs pesticide waste 3.1.3 Prepare detailed terms of reference and contracts for the provincial HWDCs according to expertise in the fields of waste management and occupational health and safety. 3.1.4 Provide training to staff from the provincial HWDCs concerning the collection, packaging and transportation of the POPs pesticide wastes	➢ Localization of POPs pesticide wastes and associated waste matrices at targeted hot spots ➢ Operation manual for the collection, packaging, and transportation of the POPs pesticides and associated waste matrices, including emergency response plan for obsolete POPs pesticide wastes ➢ Terms of reference and contract templates for the provincial HWDCs ➢ Number of trained staff from the provincial HWDCs ➢ Safe collection, packaging, and transportation of identified obsolete POPs pesticides ➢ 10,000 tones of pesticide wastes and associated waste matrices safely stored in designated storage facilities ➢ Inventory of pesticide wastes at storage sites created and maintained	➢ Report of waste localization and type for each hot spot targeted ➢ Training manual text ➢ Copies of TORs and contracts ➢ Implementation plan for collection, packaging, and transportation of POPs pesticide wastes ➢ Training materials and list of trainees ➢ Detailed implementation reports for collection, packaging, and transportation of obsolete POPs pesticides ➢ Storage implementation report ➢ Evaluation report	➢ Provincial HWDCs represent a sufficient business opportunity to attract contractual interest

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
3.1.5 Collect, package, and transport POPs pesticide waste from hot spots 3.1.6 Store POPs pesticide waste safely to prevent release of POPs contaminants to the environment			
Output 3.2 Assessment of technologies for POPs waste disposal carried out			
3.2.1 Detailed feasibility study for final disposal units based on the waste type, destruction efficiency, emissions, residues, energy/material requirements, portability, state of commercialization, and site selection 3.2.2 Preparation of detailed Terms of Reference for technology selection and Request for Proposal from vendors	➢ Feasibility study report of POPs destruction technologies and site selection ➢ Specifications of the stationary and mobile final disposal unit ➢ List of potential vendors for technology and equipment ➢ Terms of Reference ➢ Request for Proposal (RFP)	➢ Evaluation report for POPs destruction technologies ➢ Feasibility report ➢ TOR and RFP documents	➢ Contracts are commercially attractive to vendors
Output 3.3 Technology transfer promoted through PPP mechanisms			
3.3.1 Identify potential PPP arrangements for design, construction and operation of POPs waste treatment infrastructure 3.3.2 Promote cooperative relationship among technology vendors and facility designers, constructors, and operators to achieve cost-effective options	➢ Identification report for the potential PPP arrangements for POPs destruction infrastructures in China ➢ Workshop held to introduce technology transfer/ PPP concepts and promote dialogue between public and private sector groups regarding potential POPs PPP projects. ➢ Joint venture or comparable cooperative relationship established	➢ Proposal report on potential PPP arrangements for POPs waste treatment ➢ Workshop materials and report ➢ Joint venture certification ➢ Bidding documents	➢ Vendors and other parties are willing to cooperate

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
Output 3.4 Construction, certification, operation, and supervision of stationary and mobile treatment facilities arranged			
3.4.1 Environmental Impact Assessment (EIA) for one stationary and one mobile unit 3.4.2 Invite bids from potential vendors to transport POPs wastes and operate disposal facilities 3.4.3 Prepare disposal sites for deployment of selected technology, including construction of storage facility and commissioning of equipment 3.4.4 Installation of the stationary unit at the selected site and mobile unit at selected base stations Transportation of POPs waste to the POPs treatment locations in an environmentally sound manner 3.4.5 Final disposal of POPs pesticide wastes in an environmentally sound way 3.4.6 Monitoring during facility construction and operation 3.4.7 Establishment of equipment ownership arrangements	➢ Assessment of the environmental impact of the construction of stationary unit for POPs treatment ➢ Assessment of the environmental impact of installation and operation of mobile unit with four base stations ➢ Qualified vendors identified and contracted to transport POPs wastes and operate disposal facilities ➢ Site preparation for disposal facilities ➢ Storage facility construction and commissioning ➢ Stationary unit installed at selected site ➢ Mobile unit commissioned at four base stations ➢ 10,000 tones of pesticide wastes safely transported to designated stationary unit or mobile base stations ➢ 10,000 tones of pesticide wastes disposed of in an environmentally sound manner ➢ Equipment purchase, infrastructure construction, facility installation and operation ➢ Terms of Reference for post-project equipment ownership and operation ➢ Transfer of equipment title	➢ 5 EIA reports ➢ Contracts signed ➢ Progress report ➢ Monitoring reports ➢ Progress report ➢ Monitoring report ➢ Hazardous waste ➢ Transportation manifest ➢ Operation report ➢ Monitoring reports ➢ Terms of Reference ➢ Copies of signed contracts	➢ Contracts are commercially attractive to vendors Infrastructure and water/electric power supply at selected sites are suitable for construction of the stationary and mobile POPs treatment facilities

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
Output 3.5 Dioxin rich fly ash disposal implemented			
3.5.1 Target province selected for non-landfill pilot disposal of dioxin rich fly ash 3.5.2 Development of operating manual for non-landfill disposal of dioxin rich fly ash 3.5.3 Staff training for safe disposal of dioxin rich fly ash in the selected province 3.5.4 Implementation of pilot for safe disposal of dioxin rich fly ash by non-landfill options	➢ Report on target province selection ➢ Operating manual ➢ Number of staff trained in selected province ➢ Training materials developed ➢ Capacity created for disposal of at least 300 tones per year of dioxin rich fly ash safely by non-landfill technology	➢ Report on province selection ➢ Manual text ➢ Training materials ➢ List of trainees ➢ Disposal reports	
Output 3.6 Exploration of the feasibility to extend POPs waste disposal capacity to CFCs destruction undertaken			
3.6.1 Complete technical and policy review 3.6.2 Identify potential technical processes and arrangements for the extension of POPs waste disposal capacity to CFCs destruction 3.6.3 Treat of CFCs contaminants in POPs destruction unit to demonstrate feasibility of making facilities dual capable at little/no additional cost	➢ Evaluation of technical and economic feasibility to destroy CFCs in the POPs disposal facility ➢ Technical processes developed for destruction of CFCs in POPs disposal facilities ➢ Evaluation of economic feasibility to destroy CFCs in POPs disposal facility ➢ Amount of CFCs contaminants disposed in the pilot project	➢ Evaluation report ➢ Technical report	

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
Outcome 4: Qualitative environmental risk assessment (QERA) site prioritization			
Output 4.1 Inventory of contaminated sites prioritised			
4.1.1 Review existing national and international best practice guidelines for human health and ecological risk assessment 4.1.2 Develop a project-fit methodology, including QA/QC procedures for quantitative environmental risk assessment (QERA) 4.1.3 Train staff in provincial solid waste management centers 4.1.4 Carry out on-site surveys following removal activities, focusing on identification of exposure scenarios 4.1.5 Qualitatively predict POPs concentrations in identified exposure scenario and characterize risks by comparing target POPs risk factors 4.1.6 Analyze information needs for quantitative environmental risk assessment	➢ Report of international experience and applicability to QERA of POPs contaminated sites in China ➢ Copy of project-fit methodology for QERA ➢ Training agenda, course materials, trainer list, trainee list, list of qualification certificates ➢ Filled out questionnaires ➢ Report of qualitative description of exposures to POPs via environmental medias ➢ Prioritized site inventory ➢ Report of information needs for quantitative environmental risk assessment system	➢ Report of international experience and applicability to QERA of POPs contaminated sites in China ➢ Copy of project-fit methodology for QERA ➢ Training agenda, course materials, trainer list, trainee list, list of qualification certificates	Adequate data can be obtained to complete analyses
Output 4.2 Establishment and maintenance of an Internet-based information processing, display and dissemination system in place			
4.2.1 Design Internet-based system to process and display QERA results and facilitate modeling of environmental risks and remediation decision-making	➢ Number of data sets for internet-based system ➢ Bug reports ➢ Number of data entries	➢ Design report ➢ Specifications and TORs for system installation and testing ➢ System test report ➢ TOR for system operation and maintenance	

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
4.2.2 Purchase, install, and test system, maximizing use of existing hardware, software, and topographic data from the current POPs MIS 4.2.3 Input data and operate, maintain and update system 4.2.4 Conduct internet-based training and software dissemination	➢ Number of thematic maps derived by system ➢ Number of persons within CIO and local EPBs able to maintain the system	➢ System specifications and user instructions ➢ Web pages	
Outcome 5. Project management, monitoring and evaluation			
Output 5.1 Project management structure established			
5.1.1 Establish Project Steering Group 5.1.2 Establish the National Project Management Team under CIO 5.1.3 Recruit Chief Technical Advisor (CTA), a National Technical Advisor (NTA) and other project personnel 5.1.4 Establish local project management offices in target provinces 5.1.5 Hold management training classes for national and local project management staff	➢ Steering group established with representatives from national and local stakeholder agencies ➢ National Project Management Team established ➢ Necessary office equipment procured ➢ National project expert team established ➢ 3 local project management offices established ➢ Training workshops held on contractual management, project management tools, and basics of POPs waste management and disposal	➢ Report on establishment and operation of Steering group ➢ TORs for project management staff ➢ National and international expert recruitment notices and TORs ➢ TORs of the local project management offices ➢ Training materials	Project will be nationally executed by MEP/FECO.
Output 5.2 An M&E mechanism designed and implemented according to GEF M&E procedures			
5.2.1 Hold Inception Workshop 5.2.2 Prepare Inception Report	➢ Inception workshop held ➢ Detailed work plans prepared	➢ Inception workshop meeting minutes ➢ Inception report	

Interventions	Objectively Verifiable Indicators	Sources of Verification	Assumptions
5.2.3 Measure impact indicators on an annual basis 5.2.4 Prepare Annual Project Reports and Project Implementation Reviews 5.2.5 Hold annual tripartite review meetings 5.2.6 Hold biannual Steering group meetings 5.2.7 Carry out mid-term external evaluation 5.2.8 Carry out final external evaluation 5.2.9 Complete the Terminal Report 5.2.10 Carry out annual project financial audits 5.2.11 Carry out biannual visits to selected field sites 5.2.12 Establish a project management information system (MIS), including a project website to disseminate information to stakeholders	➢ Data and information against indicators input into the MIS ➢ Non-compliances identified and corrected ➢ Technical and political guidance from the Steering group ➢ Experience summarized and recommendations raised ➢ Problems identified and recommendations provided by field visits ➢ MIS established and made functional ➢ Project information, experience and lessons disseminated through website	➢ Annual Project Reports and Project Implementation Reviews ➢ Biannual Steering group meeting minutes ➢ Mid-term and terminal external evaluation reports ➢ Terminal Report ➢ Annual project financial audit reports ➢ Field inspection reports ➢ MIS development documentations and reports generated by properly retrieving data and information from the MIS ➢ Project website development and maintenance documentation	

ANNEX B: RESPONSES TO PROJECT REVIEWS (from GEF Secretariat and GEF Agencies, and Responses to Comments from Council at work program inclusion and the Convention Secretariat and STAP at PIF)

Responses to the Council Member comments

	Comments	UNIDO Responses
Comments from Japan		
1.	Standards, guidelines or tools which have been established internationally should be used.	The project team appreciated the comment. During the project implementation stage, relevant standards, guidelines or tools, which have been established internationally will be fully reviewed to avoid conflicts with them. Since a variety exits in environmental quality, management system, supervision and monitoring and engineering capacity in the world, a country has its own political, economic, technical, social, historical and cultural orientation, which resulted in adopting different environmental regulations, policies and guidelines. Therefore, the international standards and guidelines could not be directly used in a developing country like China but can be used as reference and be adapted to fit with the current situation and future development in the country.
2.	Co-finance should be confirmed (many cases are "N.A." in proposal)	All the co-finance will be confirmed during the PPG.
3.	Results of a survey of soil contamination should be reported to the Secretariat as referred in Article 15 of Stockholm Convention	MEP and the Ministry of Land and Resources jointly launched China's first soil pollution survey in July 2006. The program aims to assess soil quality across the country by analyzing the amount of heavy metals, pesticides residue and organic pollutants in the soil. The survey will focus on studying the physical-chemical properties of soil based on utilization and type of soil, analyzing soil quality changes, if any, over the last 20 years and updating and expanding the national soil sample database. It is not a survey for POPs contamination. POPs contamination sampling and analysis is only considered in few sites. In the FSP project stage, the result of soil pollution survey will be considered.
4.	How vast the land area of a country is not an appropriate "incremental reasoning" item.	The project team appreciated the comment. Although the final disposal process is not directly affected by the geographic parameters, a vast land area and dispersed distribution of obsolete POPs pesticides do set a big challenge for the ESM of these wastes in China. In principle, ESM is a whole process management concerning not only the final disposal but also the collection and transportation. The vast area and wide distribution will increase the cost of management without doubt, especially for the centralized waste treatment, which has been implemented in China.
Comments from Germany:		
1.	The first step towards the successful implementation of the NIP is a detailed nationwide inventory. This step is not yet included in the PIF.	A preliminary inventory of obsolete pesticide has been undertaken in the NIP preparation. In conjunction with the development of the proposed project, MEP initiated a survey program for production, consumption, stockpile, and disposal of POPs pesticides. The program updated the initial manufacturer and distributor surveys conducted during the preparation of the NIP where 13 POPs pesticides waste sites in 13 provinces were identified and included additional distributor sites identified during the above survey. To date, the program has identified 3840~4380 tones of obsolete pesticides in the production field, including about 2400~2800 tones of DDT, 60~70 tones of HCB/PCP-Na and 1380~1510 tones of chlordane and mirex. The detailed information could be found in Annex 8 of Project Document.

	Comments	UNIDO Responses
2.	Technology choice and – linked to this – cost-effectiveness are important issues that need further careful consideration.	The final technology choice will be implemented in the proposed FSP project based on a detailed feasibility study considering all comments from international/local consultants and stakeholders, especially for cost effectiveness.
3.	The PIF puts exclusive focus on non-combustion technologies for disposal. This seems to be premature, as the suitability of these technologies will only be known once the PPG phase is completed (see page 6, 3rd bullet).	The reason why non-combustion technology was given more concerns in the PIF is because of the high destruction efficiency for POPs waste and low PCDD/Fs emission reported. Through the technology investigation and consultation with international consultants, it has been noted that some non-combustion technologies are being commercially used and some are still in a premature stage. Technology choice will be implemented according to a detailed feasibility study in the FSP project.
4.	The detailed analysis of the cost-effectiveness under section G of the PIF should be considered as preliminary data, as there is at present too little experience with the costs of the suggested non-combustion technologies in China. Costs may not yet fully be known as the technologies need to be tested first (for example, the unit cost of disposal of € 128 for the technology suggested in the PIF). Thus, conclusions with regard to technology choice should be postponed. This type of analysis should be based on a more thorough comparison of the full range of technology options (including combustion and non-combustion technologies and temporary engineering containment) and thus come at a later stage.	Preliminary technology evaluation for POPs waste treatment has been undertaken during the preparatory phase of the project. The cost to the GEF for treatment of obsolete POPs pesticides and associated wastes directly addressed by the project will be under US$1,000/ton, which is similar to the treatment cost in the European Union and compares favorably to cost figures from other POPs waste treatment projects in China. Moreover, the implementation will avoid the 8.97 g TEQ PCDD/PCDF releases into the water and atmosphere through improved emissions control technology and directly destruct 30.67 g TEQ of dioxins in addition to destruction of 10,000 tones obsolete POPs pesticides. Given that GEF funds are leveraged at 1:3 ratio and considering the additional long-term capacity building and other benefits that the project will provide, the project's cost effectiveness from a GEF perspective is even greater. Conclusions with regard to the technology choice will be postponed to the FSP project phase, which will be based in accordance with a detailed feasibility study.
5.	The links to increasing the foundational chemical management should be strengthened. Although the project objective stated in the PIF does not explicitly exclude obsolete stocks of non-POPs chemicals, these stocks are not mentioned later on. Available evidence, e.g. from the bilateral Chinese-German disposal project suggests that POPs and non-POPs pesticides often can not easily be separated. It would make sense to develop ESM and disposal strategies for both categories in a synchronised manner.	Actually, ESM system under the project is based on the current framework of foundational chemical management and hazardous waste management, including the laws, regulations, policies, standards and institutional settings. In China, obsolete pesticide was classified as hazardous wastes (category "HW04" in the National Catalogue of Hazardous Wastes, including: wastes from the production, formulation and use of pesticides, biocides, herbicides, rodenticides and phytopharmaceuticals, including waste and herbicides) and managed under China's solid waste management system. The implementation of the project will benefit management and disposal of both POPs and non-POPs pesticide. Through discussions with the implementing agency of the bilateral Chinese-German disposal project and consultation with international experts, the difficulty of distinguishing POPs from mixture of POPs and non-POPs pesticide has been realized. Although the targeted pesticide waste are mainly composed of obsolete POPs pesticide and associated wastes, the establishment of ESM strategy for both POPs and non-POPs pesticide will be considered in the following aspects in the project:

	Comments	UNIDO Responses
		a) lifecycle management system based on ESM covers both categories, including collection, packaging, labeling, transportation and disposal. b) selection and utilization of wide-spectrum disposal technologies capable of destructing mixed pesticide. c) PPP mechanism established in the project will facilitate ESM of pesticide waste including new-POPs chemicals.
6.	The PIF is silent about the PCB issue.	The PCB issues will be mainly resolved by the GEF-funded PCB management and disposal demonstration project implemented by the World Bank.
7.	The PIF is too ambitious with regard to targets for disposal and cost-effectiveness. Based on the information in the PIF, the predisposal and disposal of 10,000 tones of obsolete pesticides would cost at least € 21.28 million (which is US $ 33.7 million at the current exchange rate). This adds up to more than 80 % of the available budget. However, most likely the disposal of 11,000 tones of POPs-contaminated fly ash will cost a comparable amount of financial resources, thus exceeding the available budget.	The objective in the Project document has been revised to dispose of 10,000 tones of obsolete pesticides and 1,000 tones of dioxin rich fly ash. In addition, a regional centralized strategy will be adopted in the proposed project, which could reduce the cost of collection, transportation and storage. It was estimated that the disposal fee is about US$1,300/t POPs waste including collection, transportation and destruction, and the cost could be covered by the project budget with the supports from GEF, Chinese government and private sectors.
8.	The table of indicative financing shows that about 62.6 % of the co-financing are in-kind contributions of the private sector. The document lacks information how these contributions will be mobilized. There is a high risks that these contributions will not materialize, as the PIF document mentions that the chain of custody has been lost and there are difficulties in applying legal and market mechanisms to enforce the contribution of waste holders and waste generators (section F, para 15). Thus, there seems to be little incentive for the private sector to contribute to the project. If private sector contributions fail to materialise, the project will have to be reshaped.	The project team accepted the comment. The share of co-financing was adjusted during the preparation of the project document in the PPG phase where 26% of the total co-financing funds are in-kind from the private sector. The project designed several incentive measures to promote the participation of private sectors by introducing PPP mechanism. About one forth of the disposal fee from GEF and the same from central government will be used as incentives to facilitate ESM of the obsolete POPs pesticides and associated wastes. At the same time, the monitoring and inspection mechanism for private sectors will also be strengthened and enforced during the actual implementation by introduction of the special management of POPs wastes as special hazardous waste in China. In addition, awareness raising and training program in this project will contribute to create a sound atmosphere for implementing the ESM system.

ANNEX C: CONSULTANTS TO BE HIRED FOR THE PROJECT

Position Titles	*$/ person week*	*Estimated person weeks*	*Tasks to be performed*
For Project Management			
Local			
NTA	1,200	108	Project management
International			
CTA	4,000	4.3	Project management
For Technical Assistance			
Local			
NTA	1,200	63	Assist CIO in overall technical support of other project activities, including institutional strengthening, policy development, replacement of redundant incineration equipment, technology assessment and selection, monitoring and evaluation, and inspection for enforcement and compliance;
Nat'l Policy expert	1,200	30	Assist CIO in policy and regulation support of other project activities
Nat'l Waste management expert	1,200	30	Assist CIO in waste management support of other project activities
Nat'l disposal expert	1,200	39	Assist CIO in POPs waste disposal support of other project activities
Nat'l PPP expert	1,200	30	Assist CIO in PPP arrangement support of other project activities
International			
CTA	4,000	40	Transfer international experience in the lifecycle management of obsolete POPs pesticides and other POPs pesticide waste (PPW) through NTA and other local experts to the managerial and technical staff of PPW owners and PPW disposal facilities. Provide technical advice for the reduction of PCDD/PCDFs emission from POPs pesticides disposal, including establishing training manual and program in technical matters as well as monitoring and evaluation;
Int'l Policy expert	4,000	20	Review laws, regulations, policies, and strategies in PCDD/PCDFs levels of obsolete POPs pesticides and PPW management in other countries and introduce international experiences in this area
Int'l Waste management expert	4,000	20	Review international experience of best technologies and practices in PPW management. Analyze the implications and applicability of international best practices and experience to China taking into account the actual technological and economic status in China.
Int'l disposal expert	4,000	27	Analyze the implications and applicability of international best practices and experience to China taking into account the actual technological and economic status in China
Int'l PPP expert	4,000	20	Review international practices and experience in commercialization of PPW disposal or alike businesses in other countries, focusing on the financing and investment aspects with specific reference to PPP arrangements

* Provide dollar rate per person weeks or months as applicable; ** Total person weeks/months needed to carry out the tasks.

ANNEX D: STATUS OF IMPLEMENTATION OF PROJECT PREPARATION ACTIVITIES AND THE USE OF FUNDS

A. EXPLAIN IF THE PPG OBJECTIVE HAS BEEN ACHIEVED THROUGH THE PPG ACTIVITIES UNDERTAKEN.

OBJECTIVE	ACTIVITIES
1. Identify targeted obsolete POPs pesticide waste and dioxins-rich fly ash	In conjunction with the development of the proposed project, MEP initiated a survey program for production, consumption, stockpiles and disposal of POPs pesticides. The survey program conducted during the preparation of the NIP updated initial manufacturer and distributor surveys identifying 13 POPs pesticide waste sites in 13 provinces. To date, the program has identified 3840~4380 tones of obsolete pesticides in the production field, including about 2400~2800 tones of DDT, 60~70 tones of HCB/PCP-Na and 1380~1510 tones of chlordane and mirex. Additional detailed survey work completed during the preparation of this project has focused on three target provinces (Chongqing, Jilin, and Jiangsu), identifying 29 additional sites in Chongqing. The 42 sites identified to date have 4219~5713 tones of obsolete pesticides (mostly DDT). Those sites were set as the direct target of this project.
2. Analyze the gap between ESM and current regulations and institutional capacities	The existing policy and legislations was reviewed and examined with regards to the general management and disposal of pesticide and fly ash wastes. The examination identified the following gaps: (1)Existing laws and regulations related to hazardous wastes are too general and their implementation is not supported by detailed regulations and technical guidelines; (2)Existing standards for hazardous waste pollution control are too broad and specific standards for POPs pesticides do not exist; (3)China's Nationwide Hazardous Waste Treatment Facility Construction Program has been developed without considering technology and knowledge transfer of ESM measures particularly in considering alternative technologies; (4) Lack of policy instruments promoting adoption of ESM in a market economy; (5) Historical pesticides manufacturing sites that stopped production long ago might not have production records based on which the size of contaminated areas and level of contamination can be estimated; (6)Weak institutional capacities for supervision and inspection of POPs waste owners' sites and dedicated disposal facilities in the areas of pollution monitoring, environmental impact assessment and operational risk assessment. All of these were set as the baseline for the project document and the barriers that would be addressed during the project implementation.
3. Study the feasibility or available innovative disposal technologies	The current situation of the POPs disposal technology was reviewed and investigated at site. At present, high-temperature incinerators and cement kiln co-processing (pilot scale) are the most common facilities used for treatment of hazardous wastes because there are few disposal alternatives with regulatory approval. Incinerators are generally designed to accept consistent waste feedstocks with low chlorine content in order to achieve the current national emission standard (0.5 ngTEQ/Nm3) and are not capable of meeting ESM requirements. Moreover, limited research and pilot demonstration have been undertaken in the application of plasma technology to treat POPs in China for disposal of PCB by-products and residues and fly ash treatment in some provinces, achieving PCDD/PCDF emissions levels of 0.02 ngTEQ/Nm^3. The above has been provided as baseline for preliminary feasibility to assess technical suitability through the full life cycle of the project.
4. Identify the potential PPP mode for the project.	The national and international experiences of PPP were reviewed. The incentives and legislative support for the PPP mechanism was proposed: (1) Introduce fee-based system for disposal of obsolete POPs pesticides and pesticide wastes; (2) Implement shared savings bonuses to SPCs for successful implementation of new, cost-effective approaches; (3) Subsidize capital investment costs of introducing environmentally sound disposal technologies; and (4) Introduce tax incentives for new facilities, technologies, and jobs in the hazardous waste treatment industry. Also the PPP approach was preliminarily designed for this project. The SPC will be responsible to the procuring government agency for meeting contractual targets and other requirements, and will of course be required to follow relevant environmental protection and other regulations. Beyond that, the SPC will have a high degree of independence in managing its internal operations and providing services. In return, the SPC will receive contractual payments and/or revenue sharing.

B. DESCRIBE FINDINGS THAT MIGHT AFFECT THE PROJECT DESIGN OR ANY CONCERNS ON PROJECT IMPLEMENTATION, IF ANY:

N/A

C. PROVIDE DETAILED FUNDING AMOUNT OF THE PPG ACTIVITIES AND THEIR IMPLEMENTATION STATUS IN THE TABLE BELOW:

Project Preparation Activities Approved	*Implementation Status*	*GEF Amount ($)*				*Co-financing ($)*
		Amount Approved	*Amount Spent Todate*	*Amount Committed*	*Uncommitted Amount**	
Output 1: Define nature, magnitude and geographic dispersion of stockpiled POPs pesticide waste						
1.1 Carry out a survey by means of site visit where obsolete POPs pesticide are stored, desk studies in association with counterparts at local administration level, sampling and analysis of some source and ecosystem receptors for obtaining inventory data on nature, type, package description, site description magnitude, and geographic dispersion of stockpiled POPs pesticide waste.	- A meeting with experts of the Chinese Research Academy of Environmental Sciences (CRAES) engaged to clarify the dispersion information of POPs obsolete in circulation field was held on 12 May 2008. - A survey has been undertaken by (CRAES), report is available. Activities completed.	30,000	30,000	0	0	100,000
Output 2: Define nature and magnitude of dioxins rich fly ash to be considered for disposal.						
2.1 Investigate current status of management of dioxins rich ash generated in incineration plants in China; Assess the current practice for dioxins rich ash management; Propose the corresponding requirement for management and disposal of such typical POPs waste. 2.2 Carry out the survey on the nature and magnitude of dioxins rich ash which are generated in typical incinerator (stoke-furnace, fluidized bed, rotary kiln) through field investigation; characterize the physical-chemical features through sampling and lab analysis, which shall be set as the context for the disposal technologies in this project.	- An assessment report has been carried out by Shenyang Environmental Science Academy (SESA). - All the activities have been carried out by a survey report on the nature and magnitude of dioxins rich ash in China by SESA.	26,000	26,000	0	0	40,000

Output 3: Contextual analysis of QERA application to the proposed hot spots of the project						
3.1 Contextual analysis of QERA application to the project, identify and assess the contextual parameters potentially including the source waste, potential pathways, vulnerable receptors, elements of geology and hydrology.The process will be carried out by the field visits to a number of sites. 3.2 Propose the specific methodology of QERA based on the report.	• Analysis of QERA application to the project have been carried out by SESA • Consultation meeting and scenario study based on information of Output 1 carried out by SESA. Activities completed	20,000	20,000	0	0	50,000
Output 4: ESM disposal policy and regulation gap analysis possible bridging actions						
4.1 Carry out analysis and assess POPs waste management policies, laws, regulations and standards regarding to POPs wastes identification, labeling, package, handling, temporary storage, transportation and disposal; propose corresponding plan in regarding to the weakness existed in current legislation framework for POPs waste management and the requirement of Environmental sound management. 4.2 Review the current practice and situation of the complete lifecycle for obsolete POPs pesticide management in China, covering identification, handling, collection, packaging, labeling, transportation, treatment; evaluate the weaknesses existing in current POPs pesticide management system. 4.3 Feasibility study on special management framework in accordance with the requirement of environmental sound management designed to the obsolete POPs pesticide management for this project shall be conducted, which consist of special requirement for disposal.	- An assessment report has been carried out by CRAES. The international experience of ESM disposal policy and regulation were reviewed by international experts. - Seminars were organized in Beijing on 15-16 May 2008 for these activities. - Feasibility study of special management for obsolete POPs pesticide undertaken by CRAES. Activities for this component are completed.	30,000	30,000	0	0	60,000

4.4 Feasibility study on special management framework in accordance with the requirement of Environmental sound management designed to the obsolete POPs pesticide management for this project shall be conducted, which consist of special requirement for disposal technologies and life-cycle management						
Output 5: National economic and market analysis for the management and disposal operations						
5.1 Study the international marketing experience for POPs waste management. Fee-based market and pricing mechanism for life-cycle management of the obsolete POPs pesticide shall be proposed. 5.2 Investigate the potential sources of co-finance for this project, including national treasure bond, pollution fee, pollution producer, capital market, national or local revenue, etc.	• A feasibility study of fee-based market and pricing mechanism for life-cycle management of the obsolete POPs pesticide has been carried out by CRAES	30,000	30,000	0	0	60,000
Output 6: Stakeholder and public-private partnerships (PPP) analysis and dynamics of local joint venture trends..						
6.1 Investigate current available practice of PPPs which cover all types of collaboration across the interface between the public and private sectors to deliver policies, services and infrastructure. Assess the candidate PPPs mechanism based on this project. 6.2 Feasibility study on stakeholder and public-private partnership which will consist of establishing the stakeholders at national and regional level including the potential for public-private partnerships in the implementation phase of the project.	• Investigation and assessment report carried out by EnviSolve Consulting Co. • Feasibility study of PPP mechanism based on the project drafted by Envisolve Consulting Co. • A seminar on PPP mechanism for public facilities attended by UNIDO experts and participants from a number of hazardous waste management centers was organized on 19 May 2008.	20,000	20,000	0	0	50,000
Output 7: Identify existing and potential institutional implementation structures						
7.1 Identifies and defines the organizational framework and related institutions in public and private sector	• A meeting with related public and private institutions including MEP, local EPBs, Hazardous Waste Management Centre (HWMC), PPW owners,	20,000	20,000	0	0	60,000

7.2 Analysis on the needs of resource allocation and capacity building based on the project management structure, the corresponding public and private institutions and field operation structure whether at national, provincial or municipal level.	disposal technology vendor and etc. was organized in Beijing, May 23-24 to discuss the thematic issues. • Organizational framework for the project was proposed.					
Output 8: Disposal technologies feasibility and innovation study						
8.1 Investigate the technical and economical features of commercialized disposal technologies for POPs pesticide domestic and abroad, the focal points including technology applicability and reliability, pretreatment requirement, destruction efficiency and destruction and removal efficiency (DE/DRE), disposal of by-products, disposal capacity of off gas treatment, resources needed, cost-effectiveness (capital investment estimation and operational costs). 8.2 Propose a feasibility technology analysis for obsolete POPs pesticide disposal based on the requirement of the project. 8.3 Field investigation on some candidate disposal technologies for hazardous waste treatment in China.	• The part for disposal technologies focusing on POPs pesticide was elaborated in the subcontract undertaken by CRAES. • The part related to assessment of disposal technologies for POPs waste was undertaken by SESA. • A feasibility study to identify appropriate disposal technologies for POPs pesticides was carried out by SESA. • A 4-day visit to disposal facility premises in Sichuan and Anhui was organized in May 2008 to learn the current status of domestic disposal technologies for POPs waste treatment	37,000	37,000	0	0	40,000
Output 9: Determination of linkages with on-going national hazardous waste program						
9.1 Feasibility study of incorporation of this project to on-going National Hazardous and Medical Waste Programme (NHMWP) shall be conducted. Examine how policies and resources in NHMWP can be harnessed to this project. The linkage area will be identified and highlighted.	• All activities have been carried out by CRAES through linkage analysis of this project to on-going NHMWP.	18,000	18,000	0	0	40,000

Output 10: Options of incremental cost analysis and mobilization of co-financing						
10.1 Determine the environmental problem, threat or barriers and the "business as usual" scenario 10.2 Identify the global environmental benefit (GEB) and fit with GEF strategic programs and priorities linked to the GEF focal area. 10.3 Provide incremental cost analysis and GEF role. 10.4 Negotiate the needs of co-financing with all stakeholders of the project.	• A assessment report has been carried out by Research Center for Eco-Environmental Sciences, Chinese Academy of sciences(RCEES-CAS) • The meeting with related public and private institutions including MEP, local EPBs, HWMC, PPW owners, disposal technology vendors, etc. was organized in Beijing from 23-24 May 2008 to discuss thematic issues.	10,000	10,000	0	0	45,000
Total		**231,000**	**231,000**	**0**	**0**	**545,000**

* Uncommitted amount should be returned to the GEF Trust Fund. Please indicate expected date of refund transaction to Trustee.

Annex 3

A Chronology of Main Activities

13th-14th Oct.,2008	The 1st PPG Coordination Meeting under Environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes in China
30th Oct.2008	Completeness of Zero Draft of Project Document and Request for CEO endorsement
31th Oct.,2008	The 2nd PPG Coordination Meeting
11th Nov.,2008	The first meeting for the response to the remark and comment on Project Document
13th Nov.,2008	The second meeting for the response to the remark and comment on Project Document
21st Nov.,2008	Reply to the remark and comment on Project Document Revised PD(Request for CEO endorsement)
10th-15th Dec.2008	Completeness of the three subcontractors' deliverables
18th-19th Dec.2008	Workshop for the project in mid-term
5th Jan.2009	Annual meeting for project summarization
21st Jan.,2009	Meeting for project's progress and implementation plan
16th,Feb.,2009	Questionnaire survey to the former POPs pesticide manufacturer
20th ,Feb.,2009	Final PD(Request for CEO endorsement)
27th March,2009	Workshop on Environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes in China
30th April,2009	PD(Request for CEO-endorsement) approved by GEF-CEO

Annex 4 Minutes

The 1st PPG Coordination Meeting under Environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes in China

The POPs Convention Implementation Office(CIO) of Ministry of Environmental Protection(MEP) Compliance (hereinafter referred to as CIO) held the 1st PPG Coordination Meeting under the project of Environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes in China for technological exchanges and project co-ordination on October 13-14, 2008. Deputy Director Ding Qiong, deputy director Lu Chenggang and senior project official Sun Yangzhao from CIO, dispute director PENG from the United Nations Industrial Development Organization (UNIDO), experts and scholars from Research Center for Eco-Environmental Sciences of Chinese Academy of Sciences(RCEES), Institute of High Energy Physics of Chinese Research Academy of Sciences(IHEP), Chinese Research Academy of Environmental Sciences(CRAES), Shenyang Research Academy of Environmental Sciences, Envsolv Co. Ltd, and other research institutions and companies, attended this meeting. New Zealand's Environmental Decontamination Ltd (hereinafter referred to as EDL) was invited to make technical exchanges and introduce their machinery to deal with chemical contamination of organic pollutants, as well as actual treatment cases. The minutes of the meeting are as follow:

1. Discussion about the project

To promote the application of full sized project smoothly, CIO launched the "disposal technology and risk assessment", "Inventory and policy" and "public-private partnership mechanism" activities. The aims is to investigate China's pesticide POPs and dioxin-rich fly inventory, study the disposal technology and environmental risks, and analyze policies and regulations of the existing standards and mechanisms for public-private partnership, to ensure the application, approval and implantation of NON-Com project.

The sub-contractors in charge of all research activities introduced the relationship between national implementation of plans and project activities, methodology and the progress of the research activities, as well as some of the results achieved at present.

(1) Disposal technology and risk assessment study

The objective of the project is to complete technical feasibility study on the disposal of abandoned pesticide POPs based on the requirements of POPs Convention Implementation of China, investigation, extensive research and evaluation of domestic and foreign advanced POPs management and technical status quo, as well as the characterization of waste incineration fly ash and risk assessment studies for contaminated sites, in order to provide technical support for PPG phase of the project.

According to the TOR of this sub-contract, actvities will be carried out as follows:

- Survey the technical and economic characteristics of domestic and industrial waste and POPs pesticides disposal technologies, focusing on practicality and reliability of the technology, pre-requirements, destruction efficiency and destruction removal efficiency, by-products of disposal, the amount of disposal capital needs and cost-effectiveness; the proposal for disposal technology of obsolete pesticides in full within the framework of the full sized project.

- Investigate the hazardous waste in China (including medical waste), study and evaluate fly ash management situation, develop fly ash inventory methodology, establish our initial inventory of fly ash; study the characteristics of fly ash, carry out fly ash identification and analysis according to its amount and features, then make proposals for the full project in the framework of the full sized project.

- Carry out a study for the category of domestic waste pesticides and POPs contaminated sites and analysis of the characteristics, develop methods of risk assessment models for abandoned pesticide and POPs contaminated sites assessment, then make recommendations for risk assessment in the framework of the full sized project.

- Carry out other work with the full implementation of the project to such as the selection criteria of dispose unit owners and the implementation of the project budget, and so on.

(2) Public-private partnership mechanism

In order to support the completion of the national task of NIP and the international community's commitment, the purposes of this study is to actively explore mechanisms for public-private partnership (PPP) in the safe disposal of POPs, to achieve the best effect of final disposal of POPs, reduce its financial burden on the disposal of POPs and private corporate profits to improve the environment.

Study the PPP model of China's urban sewage and hazardous waste, compare the successful PPP use experience at home and abroad for hazardous waste and sewage treatment, to identify the most suitable pattern for the disposal of POPs. The establishment of one or more national special companies, cooperation with the provinces and regions of hazardous waste facilities in co-operation on the storage of POPs, environmentally sound waste disposal, cost and risk sharing and revenue sharing.

During the research, the application of basic theory, PPP public-private partnership concept and model as well as the advantages and benefits for environmentally sound management and disposal system of POPs will be discussed in the sum of both domestic and foreign successful experiences Based on the strengthening of pollutants POPs environmentally sound management and disposal of public-private system applications.

(3) Inventory survey and policy research projects

Construction of the research activities should be conducive to the smooth implementation of the project management framework and promote our long-term risk of POPs waste management system as the goal. As for POPs, these kinds of hazardous waste belonging to the environment and a great threat to human health of hazardous waste according to their composition and properties. And the operation license should be issued by the administrative department in charge of Environmental Protection of State Council. However, the management is not clear, based on the need to resolve this problem. The project will rely on the private sector, as well as planning and building a 1-2 regional POPs waste disposal company. In addition, the organization will be national unity and building a mobile POPs waste disposal facilities for dealing with trans-regional POPs hazardous waste.

Policies and regulations should promote the hazardous waste pollution prevention technology policy, with regard to POPs pesticides, in order to promote reunification of the waste disposal notice (The notice should regulated clearly the disposed of responsibility, the implementation of principal operating license, preferential policies for implementation of the model, the progress of arrangements for the disposal fees, incentives, etc.), other technical management requirements and operation implementation details of the mobile disposal facility license management, as well as details of disposal charge for the implementation of the POPs hazardous waste, economic policy revision. From the national conditions of China, to establish a standardized technology management system, such as R & D system, technology assessment system, supervision and management system, monitoring / testing management system, technical training system, and push forward all-round hazardous waste POPs in the field of economic operation mechanism. And promote the whole process of technology management, technology and management to promote the organic integration.

In the standard, it should propose general engineering guideline for hazardous waste treatment and disposal, technical specifications for POPs waste collection, storage, transportation, specifications of the plasma concentration of hazardous waste disposal, specifications of the mobile hazardous waste disposal, technology Standard of plasma hazardous waste disposal facility, operation supervision and management of mobile hazardous waste disposal facility, supervision and management of technical specifications, POPs waste disposal risk assessment and emergency guidelines, assessment of the operation of disposal facilities and guidance, and monitoring of POPs waste disposal and contaminated sites, and other technical specifications.

Technical countermeasures will be carry out including: technical assessment of the POPs waste disposal, proposal of POPs pesticides as well as the typical waste incineration fly ash waste disposal technology, risk assessment of contaminated sites, assessment of the technical framework, development of contaminated sites risk assessment techniques to solve the disposal technologies, application of the disposal cost, waste issues after the disposal, management and environmental protection of contaminated sites to solve the problem.

These objectives are current core content of the project, but in the design of the project, which will be adjusted as for the understanding of POPs pesticides and waste incineration, waste management and disposal of fly ash. Technology selection will be changed, and then in the design of the management system will be adjusted.

2. Information exchange for the disposal technology

EDL is a New Zealand high-tech company that work in both technology research and pollution control. Its research and engineering to achieve an example of the mechanical application of chemical disposal technologies can effectively deal with POPs, as well as other types of organic chemicals contaminated soil. The technology has been used in the United States, Japan, Hong Kong has been the practical application of, and access to good effect. Participants on behalf of the company introduced the principle of technology, engineering instance, disposal object, the disposal capacity of EDL's. Co-operation opportunities in the future in these areas was discussed in-depth.

(1) brief of the chemical mechanical disposal technology

In recent years, this technology is based on the dechlorination chemical mechanical method developed from a technical degradation of organic chlorine. Germany and Japan to the development of a number of companies represented by the technology developed by leaps and bounds, and in Australia, Germany, Norway, Japan, New Zealand set up a semi-industrial or commercial-scale facilities on-site in recent years. Chemical mechanical milling dehalogenation (MCD) through the milling machine, to achieve dechlorination of the halogen-containing organic compounds. When hydrogen, alkali metal or alkaline dechlorination agent is in a state of excitation, the organic halogen react with reducers in a dehalogenation reaction by reduction method, then organic into inorganic halogen halogen, in order to eliminate carbon - halogen bond toxicity.

Pretreatment:

No need for special treatment, but the higher the moisture content should be dealt with dehydration before drying so that moisture content of less than 2%. organic halogen content should be determined for dealing target , adding an appropriate proportion of dehalogenation agent and hydrogen donor according to the content and pre-mixed evenly.

Harmful by-products:

No need for auxiliary heating process in this technology. The main by-products are: organic body, salt brine, such as carbide. This technology does not exhaust flue gas in the process. Cooling water will be cycled and reused. The gas within milling tank will pass through activated carbon filter to deal with post-discharge. Because of the size of particles after about 0.1μm, fine particles of gas through the collection bag filter.

The control system:

By regulating the speed of rotation of the ball mill public or to control the frequency response rate.

Table 1 energy consumption for waste treatment

Parameters	Unit	EDL on sit technology for DDT contaminated soil
Electricity	Kwh/T	75
Capacity	T/h	15
Area	M^2	30
Assernbly, on-site installation	Day	21

3. This meeting discussed and reached consensus as follows:

1). Inventory of POPs pesticides Investigation and Policy Research implemented by CRAES is basis of non-com project, a clear inventory of POPs pesticides waste and the exact amount of storage is a prerequisite to identify and select technology in the demonstration region. CRAES should speed up the progress to protect the smooth implementation of the project;

2) Activities of the three sub-contract cross each other, the implementation of the units is necessary to strengthen communication and comments asking, to ensure that research play its due role in the non-com project implementation;

3) In view of this discussion will be achieved good results, the project implementation unit will be based on the progress of the project from time to time held seminars to introduce the progress of the project, sharing information, to listen to the views and suggestions to ensure the smooth implementation of the non-com project.

The 2nd PPG Coordination Meeting under Environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes in China

The 2nd PPG coordination meeting under environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes in China was organized by CIO and held in Chinese Research Academy of Environmental Sciences(CRAES) on Oct 31, 2008. Experts and scholars from Research Center for Eco-Environmental Sciences of Chinese Academy of Sciences(RCEES), Institute of High Energy Physics of Chinese Academy of Sciences(IHEP), Chinese Research Academy of Environmental Sciences(CRAES), Envsolv Environmental Co. Ltd, and other research institutions and *companies, attended this meeting.*

Representatives of these institutes reported on the progress of their projects as well as the next stage of work, and further highlighted the sub-output targets, the minutes are as follows:

1. Inventory investigations, to speed up the file work and verification for existing obsolete pesticide manufacturers, each file should contain: the status and operation of business background, address, responsible person, contact information, the situation of storage, contact information of local environmental protection departments.

2. In the mid to late November, a mission will be organized to the abandoned pesticide sites, including: Jiangsu Province (Changqing, Jintan, Taicang), Tianjin (Bohai, Dagu), Hebei (Xingtai), and other large stock of the companies for on-site investigation, risk assessment for the site and access to information; to makee contact with the local authorities for access to local management support.

3. In the policy research: focus on the needs analysis of implementation of the project's management and deficiencies of regulations and policy, Implement research for the *introduction of "national unity POPs waste disposal management notice"*, "Mobile disposal facility license " and "plasma disposal facility operation permit ", and provide a theoretical basis.

4. Disposal technology in research: based on the distribution of abandoned pesticide, completion of technology selection criteria and contact potential suppliers for

the plasma, cement kilns, high-temperature incineration, chemical treatment (mechanical chemical, sodium reduction). A mission will be organized to Huaxin Cement Plant, which has a pilot project for 100 tons of pesticides disposal.

5. Public-private research mechanism: Chongqing can be selected as model for the implementation of regional projects, implementation of public-private model for the project can be designed.

6. The next PPG co-oration meeting was plan to be held in Institute of High Energy, Chinese Academy of Sciences.

Annex: List of participants

No.	Name	Organization
1.	Yin Guoliang	Convention Implementation Office, Ministry of Environmental Protection
2.	Peng Zhen	Convention Implementation Office, Ministry of Environmental Protection
3.	Cai Mulin	Chinese Research Academy of Environmental Sciences
4.	Chen Yang	Institute of High Energy Physics, Chinese Academy of Sciences
5.	Xu Diandou	Institute of High Energy Physics, Chinese Academy of Sciences
6.	Zheng Hailiang	Institute of High Energy Physics of Chinese, Chinese Academy of Sciences
7.	Zhu Jianxin	Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences
8.	Jiang Feng	Envsolv Environmental Co. Ltd

The 3rd PPG Coordination Meeting under
Environmentally sound management and disposal of obsolete POPs pesticides and other POPs wastes in China

Topic: Discussion on the response of GEFSCE comments on PAD

Time: Nov. 13, 2008

Participants: Peng Zhengyou, Ding Qiong, Zhu Jianxin, Chen Yang, Jiang Feng and Peng Zhen

Meeting room: 3015 Tenda

Minutes:

1. Review the all the response items prepared by Dr. Zhu and finalize the comment.

2. Dr. Zhu should revise the PD related.

3. Dr. Chen should revise the Annex 2, for the technology introduction, adding some contents about the Chinese situation about obsolete pesticides and disposal technologies

4. Mr. Jiang should do some language polishing for the response.

Annex: Response for the GEFSEC

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
A. Eligibility		
1. Is the Participating Country eligible? China has ratified the Stockholm Convention.		
2. Has the operational focal point endorsed the project? Yes		
3. Which GEF Strategic Objective/Program does the project fit into?		

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
SP2 on investments for NIP implementation (70%) and SP3 on demonstration of innovative technologies and good practices (30%)	SP1 CB 15% SP2 Impl SP3 Demo 25%	

4. Does the Agency have a comparative advantage for the project?

Yes when it comes to the demonstration aspect of technologies for POPs destruction. Less so when one looks at mainstreaming in the overall hazardous waste management strategy of the country. Nevertheless the GoC has made it clear that it wishes to work with UNIDO in this endeavour. Moreover the logic of this intervention which is to influence China's Program for Disposal of Hazardous Waste is similar to the one followed in the hospital waste management project - also implemented by UNIDO.

B. Resource Availability

5. Is the proposed GEF Grant (including the Agency fee) within the resources available for (if appropriate):

-The RAF allocation?

NA

-The focal areas?

The project as costed is still expensive with

regards the overall POPs envelop for GEF-4 and the fact that a project for China has already been approved in 2008.

Feb 20 2008. Revised budget has been reduced to $10m

-Strategic objectives?

NA

-Strategic Program

NA

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*

C. Project Design

6. Will the project deliver tangible global environment benefits?

In principle yes, through reducing environmental releases of POPs, including in securing and disposing of stocks of obsolete pesticides and other POPs wastes. I would like to see explicitly an estimate at this stage of the anticipated amount of pesticides disposed of, and reduction in TEQs. 20 Feb 2008. Revised document indicates that 10,000 tons are targeted for destruction.	Not Applicable at CEO Endorsement (FSP)/Approval (MSP)	

7. Is the global environmental benefit measurable?

Not Applicable at PIF/Work Program Inclusion	Yes. Tracking the amounts of POPs pesticides disposed of is relatively straighforward.	

8. Is the project design sound, its framework consistent sufficiently clear (in particular for the outputs)?

In general yes, but in the details I have some queries and requests for clarification. The intent to destroy the fly-ash from the incineration in particular of medical waste is intriguing. This is not common practice. Please elaborate on the evidence that these are large sources of dioxins. Elsewhere such fly-ash is typically landfilled. Why is this not acceptable in the China context? The concept of a "ppp" needs to be elaborated upon in a convincing manner, including by demonstrating that there is indeed interest in the private sector for such a partnership. Output 2.1 refers to "communication between project organiser and competent authorities for POPs disposal". Unclear what is meant. Between CIO and local authorities or	Sustainability will have to be addressed as a major element of the final proposal.	The sustainability and replicability of the project was illustrated in part C.8 Risks, Sustainability and Replicability of the PD from the policy making, institutional capacity building, and technological and engineering capacity maintenance. And the sustainability was specially clarified in the following aspects: • The continuously increasing demands for disposal of high chlorine containing and toxic pesticide waste will create a broad waste market for the facilities constructed in this project. China has a big pesticide industry for its agriculture development and a large amount of pesticide wastes are produced each year in the pesticide production and consumption. The treatment of high toxic pesticide wastes is a serious and unresolved problem, especially for the organochlorine and high toxic pesticides, such as: heptachlor epoxide, endosulfan, endosulfan sulfate and HCH, although they are still not classified as POPs. The facilities constructed in this project will extend their specially advantages in the above

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
EMBs as appropriate? Comp 3 is ok in general but the wording needs improving to convey component title / output / outcome. Comp 4 looks particularly "expensive". How much POPs waste will be addressed? Comp 6. I don't understand what activities are behind the stated outputs. In particular "continuous identification and disposal of POPs stockpiles"? Para A1. The NIP was a $10m effort. I'm surprised that we only have "a limited audit" to assess the quantity and quality of POPs pesticides waste. A2. Surely we will have to find other ways to deal with the "2million tons" contaminated soils than to dispose of them as concentrated POPs waste. The statement as drafted is perplexing. A4. See comment above on fly-ash. D12. Careful about statement on CFC destruction under the MP framework as this is a highly debated issue in that forum. G19. The difference of cost in an export option is obviously shipping cost which is fairly high, but otherwise I don't understand how the "logistic challenge of travel over vast distances from remote locations in China" is any different from the option proposed here - one still has to (re)package etc. and bring the waste from a remote location to wherever the destruction facility sits. G20. Does "cement kiln co-disposal" really "fall outside the SC standards"? I don't understand the 6000 tons / 18,000 tons distinction.		area. Also, the increasing amount of dioxin containing fly ash will be another direct waste source to ensure the continuous operation of the facilities in the future. • In accordance with the latest promulgated standard for pollution control on the landfill site in China, the waste with content of Dioxins>3 ng-TEQ/g is prohibited to landfill. So there is a growing market for disposal of high dioxin content waste such as rich fly ash which cannot be treated by landfill. In addition, landfill of dioxin rich waste is a intermediate way, which cannot make the waste destroyed or irreversibly transformed. • Market-based mechanism established by this project will have the polluters and beneficiaries pay to internalize the incremental cost. Legal responsibility of POPs owners and price regulation for POPs waste treatment will be enacted and implemented in and after the project. The disposal fee from the newer pesticide waste producers will cover the cost of facility operators. • The project will help to mainstream the disposal of POPs wastes into implementation of national programs that will be supported by national governmental funding sources. the project could also have a close linkage to the current government study eventually aimed at developing a program for the treatment of contaminated soils. Through the QERA process the project will identify and priorities. POPs contaminated sites. The government of China has allocated a budget to undertake a national survey of contaminated land and land use. This survey, if altered and intervened by the project may catalyze a nationwide soil remediation program, which will surely sustain the outreach of the project results and bring more global environmental benefits. Modified at P.53-54.
The table of "unit costs" is somewhat confusing. I don't understand what "disposal" refers to, nor how things are added up. For the first 2 lines the total is GEF + China only, but there are entries for "pre disposal" and "disposal;". Also, I wonder about the difference in "predisposal activities". 20Feb2008. The revised document and UNIDO response satisfactorily address the above comments.	Another related element that will need attention during project preparation and in the project document is related to transparency and competitiveness in the ownership and modus operandi of any facility. The "PPPs" mentioned in the PIF is still a vague concept. 29 Oct 2008. Review of	Transparency and competitiveness in the ownership and modus operandi of facilities will be guaranteed by two rounds open and transparent tendering processes. The first round is for the selection of the owners of facilities through accessing important criteria including but not limited to operating license, co-finance, relationship with local government and previous experiences for hazardous waste business. Once selected, they will participate in the next round tendering process for technology selection and equipment procurement. Both processes are jointly organized, executed and supervised by UNIDO and

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
	prodoc for CEO endorsement: the above still applies.	MEP/FECO.through international or national open bidding process. Joint-venture, BOT or TOT can all be considered to realize the EMS&disposal of POPs waste.The most suitable PPPmodul shall be determined during the biding process. Modified at P.26-27.
	Output 3.3 is stated as "TT promoted through PPP mechanism". There is little in the document to support that. The 2 page section on institutional arrangements refers almost exclusively to description of CIO, steering group, project team etc. Please provide a description of how it is envisaged the "PPP" would work; what would be the anticipated stakeholders/participants; and what evidence do we have at this stage of their interest to participate.	The allocated fund USD$38,000 is just for recruitment of international and national consultants. Disposal of POPs pesticide waste and stockpile needs disposal technologies valid for the cocktail pesticide wastes, which are difficult to identify and needs full participation of stakeholders in related consultation and study. National and international experts will be recruited to facilitate the process by expanding the scope of technology selection and candidate vendors. After the selection of the owners of facilities and technology vendors through bidding, the experts will also help to define the concrete participation module of related stakeholders, based on which PPP, in particular the waste disposal business modules would be more clarified. Modified at P.26-27.
	Please also explain how the investment will be sustained after the end of the project, and what will happen to the equipment then. The section Para 161 to 163 it too general and should focus on the specifics of the proposed investments and arrangements to run the facility during and after the project.	We really appreciate the comments and we add the following modifications: We foresee the sustainability will be an dynamic process evolving during and after the project. Based on the principle of polluters pay,the fee-based mechanism will be established focusing on the ESM&disposal of POPs waste, facilitating sustainability.of the project. During the implementation of the project, GEF contribution is needed because of the barriers to remove. GEF will provide initial funding for the technology selection and facility construction together with sufficient co-financings leveraged from other major stakeholders, including central and local governments and facility owners to build up necessary disposal equipment. This will create a pilot and demonstration effect and stimulate the replication of same practice nationally. The project draw a special attention to infant and

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
		emerging local efforts in building up a pesticide like waste disposal market, where different funding sources from central and local governments, private sectors, BOT and BOO business could be pooled in. It is expected the charge system for waste disposal and the related practices would mature during the implementation of the project. After the end of the project, the build up equipment and capacity will be brought into full play as disposal business would increase as government is giving more concern as proven in a few economically advanced cities. Modified at P.53-54.
	The goal of achieving destruction of 10,000 + 1,000 tons of POPs waste during the project lifetime appears overambitious. Based on proposed capacity of 10 + 5 tons/day, and project timetable of 30 months for implementing these activities, this would imply near continuous 24hrs/7 day a week operation during that period.	The project plans 24 months (11000 ton÷15 ton/d ÷ 30 d/m = 24.4 m) operation at full capacity over a period of 3 years starting after the commission of the proposed facilities in the first 2 years of the project implementation. This provides adequate time for the equipment for repair and maintenance purpose as well as stop for wastes to be collected and transported.
	Please indicate how experience in developing similar projects in Slovakia and the Philippines is taken into account here.	Through UNIDO,who is the EA of the both projects, we all the time keep eyss on their progress and introduce the experience and lessons of the two projects into ours.
	Neither in the list of activities or in the timetable can I find reference to bidding for the stationary and mobile units. Only for "transport of POPs waste". Please clarify.	Both the operators for "transport of POPs waste" and the construction of stationary and mobile units will be selected through bidding, which was clarified and modified for all the contents concerned with activity 3.4.2 in the relevant contents of the PD.
	Should the EIA not take place after the "detailed feasibility study"? –They seem to go in parallel in the timetable.	Agree. EIA should be a little latter than feasibility study. When the time unit is "quarter", they just seem to be in parallel in the timetable

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
	Annex 2 on environmentally sound disposal technologies lists various available technologies. This information can be found elsewhere. What seems to be lacking is a commentary on the applicability of specific technologies to the problem at hand in China.	Modified as shown in annex 2.
	Moreover, I am surprised to find "Plasma" described under "non combustion technologies".	The wide definition of "Non combustion" would include technologies such as pyrolysis and plasma arc ((PLASCON)) as well as a number of other technologies. Please see the reference: Ron McDowall, Carol Boyle and Bruce Graham, Review Of Emerging, Innovative Technologies For The Destruction And Decontamination Of Pops And The Identification Of Promising Technologies For Use In Developing Countries, GF/8000-02-02-2205, p.6. We also as well agree that some technologies of plasma torch may be defined as combustion technology which operates in similar condition as incineration.
	Please delete Para 16 which bears no relation to "GEF strategies and Programs" – please delete the corresponding paragraph 128 in the project document. Para 21 (and corresponding Para 133 in prodoc) refers to OP14. Please delete as this reference to operational program is obsolete.	Agree. Modified at P. 31
9. Is the project consistent with the recipient country's national priorities and policies? Yes the project is in line with China's NIP and will influence the overall strategy for hazardous wastes management.		
10. Is the project consistent and properly coordinated with other related initiatives in the country or in t Linkages with related initiatives in China and worldwide will be established. Noteworthy is the intent to explore synergies with the destruction of CFCs.		

At PIF/Work Program Inclusion

At CEO endorsement (FSP)/Approval (MSP)

IA Response

11. Is the proposed project likely to be cost-effective?

The PIF includes a preliminary analysis of the cost of various options, showing that this project should be cost-effective, and in fact demonstrating that cost-effectiveness will be a determinant factor in project design.

Not Applicable at CEO Endorsement (FSP)/Approval (MSP)

12. Has the cost-effectiveness sufficiently been demonstrated in project design?

Not Applicable at PIF/Work Program Inclusion

The cost-effectiveness section has to be strengthened. Where does the $1000/ton come from? Does this take all financing into account or just the GEF? What is the baseline cost of POPs destruction in China? What facilities meet the appropriate standards to destroy POPs, or could be upgraded to meet these standards if requested?

Incineration is the major method for hazardous waste in China and disposal cost for the common hazardous waste that has low chlorine content and low toxicity is US$700/t. Those incinerators operates with a emission of PCDD/Fs of 0.5 ng/Nm^3 according to the current Pollution control standard for hazardous waste incineration (GB18484-2001) in China and many of them could not meet the requirement in the day-to-day running.

The only incineration facility that will meet the Convention operating standards is located in northeast China, and is dedicated to PCB disposal at the unit cost of US$2,930/t. This facility is not yet commissioned, and when operational, the demand on this facility will be beyond its capacity, and in practice will not be available for this project. No other incineration facility currently in operation in China meets the Convention's standards for the disposal of POPs waste.

The baseline cost is $700/t for common hazardous waste destruction with an emission of PCDD/Fs of 0.5 ng/Nm^3 and US$2,930/t for PCBs wastes.

China still has no non-combustion facilities in commercial operations. So the cost for other countries was used as references in the following table.

Technologies	Runing cost
GeoMelt™	In-Container Vitrification 1585 ($/ton)
Pyrolysis	$1000 per ton for solid waste
Plasma Arc	Running cost of PLASCON: AUD$1000-3000/ton;
GPCR	For organochlorine pesticides (solid or liquid feed): • Semi-Mobile, capacity 840 ton/a, $1317/ton, labor cost $593/ton; • Full-scale, capacity 3360 ton/a, $ 1317/ton, labor cost $222/ton
BCD	Estimated running cost (Europe, 2004) : • High strength dioxins, € 1400-1700/t. The high costs for additional safety and personnel protection features; • For waste chemicals and pure

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*

		Askarels/PCB's with org. Chlorine cont 50% for a throughput of 75- 150 t/month, operating costs will be € 850-1200/t of pure chemical waste, with depreciation € 500/t.

To meet the international standards and project requirements the technology selection and facility construction will fully follow the BAT/BEP of Stockholm and technical guidelines of Basel Convention. In summary, the basic criteria are:

- PCDD/Fs 0.1 ng/Nm^3
- DRE >99.9999%
- Appropriate for the overall hazardous waste management system in China
- Enough co-finance for the potential technology and equipment providers

Modified at P.55-57.

13. Is the project structure sufficiently close to what was presented at PIF?

Not Applicable at PIF/Work Program Inclusion

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14. Does the project take into account potential major risks, including the consequences of clima

At PIF/Work Program Inclusion	At CEO endorsement (FSP)/Approval (MSP)	IA Response
The project, even at PIF stage, needs to specifically address environmental and human health risks from handling wastes, and outline (here) and demonstrate (in the full project document) how UNIDO will be able to enforce appropriate safeguards. 20Feb2008. Addressed in the revised document.	I don't think that the risk of availability of water and electric supply is worth mentioning here. However, what is missing is recognition of the health and environmental risks that POPs removal, transport, and destruction entail, including reference to the EIA process.	Agree. As for as the POPs removal, transport, and destruction, the following activities will be implemented to reduce the risks related: (a) Hire specialized and licensed waste treatment companies to implement the waste clean, transport and destruction. (b) Prepare detailed guidelines and operation manuals. (c) Strengthening capacity and training for the staff in those activities (d) Pre- and post- monitoring and evaluation by independent institutions. We have made the related certifications based on the above comments. Modified at P.51.

D. Justification for GEF Grant

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
15. Is the value-added of GEF involvement in the project clearly demonstrated through incremental reas		
In general yes, but this is also a section where the linkages and leverage on the China Program for Construction of Disposal Facilities as to be highlighted in terms of baseline and alternative. 20Feb2008. Clarified in the revised document.	The section is too generic. How concretely will the project effect the baseline constituted by the China Program for Construction of Disposal Facilities?	First, the project has a close linkage with the ongoing National Program of Disposal Facilities Construction for Hazardous Wastes and Medical Wastes, which was approved in 2004 as a pure engineering construction program in which 31 hazardous waste treatment and disposal centers will be constructed to dispose of hazardous waste by incinerators. The project will interact with and influence the Program by: 1. Introducing life cycle management into current hazardous waste management systems, including qualitative site environmental risk assessment, waste characterization, and pre-disposal treatment involving handling, collection, packaging, labeling, transportation, and storage of stockpiled POPs pesticides; 2. Mainstreaming relevant Stockholm Convention requirements for ESM of POPs stockpiles and wastes into current legal and institutional management structure; and 3. Expanding technology selection for destruction of stockpiled obsolete POPs pesticide waste thereby generating global environmental benefits. The capacity incubated through interaction with NPDFCHWMW can lay a foundation for upgraded life cycle management of hazardous waste, which would further encourage central and local government to develop and implement more projects and programs to address the needs of environmentally sound management of hazardous waste. China has a rapid economic growth and a rapidly increasing input on environmental protection and this project will make its contribution to the trend by guiding the right direction of the related environmental protection input. Second, the project could also have a close linkage to the current government study eventually aimed at developing a program for the treatment of contaminated soils. Through the QERA process the project will identify and priorities POPs contaminated sites. The government of China has allocated a budget to undertake a national survey of contaminated land and land use. This survey, if altered and intervened by the project may catalyze a nationwide soil remediation program, which will surely sustain the outreach of the project results

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
		and bring more global environmental benefits. Modified at P.55-57.
16. How would the proposed project outcomes and global environmental benefits be affected if GEF does not invest? Not Applicable at PIF/Work Program Inclusion		
17. Is the GEF funding level of project management budget appropriate? Project management costs should be shared more equitably. At present GEF is requested to support 26% of the project total, but 56% of the management costs. 20Feb2008. Addressed in revised document.	Conforms to PIF.	
18. Is the GEF funding level of other cost items (consultants, travel, etc.) appropriate? Not Applicable at PIF/Work Program Inclusion	The budget was increased by \$15,000. This is theoretically allowed but seems difficult to justify here, bearing in mind overall cost of the project and still undefined aspects of proposals for procurement etc. The budget for project travel is high. Please justify and/or reduce and explain how this is co-financed.	Although the travel cost is little higher, the part from GEF is less than 3% of the total GEF grant. Considering that the wide waste distribution, a lot of technical assessment and investigation, equipment selection and determination, the project need a lot of site- visit and investigation implement by experts. And many international experts will be invited to involve in the process. The travel cost covers all the international and domestic travel cost of experts for those activities. UNIDO's further comments needed.
19. Is the indicative co-financing adequate for the project?		

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
In principle yes. However GEF grant is too high with regards overall envelop for POPs for GEF-4/2008. A number of components should be cut down to reduce the GEF request. A brief explanation of the nature of the private sector co-financing would be useful. UNIDO co-financing is noted. 20Feb2008. Budget has been reduced.	Not Applicable at CEO Endorsement (FSP)/Approval (MSP)	
20. Are the confirmed co-financing amounts adequate for each project component?		
Not Applicable at PIF/Work Program Inclusion	We expect convincing elaboration of UNIDO co-financing and how it is additional to services provided through the fee.	UNIDO's further comments needed
	The nature of private sector co-financing should also be explicit.	Although the technology selection is still not determined in the PPG period and we have enquired only a few equipment operators, Some companies expressed interest and intention to join this project through the equipment and technology, at the same time they expressed their willingness for the co-finance in running cost, equipment investment and construction, and staff cost. Moreover, the project ensures the co-finance by mainstreaming the disposal of POPs wastes into implementation of national programs that will be supported by national governmental funding sources.
	The government letter guaranteeing the co-financing for the project is signed by the FECO DG. We would have also expected a letter from MOF.	Co-financing is a complex matter and can not fall into any single ministry mandate and MEP will organize the co-finance. Moreover, the available committed co-finance have basically met the project requirement. MEP will continue making efforts to increase co-finance. The above description for sustainability and replicablility as proven this possibility.
	Moreover, the co-financing includes large sums in kind both from government and the private sector. An explanation is required to explain better the source of this co-financing, and how it will be tracked, so as to	The co-financing from the private sector will be ensured through the contract. And the whole process of disposal facility construction and operation, including the co-finance, will be under the supervision and inspection of the local government. Modified at P.71

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*
	strengthen the case that this co-financing, although in kind, is real and will materialize. The small section Para 164 is not sufficiently detailed in that regard.	
21. Does the proposal include a budgeted ME Plan that monitors and measures results with indicators and targets?		
Not Applicable at PIF/Work Program Inclusion	Quantitative indicators with targets expects in particular for amount of pesticides waste to be addressed directly by the project, as well as after project completion. The same for avoided releases of PCDD/Fs.	Modified at P.74.
	Table 8 on key indicators (6000 + 4000 tons) does not match the rest of the documentation (10,000 + 1,000).	Modified at P.74.
E. Secretariat's Response to various comments from:		
-STAP		
None received		
-Convention Secretariat		
None received		
-Agencies' response to GEFSEC comments		
Not Applicable at PIF/Work Program Inclusion	The proposal takes into account various but not all earlier comments from GEFSEC.	Most of the comments were replied and related modification has been done in the updated PD or reflected in the previous and above response.
-Agencies' response to Council comments		
Not Applicable at PIF/Work Program Inclusion	The response to the 3rd comment from Japan (on soil contamination) does not seem to address the issue raised by Japan.	Relevant report will be reported to Secretariat of Stockholm Convention that will be included in the National Report through the focal point.

At PIF/Work Program Inclusion | *At CEO endorsement (FSP)/Approval (MSP)* | *IA Response*

F. Secretariat Decisions

22. Is PIF clearance being recommended?

Yes, pending receipt of revised PIF by Feb 11 addressing

At PIF/Work Program Inclusion the points raised in this review, including slightly reduced amount requested from the GEF. 20Feb2008. The revised document and UNIDO response satisfactorily address the above comments. I recommend the PIF for CEO clearance and WP inclusion.

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23. Items to consider at time of CEO Endorsement.

Not Applicable at CEO Endorsement (FSP)/Approval (MSP)

24. Is CEO Endorsement being recommended?

Not Applicable at PIF/Work Program Inclusion

Pending satisfactory response to the comments raised in this review.

REQUEST FOR PPG APPROVAL

1. Are the proposed activities for project preparation appropriate? Yes. The PPG will define the magnitude, nature and geographical dispersion of the stockpiled POPs pesticides waste and examine the current policy, legislations and national economic and market analysis with regards to the management and disposal of pesticides and fly ash wastes. Furthermore, the disposal technologies feasibility and linkages with ongoing hazardous waste programs will be addressed. The PPG will also determine options of incremental cost analysis and mobilization of cofinancings.

2. Is itemized budget justified?

In general, yes. However, I do not understand why China needs an international consultant for Public awareness, information system management and communication promotion. These activities are already covered by the local consultants.

3. Is the consultant cost reasonable?

The GEF contribution for local consultants ($ 160,000) appears high. This should be limited to $ 100,000 and cofinancing for this component be increased to $ 320,000.

4. Is PPG being recommended?

Upon submission of a revised PPG addressing the points raised above and clarification on the use of international consultant for public awareness, etc…

At PIF/Work Program Inclusion	*At CEO endorsement (FSP)/Approval (MSP)*	*IA Response*

6 March 2008 The revised PPG document addresses all points raised above. PM recommends the approval of the PPG for CEO clearance.

5. Other Comments

March 13, 2008

Annex 5

The status of POPs wastes in China of Document Preparation Sub-project of Environmentally Sound Management of obsolete POPs pesticides and other POPs wastes in China

The status of POPs wastes in China

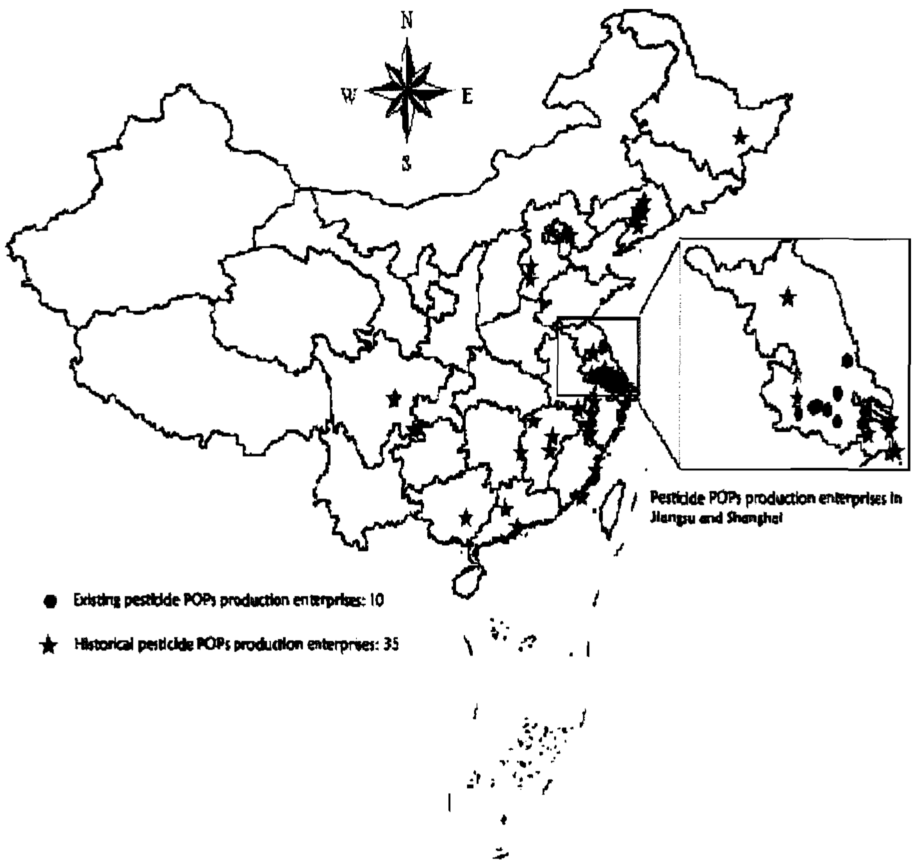
Sub-project Client: Foreign Economic Cooperation Office, Ministry of Environmental Protection

Sub-project Executer: Institute of Solid Waste Management, Chinese Research Acadamy of Environmental Science

October, 2009

Executive summarization

POPs pesticides in Stockholm Convention Annex A include: aldrin, chlordane, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex and toxaphene. China used to produce toxaphene, hexachlorobenzene, chlordane, heptachlor and mirex. There are 58 enterprises in China that produced the POPs pesticides mentioned in Annex A of the Convention (including primary production and formulation plants), which are located in 18 provinces and municipalities of China. Production and use of toxaphene and heptachlor were stopped in the 1970's, and the production and use of hexachlorobenzene were stopped in 2004. The DDT,HCB,chlordane and mirex production and use for termite prevention and control was totally prohibited by May,17,2009.



Distribution of historical and existing POPs pesticides production enterprises

There exist a total of 58 enterprises involved in production of POPs pesticides, including 14 existing units. 20 enterprises have been identified and surveyed, including all existing production enterprises as well as enterprises with larger historical volumes of production. Because the production and use of toxaphene and heptachlor was completely stopped in the 1970's, and large-scale production of dieldrin, endrin and aldrin has never been started, their chemical wastes have not been found in China. At present, the identified POPs pesticide wastes are mainly DDT, chlordane, mirex and HCB and for the latter, the production was stopped in 2004. POPs pesticide wastes in China are mainly located in Jiangsu, Hunan, Hubei,Sichuan, Shandong, Tianjin, Shanxi, Hebei and Liaoning provinces, accounting for 70-80% of the total waste quantity. At present, the storage methods of the above wastes are dominantly outdoor storage and simple enclosure. During this survery all the historical manufacture plants have been investigated. There are 1060-1170 tons of POPs stockpile identified in 4 historical manufacture plants.

In circulation field, there are totally 806 tons of POPs pesticide identified, which consist of 794 tons of POPs stockpile found in agriculture application, 11 tons of DDT found in disease control and 1.8 tons of chlordane and mirex found in termite control.

POPs pesticides contaminated sites, in proximity to the stockpile locations, are also a serious issue, including highly polluted soil found at pesticides manufacturing sites, warehouses and at waste pesticide storage. According to the survey, there are about 44 polluted sites and nine of them have been investigated. It was found there were about 100,000 tons of highly polluted soil (DDT>50 ppm) normally concentrated in top layer of soil around a single historic production plant, in which, furtherly identification work to scope 7000-8000 tons of POPs pesticide waste among the total POPs pesticides contaminated sites need to be completed in full-size project

1. Pesticide POPs Waste Survey

For the production field of pesticide POPs, in the 58 enterprises which were once involved with pesticide POPs productions, comprehensive survey was applied to 44 enterprises except the universities and institutes which never dealt with mass production. The results show that, in the nine kinds of pesticide POPs, 94% is DDT in China, which is the major waste of pesticide POPs in China.

1.1 POPs waste in historical production feild

1.1 Tianjin Chemical Plant of Tianjin Bohai Chemical Co., LTD

Tianjin Chemical Plant of Tianjin Bohai Chemical Co., LTD (former Tianjin Chemical Plant) established their 1600t/a DDT production unit on July 1956 and the production capacity was extended to 3040t in 1957. Due to the earthquake in Tangshan District, the production was stopped in 1976, and later in 1977, the unit was rebuilt with RMB1.7million investments. The production capacity was restored to 4000t/a and then extended to 10200t/a in 1980 after technical reform. The DDT unit was reconstructed with RMB 5.3million in 1990. Part of the unit was updated and realized self-control. The workshops occupied an area of 2120.66m^2 and there are 164 employees.

On March 1983, the State Council issued the decision of stopping BHC (hexachlorocyclohexane) and DDT production, but Tianjin Chemical Plant was approved to continue their production and sale of DDT products, for the production of Dicofol, hygienic pesticides, paint and other usages, including exportation. According to the 2001-2002sale records of DDT products provided by Tianjin Chemical Plant, their products are mainly supplied for enterprises, such as Jiangsu Kuaida Agrochemicals Co., LTD, to produce Dicofol, ship antifouling paint and mosquito-repellent incense. In addition, through Tianjin Bohai Chemical Industry I&E Corporation, Tianjin Chemical Plant exported certain amount of DDT products, which were mainly supplied to the Health Department of Ethiopia, Namibia as well as Madagascar Yonggu International Trades Company for the production of medication preventing malaria.

There are small amount of DDT products for sale and woven bags with lined plastic film in the stockhouse of Tianjin Chemical Plant, but there is no waste products. During the production of DDT raw powder, the discharged wastewater and waste acid contain DDT, which will pollute the environment. According to the estimation of actual situation in Tianjin Chemical Plant, producing 1t DDT can generate 3.5t wastewater, whose DDT content is 2.4mg/L. In 2001, the DDT output is 1939t and if calculated with that output, the Plant will discharge 16kg DDT each year. After the multistage treatment in sewage pool, the DDT and chlorobenzene solution in the discharged wastewater will be recycled to distillating still for further usage. Together with other wastewater, the wastewater of sewage pool will be discharged into final sedimentation pond and later into the sewage reservoir of

Hangu District when their PH is between 6~9. Then after natural sedimentation and biological process, the wastewater will be discharged into the Gulf of Bo Hai during flood season. In the wastewater at general outlet of Tianjin Chemical Plant, the DDT content is 0.001－0.006mg/L. In addition, the sedimentation pond (5×3m) is cleaned each year and 200kg DDT contained sludge is generated, which is stacked around the workshop after dried in the air. Now the dried solid waste is stored in packs and by on-site observation, it is estimated that the accumulated weight is 120t. That Plant has been producing DDT for over 40 years and DDT has been detected in the workshop as well as surrounding soil. The polluted area is as large as $4km^2$.

Fig. 1 DDT Wastes Storage Site of Tianjin Chemical Plant (2005)

Fig. 2 DDT Wastes Storage Site of Tianjin Chemical Plant (2009)

1.2 Tianjin Dagu Chemical Industry Co., Ltd

On April of 1958, Tianjin Dagu Chemical Industry Co., Ltd (former Dagu Chemical Plant) invested RMB0.76 million and established one production unit to produce hexachlorobenzene with BHC null mutant, and its production capacity was 7000t/a. RMB8.938 million was invested for santobrite production unit with a capacity of 10000t/a. In 1973, 1987 and 1995, RMB37.3561 million was invested for technical reform in accumulation and the production capacity of hexachlorobenzene was extended to 12000t/a. In 2002, there were 345 employees in POPs branch with 245 employees in hexachlorobenzene workshop, which occupied an area of $71432m^2$, and 100 employees in santobrite workshop, which occupied an area of $22000m^2$.

The State Council issued the decision of stopping the production and sale of BHC in 1983 while the Department of Health required that the production of santobrite shall be continued to break down Oncomelania, prevent schistosomiasis. Approved No. 215 Document of (83) Chemistry from Ministry of Chemical Industry, Dagu Chemical Plant was the only enterprise to continue BHC production and after lindane extraction, all BHC null mutant was used to produce hexachlorobenzene, santobrite and pentachlorophenol. In 1999, that Plant stopped BHC production and in 2003, 2004, the production of santobrite and pentachlorophenol was stopped, too. Now except 30~40t lindane, there is no other stock in the Plant. Due to the extensive production, the substandard packaging and production process, there may be pollution of various degrees in the plant site. Through on-site observation and analysis, we conclude that the most polluted places are the production area (about 500m×150m) and the areas that used to store the waste intermediate during the production of santobrite (about 30m×40m, inside the production area).

Approved by the Bureau of Environment Protection, the original units were removed after the production was stopped. The production site of hexachlorobenzene is reconstructed for polyether and other production sites were solidified with 50cm cement due to their mal smell. Before the reconstruction and solidification of hexachlorobenzene production site, there was only simple cleaning but no special treatment applied. Some of the wastes and polluted soil dug from the site were buried around the plant walls, and the backfilling area is 150m×20m×1.5m, about 5000 m^2.

Fig.3 DDT Wastes Storage Site of Tianjin Dagu Chemical Plant (2005)

Fig.4 DDT Wastes Storage Site of Tianjin Dagu Chemical Plant after Reconstruction (2009)

1.3 Xingtai Pesticide Co., Ltd

Between 1975 and 1983, Xingtai Pesticide Plant produced 5% DDT power and the accumulated output in nine years is 24698.8t. In 1983, they stopped DDT powder production according to the decision of State Council. According to 1991 No (67)

Notice on Strengthening Pesticides Management issued by General Office of the State Council on October 22, 1991, it was confirmed that Xingtai Pesticide Plant was the only enterprise that exported 75% DDT preparation in China. The raw DDT used for preparation production was supplied by Tianjin Chemical Plant and the export business was performed by Tianjin Bohai Chemical Industry I&E Corporation. In 1987, Xingtai Pesticide Plant invested RMB10.26 million to import a set of advanced production line of 75% DDT wettable powder, with a capacity of 2500t/a. On June 1996, another RMB 1.5 million was added for technical reform and the production capacity was extended to 3500t/a. In 2001, the total industrial output value was RMB 4million with a profit of RMB 0.7852 million. The workshop occupies an area of $6047m^2$, the carrying value of fixed assets is RMB 8.5million and there are 90 employees.

All the DDT wettable powder produced by Xingtai Pesticide Plant was delivered to Tianjin Bohai Chemical Industry I&E Corporation and then exported to Thailand, Ethiopia, Madagascar, Namibia, South Africa, and other countries for the production of medication preventing malaria. All the products were sold each year and there was no permanent stock. During the production process, the DDT raw materials and preparation were stored in the temporary stockhouse. Due to the small size of 75% DDT, it is easy to float in the air and therefore the problem of dust floating is severe. The DDT concentrations inside the workshops (production and crushing) and on the surface of nearby ground are rather high, and the concentration of the deposit on crushing workshop ground is as high as 0.967g/g, which is almost equal to that of the pure DDT. Within several tens of meters from the production workshop, the DDT concentration is about 200ppm and the concentration in plants is between 3ppm～20ppm, which is 100 times over the national standard; On the waste site at north of crushing workshop, the DDT concentration is as high as 0.8g/g and thus the total amount of DDT waste is more than 50 tons. Furthermore, from the production features and local climate, we also fetched samples 1km south from the production workshop. The results indicate that the DDT pollution has extended there but the concentration is in a downward trend. The DDT concentration in soil decreases from 2000ppm to 80ppb and that of plants decreases from 30ppm to 0.25ppm. In the orchard 1km away and the bed of dried Qili River, the DDT concentrations in soil are 8.4ppm and 81.5ppb, respectively and that of the plants are 1.54ppm and 0.9ppm, respectively. The plant DDT concentration on river bed is higher than that of the soil. We can conclude that, although Xingtai Pesticide Plant is located in the southeast suburb, the diffusion of floating DDT has caused severe damage to the environment of surrounding area even part of the city. By preliminary estimation, the polluted area is more than $2km^2$ and the weight of DDT wastes is over 60t. (The monitoring data is provided by Department of Environmental Science & Engineering, Tsinghua University)

In 2007, Xingtai Pesticide Plant excavated the severe polluted land and the soil was stored centralized (as shown in Fig. 5). Now the DDT polluted soil in storage is about 500-600t.

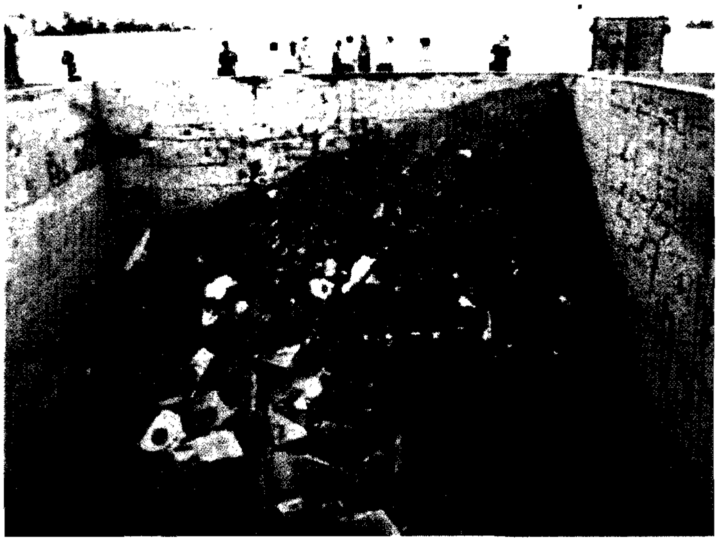


Fig. 5 DDT Wastes Storage Pond of Xingtai Pesticide Plant

1.4 Synthetic Ammonia Branch of Taiyuan Chemical Industry Co., Ltd

From 1958 to 1983, Taiyuan Chemical Plant dealt with the production of DDT and during 25 years, 75690t DDT products came out. The DDT production site occupied an area of $6466m^2$. After the DDT production was stopped, the DDT production units were used to produce hydroxylamine hydrochloride and later chloroactic acid after adjustment. Now the workshops have been out of use. The DDT products remained on the previous production units, storage tank of waste acid, pipeline, packaging workshop as well as surrounding area are not removed. In all of previous packaging workshop, there are about 5cm DDT dust.

The DDT content in the previous production workshop and nearby area of Taiyuan Chemical Plant has gone far beyond the standard level. The DDT concentration in soil is between 700ppm～5000ppm, most of which are 1000 times or higher than the standards for Grade III. It is estimated that, the DDT amount in soil is over 1.5t; the crystal in storage tank of waste acid is 15t, where the DDT content is >10% and thus the net weight of DDT is over 1.5t; the remained DDT on previous production units, pipeline and workshop is over 0.5t; there is remained DDT crystal on walls, ground and platforms and its concentration is as high as 0.8g/g, where the total amount of pure DDT is about 3t. Moreover, in the Barrel Manufacturing Plant, 300m in the north of production and packaging workshop, the DDT content in soil is 7.63ppm, which indicates that there are DDT pollutions in other sites apart from the previous workshop and the concentration is also rather high. In the plants nearby the production workshop, the DDT concentration is about 56～130ppm, which is far higher than related state standards. Based on above results and analysis, it is estimated that the total mount of DDT wastes are more than 30t and the polluted area is over 10000m^2 (as shown in Fig. 6)

In addition, Taiyuan Chemical Plant had once produced hexachlorobenzene but the production period is short, which was shut down in 1960s. After reconstruction, the site was used for phosgene production, which has been stopped now, and the workshop is out of use.

Fig. 6 Waste Storage Site of DDT Workshop, Taiyuan Chemical Plant

1.5 Zhangjiakou Changcheng Agrochemical (Group) Co., Ltd

The DDT production of Zhangjiakou Changcheng Chemical Plant was started on May 1970 and stopped on March 1983 after receiving the instruction of State Council. During 14 years, 14559.415t DDT raw power was produced but the large amount of DDT wastes generated were not disposed properly. In addition, from 1978, they began to produce Dicofol and the DDT raw powder was supplied by Tianjin

Chemical Plant after 1983. Under the urgent market demand, the Dicofol products were all sold and there was no stock. There was severe DDT powder leakage in the raw material stockhouse of Dicofol production workshop for many years of DDT storage. The DDT concentration on ground is 0.36g/g and it is estimated that the total waste amount is more than 5t. The waste liquid and waste acid was not discharged outside in 14 years and is placed in a fiberglass pond now (as shown in Fig. 7). The waste liquid is about $400m^3$and the DDT concentration is more than 0.16g/L.

Although the enterprise has stopped DDT production for over twenty years, in the soil of major DDT distribution sites, the DDT concentration is between 2ppm~100ppm, which is higher than the standards for Grade III. In the key areas, the DDT concentration in plants is 0.56ppm~1.65ppm, which also exceeds national standards. Furthermore, during the 14 years of DDT production, the solid wastes and other impurities were piled on the clearing at northwest, which occupies an area of $8400m^2$ together with waste acid. In 2003, brick baking was performed on that site by the enterprise after an average of 1.5m (1~2m) soil was removed. From above results, it is estimated that the total amount of DDT waste is more than 10t and the polluted area is over $15000m^2$.

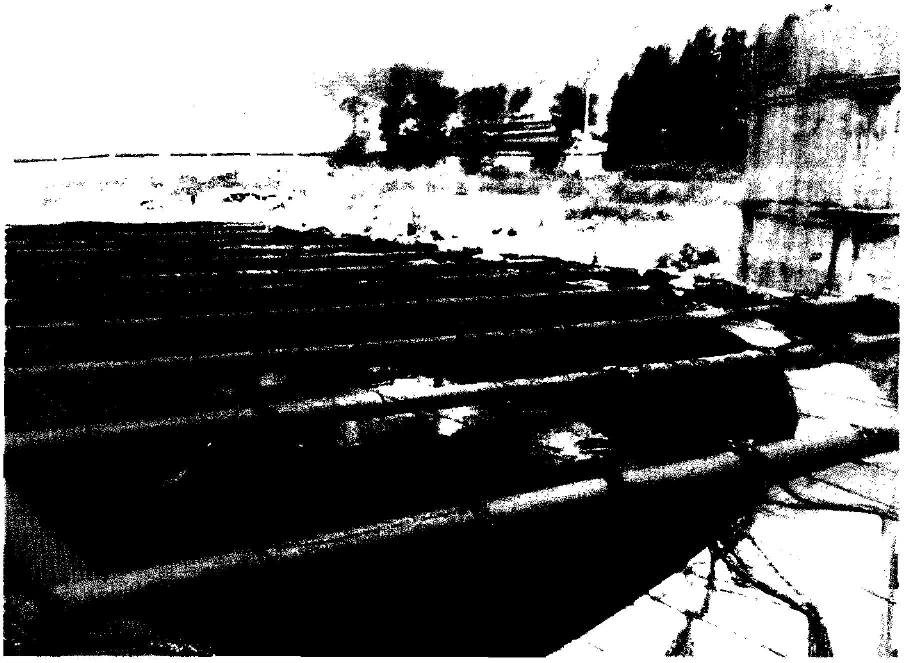


Fig. 7 DDT Waste Liquid Storage Pond of Zhangjiakou Changcheng Chemical Plant

1.6 Jiangsu Changqing Agrochemical Co., Ltd

Jiangsu Changqing Agrochemical Co., Ltd, former name Jiangdu Putou Pesticide Plant (Jiangdu Pesticide Plant), locates at No. 1 of Jiangling Road, Putou Town, Jiangdu City, Jiangsu Province. The enterprise has more than 600 employees and 400 temporary employees. It is a medium collectively-owned enterprise and in 2001, their total industrial output value was RMB15.894 million.

From September 1973, the enterprise invested RMB1.4 million for a chlordane oil production line and the capacity is 200t/a. On December 1979, RMB0.6 million was added to move the chlordane production unit of Shanghai Electrochemical Plant to their plant and the capacity was extended to 400t/a. In 1981, the workshop of chlordane production was shut down and now the production units have been removed. Due to the leakage of materials, the production sites were polluted and later used as storage sites after landfill with soil.

The production of chlordane left about 60t residues, half of which was burned with firewood and diesel while the other half was buried deep in the earth. During the production process, the major discharged gas is HCl, most of which was recycled as hydrochoric acid while the rest was sold as waste acid or discharged into nearby ponds with other wastewater. In 1975, there was a severe flood in there and about 1200t undelivered chlordane powders as well as raw materials were submerged in water, which caused severe pollution. After the flood, large amount of chlordane sludge were placed into nearby wastewater pond and now in the pond, the COD is >5000 and the organochlorine has gone far beyond the standard level. The enterprise once invested over RMB0.3 million to reinforce the pond to prevent pollutant leakage as well as the nearby water and farmland being polluted.

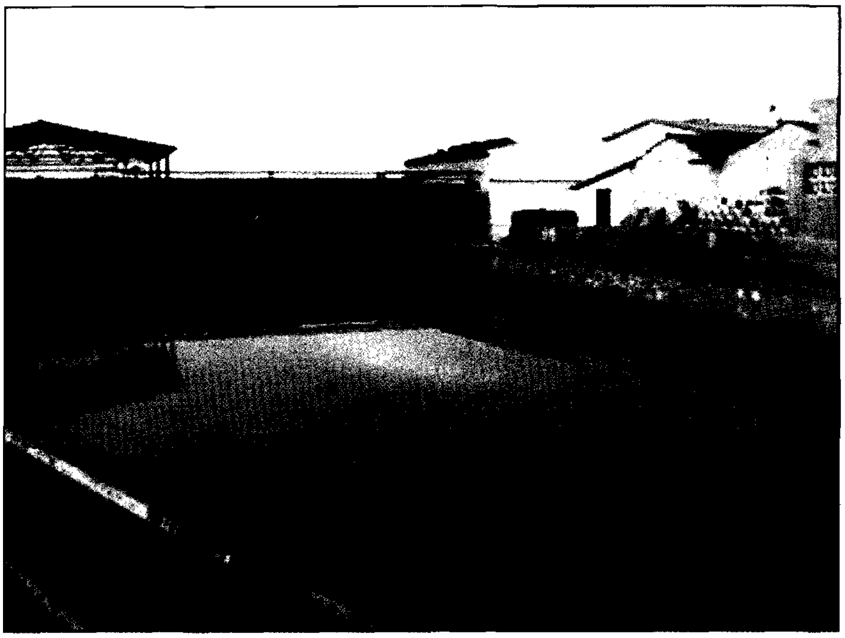


Fig. 8 Chlordane Storage Pond of Jiangsu Changqing Agrochemical Co., Ltd (2005)

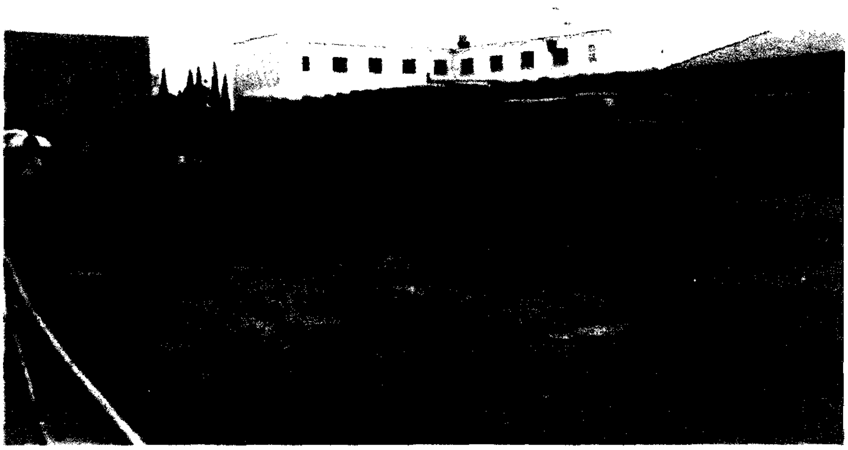


Fig. 9 Chlordane Storage Pond of Jiangsu Changqing Agrochemical Co., Ltd (2009)

At present, the enterprise has treated the wastewater in pond by pumping and the pond has been backfilled with soil. However, the pollution at pond bottom still remains uncertain and further investment, assessment is still needed.

1.7 Wuhan pesticide manufacture plant

Wuhan pesticide manufacture plant was located at Hanyang district, Wuhan, Hubei province, established in 1959, formerly engaged with pesticide production. The HCH and DDT were main products in his history. The capacity of DDT emulation oil production once reached 5000 tons/a rising from 1000tons/a. The plant replaced to the other location at the beginning of the 21^{st} century. In the history of its production, the explosive accidence once occurred in May,20,2001.

The total area of the plant is $16\times10^4 m^2$, where 5.5×10^4 m^2 is identified as contaminated surface area. The total cubic of contaminated soil is estimated as 17.125×10^4 M^3. The maximal concentration of HCH reaches 630.8 mg/kg, average concentration is 151 mg/kg, and the maximal concentration of DDT reaches 2225.5 mg/kg.

1.8 Tianyuan General Chemical Plant

Tianyuan General Chemical Plant (TGCP)has once been as one of the largest chloro-alkali producer in China, which situated at upland with elevation from 215-270 m in the Miaoershi, Jiangbei District,Chongqin Municipality in the northern bank of Yangtse River and Jialing River.

The main POPs substance identified in the plant site are HCH, HCB and PCDD/Fs.The total volume of POPs contaminated soil is 3.5×10^4 m^3. The maximal concentration of HCH is 768.5 mg/kg, and the maximal concentration of HCB is 12508 mg/kg and the maximal concentration of PCDD/Fs is 80760 μ g/kg.

1.9 Taichang Xintang No.2 Chemical Plant

The plant, situated in the east of Xintang town in Taicang county, was established in 1984.The major product was Chlordane and mirx. There are serious POPs contaminated site has been identified in this plant. The further assessement for the quantification for the specific volume is need to be carried out in the future..

1.10 Beijing Red lion Coating Co. and Beijing Third Chemical Plant

There are totally 20×10^4 m^3 POPs contaminated soil have been removed from above two plant sites, and transported to a storage resorvior, of which, the main POPs substances were DDT and HCH. Currently, 15×10^4 m^3 have been disposed by Cement kiln. The remaining part of the POPs contaminated waste is still stored in the resorvior.

2. Pesticide POPs waste in circulation field

1.2.1 Agriculture application

Chongqin Municipality

There is totally 184 tons of obsolete POPs pesticide identified and gathered throughout all the county-level regions, which is presently packaged and stored in Bishan Hazardous Waste Disposal Center.

Hubei Province

There is totally 450 ton obsolete POPs pesticide identified throughout 75 county-level regions, which is presently dispersed in the previous warehouse or storage place.

Jiangsu Province

160 tons of obsolete DDT was discovered in Jiangyan, Jiangsu province.

1.2.2 Disease control

There is totally 11 tons of DDT identified in the disease control field,which consist of 10 tons of DDT in Hunan Disease Control and Prevention Center, 0.7 tons of DDT in Yibin Disease Control and Prevention Center and 0.3 tons of DDT in Penshan Disease Control and Prevention Center.

1.2.3 Termite control

There is 1.8 tons of chlordane identified and gathered in Termite prevention field, which is currently stored in a warehouse affiliated with Hunan Institute of Termite Prevention.

2. Preliminary inventory of Pesticide POPs Wastes in China

2.1 Preliminary inventory of targeted pesticide POPs wastes in China

The major information of stored pesticides POPs wastes over 50t in China include: category, quantity, polluted area of pesticide POPs wastes and the current production situation. Table 1 shows the confirmed list of stored pesticides POPs wastes over 50t in China

Table 1 Preliminary Inventory of stored pesticide POPs wastes in China

No	Company Name	Category	Waste (ton)	Remarks
1	Tianjin Chemical Plant of Tianjin Bohai Chemical Co., LTD	DDT	120	Many years of DDT production, the only DDT producer in China now
2	Zhangjiakou Changcheng Agrochemical (Group) Co., Ltd	DDT	Waste liquid: $400m^3$	Former producer
3	Synthetic Ammonia Branch of Taiyuan Chemical Industry Co., Ltd	DDT	30-50	Former producer
4	Xingtai Pesticide Co., Ltd	DDT	500-600	Present producer
5	Bishan Hazardous Waste Disposal Center	POPs pesticide	184	Chongqin EPB
6	Jiang Su Province	DDT	160	Jiang Su EPB
7	Hubei Province	POPs pesticide	450	Hubei Agriculture Deptment
8	Hunan province	DDT	10	Hunan Disease Control and Prevention Center
9	Sichuan Province	DDT	0.7	Yibin Disease Control and Prevention Center
10	Sichuan Province	DDT	0.3	Penshan Disease Control and Prevention Center
11	Hunan Province	Chlordane and Mirex	1.81	Hunan Institute of Termite Prevention.

Table 2 Preliminary Inventory of pesticide POPs contaminated sites in China

No	Company Name	Category	Polluted Area	Remarks
1	Tianjin Chemical Plant of Tianjin Bohai Chemical Co., LTD	DDT	$4km^2$	Many years of DDT production, the only DDT producer in China now
2	Zhangjiakou Changcheng Agrochemical (Group) Co., Ltd	DDT	$15000m^2$	Former producer
3	Synthetic Ammonia Branch of Taiyuan Chemical Industry Co., Ltd	DDT	Previous workshop: $6466m^2$; Polluted area: 10000 m^2	Former producer
4	Xingtai Pesticide Co., Ltd	DDT	$2km^2$	Present producer
5	Jiangsu Changqing Agrochemical Co., Ltd	Chlordane	$1500m^2$	Former producer
6	Tianjin Dagu Chemical Industry Co., Ltd	Hexachlorobenzene, pentachlorophenol and santobrite	Previous production area: $75000m^2$ Site of polluted soil: 3000 m^2	Many years of hexachlorobenzene production, the only hexachlorobenzene producer in China until 2003
7	Wuhan pesticide manufacture plant	HCH,DDT	Site of polluted soil 5.5×10^4 m^2,estimated the contaminated volume is 17.125×10^4 m^3	Former producer
8	Tianyuan General Chemical Plant	HCH,HCB,PCDD/Fs	contaminated soil is 3.5×10^4 m^3	Former producer
9	Taichang Xintang No.2 Chemical Plant	Chlordane,Mirex		Former producer

No	Company Name	Category	Polluted Area	Remarks
10	Beijing Red lion Coating Co. and Beijing Third Chemical Plant	DDT,HCH	Remaining contaminated soil is 5×10^4 m^3	Former producer

2.2 Basic information and contacts of enterprises with POP wastes

No	Category	Enterprise Name	Former Name	Address	Contact	Information	Other contact
1	DDT	Tianjin Chemical Plant of Tianjin Bohai Chemical Co., LTD	Tianjin Chemical Plant	South Xinkainan Road, Hangu District, Tianjin	Environmental Protection Department: Wang Wu: Tel: 022-67992550 Mobile: 13516165750	Current producer, 1956~2003	
2	DDT preparation	Xingtai Pesticide Co., Ltd	Xingtai Pesticide Plant	No 36 of Xingtai Pesticide Plant Road, Hebei	Chief: Zhang Lanqi Tel: 0319-3178852	Current producer, 1968-1983, 5% DDT powder, stopped in 1983; 1990-2003, 75%DDT wettable powder	Yao Liuting (director) 0319-7617756 0319-3171775 (fax) 13903196522
3	Hexachlorobenzene santobrite	Tianjin Dagu Chemical Industry Co., Ltd	Tianjin Dagu Chemical Plant	No 1 of Xinghua Avenue, Daliang Town, Tanggu, Tianjin	Chief: Zhang Hongtao Tel: 022-25393966 -2603 (Environmental Protection Department)	Current producer, 1958-2003, hexachlorobenzene; 1958-2002, santobrite	
4	DDT, hexachlorobenzene santobrite	Synthetic Ammonia Branch of Taiyuan Chemical	Taiyuan Chemical Plant	No 75 of Huagong Road, Taiyuan, Shanxi	Chief: Wei Gong Tel: 0351-6072400	Former producer, 1958~1983, DDT, stopped in 1984 1959~1962, hexachlorobenzene;	Wu Qi (director of Manager Office) 0351-6070928 0351-6075156

		Industry Co., Ltd				stopped in 1963	FAX: 0351-6070928 Chen Chunyuan (chief of Environmental Protection Department) 13834543200
5	DDT Dicofol	Zhangjiakou Changcheng Agrochemical (Group) Co., Ltd	Zhangjiakou Changcheng Chemical Plant	Shacheng Town, Huailai County, Hebei	Chief: Wang Pengyi Tel: O31-36233065	Current producer, 1970~1983, DDT, stopped on March 1983; 1978~2003, Dicofol	Wang Pengyi (president) 13313133029 (Sun Shubao, Pesticide Society 13801191882) Director Li: 031-36233065
6	Chlordane	Jiangsu Changqing Agrochemical Co., Ltd	Jiangsu Putou Pesticide Plant	No 1 of Jiangling Road, Putou Town, Jiangdu City, Jiangsu	Chief: Yu Guoquan Mobile: 13905258879	Former producer Produced 1973-1980 and stopped in 1981	Section Chief Yang, Jiangsu Economic and Trade Commission 13905180258

Annex 6

Environmentally Sound Management and Disposal of Obsolete Pesticide POPs and Dioxin-rich Fly Ash in China at PPG Stage

Disposal Technologies Selection and Environment Risk Evaluation

(Final Report)

Submitted to

Foreign Economic Cooperation Office
Ministry of Environmental Protection, China

Shenyang Academy of Environmental Science

Institute of High Energy Physics, CAS

August 25th, 2009

Content

Figure Content

Table Content

Acronyms and Abbreviations

BCD	Base-Catalyzed Decomposition
CAS	Chinese Academy of Sciences
CAS-IMECH	Institute of Mechanical, Chinese Academy of Sciences
CFCs	Chlorofluorocarbons
CSIRO	Commonwealth Scientific and Industrial Research Organization
DDD	Dichloro-Diphenyl-Dichloroethane
DDE	Dichloro-Diphenyl-Ethene
DDT	Dichloro-Diphenyl-Trichloroethane
DDX	Summation of DDT, DDD, DDE
DE	Destruction Efficiency
DRE	Destruction and Removal Efficiency
GEF	Global Environmental Facility
GPCR	Gas-Phase Chemical Reduction
HCB	Hexachlorobenzene
ICV	n Container Vitrification
ISTD	In Situ Thermal Desorption
ISV	In-Situ Vitrification
MCD	Mechanochemical Dehalogenation
MEO	Mediated Electrochemical Oxidation
MSW	Municipal Solid Waste
NA	Not Available
NATO/CCMS	North Atlantic Treaty Organization/Committee on Challenges of Modern Science
ND	Not Detectable
NOx	Nitrogen Oxides
ODS	Ozone-Depleting Substances
PAH	Polycyclic Aromatic Hydrocarbon
PCBs	Polychlorinated Biphenyls
PCDDs	Polychlorinated Dibenzo-*p*-Dioxins
PCDFs	Polychlorinated Dibenzofurans
POPs	Persistent Organic Pollutants
SCR	Selectively Catalytic Reduction
SCWO	Supercritical Water Oxidation
SEPA	State Environmental Protection Administration of China

SPHTD	Self-propagating high-temperature dehalogenation
STAP	Scientific and Technical Advisory Panel of GEF
USEPA	Environmental Protection Agency, USA
UNIDO	United Nations Industrial Development Organization
UNEP	United Nations Environment Program
VOCs	Volatile Organic Compounds

1. Introduction

1.1 Project Background

Persistent Organic Pollutants (POPs) are toxic substances that are resistant to environmental degradation and capable of long-range transport. They can bio-accumulate in human and animal tissues, remain intact in the ecosystem for long periods, and thus pose substantial threat to human health and sustainable development. Chinese government signed the Stockholm Convention on Persistent Organic Pollutants on May 23, 2001, and the Convention became effective to China on Nov 11, 2004. The 12 initial POPs covered by the Convention include 9 pesticides (aldrin, chlordane, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, toxaphene and DDT) which have potential significant impacts on human health and the environment.

Toxaphene, hexachlorobenzene, chlordane, heptachlor, DDT and mirex have been produced in China. 44 manufactures that have been identified, including technical material companies and preparation companies, are located in 18 provinces and cities. China has ceased the production and use of toxaphene and heptachlor since 1970s, and that of hexachlorobenzene in 2004. Thus the remaining POPs pesticides that are still under production and use in China are chlordane and mirex, mainly used in the prevention and control of termites in buildings. By the end of 2004, the total amount of pesticide POPs waste (PPW) adds up to 574,000 tons, According to the last investigation, indentified stockpiled POPs waste is up to 10,000 tons. Therefore, how to solve the problem arised from PPW has become a important part of environmental management and livelihood of the people in China, and one of very important content to evaluate the performance of Stockholm Convention implementation.

In order to manage and control PPW, the State Council ratified the National Implementation Plan (NIP) for the Stockholm Convention in April 2007. According to the National POPs Implementation Plan, Chinese government intends to forbid the production, use and exportation of PPW by 2010, to ban the production and use of hexachlorobenzene by 2008, to basically eliminate the production and use of chlordane and mirex by 2009, to try the best to avoid the production and use of DDT by 2009 (except DDT of intermediate and acceptable usage in limited and closed systems), and to prohibit any exportation and importation of DDT by 2009. In addition, the Chinese government plans to improve the Environmental sound management system on POPs waste, and to basically complete the environmental sound management and disposal system of those already identified POPs waste.

According to the national construction planning of disposal facilities for hazardous waste and medical waste, China plans to build 31 provincial-level disposal centers for hazardous waste. In terms of technology applications, these disposal centers would mainly adopt such technologies as rotary kiln and environmentally safe landfill. In terms of theory, although these facilities, especially incineration facilities, can solve the disposal problems of PPW, special management through special technologies is still necessary, due to the particularities of PPW such as special waste ingredients and applicability of technologies. In other words, the unified management and disposal of PPW should be organized and implemented by the government. However, in actual practice, some places had adopted regional incineration facilities, thus had caused heavy burdens on existing equipments, resulted in serious environmental pollutions, and in particular, had lead to excessive emissions of by-product POPs.

Due to the wide distribution, high chlorine content and huge threat to the environment, the storage of obsolete pesticide POPs has become one of the most serious concerns in China. At present, the storage conditions of PPW is quite poor, for sometimes they are just stored outdoors in closed enclosures. In this way, erosion may lead to leakage of containers, polluting groundwater and soil, and putting threat to the environment and human health. China is still lack reliable theoretical foundations over this issue, and the mainstream disposal method now is incineration, not considering much of the secondary pollution of by-product POPs brought by the incineration process. In addition, the inadequate management system, together with the lack of construction and disposal fund, has added to the difficulties of organizing comprehensive and united disposal methods in the near future.

In order to promote China's implementation of the Stockholm Convention, safeguard our environment and human health, the convention implementation office of China Ministry of Environmental Protection (MEP) and United Nations Industrial Development Organization (UNIDO) worked in concert to apply for the project titled "environmentally sound management and disposal of obsolete pesticide POPs and dioxin-rich fly ash environment in China" (hereinafter referred to as the Project). The Project Identification Form (PIF) was successively authorized by the president and council of Global Environment Facility (GEF) on Feb. 20th and Apr. 24th 2008; the Project Preparation Grant (PPG) was authorized on Mar. 13th. In order to promote the follow-up work of the Project, organized by MEP and UNIDO, Shenyang Academy of Environmental Sciences and Institute of High Energy Physics (IHEP) jointly finished the implementation work of the sub-item of the full sized project which focused on the research of disposal methods and environment risk evaluation.

This report is based on earnest implementation of the project contract (Contract No. C/V/S/08/270) and is carried out through full considerations of the Project's document preparation at preliminary design stage as well as the actual demand in the progress of advanced stage. On one hand, it is intended to provide statistical proof for technological choices in the implementation office of MEP's declaration progress; on the other hand, it may also instruct the implementation of the Full sized project and provide management and technological proofs for the final implementation pattern.

1.2 Project Objectives and Contents

1.2.1 Project objectives

According to the implementation requirements of China, this project, based on the broad research and evaluation of advanced technology and management systems home and abroad, as well as the situation of China, will finish the feasibility study of disposal methods for obsolete POPs pesticides, the identification of components and characteristics of fly ash of the incineration remains of obsolete POPs pesticides, and also the study of risk evaluation methods for contaminated sites so as to provide technological support for implementation at PPG stage and the further implementation of the Full Project. With respect to specific content of the Project based on the outline of sub-items, we will carry out the following actives:

(1) To investigate the technological and economic characteristics of industrialized disposal methods of obsolete POPs home and abroad, especially practicality and reliability pre-processing requirements, efficiency and incineration removal rate, by-products, disposal

capacity, fund requirement and cost benefit, in order to pose feasible suggestions on disposal technologies of obsolete pesticide POPs and dioxin-rich fly ash by incineration.

(2) To investigate, research and evaluate China's current management of dioxin-rich incineration fly ash , develop inventory methodology on dioxin-rich fly ash, complete a preliminary inventory in China and propose corresponding disposal technical line and managing methods; to indentify the characteristics of typical fly ash and put forward diversified disposal methods according to natures and quantities of domestic incinerators.

(3) To analyze the application of risk evaluation technology for POPs contaminated sites indentify and evaluate relevant parameters, so as to study evaluation methodology with typical contaminated sites and give practicable advices during the implementation of the Project.

1.2.2 Project components

1.2.2.1 Evaluation of disposal methods for POPs waste

This part will closely link with the overall development trend of international technologies and each country's respective basic requirements in the management of this area, while at the same time, based on the specific situations of the implementation of Convention in China, to carry out researches home and abroad in order to provide basic materials for the Project. POPs waste in this project mainly focus on obsolete POPs pesticides, dioxin-rich incineration fly ash, and sometimes also include other POPs waste. The design scheme of the main content and structure of the Project is as follows:

(1) Disposal technologies and theirs application home and abroad

This project will investigate and survey disposal technologies of POPs waste home and abroad, especially management systems; analyze and study typical cases; summarize their technical characteristics and requirements; and analyze their respective development trends. Main points: (a) overview of technologies; (b) management systems of technologies; (c) cases.

(2) Evaluation of disposal technologies home and abroad

This project will systematically evaluate disposal technologies of POPs waste home and abroad, including their applicability, economic costs and management. Main points: evaluation of disposal technologies abroad; evaluation of disposal technologies in China. Key points: (a) different categories of disposal technologies applicable for different waste; (b) advanced natures of operational parameters; (c) maturity and stability; (d) economical efficiency.

(3) Conception of disposal technology system construction in China

Main points: (1) analysis of development trend for applications of disposal technologies; (2) suggestions for China's future POPs waste disposal technology framework.

(4) Suggestions on the application of technologies in the Project

In this part, we will mainly examine plasma, cement kiln and PCBs incineration facilities, together with the application situations of disposal technologies; and we will build 1 or 2 fixed disposal facilities and a mobile plasma disposal facility under consideration of the Project so as to further analysis the feasibility. In addition, we will also consider adopting cement kiln disposal technology which is relatively of lower economic cost, and the technology to dispose waste during the progress of incineration which is proposed by Shenyang experts. The above work will closely encircle following points: (a) project objectives; (b) key contents analysis of the project; (c) technical requirements of the implementation of the project; (d) suggestions on the application of technologies in the project, including choice criterion and choosing plans of techno lies.

1.2.2.2 Investigation of fly ash inventory, characteristics identification and analysis of disposal technology

This part will closely integrate with the investigations of the characteristics of typical incineration fly ash and the advanced technologies and disposal methods of other countries. According to relevant requirements of the Convention, we will carry out investigations and studies both home and abroad to provide basic stuff for the project, and so as to develop inventory methodology on dioxin-rich fly ash and to complete a preliminary inventory in China; to indentify the characteristics of typical fly ash and put forward diversified disposal methods according to characteristics and quantities of domestic incinerators. This part mainly includes:

(1) Investigation of inventory of fly ash

In order to indentify the characteristics of fly ash contrapuntally, we must first develop a inventory of fly ash. First, we should research the methodology, frame proper investigation procedures and methods and determine the quantity and characteristics of dioxin-rich fly ash released by different incineration plants and relevant companies. Thus we can finally gather all the information into a inventory of dioxin-rich fly ash. Main points: (a) identification and classification of emission sources; (b) establish an emission sources list according to classification rules; (c) determine the generation rate of fly ash of different kinds of emission sources; (d) make sampling analysis of different kinds of fly ash and determine their physical and chemical characteristics; (f) establish fly ash generation rate list with physical and chemical characteristics of fly ash. Finally, we can complete the preliminary list in China.

(2) Differentiation of the characteristics of typical fly ash

Analyze the characteristics of fly ash in the survey list, especially their basic features such as morphological features, elemental composition, mineral composition and leachable toxic dioxin, and work out an evaluation report. Main points: (a) sampling analysis of typical fly ash; (b) evaluation of the characteristics of typical fly ash.

(3) Analysis of disposal technologies of fly ash

Investigate and study the disposal technologies of fly ash home and abroad, focus on the analysis of technical applicability and economic analysis, and make comparable analysis of different technologies. Based on China's development direction and the requirements in implementation of the Convention, while keeping in mind the gap between China and other countries, we will analysis those typical disposal technologies and give priority to the analysis of the advantages of non-incineration technologies. Main points: (a) overview of disposal technologies for fly ash home and abroad; (b) analysis of typical disposal technologies for fly ash. Besides, we can also analyze those technologies according to different emission sources, for example, the self-use disposal pattern in large scale incineration plants, centralized disposal pattern of small inclinators, or small emission sources relied on big incineration plants, and thus put forward respective disposal technologies and disposal scope according to the different characteristics, disposal patterns and service areas of fly ash.

(4) Implementation suggestions for the disposal of fly ash

Closely integrated with the design ideas of the Full Project, this part will put forward relevant implementation suggestions from the perspective of the promotion of disposal works of the 1000-ton fly ash. Main points: (a) project objectives; (b) key contents analysis of the project; (c) technical requirements of the implementation of the project; (d) suggestions on the application of technologies in the project.

1.2.2.3 Risk evaluation of contaminated sites(qualitative environmental risk evaluation, QERA)

This part of the Project will tightly coupled with the overall development trend of risk evaluation of contaminated sites in the world as well as the advanced experience in the area of risk evaluation of contaminated sites in USA and European countries, and integrate with China's realities, in order to explore China's own management system of risk evaluation technologies in contaminated sites. The design scheme of the main content and structure of the Project is as follows:

(1) Current situation and development trend of the risk evaluation of contaminated sites home and abroad

Investigate the governance situation of POPs contaminated sites home and abroad and relevant situation of risk evaluation (including risk evaluation of contaminated sites, post-evaluation and technical evaluation) in recent years, giving priority to the study of development trend for risk evaluation of contaminated sites in other countries, and put forward some suggestions while analyzing domestic trends. Main points: (a) Current situation and development trend of the risk evaluation of contaminated sites abroad; (b) Current situation and development trend of the risk evaluation of contaminated sites in China.

(2) Case studies of typical risk evaluation of contaminated sites

Select typical cases of contaminated sites. For example, select typical cases respectively from such different categories as single-POPs contaminated sites, complex POPs contaminated sites, and POPs-heavy metal combined contaminated sites. Then, systematically analyze those cases from the perspectives of basic social environment, natural conditions, relevant management measures, adoptive risk evaluation methods, remediation measures and post-evaluation methods; pick up those adoptable risk evaluation methods and relevant management measures which are integrated with China's realities. Main points: (a) basic situation; (b) relevant management countermeasures; (c) adoptive risk evaluation method

(3) Suggestions for the improvement of China's risk evaluation system

Although China has already launched some revision works regarding the policies, laws and standards of contaminated sites in order to improve the management system, the current system in China is still far from mature, especially that of POPs contaminated sites. This means we should establish and improve our framework of the clean up and disposal technology system of contaminated sites, especially determine the adoptive technologies and methods of risk evaluation. Main points: (a) framework of risk evaluation technology system for contaminated sites; (b) technologies and methods of risk evaluation, including the establishment of technology index system, selection of criterion, establishment of evaluation patterns, application and validation of technologies.

(4) Suggestions for the implementation of China's risk evaluation of contaminated sites

At present, China's environment management of contaminated sites still face many problems, such as lack of specific laws and regulations, imperfectness of management system, indeterminacy responsibility undertakers, imperfectness of the investigation and evaluation system, imperfectness of remediation technology of contaminated sites and capital system. The risk evaluation of contaminated sites should be implemented and managed on the basis of risk, and should be intended to lower the risk. We should carry out area survey and risk evaluation, determine relevant management requirements and technical policies, and lay the foundation for the elimination of POPs contaminated sites step by step. Main points: (a) project objectives; (b) key contents analysis of the project; (c) technical requirements of the implementation of the project; (d) suggestions on the application of technologies in the project.

(5) Works launched in coordination with the preparation works of the Full Project

In order to promote the expansion of the Full sized project, works that should be carried out in this stage include: (a) in terms of choice of disposal technologies, we should put forward choice criterion and methods for plasma disposal facilities, cement kiln facilities, fixed and mobile facilities; (b) we should put forward choice criterion for disposal project owners in the implementation of POPs waste disposal; (c) we should put forward capital budgets for the implementation of the Project; (d) we should supplement, amend and improve other issues in order to meet the needs of the implementation of the Project, for example, the information of providers for technical equipments, and preparation for tending and bidding schemes.

1.2.3 Organizational management and implementation process of the project

(1) Project management

During the implementation of the Project, Shenyang Research Academy of Environmental Sciences worked closely with The Institute for High Energy Physics (IHEP) jointly promoted the implementation of the Project. In addition, we also invited experts and scholars in the fields of policy standard, technology research and development, facility operation, supervision and management to participate in our Project, so as to make sure the scientificity and practicability of the project outcomes. In terms of overall stages, the Project can be divided into three stages: research and development as well as collection of materials, report compiling, and expert consultation and evaluation. These stages can make sure that the Project can achieve the goal of mutual complementarily in terms of power integration, and lay the foundation for the final succeed of the project.

As for project management, we have adopted the basic principles of using specialized staff and funding. In the implementation of the Project, we have strictly followed the implementation plans confirmed by the implementation office of China Ministry of Environmental Protection (MEP), and inspected our project output in each stage, so as to make sure the Project can be finished on time and of high quality. Through the implementation of the above works, the research team have successively achieved the goal of completing a terms of reference for the Project, and finished the compiling of the sub-item report of for Full sized projectof environmentally sound management and disposal of obsolete pesticide POPs and dioxin-rich fly ash environment in China.

(2) Project implementation progress

During the implementation of the Project, the research team has actively carried out relevant investigation and research works based on the terms of reference for the Project and work objectives determined by treatment regimen. (a) Research team has carried out international investigation and evaluation works in an all-round way according to the requirements of the implementation of the Convention. The POPs waste referred to in this Project are of large quantity and wide coverage, therefore, the research term fully investigate and evaluate POPs Convention, Basel Convention as well as other relevant information about the disposal technologies of PPW and application cases provided by international agencies such as UNEP and IHPA, so as to fully grasp the latest information in that area. (b) Research team has promoted effective linkage among PPW inventory, fly ash management and technology application according to China's realities. During the implementation of the Project, the research team has done investigations and researches on the spot in major domestic companies in order to meet the needs of the actual output of the sub-item. Main contents in these investigations and researches include management of PPW and fly ash, national and regional environmental planning and management, disposal technologies and facility operations. The research team has also taken carefully to the views and suggestions of experts, scholars and front-line staff and accepts these suggestions in this report.

During the implementation of the Project, the research team has received constant and vigorous support and assistance from the implementation office of China Ministry of Environmental Protection (MEP) and United Nations Industrial Development Organization (UNIDO). The research team has used forms such as panel discussion and seminars to discuss concrete problems and relevant solutions in the implementation of the Project, and actively promote the linkage between the team and other executive units at the PPG stage of the Project. All of their efforts have provided organic safeguards for a comprehensive "research paper on environmentally sound management and disposal of obsolete pesticide POPs andlso dioxin-rich fly ash environment in China" which not only meets the requirements of the Convention, but a conforms to China's actual conditions.

1.3 Research Approaches and Technique Flow

The research was conducted after widely investigating analyzing, and evaluating management regulations and technologies, and the technologies selection was determined considering the character of each technology:

(1) Selection and application prosposal of disposal technologies for pesticides POPs waste and dioxin rich fly ash is to be given after understanding the application and

management status abroad of POPs disposal technologies via literature, case study, system analysis, experts acquisition, and based on above study and the status of China.

(2)Disposal advice for fly ash by hazardous waste(including medical waste) incineration is to be given after inventory methodology research and output quantity of fly ash by hazardous waste(including medical waste) incineration, selections and evulation of suitable disposal technologies for PPW, and expert consulting have been done.

(3)Evaluation methodology for Pesticide contaminated site is to be given after analyzing the status and devoleping trends of risk evaluation of contaminates sites home and abroad, and comprehensive utilizing systetmatic analysis, mathematical analysis, logical deduction and expert acqustion, which provide the base for risk management of POPs contaminated site in China.

Figure 1 shows the technique flow chart of the Project implementation.

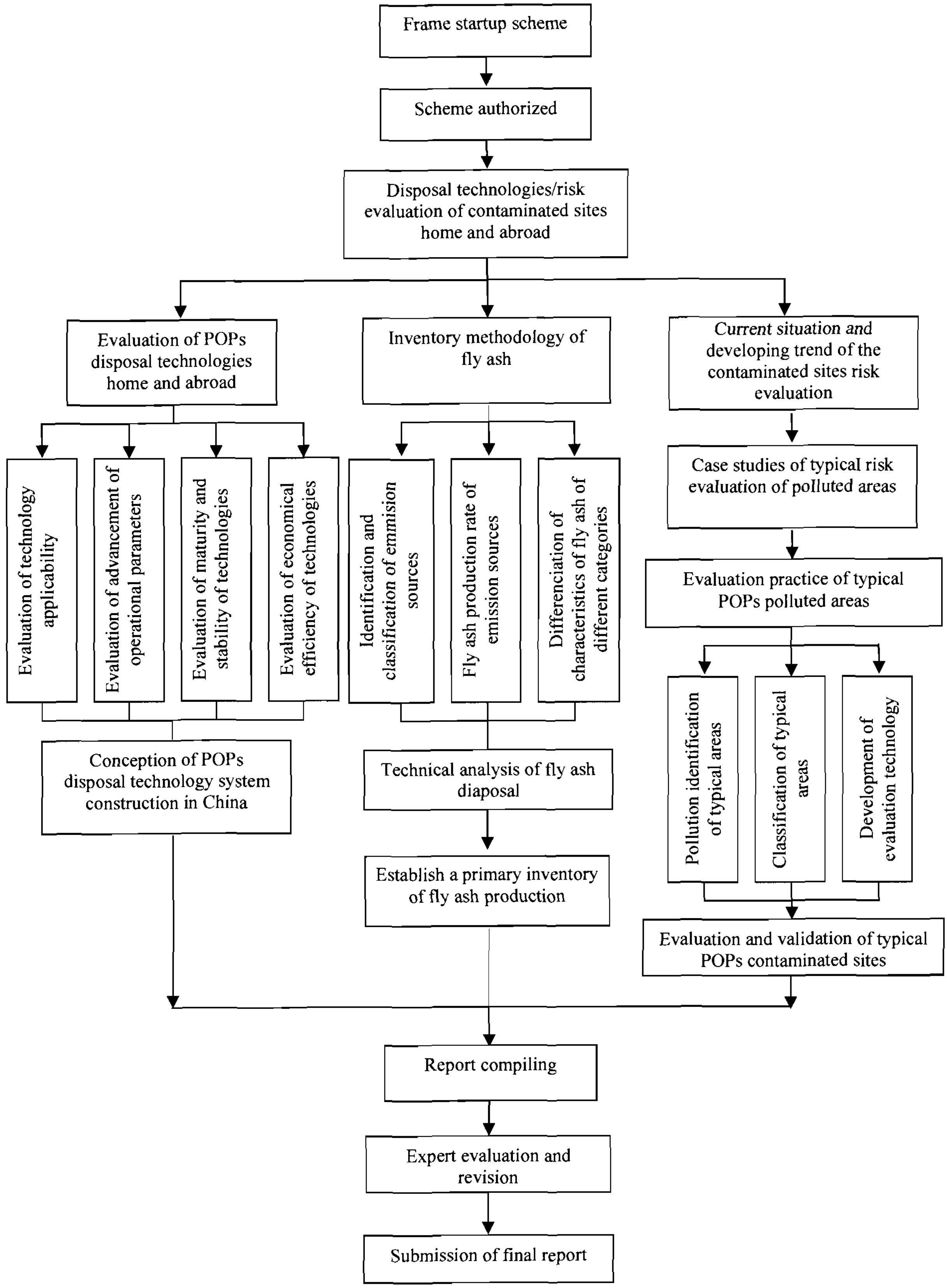


Figure 1 Technique Flow Chart of the Project Implementation

2. Preliminary Inventory of Pesticides POPs, Contaminated Sites, Fly Ash and Disposal of Task Analysis

2.1 Inventory of POPs Pesticides and Disposal of Task Analysis

2.1.1 Inventory of stockpile POPs pesticides

According to the report "The preliminary inventory investigation and disposal strategy for pesticides POPs waste and stockpiles in China", characteristics of regional distribution of stockpiles/obsolete pesticides POPs in China mostly are DDT,which locates in Jiangsu, Hunan, Sichuan, Shandong, Tianjin, Shanxi, Hebei and Liaoning, accounting for 70-80 percent of the total amount. The total amount of 9 pesticides POPs waste in China is 4000-6000t, including 2600-4500t DDT, 1500t HCB, chlordane and mirex, very little toxaphene, heptachlor dieldrin, endrin, aldrin, which show in **Table 1**.

Table 1 Currently Known Pesticides POPs Waste in China

Sector		DDT	Chlordane /mirex	HCB	Toxaphene	total
Production sector	The amount of waste(t)	2400-2800	1380-1510	60-70	-	3840-4380
Circulation sector	The amount of waste in agricultural sector(t)	164-1640	-	-	-	164-1640
	The amount of waste in sanitation sector(t)	55-73	-	-	-	55-73
Total amount of waste(t)		2619-2513	1380-1510	60-70	-	2059-4093

There are 3840-4380 tons obsolete pesticide POPs in production sector in China including 2400-2800 tons DDT, 60-70 tons HCB/Na-PCP, 1380-1510 tons potential waste chlordane and mirex. Among 3840-4380 tons, 2228-2458 tons has been identified, which accounts for approximately 60% of total amount.

The amount of waste pesticide DDT in agricultural sector in China is 164-1640t, among which 14.3 tons has been verified. The amount of waste pesticide DDT in sanitation sector in China is 55-73 tons, 11t has been verified. **Figure 2** shows the location and amount of Pesticides POPs Waste.

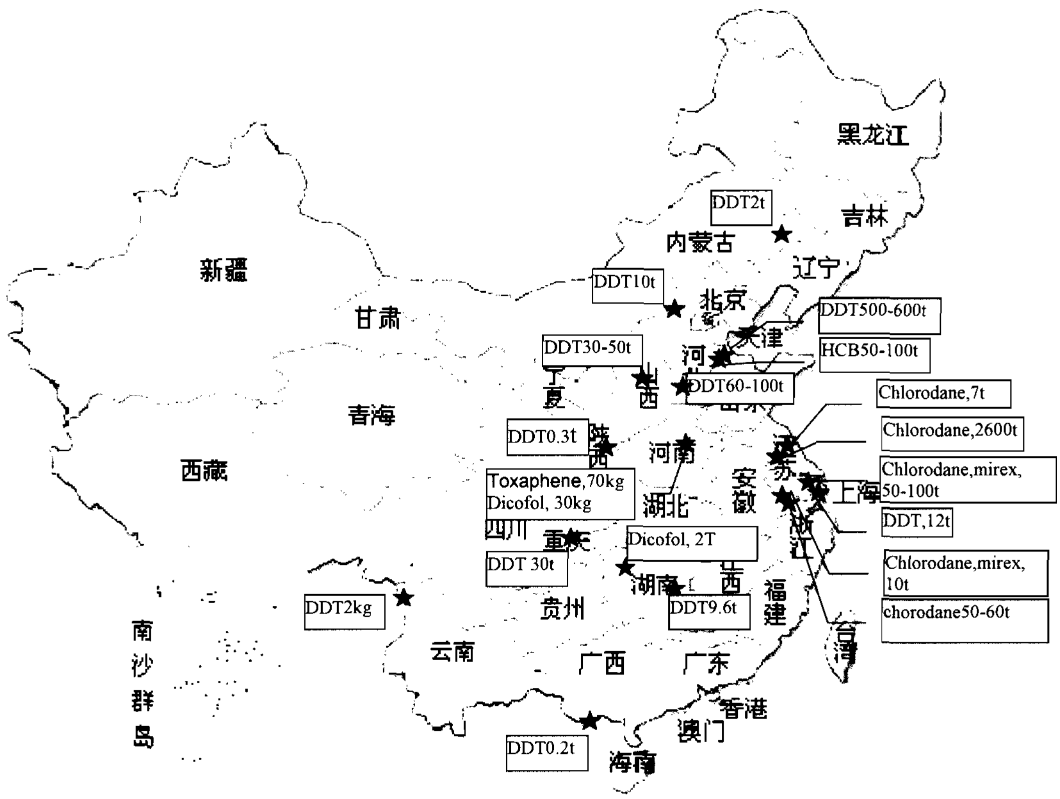


Figure 2 Distribution and Quantity of Pesticides POPs Waste

In the project implementation process, CIO also organized PPW site visiting work in Hebei, Tianjin, Jiangsu, Shaanxi and Chongqing provinces and new data obtained. Preliminary conclusions are as follows: 1360 tons Pesticides POPs waste have been verified, estamated 7000-8000 tons waste from contaminated sites need to conduct qualitative and quantitative analysis. During project implementation the amount that might be found in project implementation procedure, is about 500-1000tons. Comparing amount of PPW from site visiting with the data issued by "The preliminary inventory investigation and disposal strategy for pesticides POPs waste and stockpiles in China", the data changed very obviously, and the further checking needs to conduct.

Furthermore, from the view of PPW distribution: it distributed widely and mainly in the Manufacturers and Circulation section and the user. Many agricultural companies, health sector and termite control organization also have obsolete pesticide waste, however, this part is scattered and hard to identify. From the view of the components of Pesticide POPs POPs waste, besides contaning POPs, it also contains other substance,, such as Non-POPs composition, soil, gravel, etc.

2.1.2 Disposal task analysis of pesticide POPs waste

According to the location and amount of pesticides POPs Waste, PPW in China are mainly located in Hebei, Jiangsu, Zhejiang, Tianjin, Shanxi. Historically, those provinces produced plenty of pesticide-producing. In addition, provices or cities that stockpiled more than 10 tons or so are Shanxi, Beijing and Hunan Province. Based on full sized project design, it is that 11,000 tons of pesticides POPs waste need to be disposed within the running period of the project. In these waste disposal process, will actively promote the adoption of best feasible and environmentally sound disposal of technology. Therefore, from the project view, the project designs, on one hand to solve most of China's PPW disposal problems. On another hand, in its disposal process would also like to use safe and reliable, to reduce or avoid class POPs by-products of technology generation and emissions .In addition, by pesticides POPs waste disposal class, but also will promote the relevant management system, Public-private partnership and China's implementation process.

The project will promote environmentally sound disposal of 10,000 tons pesticides POPs waste and 1000 tons of incineration fly ash(tentative and co-processing) with 3 to 5 year. In fulfil that target, the project should face with the following issues:

(1)The component and distribution of pesticides POPs waste shows strongly Chinese feature. The distribution of PPW is wide and component is very complex. The components of waste include not only POPs but also some non-POPs components, like clay, detritus and even organic solvent. So the technologies should be wide-spretrum ones.

(2)The task of disposal under overall project framework is very huge. Mostly four issues should be handled:(a) centered distributed Pesticides POPs disposal issue;(b) scatter-distribute pesticides POPs waste should be disposed meanwhile;(c)fly ash by hazardous waste(including medical waste) incineration should be disposed in compliable with POPs waste disposal; (d) the technology selection should not only meet the requirement of BAT/BEP under international convention but also the management and disposal requirement of China government to hazardous waste.

(3)In view of the thinking of project design, from one hand, it needs to handle over the majority POPs waste disposal issue in China, on another hand, it need to apply environmentally sound technology to prevent sencondary pollution, and the third, by pesticides POPs waste disposal class, but also will promote the relevant management system, Public-private partnership and China's implementation process.

2.2 Preliminary Inventory of Pesticides POPs Contaminated Sites and Disposal of Task Analysis

2.2.1 Inventory of contaminated sites

According to status of pestcides whose location and amount have been known, PPW in China are mainly located in Hebei, Jiangsu, Zhejiang, Tianjin, and Shanxi. Historically, those provinces produced plenty of chemical and pesticides. In addition, the provinces more than 10 tons in stockpile are Shanxi, Beijing and Hunan Province. Because of the historical production and use of POPs waste, and environmental protection facilities was quite lagged at that time, so that the surrounding soil has been seriously polluted. At present, although most of the factories have stopped production or shut down, but environmental protection facilities at historically pesticides POPs waste stockpiled site were destoried or short of mantenance, and management level and the conditions of the relative lag, Which has resulted in serious pollution of the soil, forming a large area of pesticides POPs contaminated sites. At present the list of contaminated sites have a new investigation findings shows in **Table 2**.

Table 2 Preliminary Inventory of Pesticides POPs and Stockpile in China

No.	Units	Category	Obsolete (tons)	Contaminated site	Additional remarks
1	Tianjin Chemical Plant of Tianjin Bohai Chemical Co., Ltd	DDT	500-600	4000m^2	To DDT production for many years, is currently the only factory producing DDT
2	Zhangjiakou Greatwall Chemical Co., Ltd	DDT	10t; Residue 400m^3	15000m^2	History manufacturers
3	Taiyuan Chemical Plant Alkali-Chlorine Enterprises	DDT	30-50	The original production workshop:6466m^2;Contaminated area:10000 m^2	History manufacturers
4	XingTai City Pesticide Co., Ltd	DDT	60-100	2000m^2	History manufacturers
5	Tianjin Dagu Chemical Co., Ltd	HCB/PCP-Na	50-100	The original production area:75000m^2 Contaminated soil pile locations:3000m^2	To HCB production for many years, is currently the only factory producing HCB stop production in 2003
6	Jiangsu Jintan Shuibei HUIBEI Termite Control Material Plant	Chlordane	50-60	The original production workshop:100 m^2;Waste dumping ground:60 m^2	History manufacturers
7	Jiangsu Changqing Pesticide & Fertilizer Co. Ltd	Chlordane	1600t Wastewater;1000t Sediment	1500m^2	History manufacturers
8	The Second of Taicang City Xingtang chemical plant	Chlordane/ Mirex	100-150t	production workshop:3000m^2; Waste dumping ground:200m^2	Existing manufacturers

2.2.2 Disposal of contaminated sites task analysis

Based on full sized projectdesign, did not involve the remediation of contaminated sites, but contaminated sites is closely related to pesticides POPs waste storage and clean-up process, although remediation of contaminated sites will not be carried out under the full sized projectis framework , the corresponding risk evaluation is very necessaary. Through risk evaluation, a comprehensive understanding of the basic characteristics of contaminated sites, environmental risks, and inventory of contanminated sites, pollution risks and relevant environmental protection countermeasues can be developed in accordance with the principles of classification and management at different levels, advice and suggestions for treatment and remediation of contaminated sites can be put forward practically as well.

Aimed to the detailed requirements of full sized project implementation, the project determined the preliminary inventory and developed basic risk evaluation methodology based on analysis of risk evaluation and management mode home and abroad, to provide initial work for full sized project implementation .

2.3 Inventory of Hazardous Waste Incineration (Including Medical Waste) Fly Ash and Disposal of Task Analysis

2.3.1 Inventory of hazardous waste incineration (including medical waste) fly ash

2.3.1.1 Fly ash inventory from the hazardous waste incineration

Some researches show that the fly ash volume from the incineration of hazardous waste is 3% that of hazardous waste disposed. Based on this, the fly ash inventory from hazardous waste incineration can be calculated which shows in **Table 3**.

Table 3 Fly Ash Inventory from Hazardous Waste Incineration (×10^4t/a)

Province	Incineration design scale	Actual disposal amount	Fly ash amount from design scale	Flay ash amount from design scale
Guangdong	4.1	1.69	0.123	0.0507
Hainan	0	0	0	0
Shanghai	5.16	2.13	0.1548	0.0639
Zhejiang	12.46	5.15	0.3738	0.1545
Liaoning	1.44	0.59	0.0432	0.0177
Hebei	1.09	0.45	0.0327	0.0135
Chongqing	0.12	0.05	0.0036	0.0015
Jilin	0.6	0.25	0.018	0.0075
Hubei	1.64	0.68	0.0492	0.0204
Jiansu	11.71	4.84	0.3513	0.1452
Sichuan	0.5	0.21	0.015	0.0063
Heilongjiang	6.2	2.56	0.186	0.0768
Beijing	1	0.41	0.03	0.0123
Fujian	1.43	0.59	0.0429	0.0177
Tianjin	1.35	0.56	0.0405	0.0168
Henan	1.5	0.62	0.045	0.0186
Anhui	0.34	0.14	0.0102	0.0042
Hainan	0	0	0	0
Guizhou	0	0	0	0
Shandong	0.6	0.25	0.018	0.0075
Guangxi	0.5	0.21	0.015	0.0063
Shanxi	0.1	0.04	0.003	0.0012
Shanxi	0.09	0.04	0.0027	0.0012
Jiangxi	0.2	0.08	0.006	0.0024
Total	52.14	21.5	1.5642	0.6462

National hazardous waste incineration produces ash disposal facility design and the actual amount of fly ash produced as shown in Figure 3 and Figure 4.

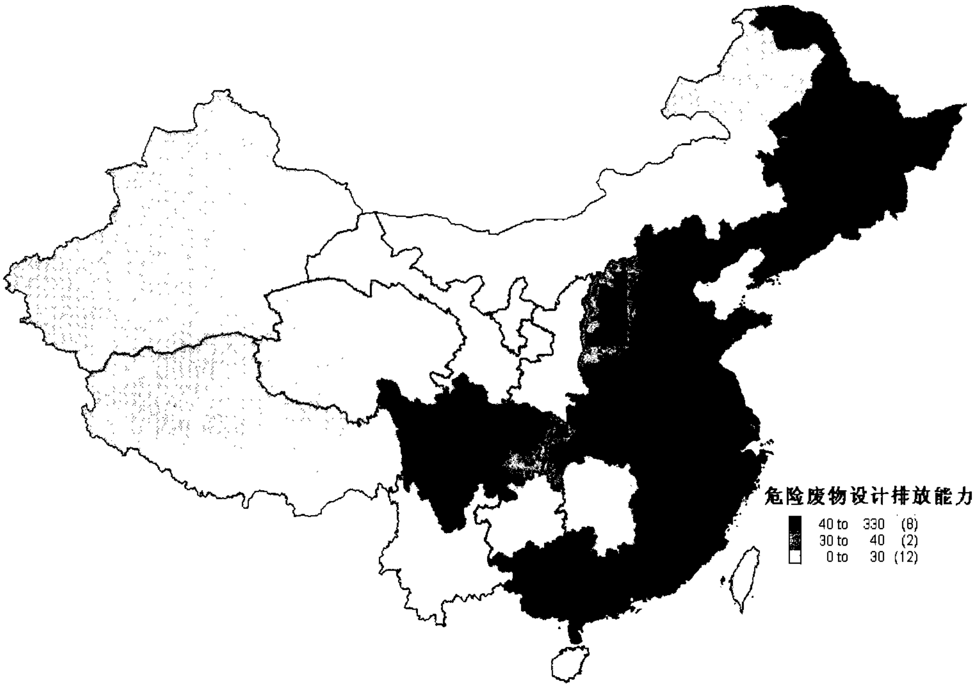


Figure 3 Fly Ash Design Generation Amount by National Hazardous Waste Disposal Planning (T/A)

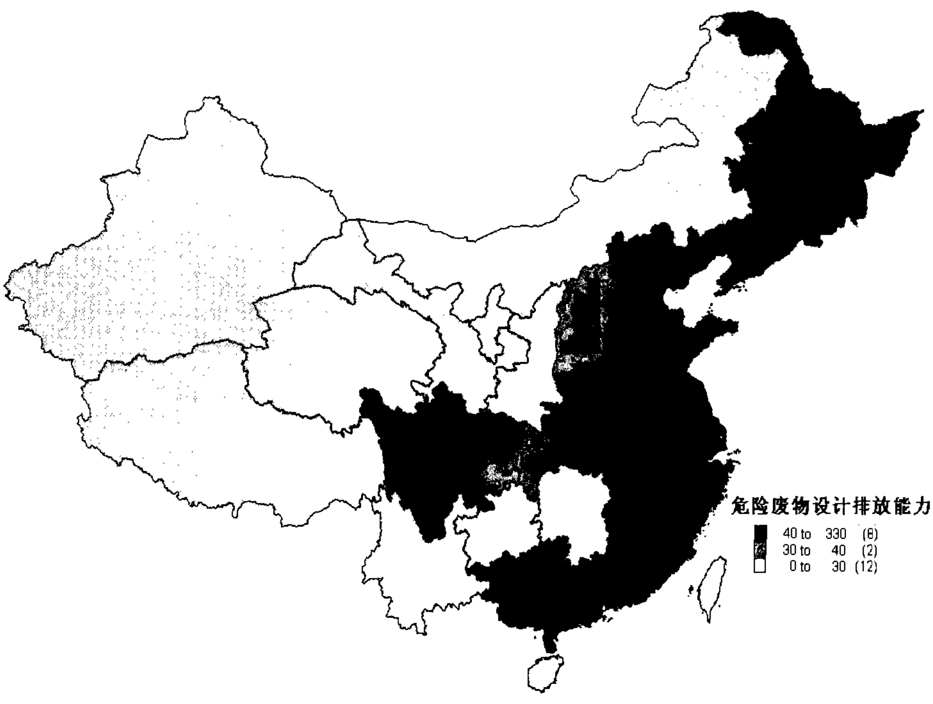


Figure 4 Fly Ash ActualGeneration Amount of Hazardous Waste Incineration Disposal(T/A)

2.3.1.2 Fly ash inventory from medical waste incineration

The total design capability of medical waste disposal is 33.6×10^4t/a all over the country in 2004, the reaching production percentage is 32%. Based on this, the actual disposal amount of medical waste is 10.76×10^4t/a(not include Jiangsu, Henan, Neimenggu,Ningxia and

Hunan,etc. The fly ash inventory from POPs waste incineration can be calculated, which shows in Table 4 in terms of same methods as the calculation of hazardous waste.

Table 4 Fly Ash Producing Amount of Medical Waste Concentrated Disposal Facilities

Provinces	City(Scale t/d)	Fly ash producing amount from design t/a	Actual Fly ash producing amount t/a
Guangdong	Meizhou (11.2), Guangzhou (12), Foshan (51), Yunfu, Yangjiang	755.57	241.78
	Heyuan (3.6), Zhanjiang (3.6), Jiangmen (3.6), Zhaoqing (3.6), Shanwei (3.6), Huizhou (3.6)	213.84	68.43
Shandong	Jinan (24), Qingdao (5), Zibo (8), Dongying (8), Yantai (10), Weifang (8), Jining (16), Taian (10), Weihai (4), Rizhao (6), Dezhou (5), Binzhou (7)	1098.90	351.65
Shanxi	Taiyuan (50) *Jinzhong (3.6), Jiexiu (3.6), Yuncheng (5), Jincheng (3), Lvliang (5), Linfen (3), Houma (2.4)*	748.44	239.50
Zhejiang	Hangzhou (30), Shaoxing (1.2), Huzhou (10), Linhai (3), Chengzhou (0.4), Ningbo (24), Zhuji (2)	698.94	223.66
Jiangsu	Suzhou (18), Yanghzhou (18), Xuzhou (15), Taizhou (10), Changzhou (22), Lianyungang (18), Nantong (18), Wuxi (18), Jiangyin (6), Nanjing (34), Huaian (6), Zhenjiang (10), Yancheng (10)	2009.70	643.10
Heibei	Changzhou (8), Tangshan (9), Qian'an (0.8), Xingtai (10) *Shijiazhuang (7.2), Handan (8), Baoding (15.2), Qinhuangdao (0.29), Langfang(2.4)*	602.81	192.90
Heilongjiang	Qiqihar (10), Mudanjiang (2), Jiamusi (6), Daqing (20), Jixi (6), Qitaihe (2.5) *Harbin (10)*	559.35	178.99
Liaoning	Shenyang (15), Dalian (10), Fushun (8), Benxi (4), Yingkou (2), Panjin (4)	425.70	136.22
Shanghai	5 facilities (55.2)	546.48	174.87
Beijing	Nangong (30), Chest Hospital (5), Jingjie (10), Miyun Environmental and Sanitary Office (1), Pinggu Disinfection Center (0.5)	361.35	115.63
Fujian	Xiamen (12), Quanzhou (6), Zhangzhou (5), Sanming (1.68), Nanping (0.24)	246.71	78.95
Sichuan	Luzhou (10, 2 sets), Chengdu (0.5), Penghzhou (0.8) *Mianyang (2), Deyang (4.8), Neijiang (2), Zigong (2.4), Luzhou (4.8)*	270.27	86.49
Xinjiang	Urumchi (30), Shihezi (0.6), Bazhou (5), Karamay (5), Kuitun (2.5)	436.59	139.71
Inner Mongolia	*Hohhot (12), Baotou (8), Tongliao (3)*	227.70	72.86
Hunan	Yueyang (10)	99.00	31.68
Shanxi	Xi'an (45), Xianyang (5), Baoji (5), Hanzhong (5)	594.00	190.08
Guangxi	Nanning (12), Guilin (10), Liuzhou (12)	336.60	107.7120
Guizhou	Zunyi (4), Guiyang (15)	188.10	60.1920
Hainan	Sanya (5), Haikou (6)	108.90	34.85
Henan	Zhenzhou (24) *Shangqiu (1), Luoyang (24), Anyang (2.4), Xuchang (2.4), Sanmenxia (1.5)*	547.47	175.19
Hubei	Wuhan (45), Xiangfan (10)	544.5	174.24

Provinces	City(Scale t/d)	Fly ash producing amount from design t/a	Actual Fly ash producing amount t/a
Jilin	Changchun (8), Jilin (15)	227.7	72.86
Gansu	Lanzhou (12)	118.8	38.02
Ningxia	*Yinchuan (5), Shizuishan (5), Wuzhong (4.8), Guyuan (3)*	176.22	56.39
Jiangxi	Ganzhou (8) *Nanchang (11)*	188.10	60.19
Qinghai	Xining (7.2)	71.28	22.81
Tianjin	(20)	198.00	63.36
Chongqing	Tongxing Corporation (20) *Solid Waste Management Center (26), Fuling Solid Waste Management Center (8.6)*	540.54	172.97
Total		13141.56	4205.28

Fly ash generation and medical waste incineration flay ash of each province in China is shown in Table 4. Estimated from the current design scale, the fly ash production amount is 13141.56t/a and 4205.28t/a estimated by the generation rate specified in environemtnal standard. The estimated generation amount and actual gernation under the design of National medical waste incineration disposal facility are shown in Figure 5 and Figure 6 respectively.

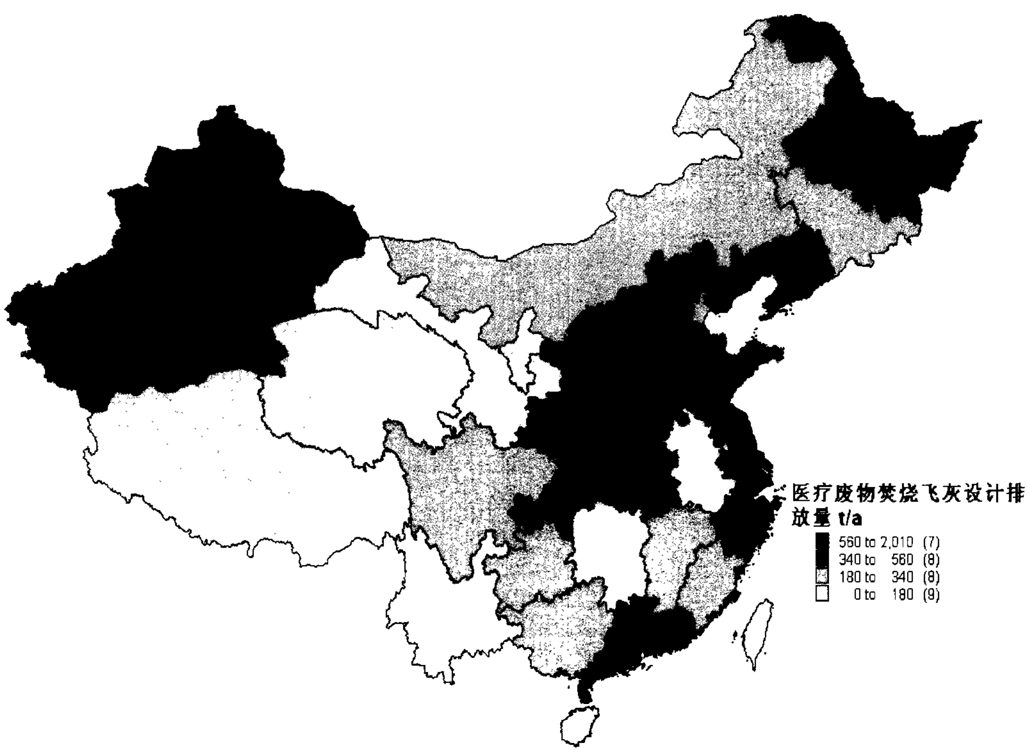


Figure 5 Fly Ash Design Generation Amount from Medical Waste Incineration Disposal Pnanning (T/A)

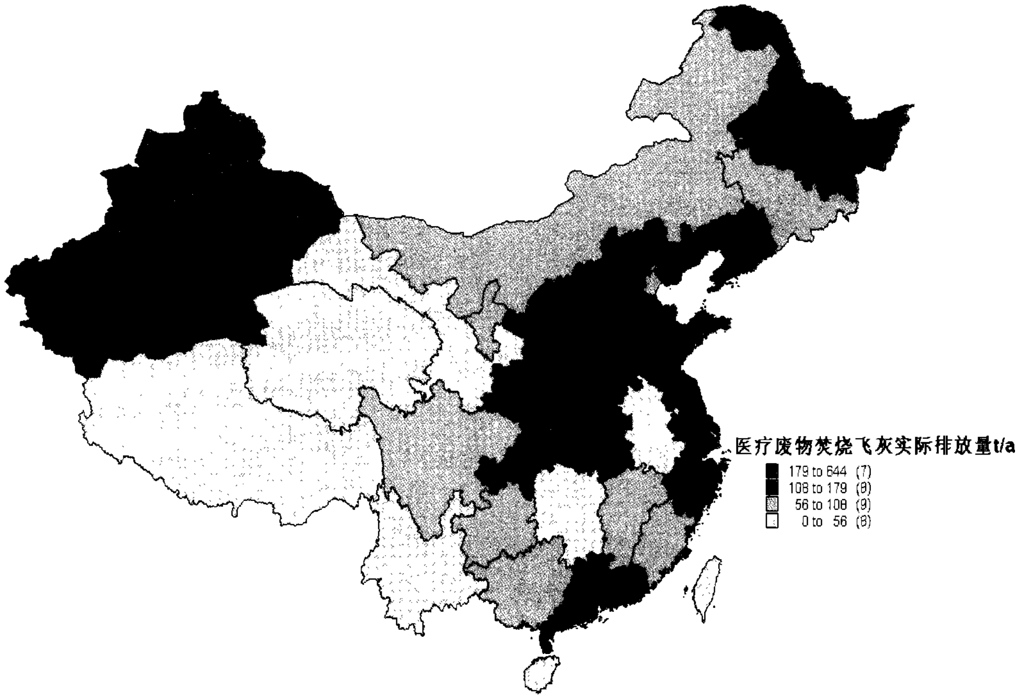


Figure 6 Fly Ash ActualGeneration Amount From Medical Waste Disposal (T/A)

2.3.2 Incineration fly ash disposal task analysis

Fly ash disposal problems under full sized project framework is to conduct a pilot disposal , its main aim is to dispose of some 11,000 tons of pesticides POPs waste and to apply the same techniques to dispose other hazardous waste (including medical waste disposal) surrounding POPs disposal facilities at same time, which total disposal is about 1 000 tons. The launching of disposal activities and specific disposal plan will be based on pesticides POPs waste disposal activities conducted.

References

1. The preliminary inventory investigation and disposal strategy for pesticides POPs waste and stockpiles in China.2004.7
2. National medical waste and hazardous waste disposal facilities construction plan 2004.1

3. Technique Evaluation and DisposalConception of Pesticide POPs Waste

3.1 Technology Evaluation of Pesticide POPs Waste

3.1.1 Technology selection for POPs waste disposal by Stockholm convention

The Stockholm convention aims at reduction, elimination and prevention of POPs pollution to protect the human being health and environments. The annex of the Convention issued 12 kinds controlled POPs in first batch, including: (1) Annex A (intentional produced chemicals is required to eliminated according to the Convention): Aldrin, Chlordane, Dieldrin, Endrin Heptachlo, Hexachlorobenzene Mirex Toxaphene, Polychlorinated Biphenyls (PCB); (2)Annex B(intentional production, is limited by the convention), DDT; (3) Annex C (unintentional production, is required to reduction or elimination the emission), PCDD/PCDF, Hexachlorobenzene (HCB), Polychlorinated biphenyls (PCB). The convention also clarified that the controlled list is opening and subject to add new controlled production abiding by the procedure of convention. Till up to now there have been 10 candidates listed. To promote the implementation of the convention, the convention give directive measure to 12 kinds POPs mentioned above all, and all parties should carry out the implementation of the Stockholm convention based on the situation of each country;

The article VI and article V stipulate the relevant requirements for reduction or eliminatin of byprodoct POP releasing, and reduction or elimination of stockpiled POPs waste.

In accordance with Article VI of the Convention, all contracting parties should meet the following requirements: (1) strategies should be made to ascertain the stocks of POPs products (semifinished products) and of waste containing POPs or contaminated by POPs. (2) based on this strategy, stocks of POPs products or semifinished products should be ascertained as soon as possible. (3) these stocks should be properly managed in a safe, effective and harmless way. (4) appropriate measures should be taken to ensure that POPs waste will be managed and finally disposed of in a harmless way. Fifth, every effort should be made to develop strategies aiming at ascertaining contaminated sites, as well as to ensure that harmless methods will be adopted in the restoration of these contaminated sites.

In accordance with Article V of the Convention, to the pollution control of by-product POPs, the convention stipulates that all parties should develop and implement action to find out the emission of chemicals listed in annex C and action plan for their emission reduction in BAT/BEP way; The key source and new source listed in annex C part II should be taken in BAT/BEP way as soon as possible and the action should be conducted in a phase-out way no less than 4 year after the Convention come into force. The existing source listed in annex C should be eliminated step by step. All parties should consider the universal guidance on by products POPs generation and emission, and the best available techniques and guidance on best environmental practices approved by contracting parties committee (base on article V and annex C, in brief BAT/BEP guideline). The 3rd contracting parties meeting approved BAT/BEP guideline on May this year, and BET/BEP concept transplantation and demonstration action to developing countries is the key scopes of convention funding and technique supporting.

According to the definition, the Best practices technology means that the activities and operation procedures have achieved most effective and developed phase, and the specific technology is feasible in principle, which aims to prevent or cut-off the pollution may occur, or reduce the emission of chemicals listed in annex C. Technologies includes the design, building, maintenance, operation and elimination procedures that might be taken. The practical technology means that the users can acquire or develop with best cost benefit efficiency under sound technology and economy conditions and can be applied in relevant industrial department. The best means that the technology can protect the environment with highest level. The best environmental practices mean application of most suitable combination of environmental control and strategies. New source" means any source of which the construction or substantial modification is commenced at least one year after the date of: entry- into-force of this Convention for the Party concerned; or entry into force for the Party concerned of an amendment to Annex C where the source becomes subject to the provisions of this Convention only by virtue of that amendment. Release limit values or performance standards may be used by a Party to fulfill its commitments for best available techniques under this paragraph.

So far we can see that BAT/BEP includes those aspects:

(1) Analyzing of BAT, we need the most advanced and effective technology, not only economy feasible, environmental friendly, but also the dependable technology. However, the technologies are not merely technologies themselves, they include design, construction, maintenance, operation, elimination et al, as well, and more consideration should give to technology-economy level, literature background.

(2) Analyzing of BEP, the core is a management section, which the nature is to realize the combination of environmental control so as to prompt the pollution control.

(3) Analyzing the relationship between BAT and BEP. BAT and BEP are organic unity. BAT emphasizes on handling pollution control with technology view and BEP emphasized on with management view and utilizing end-control, processing-control and alternative technology in concrete unit. The reduction of low risk waste release, the waste generation cut-off from the source and the resource recycling can come to true when well BAT and BEP integration. The POPs waste release will be cut down to the lowest level. However, we should consider more of public healthy, environment sound, socials and economy factor, and the situation of China when promotion of BAT/BEP and the sustainable development of social, environment and economy will be promoted.

(4) Considering the requirements of the Convention, to propel the processing of the Convention implementation is the same problem for each contracting party. BAT/BEP method is a crucial way to control the pollution of by-products POPs. Totally, with regard to great difference on the scale, technology, management and pollution control measure, environmental awareness of waste-releasing enterprises. Implementation of BAT/BEP at by-products area is facing with great challenge.

To fulfill requirements of the Convention, China has promised to take the following actions. First, standards and norms should be set to identify POPs waste, which will provide technical basis for the investigation and obtainment of POPs waste state list. Second, investigation plans should be made to investigate and obtain POPs products stocks and POPs waste state list. Third, relevant regulations and standards should be improved, at the same time the supervision and management capacity should be strengthened, in order to ensure an effective environmentally safe management to POPs products stocks and POPs waste. Fourth, a safe, effective and harmless way should be adopted to treat and dispose of POPs waste. Fifth, standards and norms should be set to identify POPs contaminated sites. Sixth, action plans should be developed to investigate and obtain the list of POPs contaminated sites. Seventh, a sound regulatory system should be established to effectively manage contaminated sites. Eighth, technical system of contaminated sites restoration should be established, and at the same time the restoration projects will be demonstrated.

To sum up, pesticide POPs management and disposal have covered Article V and VI of the Convention. Thus, PPW should be managed and disposed of to meet the corresponding performance requirements, accordingly to requirements of the Convention and China's national conditions.

3.1.2 Recommended technologies by the Basel Convention

The secretariat of the Basel convention, the Environment Protection Agency of United states(EPA), Union Nation Environmental Program(UNEP), and International hexachlorobenzene and Pesticides Association(IHPA) issued guideline or technology summary on non-incineration disposal of POPs waste. The reports are summarized as fellow:

Secretariat of Basel Convention, 2006, 'Updated general technical guidelines for the environmentally sound management of waste consisting of, containing or contaminated with persistent organic pollutants (POPs)' approved on the COP8. Online Address: http://www.basel.int/pub/techguid/tg-POPs.pdf. This guideline is pursuant to decisions IV/17, V/26, VI/23, VII/13 and VIII/16 of the Conference of Parties of the Basel Convention on the Control of Transboundary Movement of Hazardous Waste and Their Disposal, I/4, II/10, III/8, IV/11 and V/12 of the Open-ended Working Group of the Basel Convention, resolution 5 of the Conference of Plenipotentiaries to the Stockholm Convention on Persistent Organic Pollutants, decisions INC-6/5 and INC-7/6 of the Intergovernmental Negotiating Committee for an International Legally Binding Instrument for Implementing Action on Certain Persistent Organic Pollutants and decisions SC-1/21and SC-2/6 of the Conference of the Parties to the Stockholm Convention, provide guidance for the environmentally sound management (ESM) of waste consisting of, containing or contaminated with POPs. In section G (2)- destruction and irreversible transformation methods of this guideline, the following destruction technologies were introduced:

(1) Alkali metal reduction
(2) Base-Catalyzed Decomposition (BCD)
(3) Catalytic hydrodechlorination (CHD)
(4) Cement kiln co-incineration
(5) Gas-Phase Chemical Reduction (GPCR)
(6) Hazardous-waste incineration
(7) Photochemical dechlorination (PCD) and catalytic dechlorination (CD) reaction
(8) Plasma arc
(9) Potassium tert-Butoxide (t-BuOK) method
(10) SCWO and subcritical water oxidation
(11) Thermal and metallurgical production of metals
(12) Waste-to-gas conversion

3.1.3 Recommended technologies by UNEP

UNEP, Science and Technology Advisory Panel(STAP) of the GEF, 2004. 'Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing countries.' GF/8000-02-02-2205. Online address: http://www.basel.int/techmatters/review_pop_feb04.pdf. This report provides a summary overview of disposal technologies that are considered to be innovative and emerging and that have been identified as potentially promising for the destruction of POPs in stockpiles. The report was originally a background document for the STAP-GEF workshop held in Washington, DC, in October 2003 and was based on work done by the International Centre for Sustainability Engineering and Science, Faculty of Engineering, at the University of Auckland, New Zealand. This report contains overviews of the following non-combustion technologies. This summary classifies the 27 technologies into five categories: A)- Commercialized technologies with considerable experience, B)- Technologies near or at the start of commercialization, C)- Promising technologies, D)- Technologies which require significant research, E)- Technologies which are unlikely to be applicable for destruction of POPs stockpile (including Bioremediation technologies, which are separated in this report as F) and G)- Not classifiable.

A) Six commercialized technologies with considerable experience, technologies with operating plants, which are licensed to destroy high strength POPs stockpiles, including:

(1) Gas-Phase Chemical Reduction (GPCR)
(2) Base-Catalyzed Decomposition (BCD)
(3) Sodium Reduction
(4) Supercritical Water Oxidation (SCWO)
(5) Plasma Arc
(6) Pyrolysis

B) Two technologies near or at the start of commercialization, technologies, which have operating pilot plants, are starting to build operating plants and are claimed to be suitable for treating high strength POP waste. The latter treatments would require proof of concept (99.9999% destruction and no formation of toxic daughter products) before being considered fully suitable, including:

(7) Molten Salt Oxidation
(8) Solvated Electron Technology

C) Five promising technologies, technologies, which require minimum research to prove capability to destroy high strength POPs stockpiles, or which are operating successful pilot plants. Processes, which have demonstrated in the laboratory the ability to treat moderate to high strength POPs with a high efficacy and no formation of toxic daughter products are included.

(9) Ball Milling
(10) GeoMelt™ Process
(11) Mediated Electrochemical Oxidation (CerOx™)
(12) Mediated Electrochemical Oxidation (AEA Silver II™)
(13) Catalytic Hydrogenation

E) Six technologies which are unlikely to be applicable for destruction of POPs stockpiles, technologies which have inherent flaws which will make them unlikely to be successful in treating high strength POPs. It must be recognized, however, that it is likely that some information on these and other technologies has not been published and therefore some data may not be available which could show that these technologies may be feasible, including:

(14) $MnOx/TiO_2–Al_2O_3$ Catalyst Degradation
(15) TiO_2-based V_2O_5/WO_3 Catalysis
(16) Fe (III) Photocatalyst Degradation
(17) Ozonation/Electrical Discharge Destruction
(18) Molten Metal
(19) Molten Slag Process

F) Seven bioremediation technologies, bioremediation techniques have been placed in category F because of their unsuitability for destruction of highly concentrated POPs waste. But it was felt that the bioremediation technologies are a category on their own, because of their enormous potential to remedy soil contaminated with POPs, containing both proven and unproven technologies. Subsequent to the review it was suggested that the Astra Zeneca bioremediation technology should be added, because of its good results obtained on Toxaphene at Tampa Stauffer.

(20) Photochemically Enhanced Microbial Degradation
(21) Biodegradation / Fenton's Reaction
(22) White Rot Fungi Bioremediation
(23) Enzyme Degradation
(24) In situ Bioremediation of Soils
(25) DARAMEND® Bioremediation
(26) Phytoremediation

G) Not Classifiable

(27) Self-Propagating High Temperature Dehalogenation (SPHTD)

3.1.4 Technologies recommend by IHPA

IHPA. 2002. IHPA and North Atlantic Treaty Organization (NATO) Committee on the Challenges of Modern Society (CCMS) Pilot Study Fellowship Report: 'Evaluation of Demonstrated and Emerging Remedial Action Technologies for the Treatment of Contaminated Land and Groundwater (Phase III).' Online Address: http://www.ihpa.info/libraryNATO.htm. This report describes emerging non-combustion alternatives for the economical destruction of POPs. Mr. John Vijgen of IHPA collected the technology data and authored the report. The report contains fact sheets for the 11 technologies for POPs treatment, 11 of which were also covered by the report GF/8000-02-02-2205, the extra 2 technologies are:

(1) In situ thermal destruction
(2) TDR-3R™

3.1.5 Technologies recommened by USEPA

USEPA,, 2005, 'Reference Guide to Non-combustion Technologies for Remediation of Persistent Organic Pollutants in Stockpiles and Soil', EPA-542-R-05-006, Online address: http://www.clu-in.org/POPs. Based on 29 technologies described by GF/8000-02-02-2205 and Mr. John Vijgen' report, 13 technologies were selected to be evaluated, and the plasma arc technologies was divided in to three companies' processes. Four technologies were also introduced in the report, which are Anaerobic Bioremediation Using Blood Meal for Treatment of Toxaphene in Soil and Sediment, In situ thermal desorption and Sonic Technology and Xenorem™. This report provides a high level summary of information on the applicability of existing and emerging non-combustion technologies for the remediation of POPs in stockpiles and soil for the state and local policy makers, owners and operators of contaminated sites, consultants, and other partners related. In total, 19 non-combustion technologies were reviewed and classified as seven full scale technologies (Full in following table), five pilot scale technologies (Pilot in following table), three bench scale technologies (Bench in following table), and four full-scale technologies with potential to treat POPs (Full-P in following table), including:

Full scale technologies (7):

(1) Anaerobic Bioremediation Using Blood Meal for Treatment of Toxaphene in Soil and Sediment
(2) DARAMEND® Bioremediation
(3) Gas-Phase Chemical Reduction (GPCR)
(4) GeoMelt™ Process
(5) In situ Thermal Desorption (ISTD)
(6) Mechanochemical Dehalogenation (MCD)
(7) Xenorem™

Pilot scale technologies (5):

(8) Base-Catalyzed Decomposition(BCD)
(9) Mediated Electrochemical Oxidation (CerOx™)
(10) Phytoremediation
(11) Solvated Electron Technology
(12) Sonic Technology

Bench scale technologies (3):

(13) Self-Propagating High-Temperature Dehalogenation (SPHTD)
(14) TDR-3R™
(15) Mediated Electrochemical Oxidation (AEA Silver II™)

Full-scale with potential to treat POPs (4):

(16) Plasma arc (PLASCON™)
(17) Plasma Arc Centrifugal Treatment (PACT)
(18) Plasma Converter System (PCS)
(19) Supercritical Water Oxidation (SCWO)

CMPS&F- Environment Australia, Review Report Number 4-November 1997, 'Appropriate technologies for the treatment of scheduled waste'. Online Address:

http://www.environment.gov.au/settlements/publications/chemicals/scheduled-waste/swtt/index.html. A review has been carried out to determine the current status of the development and availability of technologies for treating scheduled waste within Australia.

The treatment technologies reviewed included:

(1) Ball Milling
(2) Base Catalysed Dechlorination (BCD)
(3) Catalytic Treatment
(4) Cement Kilns
(5) Gasification
(6) Eco Logic (GPCR)
(7) Molten Metal
(8) Molten Slag
(9) Molten Salt
(10) PCB Gone
(11) Plasma Arc Centrifugal Treatment (PACT)
(12) Supercritical Water Oxidation
(13) Solvated Electron Technology
(14) Steam Detoxifier
(15) PCS Thermal Desorption
(16) STARTECH (plasma technology)
(17) In Situ Vitrification
(18) Solar Detoxification
(19) TFS Thermal Desorption Retort Technology
(20) Pre-treatment Technologies

- Solvent extraction
- Thermal extraction
- Stopped Counter Flow Adsorption

3.1.6 A overview of disposal technologies on POPs waste worldwide

Table 5 summarized the technologies discussed above all as a prilimiary technological screening name list. In this section, several factprs are considered, including application range, type, muturity, and applicability to POPs. The type means here two sub-types, which are incineration and non-incineration according to the international customs. According to their mechanisms, techologies can be classified as pyrolysis, incineration, chemical-process, biological-processing. However, In this section, cheimical process are not be classified furtherly although it can be as advanced oxidization and reduction technologies.

Above mentioned techologies are summerized in **Table 5**, as the candicate technologies source for preliminary screening. The factors includes application range, maturity, and adaptivity to PPW. As aspect of technologies type, it can ben divived into four categories, which are thermal treatment techologies(including incineration, pyrolysis, cement kiln, plasma, melting, thermal desorption), chemical treatment(including chemical oxidation, chemical reduction), physicochemistry treatment, biology treatment. Technology maturity can be classified as commercialization level, demonstration level and pilot level.

Table 5 A Overview of Disposal Technologies on POPs Waste Worldwide

No.	Title	Application range	Type	Patent	Maturity	Suitability*
1	High Temperature Incineration	All POPs waste	incineration	Yes	commercialization	OK
2	Pyrolysis	All POPs	pyrolysis	Yes	commercialization	OK
3	Cement Kiln co-processing	All POPs waste	incineration	Yes	commercialization	OK
4	Plasma Arc Centrifugal Treatment（PACK）	all POPs waste	plasma arc	Yes	commercialization	OK
5	Plasma Converter System（PCS）	all POPs waste	plasma arc	Yes	commercialization	OK
6	Plasma Enhanced Melter™（PEM）	All POPs waste	all POPs waste	Yes	commercialization	OK
7	GeoMelt™	All POPs waste	melting	Yes	commercialization	OK
8	Molten metal	Gas, liquid, powder, may e suitable to all POPs.	molten	Yes	pilot	OK
9	Molten salt oxidation	All waste, but just a few case to pesticide	molten	Yes	demonstration	OK
10	Molten Slag	Almost all POPs waste	molten	Yes	pilot	OK
11	In-situ thermal desorption/destruction	PCBs and dioxin containing soil or sediment	Pyrolysis/incineration	Yes	commercialization	OK
12	Solvated electron technology	All POPs and other organic chemical contaminated soil, including PCBs,DDT,HCB and malathion, mixing chlorinated pesticide, dioxin/furan and explosive waste	chemical reduction	Yes	demonstration	OK
13	Mechanochemical dehalogenation (MCD) / Ball Milling	All low POPs content waste	chemical reduction	Yes	commercialization	OK
14	Base-catalyzed decomposition（BCD）	All POPs, 30% PCBs- containing waste, soil, sediment, and liquid. wood, paper, PCBs in transformers	chemical reduction	Yes	commercialization	OK
15	Sodium Reduction	Transformer oil with PCBs, ceiling 10,000 ppm	chemical reduction	Yes	commercialization	OK
16	Catalytic hydrogenation	All low POPs content liquid	chemical reduction	Yes	demonstration	OK

No.	Title	Application range	Type	Patent	Maturity	Suitability*
17	Gas-phase chemical reduction(GPRC)	All POPs, high / low concentration, hydrophilic and hydrophobic liquid, sediment, transformers and capacitors	chemical reduction	Yes	commercialization	OK
18	Electrochemistry enhanced microbialdegradation	All low POPs content contaminated soil and sediment	biology	Yes	demonstration	OK
19	chemical oxidization nAEA Silver II™ Mediated electrochemical oxidation	Chlorinated hydrocarbons, sulfur-containing and phosphorus-containing pesticide, can also used to treat organic radioactive waste	chemical oxidization	Yes	demonstration	OK
20	chemical oxidization CerOx™ Mediated electrochemical oxidation	low chlordane, dioxins and PCBs content liquids, solids and sediments	chemical oxidization	Yes	demonstration	OK
21	Fe(III) photocatalyst degradation	Low POPs content water	chemical oxidization	Yes	no data	OK
22	DARAMEND®	low toxaphene and DDT containing soil and sediment	biology	Yes	commercialization	OK
23	Self propagation high temperature dechlorination (SPHTD)	HCB containing contaminants	unknown	Yes	Laboratory	OK
24	TDR-3R™	High HCB content contaminants	incineration	Yes	pilot	NA
25	Sonic technology	PCBs contaminated soil	Physical /leaching	Yes	demonstration	NA
26	Supercritical water oxidation (SCWO)	All POPs, in form of liquid and solid particles with 200μm diameter. Organic substance content less than 20%	chemical oxidization	Yes	commercialization	NA
27	TiO2-based V2O5/ WO3 catalysis	All POPs maybe	chemical oxidization	Yes	no data	NA
28	MnOx/ TiO_2 - Al_2O_3 catalyst degradation	Low POP content, merely HCB and dichlorobenzene test available	chemical oxidization	Yes	no data	NA
29	Ozonation / electrical discharge destruction	PCDDs/PCDFs and other POPs in form of gas.	chemical oxidization	Yes	no data	NA

No.	Title	Application range	Type	Patent	Maturity	Suitability*
30	Rot Fungi remediation	Minor contaminated soil by PCBs dioxin, PAH, and halogenic substance	biology	Yes	pilot	NA
31	Electrochemistry enhanced microbial degradation	All POPs	biology	Yes	no data	NA
32	In situ bioremediation of soils	DDT(2,500ppm)	biology	Yes	Laboratory	NA
33	Photochemically enhanced microbial degradation	All POPs	biology	Yes	no data	Bad
34	Enzyme degradation	Low content PCBs	biology	Yes	pilot	Bad
35	Bioremediation/Fenton reaction	PAH contaminated soil(600ppm)	biology	Yes	No data	Bad
36	Xenorem™	Soil and sediment with low content chlorindane, DDT, dieldrin and toxiphene	biology	Yes	commercialization	Bad
37	Anaerobe remediation	Soil and sediment with low content toxiphene	biology	Yes	commercialization	Bad
38	Phytoremediation	Low POP content soil, sediment and groundwater	biology	Yes	demonstration	Bad

(* OK: suitable， NA: no acknowledgement; Bad: unsuitable)

From **Table 5**, we can see that such thermal treatment technologies as high temperature incineration, molten/melting, cement kiln co-processing, plasam, and chemical reduction technologies and chemical oxidiation technologies are suitable to dispose of pesticides POPs at certain degress, while other technologies have some gap in application to disposal of that.

3.2 Evaluation on Aboard and Home Pesticide POPs Waste Disposal Technologies

3.2.1 Thermal treatment technologies

3.2.1.1 High temperature Incineration

(1) Brief introdution

In this technology, POPs waste are decomposed into water, carbon-dioxide, kind nonflammable kind solid material like fly ash and slag etc. by high temperature oxidization, and the pollution are eliminated. Incineration technology has a very high disposal load, and 24-hours continuous running, applicable to liquid, solid pesticide, mud, sludge, slurry, contaminated soil and vessel. The DRE can reach 99.99995%. Incineration is very powerful in disposal of high-content POPs waste. However, bad management can lead more poisonous matters generation, like dioxin. During incineration processing, organic pollutants molecular can decomposed into gas and nonflammable solid matters. Those solid matters components mostly slag and fly ash. The exhaustive gas emit to the atmosphere from stack or flue. The flue gases contains steam, carbon dioxide, acid or poisonous gas and particles like fly ash and metal oxides. To prevent the pollution, the furnace should be equipped with gas purification equipments, like auto-cleaner, electrostatic precipitator etc. The residual solid should be disposed by landfill.

The incineration furnace for hazardous gas has a main incinerator and pressurized combustor (see **Figure** 7).

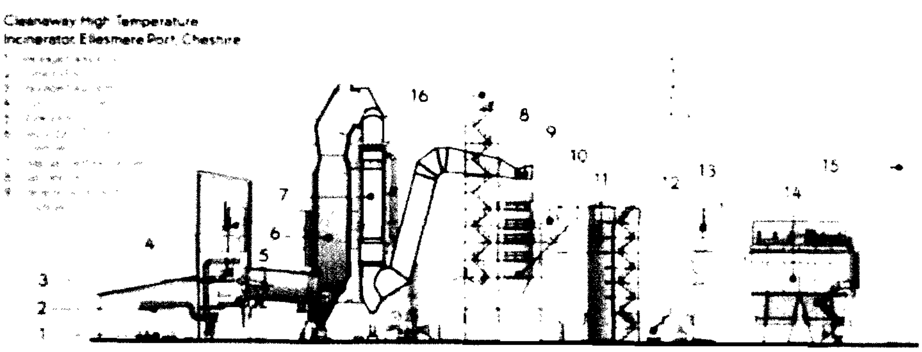


Figure 7 Schematic Diagram of High Temperature Incineration Facilities

The main incinerator is used to waste incineration. The off-gas was introduced into pressurized combustor and retained 2 seconds(residence time) under suitable temperature(usual 1100°C) to destruct the hazardous waste a the largest extend. Because off-gas cleaning equipments could not treat hot off-gas, the flue gas should cool down to 200°C.

The waste incineration facilities comprise of 5 components, which are feeding, stocking, storage, incineration/energy recycling and exhaustive gas purification/residual treatment. Conventional incineration facilities include large-scale fixed incinerator, small-scale fixed incinerator and mobile incinerator.

After more than 20 years of evolution, incineration technology has been quite mature, and many different types of waste incinerators have been developed, **Table 6** and **Table 7** lists the main burning furnace type, applicable waste types and operating conditions for reference.

Table 6 Type and Typical Operation Range

Type	temperature / °C	Residence time	Type	Temperature/°C	Residence time
Rotoary	820-1600	liquids and gases:1-3s Solid:30min-2h:30min-2h	multi-bed incinerator burning dry zone	dry zone :320-540 Ou;buring:760-980	solid:0.25-1.5h
Liquid injection	650-1600	0.1-2s	Fixed bed incineration	480-820	liquids and gases :1-2s ; Solid: 30min-2h
Fluid bed	450-980	liquids and gases :1-2s; Solid: 10min-1h			

Table 7 Dispoal Objective of Incinerators

Types of waste	Rotary kiln	Liquid injection furnace	Fixed bed	Multi-furnace	Fixed bed furnace
1. Solid					
(1) granular material	√		√	√	√
(2) low melting point material	√	√	√	√	
(3) The molten ash containing	√			√	√
organic material	√				
(4) Large-shaped, and					
irregularly shaped items					
2. Gas					
VOC	√	√	√	√	√
3. Liquid					
(1) containing toxic	√	√	√		
ingredients of high organic	√	√	√		
waste					
(2) - as organic liquid					
4. Other					
(1) chlorine-based organic	√	√			
waste	√		√	√	
(2) high water content of the					
organic sludge					

From **Table 6** and **Table 7**, we can see that rotary kiln incinerator can also handle solid, liquid and gaseous hazardous waste, in addition to non-combustible materials like heavy metals, water, or inorganic compounds, , the variety of different physical state (solid, liquid, sludge, etc.) and shape (granules, powder shape, block and barrel) can all deliver into rotary kiln. Many toxic substances such as PCBs and obsolete ammos can also use the rotary kiln processing.

(2) Aboard Application Status

The incinerator is divided into fixed type and mobile type in developed coutries. Fixed incinerator is the most suitable method for organic pollutants. A modern fixed incineration usually consists of a rotary incineration chamber, a pressurized combustors and exhaustive gas purification system. The incineration temperature should keep at 1100°C-1300°C, The residence time for pressurized combustor should keep greater than 2 seconds. DRE value is about 99.99%-99.999995% usually, and disposal capacity is about 0.5-7t/h, 24h continuous running. Such incinerator can be competent for solid and liquid matter, for example contaminated soil, raw material, vessel and packing tailing. Because of either early investment or operation cost are very high, it is only used in some developed countries. A higher efficiency can be attained only under continuous feeding condition. Till up to now, some application cases can be found in British and Finland. The existing mobile incinerators mostly are moderate or small scale, which has a large rotary incineration chamber and air pollution control system. In United States of American, this technology mostly is used for in-situ disposal of hazardous waste. This type incinerator can dispose enormous liquid, solid and muddy waste and contaminated soil, with the same disposal performance and emission standard. A set of mobile incinerator will cost 1500,000-15,000,000 US$. It will take 6 months and spend over 1,000,000 US $ to install a mobile incinerator to somewhere. Extra operation cost is about 600-2,000 US $ per ton based on the form of incinerator and waste type being disposed. The disposal capacity is about 2-20tons per day. Those incinerators can obtain more than 99.999% DRE and meet the standard of exhaustive gas discharge.

(3) Domestic Application Status

At present, burning stove in China mainly include rotary kiln incinerators, burning furnace, pyrolysis burning stove, grate furnace, fluidized bed incinerator, which fire grate is easily damaged under high temperature inside the hearth and grate furnace are very stringent for material, it is often not used. Fluidized-bed incinerator due to more stringent requirements on the material, the material must be destroyed to a certain diameter below to meet the requirements of the particle size. Control difficulties, poor operation stability, coupled with difficult to deal with fly ash, it usually can't be used. Presently, the most frequently used incinerators are two forms rotary kiln hazardous waste incineration and pyrolysis incinerator.

Currently, there is a certain foundation for the domestic production of hazardous/medical waste incineration equipment, but on the whole, most of the products have low level technology and imperfect equipment configuration, and can not meet the technical requirements. The currently available equipments could roughly be divided into rotary kiln furnace, pyrolysis gasification furnace, grate furnace (Guizhou Hangfa, Beijing Fajing, etc.) and small and simple incinerator (Yixing Fuding, Harbin Longtie Environmental Protection Equipment Factory, etc.). Since the grate furnace and the small and simple incinerator can hardly meet the requirements, they are not recommended by relevant national regulations and standards in the list. Now, factories producing rotary kiln mainly include Beijing Mechanical and Electrical Institute, Shenyang Academy of Environmental Sciences, Chongqing Zhongtian environmental protection LTD. and so on. The pyrolysis gasification furnace manufacturers are mainly Shenyang Academy of Environmental Sciences, Shenzhen Han's, Shanghai Wanqiang and so on. These products are already quite mature and reliable.

Currently, there are about 30 disposal plants in China capable of treating hazardous waste, with a annual processing capacity of 120 thousand tons.Nearly most incineration facilities in China can't treat waste with high chlorine content, i.e pesticides POPs waste. However, some incinerators, for example, Shenyang disposal center, exhibit a good adaptivity to organic waste with high chlorine content.

However, there's no detailed requirements on POPs related waste incinaration in China yet. There's only clear provisions about the pollution prevention during the PCB-containing waste incineration process. According to hazardous waste pollution prevention and control technology policies, waste containing PCBs should be collected to dedicated incineration facilities for disposal as soon as possible and should not be treated in other ways. The dedicated incineration facilities shall comply with requirements in national *Hazardous Waste Incineration Pollution Control Standard* (GB18484 -2,001). Moreover, It is pointed out in the PCB-containing waste pollution control standards (GB 13015-91) that hazardous waste with the the 50-500 mg / kg PCB content is allowed to be disposed of by the safe landfill technology or high temperature incineration technology. Hazardous waste with PCBs content> 500 mg / kg and PCBs used as impregnation agent in electrical capacitor must be disposed of by high temperature incineration technology. According to the *Hazardous Waste Incineration Pollution Control Standard* (GB18484-2001), PCB waste incineration conditions are: burning furnace temperature ⩾ 1200 ℃, gas residence time ⩾ 2.0s, the combustion efficiency ⩾ 99.9%, burned removal ⩾ 99.9999 %, the thermal ignition rate of burning residue % < 5%.

Although China has established many incineration facilties for hazardous waste, however those can't be applied to dispose of pesticides POPs waste, the reasons lies at:

- The disposal facilities in technologies can not match the requrement. Those facilities comply with the requirment of National Construction Planning of Hazardous Waste and Medical Waste Disposal Facilities(2003), without considering the requirements of POPs waste disposal. Presently, 31 provincial level disposal centers for hazardous waste can't be adept at disposal of hazardous waste of chlorine content over 5% in application range. Pesticide POPs is high chlorine content waste, and it will give out a lot of acidic gas when incineration, which is very strongly erode the facilities and effect the service life of facilties. Moreover, it will give out dioxin maybe, which need special pollution control equipment for dioxin emission.
- License acquisition. PPW belongs to hazardous waste according to the Hazardous Waste Management Regulations License(2004), and its operation license granting shoud be approved by environment authority of state council. With this basis, just a few companies/organizations acquired the operation license for PCBs disposal, which are Shenyang PCBs incineration disposal center, Tianjin Hejia Veolia environmental service co.. LTD, SCIP Swire SITA Waste Services Company Ltd. (SCIP-SSWS). Those companies is mechanically adequate for pesticides POPs disposal, which can be considered as the candidates.
- The third, In view of the nature of PPW, its complex morphology and components, it requires not only stringent requirement for incineration technologies but also the stringent requirement for the storage, pretreatment et al to assure that the POPs is disposed of in a environmentally sound manner. Besides the experience for harzadous waste mangement plays a very important role in the final performance of disposal and ennvironmenal mangement of pesticides POPs disposal. However, nearly most enterprises can't satisfy those requirements.

At present, Shenyang incineration Center is the only unit getting the approval for PCB waste incineration. It is located in State Forest Farm Machinery, Gujiagong District, Xinmin, Shenyang. It was applied by the Shenyang Academy of Environmental Sciences to the original State Planning Commission, and officially started construction in May 2002. The disposal capacity of the PCBs incineration facilities under construction is 15 tons / day and has received the relevant EIA approval and acceptance of Liaoning Province Development and Reform Commission. In order to ensure that PCBs waste shipped from Zhejiang can get the necessary pre-treatment before entering the incineration process and achieve the safe storage, it is proposed to reserve space in the west side of the incineration center to build a PCBs warehouse and a pre-workshop, and add a waste identification module. Considering of POPs nature and forms of waste and the existing incineration technologies in China, it can be seen that, Shenyang PCBs furnace may be applied to pesticides POPs. Besides, there are several disposal center for PCBs incinerations have acquired operation license, which are potential to disposal pesticide waste. In principal, disposal enterprises that acquired PCBs operation license are competent for pesticide POPs disposal. The disposal cost is about 4000~8000RMB Yuan/ton.

3.2.1.2 Cement-kiln co-processing technology

(1) Brief Introduction

The principle reaction of cement producing starts from calcium carbonate ($CaCO_3$) decomposition at 900°C. The calcium carbonate converts to calcium oxide and carbon dioxide. This procedure is called pre-calcining. The calcium oxide reacts with silicon, aluminum and ferric oxide at 1400-1500 °C, and the clinker is produced. This procedure is call calcining. The clinker will mix with gypsum and other additive, milling to cement.

The rotary kiln is the most popular type at the moment. It can be classified into two types, wet kiln and dry kiln. In wet kiln, the raw material was prepared into slurry with 32% to 40% water content. The slurry is easy to flow and mixture, so the cement quality is better. The shortcoming of wet kiln is extra energy is needed to evaporate the water. In dry kiln, to mix the raw materials homogenously is very hard and remaining heat is hard to reuse, but the water content is less than 1%, the energy consumption is much less than wet kiln. The dry kiln can be classified into conventional dry kiln and precalciner rotary kiln.Some environmental sound measure should take to cement kiln in order to adapt to POPs like hazardous waste disposal. Co-processing of fuel alternative or raw material alternative substance can be took place at main burner.

Rotary kiln mostly comprise of feeing, rotary cylinder, cooling cylinder. Pulverized coal is fed from the lower drum by blower, shown in Figure 8. Rotary kiln (rotary kiln) is a tilting cylinder that have a certain slope, slope of 3 to 3.5%, to promote the material in the rotary kiln (rotary kiln) in mixing with the help of the rotating kiln, so that raw materials mixtures, contacts and reacts each other. Pulverized coal injected at the head of kiln which generates a lot of heat. The heat is propagated to the raw material by forms of flame radiation, heat convection, brick kiln (kiln skin) conductive. Raw material moves in the kiln forward depends on the slope of the kiln and the kiln cylinder rotation. (1) rotary is a incineration facility, it is also a heat transfer equipment. Raw materials absorb the heat from calcining gas. Sometimes, the raw material may be transported from feed end to discharge end. The fuel combustion, heat transfer and raw materials movement must be matched well in order to transfer the heat generated by fuel combustion to raw material in rotary kiln timely, reaching high-yield, high-quality, low-cost purpose. (2)The movement of raw material particles in the rotary kiln is much complicated. If we assume that particles of raw materials in the kiln wall and raw material inner-layers don't slide, generally considered material movement is like this: under the influence of raw materials in friction, together with the kiln wall as slowly as a whole rises, when the go to a certain height When the material layer surface and the angle of the horizontal angle is equal to the accumulation of raw material, then material particles under the action of gravity, slide down along the material layer. As the rotary kiln (rotary kiln) has a certain inclination, while the raw material particles, when rolling along the slope direction of the largest drop, it moved forward a certain distance. (3) When the movement of raw materials in the kiln, raw material particles are cyclical changes in movement pattern, or buried in the material layer inside the kiln, together with the upward movement, or to the material layer on the surface and landed down. But only in the raw material particles along the surface layer of the process of landing, it can be along the kiln length direction. Raw materials in the kiln will affect the movement of raw materials in the kiln residence time (ie, raw material heating time); raw materials in the kiln of the fill factor (ie, raw material heating surface); raw material particle size flip situation also affects the uniformity of raw materials (ie, combustion products and raw materials affect the surface temperature). Various sports center angle of the conditions, that is, particles of the filling factor of the impact of raw materials that must be addressed. If you want to fill the kiln to maintain a certain factor, they need to make the kiln speed and feeate of co-ordination, and to maintain a certain ratio; It is also to increase production, quality, stability and thermal systems, to overcome the knot groups, and other process conditions.

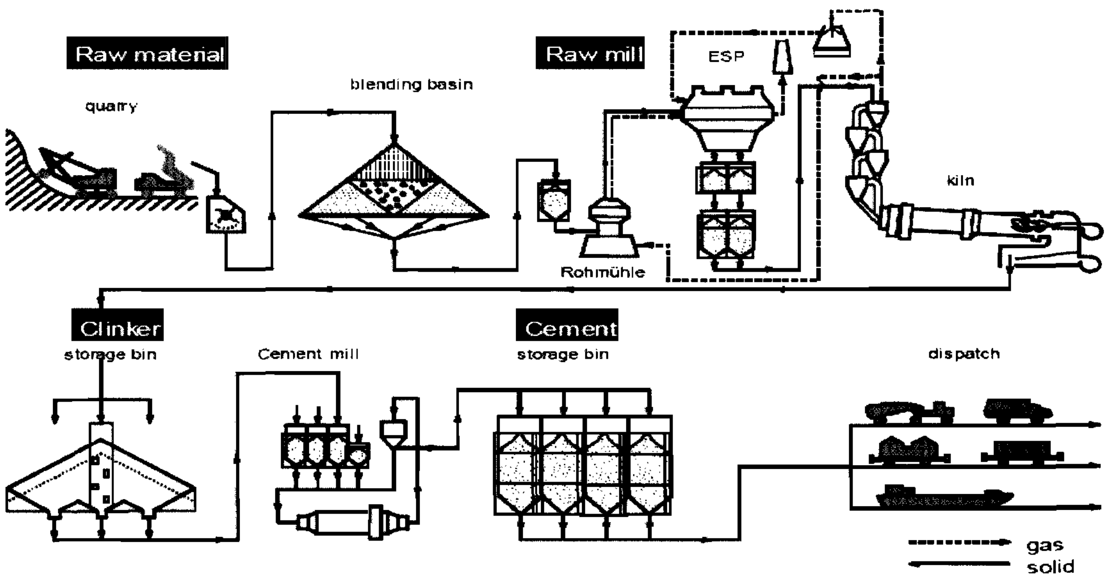


Figure 8 Flow Chart of Cement Production

All rotoary kilns, dry kiln only can be suit to dispose POPs waste, because dry kiln is of those characters including high tempetuare(1600°C), long flue gas residence time(more than 6 seconds), alkiline oxidazation, so that acidic gas discharage is reduced and POPs destory is impoved.

Cement kiln co-processing hazardous waste has those advantages in summary:

- Cement kiln has long body, high temperature and high thermal inertia which makes it has great advantage in disposal of non-radioactive hazardous waste. Table 8 draws a comparison between cement kiln and incinerator. It says that hearth of cement kiln is higher than incinerator and residence time for material and fuel gas also longer, which make it destroy organic substance much completely. Usually more than 99.99%, besides that, co-processing of cement kiln has those advantages below:
- Good turbulence condition. The heated air flow reverses with raw materials, leading strong turbulence, which contributes to mixture of solid phase, heat transfer, decomposition, chemical combination, and diffuse.
- Alkaline circumstance. The reaction produces plenty of alkaline substance that can effectively neutralize acid substance in waste into salt. Thus, the acidic substance discharge is greatly decreased, and the risk of dioxin generation is reduced. Reported by EPA, dioxin monitoring data from 2200 co-processing cements worldwide, can meet the standard of 0.1ng TEG/Nm^3.
- No residual release. Fly ash and slag convert into cement products
- Heavy metal stabilization. Majority heavy metals are stabilized into clinker.
- Multi feeding spots, powerful adaptability. There are many hot feeding spots all over the rotary kiln that can be adaptive to various POPs waste with different characters and forms.
- Low investment and operation costs. The existing rotary kilns need technique transformation to adapt POPs waste disposal, which cost covers merely 10-20% of building incineration plant with similar disposal capacity.

- Exhaustive gas emission reduction. Co-processing technology use flammable industrial waste to substitute coal as fuel. Comparing with producing cement by coal and disposal of waste individually, the exhaustive gas emission can be reduced profoundly.

Table 8 Comparison of Cement Kiln and Incinerator

Parameters	Rotary kiln	incinerator
Highest temperature(°C)	2200	1450
Highest temperature of solid	1500	1350
residence time for air≥1100°C(s)	6-10	1-3
residence time for raw material≥1100°C(s)	2-30	2-20
turbulence of air(Reynolds number)	>100,000	>10000

(Source: Fang Wei, 2002)

From Table 8, it shows that temperature in hearth is far more than incinerator, and resistence time for material and flue is longer, so the destruction efficiency is more complete.

The disavatage of cement kiln co-processing hazardous waste can summaried as:

- Sulfur and chlorinate in flammable waste should be less than a sound value. Flammable waste with low heat value or high water content is hard to dispose in co-processing of cement kiln.
- Volatile organic components of waste should be pretreated.
- Comparing with original cement kiln, it needs extra monitoring equipments and dust-cleaning facilities, and more rigid emission standard is required.
- The complexity of cement product line, labor increases, and operation, control procedure goes complex more meanwhile, which may affect the interest of own to kiln technique improvement.

(2) Foreign Application Status

The co-processing of waste by cement kiln is to alternate raw material or fuel by waste, thus, the thermal or mineral ingredient can be utilized to produce cement and the waste is disposed in a environmental sound measure. Fuel alternative is the most consideration in European country. For example, Fhonenix cement kiln, Germany, conducted a PCBs containing waste oil disposal pilot by cement kiln, and the substitution rate is 10%. 12 cement kilns in European Union utilized waste as fuel substitution, the majority at the ratio of 10% -30%, some kilns even up to 50%. In the United States, cement kiln has become a BAT demonstration technology and there are several dozens cement kilns to use hazardous waste as fuel substitution. In Japan, raw material substation is the most utilization measure. Industrial waste and domestic waste are incinerated by incinerator and the product, fly ash is used to produce cement at a certain ratio in raw material ingredients.

(3) Domestic Application Status

2004, China has more than 5000 cemeent plant, and 1900 or so plants suspend production or reduce production. But the combination of cement enterprises go smoothly. The population of cement kilns at products capacity of 200,000-600,000 tons per year (550-1,650 tons per day)increases from 565 in 2000 to 973 in 2004 and the popluation of cement kilns(including cement clinker plants) at 600,000 tons per year increase from 102 to 265. The population of oversize cement enterprises, that annual production capaicity over 1,200,000tons (3,300 tons per day), increases from 32 to 87.

China have the preliminary co-processing capacity to dispose of POPs waste. According to SEPA statistics, in 2003, with the processing of the tetramine special rectification actions being carried out, there are about 40 cement plants hazardous waste disposal can be compete for hazardous waste disposal. Wan-an enterprise in which Shanghai Corporation (formerly Jinshan cement) and the Beijing Cement Plant has acquired hazardous waste operating licens from local environmental government. Since 2001 Shanghai Wan-an enterprise head office has already conducted a test incineration for pesticide and pharmaceutical waste by cements; Beijing Cement Plant built the first domestic disposal of cement kiln production lines together, its processing capacity 8 to 100 thousand tons of waste, and was put into operation in in 2006 (Jiang Mingling, 2007). Hubei Huaxin Cement Factory conduct trial burning of waste POPs pesticide, and Jiangsu Huaxin Cement Factory (Suzhou) conduct pesticides POPs waste incineration test at the end of 2009,.

In addition, there are many domestic companies can be adapable to pesticide waste disposal via technology transformation, such as, Tianjin Hejia'aolvsi environmental Protection Co., Ltd., Beijing mangrove environmental technology engineering Co., Ltd., Wuxi industrial waste safety disposal Co., Ltd., Shanxi lion's head cement, industrial waste disposal center, Changzhou, Taizhou Yuxin Solid Waste Disposal Ltd (waste water), Zhenjiang New Solid Waste Disposal Ltd (sludge), waste disposal Lianyungang Suzuki Group Co., Ltd., Shanghai Oasis utilization of waste disposal center, Kunming Cement Co., Ltd., Shaanxi Qinling Cement Group, Shaofeng Group and the Guangxi Liuzhou Cement and cement plants.

According to the leader of hazardous waste disposal enterprise by cement kiln co-processing, the quotation for waste incineration by cement kiln co-processing is about 1000-2000 RMB yuan/ton.

3.2.1.3 Plasma

(1) Introduction

Thermal plasma is a high-temperature state of substances, whose basic components are electron, positive and negative ions, dissociated neutral atom and molecule. The electric property of plasma is neutral, since there are almost the same numbers of positive and negative particles in side the plasma, but the electric conductivity is very good. Thermal plasma study is divided into two groups of high temperature plasma and low temperature plasma. The particle temperature of high-temperature plasma is above 20 000 K and even as high as 100 million K. At such high temperature, together impacted particles have enough energy to make nuclear fusion reaction. The temperature of particles in low temperature is between 2000 and 20000 K, and the molecule and atoms dissociate, and thus the dioxin decomposition efficiency is very high. For example, in plasma melting furnace, the energy of plasma is extremely high, the temperature of ions is as high as the electrons, the apparent temperature is of 10 000 K to 20 000 K, every particle has a high chemical reactivity. Thus, in the condition of extremely high temperature, the high reactivity particles and oxygen, the molecules of contamination such as dioxins, etc. are dissociated drastically, and the dioxin dissociation efficiency can be beyond 99.99%. The technology attains the aim to destruct the contamination, especially to destruct the waste, which are very difficult to be disposed or special kinds of waste, to show their significant advantage and superiority.

Plasma technology can be divided into two groups, non-equilibrium plasma (cold plasma) and equilibrium plasma (thermal plasma). Cold plasma includes glow discharge, low voltage radio-frequency discharge, corona discharge, etc. The normal fluorescent lamp, the etching technology used by semi-conductor industry, and plasma television sets are all belong to cold plasma technology. Cold plasma has low concentration of energy, heavy particles' temperature is similar with room temperature and electron has very high temperature. Electron and ions have very high reactivity. On the other hand, thermal plasma has very high energy concentration; the temperatures of heavy particles and electron are quite similar. If the temperature of plasma is in the range of 2000 – 20000 °C, the thermal plasma is so-called low temperature thermal plasma. If the temperature is higher than 20000°C, the plasma will be so-called high temperature thermal plasma. In low temperature thermal plasma, all particles have very high reactivity. Low temperature thermal plasma can be generated by arc discharge between electrodes (DC/AC arc discharge) under atmospheric pressure, inductance coupling under normal voltage plasma induction discharge, microwave discharge under normal voltage etc. plasma arc means the low temperature thermal plasma generated by electrical arc discharge.

Thermal plasma uses the electric arc to generate heat, and the heavy current heats low-pressure air current to form the hot plasma region, whose temperature could reach more than 10,000 °C. The temperature of reaction zone shall be controlled at more than 1,500 °C, and then hot plasma will crack the injected waste in the high temperature region. Plasma Arc Technologies is the main way to produce low temperature thermal plasma and also the main plasma technology evaluated in this report(International HCH and Pesticides Association).

(2) Foreign Application Status

With the requirement for solid waste processing technologies as the times past, many large companies and famous plasma research institutions initiated many research projects to develop plasma arc technologies for waste treatment. There are many successful commercialization cases. Among them the most well-known technologies include: PLASCON™ In-Flight Plasma Arc System jointly developed by Australian Commonwealth Science and Industry Research Organization (CSIRO) and SRL Plasma, Plasma Arc Centrifugal Treatment PACT developed by Retech Systems LLC of American Lockheed Martin Corp., Plasma Converter System developed by an American company STARTECH, Plasma Enhanced Melter™ - PEM™ by American Integrated Environmental Technologies, LLC (IET). Other technologies include Westinghouse Environmental Service, Plasma Fluidized-Bed Reactor from France, electrical induced coupling plasma pollutant processing system. The technologies from French Aerospatial Espace & Defence and Britain Tetronics, and Plasma Gasification Melting (PGM) of Israel EER Company have all come into commercialization stage. The other technologies include AC plasma torch by the Institute of Electrical Physical Problems at St. Pertsberg of Russia, (registered the Scientific Utilization, Inc. in USA for promoting AC plasma torch system), PCB processing system by Institute of Plasma Physics and Laser Microfusion, Poland and INERTAM system, French EUROPLASMA system, INCIDIS system, American TCC company plasma system, hollow graphite electrodes plasma fly ash melter by Japanese company Takuma, the 2000 kW medical waste plasma furnace with processing capacity of 24 ton/d by Resorton Canada Limited, etc.

Some other plasma technology for chemical weapon destruction also can be considered, such as Swiss MGC Plasma, which produced PLASMOX® RIF-2 and PLASMARC® system to destroy chemical weapon with the license of Retech, and now 1500kW Munster II Plant has been constructed. Vanguard Research, Inc. developed Plasma Energy Pyrolysis System PEPS®, it is reported that they have 10 ton/d stationary system and a mobile system with capacity of 3-5ton/d. A German company BUCK has developed electromagnetic induced mobile system and stationary system with capacities of 10,000ton/a and 40,000ton/a respectively.

Four plasma technologies that have been widely used are selected to introduct from above vendors.

(a) PLASCON™ "in-flight" plasma-arc

The PLASCON™ "in-flight" plasma-arc system is an ex situ technology, and was developed by the Commonwealth Scientific Industrial Research Organisation (CSIRO) and commercialized by an Australian company, SRL Plasma Pty. Ltd. PLASCON™ is potentially applicable to both low- and high-strength waste containing POPs contamination. The process develops a high temperature (>10 000°C) plasma-arc by ionizing argon gas using a 150 kW DC discharge between the cathode and the anode. The liquid waste or gaseous waste is injected directly into the plasma and rapidly (<1 ms) heats to about 3000°C and is pyrolyzed for about 20 ms in the water-cooled reaction chamber (flight tube). Contaminants in solid and bulk waste are thermally desorbed and condensed and then fed as a liquid to the PLASCON unit for destruction. No solid waste can be treated directly, since there is not any feeding system for solid waste. To ensure no formation of soot, a controlled amount of oxygen is injected into the plasma to convert any carbon to CO. A piolot plant of plascon™ is shown as **Figure 9** and technology flow chat is shown as Figure 10.

Gases exit the tube at a temperature of about 1 500°C and are rapidly cooled to less than 100°C in a spray condenser using an alkaline spray solution. The gases are further cooled and scrubbed of any remaining acid gases in a packed tower. Off-gases, which contain mainly carbon monoxide and argon, are then thermally oxidized to convert carbon monoxide to carbon dioxide.

The "in-flight" plasma arc PLASCON™ technology has been operating commercially since 1992. To date there are 9 commercial plants operating with licenses from the Victorian and Queensland EPA's in Australia, the UK EPA and the Japanese Ministry of the Environment. Four commercial 150 kW PLASCON™ units are operating in Australia, two units were installed at the Nufarm Ltd Agricultural Chemicals in Melbourne in 1992/1993, and one unit was installed in Melbourne in 1997 to destroy Halons and Freons. BCD Technologies Private Limited in Brisbane, Australia, purchased a PLASCON™ plant to treat concentrated PCB solutions (>10 %) as well as a range of POP pesticides, which is the fourth unit. This firm used a thermal desorption system in conjunction with PLASCON™ to treat a range of solid and semi-solid waste streams One unit is operating in the UK destroying fire retardants and ODS. In Japan, a large chemical

Figure 9 PLASCON™ Plant

company has installed four PLASCON™ plants to destroy PCB waste.

Standard 150 kW PLASCON™ Plant costs approx. USD 1 million. The operating & Maintenance costs USD 1.50 per kg for Schedule Waste.

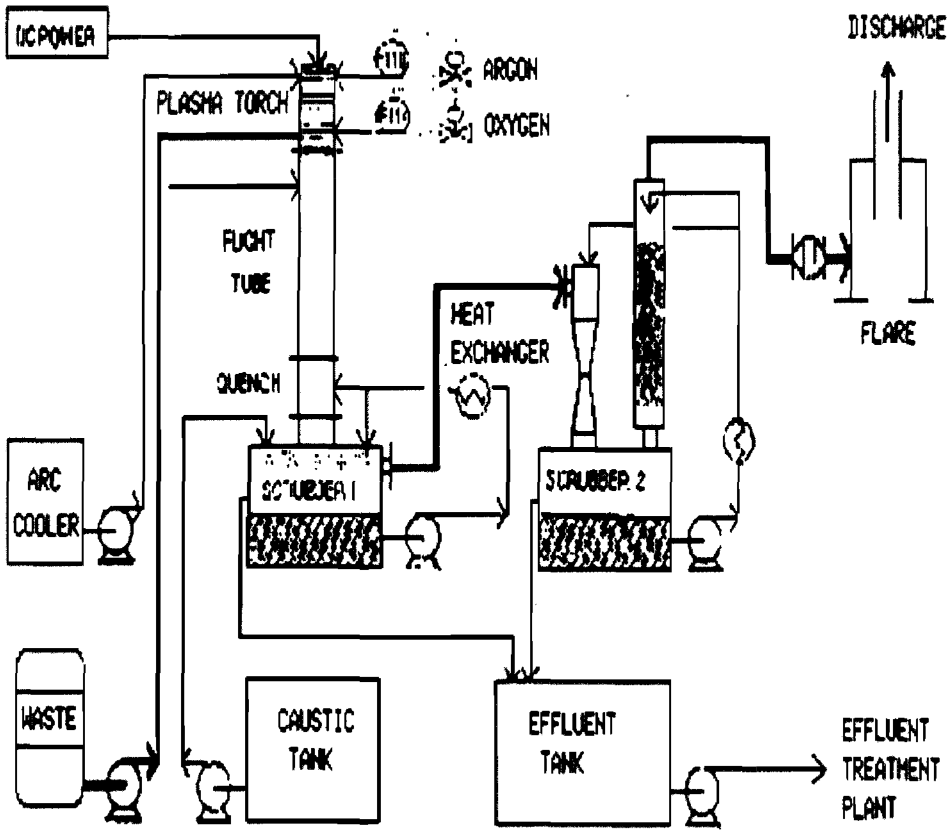


Figure 10 Scheme Diagram of Plascon™ Technology

(b) Plasma arc centrifugal treatment - PACT™

The Plasma Arc Centrifugal Treatment (PACT) process is a full-scale ex situ treatment technology, which can be used to treat low- and high-strength waste containing POPs contamination, developed by Retech Systems LLC. The PACT uses heat generated from a plasma torch with air as plasma gas to melt and vitrify solid feed material. The plasma torch heats waste material within its field of influence to a temperature of about 1 650°C. Primary treatment occurs inside a centrifuge tank housing the plasma torch. Centrifugal force produced by the rotating tank pushes the waste material away from the center and into the plasma torch's field of influence. At the end of primary treatment, the tank stops rotating and the molten waste exits the tank through a chute at the center of the tank. Molten waste is collected in molds and cooled to form vitreous solids. Volatilized contaminants pass from the centrifuge tank to a natural gas-fueled secondary treatment tank. Secondary treatment of gaseous contaminants

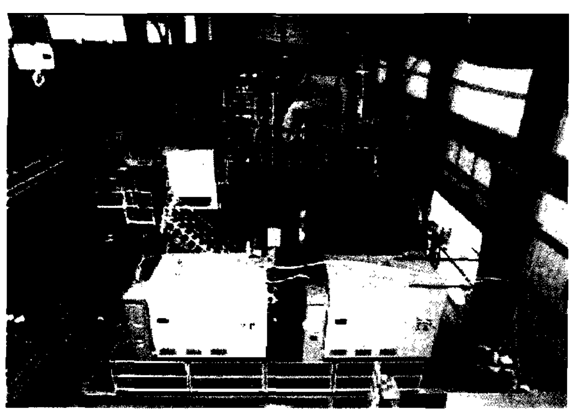


Figure 11 Plasma Arc Centrifugal Treatment Plant

occurs at a temperature of about 1 000°C. This part of the process ensures destruction of products of incomplete combustion such as dioxins and furans. Exhaust gases are discharged to an off-gas treatment system that cools the exhaust and scrubs it to remove acid gases. Metal-bearing solids are vitrified into a monolithic non-leachable mass. Since a special transferred plasma torch with tangential swirl plasma gas inlet port is employed, an electric conductive crucible at any temperature and the molten metal are needed as one of the electrode, the start process is very completed since the cold slag is not electric conductor at the start time.

PACT has been used at a pilot scale to treat waste contaminated with HCB and has been used at full scale to treat contaminants other than POPs. Waste containing HCB was treated in a PACT demonstration plant in 1991. PACT™ is used to treat hazardous waste not only in USA, but also in Europe successfully, such as used to treat contaminated soil by German Ministry of Defense. The vendor, Retech Systems LLC, plans to ship a PACT system to Russia in 2005 for treatment of capacitors contaminated with PCBs. In May of 2004, the first licensed low radiative waste treatment PACT™ system was built by Zwischenlanger Wurenlingen AG in Switzerland, the capacity of the system is 200 kg/hr. The technology flow chat is shown as Figure 12.

PACT can be expected to have a relatively high capital cost, and operating cost ($4000 - $8000 per ton). However, the cost will be dependent on the scale of operation, and because the PACT process has the capability of directly treating diverse waste types, it can avoid the preparation or pretreatment costs, which may otherwise be necessary for treatment by other processes.

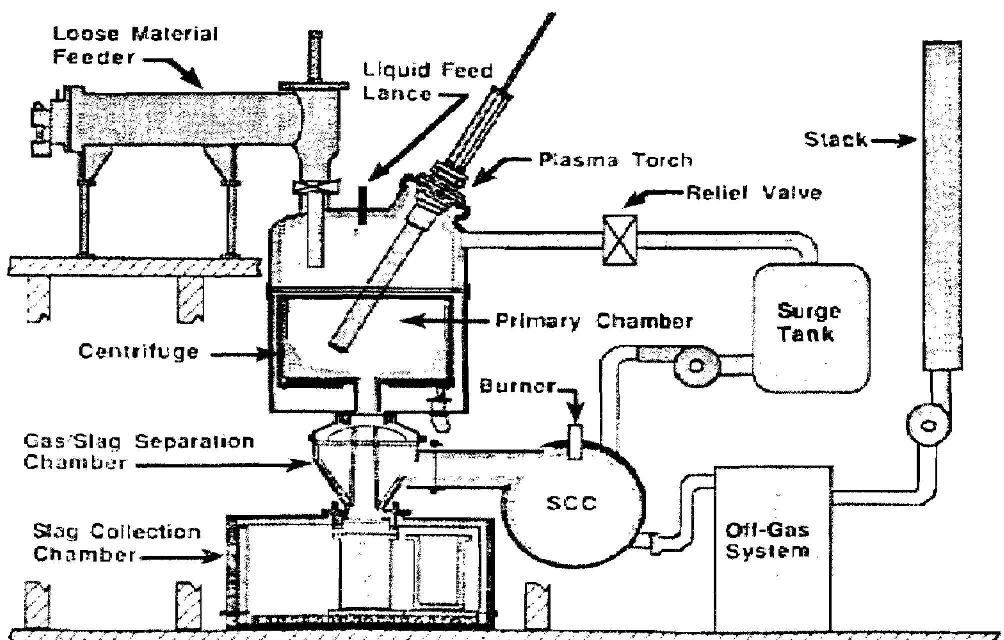


Figure 12 Scheme Diagram of Plasma Arc Centrifugal Technology

(c) Plasma Converter System

The PCS is a full-scale ex situ technology that is manufactured and marketed in the United States by STARTECH Environmental Corp. PCS can be used to treat soil, liquid, and gaseous waste streams, and is potentially applicable to both low- and high-strength waste containing POPs contamination. A demomstration facilites is shown as **Figure 13**.

Figure 13 A Plant of Plasma Converter System

The principle is described as follow. PCS uses plasma generated by a torch inside a cylindrical reaction chamber. Mixed waste fed into the reaction chamber passes through the plasma as the waste moves from one end of the chamber to the other. The arc inside the plasma can reach a temperature as high as 16 000°C. Contaminants dissociate into their constituent elements within the plasma. The elements recombine outside the plasma to form gaseous and molten products. Molten material formed in the reaction chamber is removed from the bottom of the chamber and cooled to form inert solids. These solids can include metals and inert silicate stones. Exhaust gases from the reaction chamber pass through an off-gas treatment system and are then discharged. The off-gas treatment system includes a cyclonic separator for removal of particulate matter, cartridge filters for dust removal, a catalytic converter for reduction of oxides of nitrogen, and a scrubber for removal of acid gases. The recovered gas may be used to produce polymers or fuel gas. The off gas treatment system consists of a cyclone separator, a baghouse filter, a de-NOx catalysis converter and a de-acid scrubber. The technology flow chat is shown as **Figure 14**.

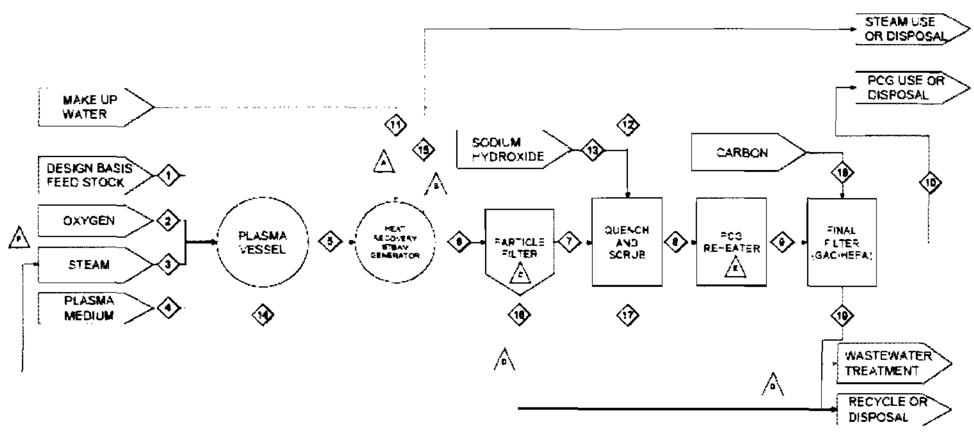


Figure 14 Scheme Diagram of Plasma Converter System

Through controlled reforming, an energy rich gas can be generated in plasma vessel, which can then be applied to produce polymers and fuel. The usage of off-gas is a significant advantage of this technology. STARTECH has developed an electric generation system to use this energy rich gas, Organic waste streams like PCB's and Hydrocarbons that generate significant quantities of Plasma Converter Gas (PCG) are likely to be viable in generating adequate electricity so as to operate the Plasma System without requiring an external source of electricity. The pure hydrogen separated from syngas can be applied as an alternative fuel for motor vehicles (STARTECH has developed StarCell which use hydrogen as fuel of the vehicle) and / or a raw material for chemical manufacturers. The Plasma Converter System can also be used to convert wheel to ethanol.

PCS has been used at a pilot scale（5tons/ day） to treat PCB, waste contaminated with PCB and hazardous incinerator ash in Mihama, Hiemji, Japan, and a set of full scale eqauipment(10tons/day) has been used at full scale to treat an assortment of industrial and institutional waste in New South Wales, Australia. The plasma converter vessel is available in several sizes with treatment capacities ranging from 5 to 100 tons per day. The technology vendor, STARTECH Environmental Corp., has stated that the PCS could be tailored to treat PCBs and HCB. Global-green Plasma Technology Co., Ltd, a Joint Venture of Mega-green Environmental Science and Technology Co., Ltd and Globaltech Environmental Inc, is established in Beijing in 2007. They are planning to invest RMB 100 million in the Resource Recycling Industrial Park of Liquan, Shaanxi Province, China and developing a 10 ton/d POPs disposal demonstration.The operating cost of PCS is lower than the other plasma systems; it is approximately 1000 - 1500 Australia dollar/ton but will depend on the waste stream being treated.

(d) PEM™ -Plasma Enhanced Melter

PEM™ system was a new important technology developed by MIT and Battelle Pacific Northwest National Laboratory (PNNL) supported by DOE. Integrated Environmental Technologies, a Richland, WA company, is commercializing Plasma Enhanced Melter™ (PEM™) technology for waste treatment and clean energy production in a range of markets. PEM™ needs 2 electrodes, DC Arc system used to plasma heating and AC resistance system used to joule-heated glass melter. This allows the system the ability to "idle" in a hot standby mode using the AC electrode power system by relatively low power requirements. The ratio of 2 heating resource can be modulated depending on the waste stream being treated, which can enhance the energy usage. Operating with steam as working gas, the syngas was converted to electric power by internal-combustion engine. A plant of Plasma Enhanced Melter is shown as Figure 15. According to IET test report, a system with 1/2 ton capacity for fluorine contaminated waste treatment, uses 100 kW plasma power with 30 kW resistance power, the temperature in working area is at 1200 - 1400°C, and the CO, NOx and SOx in off gas are under detective limitation, but only THC in off gas is over the standard. The equipments is shown as **Figure 15**.

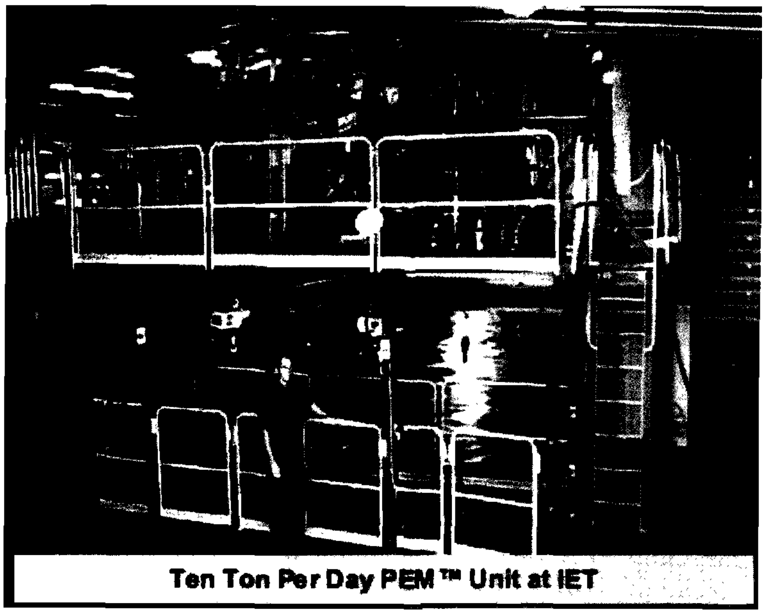


Figure 15 A Plant of Plasma Enhanced Melter

IET has already sold and installed several commercial units. IET has installed its first commercial units for mixed radioactive/ hazardous waste treatment at Richland, WA, and medical waste at Honolulu, Hawaii. In 2003, Kawasaki installed IET technology in Japan to destroy PCBs. In 2004, Kawasaki purchased non-exclusive rights to market the PEM™ system in Japan. In 2005, Global Plasma Corporation in Taiwan began operations at a plant using IET equipment to convert medical waste into electric power and to recycle used batteries.

(e) Advantages and disadvantages of plasma arc technologies

The technical characteristics of the technologies described above are concluded as follows:

Table 9 Technical Characteristics of Plasma Arc Technologies

Commercial Name	Power Supply	Power kW	Generation Technology	Plasma Gas	Feeding Form	Processing Object	Off-gas Treatment	Special
PLASCON™	DC	150	Arc	Ar	G, L	Contain Chlorine	Yes	Thermal Desorption
PACT	DC	-400	Transferred Arc Torch	Air	G, L, s	Contain Chlorine	Yes	Rotary Crucible
STARTECH	DC	100-1000	Transferred Arc Torch	N_2	G, L, S	Contain Chlorine	Yes	Syngas
PEM™	DC+AC (resistance)	200-1000 (in Total)	Arc+ Resistance	H_2O/ O_2	S	Contain Chlorine/ Fluorine	Yes	Syngas
CAS-IMECH	DC/AC	150-400	Arc	H_2/Ar	G, L, S	PCBs	Yes	HCl Recovery

Forms of processed objects: G-Gaseous phase, L-Liquid phase, S-Solid phase, s-soil

The major advantages of plasma arc POPs treatment are:

1) The higher energy strength and higher temperature of thermal plasma make reaction rate very high. The temperature inside furnace is higher than conversional incinerator and the reaction not rely on the existence of radical. It can decompose the toxic substances (e.g. dioxin) in waste effectively and could process great amount of POPs in small reactor.

2) Can process both high- and low-strength POPs pollutants, especially suitable for dioxin, furan and PCBs. The form of feedings can be gaseous, liquid or solid phases.

3) By controlling working atmosphere, inside furnace is in pyrolyzing condition (almost no

oxygen consumption), big molecules can be cracked down into H2、CH4、CO and other small molecular combustible gas and there is possibility to recover.

4) Since there are less off gas, it is easy to reach high cooling speed and depress the production of non-equilibrium components and easy to avoid the regeneration of dioxins.

5) If combustible gas burn in incineration chamber, since there is no need for POPs destruction, its temperature can be lower than conventional secondary chamber. The amount of generated NOx is much lower than conventional incineration.

6) The higher temperature inside furnace can melt bottom ash and form stable glassy slag. It makes the reuse of dregs possible.

7) Compare with conventional incineration, it can be relatively fast turned on or shut down. The stable operation can be easily achieved.

Major disadvantages of plasma arc POPs treatment are:

1) Restricted by working mechanism and feeder structure, some plasma technology can only process gaseous phase or liquid phase pollutants, some can only process solid waste and some can only process soil. The processing object is restricted.

2) Taking electricity as energy source, the energy consumption and operation cost is relatively higher.

3) Comparing with conventional incineration, plasma process has too many process control parameter, and has higher requirement on automotive degree.

4) Both plasma area and furnace body have very high temperature, it need very special materials. The damage of water molecules to furnace material is not neglected.

5) There are two ways to recover energy, waste heat boiler and gas engine to use syngas (off gas) for electricity generation, but make process, equipment and control system very complicated.

Theoretically, off gas of plasma furnace contains combustible gas and can be recovered (refer to **Table 10**). In fact, there are many problems exist in off gas recovered. Firstly, incineration processing is different from industrial production, and is impossible to control the composition of the syngas. The property of the processing object decides the composition and characteristics of the off gas. The changes of the objects will changes the composition of the gas dramatically, which makes it not easy for off gas recovery. Although the plasma processing temperature is very high and the possibility to generate hazardous gas is very low, but the off gas of POPs contains chlorine. The off gas has to be cleaned up and de-acidified before utilization. It normally need two stages gas washer and dust remover.

Table 10 Compositions of Syngas

Waste type	Electronic waste	MSW	Medical waste
N_2	61%	44.1%	44.2%
H_2	18.3%	25.6%	28.1%

Waste type	Electronic waste	MSW	Medical waste
CO	9.7%	17.2%	14.8%
CO_2	6.2%	11%	11%
H_2O	5%	5%	5%
CH_4	1.3%	3.5%	3%
He	0.07%	0%	0%
O_2	0%	0%	0%

According to the evaluation report, American Environmental Technology Evaluation Center (EvTEC) about the PEM™ plasma technology of in Dec. 2002, 200-240 m^3 synthesis gas can be generated by processing 100 kg waste. There are many factors influence the composition and amount of syngas. The major factors are: organic content of the waste, inert substances content, the types of plasma gas and amount of added oxygen, etc.

From the point of the view of energy utilization, different waste type, different heating value, and different organic content all can influence energy recovery. When the processed waste is electronic waste-PCBs (printed circuits boards), 1 kg waste can generate 2.04 kWh electricity and consume 2.7-4.9 kWh/kg. At the same time, if the waste is high heating value waste tyres, then will consume energy 2.0 kWh/kg and generate 3.84 kWh/kg.

Since in most cases plasma nitrogen is used as working gas, so the off gas has very high nitrogen content. Waste composition has very high organic content can generate syngas with high percentage of combustible gas. From **Table 10**, it is clearly that MSW and medical waste can generate syngas with higher percentage of combustible gas than electronic waste PCBs.

According to the experimental data of one American plasma company, the off gas composition is as follows, the secondary emission of off gas can all meet environmental standard, see **Table 11**.

Table 11 Off Gas Composition

Waste types	Electronic waste	MSW	Medical waste	Propane test	Medical waste
Application of syngas	Power generation	Power generation	Power generation	Direct combustion	Power generation
Output power (kW)	102.00	65.00	130.00	-	130.00
Off gas temperature °C	833.00	1145.00	1191.00	1073.00	886.00
Velocity of off gas (m/s)	40.87	30.38	53.07	3.36	32.94
Off gas flow rate (m^3/h)	369.41	228.12	367.71	2519.49	270.67
O_2 (%)	0.00	0.00	0.00	16.50	0.00
CO_2 (%)	12.50	14.00	14.00	3.10	14.30
CO (ppm)	159.00	197.00	359.00	1.70	258.00
NOx (ppm)	57.70	15.90	18.00	25.00	-125
SO_2 (ppm)	1.20	0.30	0.30	2.30	0.40
THC, wet (ppm)	15.60	11.30	16.00	0.10	9.90
HCl (ppm)	-	<0.6	<0.6	-	<0.6
Cl_2 (ppm)	-	<0.6	<0.6	-	<0.6
H_2O, wet (%)	14.50	16.10	15.90	5.90	18.10
Total dust (mg/dscm)	<5	<3	<2	3.5±32%	<2

There are two ways to recover energy, one is producing steam through waste heat boiler for power generation, by which the system efficiency is relatively low, and need use outside power to generate plasma, increasing the cost.

Driving gas engines or gas turbines by syngas is a high efficient way to recover energy with higher efficiency, but the waste composition affects syngas quality greatly, so the heating value of syngas is not stable and cannot keep engine stable for long time.

(3) Domestic Application Status

A part of domestic patents about plasma arc technologies and facilities for waste treatment are listed in**Table 12**. Institute of Mechanics, Chinese Academy of Sciences (CAS-IMECH) is the inventor of 11 patents.

Table 12 Part of Domestic Patents about Plasma Arc Technologies for Waste Treatment

No.	Patent Name	Patent No.
1	Plasma pyrolytic gasifying apparatus for polymeric rejected material – Plasma arc pyrolysis/gasification apparatus for waste polymers	02250661.6
2	Method of plasma arc treatment for chemical weapon (Patent for National Defense)	03105936.8
3	Method of treating waste matter using plasma electric arc technology and its device – Method and facility for waste treatment by plasma arc technology	200310115200.3
4	Method for cracking organic debris reinforced by plasma and plasma furnace – Method and facility for plasma arc enhanced pyrolysis for organic waste	200310113485.7
5	Plasma multi-stage cracking technology and apparatus capable of processing multiple organic waste simultaneously – Technology and facility for multi-stage plasma arc pyrolysis for multi-sort of organic waste	200310115199.4
6	Equipment and method of combined plasma arc and electric heat for cracking organic waste – Method and facility for pyrolysis by combining plasma-arc and Joule-heat for organic waste	200310121342.0
7	AC plasma refuse cracking apparatus – AC plasma arc waste pyrolysis apparatus	200310103200.1
8	Dangerous waste treatment device using plasma arc technology – A plasma-arc technology facility for hazardous waste treatment	200320122193.5
9	Plasma cracking furnace having organic refuse reinforcedly cracked – A plasma arc pyrolysis furnace with enhanced pyrolysis effect for organic waste	200320121907.0
10	Integrated plasma multistage, cracking furnace for simultaneously treating multiple kinds of organic refuse – A multi-stage plasma arc pyrolysis furnace for multi-sort of organic waste	200320122194.X
11	Device for cracking organic waste using plasma arc and electric heating – A pyrolysis arc facility combining plasma-arc and Joule-heat for organic waste	200320127919.4
12	AC plasma waste cracking device – AC plasma arc pyrolysis facility	200320103141.3

(a) CAS-IMECH Plasma Arc Pyrolysis

CAS-IMECH plasma arc pyrolysis system is developed by the Institute of Mechanics, Chinese Academy of Sciences (CAS-IMECH). CAS-IMECH started the plasma technology application in electric-arc wind tunnel for the program of satellite reentry atmosphere in 1960 in China firstly, promoted MSW incineration actively in 1991, and is the first and the leading research institution for studying hazardous waste by plasma arc technology in China. In 2003, CAS-IMECH carried out a project, sponsored by National Hi-Tech Project 863, to develop plasma arc technology for medical waste treatment and completed plasma-arc pyrolysis system with reductive atmosphere in the laboratory. The technology is based on Chinese patents such as 3-phase AC plasma metallurgy furnace (ZL 96119824.9) and DC arc technology (listed in **Table 12**), etc., it uses Hydrogen or Argon as plasma gas to get reductive atmosphere, its feasibility is confirmed by using the pyrolysis treatment experiments of various waste such as chemical warfare agents, chemical waste, medical waste and electronic waste. In 2002, the chemical warfare agent destruction experiment was taken in this furnace for Chemical Defense Institute of PLA. The load capacity is 60 kg/h and the vitrified slag with very stable physio-chemical property was obtained. Furthermore, it is also used to treat waste oil, waste plastic, waste rubber, printed circuit board, etc. in the lab. Recently, CAS-IMECH has applied for 12 Chinese patents in several fields of plasma hazardous waste treatment.

CAS-IMECH built up the plasma-arc medical waste treatment system (Figure above), with the capacity of 3 to 5 ton/day, is a full-scale demonstration and can be used to destruct gases, liquids and solid waste. Since using graphite as furnace liner and electrodes, the system can be used to treat strong-corrosive CFCs waste containing fluorine. The system introduces H_2 to form reductive atmosphere, consumes less plasma gas and produces low volume off-gas of 200 to 300 Nm^3/hr. It includes a simplified pre-treatment subsystem, a plasma pyrolysis reactor, a plasma power supply, and an off-gas treatment subsystem, a monitoring/controlling subsystem and a cooling subsystem, etc. The pre-treatment subsystem consists of a hydraulic ram feeder and a guillotine-door, the entire medical waste pre-treatment subsystem also includes a crusher, a conveyer an additives storage tank, an additives screw feeder and a seal system. The plasma pyrolysis reactor includes an AC plasma-arc generator, a reactor tank, an set of electrode driving machine, a feed-in system, a cooling system and a taphole system etc. The temperatures can attain above 7000°C in arc zone, 1000-1500°C in reaction zone and 900-1100°C at off-gas port, the output of the slag forms vitreous slag. Plasma power subsystem with power capacity of 250kW includes a transformer, an electric reactor and a controlling system, which is obligated for the capacity of 5 ton/day. The integrated off-gas subsystem in the lab is a full system, which involves an off-gas fast heat exchange cooler (to about 600°C), an air pre-heater (heat fresh air to 150°C, while the temperature of the off-gas reduces to around 500°C), and then off gas enters into a carbon-fiber adsorber box to remove dioxins and furans. The fabric filter is not fixed in the system, because of small amount of off-gas taking little particles in it. However, a fabric baghouse is built up in this position in order to catch more fine particles in industrial system. The off-gas after removal of particles is turned into a wet acid gas scrubber where the acid gas in the off-gas is removed, then heated to 150°C by hot air from air pre-heater, and then discharged to a combustor. The off-gas combustor is fixed at the end of the subsystem, and the system before the combustor is designed as sealed and explosion-resistant system. The combustible gas recycling and syngas producing technique are not employed in this system, thus the technical process and facilities are rather simpler and the system and control strategy is much easier. The shoot diameters produced by pyrolysis progress is around 50 nm and can be collected by fabric filter, which is determined by its purity, the unrecycled shoot will be returned to the feed-in side and then re-treated.

Recently, a joint venture, CAS-IMECH Plasma Research Co., Ltd. (Shenzhen, China), set up by CAS-IMECH and Mega-Green Environmental Science and Technology Co., Ltd., has started to build a plasma-arc pyrolysis demo-plant in Liquan County, Xianyang City, Shaanxi Province with the capacity of 5 ton/day, which is used to destruct hazardous waste such as POPs and medical waste, etc. The integrated plant consists of a heat recovery system to steam the plastic waste, which can be recycled after disinfection. To simplify the operation, the off-gas combustion chamber is fixed directly after the plasma reactor and before the boiler, thus, the combustible gas will be burnt out, and there is no explosion risk. CAS-IMECH Plasma Research Ltd. plans to industrialize the plasma arc treatment system.. See Figure 16.

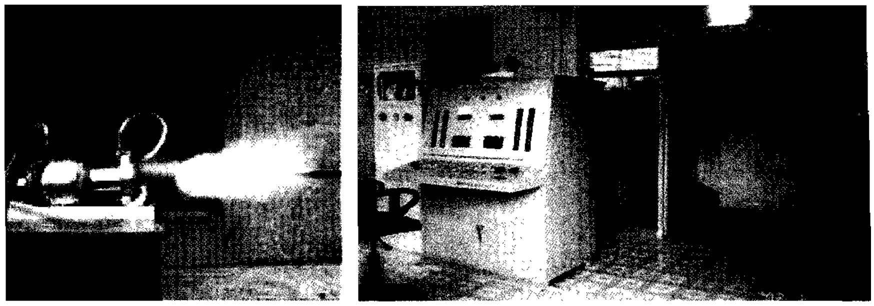


Figure 16 Plasam Technology of SWIP, in shenzhen City

According to the data provided by CAS-IMECH, the costs of facility with 5 ton/day capacity is about RMB 6 million, the running cost is about RMB 2,600 to 2,800 per ton of waste.

(b) High Power Plasma Technology for Hazardous Waste Treatment – IPP

The DC 150kW non-oxygen plasma-arc furnace for pyrolysis treatment of hazardous waste is successfully developed in IPP, the Institute of Plasma Physics of CAS (Chinese Academy of Sciences).

The lab furnace includes plasma reactor kettle subsystem, waste feed-in subsystem, electron driving subsystem, cooling and seal subsystem, molten metal and vitrified slag ejecting valve. Nitrogen is as the working gas, but no off-gas treatment system. It can treat 500 kg of printed circuit board per day, and also intend to treat hazardous waste, industrial waste, medical waste, municipal waste and waste tires, etc. The experiments for typical electronic

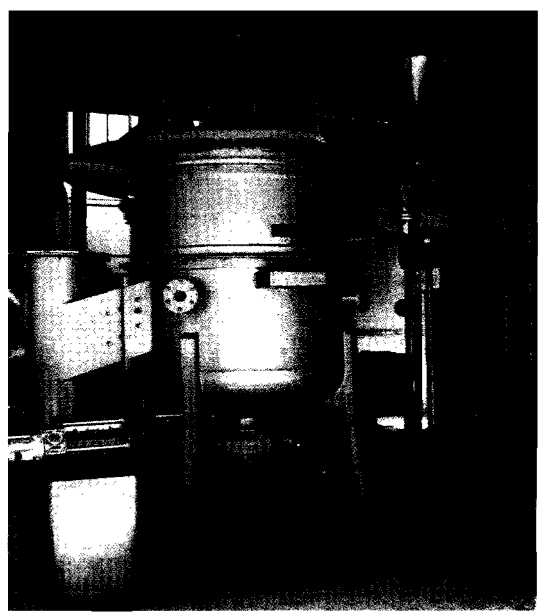


Figure 17 DC Plasma Arc 150kw Oxygen Plasma Pyrolysis Furnace,CAS

waste (printed circuit board) treatment have been carried out, and the metal, vitrified slag and off-gas were effectively separated through three output ports respectively. The detection reports said that 'the emission of hazardous materials is far below the emission standard of national medical waste incineration (there is no national emission control standard for electronic waste), especially, no-oxygen pyrolysis treatment results in low oxide emission'. In 2004, IPP took part in a joint project responded by CAS-IMECH, supported by the Innovation Engineering Program of CAS, and is in charge of the sub-program for inorganic waste treatment. The second DC 150kW non-oxygen plasma arc pyrolysis furnace (**Figure 17**) was built up in July of 2007. There is no commercialization report up to now. This Technologies will apply to Ma'anshan plasma disposal facilities, the majority operation cost is eletricity by plasma gear, which is about 1kWh/kg and estimated cost is abut 5000-6000 Yuan/ton.

(c) Plasma Medical Waste Incineration Technology – SWIP

Southwestern Institute of Physics (SWIP) applied DC plasma torch to develop experimental facility for chemical warfare agent treatment (1kg/h), but no industrialized application. In 2002, cooperated with some engineers of SWIP, Zhen Gao Ke Industry Co., Ltd. (Shenzhen, China) developed a plasma waste incinerator (2 ton/day), using SWIP technology and key components (plasma torch and power supply). Actually, the capacity of the furnace cannot achieve 2 ton/day (SWIP now announced that it is only 1 ton/day) and built up a set of 1 ton/day medical waste facility in Pingshan People's Hospital, Longgang Dictrict, Shenzhen. It was said that the incinerator can reach 2000°C or even more in reaction area and decompose effectively the virulent materials, which make great harm to human beings. It also can be used for environmental-friendly treatment of municipal solid waste, medical waste, asbestos, battery, waste tire, PVC, and other hazardous industrial wastewater or waste gas. This furnace has no flue gas treatment equipment, so the flue gas is directly discharged. Furthermore, the technology uses air as plasma gas, the exceed air ratio is above 5, the system is an oxidative system, like a combustion system, the energy supplied by plasma is not enough to pyrolyze waste.

SWIP said they start marketing promotion, but does not offer any examples except the furnace in Pingshan People's Hospital, donated by SWIP. The following figure (**Figure 18**) is the flow chart of the system.

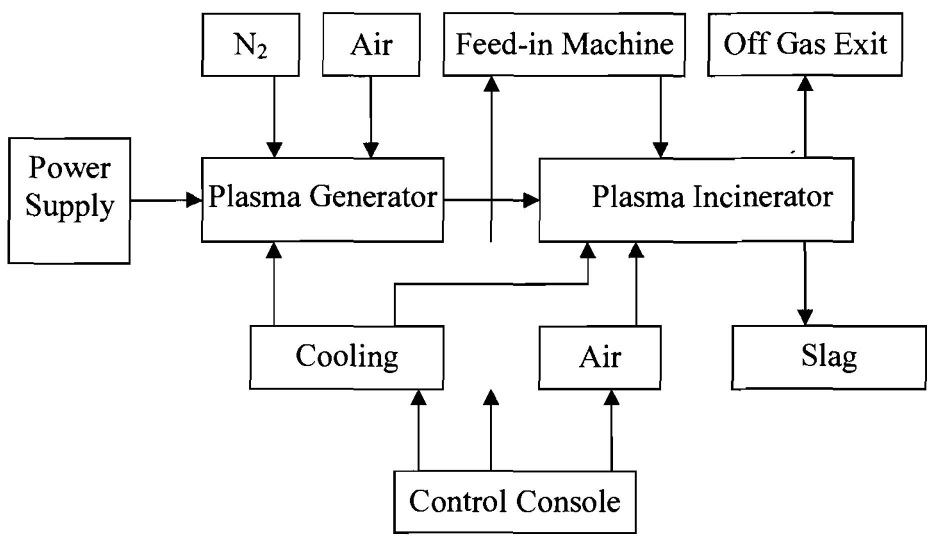
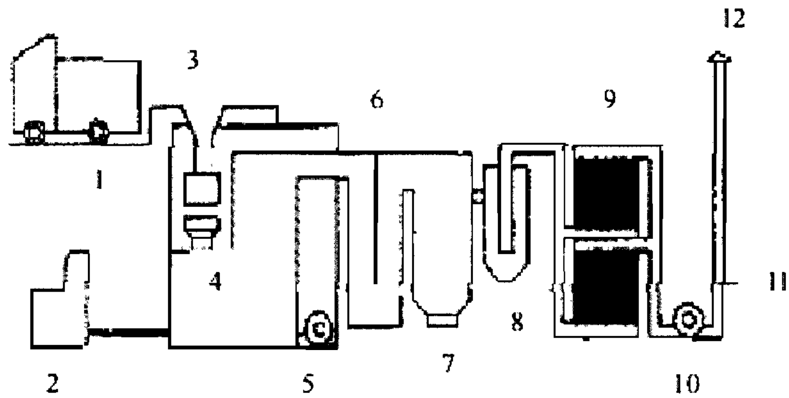


Figure 18 Mechanism of Plasma Technology of SWIP

Actually, the capacity of the furnace cannot achieve 2 ton/day (SWIP now announced that it is only 1 ton/day) and built up a set of 1 ton/day medical waste facility in Pingshan People's Hospital, Longgang Dictrict, Shenzhen. It was said that the incinerator can reach 2000°C or even more in reaction area and decompose effectively the virulent materials, which make great harm to human beings. It also can be used for environmental-friendly treatment of municipal solid waste, medical waste, asbestos, battery, waste tire, PVC, and other hazardous industrial wastewater or waste gas. This furnace has no flue gas treatment equipment, so the flue gas is directly discharged. Furthermore, the technology uses air as plasma gas, the exceed air ratio is above 5, the system is an oxidative system, like a combustion system, the energy supplied by plasma is not enough to pyrolyze waste. It seems that this technology does not belong to non-combustion category. SWIP said they start marketing promotion, but does not offer any examples except the furnace in Pingshan People's Hospital, donated by SWIP. The following figure is the flow chart of the system.

RITS (Research Institute of Tsinghua University in Shenzhen) designed a plasma medical waste treatment facility, based on the experience INER (Institute of Nuclear Energy Research, Taiwan) for low-radioactive waste. The RITS improved plasma medical waste treatment system employs a DC non-transferred plasma torch. Except for treating municipal solid waste, it can destruct asbestos, low-radioactive waste, PCBs, medical waste, and can restrain the formation of dioxins.



1. garbage truck 2.control panel 3.negative feed 4.reactor 5.fan 6.heat exchanger 7.scrubber 8.dust catcher 9.active carbon adsorption tower 10.ID-fan 11.CEMS 12.stack

Figure 19 50 Kg/H of the Plasma Furnace, Research Institute of Tsinghua University, Shenzhen

Recently, RITS said that they have built up a 50 kg/h plasma furnace, applying air as the plasma gas and N_2 as the electrode- protecting gas. Otherwise, RITS said that a 5 ton/day plasma facility has been designed for medical waste treatment by RITS, but no more plan for it.

3.2.1.4 Melting/molten

(1) Brief Introduction

Ore, soil, glass, fly ash and other material rich in silicate minerals at higher temperatures (at 1400 ° C and above) by adding a flux (mainly alkali metal oxides, alkaline earth metal oxides), makes original refractory material reduce the melting point and form into molten liquid phase, metallic liquid phase is located in the lower part, while the silicate component is located in the upper part. Silicate slag formed after cooling block of the vitreous. In industrial the technology is used to metal refining, production of special purpose glass. As the reaction temperature is high, strong oxidation atmosphere, is makes vitreous products that is of chemical stability. In principle, therefore, it is also suitable for disposal of toxic chlorine harmful substances. Prensently, at home and abroad have developed a variety of technologies, including: melting molten glass technology, molten metal, molten salt oxidation and slag, etc..

(2) Foreign Application Status

GeoMelt™ is a process of high temperature vitrification (1200-1400°C), is a new contaminated soils and waste treatment technology developed by Battelle Memorial Institute for DOE of USA. That can be used by both in-situ vitrification (ISV and Subsurface Planar Vitrification SPV™) and in container vitrification (ICV™). GeoMelt™ can treat low radiative waste, hazardous waste, heavy metals, mixed waste and organic residues. As for ISV, the electrodes are plugged into the contaminated soil in the process. The electric energy was turned into heat energy and the soil was melted gradually when the electric current passes through the soil. The melting proceeds outward and downward until all the contaminated zone was melted. GeoMelt™ was ever used to dispose more than 1000 tons of surface and underground waste. At high temperature, the waste matrix melts, and organic contamination are destroyed or volatized. The off-gas from the process passes a stainless steel cover and enters a off-gas treatment system, which includes a filter, a dry scrubber, a wet scrubber, and a HEPS filter. After treatment, the soil and waste were solidified as a glass/ore material. GeoMelt™ was used in USA, Japan and Australia. AMEC was the only authorized GeoMelt™ Company.

Molten metal technology uses the blast furnace and converter or hot steel and iron slags to destruct POPs waste. Molten metal technology was also described as the catalytic extraction process (CEP) in which molten metal acts as both solvent and catalyst. This process uses a heated bath of molten metal at about 1650°C to catalytically disrupt molecular bonds of contaminants and convert hazardous waste into products of commercial value.

Molten salt oxidation is a thermal means of completely oxidizing the organic constituents of mixed and hazardous waste. The molten salt was used as the solvent and catalyst in the process. The organic components of the waste react with oxygen to produce CO2, N2 and water.

Molten slag system is used for treatment of liquids, sludge and metal-bearing waste. In this process, the waste to be treated is blended with steelworks dust and fluxing agents, extracted, dried with heat from the furnace off-gases and fed into a foaming slag layer which forms at the top of the molten iron in an electric arc furnace at a temperature of around 1500°C. The waste sinks into the slag phase, metal oxides are reduced to metals and all organic materials return to their basic elements, like in the molten metal process. Nippon Steel reported a kind of molten slag process to destruct PCBs completely, which was heated to 1400°C by plasma arc. Several results of bench scale trials were described and the process could disrupt about 200-333 kg PCB waste in 8 hours.

Melting solidification is the most preferred flay ash solidification technology in Germany, USA and other developed countries. When the temperature beyond 1400°C, dioxin and other organics in fly ash will be decomposed, part of low boiling point heavy metal salt gasified and most of the metals fixed in vitrified (glassy) slag.

(3) Domestic Application Status

Many different melting furnaces have been developed and put into application domestically and internationally. They might be divided into two groups of fuel fired melting furnace and electricity powered melting furnace, according to the heat source. Fuel fired furnace can be subdivided into surface melting furnace, inside melting furnace, cyclone-type melting furnace, coke melting furnace and rotary melting furnace. The electricity powered melting furnace can be subdivided into electric-arc furnace, plasma furnace, resistance furnace and inductance furnace. The surface furnace is the typical one among fuel fired melting furnace, which use heavy oil and fuel gas as the fuel. This kind of furnace can produce huge amount of flue gas and the process capacity is relatively small. The inside melting furnace takes the residual heating value of fly ash as the energy source, which is connected to MSW incinerator, the hot ash is discharged from incinerator directly into the furnace, and a preheated air blown in to the furnace to support the burning of the slag. The electric-arc furnace powered by electricity, the high temperature electric arc generated between electrodes is applied to melt ash and slag. This kind of furnace exhausts little off gas, which is very easy to be treated. The shortcoming of electric-arc furnace is that well-skilled operators are needed and the slag outlet is easy to be damaged. Plasma melting furnace is powered by electricity also; consist of furnace body, plasma generator, power supply, plasma gas supply, etc.

Shanghai Sifang Boiler Company and **Shanghai Power Equipment Research Institute** developed jointly a 5000 kg/d MSW incineration fly ash swirl-type melting furnace, a kind of fuel fired melting furnace. The rated load of the testing equipment is 5000 kg/d, and it can be reduce to 30% of the rated load. The off gas outlet port temperature of the furnace is around 1300°C and the temperature inside the furnace is between 1350-1550°C. The resident time of ash in the furnace is 30 min, more than 99.5 % dioxin is destructed, and slag yield rate is ≥95 %. Some glass powder, the borax and other fluxing agent added with fly ash put may help reduce molten temperature. After water quenching, the slag forms vitrified substance, which well fix heavy metals inside, so the slag may be used as the building material. The off gas cools down by water-cooled heat exchanger and the air pre-heater, temperature of off gas drops down to 200°C approximately, and then an ID fan discharges it into stack. The cold fresh air is heated up to 400°C approximately and sent into the furnace. The hot water from heat exchanger is supplied to customer.

In 2005, **Zhejiang University** started the study of plasma fly ash melting solidification.

The domestic patent application for molten process and equipment are listed as follows:

Table 13 Domestic Patents for Waste Molten Process and Equipment

No.	Patent Name	Patent No.
1	Ash fusion devices	02106569.1
2	Process for recovery of waste chrome-plating bath solution by concentration, smelting and purifying	92106822.0
3	Tunable, self-powered integrated arc plasma-melter vitrification system for waste treatment and resource recovery	96192788.7
4	Method for fusion treating a solid waste for gasification	97195870.X
5	Ash melting furnace and ash melting method thereof	99800393.X
6	Waste material incinerator	02241446.0
7	Resin waste melting and volume reducing device, and volume reducing method using the device	02816870.4
8	Method of processing refuse burning fly ash through cyclone furnace high temperature melting	200410044191.8
9	New type heating and fusing method and equipment for dealing with flying ash generated by burning garbage	200510047774.0
10	Chromium-free monothilic refractory for melting furnace for waste and melting furnace for waste lined with the same	200480007261.0
11	Additive for fusing fly ash in use for refuse burning process	200410101493.4
12	Electric arc molten processing system and method for processing rubbish combustion ash	200610047497.8
13	Waste melting furnace ventilator scoop structure and the method to blow in combustible dust.	200480043304.0

No.	Patent Name	Patent No.
14	Hazardous waste cyclone gasification melting system	200710027131.9
15	Fly ash melting furnace	200520039468.8
16	Waste-melting and fiber producing structure	200520108111.0

Zhongtian environmental protection Group introduced hazardous waste moten slag technology of Lurgi lentjes company, Germany and conducted secondary development technology based on China's national conditions. The technology can use the heat of combustion of fuel and electric heating. At high temperature (1400 °C), organic matter in fly ash thermal decomposition, combustion and gasification, while the mineral is fused into a vitreous slag. **Molten slag process** is used to handle waste like liquids, sludge and metal bearings. Mix the to-be-treated waste with the steel's ashes and flux, and after extraction and heated by furnace exhaust gas, the outcome is feeded into the foaming slag formed by the melting iron at the upper layer of the electric arc furnace at around 1500°C. After the waste being injected into the slag phase, like molten metal, metal oxides are reduced to metal, and all of the organic material to basic elements. Zhongtian environmental protection industrial group took a world-wide inspection and finally decided to introduce a world-class hazadous waste slag incineration technology- Lurgi lentjes hazadous waste slag incineration technology and officially signed the technology tranfer contracts on July 22^{nd}, 2005. The major parameters of Zhongtian's high temperature melting can be seen in Table 14.

Table 14 Main Distribution and Performance Parameters of Zhongtian High Temperature Melting

location	Production line	Handling capacity t/a	Thermal load MW	Steam quantity t/h	Steam statistics MPa	°C
Chongqing Bishan	1	15000	8.6	8.0	1.57	204
Chongqing Changshou	1	15000	8.6	8.0	1.57	204
Shanxi Xianyang	1	7761	3.9	3.0	1.27	194
Qinghai Xining	1	6722	3.1	2.3	1.27	194
Henan Zhengzhou	1	9996	4.7	4.5	1.27	194

Guangzhou Institute of Energy, Chinese Academy of Sciences, have studied the solidification effect of heavy metal in fly ash under different condition and pointed out 1) Melting solidification shows good effect for all heavy metals, 2) Acidity ($pH \leq 4.5$) and alkali ($pH \geq 11.5$) conditions have significant impact on fly ash solidification; 3) Humid environment ($L/S \leq 100$) do not have impact on fly ash solidification effect and the heavy metals leaching value is still lower than leaching standard. It is safe to landfill fly ash solidified by molten methods.

Institute for Thermal Power Engineering of Southeast University and **the Institute for Thermal Power Engineering of Zhejiang University** studied chemical composition of fly ash, microscopic appearance and mineral characteristic. The bottom ash from MSW (Municipal Solid Waste) incinerators is molten and then quenched by air or by water, the heavy metals in the ash is fixed in the vitrified slag very stably. At the same time they also analyzed the destruction mechanism of dioxin. The concentration of the dioxin is 320 ng/g (3.7ng TEQ/g) in incineration ash, which is very high level, but it is only 0.012 ng/g (0.0064 ng TEQ/g) in molten slag, and the concentration of the dioxins is 1.0 ng/g (0.0064 ng TEQ/g) in melting furnace fly ash, and 2.5 ng/m^3 (0.028 ng TEQ/m^3) in melting furnace off gas, which shows the decomposition rate is 99.93% by melting furnace. The reasonable explanation is that the temperature of dioxins decomposition is only 800°C, but the temperature in the melting furnace is higher than 1000°C, some times, is even over 1700°C, the higher temperature in the furnace support enough energy to crack the organic structure to decompose dioxins to CO, HCl, H and O.

Chinese Academy of Environmental Sciences and **Chemical Engineering College of Beijing University of Chemical Technology** studied the solidification mechanism of heavy metal in bottom ash from MSW incinerators in meltdown process and the slag leaching property.

Institute of Clean Energy and Environmental Engineering of Shenyang Institute of Aeronautical Engineering, the Department of Environmental Science and Engineering of Tsinghua University and the Institute for Thermal Power Engineering of Zhejiang University have studied the destruction of dioxin in meltdown process. The results show 1) Fly ash meltdown can effectively decompose dioxin and the destruction efficiency of dioxin in meltdown process can be as high as 99.96% and only little part leaves in slag and there is no dioxins detected from off gas emission of meltdown process. 2) Melting temperature has great influence on dioxin destruction, the higher the melting temperature, the higher the destruction efficiency of dioxin within the temperature range tested, the destruction efficiency is 99.968% at 1100°C and can reach 100% at 1460°C. 3) The melting atmosphere has also influence on dioxin destruction at high temperature. Under the same condition, the dioxin destruction efficiency is higher under oxidizing atmosphere than inert atmosphere.

The Department of Thermal Engineering of Tongji University and **Shenzhen Municipal Clean-up Service** have jointly studied the low temperature vitrification mechanism and technology for MSW incineration ash.

Department of Environmental Science and Engineering of Tsinghua University studied the influences of additives on the dioxin destruction during fly ash meltdown process. The results show that CaO have different influences on dioxin destruction. Under oxidative atmosphere condition, CaO slightly decrease the dioxin decomposition efficiency but increase under reductive atmosphere condition. Liquid ceramics additives have significant influences on dioxin decompose in meltdown process. At the temperature of 1400°C, the dioxin decompose efficiency is increased from 99.997% to 100%, when liquid ceramics additives added from zero up to 10%. And 10% of liquid ceramics can decrease the dioxin thorough destruction temperature from 1460°C down to 1100°C.

From 2002 to 2005, the Research Institute of Solid Waste Treatment, **Department of Environmental Science and Engineering, Tsinghua University** carried out a project of Hazardous Waste Treatment and Disposal Technology, sponsored by National High-Tech Project 863. The research group provides process technology and facilities for fly ash high temperature calcinations and melting, and fly ash stabilization by adding agents, through technical research and pilot scale demonstration. At the same time, they studied and drawn a documents system for long term management of incineration ash treatment and utilization.

High temperature melting technology can dispose of hazardous waste in general. For pesticide waste, it is subject to further experimental verification. Yet, in principle, there should be no problem. The disposal cost is estimated at RMB 4000-5000 yuan/t.

3.2.1.5 Chemical reduction

(1) Brief Introduction

It is generally believed that hydrodeoxygenation and oxygenation are reduction reaction. Pesticide POPs is a kind of hydrocarbon halides, although the chemical properties are very stable, but the highly reactive H. can react with such chemicals. After reaction, the halogen elements form hydrogen halide with Hydrogen while alkyl converted into biphenyl, making toxicity of POPs removed, this process of reduction reaction. Such kind disposal technologies of POPs 1 that use H. as reduction agent collectively referred to as chemical reduction technologies, including: gas-phase chemical reduction, alkaline-catalyzed decomposition, alkaline polyethylene glycol, mechano-chemical method (ball milling) and sodium reduction.

The major advantages of reductive technologies are

- Excellent DE
- Low amounts of solid residuals
- All types of waste, mobility, scalability
- Can be designed as mobilized facility or large plant
- Experience with POPs Containment

Limitations, disadvantages, and concerns are

- Safety issue related to hydrogen
- Complexity
- Costly for low strength waste or small scales.

(2) Foreign Application Status

(a) Gas-Phase Chemical Reduction – GPCR

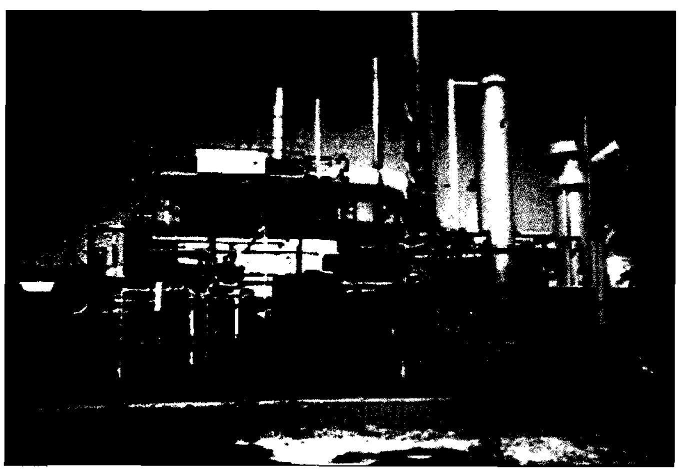


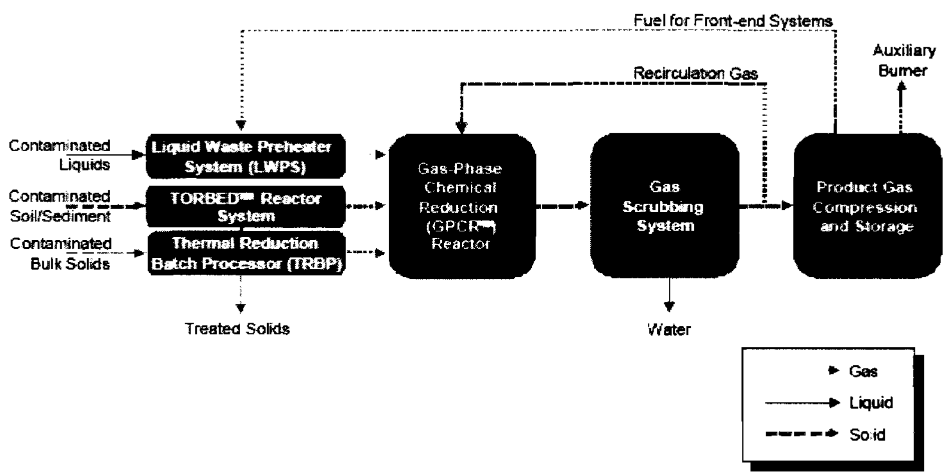
Figure 20 Gas-Phase Chemical Reduction of ELI Eco Logic International Ontario Canada

GPCR technology was developed by ELI Eco Logic International, Inc., Ontario, Canada. Eco Logic's GPCR technology involves the gas-phase chemical reduction of organic compounds by hydrogen at a temperature of 850°C or higher. Chlorinated hydrocarbons, such as HCB, polychlorinated dibenzo-*p*-dioxins (dioxins) and other POPs, are chemically reduced to methane and hydrogen chloride (HCl). Unlike oxidation reactions, the efficiency of these reduction reactions is enhanced by the presence of water, which acts as a heat transfer agent as well as a source of hydrogen. Therefore, dewatering of input waste is unnecessary. The water shift reactions produce hydrogen, carbon monoxide and carbon dioxide from methane and water. These reactions can be used at higher efficiencies to generate hydrogen for reuse in the system by subjecting scrubbed methane-rich product gas to high temperatures in the presence of a catalyst. The mechanism of GPCR is shown as following:

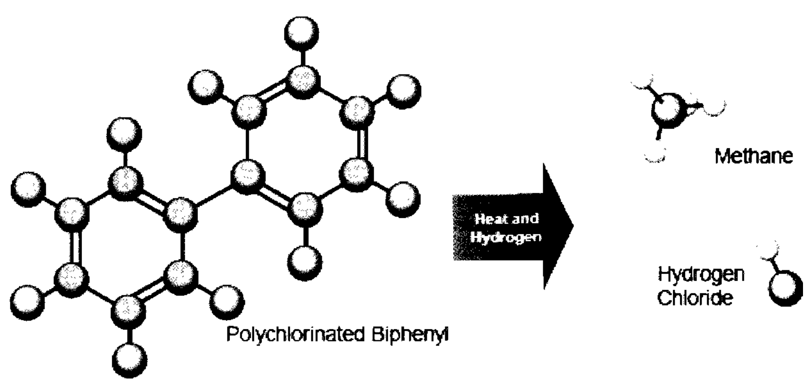
$$C_mH_nO_pCl_q + \frac{4m+2p+q-n}{2}H_2 \xrightarrow{\geq 850\ ^{o}C, catalyst} mCH_4 + pH_2O + qHCl$$

Solid and bulk waste materials are processed in a Thermal Reduction Batch Processor (TRBP). This waste is placed in the TRBP, which is sealed and heated in an oxygen-free atmosphere to about 600 °C. Organic components are volatilized and swept into the GPCR reactor, where complete reduction takes place at 850-900 °C. Gas leaving the Gas leaving this reactor is scrubbed to move particulate and acid and then stored for reuse as a fuel.

A Commercial system operated in Australia for more than 5 years, treating more than 2,500 tons of PCBs, DDT and other POPs. In 1999 a full-scale test on HCB was conducted using the commercial plant. Eco Logic's partners in Japan have recently built a semi-mobile GPCR plant for the treatment of PCB waste, which will be operational in 2003.Eco Logic has partnered with Torftech Inc. for the treatment of soils and sediments at rates of up to 20 tons per hour.



(a)main technique flow chart



(B)Reduction Procedure Of PCB

Figure 21 A Schematic Diagram of Machnism of Gas-Phase Reduction

In 2005, ELI Eco Logic Inc announced that it has delivered a reactivation plan to the TSX Venture Exchange. Under the reactivation plan, the Company will be a newly organized merchant banking organization that provides financial services primarily within the North American residential real estate market. The new organization will operate under the name Global Development Resources, Inc. The Company will operate two offices, one in Toronto, Ontario which will be its new registered office and one in Ashville, South Carolina.

(b) Base-catalyzed decomposition – BCD

In a base-catalyzed decomposition (BCD) process, POPs waste are mixed with hydrogen donor oil, sodium bicarbonate and patented catalyst and heated to above 300 °C, when high active hydrogen atoms produced from the donor react with waste and detoxify the POPs. The BCD patented process is divided into 2 separate and distinct processing steps; the first makes use of modified indirectly heated thermal desorption to decontaminate media such as soil and building rubble contaminated by POPs and is a continuous process, the second is a batch process in which POPs in the form of pure chemicals, or concentrates obtained from the desorption step are destroyed by a chemical reaction in a heated stirred tank reactor, as shown in the following equations.

$$POPs + NaHCO_3\ (1) \xrightarrow[315\text{–}500\ ^oC]{thermal\ desoprtion} condensate$$

$$(2) BCD\ LTR \rightarrow \text{decontaminated soil}$$

The BCD patent indicates that the alkaline chemical may be added to the contaminated medium in an aqueous solution, or in a high boiling point solvent. If the chemical is added in the form of a solid dispersion or suspension in water, the water assists in distributing the metal compound homogeneously throughout the contaminated medium. If the chemical is added with a high boiling point solvent, the solvent must have a boiling point of at least 200°C, and preferably be in the range from 200°C to about 500°C. Otherwise, it will distil from the mixture during treatment.

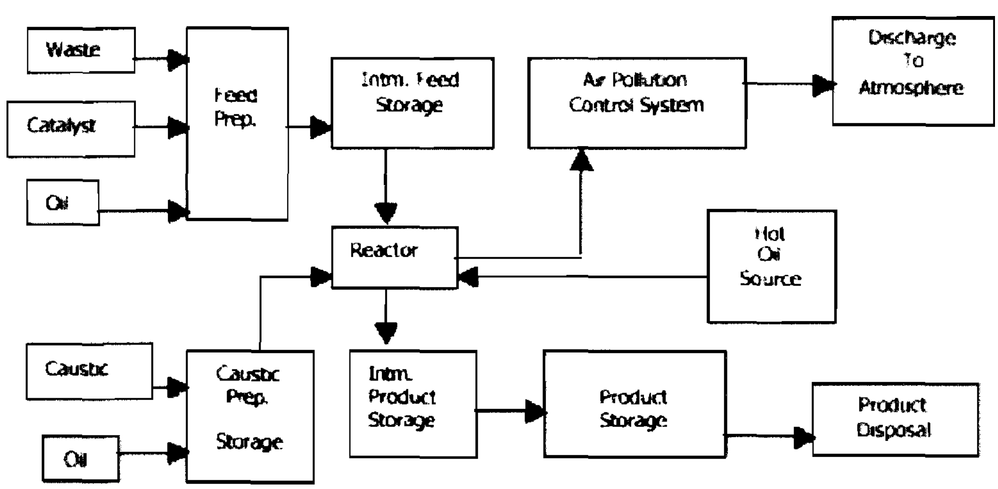


Figure 22 A Schematic Diagramfor Mechanism of POPs Alkaline-Catalyzed Reduction Technology

Alkali is added to the contaminated medium in proportions ranging from 1 to about 20 percent by weight. The amount of alkali required is dependent on the concentration of the halogenated or non-halogenated organic contaminant contained in the medium.

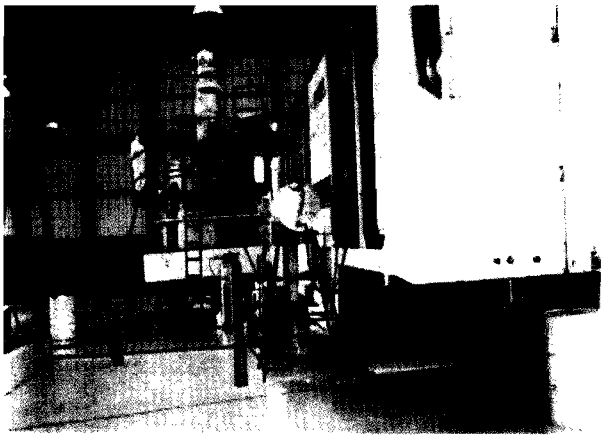


Figure 23 BCD Fixed Plant

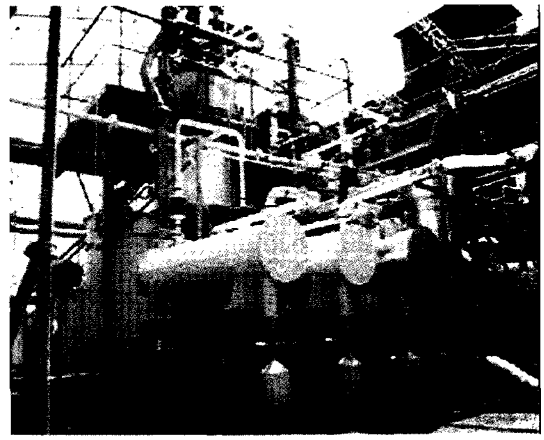


Figure 24 BCD Mobile Plant

The mixture is heated at a temperature and for a time sufficient to totally dehydrate the medium. This may be performed at atmospheric or at reduced or elevated pressure. The water, which is included in the aqueous solution allows homogeneous distribution of the alkali throughout the mixture and acts as a wetting agent and penetrates. When the water is removed from the medium during the dehydration step, the alkali is concentrated to a reactive state.

After dehydration, the medium is further heated at a temperature between 200°C and 400°C for a time sufficient to effect reductive decomposition of the halogenated and non-halogenated organic contaminant compounds, typically 0.5 to 2 hours. At this temperature the carbon source (eg the carbohydrate) acts as a catalyst for the formation of a reactive hydrogen ion from the hydrogen donor compound and remove the contaminant.

The hydrogen donor employed in the process is recovered in concentrations up to 90% by centrifugation after POPs have been treated and the recovered oil is reused. Treated materials are reduced to a carbon residue, sodium chloride when chlorinated compounds are destroyed, and residual or unused alkali metal hydroxide. The catalyst employed in the process is low cost, an organic material, non-toxic, and is readily available in all countries.

By practice, BCD can be used for treating every kind of waste with high-strength POPs, especially for PCBs concentration is higher than 30%.

BCD process has been, and is today actively used commercially for more than 13 years and therefore it is a mature technology. Starting in 1994 BCD Technologies Pty Ltd., a firm in Brisbane, Australia has treated annually thousands of tons of PCBs and PCB transformers/capacitors. Since 1997, S.D. Myers de Mexico (near Mexico City) has been processing PCBs and other materials in a 10 000 liter commercial plant. Ebara Corporation, a major firm in Japan, completed construction of commercial BCD plants for use in Japan in 2005. Also, a major BCD facility is being built by Environmental Solutions and Technologies Inc. (ETSI) in Chicago, Illinois starting in 2006. **Figure 23~Figure 24.**

Figure 25 BCD Application Case

Take the 10 tons/day (assuming operating 240 days per year, 2 batches per day) for example, the estimated cost of fabricating a fully operational BCD plant is USD 1.0-1.5 million. The construction cost depends upon the size of the reactor, the number of reactors, vendors of the components (pumps, valves, piping, gauges, etc.), and the place of manufacture. When 2400 tons of PCBs or POPs are destroyed annually,. for 30% concentration, the processing cost is about USD 392 per ton. Treatment of 50% concentration would cost about USD 572 per ton. Treatment of 100% concentration of PCBs or POPs would cost about USD1022 per ton. Rarely are PCBs or POPs found in 100% concentration.

(c) Mechanochemical dehalogenation – MCD / Ball milling

Mechanochemical dehalogenation (MCD) process occurs ex situ in an enclosed ball mill, and the grinding medium provides the mechanical energy and mixing. It uses mechanical energy to promote reductive dehalogenation of contaminants. In this process, contaminants react with a base metal and a hydrogen donor to generate reduced organics and metal salts. The base metal is typically an alkali-earth metal, an alkaline-earth metal, aluminum, zinc, or iron. The hydrogen donors used include alcohols, ethers, hydroxides, and hydrides. The mechanism of MCD is shown in the following equation (Thiess_ServicesNSW_2004):

$$C_mH_nO_pCl_q + Na/Mg + H\ donor \xrightarrow{Ball\ mill} \text{Reduced organics} + NaCl/MgCl_2$$

The technology is applicable to soil, sediments, and mixed solid-liquid phases. MCD™ has been used to treat high-strength waste containing POPs. The mobile MCDII was ever used for the Chemical Company (FCC) site of New Zealand and the DDT concentration was reduced from >3500mg/kg to 200mg/kg.

$$C_mH_nO_pCl_q + Na/Mg + H\ donor \xrightarrow{Ball\ mill} \text{Reduced organics} + NaCl/MgCl_2$$

Mechano-chemical dehalogenation method is suitable for treatment of high concentrations of POPs contaminated soil, sediment, and solid-liquid mixed waste. Alkaline metals commonly used include: alkali metal, alkaline earth metals, aluminum, zinc or iron. Hydrogen donor include: alcohol, ether, hydroxide and hydride. After treatment the product is non-toxic organic matter and salts.

MCD technology of EDL New Zealand has developed to the fifth generation, the performance shown in Table 15. EDL has in California, New Zealand, Mary Mapuma City, Hong Kong, China and other places on-site demonstration project, Table 16.

Table 15 Fifth-Generation MCD ™ System Performance

Decomposition efficiency	Acceptance standard	Load lmpact torlence	System output	Energy input	Noise
>99.99%	Accomodation and commerical	<20,000mg/kg	15t/h	<10mg/m^3	60-107.5dBa

Table 16 A Summary of MCD Demonstration Project

location	contanmination	Contamination range	Remediation standard	performance
American	PCBs and heavy metal	PCBs 1260, 170,000ppm;Pb 2,100ppm	PCBs 1ppm; Pb 5mg/L(TCLP)	Less than 1ppm
New zeland	High content pesticides,like DDx and ADL*	420 ha.,65,000m3,DDx 2,600ppm,ADL 100ppm	Deeper than 0.5m,200ppm,DDx and ADL 60ppm;deeper than 0.5m,5ppm DDx,3ppm ADL	Better than remediation standard
Hongkong	High petroluem contaminated soil	No information	TPH 100mg/kg Metal refer to US EPA 8015 method	Better than remediation standard

*DDx:DDT、DDD、DDE;ADL:Dieldrin,aldrin,lindane

Mobile MCD(II) has been used in a Chemical Company (FCC) site of New Zealand. The concentration of DDT decreases from > 3500mg/kg to 200mg/kg DDT. However, after MCD treatment, the waste may also contain higher concentrations of POPs.

(d) Sodium reduction

Alkali metal reduction involves the treatment of waste with dispersed alkali metallic. Alkali metallic reacts with chlorine in halogenated non-aqueous waste to produce salt and non-halogenated waste. Typically, the process operates at atmospheric pressure (sometimes up to 4 atmospheres) and temperatures between 60°C and 180°C (actually normally between 90°C and 165°C, the quality of transformer oil deteriorates above 165°C, so higher temperatures are undesirable as most chemical decontamination is followed by dielectric regeneration to allow re-use of the oil as a transformer fluid). Treatment can take place either in-situ (i.e. PCB contaminated transformers) or ex-situ in a reaction vessel. There are several variations of this process. Although potassium has been utilized, metallic sodium is the most commonly used reducing agent (other reagents, mostly organo-metallic ones such as K-Peg (Polyethylene glycol) and sodium naphtalide, are also used). The remaining information is based on experiences with the metallic sodium variation. The mechanism of Na reduction is shown as following:

$$C_mH_nO_pCl_q + Na \xrightarrow{Ball\ mill} NaCl + \text{Non-halogenated organics}$$

This process has been used commercially for approximately 25 years. It has been used extensively in particular in North America and in Germany where most of the oil above 50 ppm of PCB has now been treated. Plants are also located in France, Spain, Iran and Japan. In the last years, one of the Canadian technology suppliers has commercialized a variation the so called Sodium Powder Dispersion Process for the destruction of PCBs in contaminated solids, specifically fluorescent light ballast waste and capacitors. A commercial plant began operation in Canada in 2003. In Japan, in such a system 214 kg of PCBs in capacitors was treated in Okayama prefecture in 2002.

Costs are the same in Canada, the US, England and other locations, but the method of calculation may change from one organization to another. One of the Canadian fixed plants from UNEP, 2004 indicates: PCB contaminated mineral oil: CAN$ 0.15/L, PCB contaminated capacitors: CAN$ 5.10/kg, PCB contaminated fluorescent light ballast waste: CAN$ 1.10/kg. Here the costs of pre-treatment and disposal of the residuals are included.

(e) Solvated electron technology - SET™

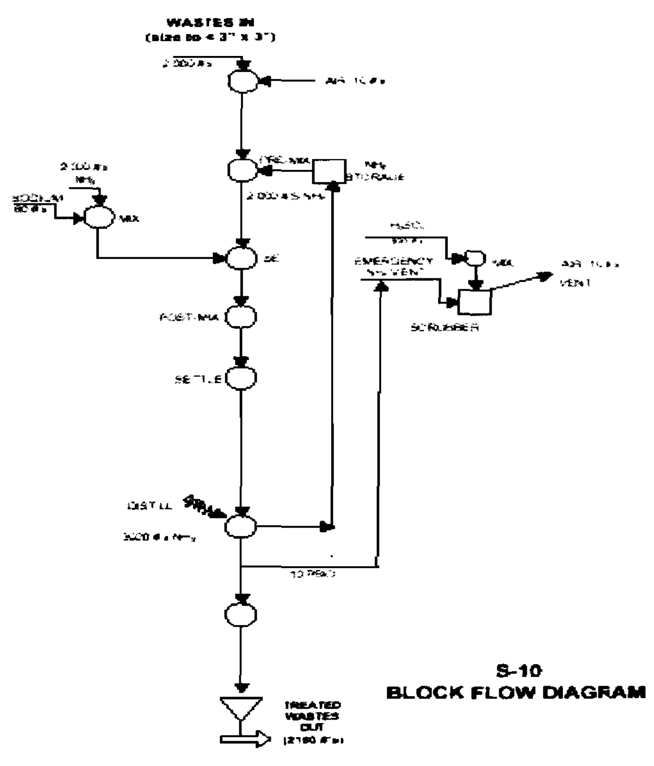


Figure 26 Flow Chart of Solvated Electron Technology

The Solvated Electron Technology (SET™) is a patented non-thermal process for the treatment of a wide range of organics, and Commodore Solution Technologies, Inc. is the vendor of the technology. It applies a series of non-thermal methods to process organic pollutants. The SET™ process uses solvated electron solutions to reduce organic compounds to metal salts and the parent molecule (dehalogenated). Solvated electron solutions, which are strong reducing agents, are formed by dissolving alkali or alkaline earth metals such as sodium, calcium and lithium in solvents such as anhydrous liquid ammonia. Example byproducts from treating PCB contaminated waste include petroleum hydrocarbons, sodium chloride, and sodium amide.

In March 1996, USEPA issued Commodore Solution Technologies, Inc. the nationwide permission to treat PCBs contaminated soils and metal surface. At the same year, the US government did choose SET™ as one of three fast commercialized demonstration technologies. In 1998, the nationwide permission added PCBs remediation and recovery projects. Commodore Solution Technologies, Inc., the vendor of the technology, is not currently marketing the technology because of its high treatment costs.

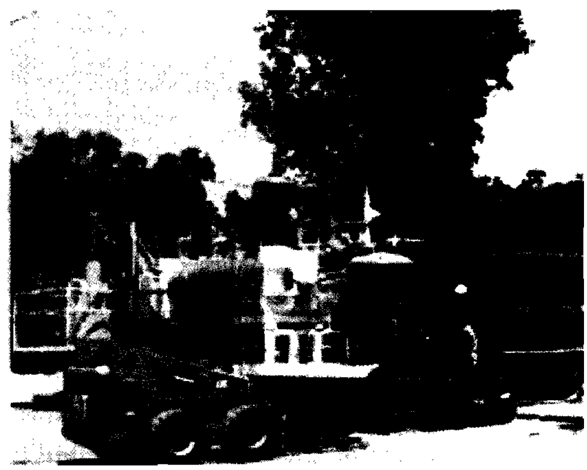


Figure 27 A Mobile Plant of SET™

(f) Sonic technology

The technology was developed by Sonic Environmental Solutions, Inc. in Vancouver, Canada. Sonic Technology is an ex situ technology that is used to treat low- and high-strength soils containing PCB, and a combination of Terra-Kleen solvent extraction technology and the PCB

Sonoprocess™. Sonic's Terra-Kleen solvent extraction technology is a passive extraction system, which removes and concentrates PCB, carbon chloride, PAH, dioxins/furans and other contaminants from soils, sediments, sludge, and debris. Passive extraction systems are advantageous where soils contain organic and fine materials as the volume of concentrate is kept to a minimum. In Terra-Kleen process, contaminated soil is first mixed with a solvent. The mixture is then subjected to sonic energy generated by a proprietary low-frequency generator. Using sonic energy, the mixture is agitated and the PCBs from the soil are extracted and suspended in the solvent. The solvent is then separated from the mixture using multistage liquid separators. Soil is returned to original place after the treatment. The Terra-Kleen solvent extraction technology removes semi-volatile and non-volatile organic contaminants from soil results in a highly concentrated material that serves as feedstock for the PCB Sonoprocess™.

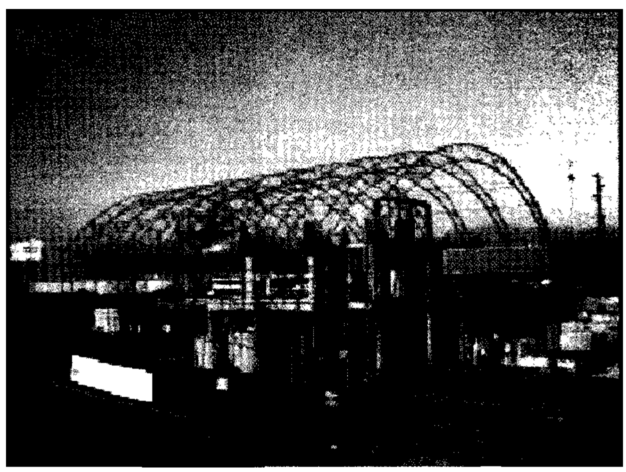


Figure 28 Sonic Technology, Vancouver, Canada

Sonic's primary technology is the PCB Sonoprocess™, which chemically destroys polychlorinated biphenyl and many other persistent organic pollutants in liquid and made slurry waste streams. In the process, the solvent is mixed with elemental sodium, and subjected to sonic energy again. The sonic energy activates dechlorination of the PCBs in the solvent. The spent solvent can then be recycled through the system. Any off gas from the process is treated using condensation, demisting, and multistage carbon filtration.

In a pilot scale application of the technology to treat PCB-contaminated soil, the concentrations of PCBs before treatment were 388 to 436 mg/kg, and the concentrations after treatment were 0.35 to 0.81 mg/kg.

Sonic has constructed full scale treatment facilities using this process and has successfully deployed these facilities on-site to treat PCB contaminated soils to less than 2 ppm. The system can be used to directly destroy the PCB in soil and sediment slurries or integrated with technologies to first extract and concentrate the PCB contaminant.

By combining the two technologies in a single treatment facility Sonic offers the most cost-effective and environmentally friendly solution for PCB and POPs destruction. As a mobile on-site treatment solution, Sonic eliminates the need to (and associated costs of) transport hazardous materials, often over great distance and through urban and rural communities to incineration treatment facilities.

Sonic established a Terra-Kleen demonstration at its project site in Delta, BC in 2006 and gained BC regulatory approval for the process. Based on this data the Company was able to obtain a Certificate of Approval for Terra-Kleen in Ontario. The Company secured its first project in Ontario. The Company also secured, deployed and completed a smaller project in Sault Ste. Marie, Ontario. This project was another milestone for Sonic in that it demonstrated the ability of the Sonic Treatment System to be adapted to a relatively small site of less than 1000 tons.

(g) Alkaline polyethylene glycol – APEG

The operating temperature of alkaline polyethylene glycol (**APEG**) is 100-180°C, about a half of glycol used as hydrogen ion displacement reaction to dechlorine, and also be used as hydrogen source for alkali catalytic reaction to destruct toxic contaminates, which is different from current BCD, which uses high boiling point oil as the hydrogen source. The operating temperature of APEG is relatively lower, and the mechanism of APEG is different from BCD.

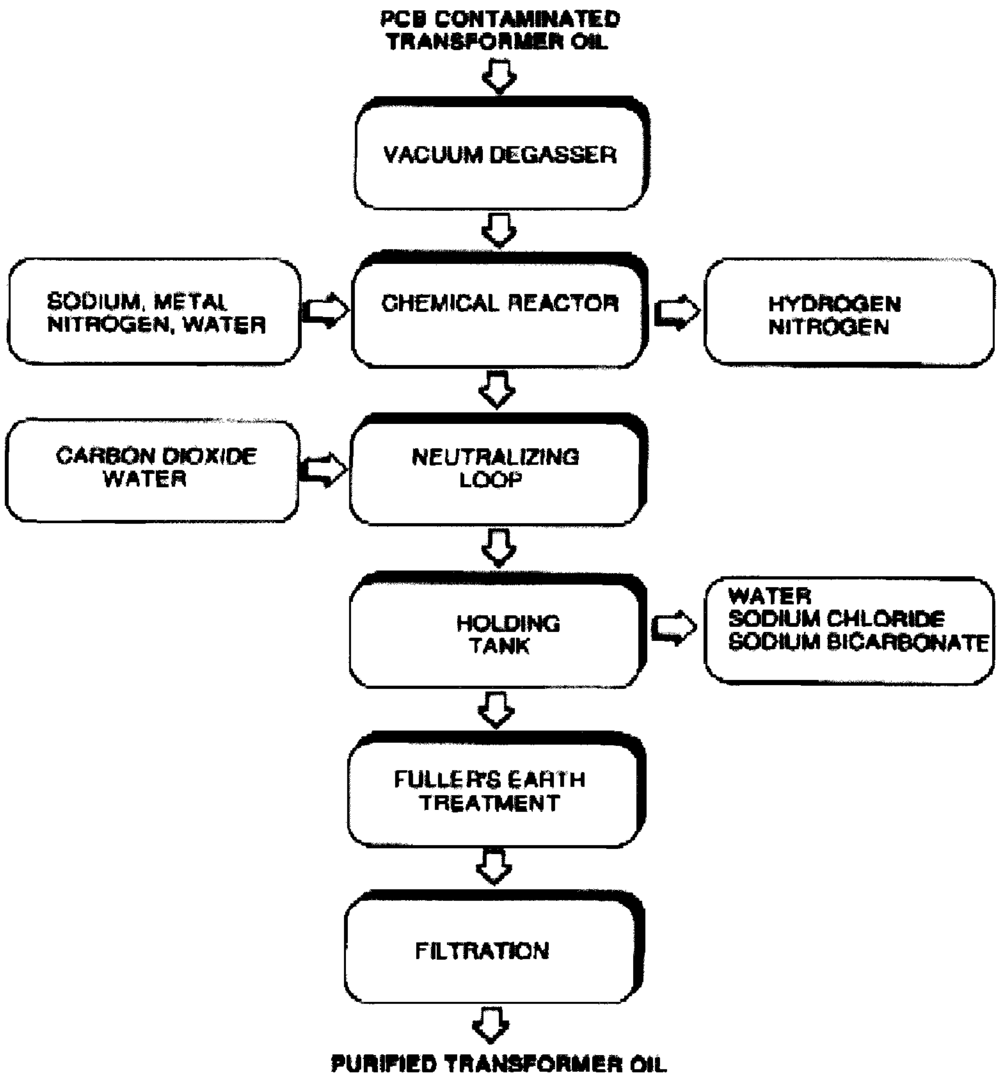


Figure 29 A Technique Flow Chart of APEG

(h) Catalytic hydrogenation

This process is developed by CSIRO, and based on the mild hydrogenation of spent oil in a packed bed catalytic reactor, operating at moderate temperatures and pressures. Under process conditions hydrogen reacts with heteroatoms in the oil itself, and also with any organochlorines present. The removal of halogen atoms from organic structures by hydrogenation over noble metal catalysts has been known for many years, and its potential application to the destruction of chlorinated waste recognized. These reactions can be accomplished at very mild pressures and temperatures, but unfortunately the catalysts are very susceptible to poisoning by a wide range of elements commonly found in "real world" situations. Prominent among these poisons are the sulfur compounds found in petroleum products such as transformer oils. Fortunately, there is a group of hydrogenation catalysts based on metal sulfides, which are extremely robust and tolerant of most catalyst poisons. They are considerably less active than noble metal catalysts, so that at the conditions required for hydrodechlorination, the hydrogen chloride formed causes extensive cracking and rearrangement of hydrocarbons. This results in excessive hydrogen consumption and unacceptable changes in transformer oil composition.

CSIRO has overcome this problem by using a proprietary additive, which scavenges the hydrogen chloride and ensures that the hydrochloric acid produced does not lead to degradation of the catalyst and which reduce hydrocarbon cracking reactions on the surface of the catalyst. After a program of catalyst and process optimization, it was possible to keep the hydrocarbon structure of transformer oil essentially unchanged, while achieving better than 99.999% destruction of PCB. With transformer oils oxygen present in compounds resulting *Review of emerging, innovative technologies for the destruction and decontamination of POPs and the identification of promising technologies for use in developing countries* 24 from aging of the oil in service is converted to water, while any chlorinated species present are converted to hydrogen chloride and light hydrocarbons. Catalytic hydrogenation occurred in a very serious condition, so the facilities and operation cost is very expensive and it is very difficult to storage and transport of hydrogen, which affect its commercialism seriously.

A 1000 L/day unit for transformer oil regeneration has been operating at CSIRO Lucas Heights Laboratories since 1997. Pilot scale used for a commercial treatment of 3000 liters of PCB oil with concentration < 1000 ppm, has also been tested on a wide range of POPs. Kohleol-Anlage Bottrop Company in Germany compounds heavy oil from plastic by hydrocracking. Plastics were cracked in 10 MPa and 420-470°C, the composition of the production is similar with crude oil and it is saturated at the end of chain. Plastic waste melt and recombine formed hydrohalogenation in which the halogen content is up to 80%, and then the hydrohalogenation gas was recycled by water washing or alkali. Although dehalogen is very effective by Catalytic hydrogenation, it has few applications in pyrolysis dehalogen for its serious condition and high cost.

(3) Domestic Application Status

Catalyzed dechlorination is a commonly used chemical process, widely applied in crude oil refining, synthetic ammonia and oil refining, etc. The chlorine is the common poison to catalyst, it has very high electron affinity and migratory aptitude, easily react with the metallic ion, also often migrate along with the processing gas to the downstream process and poison the catalyst permanently. In the reforming and processing stage, the organic chloride will be converted into the hydrogen chloride after raw material goes through the hydrogenation pretreatment. The hydrogen chloride and water or ammonia forms the hydrochloric acid and the ammonium chloride separately, which will create the serious corrosion of the equipment and block the pipeline. Furthermore, in some serious condition, the facilities should be cause shutdown to be maintained, which leads to huge economic loss to the plant. The catalyzed dechlorination technology is a relatively matured technology in existing dechlorination technology and applied widely. The organic chlorine desorption technology mainly have 2 kinds: the catalytic hydrogenation dechlorination and the catalytic hydrogen transfer dechlorination. The reaction mechanism of catalytic hydrogenation dechlorination has 4 steps: the first, hydrogen adsorption in catalyst surface; the second, the organic chloride adsorbed on the catalyst carrier surface; the third, surface reaction – the adsorbed hydrogen and the organic chloride produce HCl and corresponding hydrocarbon compound; the last, product desorption – produced hydrocarbon compounds and hydrogen chloride detach from dechlorination catalyst surface.

The reaction mechanism of catalytic hydrogen transfer dechlorination is as follows: in the first step, the catalyst and the hydrochloric hydrocarbon to form the complex compounds via contact; in the second step, the hydrogen donor transfers hydrogen to complex compounds to take the place of chloride ion and forms new complex compounds, and the chloride ion leave complex compounds as free-stuff; in the third step, the new complex compounds decompose and then forms new complex compounds; in the last step, after the new complex compounds decompose and form catalyst and corresponding hydrocarbon compounds.

Generally, the dual-metal catalyst as dechlorination catalyst is applied for the organic chloride. At present, the iron contained compounds are used as the main catalyst, with other noble metal and corresponding ion as the auxiliary catalyst. The carrier normally is selected according to the hydrogen source, for example, when take methane series hydrocarbon as hydrogen source, normally the activated carbon, the activated carbon fiber or the activation carbonization resin are used as the carrier. When choosing Al_2O_3 or PVP (polyethylene base pyrrolidone) as the carrier, gaseous hydrogen is taken as the hydrogen source. Regarding to the aromatic chloride catalytic dechlorination, generally, reaction is taken in the aqueous phase and catalytic hydrogen transfer dechlorination agent is often used. There are many research about this exist in China.

The State Engineering Research Center for Urban Pollution Control, College of Environmental Science and Engineering, Tongji University, studied the technology and mechanism of catalytic reduction dechlorination of chloralkane in aqueous solution, taking the substances as the carbon tetrachloride and the tetrachloroethane as the examples. The Environmental Science Research Institute, Xi'an University of Technology, studied the technology use nickel/iron dual-metal catalytic degrade atrazine and parachlorophenol in the water body. The Henan Hsinhsiang Medical College has studied catalytic dechlorination of PCBs in isopropanolin water solution under mild condition. The Chengdu Institute of Organic Chemistry, Chinese Academy of Science, has studied the Pt/ZSM - 5 catalytic carbon tetrachloride with gas phase hydrogenation dechlorination technology. The Research institute of Environmental Chemistry and Application Technology, Hanshan Normal School, has studied the dechlorination technology for pentachlorophenol with null valence metal in soil.

Although catalytic dechlorination is a relatively matured technology in existed dechlorination technology, few POPs processing experiences have been obtained and not finish laboratory test yet.

3.2.1.6 Thermal desorption-destruction

(1) Brief Introduction

In situ thermal destruction was developed on the basis of in situ thermal desorption (ISTD). In general, the operation temperature of ISTD is relatively low, which was also called as thermal evaporation, low temperature volatilization and soil roasting. The volatile and semi-volatile compounds and elements (petroleum and hydrocarbon at most of the time) were separated from the polluted materials (contaminated soil in most of the cases). ISTD was ever used for the decontamination of PCBs-containing dielectric oil contaminated equipments and shells. However the treatment of POPs contaminated equipments and soil by ISTD may cause the unintended POPs production. So the in situ thermal destruction increases the treatment temperature (about 600°C) and off-gas destruction after the desorption process to avoid the possible emission of unintended POPs products. Terra Therm offers two different methods of vapor treatment. One treats extracted vapor without phase separation, and the other cools heated vapor, separate the resulting phases, and manage each phase separately.

(2) Foreign Application Status

Thermal desorption technology can be divided into direct contact and indirect contact rotary kiln rotary kiln system according to the type of furnace, application examples see Table 17 and Table 18.

TDR-3R™ is an ex situ technology used to treat high and low-strength soils containing HCB contamination. The TDR-3R™ technology uses a continuous low temperature thermal desorption process conducted in the absence of air. The main component of this process is a specially designed, indirectly fired, horizontally arranged rotary kiln. Some cases of direct/indirect contactrotary drying furnace applied are showed in Table 17 and Table 18. Contaminated soil is heated in the kiln to a temperature typically between 300 and 350°C under an applied vacuum of 0 to 50 Pa. The vaporized contaminants are recovered from the kiln and combusted in a thermal oxidizer for at least 2 seconds at a temperature exceeding 1,250°C. Off-gas from the thermal oxidizer is rapidly cooled, passed through a wet gas multi-venturi scrubber, and discharged. Process water from the scrubber is treated and discharged. Treated soil exiting the kiln is cooled indirectly and removed. TDR-3R™ has been implemented at a bench scale in Gare, Hungary, to treat 100 kg of soil contaminated with HCB. Treatment occurred at a temperature of 450°C under a vacuum of 30 Pa. The technology reduced the soil's HCB concentration from 1215 to 0.1 mg/kg.

TDR-3R™ is marketed by the Terra Humana Clean Technology Engineering Co. Ltd. in Hungary. This firm is a subsidiary of Thermal Desorption Technology Group LLC in the United States.

Table 17 Application Cases of Direct Contact Rotary Drying Furnace

Case	Disposal temperature ℉	Quantity	Before disposal (/ppm)	After disposal ppm	Efficiency%
Old Marsh, Aviation Site	730	52000 tons Toxaphene, DDT, DDD, DDE other POPs pesticides	average 200-500 maximum 2500	1.09 DDT,DDD,DDE 3.52 in total	>99
TH Agriculture, And Natrition	833-1082	POPs pesticides	400-500	DDT<0.13 toxaphene<6.8	>95
S&S Flying /Malone	700	5500 tons toxaphene contaminated soil	634	<1.5	>99.76
Port of Los Angeles	554	petroleum product	maximum 30000	hydrocarbon chemicals<200 PAH<1	>97
Ecotechniek	1112-1130	pesticides contaminated sites	aldrin 40-70, dieldrin 130-200 endrin 450-2000	<2 in total	>99
NBM	1242	pesticides contaminated sites	aldrin 34 dieldrin 88 endrin 710 lindane 1.8	<0.01 in total	>99

Case	Disposal temperature ℉	Quantity	Before disposal (/ppm)	After disposal ppm	Efficiency%
General Motors(GM) Proving Grounds	600-900	6727 tons diethylbenzene contaminated soil	380-2400	<0.01	>99.9
Explorer Pipeline,Spring,TX	600-900	4,873tons BTEX contaminated soil	max 15000	<1	>99
Niagara Mohauk	600-1000	5000 tons contaminated soil	max 50000	<3	>99
Kelley Air Force Base, San Antonio ,TX	500-1000	20000 tons TPH contaminated soil	max 5000	<10	>99
Garage in City of Brooklyn Center, MN	500-1000	diesel, bemzem, xylene	5600 0.09 0.22	<0.6 <0.03 <0.08	99 66 63
Petroleum facility, NorthAdams,MA	600-1000	24,000tons BTEX,TPH contaminated soil	50-1000	<1	>99

Table 18 Application Cases of Indirect Contact Rotary Drying Furnace

Case	Disposal temperature ℉	Quantity	Predisposal (/ppm)	After disposal ppm	Efficiency %
Former Sperncer Kellog Site	no data	6500 tons VOCs	5.42	0.45	>90
Cannon Bridgewater	no data	11300 tons VOCs	5.3	0.025	>99
Ottati and Goss	no data	4,500 m^3 soil 1,1,1-TCA, TCE, ethylbenzene, xylene	12-470 6.5-460 4.9-1200 87-3000 50-440 170-1100	<0.025 <0.025 <0.025 <0.025-0.11 <0.025 <0.025-0.14	>99 >99 >99 >99 >99 >99
McKin	no data	11500 tons VOCs SVOCs	2.7-3100 0.44-1.2	<0.05 <0.33	>99 >75
South Kearney	no data	16000 tons VOCs SVOCs	308.2 0.7-15	0.51 1.0	>99 >93
South Glens Falls Drag Site	625	PCBs	average 500, max 5000	0.286	>99
	630	PCBs	average 500	0.181	>99
	646	PCBs	average 500	0.073	>99
	658	PCBs	average 500	0.181	>99
	690	PCBs	average 500	0.083	>99
	822	PCBs	average 500	0.040	>99
	842	PCBs	average 500	0.012	>99
	904	PCBs	average 500	0.017	>99
Mayport Naval Station	650	2400tons petroleum contaminated soil	TRPH=838-13550 (13 samles)	<5 (all samples)	>99
Wide Beach Site	no data	42000 tons	max 500	average	>99

		PCBs contaminated soil		0.043	
WauKegan Harbor Cleanup	no data	13000 tons PCBs contaminated soil	max 17000	no data	>99
Dustcoating Inc	1100	10000 tons coal tar contaminated soil	3531	0.72	>99.9

note: VOCs- Volatile organic compounds, SVOCs-semi Volatile organic compounds, TCA- trichloroethane, TCE-Trichloroethylene, TRPH- total recoverable petroleum hydrocarbon

(3) Domestic Applicatoin Status

In January 2006, China's first demonstration project of POPs Convention Impliementaton-China polychlorinated biphenyls (PCBs) Management and Disposal Demonstration Project was officially launched, and the project by China's State Environmental Protection Administration in cooperation with the World Bank launched in Zhejiang and Liaoning Provinces. Demonstration project will ship PCBs waste in Zhejiang Province to Liaoning Province for environmentally sound disposal,, including obseleted PCBs electricity facilties and other waste of high PCBs content, and to demonstrate dechlorination technology of electrical equipment containing PCBs. Waste of low PCBs content need to enrich through the thermal desorption technology to meet the disposal requirements. At present this project has just completed a technical evaluation of thermal desorption just entered the bidding phase of the project, and it is expected to sign technology transfer agreements in the near future. After the completion of this project it will dispose low PCBs content waste and soil in Zhejiang . Content of engineering construction includes PCBs thermal desorption unit and supporting facilities, disposal of the scale of 50 tons / day, with a total disposal capacity of 20,000 tons.

3.2.1.7 Avanced oxidation technologies

Advance oxidation technologies includes super critical waster oxidaztion (scwo), Ozonation/electrical discharge destruction, mediated electrochemical oxidation (includes CerOx™, AEA silver II™) and catalytic oxidazation.

(1) Super critical water oxidization(SCWO)

Critical state is a special fluid condition. When a fluid is heated the density of liquid phase will decrease while the density of gas phase will increase. When the temperature and pressure reach a point (critical point) at which the liquid and gaseous phases of a pure stable substance become identical. When the temperature and pressure of a fluid is higher than the temperature and pressure of the critical point is call as supercritical fluid. Water is the most common and important solvent and its critical point is 373.976 °C and 22.055 MPa. It has quite different physiochemical properties under the supercritical state.

With the increase of temperature the specific inductive capacity (SIC) of water decreases gradually. Under a standard condition the SIC of water is 78.5, while the SIC decreases to 2 at 500 °C. At such a supercritical state, waste is a good solvent for organic materials. It can also complete soluble with air and oxygen. The inorganic salts have much lower solubility in supercritical water. Without a gas-liquid phase interface, a supercritical fluid has a lower viscosity and better diffusibility. Because of the surface tension is about zero, the water has a much higher infiltration capacity to the pole structure of a solid material. So the chemical reaction speed increased largely from normal conditions. When O_2 is added into the supercritical water it forms a single phase with the water, where organic pollutants can be oxidized completely at a rapid speed.

SCWO destroys toxic and hazardous organic waste in a completely enclosed system, using an oxidant (e.g. oxygen or hydrogen peroxide) at temperatures and pressures above the critical point of water. Under these conditions organic materials become highly soluble in water and react rapidly produce carbon dioxide, water and inorganic acids or salts. After the treatment of SCWO, carbon is converted to CO_2, hydrogen to H_2O, organic Cl to Cl^-, nitric compound to nitrate; sulfur to sulfite; and phosphorus to phosphate. And the off gas does not contain NOx, HCl, SOx and particles. The CO content is lower than 10 ppm. Both the water and gas meet the discharge standards. In addition, a small scale SCWO equipment can treat a high volume of wastewater because of its high reaction speed.

Advantages of SCWO are

- An environmentally friendly method with many uses,
- High DE for persistent organic substances (>99.9999%),
- Off gas doesn't contain NOx, HCl, SOx and particles,
- Discharged water meets the discharge standards,
- Suitable for wide range of wastewater treatment (ppm-%),
- Oxidation with high speed, small equipment and simple structure,
- Secondary treatment is not necessary.

Disadvantages of SCWO are

- High corrosion speed, the material requirement of a autoclave is high,
- That low solubility of inorganic salt may cause the blockage of discharge hole and discontinuous running,
- High capital investment at initial stage,
- Lack the evidence for the formation of dioxins at the operation temperature.

Many compounds, including the phenols, methanol, ethylic acid, pyridine, phenolics, polystyrene, polychlorinated biphenyl, halogenated aromatic compound, halogenated aliphatic compound, DDT, chemical warfare agent BZ, the sarin nerve agent, etc., may all be destructed into CO_2, H_2O and other non-toxic, simple and small molecular substances by SRWO technology. At present, there is a better foundation regarding the SCWO hydrogen production in China, and there are reports for its application in organic wastewater processing, but is no report for its application to destruct the POPs.

The domestic patent status about SCWO waste treatment technologies are listed in **Table 19**.

Table 19 Domestic Patents about SCWO Waste Treatment Technologies

No.	Patent Name	Patent No.
1	Wastewater treatment process by super-critical aqueous oxidation	98120547.X
2	Reactor for super-critical water oxygenation waste-water treatment	98241717.9

3	Method of sewage oxidation treatment using supercritical water	200510012579.4
4	Super critical water treatment system of waste organic liquid pollution less discharge and resources utilization	200610042926.2
5	Supercritical water oxidation processing device for waste and old battery	200320111292.3

(2) Ozonation/electrical discharge destruction

In 1998, Sun et al reported that an electrical discharge is used to either directly treat a VOC and PCDD/F containing gas stream or to produce ozone to indirectly treat the gas stream. Both indirect and direct treatment by electrical discharge can reduce NO/NO_2 and SO_2 and can destroy PCDD/F in off gas; indirect treatment destroys about 90% of PCDD/F in real industrial off gas; it is possible to destroy NO/NO_2, SO_2 and PCDD/F in one step.

A systematic study with the aim to reduce NO/NO_2, SO_2 and to destroy VOCs and PCDD/Fs in off gas by electrical discharge has been performed, both in laboratory and at a pilot plant. Currently treats only low-strength of dioxins/furans, and has no further report about commercialization.

(3) Mediated electrochemical oxidation CerOxTM and Silver II™

The principle of electrochemistry technology is converting the pollutants by direct electrochemical reaction or indirect transfer on the electrodes named direct electroanalysis and indirect electroanalysis. The indirect electroanalysis converts the pollutants into other substances with smaller toxicity using the REDOX formed in electrochemistry process as Catalysis or Reactant. Mediated Electrochemical Oxidation is a reversible indirect electroanalysis process. It can produce strong oxidation by anode reaction of electrolytic cell, such as Ce[IV] and Ag[II], which can be reagent or catalysis, convert the organic waste to harmless CO_2 and H_2O and convert the chlorine joint with carbon to molchrorine. These intermediate substances can be recycled and reused by electroanalysis.

At present, there are two successful mediated electrochemical oxidation technologies:

- CerOx ™
- Silver II ™

The process belongs to the category of Mediated Electrochemical Oxidation or Catalysed Electrochemical Oxidation. The technology was developed by CerOx Corporation in Santa Maria, California, USA. The Ce4+ ions are produced in an electro-chemical cell and then mixed with the waste stream prior to passing into a liquid phase reactor. The Ce^{4+} acts as an oxidizing agent, reacting with POPs to produce CO_2, neutral salts and dilute acid solution. The process operates at low temperature (90-95°C) and near atmospheric pressure. The liquid effluent from the reactor is returned to the cell for regeneration of the cerium reagent. Gaseous products are passed into a counter-current packed bed gas/liquid reactor, which uses a flow of Ce^{4+} for oxidation of the residual organics. The treated gases (mainly CO_2 and Cl_2) are then passed through a condenser (for VOC recycling) and a caustic scrubber for chlorine removal.

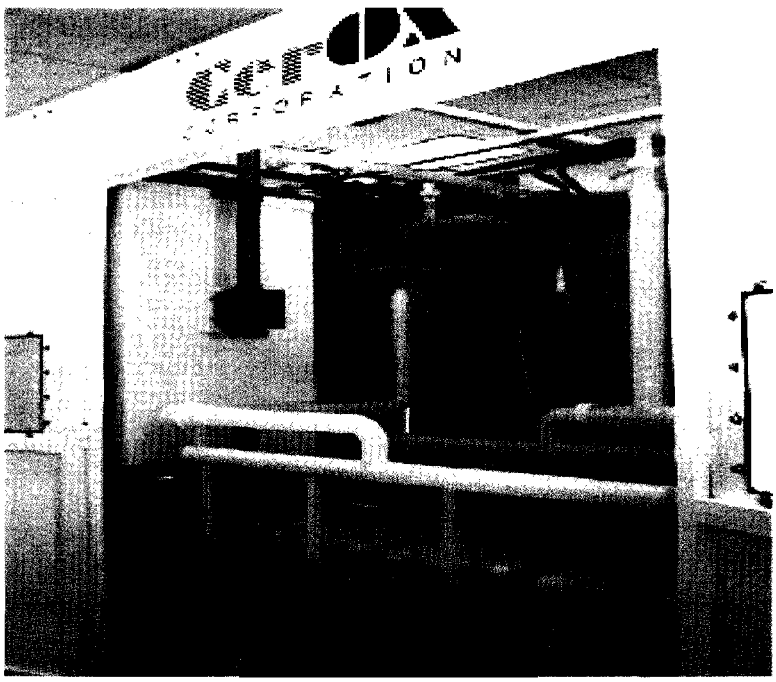


Figure 30 CerOX™ Facilities

The first CerOx™ system was installed at the University of Nevada at Reno (UNR) to destroy surplus chlorinated pesticides and herbicides from the university's agricultural departments. Prior to use of this system by UNR, CerOx™ Corporation conducted proof of performance tests in May 2000. The medium treated was a pesticide-water emulsion.

CerOx™ Corporation offers a variety of CerOx™ treatment systems for commercial use.

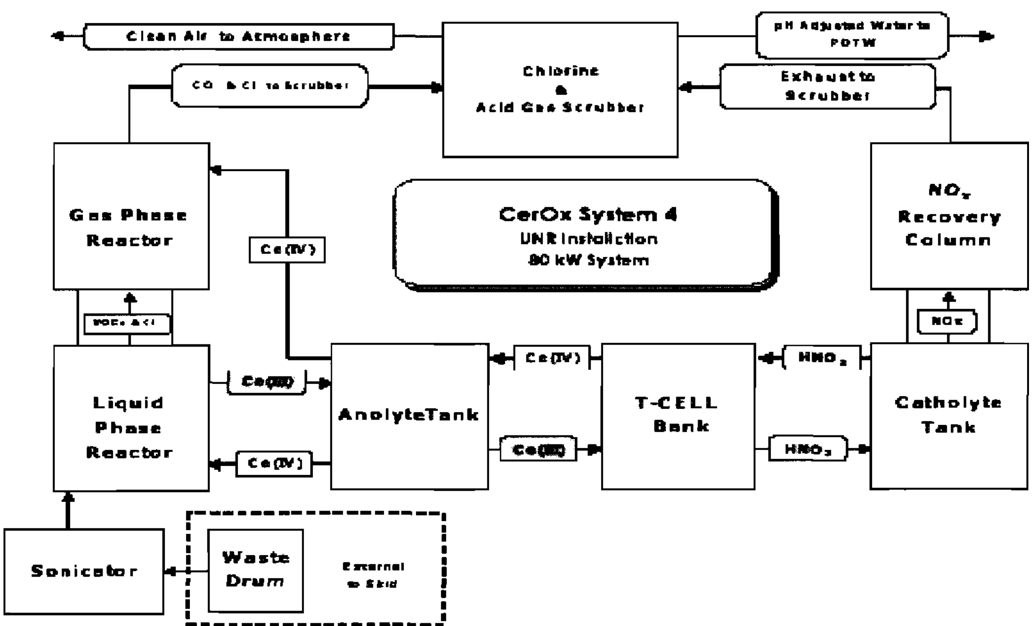


Figure 31 A Flow Chart for CerOX™ System

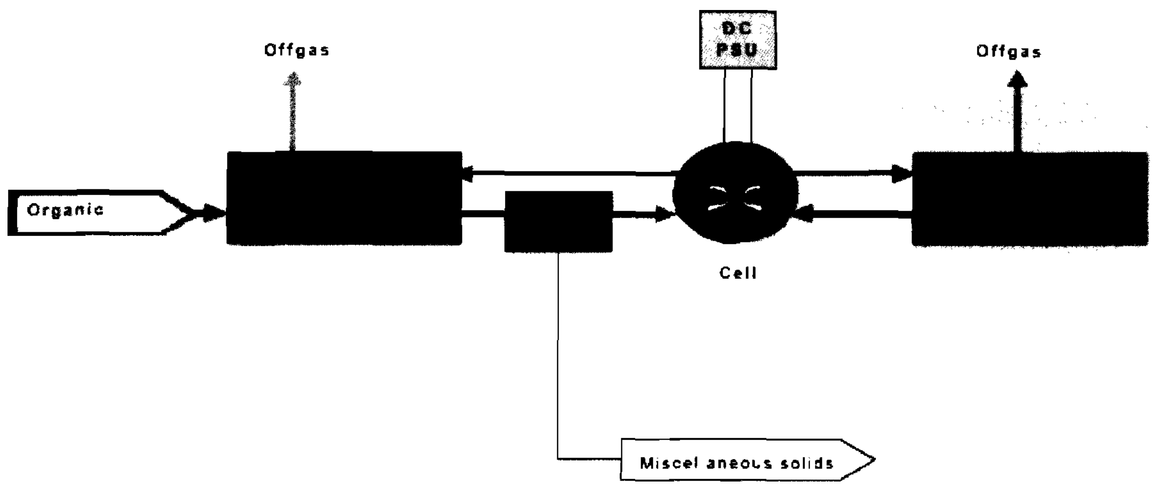


Figure 32 A Scheme Diagram of Silver II™ Mechanism

AEA Technologies Inc is the vendor of Silver II technology. The AEA Silver II™ process is very similar to the CerOx system but utilizes oxidation of organics with Ag2+ ions in solution. System design is similar to CerOx but includes a hydrocyclone between the reactor and the electrochemical cells, which may reduce potential problems from solids inputs.

AEA Silver II™ is not applicable for soil or sediment. The contaminant has to be in an aqueous phase for the technology to be applied. Therefore, pretreatment is needed to extract the contaminant from the solid phase to an aqueous phase. AEA Technologies Inc. is not currently marketing this technology.

(4) Catalytic technologies

Catalytic technologies can be used for certain POPs now, and cannot be used as a full scale application except catalytic hydrogenation, which can be used as auxiliary technology combined with other technologies.

MnOx/TiO_2–Al_2O_3 catalyst degradation

A highly active catalyst, MnOx/TiO_2–Al_2O_3, was prepared by impregnating MnOx species on TiO_2-modified Al_2O_3. The TiO_2 species in TiO_2–Al_2O_3 support is in monolayer dispersion, and the MnOx species is again highly dispersed on TiO_2–Al_2O_3 support. The total oxidation of chlorobenzene and *o*-dichlorobenzene on MnOx/TiO_2–Al_2O_3 catalyst can be achieved at 300°C and 250°C respectively, at the space velocity of 8000 h^{-1}. The activity of MnOx/ TiO_2 –Al_2O_3 catalyst (Min loading 11.2 wt%) is gradually increased in the first 10–20 h and then keeps stable at least for the measured 52 h at 16,000 h^{-1}. Furthermore, no chlorinated organic byproducts are detected in the effluent during the oxidative destruction of chlorobenzene and o-dichlorobenzene.

This has only been tested at laboratory level for treating low strength POPs, and has no further report about commercialism.

TiO_2–based V_2O_5/WO_3 catalysis

In 2001, Weber and Sakura and in 2003, Lomnicki public report PCB were destroyed on a V_2O_5/WO_3 supported titanium catalyst at low temperature in the range of 150–300°C.

TiO_2-based V_2O_5/WO_3 Catalysis initially designed to denitrogenation in SCR process, it was now used to destroy the PCDD/PCDFs for its good disposal effect at the temperature denitrogenation occurred. The catalyst agent based V_2O_5 as active component applied extensively in project and developed maturely, the optimal temperature is 300-400 °C. The added WO_3 play an important role in the catalyst to enhance catalyze activity and heat stability, avoiding agglomeration of agent and loss of specific surface area. Another, WO_3 would compete surface basic sites with SO_3 and replace it to stop form sulfate. If added the ammonia, these catalysis combination could be used to destroy PCDDs and NOx together. This SCR catalysis combination to destroy PCDDs and NOx has commercialized in these days, and its oxidation increase by increasing vanadium content, then optimizing the catalysis process.

Catalyst currently used in commercial operations for NOx removal, and only destroys PCBs and PCDD in the laboratory; research is needed into its potential for destruction of POPs and other hazardous organic waste.

Fe (III) photocatalyst degradation

The photodegradation for POPs includes sun light destruction, photochemical degradation, ultraviolet destruction and photocatalyst degradation. This report evaluates only the last one.

In 1999, Huston and Pignatello public report their research. Degradation of pesticides in water at solubility levels using Fe (III)/H_2O_2/UV. Most 100% degraded but some were lower with concerns re toxic daughter products. Reactions were carried out in a cylindrical 300-ml borosilicate double-walled reaction vessel with water circulated through the walls to maintain constant temperature. The photochemical reactor chamber (Rayonet RPR-200) contained sixteen 14-W fluorescent black lamps, which emit in the range 300-400 nm. Ferrioxalate actinometry indicated that the total light intensity was 1.2×10^{19} photons l–1/s. The lamps were warmed up for 10 min to reach constant output. The pesticide, iron (III) perchlorate, and sodium perchlorate, as needed, were added to the reaction vessel and the temperature was equilibrated to 25.0°C. The pH was then adjusted to 2.8 with $HClO_4$. The reaction was initiated by adding H_2O_2 (30%), followed by inserting the vessel into the chamber. This technology currently only test for treating low strength POPs waste and it is unlikely be feasible for higher strength waste for current applicable and efficiency levels are too low.

Advantages and disadvantages of catalytic technologies

The advantages are:

- Low dioxin generation risk,(but the mechanism is unknown for the monent)
- Mild operation condition(comparing with thermal destruction)
- Small solid residual amount
- Subject to modulization and mobilzation

The disadavanteges are

- Lack of commercialized large-scale operation experience.
- Little on-line monitoring data can be obtained.
- Electrolyte membrane is much sensitive to solid particles

- Substances that can not dissolve in water treatment effect was not obvious for chemical oxidization procedure
- The performance is mainly depends on the catalysis o TiO_2–based V_2O_5/WO_3

3.2.1.8 Summary of disposal technology of PESTICIDE POPS WASTE

(1) Development trends of technology

Based on information above, the existing technologies in China can be classified into 3 types approaching to international level, developing technologies and absent technolgies. The sitiuation is mostly because of Chinese environmental technologies research and commerilization levels.

- **Approaching to international level technologies**

Approaching to international level technologies includes: high temperature incineration, plasma disposal technologies, cement-kiln co-processing, molten technologies. Those technologies have been applied in China, or have been tested for a long time, which should be the main strength to dispose pesticide POPs.

- **Developing technologies**

Chemical oxidization/reduction technologies are a series developing technolgies. Catalytic dechlorination technology have been reaserached in China for may years, but till up to now, no lab research on POPs have been done.

- **Absent technologies**

Thermal desorption technologies is absent technology. There is no lab or polit test work done in China. It was just imported this two year.And it is to be used recenlty.

(2) Advices on China technologies development

The reason for forming such technology situation can summarized as:

Firstly, University-Industry Cooperation relationship in environmental field is very late in China, So , patented technologies are less than some developed countries. Most research products are still at lab level.

Secondly, the reseach was dominated by plan ecomony model for a very long time, which led to some fields is huge while some fields is very small. The research chains seems to be weak.

The third, environment practices in China occurred late, especially on soil and POPs pollution, thus, the requirement for technologies research and development is weak.

The fourth, hazardous waste, including POPs waste, mangement and disposal is just gotten attention in this decade.

With respect to such situation, and to promote PPW disposal technology in China, those aspects should be well considered.
First, the existing technologies such as plasma, cement kiln, molten destruction, incineration should be given priority, meanwhile advanced management of abroad could be introduced and assimilated while the operation of disposal, which could make China management level keep track with international level.

Second, some advanced technologies, such as plasma, MCD, sodium reductions should be actively imported in consist with the overall arrangement of China pesticide POPs disposal.

Third, environmental practices on POPs should be enforced, in order to improve the ability of environmental sound disposal of POPs waste of China. Sound and effective technologies should be prompted as soon as possible. The overall management and regulations system establishment should be enforced in pesticide POPs management and centralized disposal.

3.3 Technology Selection of Pesticide POPs Disposal in China

3.3.1 Principals for technology selections of pesticide POPs disposal in china

According to the feature of POPs inventory, national situation and the requirement of Stockholm Convention, Chinese POPs disposal technologies should meet those requirements:

(1) Best available technologies

According to the requirement of implementation of Stockholm convention in China, it should give priority consideration to environmentally sound disposal in technology selection, in order to reduce the productions and discharge of POPs by products. As to incineration technology, if its PCDD/PCDFs emission meets 0.1ng TEQ/m3 standard, it could be considered either, because incineration technology has been wide used and it has successfully disposed .many types POPs waste. Need to note here, economy effective should be a very sharp consideration in technology selection. A good technology must have a practical construction cost and disposal cost so as to apply, and it also must be consist with economy situation in China.

(2) Wide-spectrum technology

Pesticide POPs in China has a wide category, a complex components and storage form. Water content is quite high because of long term stockpile and disposal uneasily. Thus, the technology should be a wide-spectrum technology that has powerful adaptability to the feature of Chinese pesticide waste.

(3) Sustainable technology of consistence with national waste disposal plan

A technology application should be sustainable, that means technology not only can dispose pesticides waste within project period, but also can be used to dispose other hazardous waste after the project completion. And the investment could be long-term effective. National plan on hazardous waste including medical waste should be another important consideration to choose a sustainable technology. In principle, the selected technology should also serve national hazardous waste disposal.

(4) Stockholm convention implementation satisfaction

Both Stockholm convention implementation and full scale project have a fixed time table. Objectively, 11,000 tons pesticide POPs should be disposed with 4 years, so adaptability and scale should be considered as a whole.

(5) Well government and public acceptance

Application of one technology, it should not be limited to obey the existing management system, to solve the problems when Stockholm convention implementing, but to acquire the public and government acceptance, which is also a very important condition to decide if a technology can be apply or not.

(6) Nearest disposal and multi-technologies applied

The distribution of Pesticide POPs is quite wide and on the other hand, the types and distribute of disposal technologies in current China is very like the flowers blooming after the rain, Based on the feasible economy condition it is expected to select feasible technology as a nearest disposal priciple, and prompted to dispose of pesticides POPs waste in a environmental sound way. It is expeced to select the neareast transportation route preferentially, considering of the existing construction planning for hazardous waste construction and operational condition.

(7) Encouraging new technology demonstration

After considering the distribution and nature characters of PPW and contaminated soil, as well as the developing requrements within relavant industries, it is expected to introduce innovative technologies from developed countries under the framework of the project, and to practice them in national wide disposal activties, so as to improve overall implementation capacity of China and disposal/management capacity of POPs waste in China.

Insecticides can be combined with China's current high concentrations of POPs waste and contaminated soil characteristics of the actual distribution and composition, and to consider China's development needs in related fields, in the framework of the project was to introduce foreign advanced processing technology and experience to take this opportunity to promote the demonstration access to and promote, and enhance China's overall performance capabilities, and domestic POPs type of waste management and disposal capacity.

3.3.2 Short list for pesticide POPs waste disposal technologies

In this section, a comphensive comparison was conducted following **Table 5**, with consideration of those factors,which are adaptivity to POPs waste in China, the maturity of technologies, environmental risk, construction cost, operational cost, and availability. Each factor is ranked by excellent, good, moderate, bad, and scoring with 4, 3, 2,1, see **Table 20**.

From **Table 20**, we can achieve such conclusion, High incineration, cement kiln co-processing, molten/melting, plasma, MCD, sodium reduction, base catalytic reduction are selected as candidate technologies. Among those technologies, incineration, cement kiln co-processing, molten/melting, plasma exist home and abroad, with enormous application cases, while the latter three technologies are of great application potential and no enterprise owns them. Such three technogies is expected to import and localized before application. The basic status of candidate technologies is shown in **Table 21**.

Table 20 A Suitability Comparison of Existing Disposal Technologies to Pesticide POPs Waste in China

No.	Type	Title	feasibility	maturity	Environmental risk	Construction cost	Operation cost	availiblity	Total score
1	Thermal treatment	High temperature incineration	4	4	2	3	3	4	20
2	Thermal treatment	pyrolysis	4	3	2	3	3	4	19
3	Thermal treatment	Cement kiln co-processing	4	3	3	4	4	4	22
4	Thermal treatment	Plasam	4	3	3	2	2	4	18
5	Thermal treatment	Molten/melting	4	3	3	3	2	4	19
6	Thermal treatment	ISTD	2	2	2	3	2	3	14
7	Chemical reduction	Sovlent electron technologies	2	2	2	3	2	2	13
8	Chemical reduction	Mechnical chemical Destruction(MCD)	3	3	3	2	2	3	16
9	Chemical reduction	BCD	3	3	2	1	1	2	12
10	Chemical reduction	Sodium reduction	3	3	2	1	1	2	12
11	Chemical reduction	Catalytic hydrogen	3	3	2	1	1	2	12
12	Chemical reduction	Gas—phase chemical reduction(GPRC)	3	3	2	1	1	2	12
13	Chemical oxidization	Mediated electrochemical oxidation	1	1	2	1	2	1	8
14	Chemical oxidization	Fe (III) photocatalyst degradation	1	1	2	1	2	1	8
15	Biological treatment	Electrochemistry enhanced microbialdegradation	1	1	2	1	2	1	8
16	Biological treatment	Biological remediation	1	2	2	11	2	2	20
17	Unknown	Chemical enhanced microbial degradation	1	1	2	1	2	1	8

Table 21 Suitable Technologies for Pesticide POPs Disposal in China

Technologies	Type	Source	Application Range	Reasons for selection	Drawback	Shortage of management
Incineration	incineration	home/abroad	wide	1.Good performanc 2.Good Application base	1. High construction cost 2. High POPs by-products generation 3. Futher Residual treatment 4.Acidic gas emisson	1.licence releasing condition unsure
Cement kiln	incineration	home/abroad	higher heat value waste	1. Low investment 2.Good Application base	1.Low chlorine content of feeding material	1.licence releasing condition unsure
Plasma	plasma/ thermal destruction	home/abroad	wide	1.Good performance 2.Good volume reduction	1. High investiment 2. High energy comsuption 3. Acidity gas emission	1.No management regulationand guildeline
Moten destruction	incineration	home/abroad	wide	1.Good performance 2.Good Application base	1. High construction cost 2. High POPs by-products generation 3. Futher Residual treatment 4.Acidic gas emisson 5. Long distance transporation	1.licence releasing condition unsure
MCD	chemical/ non-inciner-ration	abroad	wide	1.Moderate investment 2.Good performance	1. High energy comsuption 2. Acidity gas emission	1.No management regulationand guildeline 2.No home applicatoin case
BCD	chemical/ non-inciner-ration	abroad	wide	1.Moderate investment 2. Good performance	1. Explosive gas generation 2. Akline Erosion	1.No management regulationand guildeline 2.No home applicatoin case
Sodium redcution	chemical/ non-inciner-ration	abroad	mostly in oil phase	1.Plenty of abroad application cases 2. Maturity 3. Moderate cost	1. Explosive materials used 2. Complex pretreatment	1.No management regulationand guildeline 2.No home applicatoin case

3.3.3 BAT/BEP application model for alternative disposal technologies

3.3.3.1 BAT/BEP General Requirements for alternative disposal technologies

The Convention requires that within two years' time after it takes effect, the contracting parties should make and implement the action plan, which aims at ascertaining the emission of chemicals listed in Appendix C, and the gradual adoption of BAT/BEP to reduce the emission. For key sourses and new sources listed in the second part in Appendix C, BAT should be adopted as soon as possible. These techniques should also be stagedly implemented no later than four years after the convenent takes effect. As for the existing sources listed in Appendix C, their emissions should be reduced by adopting BAT/BEP. When adopting and implementing BAT/BEP, contracting parties should take into conciderationthe general guidelines about POPs byproducts prevention and emission reduction measures, as well as the "Guidelines of Best Available Techniques and Best Environmental Practices" (abbreviated as BAT/BEP Guidelines accordingly to Article 5 of POPs Convention and Appendix C) decided and passed by the Conference of the Parties.

After the study of international relevant requirements and comparison with BAT/BEP Guidelines, the following factors should be considered when conducting waste disposal technologies.

- Environmental desirability. The adopted waste disposal technology and management ability can ensure public health and enviromnental security.
- Administrative diligence. The corresponding management ability can ensure that the adopted policies and measures will be implemented and long-term effective. The key point is the effect on environment.
- Economic effectiveness. The adopted disposal technology and means of management should be effective. At the same time, the economic value of waste should be taken into account.
- Social acceptability and equity. The adopted disposal technology and means of management can be supported and accepted by local communities. The effectiveness of waste management approaches should be included.

Therefore, the BAT/BEP guidelines on POPs waste disposal technology evaluation indicators include factors as follows, technical performance indicator, environmental impact, economic performance and social conditions. Details are illustrated in **Table 22**.

Table 22 BAT/BEP Evulation Indicator System of Pesticide POPs Disposal Technology

Item	Scope	No.	Indicator	Comments
A	Technical Performance	A1	Adaptation of disposal scale	It refers to the amount of waste that could be disposed of within the prescribed time. The adaptability to the local planning scale should be considered.
		A2	Effectiveness of disposal results	It refers to the achievable destruction efficiency, volume reduction, disfigurement and the follow-up disposal requirements, in the course of PPW disposal. The compatibity with local collocation facilities should be taken into account.
		A3	Adaptation of disposal waste	It refers to the applicating scope of various kinds of PPW. The complementarity to local waste

Item	Scope	No.	Indicator	Comments
				catogaries and collocation facilities should be taken into account.
		A4	Completeness of system configuration	It refers to complete set of facilities and unit facilities that the disposal facilities should have. The conformance with standards should be taken into account.
		A5	Advancement of unit design	It refers to the advancement of each disposal unit. The conformance with national relevant standards should be taken into account.
		A6	Automation of control level	It refers to the level of automatic control that disposal facilities do to the relevant condition parameters and operating parameters, the compatibility with relevant standards and norms, and to make sure leading automation techologies applied.
		A7	Safety of disposal facilities	It means that the PPW disposal system should have cmplete emergency protection plan. In case of exigency, the emergency safety system, composed of work area surveilance system, grading alarm display, linkage self-locking devices, emergency power and equipment, can be used to ensure the safety of the system. The support of facility security protection measures should be taken into consideration.
		A8	Infrastructure that needs to be supported	It means that apart from the main equipments and auxiliary equipments, other facilities need to be supported, such as water, electricity, disposal of secondary pollutants, etc. Difficulty of the support of facilities should be taken into account.
		A9	Energy-saving performance	It means that the disposal systeme energy-consumption performance is measured by the energy- consuption, which is used to dispose unit volume of waste.. The comparative advantage of energy-saving effect should be considered.
		A10	Operability of disposal facilities	It refers to the difficulty, intensity, time of disposal operation. Complexity and operability of the facilities should be taken into consideration.
		A11	Realizability of means of supervision	It refers to the realizability of local implementing and supervising hardware and software conditions. Relevant local supervising and monitoring capacities should be taken into account.
B	Effects on environment	B1	Risk of producing toxic or harmful pollutants	It refers to the probability of harm that pollutants do to the environment. These pollutants, which can be toxic and harmful gases, liquids or solids, are more or less produced by all kinds of PPW disposal. The toxic and harmful materials like POPs should be taken into consideration.
		B2	Risk of producing secondary pollutants	It refers to the probability of secondary polluting caused by emmisions. These emissions are toxic and harmful materials that are emitted after disposed by pollution control devices. Environmental factors, such as waste gases, water, residues and noise should be taken into consideration.
		B3	Risk of occupational	It refers to the prabability of insecurity and harmful consequences that are posed to workers. These unsafe factors include toxic and harmful dangers and

Item	Scope	No.	Indicator	Comments
			healthy	hazardous operations, such as mechanical injuries, thermal surface burns, radiation, chemical injuries and pathogen cross-contamination, etc. The risk posed by technical application to operators' health should be considered.
		B4	Risk of environmental impact on local residents	It refers to the probability of harm that is exerted on local residents' health by disposal activities. The influence of pollutant emission on local residents should be considered.
		B5	Risk of impact on eco-environment	It refers to the negative impact caused to ecological environment, including soil, water and air in the disposal place. These impacts are exerted by harmful matters produced or emitted in PPW disposal. The influence of pollutant emission on ecological environment should be considered.
C	Economic performance	C1	Construction cost	It refers to the estimation of projects' total investment, including construction investment, current funds and the capital required year by year during construction period. Cost of main equipments and auxiliary equipments should be taken into account.
		C2	Operating cost	It refers to various expenses of project producing and operating. In most cases, the unit waste disposal cost and the total cost are used to reflect the cost expenses. The disposal cost and equipment depreciation should be taken into account.
		C3	Income level	The income level reflects the project profitability. FIRR, FNPV and the return period of investment are main profitability indicators. The run level and run sustainability should be taken into account.
D	Social Conditions	D1	Public acceptability	It refers to the social exclusive and acceptab level, accordingly to people's knowledge of disposal methods and technical programs of predicate POPs waste. The comprehensive evaluation should be made by considering the contamination degree and public reaction.
		D2	Degree of policy permission	It refers to the acceptance or deflection that the selected disposal technologies get from national and local standards and regulations. The evaluation should be made in terms of technology application policies.
		D3	Difficulty level of site selection	It refers to the alternative disposal technologies of predicate POPs waste, the matching and adaptation level of the available conditions in project site with siting requirements. The evaluation should be made in terms of health and safety protection distance.
		D4	Difficulty level of technology obtaining	The difficulty level of technology obtaining is related to background of technology suppliers, technology commercialization, technology import methods and nationalization. The evaluation should be made by considering the difficulty level of technology obtaining.

The key issuers of PPW disposal technology application includes the disposal technology application conditions, scope of application, pollution control measures, environmental management requirements and so on. The technology application condition and the scope of application have been discussed respectively in Chapter two and Chapter four. Since the alternative processing techniques, disposal costs and other factors vary greatly, the pollution control should be focused on: (1) adopt the most advanced technique and the best available environmental practice; (2) The overall control on pollution emission; (3) Control on the whole process of the waste disposal. This chapter describes the pollution control measures during the technology application process and the potential problems in environmental management section by using forms. The pollution control requirements of alternative technology application can be seen in**Table 23**.

Table 23 Pollution Control Requirements of Alternative Technologies

Technology	RE	PCDD/Fs	Other pollution control factors	Applicable pollution control standards
Plasma	99.9999%	$0.1ngTEQ/m^3$	HCl	Pollution control standards for hazardous waste incineration
Cement kiln	99.9999%	$0.1ngTEQ/m^3$	HCl,NOx,SOx,TSP	Pollution control standards for hazardous waste incineration
High temperature incineration	99.9999%	$0.1ngTEQ/m^3$	HCl,NOx,SOx,TSP	Pollution control standards for hazardous waste incineration
Hot melting	99.9999%	$0.1ngTEQ/m^3$	HCl,NOx,SOx,TSP	Pollution control standards for hazardous waste incineration
MCD	99.9999%		Undermined	None for the moment
Alkali metal reduction	99.9999%		PAHs	None for the moment
Based catalytic reduction	99.9999%		--	None for the moment

To ensure the safe application of the above mentioned technologies, focusing on the core goal of pollution control, we should clarify the specific requirements on the system configuration, unit facilities and disposal facility operation management of particular disposal technologies. This report only stated key issues of relevant technologies. And the specific issues concerning particular disposal technologies will later be in-depth researched and clarified during the full sized project implementation process.

3.3.3.2 Pollution control measures of high temperature incineration

(1) The BAT/BEP requirements for high temperature incineration

There are no specific BAT/BEP requirements in the Convention on high temperature melting as a hazardous waste disposal technology, but its fundamental disposal principle is heat treatment. Its basic point of departure should be similar to the high-temperature incineration technology. Accordingly, the following BAT/BEP requirements are made.

BAT requirements:

Technologies adopted for the waste disposal should be practical, energy saving, safe, cost-effective, and comprehensively environmental-friendly. Thus, those technologies should meet the demands of Technical specifications for Centralized Incineration Facility (HJ/176), so as to reduce the impacts on human health and cut down the resulting emissions of secondary pollution. Additionally, the following conditions should be particularly satisfied.

(1) Equipping with a complete waste feeding system (adaptable to liquid, solid materials, etc), and the capacity of material compatibility.

(2) The capacity of stongly controlling pyrolysis temperature in rotary kiln.

(3) The capacity of ensuring that the burning temperature in the second combustion chamber stays above 1100℃.

(4) The capacity of ensuring loss of ignition of clinkers can reach the required standard and further improve.

(5) The measures of preventing tail heating surface from slag and fly ash.

Requirements of BEP:

In the light of different specific circumstances, a set of reasonable and scientific management mode should be explored. With this mode, the whole process of waste management---including waste composition control, waste generation, lassification, packaging, transportation, temporary storage, treatment and disposal--- is able to save energy, reduce consumption, avoid cross-contamination, and reduce emissions and pollution.

On the basis of **Table 22**,**Table 23** and **Table 23**, taking into account the process features of high-temperature incineration disposal technology, the analysis of its correspondences with BAT/BEP indicator can be seen in the **Table 24**.

Table 24 BAT/BEP Indicator Analysis of High-Temperature Incineration Disposal Technology

Item	Scope	No.	Indicator	Technical Characteristics
A	Technical performance	A1	Adaptation of disposal scale	The existing facilities can basically meet the needs of pesticides POPs waste disposal.
		A2	Effectiveness of disposal results	DRE>99.9999%, Dioxin in gas emissions <0.1ng TEQ/m^3
		A3	Adaptation of disposal waste	It applies not only to pesticides POPs waste, but to other types of pesticides. Solid, liquid and gaseous forms of waste can all be handled
		A4	Completeness of system configuration	The evaluation should be made by taking specific technology facilities into consideration.
		A5	Advancement of unit design	
		A6	Automation of control level	
		A7	Safety of disposal facilities	
		A8	Infrastructure that needs to be supported	
		A9	Energy-saving performance	

Item	Scope	No.	Indicator	Technical Characteristics
		A10	Operability of disposal facilities	
		A11	Realizability of means of supervision	
B	Effects on environment	B1	Risk of producing toxic or harmful pollutants	It will give off acidic gases like HCI, and may produce dioxin.
		B2	Risk of producing secondary pollutants	It will produce flying ashes, which are rich in dioxin. They need secondary disposal.
		B3	Risk of occupational safety and healthy	Related management regulations of labor safety should be made, in order to prevent mechanical injuries, thermal surface burns, and chemical injuries.
		B4	Risk of environmental impact on local residents	It should stay away from residential areas and environmentally sensitive areas.
		B5	Risk of impact on eco-environment	If the disposal facilities went wrong , excessive emissions of air pollutants would produce a certain impact on ecological environment.
C	Economic performance	C1	Construction cost	The evaluation should be made by taking specific technology facilities into consideration.
		C2	Operating cost	
		C3	Income level	
D	Social Conditions	D1	Public acceptability	The evaluation should be made by taking specific facilities into consideration.
		D2	Degree of policy permission	
		D3	Difficulty level of site selection	
		D4	Difficulty level of technology obtaining	

(2) System configuration and module design requirements

High temperature incineration disposal technology is applicable for solid, liquid and gaseous POPs waste with high and low concentrations. Configurations vary according to the different furnace types. The system configuration and module design include:

Main facilities

Pretreatment system and feed system

Incineration furnace (The primary furnace and secondary furnace)

Waste heat boiler

Gas purification unit (emergency security chimney, emptying control, the main chimney)

Residue processing unit

Control and monitoring system

Ancillary facilities

Receiving unit: waste metering facilities

Temporary storage unit

Analysis unit

Supporting facilities

Electrical System

Water supply, drainage and fire-fighting system

Construction and organization

heating, ventilation and air conditioning

Other supporting facilities

Take the Shenyang PCBs waste incineration disposal center for example, the specific technique process is shown in

Figure 33.

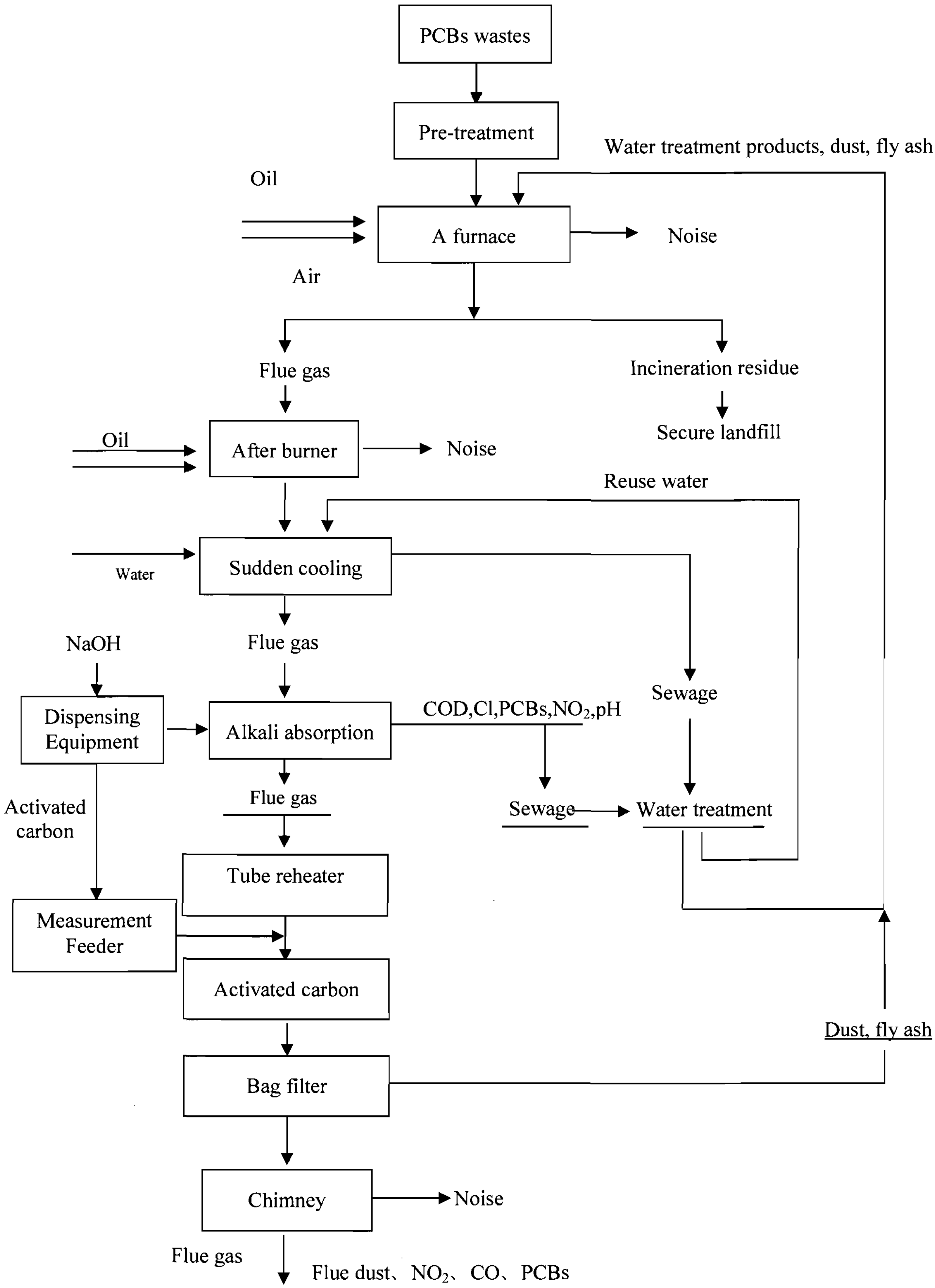


Figure 33 The Processing Flow in Shenyang PCBs Waste Incineration Disposal Center

(3) Operation management requirement

Staff composition

(a) The operation units should have appropriate professional and technical personnel in waste disposal. The main management, full-time professional and technical personnel (PCBs waste disposal technology, environmental protection equipment, thermal engineering, testing laboratories, etc.) should be able to meet the special technical requirements of PCBs waste disposal.

(b) Operators need to be trained before going to work, and should hold the appropriate training certificate.

Requirements on disposal institution

(a) The operating units engaged in PCBs disposal should have the license issued by national environmental protection authorities to treat the hazardous waste.

(b) The operating units should develop and put out management systems for operation, security and environmental protection of PCBs disposal. A perfect shift relief and operation registration system should used to ensure the strict implementation of the transfer of hazardous waste manifest.

(c) The disposal facility should subject to trial incineration and performance test before operating the formal incineration disposal. Trial burn plan shall be put into practice after being approved by the state environmental protection authority, and the trial burn performance test reports should subject to the review organized by the national environmental protection administrative department.

Waste pre-treatment

(a) Certain pre-treatment measures should be taken according to the waste characteristics and disposal of disposing facilities. Pre-crushing operations must be carried out in special sites before starting the dust exhaust equipment.

(b) The solid-liquid separation of semi-solid waste and liquid waste and the process to reduce the viscosity should be carried out in the steel tank seepage. If there is waste spilling out of the tank, it should be promptly cleaned up.

(c) Solid waste should be arranged in groups before the incineration disposal. Mechanical mixtures of waste should be made according to the arrangement program through the mixing device.

(d) Pre-treatment must be carried out with a full hood-type air-purifying respirator. Any contact with PCBs waste in the absence of protection is strictly prohibited.

Incineration facility operation

(a) When starting the system, we should first start the quench and flue gas treatment equipment before starting the ignition devices of incineration to heat up.

(b) We should slowly heat up the incineration furnace and at the same time, warm up the rotary kiln and secondary furnace and set the sec furnace exhaust flue gas temperature as the benchmark.

(c) Cold starting furnace must first raise the temperature up to 500 °C, and 6 to 8 hours of maintenance later, a predetermined operating temperature could be achieved. Only then, waste could be put into incineration disposal.

(d) The combustion temperature of rotary kiln should be controlled at 900 - 1000 °C. And the temperature of Sec furnace should be controlled at 1200 - 1250 °C.

(e) Sec furnace exit flue gas temperature should achieve the network real-time display with the environmental management departments as required and the records of the whole process should be stored.

(f) The amount and rate of PCBs put into the combustion system should be continuously or at regular intervals (time intervals no more than 30 minutes) measured and recorded.

(g) It is strictly prohibited to put PCBs waste into incineration system in the state of open bypass and untreated flue gas. Emergency discharge flue must be opened when there is an accident, and must be stopped from feeding before its opening.

(h) Every device of the incineration fly ash disposal system should remain closed. Fly ash disposal should be operated by mechanical or pneumatic means. The ash cans used to collect the fly ahs should be frequently checked and timely removed and packed.

(I) Bottom ash and fly ash produced by PCBs waste incineration are hazardous waste, and should be sent to hazardous waste landfill for secure landfill disposal.

(J) Bottom ash and fly ash temporarily stored at the venue should meet the relevant provisions of hazardous waste. The transportation out of the factory should meet the relevant regulations on hazardous waste transportation and strictly apply the leaving factory registration.

The automatic control and on-line monitoring

(a) When the incineration system starts running, self-control devices should fully control the storage, pre-treatment facilities, incineration devices, flue gas purification equipment and industrial effluent treatment plant, and continuous monitor and record the important condition parameters of feeding, incineration, flue gas treatment equipment and their operation state.

(b) In emergency situation, the emergency shutdown system should be able to started in the main control room or in local control area.

(c) On-site industrial television monitoring system should perform the on-site live monitoring of the storage warehouse, the material transfer process and the important parts of the burning line, and if necessary, keep monitoring records.

(d) PCBs incineration system must be operated when the on-line automatic monitoring system starts. Flue gas, sulfur oxides, nitrogen oxides, hydrogen chloride and other pollutants produced before and after burning, as well as oxygen, carbon monoxide, carbon dioxide and other indicators should subject to on-line monitoring, and the monitoring results should show, record and adjust the control condition. On-line monitoring data should be displayed on the local environmental protection department network.

(e) When the main working parameters exceed, the on-line monitoring system should automatically stop feeding through the feed cut-off system.

The monitoring requirements in the process of PCBs waste disposal operation

In order to ensure the safe operation and management of waste incineration disposal facility, waste gas, noise, waste water and slag generated in the process of waste disposal should be monitored. The main monitoring requirements are demonstrated in **Table 25**

Table 25 PCBs Emission Monitoring Requirements for Waste Incineration System

Indicators		Monitoring frequency	Time	Monitoring location
Smoke emission	Particles, O_2, CO, CO_2, NO_x, SO_2, HCl	Online monitoring	Refer to relevant national standards	Flue
	Flue gas blackness	Once /quarter		
	Heavy mental	Once/quarter		
	PCBs	Once/month		
	Dioxins	once/quarter		
Domestic wastewater	pH, CODcr, water	Online monitoring	Refer to relevant national standards	Wastewater discharge
	SS, NH_3-N	Once/day		
	PCBs, BOD_5, Petroleum volatile phenol	Once/week		
Storage warehouse gas	PCBs、	Once/quarter	Refer to relevant national standards	Storage warehouse front and the exhaust port
slag	PCBs, Characteristics of hazardous waste	Once/month	Refer to relevant national standards	Slag exit
noise	Sound level (A) (Leq)	Once/month	24h/d	Sensitive section 1m out of the statutory plant bounds and 1.2 height above

3.3.3.3 Pollution control measures on cement kiln co-processing disposal

(1) BAT/BEP requirements for cement kiln co-processinng hazardous waste disposal

The BAT/BEP technical guidelines take cement kiln as the possible source of dioxin creation. As the high-temperature retention time of Cement Kiln is long and the technique itself has quencher devices, the Cement Kiln becomes a good disposal equipment for hazardous waste in well-managed environment.

On the basis of **Table 22** and **Table 23**, taking into account the process features of Cement Kiln co-processing technology and comparing it with incineration disposal technology, its BAT/BEP requirements are demonstrated in the **Table 26**.

Table 26 BAT/BEP Indicator Corresponding Analysis of Cement Kiln Co-Processinng Disposal

Item	Scope	No.	Indicator	Technical Characteristics
A	Technical performance	A1	Adaptation of disposal scale	It has made technical innovations on the basis of existing rotary kiln. There is no problem in the disposal scale.
		A2	Effectiveness of disposal results	DRE>99.9999%, Dioxin in gas emissions <0.1ng TEQ/m^3
		A3	Adaptationof disposal waste	It applies not only to pesticides POPs waste, but to other types of pesticides. Solid, liquid and gaseous forms of waste can all be handled
		A4	Completeness of system configuration	The evaluation should be made by taking specific technology facilities into consideration.
		A5	Advancement of unit design	
		A6	Automation of control level	
		A7	Safety of disposal facilities	
		A8	Infrastructure that needs to be supported	
		A9	Energy-saving performance	
		A10	Operability of disposal facilities	
		A11	Realizability of means of supervision	
B	Effects on environment	B1	Risk of producing toxic or harmful pollutants	It will give off acidic gases like HCI, and may produce dioxin.
		B2	Risk of producing secondary pollutants	It will produce flying ashes, which are rich in dioxin. They need secondary desposal.
		B3	Risk of Occupational safety and healthy	Related management regulations of labor safety should be made, in order to prevent mechanical injuries, thermal surface burns, and chemical injuries.
		B4	Risk of environmental impact on local residents	It should stay away from residential areas and environmentally sensitive areas.
		B5	risk of impact on eco-environment	If the disposal facilities went wrong , excessive emissions of air pollutants would produce a certain impact on ecological environment
C	Economic performance	C1	Construction cost	The evaluation should be made by taking specific technology facilities into consideration. The economic performance is better than the incineration disposal.
		C2	Operating cost	
		C3	Income level	

Item	Scope	No.	Indicator	Technical Characteristics
D	Social Conditions	D1	Public acceptability	The evaluation should be made by taking specific facilities into consideration. It has advantages over incineration disposal in public acceptability and site selection.
		D2	Degree of policy permission	
		D3	Difficulty level of site selection	
		D4	Difficulty level of technology obtaining	

(2) System configuration and module design requirements
System configuration requirements

The configuration of the new-built cement kiln co-processinng disposal system at least should include: hazardous waste receiving system, analysis and identification system, storage and delivery system, incineration system, ground system, thermal energy utilization system, flue gas purification system, residue handling system, automatic control system, on-line monitoring system, electrical system, and fuel supply, compressed air supply, power supply and distribution, water supply and drainage, sewage disposal, fire, communications, HVAC, mechanical maintenance, vehicle washing facilities. According to their structure, they could be divided into the following modules:

(a) Temporary unit: provide temporary waste storage venue and security management, including warehouses.

(b) Pre-treatment unit: adjust the waste moisture content, calorific value and grinding of waste.

(c) Feeding unit: spray devices (liquid feed) or powder injection (solid feed) devices.

(d) Main incineration unit: cement rotary kiln.

(e) The clinker grinding unit: grind the clinker and put into the cast to regulate the clotting time.

(f) Flue gas purification unit: all devices involved in flue gas pollution control.

(g) Transport and drive unit: all the transport devices needed in the above mentioned process belong to the transport and drive unit. They deliver from waste transporter to the temporary storage, from the temporary storage to the transmission devices of pre-treatment unit, from the pre-treatment unit to the conveyor of the feed inlet, from the clinker to the grinding machine devices and so on.

In order to transform the exiting cement kilns to better fit the cement kiln co-processinng disposal system and make the exiting cement rotary kilns meet the PPW disposal requirements, the following modules of the exiting cement rotary kilns should be increased/ improved:

(a) Waste sorting and pre-processing unit: new added unit, which prevents the effect of incorporation of waste on cement production.

(b) Flue gas and dust purification unit: enhance the disposing efficiency of exiting purification devices on dioxin.

(c) Fly ash collection and reprocessing devices: collect the dioxin-rich fly ash and return to disposing cycle.

For both new built and modified cement kiln co-processinng disposal systems, apart from handling the PPW, we should not affect the normal production of cement kiln, affect the product quality, damage the production equipment, or bring any harm to operators' health or the surrounding environment during the disposal process.

Module design requirements

(a) Design requirements on pre-treatment unit

- PPW should be arranged into groups according to their composition, calorific value and other parameters before feeding into the kiln, to ensure the stable operation of incinerators and reduce the burning rate of incineration residue.
- The compatibility of PPW should be noted in order to avoid the adverse consequences result from mixing incompatible hazardous waste together.
- PPW should go through appropriate crushing and grounding treatment to be better mixed, in order to facilitate a stable, safe and efficient operation. As for the waste with high moisture rate (such as sludge, liquid waste), proper dewatering process could be adopted to reduce the energy consumption.
- When design the mixing or processing system of the hazardous waste, we should take into account the nature of incineration waste, the crushing way, the mixing of liquid waste, pumping of the feed and the layout of the piping system.

(b) Design requirements on waste feeding unit

- Sorting devices should be set to handle waste which are not classified or wrongly classified;
- Grounding unit should be set to let the waste go through special feed inlet together into the incinerators;
- Automatic feeding devices should be set and the feed inlet should be equipped with air tightness maintaining devices, in order to ensure the stable operation of the incinerator;
- Feed system should be in vacuum state, to prevent the escape of harmful gases;
- Some issues should be paid attention to when design the liquid production line: nozzles should be corrosion resistant and easy to remove solid particles; under the premise that security is guaranteed, the system should be as simple as possible, to reduce intermediate links and facilitate the operation; the design should be one level higher than the system working pressure, leakage should be prevent during the installation, and operators should be protected from the waste; in addition, the selection of pump should meet the requirements of spray nozzle.

(c) Design requirements of main incineration unit

The BAT/BEP the convention guidelines requires: based on the requirements of best available techniques, PCDD/PCDFs in the flue gas of the exiting cement kilns should be less than 0.1 ng TEQ/Nm^3. Emission level should be adjusted based on 273 K, 101.3 kPa, 10% of the O2 and dry calibration gases.

(d) Design requirements of flue gas purification unit

- Bag filter or electrostatic precipitator should be adopted.
- The temperature of the dust catcher import should be strictly controlled to prevent the production of dioxin-like substances.
- If the concentrations of NOx and Sox in the flue gas exceed the standards, desulfurization and denitrification devices should be equipped between the dust removal devices.
- Fly ash generated by the cement kiln needs to be returned to the treatment techniques to become the raw materials of cement, but if the content of alkali metal exceeds standards, it should be washed first and then put back into the treatment process. If not allowed by the local law, it can be treated via secure landfill.

(e) Design requirements of automatic control unit

- Automatic control system must be applicable, reliable, and should be designed based on the characteristics of hazardous waste incineration facilities and meet the requirements on security, economic operation and secondary environmental pollution prevention.
- Automatic system of the rotary kilns should adopt the sophisticated control technology and reliable equipment and components with appropriate cost performance. The new products and new technologies used in the design should once be run successfully in the relevant field.
- Rotary kiln should have a higher level of automation and could realize the centralized monitoring and distributed control of the hazardous incineration lines, heat energy use and auxiliary systems in the central control room through a decentralized control system.
- The main elements of the automatic control should be determined based on the size of the rotary kilns and settings of each technique system, generally, including: feed system control, incineration system control, heat energy use system control and flue gas purification system control.
- For the auxiliary devices which do not affect the overall control system, local control cabinet, or in-place control room, if necessary, could be set up. However, the important information should be sent to a central control room.
- For the important parts of storage warehouse, the material transfer process and the incineration lines, the on-site industrial television monitoring systems should be set up.
- For the alarm and display of important parameters, optical plate alarm and digital display instrument can be installed.
- Emergency shutdown system independent of the distributed control system should be set.
- All the alarm projects within the scope of computer monitoring system functions should be able to be shown on the display and printed out.

(3) Operation management requirements

Staff composition requirements

Provide relevant professionals and general workers according to the disposal scale. Areas of expertise include mechanism, electron, automation, water supply and drainage, civil construction and environmental protection.

Pre-treatment requirements

Waste pre-treatment aims at changing the physical parameters (such as size, moisture content and viscosity, etc.) of waste to be handled, so that it can be directly matched up to the burning and injection system of cement rotary kiln for effective control. Since metal can easily lead to alkali-aggregate reaction of the cement clinker, alkali content is required no more than 3kg/m3. In addition, to a certain extent, the chlorine content affects the quality of cement. Generally, for the no-pass cement kiln, the chlorine content could not exceed 0.35% -0.5% of the quality, and for the rotary kiln with bypass, no more than 0.4% - 0.7%. Pretreatment should be considered to meet a certain standard requirements, such as shown in **Table 27** (Jiang Minglin, 2002).

Table 27 Pretreatment Product Standards

	Factors to be considered	Technical requirements on products produced in the pre-treatment plant	
Solid	1. Stable fuel quality in order to properly control the burner and flame	Calorific value: Chlorine content:	≥3000kcal/Kg 0.3%
	2. Adapt to the mobility of material loading and unloading of the tube-type reservoir	Ash content: Granularity:	35% <12mm,<80mm
	3. Adapt to the loading and unloading ability of piled up materials	Alkali content:	<10mm,main burner
	4. Adapt to the technique process and regulations of the acceptance criteria approved by authorities		>40mm,<80mm calciner 2-3%
	5. Adapt to the main kiln burner and calciner feeding facilities	Moisture	30-40%
Solvent	1.Stable fuel quality in order to properly control the burner and flame	Calorific value: Chlorine content:	6500kcal/kg 0.6%
	2.Adapt to the technique process and regulations of the acceptance criteria approved by authorities	Ash content: Granularity:	1% 3mm
	3.Adapt to the main kiln burner and calciner feeding facilities	Alkali content Moisture	1-3% 15-25%
Liquid waste	Same requirements of solvent	Calorific value: Chlorine content: Ash content: Granularity: Alkali content: Moisture:	1000kcal/kg 0.2% 1% 3mm 1-3% 85%

The indicators in **Table 27** are proposed for a particular technology. According to the operating experience (Fang, 2000), waste handled by cement kiln should meet the following requirements:

- Non-radioactive
- No strong corrosive
- Heavy metal content < 3000ppm
- Moisture content <20%
- Chlorine content <3%;Alkali content <4%;Sulphur content<2%
- Calorific value as fuel ≥4000kal/kg
- Non-volatile, semi-volatile metals and metal oxides

Of course, these indicators could be appropriately adjusted and amended according to the amount and physical form of the waste.

Feed requirements

Prevent the waste from obstruction and maintain the pathway smooth when feeding. As for the feed point, the special structure of the rotary kiln determines that there are many selectable kiln feed points, such as the main combustion furnace at the rotary kiln outlet section, transformation warehouse at the rotary kiln entrance, pre-calcination furnace, point between the feed ramp and the pre-calcination furnace(for adding the block fuel) and so on. Since volatile organic compounds may cause obstruction of the cyclone dust collector during the disposing process of the hazardous waste in cement kiln, Waste containing volatile organic compounds need to be treated in preheat furnace or pre-calcination furnace before being processed in the rotary kiln or choose to be feed at the high-temperature feed point (main burner).

As the cement kiln is more suitable for processing liquid organic waste and has poor adaptability to solid waste, try not to feed solid waste. If unavoidable, such waste should go through full ground and special techniques should be adopted to ensure the uniform distribution of waste in cement kiln. The caloric value need to be under strict control to avoid kiln flameout or inferior quality of the products.

Operation management requirements

The BAT/BEP guidelines under the POPs convention put forward the corresponding requirements on the operation management of cement kiln co-processinng disposal of hazardous waste, mainly including: Emissions Control (gas NOx, SO2, particulate matter, heavy metals), inspection and reporting system configuration, the incineration disposal license management, occupational safety and health, and training.

Concerning the operation process indicators for the cement kiln co-processinng disposal of hazardous waste, United States, the European Union, Japan and the Stockholm Convention Secretariat all put forward similar indicators of operating parameters, as illustrated in **Table 28.**

Table 28 Main Process Parameters of Cement Kiln(EPA,1999)

Main furnace temperature	>1450°C(Material temperature) >1800 (Flame temperature)
Retention temperature	>1200°C 12-15s >1800°C 5-6s
Pre-calcination furnace	>1450°C(Material temperature) >1800(Flame temperature)
Retention temperature of pre-calcination furnace	>800°C 2-6s

In addition, the oxygen content of exit flue gas from incineration furnace should be ensured to reach 6% -10% (dry gas).

Pollution control measures and process optimization

Measures suggested in the convention's BAT/BEP guidelines to reduce PCDD/PCDF are:

(a) Process optimization

- Rapidly cool the kiln tail gas to below 200°C and quickly go through this dangerous temperature area in clinker process.
- Highlight a good operation and use it as a basis to improve other operational performance. After the establishment of a good kiln, by adding the controlled amount of waste, set the relevant data, observe the changes and needs of control, and then take measures to control emissions.
- The process management of the kiln could achieve a stable operating condition through taking relevant measures: process control optimization, including computer-based automatic control system; the modern gravity method of solid fuel feed system.
- Minimize the fuel energy source through the following measures: take into account the system structure of the exiting kiln, use the warm-up and pre-calcination technique as far as possible; the use of modern clinker cooler allows for maximum heat recovery; recover heat from waste.
- Minimize the use of electricity through the following measures: energy management systems; grinding equipment and other electronic equipment with high efficiency.
- Control of chemicals listed in Appendix C: use the indirect method. In exceptional circumstances, the reduction of chemicals listed in Appendix C has a negative effect, but it is an integrated part of the concept; it is generally feasible and technologically simple.

(b) Feed preparation

- Pre-process the waste (only waste) to provide a more homogeneous and more stable feed combustion conditions: drying, cutting, mixing and grinding.
- Maintenance and proper storage of fuel.
- Maintenance, proper storage and disposal of waste and its warehouse.

(c) Input control

- Continuous long-term supply of secondary waste feed (one month or longer) is needed to maintain stable operation conditions.
- Carefully choose and control the materials entering the kiln to reduce the introduction of sulfur, nitrogen, rates, metals and volatile organic compounds.
- Continuous supply of fuel and waste require the separation of the following substances: heavy metals, chlorine (limited, depends on the product / process), and sulfur.
- Ensure the temperature of the waste in the pre-calcination / pre-heater kiln, through the primary or secondary burner feed, is above 900 °C.
- If it contains organic matter, it can not be regarded as part of the original mixture of waste feed.
- No waste feed in the process of startup and shutdown.

Control of chemicals listed in Appendix C: use the indirect method. In exceptional circumstances, the reduction of chemicals listed in Appendix C has a negative effect, but it is an integrated part of the concept; it is generally feasible and technologically simple.

(d) Stability of process parameters

- Specifications of fuel characteristics (alternative fuels or fossil fuels)
- General usage
- Excess oxygen
- CO Monitoring

Control of chemicals listed in Appendix C: use the indirect method. In exceptional circumstances, the reduction of chemicals listed in Appendix C has a negative effect, but it is an integrated part of the concept; it is generally feasible and technologically simple.

(e) Process amendment

- For the rapid cooling of the kiln exhaust with the temperature lower than 200 °C, during the clinker treatment process, the critical temperature range is often quickly exceeded. The efficiency of this method is low and the renovation of the existing facilities demand high techniques.
- Exhaust gas and dust should be put back to the kiln in order to reduce as much as possible the problems to be dealt with and the possibility of related emissions. The dust can be recycled should be managed in a safe manner.

Control of chemicals listed in Appendix C: use the indirect method. In exceptional circumstances, the reduction of chemicals listed in Appendix C has a negative effect, but it is an integrated part of the concept.

Generally speaking, the above-mentioned measures would allow new and existing equipment to achieve emission levels of 0.1 ng TEQ/Nm3. The effect should be monitored. If all of these measures can not achieve the performance of less than 0.1 ng TEQ/Nm3, the following secondary measures should be considered.

Secondary pollution control measures and process optimization

The Guideline of BAT/BEP under Stockholm convention stipulated

(a) Improvement of dust removal and recycling

Control of chemicals listed in Appendix C: reducing dust deposition temperature can lead to decrease in efficiency; generally applicable; medium-sized technology architecture; Consider chemicals listed in Appendix C as the replenishment of particulate matter.

(b) Carbon Membrane

It has a high degree of efficiency in removing trace pollutants ("90%); pollutants such as SO2, organic matter, metal, NH3, NH4 + compounds, HCl, HF and residual dust (in the EP or fiber membranes) can be removed from the exhaust by activated carbon adsorption. The only European cement plant installed with activated carbon membrane is in Siggentha , Switzerland. Siggentha kiln is a 4-stage cyclone preheater kiln, with a production capacity of 2,000 tons of clinker / day. Measurements show its high removal efficiency of SO2, metals and PCDD / PCDF.

Control of chemicals listed in Appendix C: generally feasible, need technical-type construction.

(c) Selective catalytic reduction (SCR)

SCR equipment is applied in NOx control. It can convert NO and NO2 into N2 in the presence of NH3 and a catalyst in the temperature range between 300-400 °C (which means heating the exhaust). So far, SCR is only tested in the preheater and semi-dry method (Lepol) kiln system, but it can also be used for other kiln systems.

The high cost of this approach could make it economically unviable. The first comprehensive plant (Solnhofer Zementwerke) started its operation at the end of 1999.

Environmental monitoring requirements

As for environmental monitoring, the use of cement kiln co-processing disposal of hazardous waste would involve in the atmosphere, waste water, noise and so on. In this case, the major pollution factors will be taken into consideration, and only environmental monitoring of atmospheric pollutants will be stated.

Convention BAT / BEP guidelines proposed to carry out continuous monitoring of the following parameters, including: pressure, temperature, O2 concentration, NOx, CO, and SO2 and so on.

Periodic monitoring should be carried out on the following materials:

- Metals and their compounds
- TOC
- HCl
- HF
- NH_3
- PCDD/Fs

Under special operating conditions, the following substances may require monitoring from time to time:

- Monitor the destruction and removal efficiency of cement kiln in treating persistent organic pollutants
- BTX (benzene, toluene, xylene)
- PAH (polycyclic aromatic hydrocarbons)
- Other organic pollutants (such as chlorobenzenes, PCB (polychlorinated biphenyls, including coplanar substances of the same kind, polychlorinated naphthalene, etc.))

According to the current emission standards of domestic cement industry, the emission limits of main air pollutants in the cement industry such as particulate matter, sulfur dioxide, nitrogen oxides and fluoride are listed in the table below. The standard for dioxin / furan is 0.1ng TEQ/Nm^3. For other pollutants, please refer to the discharge limit stipulated in the *Hazardous Waste Incineration Pollution Control Standard* (GB18484).

Table 29 Emission Standards for the Domestic Cement Industry

Production	Equipment	Particles		Sulfur dioxide		Nitrogen oxides (in terms of NO_2)		Fluoride (in terms of total fluoride)	
		Emission concentration mg/m^3	Emissions per unit of product kg/t	Emission concentration mg/m^3	Emissions per unit of product Kg/t	Emission concentration mg/m^3	Emissions per unit of product Kg/t	Emission concentration mg/m^3	Emissions per unit of product Kg/t
Mining	Breakers and other ventilation equipment	50/30	-	-	-	-	-	-	-
Cement manufacturing	In-line kiln/raw mill*	100/50	0.30/0.15	400/200	1.2/0.60	800	2.40	5	0.03/0.015
	Drying machines, dry grinding, coal grinding and cooling machine	100/50	0.30/0.15	-	-	-	-	-	-
	Crusher, grinding machine, packaging machines, and other ventilation equipment	50/30	0.04/0.024	-	-	-	-	-	-
Production of cement products	Cement silo and other ventilation equipment	50/30	-	-	-	-	-	-	-

Notes:*It refers to the emission concentration and emission per unit of product when the O_2 content in flue gas is 10%. Data before "/" is the present value, and after is the limit value after 2010.

In the aspect of environmental monitoring, carry out performance test on the disposal system after the installation testing and equipment maintenance and evaluate the achievable optimal efficiency of the system and its disposal result in the most adverse circumstances. The Air Pollution Monitoring Program for the Cement Kiln Co-Processinng Disposal of Pesticide POPs can be seen in **Table 30**.

Table 30 The Air Pollution Monitoring Program for the Cement Kiln Co-Processinng Disposal of Pesticide POPs Waste

Pollutants	Monitoring Method	Monitoring Frequency	Monitoring executor
PCDD/Fs HCl	*Environmental Monitoring technical specifications* (waste gas and atmospheric part)	Once a year	Qualified Dioxin testing laboratory
SOx NOx Fly ash		Once a year	Laboratory passed the National Measurement Accreditation
Heavy mental		Once every half year	Laboratory passed the National Measurement Accreditation
CO		May determined by competent authority	

Smoke degrees, hydrogen fluoride, heavy metals and their compounds should be sampled and monitored at least once every quarter. The frequency of dioxin sampling should not be less than one time/year.

3.3.3.4 Pollution control measures for Plasma disposal technologies

(1) BAT/BEP requirements for plasma disposal technology

The plasma disposal technology is listed as a new dispoal technology of dioxin-rich fly ash in the BAT/BEP guidelines, but there are no detailed explanations on how this technology use BAT/BEP to control pollutant source the pasma pyrolysis disposal technology in the guidelines. The plasma disposal technology is also a kind of high-temperature technology. Under the condition of high temperature, POPs waste will be broken down into chlorine and organic-rich end gas by plasma. It will also be possible to produce dioxin in the process of cooling to room temperature. Therefore, in the appllication of plasma technology, its pollution spot should be analyzed, and the BAT/BEP application plan should be supplied accordingly to the technical features of plasma..

On the basis of **Table 22** and **Table 23**, taking into account the process features of plasma pyrolysis disposal technology, and comparing with incineration disposal technology, the analysis of its BAT/BEP requirements is demonstrated in **Table 31**.

Table 31 BAT/BEP Indicator Analysis of Plasma Disposal Technology

Item	Scope	No.	Indicator	Technical Characteristics
A	Technical performance	A1	Adaptation of disposal scale	The existing facilities can basically meet the needs of pesticides POPs waste disposal.
		A2	Effectiveness of disposal results	DRE>99.9999%, Dioxin in gas emissions <0.1ng TEQ/m3
		A3	Adaptation of disposal waste	It applies not only to pesticides POPs waste, but to other types of pesticides. Solid, liquid and gaseous forms of waste can all be handled
		A4	Completeness of system configuration	The evaluation should be made by taking specific technology facilities into consideration.
		A5	Advancement of unit design	
		A6	Automation of control level	
		A7	Safety of disposal facilities	
		A8	Infrastructure that needs to be supported	
		A9	Energy-saving performance	
		A10	Operability of disposal facilities	
		A11	Realizability of means of supervision	
B	Effects on environment	B1	Risk of producing toxic or harmful pollutants	It will give off acidic gases like HCI, and may produce dioxin.
		B2	Risk of producing secondary pollutants	It will produce flying ashes, which are rich in dioxin. They need secondary disposal.
		B3	Risk of Occupational safety and healthy	Related management regulations of labor safety should be made, in order to prevent mechanical injuries, thermal surface burns, and chemical injuries.
		B4	Risk of environmental impact on local residents	It should stay away from residential areas and environmentally sensitive areas.
		B5	Risk of impact on eco-environment	If the disposal facilities went wrong , excessive emissions of air pollutants would produce a certain impact on the ecological environment
C	economic performance	C1	Construction cost	The evaluation should be made by taking specific technology facilities into consideration.
		C2	Operating cost	
		C3	Income level	

Item	Scope	No.	Indicator	Technical Characteristics
D	Social Conditions	D1	Public acceptability	The evaluation should be made by taking specific facilities into consideration.
		D2	Degree of policy permission	
		D3	Difficulty level of site selection	
		D4	Difficulty level of technology obtaining	

(2) System configuration and unit design requirement

System configuration requirement

(a)Plasma disposal facilities at least include receiving and storage systems, plasma pyrolysis systems, exhaust gas treatment system, and ancillary works and other facilities.

(b)Receiving and storage systems: metering, unloading, temporary storage, transportation, characteristics analysis and identification, pre-treatment and other facilities for hazardous waste.

(c)Plasma pyrolysis systems: nitrogen systems, hazardous waste feeding facility, pyrolysis facility, cooling and collecting facility of vitreous marker, etc.

(d)Exhaust gas treatment system: Heat exchanger, venturi quenching facility, washing facility, adsorption facility, dust facility, combustible gas utilization facility and so on.

(e)Ancillary works are mainly include facilities like general layout and transportation, communications, HVAC, mechanical maintenance, monitoring laboratory tests, measurement and roads.

Unit design requirements

(a)**Pre-treatment unit**

- PPW need pre-treatment before being treated by plasma technology. The pre-treatment includes removal of packaging, separation, solid mixtures, crack of disposable packaging, liquid filtration, etc.
- The compatibility between PPW should be paid attention to in order to avoid mixing incompatible hazardous waste together which would result in adverse consequences.
- As for two or more single waste, the necessary mix and combination scheme can be designed based on the major components of each waste and the processing technique of plasma disposal facility, in order to achieve the best, most economic and most efficient disposing result.

(b) **Waste feeding unit**

- The feeding unit should be divided into solid, semi-solid and liquid.
- The feeding unit of solid and semi-solid materials should include feed hopper, metering devices and propeller

- The liquid feeding unit should include pumps, injectors, metering devices, valves and piping, etc.

(c)Plasma disposal unit

- The main facilities of plasma disposal unit include plasma melting furnace, power equipment, measuring equipment, control equipment, and nitrogen-making equipment.
- Plasma generator power supply should have protection function to automatic diagnose the over current, over temperature, over voltage, under voltage, phase failure, reversed phase sequence, etc. The protection time is less than 10ms. It can display directly, and after the fault clearance, automatically resetting itself. Its power has local control and computer remote control functions.
- Heat pipe structure should be used for cooling to ensure the cooling effect and its reliability, and at the same time reduce the noise of the running equipment.
- Nitrogen preparation equipment should be able to obtain high-purity nitrogen. The purity of nitrogen produced should be up to 97-99.9%, and the flow rate should be from 1 Nm^3/h to 5000 Nm^3/h, with the pressure of 0.05-1.0 MPa.

(d)Technical requirement for automatic control system

- Plasma disposal system should adopt the central control technique to control the whole process. The whole control system is composed of a central controller, the signal acquisition device, isolation amplifiers, output controlling driver and output protection driver.
- Automatic control system must possess the functions such as the acquisition and processing of the required signal, data storage and query, control and protection of signal output, real-time data display, etc.
- The interlock and alarm of each device, accident parking and sequential control system should be included in the automatic control system.

(e) Technical requirements for exhaust gas purification system

- The exhaust gas purification system of the plasma disposal facility should include waste heat boiler, combined Venturi sudden cold system, dry-type cyclone absorption tower, nano-ceramic dust collector, induced draft fan and some other parts.
- Exhaust gas temperature at the exit of waste heat boiler should be controlled under 600°C.
- The combined Venturi sudden cold system should reduce the exhaust gas temperature to below 250°C. .
- The combustible component volume of the treated combustible gas should be at 60%-74%, and the heat value should be at 1300-2000 $kcal/Nm^3$. It can be used as a fuel.

(f) Operation and management requirements for plasma disposal facility

Staff composition

(a)Appoint relevant professionals and general workers according to the disposal scale. The expertises include mechanics, electricity, electronics, automation, water supply and drainage, environmental protection and so on.

(b)Operators need to run through job training, and hold the appropriate training certificate.

Operation Conditions

(a)A permit must be obtained in accordance with the “management regulation of hazardous waste operation license” before operation; without obtaining a license, any unit shall not engage in disposal activities.

(b) The complete regulations and rules to ensure the safe handling and disposal

(c) Revolving fund and auxiliary raw materials to guarantee the normal operation of incineration plant

(d) Agencies and personnel in charge of testing and evaluating the disposal effect

Waste reception

(a) The manifest system of hazardous waste transfer should be implemented in waste reception.

(b) In the on-site transfer of hazardous waste, the number, type and logo of the hazardous waste should be carefully checked and matched with the transfer manifest.

(c) Timely registration of the received waste

Shift relief and operation registration system

(a)The transfer of production facilities, equipment, tools and supporting materials for production;

(b) Waste hand-over

(c) Operation record transfer;

(d) Shift relief personnel should perform the in kind transfer in the field;

(e) Before handing out the operation record, the shift relief personnel should take a co-site inspection;

(f) If the shift relief procedure fails to be completed, it shall be promptly reported to the person in charge of production management;

(g) The shift relief personnel should sign after checking the physical objects and confirming the operation records.

(h) The type, quantity, final destination of the collected, stored or disposed waste, and whether there is an accident or other unusual situation should be document in detail every day, and the transfer manifest needs to be filed should be kept according to the relevant regulations of the hazardous waste transfer manifest.

Special requirements for mobile plasma disposal facility

(a) The main body construction of the mobile plasma disposal facility should be considered equivalent to that of the fixed facility.

(b) The construction scale of the mobile plasma disposal facility should appropriately be 3-5 tons/ day.

(c) Though based on the mobile property, a fixed position should be chosen in one region for the mobile plasma disposal facility to carry out its disposal.

(d) The workplace of the mobile plasma disposal facility should be equipped with water, electricity and other supporting facilities meeting the corresponding requirements and the generated waste water, waste gas, solid waste and other pollutions can be handled here.

(e) The mobile plasma facility is suggested to carry out disposal in the local hazardous waste disposal plant (or centre) to meet the basic requirements.

(f) During the working process of the mobile disposal facility, data and information like the disposal record and the transfer manifest should be kept for later examination at any time.

(g) Mobile Plasma disposal facility operators must have the hazardous waste operation license issued by the country.

3.3.3.5 Pollution control measures of high temperature melting

(1) The BAT/BEP requirements for high temperature melting.

There are no specific BAT/BEP requirements in the Convention on high temperature melting as a hazardous waste disposal technology, but its fundamental disposal principle is heat treatment. Its basic point of departure should be similar to the high-temperature incineration technology. Accordingly, the following BAT/BEP requirements are made.

BAT requirements:

Technologies adopted for the waste disposal should be practical, energy saving, safe, cost-effective, and comprehensively environmental-friendly. Thus, those technologies should meet the demands of ***Technical specifications for Centralized Incineration Facility*** (HJ/176), so as to reduce the impacts on human health and cut down the resulting emissions of secondary pollution. Additionally, the following conditions should be particularly satisfied.

(1) Equipping with a complete waste feeding system (adaptable to liquid, solid materials, etc), and the capacity of material compatibility.

(2) The capacity of stongly controlling pyrolysis temperature in rotary kiln.

(3) The capacity of ensuring that the burning temperature in the second combustion chamber stays above 1100℃.

(4) The capacity of ensuring ignition loss of clinkers can reach the required standard and further improve.

(5) The measures of preventing tail heating surface from slag and fly ash.

Requirements of BEP:

In the light of different specific circumstances, a set of reasonable and scientific management mode should be explored. With this mode, the whole process of waste management---including waste composition control, waste generation, lassification, packaging, transportation, temporary storage, treatment and disposal--- is able to save energy, reduce consumption, avoid cross-contamination, and reduce emissions and pollution.

(2) System configuration and cell design requirement

The Disposal technology of high-temperature melting are applied to high concentration and low concentrations of POPs waste, no matter it is solid, liquid and gaseous. Different configurations in accordance with its furnace vary. The most applied slag processing technology in domestic is solidify heavy metal through melting at high temperature 1400 °C, and decompose dioxins. The slag can be used as a recycling resource. The system configuration and cell design include:

Main body establishment

The disposal techniques of hazardous waste includes: hazardous waste receiving system, analysis identification systems, storage and distribution systems, pretreatment and feeding system, incineration systems, waste heat recovery systems, flue gas quench system, deacidification system, flue gas purification systems such as Bag Filter device systems, residue handling systems, automatic control systems, on-line monitoring system, electrical system and other systems.

Subsidiary facility

Subsidiary systems include: fuel supply, compressed air supply, power supply and distribution, water supply and drainage, sewage disposal, fire control, communications, HVAC, mechanical maintenance, vehicle washing and other auxiliary facilities. Flow of hazardous waste disposal process scheme is shown in Figure 34.

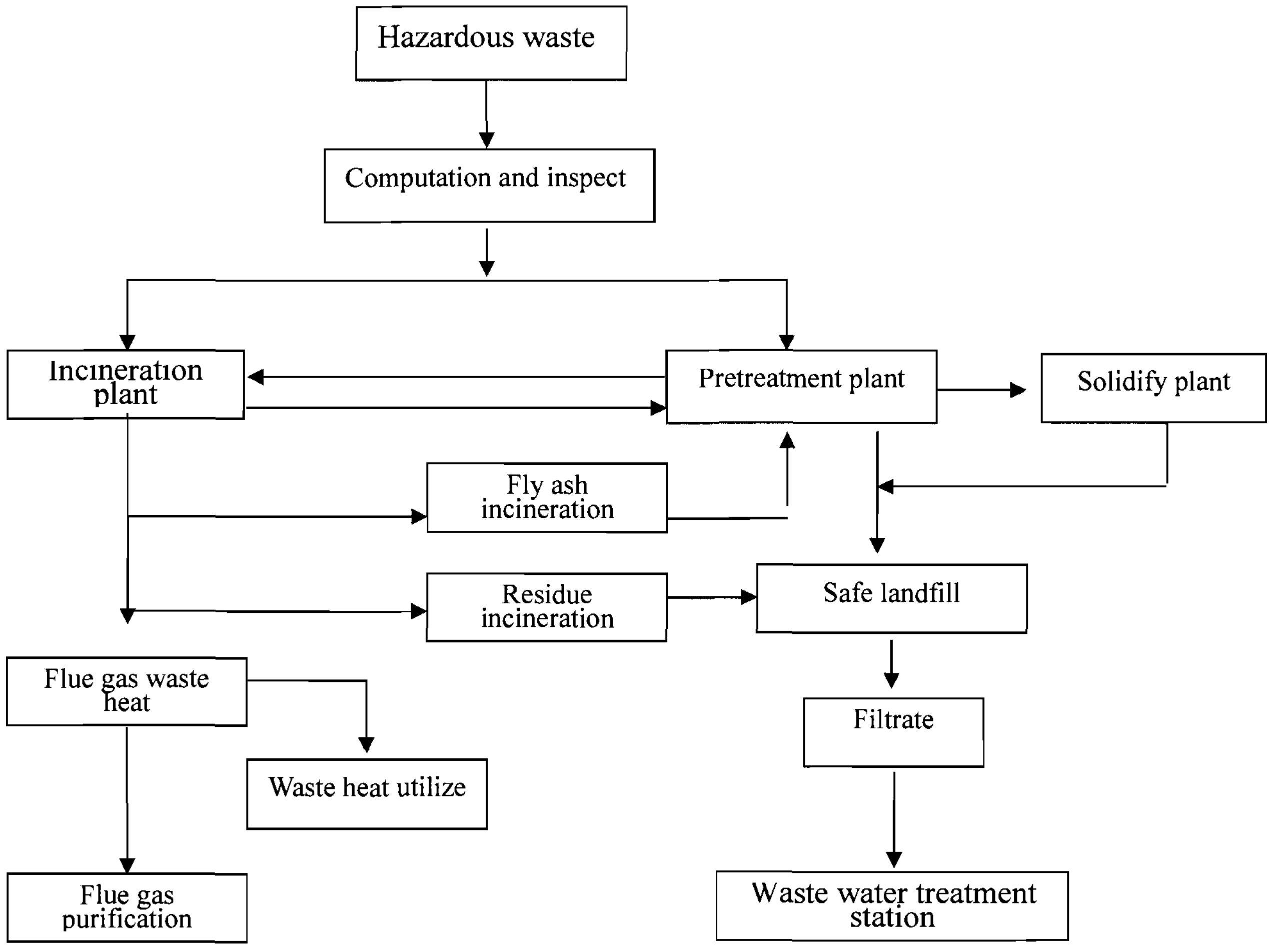


Figure 34 Disposal Techniques Flow Chart of Hazardous Waste

Comment: melting incinerator which is used to melt residue can be integrated utilized directly and doesn’ t need to be filled in safely.

(3) Demand of Operations Management

Personnel Form

(a) Facilities operating unit should have an appropriate waste disposal team composed of professional and technical personnel. The main management, full-time professional and technical personnel (waste disposal technology, environmental protection equipment, thermal engineering, testing laboratories, etc.) should be able to meet the job requirements of waste disposal.

(b) Operators need to run through job training, and hold the appropriate training certificate.

Demand on the disposal unit

(a) Facilities operating unit should have hazardous waste disposal license issued by the state environmental protection department

(b) Facilities operating unit should develop, publish systems perfect waste disposal operation, security and environmental protection management, and a perfect shift relief and operation of a registration system to ensure strict implementation of the transfer of hazardous waste manifest.

Waste pretreatment

(a) As the range of waste types and patterns are various, part of the waste can be directly addressed, as well as some of the waste need to be processed after pretreatment. People should take certain pre-processing measures based on the characteristics of waste disposal facilities and the waste. Pre-crushing need to be optioned on the dedicated site after cleaning exhaust equipment is operated on.

(b) People should deal with semi-solid waste and liquid waste through solid-liquid separation, and the process of reducing the viscosity should be carried out in the steel tank seepage, and the slot should be promptly clean up if there is waste stream spill out of the tank.

(c) Solid waste should be burned after the disposal of compatibility, according to the program through the mixing device compatibility mechanical mixtures of waste. For example, liquid waste should be filtrated or heated, solid and semi-solid should be mixed before throwing into the furnace generally; Due to the limit of the size and heat capacity waste barrel need to be broken in order to install the furnace burning, and medical waste need to be packaged into the furnace.

(d) People must be equipped with a full hood-type air-purifying respirator in the pre-operation processes, and any contact with PCBs waste without protective cases is strictly prohibited.

Operation of molten slag incineration establishment

(a) The waste is transported into rotary kiln incinerator by different feeding systems after storage and pre-treated. For example, solid and semi-solid waste is transported into the incinerator through bridge crane with grab loading method, liquid waste and auxiliary fuel burner is through combustion means, and barrels of waste using hoist way.

(b) Rotary kiln incinerator system is the place where all waste and auxiliary fuel is combusted place which ensure full materials is combusted completely, and has a corresponding transmission and protective measures.

(c)Melting process has two types of utilizing heat, the use of melting heat of combustion of fuel and heating, namely, organic matter in fly ash thermal is decomposed, combusted and gasificated, while the mineral is fused into a vitreous slag at high temperature (1400 °C) of the situation, .

(d) Waste is changed into incineration residues and flue gas into a burning in the fly ash and incineration residue is collected by scraper slag machine after used (ordinary incinerator burning residues required to secure landfill disposal.

(e) As the high temperature, heavy metal content is low, waste heat boiler fly ash can spiral out of ash collected recycled slag machine (only burning furnace slag) through the flue gas after the cooling system, or directly be treated at landfill. Because of high levels of heavy metals, purified flue gas which is collected through the gray ash screw machine shop is evacuated into solidification unit before buried.

(f) The exit flue gas temperature of sec furnace should be required to achieve the network real-time display with environmental management departments, and people should make the whole process of stored records.

(g)The temporary storage of bottom ash and fly ash at the venue should be consistent with the relevant requirements of hazardous waste storage, and the provisions of the factory should be consistent with the relevant provisions of hazardous waste transport management, and strictly apply the factory registration.

Auto-control and online monitoring

(a) Automatic control system is the high pledge of the complete sets of equipment of clinker burning system, which automate the completion of the process equipment or mechanical operation through the automatic control system and electric control system to, so that the completion of the setup process are in accordance with the corresponding function operation, in addition, when there is an emergency accidents, they can be completed entirely through a series of chain process protection to prevent accidents.

(b) The role of gas-line monitoring system is to monitor the harmful components in flue gas by adjusting the amount of agents automatically through controlling system, which can not only guarantee discharge standards, but also make by the Pharmacy to the economy.

(c) The corresponding data can also be transmitted to the local environmental protection departments with relevant environmental supervision and management through the network interface.

The monitoring requirements in the treat-operating processes

In order to ensure the safety operation and management of waste incineration disposal facilities, people should monitor the waste gas, noise, waste water and residue generated in the process, noise. The main monitoring contents and requirements are similar to the disposal of hazardous waste incineration which is not repeated here.

3.3.3.6 Pollution control measures of mechanized chemistry treatment techniques

(1) The BAT/BEP requirements of MCD

Mechanical and chemical disposal technology does not appear in the Convention BAT/BEP Technical Guidelines or in the Basel Convention. MCD, not producing dioxins itself, can be attributed to the incinerating treatment technology accordingly to its properties. However, the waste removal rate of this technology is lower than the heat treatment technology, and its position effect is not stable. The monitoring procedures should aim to serious pollutant from MCD processing. Disposal end products that do not meet the requirements of Convention should be sent to heat treatment or other kind of facilities for final disposal.

(2) System configuration and cell design requirement

The system configuration and cell design of mechanized chemical processing technology is relatively simple. Its composition includes temporary storage unit, feeding unit, drying unit, exhaust gas purification units, grinding damage response element, in addition to material unit, and its technical processes and emplace is as **Figure 35** shows.

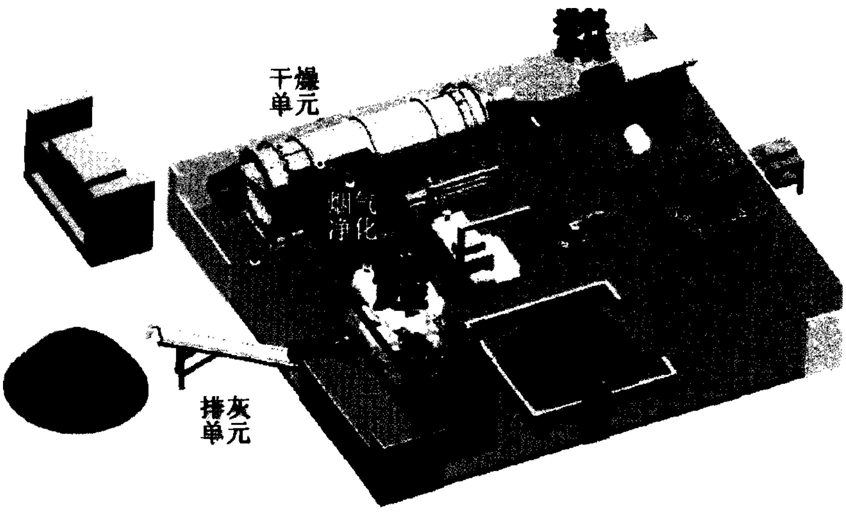


Figure 35 A Layout of Mechanical Chemical Destruction Technology

MCD has the following advantages:

(a) The process is simple, operating condition is mild, energy consumption is small, high efficiency. When using chemical Process Treatment of POPs contaminants, people don't need to do any special pre-processing for waste material, and material mixing, dispersion and reaction processes can be completed in a ball mills which is simple process; Operation can be done under normal temperature and pressure without high temperature and pressure or vacuum and other harsh conditions which is easy to be implement. Machinery and chemical reactor capacity of 2 mill varies due to contaminants, vary in unit, energy consumption is small, cost of processing is low and handling efficiency is high.

(b) The application range is wide, and it can handle a variety of categories form pollution. No matter the contents and forms of PCBs, dioxins, pesticides and other POPs waste category, they can be treated through mechanical chemical dispose without hazards, and this technique is also applied to treat or deal with the high cost of pure PCB oil which contains high concentrations of pesticides, as well as low levels of dioxins in the solid waste, and using mechanical and chemical processes deal with the same cost-effective. In addition, as far as POPs contaminated soil and construction waste, there is no need to conduct pre-enrichment, and people can directly use mechanical and chemical processes in-situ treatment can be achieved harmless purposes.

(c) Security is good, the potential emission of secondary pollutants is small, and it can be effectively realize resource recycling. As the mechanical and chemical processing operations are performed at room temperature and atmospheric pressure in an enclosed system, and there is no gas emission of dioxins and other POPs regenerate in this process, the treatment of waste is thorough which reduce the potential emissions of secondary pollutants, and dehalogenation can be used in metal recycling.

But the MCD technology is based on the generation of Si-O bond arising from reaction of the active center, allowing pollutants to be degraded. In order to achieve treatment effect, people often need to add a certain amount of quartz sand. In addition, when contaminated soil is too high viscosity component, it will greatly affect the treatment effect.

However, the application of technology in China still issue has the following issues to be resolved:

(a) Based on that China is implementing the GEF-type PPW disposal projects in China, and based on the characteristics of pesticides of POPs waste, the technology should be broad-spectrum technology for the application of POPs waste in China which has a wide range of pesticide classes, various components, storage forms, a lot of moisture content is relatively high, not easy to handle and so on.

(b) How to advance the technology with China's existing laws, regulations, standards convergence, and for the government and stakeholder acceptance.

(c) In technical performance, how to explore practical and application scheme considering the characteristics of polluted soil in China in order to achieve the effective convergence between technical and economic, environmental, social and other factors.

(d) In the market-oriented applications, how to find the best starting point to explore practical marketing and applications in order to effectively play the technology in advancing China's pollution control and rehabilitation of soil's role.

Judging from the current pre-study situation, EDL from New Zealand has developed a chemical treatment technology satellites designed to the treatment and rehabilitation of POPs contaminated soil, and this company has put this technique into work to treat and repair polluted soil by POPs in New Zealand, Canada, Hong Kong and other countries and regions of contaminated soil aspects of practical application, and has achieved good governance repairing effect. After initial inspection, as a more mature technology, the technology's application experience has a good reference for the Chinese POPs contaminated soil management, and it is necessary to provide technical support and repair for China POPs contaminated soil treatment by way of bilateral cooperation.

(3) Operation and management requirements

According to foreign application cases, the technology will also produce waste water, waste gas, and noise and so on in the application process.

In order to improve the application of technology in China, we must effectively conform to China's real needs. The technology used should be able to meet the overall human health and the environment protection requirements, environmental standards or laws and regulations, governance, long-term effectiveness and short-term effect of validity, feasibility, cost reasonableness, government departments acceptability for the treatment program as well as the community or residents acceptability for the disposal program and so on. Running management will be related to staffing requirements, pretreatment requirements, pollution control requirements, etc. We propose to explore the application of operational procedures and management measures in China by combining technology applications in the past cases through China and New Zeal experts in close cooperation, combing with the actual demand for contaminated soil management in China, regarding the MCD technology collection features, and basing on current management of contaminated soil in developed countries as the basis, treatment and considering pollution control in the process of remediation as the core technology.

3.3.3.7 Pollution control measures of chemical reduction technology

(1) Chemical Reduction Technology Overview

Chemical reduction technique involves sodium reduction technology (Sodium reduction Technology, SRT) and alkaline Catalytic Reduction (Base catalyzed Destruction, BCD) technology. According to Internationally Applied case situation, two technologies are applicable to PCBs and the disposal of waste containing PCBs in a larger range of concentrations, and also have a good adaptability for POPs waste matrix. SRT and BCD do not appear in Convention BAT/BEP technology guidelines and Basel Convention. They do not produce dioxin by their nature,

SRT's principle is metal sodium reacts with mineral oil used as a solvent to generate free radicals HO, which is very reactive, detachable addition to the pesticide molecule Cl, and generates a non-toxic substance such as NaCl. However, biphenyl substances in pesticides form polyphenylene biphenyl substances, which do not dissolve in the oil phase and settle down. The main reaction is as follows:

$$RH_{10-x}Cl_x + oNa \text{ ----> } NaCl + oRH_{10-x}Cl_{x-1}$$

$$RH_{10-x}Cl_x + {}^oH \text{ --->} RH_{10-x}{+}1Cl_{x-1}$$

- Ensuring adequate supply of electricity;
- All-closed facilities, the dispose workplace should maintain negative pressure.
- SRT needs natrium as reducing agent. However, natrium is hazardous article. The hydrogen produced in the process needs to be removed in time to avoid exposion.

The principle of BCD is that chlorined organic under strong alkaline environment and the role of catalyst, mineral oil as a solvent produced the originally ecological HO that removal chlorine elements in POPs. The main reaction is:

$$POPs + NaHCO_3 \; (1) \xrightarrow[315\text{–}500\ ^oC]{thermal\ desoprtion} condensate$$
$$(2) BCD\ LTR \rightarrow \text{decontaminated soil}$$

Thereby, the BAT of BCD technology can be defined as follows,

- It generally uses water as a solvent. If using other solvents, the solvent boiling point should be 200-500 °C, otherwise it will distilled from the mixture and the failure in the process;
- Alkali concentration should be in the range of 1-20%. But in fact, the amount needed depends on the alkali halide and non-halogenated organic pollutants concentration ;
- It should choose the reaction -pressure and corrosion-resistant cans.

Requirements of BEP:

In the light of different specific circumstances, a set of reasonable and scientific management mode should be explored. With this mode, the whole process of waste management---including waste composition control, waste generation, lassification, packaging, transportation, temporary storage, treatment and disposal--- is able to save energy, reduce consumption, avoid cross-contamination, and reduce emissions and pollution.

(2) System configuration and module design requirements

Chemical reduction dechlorination process is different in accordance with its different configurations vary, but generally speaking, it contains at least the following modules: a temporary single pretreatment units, chemical dechlorination unit, gas purification units, solvent regeneration unit, residue processing unit and so on. Chemical reduction technology provided by Canada Kinectrics crop realizes the chemical reaction between chlorinated organics and alkali metals at low temperatures. The technology is already widely applied in Canada, Japan and Korea apply this technology in dealing with PCBs and waste containing PCBs. It will combine with the thermal desorption technology or solvent-leaching techniques to apply in its specific application process. Studies have shown that the technology is also satisfied with the corresponding removal efficiency for waste containing DDT, pentachlorophenol and other pollutants. But the technology remains untested for China's POPs waste and their corresponding question of the utility in contaminated soil. The main flow is shown in Figure 39.

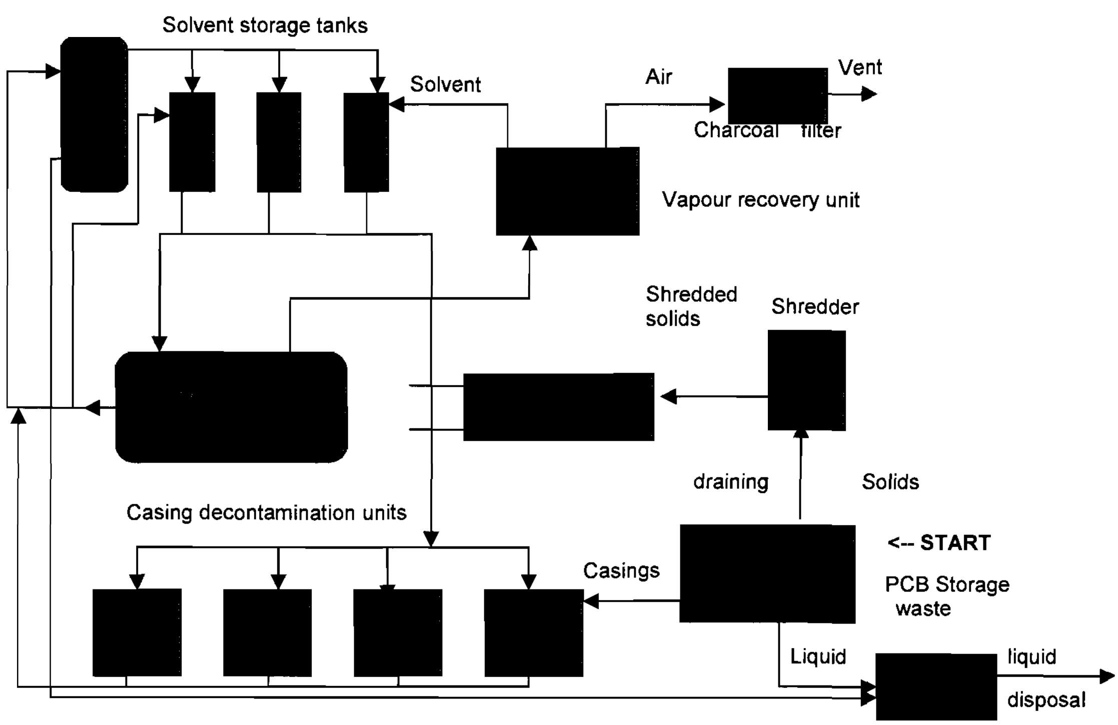


Figure 36 Kinectrics Crop. Sodium Reduction Process Flow

(3) Operation and management requirements

Personnel requirements

As the BCD and the SRT technology are a relatively high degree of automation, the whole operation will only require two people. One completes an automatic control operations and the sample analysis, and another person is responsible for on-site inspection, switches, valves and assistance in sampling work. Therefore, two people must have a professional background of chemical analysis.

The requirements for disposal institution

Hazardous waste disposal agency must have a business license and comply with the appropriate hazardous waste management licensing requirements.

Pretreatment operation and management requirements

Sodium reduction technology are based on different types of pollutants, using different pre-processing methods in order to separate the pollutants from the environment and enrich to the medium can handle range. Major considerations include:

- Contaminated soil can use thermal desorption technology, equipment contaminated by pesticide can use solvent leaching techniques.
- In the design of hazardous waste mixture and processing systems, it should take the nature of the burning of waste, broken way, liquid waste mixing and suction feeding and layout of piping system into account.
- It should be adjusted to the moisture content of waste to be addressed in order to meet the scope of application of the acceptable disposal technology.
- Gross solid substances should be broken and screened handle prior to treatment through that to meet the corresponding requirements of waste particles.

Operating requirements for waste disposal facilities

- Soil must subject to thermal desorption before treatment in order to make the pesticide POPs enriched. Glasses need to be eluted in rotating drums using the full-eluting solvent; elution is treated in subsequent processing. If using SRT treatment, running campaigns should be controlled at 180 degrees. If using BCD technology, the temperature should be controlled at 300-400 degrees. All operations that is possible to directly contact with air should be in a confined environment, and maintain negative pressure. The air should be drawn through the activated carbon adsorption before discharge.
- Conveying, feeding device of hazardous waste shall meet the following requirements: adapting the automatic feeding device, installing the advice of keeping gastightness in feed port in order to guarantee the stability conditions in the furnace. Preventing waste block when feeding, maintaining the feed flow; feeding system should be in vacuum state to prevent the escape of harmful gases; It should fully consider liquid waste corrosion and solid waste particles clogging problem in the nozzle when transporting liquid waste. If using BCD technology, it also needs to adjust the pH value of waste to alkaline; mixture should be heated to a certain temperature under atmospheric pressure or negative pressure or pressure so that contaminants completely dehydrated. For solvent regeneration, chemical reduction processing system should be configured to restore the solvent regeneration unit, clean as a solvent of water and oil,as well as pre-generated wastewater. Pretreated waste solvents produced during SRT technology need to be treated before reuse. The concentrated waste containing POPs obtained

after distillation must be sent to chemical reductive dechlorination unit to carry out the final disposal. Waste solvents of SRT are from the two aspects - chemical reductive dechlorination and thermal desorption. Solvent is oily solvent for dissolving solids POPs such as mineral oil and carbon tetrachloride. Thermal desorption will be added into a certain amount of water as a steam source, evaporating out of POPs contained in the solid debris or soil. In order to increase the effect of steam extraction, It is often added into a certain amount of mineral oil. As the applied gas pressure is about 3-4 atm, the steam can bring out water, mineral oil and POPs together. The oil abstracted from condensed steam through the oil-water separation is disposed using sodium handling device, and the water will be further treated for reuse, excess water is needed to deal with compliance requirements before discharge using to increase the depth of treatment plants.

- Waste solvents generated in BCD technology are water; it uses water as solvent and reaction medium, Generating solid sludge after completion of the reaction. Treated water obtained by centrifugation this solid can be returned after use, excess water subject to further treatment after discharge standards.
- In the residue treatment, the sediment after treated by the SRT contains NaOH, NaCl and polystyrene. But it have not yet been confirmed if it also generates other harmful substances. Residue after desalination can be used as cement kiln fuel or PCBs furnace to obtain the ultimate safe disposal. The sediment after treated by BCD contains water, NaOH, NaCl, non-toxic and harmless petroleum hydrocarbons.

Pollution control

Both of the disposal technologies doesn't release emission. Gas pollution is mainly from the pre-treatment (broken, thermal desorption), and negative pressure operations on feed port and others. Gas is adopted through the activated carbon and exhausted into the atmosphere. If the concentration of POPs is higher, it should be exhausted after being absorbed by the solvent and then filtered with activated carbon adsorption, solvent is regenerated in the dechlorination equipment.

Environmental monitoring

Disposal facilities should be run on a regular basis to monitor the situation to ensure the discharge standards. It mainly includes:

- For DDT, HCH, PCBs, PCDDs and PCDFs, destroy rate should be 99.99%-99.9999%, DEs> 99.999 %,DREs > 99.9999 %;
- Organic chlorine content in treated residue should be below 2mg/kg;
- Generated pollutants in the process of being discharged into atmospheric to should be achieved certain standards.

Above is the overall analysis based on chemical reduction processing technology, but there is not application practical cases on this technology in china, therefore, if wanting to promote the application of this technology, we should carry out case studies on its applicability as such as promote mechanical chemical reduction technology in china in order to its better consistent with China's national conditions, ensuring its maneuverability.

3.3.4 Disposal requirements for pesticides POPs waste and advices on technology application under full sized project framework

3.3.4.1 Requirements Analysis on Pesticides POPs Waste

According to the national hazardous waste and medical waste disposal facility construction plan, there will build 31 provincial-level hazardous waste disposal centers. From a technology point of view, it basically adpoted such a technical line of hazardous waste management and disposal that mainstream technologies are rotary kiln, landfill. In principle, these facilities, particularly incineration facilities can solve the disposal of pesticide POPs, but taking into account the special nature of POPs waste, such as waste composition, technical suitability and so on, need to adopt a special technology for special management, not only by the State to implement the unified organization to waste management and disposal. However, in practical work, incineratin technologies also used in dispose of PPW. Therefore, how to better promote the current project management concept, there are still technology issues. According to China's POPs inventory, based on the above results of technical analysis at home and abroad, as well as the existing disposal facilties and theirs distribution, the total 11,000 tons of pesticide waste disposal should take such a overall stategy that **incineration, cement kiln is the base, plasma is the priciple and chemical reduction is the auxillary**.

It should also be noted that hazardous waste disposal in China has just started, lack of experience, China should first concentrate on demonstration projects construction and demonstration projects should adopt most advanced technologies, by demonstration, foreign advanced and mature technology could be introducted and fully applied. in China . Experience and lessons can be learnt from demonstration projects, which contributes to the development of China-made equipment, standardization work, and to lead and regulate of large-scale projects construction nationwide. In addition, digesting advanced technologies and accumulated good management experiencess should be carried out duruing technology innovation. National conditions of China has great difference with the developed countries and also there is great difference between various provinces and cities ,so it is very necessary to find out suiable technologies for difference provinces. At the same time government should make an effort to foster and support several domestic general contractor for construction projects to facilitate linking the section of design, construction and manufacturing together.

The environmental Administration should as soon as improve and adjust relavant technical specifications and requirements, strengthen environmental supervision, strictly control over releasing of license, strengthen pre-work, improve the surveys waste amount, realize mutual promotion of environmental management and project construction, so that the project can play role after it constructed. Government departments should take the responsibility, attention to preparatory work; play its due responsibility in the siting, financing, fees and charges policy. The government should also have responsibility to select responsible and technology-owned enterprising owners, concerning the technical route check, and properly handle the existing facilities. At present, the government should also strengthen the support for the solid waste management center, and the construction of demonstration project to accumulate experience for other projects.

Environmental technology and environmental protection industries is priority development areas in.National Environmental Protection "Eleventh Five-Year Plan". Pesticides POPs waste disposal involves globlal environmental issue, environmental healty and ecology safe, solid waste and chemicals prevention and control, soil contamination et al, so the goal to develop PPW disposal technology and industry is consistent with Chinese "Eleventh Five-Year Plan".

3.3.4.2 Proposed Pesticides POPs Waste Disposal Technology

Based on full sized project design, it will take three years to address final disposal of about 11,000 tons POPs pesticides waste, and approximately 1,000 tons of waste incineration fly ash (hazardous waste and medical waste) and polit test of PPW disposal by non-incineration technologies. To fufil this goal, this project ithe basic resolution of China's PPW disposal problems. To achieve these objectives, the project should address region-centralized POPs waste disposal issue and dispersed POPs waste disposal separately, and to disposal Stockpiled/circulation area pesticides POPs in a environmentally sound manner and also to meet the requirements of Stockholm Convention and the Basel Convention on the POPs and hazardous chemicals disposal and the Chinese government to hazardous waste management.

To effectively organize the existing disposal technical force, and to clarify PPW disposal tasks, those application principles are put forwards here specifically in order to satisfy the reqirements of the convention and the application mode of PPW disposal in China, and to provide a good base the ultimate goal of the overall project.

- **Disposal arrangement integrated in national planning**

PPW will be integrated within the disposal framework of Chinese hazardous waste including medical waste, to make full use of existing disposal technology, management strength and the laws and regulations to achieve final task of PPW disposal, and keeping in consistence with the objectives of national hazardous waste management.

- **Best environmental benefits**

Give full consideration to the disposal task as well as the special nature of POPs pesticides waste, reasonable arrangements for capital, technology and personnel input to achieve the best possible environmental benefits.

- **Best Convention Implementation Performance**

The technology used and the treatment and disposal planning should meet the requirements of Stockholm Convention and the Basel Convention in a given period of time, striving to achieve the minimum inputs while maximum convention implementation performance.

- **Requirements balanced abroad and home**

Facilities established, regulatory bodies, laws and regulations established for pesticides POPs disposal should be able to meet not only China's "national hazardous waste and medical waste disposal facility construction plan" requirements, but also can manage and dispose of other hazardous waste and medical waste in China.

- **Cost-effective**

The technology used and disposal of strategy should be the most economical, and make sure that each stakeholder can gain benefit.

- **Collaborative Management**

Pesticides POPs management should use established solid waste management system, in particular, in particular, hazardous waste management system, to achieve collaborative management of PPW disposal and other types of hazardous waste treatment and disposal.

- **Market-oriented resources allocation**

In accordance with the principles of market-oriented basis, the organization of state-owned and private disposal, management, and capital strength of state-owned and private should be organized according to the market order to maximize the benefits. On one hand, it is to meet the needs of pesticides POPs waste disposal, while the other to makes the investors to obtain the corresponding benefits.

3.3.4.3 Suggestions on application of PESTICIDE POPS WASTE disposal technologies

The field survey done by compliance office during May and June, 2009 showed that: there are 500 tons of pesticide DDT solid waste in Xintai, 400 tons of agricultural DDT waste slag in Zhangjiakou great wall agricultural chemistry plant and 120 tons of DDT solid waste in Tianjin Chemistry plant, 160 tons of DDT pesticide in Jiangyan, Jiangsu, 300 tons of discarded POPs pesticide in Hubei, and 150 tons of discarded POPs pesticide in Chongqing. Besides, there are 7 contaminated sites, including Xintai pesticide venues with 400-500 tons of DDT waste, removed chlor-alkali DDT plant in Taiyuan chemical industry Corporation, Shandong Dacheng agricultural chemical sites, Jiangsu Changqing agricultural chemical sites, Jiangsu Jintai termite control material factory, Taicang Xintang second chemical plant, Changzhou chemical products factory and so on. The amount of pesticide waste generated can be determined after risk evaluation and monitor. Waste with high concentration clear out of these contaminated sites will be regarded as PPW, and disposed of by one or more alternative technologies and foreign technologies considered to introduce. Distribution for the Domestic Potential PPW and the Disposal Facilities can be seen in **Figure 37**.

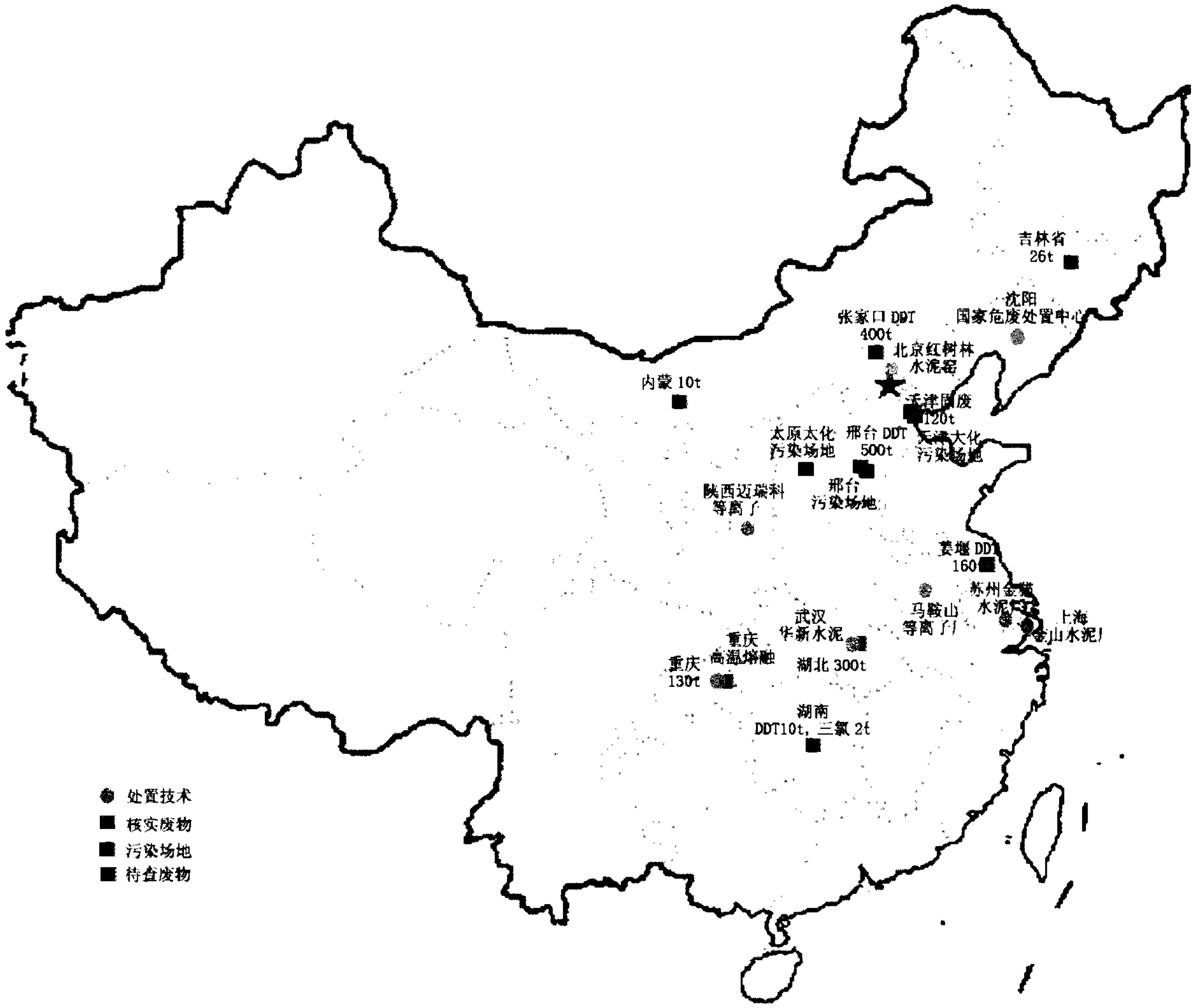


Figure 37 Distribution for the Domestic Potential PESTICIDE POPS WASTE and the Disposal Facilities

For domestic disposal technologies, there're 3 companies using high-temperature incineration, 2 using plasma, 1 using high temperature melting, and 1 using cement kiln. From the perspective of spacial distribution, there's 1 company in northeast, 1 in North China, 1 in northwest, 2 in South China, 1 in Central China, 1 in southwest, and none in other area. High incineration is the most mature technology among these four technologies, suitable for handling any wast of high chlorine, and has received license for hazadous waste treatment (including collecting, storage and disposal). As for four companies which have cement kiln disposal technology, all have received the hazadous waste treatment licence, except Suzhou golden cat Co., Ltd.. The plasma disposal facility in Shanxi, high temperature melting facility in Chongqing and plasma disposal facility in Ma'an shan, Anhui have all been built, though needing further trial operation and performance test to get the licence.

In summary, the following advice is proposed for the technologies selection of the project implemenation at rear phase, based on the disposal technologies application status home and abroad:

(1) Those foreign technologies that have been acknowledged by public, and achieved many application cases, as well as be of good application background,such as incineration, cement

kiln co-processiong, molten/melting, are expected give support preferentially in implementation of full-sized project. However they should be evaluated in a BAT/BEP manner to assure whether meet the requrement of the projectat implementation phase of full-sized project.

(2) Those innovative and commerilized technologies like plasma,BCD, MCD, as a matter of fact,no application cases can be found. It is expected to conduct validity evaluation before decide to use according to the result of pilot test for pesticides POPs in China.

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4. Progress of Risk Evaluation Studies on Obsolete Pesticide POPs Contaminated Sites

4.1 Research on Risk Evaluation Mode and Methodology of Contaminated Sites at Home and Abroad

4.1.1 Requirements of international convention on contaminated sites

As to the control of the hazardous waste' transboundary movement and their disposal, the signatories of Basel Convention has formulated an overall technological guidance for environmentally sound management of contaminated sites that contain POPs or those that are contaminated by POPs.

Stockholm Convention on Persistent Organic Pollutants (hereinafter to be referred as "POPs Convention") aims to reduce, eliminate and prevent POPs pollution and to protect human health and the environment. According to Attachment C, the signatories of the Convention should formulate and implement an action plan aiming to find out the discharge of the POPs materials listed in the Attachment C and then gradually reduce its discharge by the application of BAT/BEP within two years since the Convention entered into force.

While the POPs Convention makes compulsory requirements for the reduction, elimination and prevention of POPs pollution, it also provides opportunity for China to develop international cooperation on this issue, especially with developed countries that have more mature risk evaluation and disposal technologies for POPs contaminated sites, which can help China to learn advanced philosophy, technology and experience in the risk evaluation and management of the POPs contaminated sites, to improve management and treatment skills, to promote the establishment of environmental management system of contaminated sites, to advance the implementing process of the convention and to keep sustainable development. According to the management and disposal requirements for the POPs contaminated sites, an environmentally sound management and recovery support system involving closure of POPs contaminated sites, land application and environmental remediation should be established within 2015.

4.1.2 Summarization of risk evaluation models and methods of foreign contaminated sites

4.1.2.1 America's Risk Evaluation Models and methods on contaminated sites

(1) Management System of Contaminated Sites in America

Since the 1870s, both the congress and public in America have been aware that many environmental incidents and contaminated sites occurred during the industrial process are threats to the environment and the civilians. Therefore, under the national and public appeal, the federal government established and gradually improved related legal regulations, formulating definite rules for the full management process from the discovery of contaminated sites to the final remediation to control environmental pollution caused by improper disposal and illegal discharge of hazardous waste, and by idle waste sites.

The American Congress promulgated Resource Conservation and Recovery Act (RCRA) in 1976, involving such issues as hazardous waste, its storage and management. Its provisions on the hazardous waste management have become an important reference for the management system of contaminated sites. On December 12 1980, the American congress promulgated Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also called Superfund) which was further modified into Superfund Amendments and Reauthorization Act (SARA) on October 1976. Under the guidance of the Act, America has established standard management system of superfund sites from environmental supervision, risk evaluation to site remediation, which provides strong support for the management and land reutilization of contaminated sites in America.

Under the 40 CER 300 (NCP), it requires to develop NPL in the hazardous waste sites that need eliminating. The NPL sites need to have RI/FS. The process includes RI/FS work plan, investigation of the site recovery, sites' RI, sites' exposure or potential exposure, risk evaluation, no-action evaluation and the FS of the eliminating methods (project evaluation).

CERCLA requires implementing basic risk evaluation during the process of RI/FS. The RI process involves identification of site features and disposal investigation. The identification of sites' features includes field investigation, definition of polluting nature and degree (waste's category, concentration and spreading) and confirmation of ARARs of particular chemical contaminated sites in federal or local areas and baseline risk evaluation.

CERCLA's RI / FS process includes baseline risk evaluation of specific site to identify existing or potential threats to human health and environment caused by contaminants that migrate to the surface water or groundwater, are released into the atmosphere, leach through the soil, remain in the soil, and bioaccumulated in the food chain. This baseline risk belongs to the risk of inaction of the public. The use of the baseline risk evaluation including inaction can "help establish acceptable exposure levels for the development of remediation programs." If there are no ARARs (a specific clean-up standards), the exposure level can be equivalent to 10-6 lifetime cancer risk and applicable to known or suspected carcinogens. If there are ARARs, only when there is no risk from the risk evaluation can the degree of ARARs exemption be known.

After the U.S. launched the brown field site project in 1995, the federal government promulgated Act on Small Business Enterprises compensation Liability and remediation of Brown Field Sites (also called Brown Field Sites Act), and further made amendments to the contents of the CERCLA through sponsoring brown field site evaluation and cleaning-up.

Table 32 Related Laws and Regulations of Contaminated Sites in America

Year	Laws and regulations
1976	Resource Conservation and Recovery Act (RCRA);Toxic Substances Control Act(TSCA)
1977	Community re-investment Act (CRA)
1980	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund)
1982	National oil and hazardous substances pollution Contingency Plan (RNOHSPCP)
1984	Hazardous Solid Waste Amendment (HSWA)
1986	Superfund Amendments and Reauthorization Act (SARA) and The first Contingency Planning and Community Right to Know Act
1990	Oil Pollution Act (OPA)
1997	Brownfield National Partnership Action Agreement

1999	Declaration of Superfund revitalization
2000	Brownfield Economic Recovery Plan
2002	Small Business Enterprises compensation Liability and remediation of Brown Field Sites

(2) Positioning and Role of Risk Evaluation

The steps of clean-up and repair of contaminated sites in the United States are as follows:

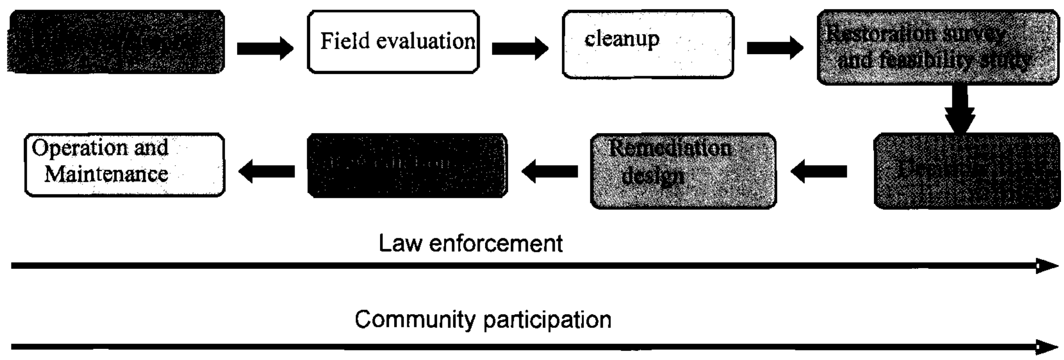


Figure 38 U.S. Clean-up Flow Chart of Contaminated Sites

The laws and regulations of American have provided clear legal standards on the full-process management of contaminated sites. Meanwhile, the risk evaluation of the contaminated sites has been paid much attention, and several soil remediation technologies for the contaminated sites have been testified and applied to certain degree.

The American EPA has also particularly studied the following aspects' influences on the risk evaluation : 1. harmful substance can enter into man's body through various ways; 2. the acceptable amount of the body has to conform to the density of the surroundings; 3. perhaps certain intermediate media like fish has its own factor of biological accumulation; 4. the view that carcinogens have critical value and non- carcinogens have no critical value is still under discussion; 5. in some circumstances, the seriousness of responses is more important than the occurrence frequency; 6. the influences on different organs vary.

In the national linear list, with the principle of priority and the application of structuring method, there are four approaches to assess the contaminated sites, including the transportation of the underground and surface water, soil exposure and the migration of the atmosphere. The results of the evaluation will determine whether the contaminated site should be cleared out. The environmental risk evaluation can help understand the specific definition of certain threats' bottom line and the range of cancer risk.

The environmental criteria defined by America's EPA are based on either risk (risk criteria) or technology (technology criteria). The current technology can meet the technology criteria, but whether there are applicable technologies to meet the risk criteria is uncertain. SDWA criteria can be considered as risk criteria, while major deterioration prevention and CWA's discharge criteria can be regarded as technology criteria.

(3) Risk evaluation models and methods of contaminated sites

The risk evaluation processes of American EPA include risk analysis, risk communication and risk management. The risk analysis is to determine the degree of the risk through scientific method; the risk communication belongs to the social science or the element of public policy and the risk management contains both scientific and social elements. Certainly, the element of public policy in the risk management refers to the American EPA or the laws and regulations of every state, while the scientific elements are the basis of formulating the laws and regulations and developing Acts in accordance with current laws.

The risk evaluation involves the hazard identification (produce which kind of toxicity), appraisal of dosage-response (the amount of the toxicity), the appraisal of environmental exposure (the maximum exposure density of the human body) and the identification of the risk (the risk rank). The environmental exposure is the function of exposure dosage (rank) and toxicity (of chemicals themself). The formula can be: **risk ≈ dosage·toxicity**

The specific composition of chemical substances includes hazard identification and dose-response evaluation. Hazard identification consists of analysis of toxicological data, measurement of the characterization caused by toxic chemicals and evaluation of whether certain sites' (laboratories, workplace) toxicity impact will affect other places (environment).

The analysis of toxicology data is determined by both human and animal experimental data. The human experimental data is the key data obtained through study of case reports and epidemiology, but the definition of exposure is indefinite, the statistical data is insufficient, and also have interference factors. Animal experimental data is obtained based on short-term acute-, medium-and long-term chronic sub-chronic studies of non-carcinogenic toxicity and also through comprehensive studies of carcinogenicity, developmental / reproductive effects and immunotoxic effects in special toxicity research. The data can well define the exposure effects, and easily build causal relationship. However, the correlative between human and animal, the relation between high dosage and low dosage, and the difference between animals' homogeneity and human's heterogeneity are all interference factors that affect the data's validity.

As to the formula's dosage, the identification of the referential dosage and concentration should be considered, whether the daily exposure level could have negative influence on the human beings should be mainly evaluated with an emphasis on awareness of non-carcinogenic toxicity and protection of vulnerable populations. The resource of toxic data is gained through risk information system, mainly depending on the changeable referential dosage, referential concentration, cancer-link curving rate, unit risk, toxic information resources that EPA approved and other files and information in the list.

As to the exposure issue, it needs to determine the human's exposure degree and frequency, whether the exposure cases have high risks or central tendency and whether the exposed public has uncertainty. Hypothesis can be made for the exposure, for example, the land can be used as living, working and entertaining places, and the different the different land uses at present and in the future and different ways of hazardous substances' penetration should also considered and correlation channels should be analyzed.

The formula is as follows: $\text{Dose} = C \times [(CR \times EFD)/BW] \times 1/AT$

Dose represents the amount of daily inhalation of pollutants (exposure); C for the concentration of the contaminated media; CR for the contact frequency of the contaminated media; EFD for the exposure frequency and duration; BW for weight; AT for the average time

The risk identification can be achieved through the comprehensive results of toxicity identification, dosage-response evaluation and exposure evaluation, and the framework of such aspects as risk evaluation, human's health, eco-system and the importance of developing risk. There are two types of risks, that is, individual risk and crowd risk. The individual risk can assess the exposed public's average or medium risk through central tendency and assess the 90-99% of the population's risk through high risk. The population risk is the amount of the potential disease cases (Cancer or non-cancer toxicity) or disease incidents among the exposed population and is assessed as central tendency risk. The number of affected groups in the conclusions is several times than the actual number of exposed people, while important subgroups should be identified.

In terms of cancer risk evaluation, if the cancer risk is 3×10^{-5}, it can be explained that, if you accept that 100,000 people are exposed to pollutants under the assumption conditions, extra three people may get cancer in their lifetime, not particularly pointing to certain people. It is very important to be aware that the risks are actually applied to the entire population areas, rather than a separate entity.

As to non-cancer toxicity evaluation, consider all of the exposed channels, target organs, separation effects of chemical and biological mechanism on the chemicals, as well as toxicological quotient (HQ) is equal to the level of exposure / reference standards. If the toxicological quotient is over 1.0, it means that if people are exposed to the assumed conditions, some people will have adverse health effects (similar to the most vulnerable populations). If the exposure frequency and exposure ratio surpass the reference dose / reference standard, the adverse impact on the population will probably be increased.

The risk evaluation includes the following issues: harmful identification according to the animal data and negative epidemiology data; dosage-response evaluation from high to low dosage through extrapolation method; exposure evaluation of the exposure situation and case analysis through comparison of models and supervision; risk identification through quantitative and qualitative comparison. The risk evaluation is an essential part before clearing and restoring the contaminated sites, and soil disposal technology used in the contaminated sites is key to the action plan for the clearance and remediation.

4.1.2.2 Risk Evaluation Models and Methods of European Unions

(1) Management System of Contaminated Sites of EU

It is estimated that there are 300,000 to 1.5 million contaminated sites in the European Unions. This wide-range estimation is due to the lack of common identification for the contaminated sites, as well as the different acceptable risk levels, protection goals and exposure parameters. Despite that the heavy-industry areas are the largest and the most affected, the contaminated sites in the entire European continent can be seen everywhere. The huge contaminated sites bring potential or practical threats to the underground water, deposit sediment, soil and surface water. Such contaminated sites need complicated and expensive remediation (such as mining sites, asbestos, or more frequent site of large industrial facilities, etc.), and they can become complicated due to the frequent change of owners (past and present), and exploration, accidents and multi-pollutants during the declining industrial period.

Nowadays, the approaches applied by most European countries to the contaminated sites are risk evaluation and management based on different principles, among which include "polluters pay" and "usable". Therefore, the management of the contaminated sites is a practical process conforming to the system and standard. As to the policy aspect, the European Union and its members are making policies to strengthen the management and remediation of contaminated sites to make proper use of the contaminated land; from the perspective of legislation, the European countries that use risk evaluation to manage the contaminated sites have a common framework on the risk evaluation procedure. In these European countries that have had this kind of procedure, the risk evaluation is usually to register, categorize, list and recover the sites and it is conducted step by step. France, Germany and Britain have some related laws and regulations that can be drawn on.

The European Union has made further rules on the risk management of the contaminated sites. The risk management is a decision made for the contaminated sites that are left over by history and need dealing with. Any possible action depends on the basis of the risk evaluation. The risk management based on the risk evaluation includes site investigation, supervision, selection of proper remediation solution and follow-on maintenance. The risk management strategy is to control and clear the contaminated sites or to reduce the polluting level to the acceptable degree and to consider the management of contaminated sites and the decision of the risk evaluation and risk management as a one concept has increasingly

(2) Positioning and Role of the Risk Evaluation

The risk evaluation provides objective technical resources for the unacceptable influences on human's health and environment, aiming to evaluate the demands for the prevention action, because the specific risk evaluation is the precondition for all the prevention actions. If the scientific knowledge is commonly incomplete and uncertain, the risk evaluation is a structural and analytical approach. It is referred to list and assess the data and quantifies the risk through definite way, which enables the conductor to make the most decisive response to the situation that he/she is facing. The conductor can decide which problems need the quickest disposal by considering the risk. The process to make the decision and the following actions are risk management. The decision process based on the risk can provide clear framework for those that participate in the making of decision for contaminated sites, leading them to consider the acceptability of the risk caused by the pollutants before and after handlement and how to effectively reduce necessary risk. There exist uncertainty in the risk evaluation and management and the uncertainty can be decreased through future research. See **Figure 39**.

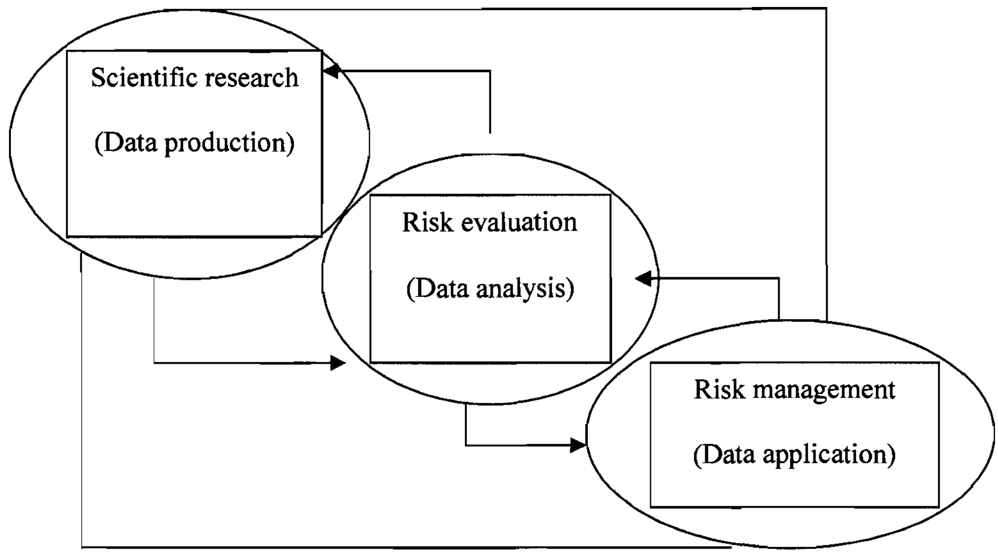


Figure 39 Future Research on the Reduction of Risk Evaluation and Limitation of Uncertainty in Risk Management

After the restoring project, the reutilization of the land will not make it become more sensitive or have any hazardous waste left. If the land becomes more sensitive, the risk evaluation and management must be re-conducted. One purpose of conducting risk evaluation for land usage is to keep sufficient record for the future.

(3) Risk evaluation Models and Methods of Contaminated Sites

The risk evaluation is to study the possible hazardous, harmful and physical effects through analysing the hazard and exposure data. It mainly includes four steps: risk identification, risk evaluation, exposure evaluation and risk description and evaluation. The general method of risk evaluation is on the basis of coexistence of such factors of pollutant source, the potential vector quantity of pollutants transmission and target groups. The lack of any factor is insufficient to decide whether the risk exists. To evaluate the potential influences of the soil pollutants, not only should their concentration be considered, but their environmental behaviour and the exposure mechanism to human's health should be within consideration.

The recipients that need to be assessed include men's health, eco-system, water source and building material. Actually, the assessed targets are those defined during the site-identification process, so as to quantize the acceptable risk intake amount. As to men's health, it contains ADI, TDI and cancer risk in the extra life cycle. As to the ecological aspect, it includes NOEC; as to water source, it includes different protection levels among European countries and as to the building material, the influence of the erosion should be considered and action should be taken to avoid the influence. European countries have different standards on the acceptable or tolerant degree of the risk.

The risk evaluation can be referred as: evaluating a group of sites in order to decide the action or the priorities for the further investigation, like site selection and priority listing; evaluating the risks revealed in single site; defining the clearance standard or action for specific site; gene guide associated with specific media and target; the genetic standard provides sufficient prevention model for specific site; the balance between risk and benefits; thinking of the long-term legal and financial responsibilities for the present or future land owners.

The discrepancies among different levels of risk evaluations in the European countries are mainly reflected in the following aspects: considering the target according to different levels of the risk evaluation, while no need to consider the eco-system or the building material, especially in the preliminary stage; the land use can cause apparent differences of men's exposure, so the healthy risks obviously differ; the exposure parameter, like the exposure period of the life cycle (normally 70 years); the acceptable risk level, for example, as to the cancer risk, the usually used method has no dosage limitation, and the risk of death rate between 10^{-4}-10^{-6} is considered acceptable.

4.1.3 Status quo of the management and risk evaluation of the contaminated sites in China

4.1.3.1 Requirements of Contaminated Sites Management and Risk Evaluation in China

Presently, the general situation of the soil pollution in China is relatively severe. According to incomplete preliminary data, the amount of the contaminated farmland has reached about 150 million mu, among which the farmland contaminated by heavy metals covers $2\times10^7 hm^2$, that contaminated by organics and chemicals amounts for $6\times10^7 hm^2$, that polluted by the sewage has $6\times10^7 hm^2$ while the amount destroyed or engaged by solid waste reaches 2 million mu. Those contaminated farmland engages over 10% of the entire farmland and most are located in the more developed areas.

As a guiding document for China's implementation of POPs Convention, the National Implementation Plan for the Stockholm Convention further defines the implementation goal, strategy and each action, requires establishing and improving POPs control standards and laws and regulations, accelerates the development of pesticide-kind POPs replacements and alternative technology and Dioxin control technology, and nurtures management market for POPs waste and contaminated sites.

According to related requirements of the convention, China will properly update and revise the national implementation plan under the POPs Convention. Limited by such factors as investigative range, research, monitor, replacement and reduction technologies, the list of the POPs pollutants and contaminated sites mainly depends on the limited information and calculation. Besides, the convention will add new POPs categories, and the national plan has also mentioned to formulate and improve related laws and regulations on POPs, and revise and add new contents to the current POPs management document and pesticide-kind POPs list.

The national implementation plans mentions related goals targeted the recognition and environmentally sound management, including establishment of laws and regulations on the environmentally sound management of POPs contaminated sites, development of recognition and risk evaluation of POPs contaminated sites, and formulation of environmentally sound management strategy of POPs contaminated sites. However, currently, there are some gaps between China's situation and the implementation of the convention, that is, lack of recognition and risk evaluation standards for the contaminated sites, lack of related laws and regulations on the environmentally sound management for the

POPs contaminated sites; the uncertainty of the environmentally sound management mechanism of the POPs contaminated sites and lack of economic and technical policies on the environmentally sound management of the POPs contaminated sites.

As to some prominent problems, related departments will take the following actions to promote the implementation process: up till 2010, formulate identification standard of POPs contaminated sites according to China's situation, ecological risk evaluation standard for the POPs contaminated sites and preliminarily formulate information collecting system of the POPs contaminated sites; up till 2015, assess and analyze the current legal system and related enforcement sector's functions of the land application, prevention and management of soil pollution, formulate service agency and legal system on environmentally sound management and recovery of POPs contaminated sites and promulgate Approach to environmental management of contaminated sites, Prevention and Control Act on Soil Pollution and technical policy and Standards on the recovery of the POPs contaminated sites; make a long-term action plan for the environmentally sound management of the contaminated sites according to the investigative results of the contaminated sites, develop risk evaluation for the POPs contaminated sites; determine the priority level for the development of risk management; properly conduct recovery demonstration spots in the contaminated sites.

The National implementation plan stressed the need for studying the biological indicators that reflect the environmental exposure to POPs targeting China's pollution characteristics, human characteristics and living habits, carrying out research on the dose-response relationship of POPs exposure to the ecological environment and human health effects, establishing the standard system safety evaluation for the POPs' effects on human health, establishing exposure models and conducting simulation studies, mainly including impacts of POPs' wide range of migration on the ecosystem, studying the ecological risk of the POPs in the soil, studying the formation and influences of POPs in the water of highly contaminated area, studying appropriate intervention measures and environmental Cost-Benefit Analysis, and so on.

Priority development areas of environmental protection industry in the "National Environmental Protection Eleventh Five-Year plan" include contaminated site remediation technology, which highlighted such aspects as the development of eco-efficiency control and remediation for reducing soil pollution, remediation of soil chemical pollution, and forest revegetation in the mining waste land. In the renovation of the rural environment and requirements for the promotion of a new socialist countryside construction, it also strengthened the prevention and control of soil pollution, including investigation of current situation of the national soil pollution, establishment of soil environment quality evaluation and monitoring system, conduction of remediation demonstration of the contaminated soil.

The moving enterprises must well remediate the soil of the original site and manage the land with excessive POPs and heavy metal pollution in a comprehensive way; and legally adjust the land use when pollution is serious and the land is difficult to repair. In the contents of improving the integrated environmental evaluation capabilities, investigations of the status quo of soil pollution and of the POPs distribution are emphasized. Besides, it requires to regularly carrying out evaluation of environmental quality and ecological changes as well as environmental and economic accounting. As for control projects for chromium residue pollution, it demands for comprehensive management of stockpiling of chromium residue and contaminated soil.

From the "National Implementation Plan", "National Environmental Protection Eleventh Five-Year plan" and conduction of national soil survey, it can be concluded that, presently, there is a big gap between China and other developed countries in the POPs management and disposal, especially in management and risk evaluation of the sites contaminated by obsolete pesticide POPs, which encourages China to do systematic study on the risk evaluation and management of sites contaminated by obsolete pesticide POPs while developing corresponding implementation plan, to propose models and methods of risk evaluation, and to form a relatively complete system of risk evaluation, so as to continuously do effective management of contaminated sites, and ultimately to achieve the elimination of environmental risks through the implementation of the remediation and management projects.

4.1.3.2 Problems of the Domestic Management and Risk Evaluation of Contaminated Sites

At present, relevant laws and regulations for POPs contaminated sites in China are incomplete, and only some laws and regulations reflected the management of POPs contaminated sites.

"Environmental Protection Law" is China's basic law, which states that the land is the element of the environment, and governments at all levels should strengthen the protection of the agricultural environment to prevent soil pollution. The production, storage, transportation, sale, use of toxic chemicals and materials containing radioactive substances must comply with relevant state regulations in order to prevent environment pollution. Therefore, the primary role of the "Environmental Protection Law" is to clearly identify the contaminated sites and soil as the objects of the environmental protection and pollution prevention and control.

“Law of Prevention and Control of Solid Waste Pollution " is a special legislation for solid waste management, and any unit that produces solid waste should take pollution prevention and control measures. Construction of storage and disposal facilities, sites must meet standards for environmental protection, and any unit should take pollution control measures for the waste storage and disposal of facilities and sites.

These provisions, including the management of contaminated sites caused by the generation, storage and disposal of the solid waste, also belong to the scope of the management of contaminated sites, and provide a legal basis for the definition of the main responsibilities for these contaminated sites. As to the cost of pollution control, the Solid Law requires that “prior to the implementation of this Law, the costs of the disposal of the industrial solid waste, their storage and disposal facilities and the safe disposal of the sites which the unit has undone are charged by related governmental department. However, if the unit legally transfer land use rights, the assignee is responsible for the disposal fees. The decommissioning costs of the concentrated disposal facilities and sites for hazardous waste should be withholded and be included in the budgets or operating costs.” This provision provides a reference basis for the establishment of the management funds for the remediation of sites contaminated by hazardous waste in China and, and for the establishment of a clear responsibility-sharing mechanism.

"Land Management Law" is an important law for the land protection, and it provides that "to protect and improve the ecological environment and ensure the sustainable use of land" is one of the basic principles for writing the "general planning for the land use ". Governments at all levels should take measures to improve soil and prevent land pollution. If the digging, collapse and pressure, etc., cause the land destruction, land units and individuals shall be responsible for reclamation in accordance with relevant state regulations. These provisions can be used as principles that should be followed for the prevention of pollution generation, treatment and rehabilitation of contaminated sites.

In the Management Regulations on dangerous chemicals, there are also some provisions that apply to the management of POPs contaminated sites. For example, if the disposal of dangerous chemicals waste and the dangerous chemicals in quantities equal to or exceeds the critical discharge (including the places and facilities), it is listed as major hazard sources; Dangerous chemicals must be stored in special warehouses, private premises or private storage room, and the method and amount of storage must conform to national standards and be managed by specialist. Relevant local governments and departments should take necessary measures to reduce accident loss, to prevent accidents expanding, including such measures as sealing, isolation, decontamination of the contaminated soil. In addition, under the Environmental Impact Evaluation Law, before the remediation and management of the POPs contaminated sites, environmental impact evaluation shall be conducted in accordance with the requirements of the construction project, and environmental protection shall be inspected and accepted after completion of the project.

In the "National category of Hazardous Waste", PPW belong to HW04 class, and the sources generate during the process the production, distribution, preparation and use of regulator for the insecticide, sterilization, weed, rodent control and plant growth. PCB-containing waste are classified as the HW10 class, including the soil and packing material contaminated by PCBs, PBBs and PCTs. Therefore, the contaminated sites within a certain range can be managed and disposed as hazardous waste.

Soil Environmental Quality Standard specifies the maximum allowable concentration of the soil contaminants and corresponding monitoring methods, and based on soil function and conservation objectives, the quality of soil environment will be divided into three different categories, while the corresponding standard is divided into three classes. The first class standard is the limit value of soil environmental quality for the protection of regional natural ecology and the maintenance of the natural background, the second class is soil limit value for the protection of agricultural production and safeguarding human health, and the third is the soil critical value for the protection of the agriculture and forestry production and normal growth of plants. The standard includes two types of POPs substances. This hierarchical principle of classification provides an important basis for the formulation of identification and repair standards for the POPs contaminated sites.

When the pollutants entering the venue reach a certain amount, they possibly enter into the groundwater or even move into the surface water which is a source of drinking water through migration, leaching and other processes. In order to prevent groundwater pollution caused by contaminated soil, necessary means and technical measures must be taken for the repair and disposal of the contaminated sites or contaminated soil. China's "Groundwater Quality Standard" on the groundwater quality indicators can be used as a reference for the repairing of contaminated sites and groundwater.

In addition, China's technical requirements of environmental impact evaluation on construction of hazardous waste disposal facilities include investigation of the soil in the construction sites. The contents of the soil investigation include soil type, soil thickness, soil-forming parent materials and soil texture, soil environmental quality and soil permeability coefficient. If soil pollution exists, the investigation should also include main polluting factors, as well as soil pollution levels. Disposal of POPs waste and site management should comply with this request.

In China's basic system of environmental management, the environmental impact evaluation system, centralized control system and limit control system can have direct impacts on disposal and management of POPs contaminated sites. During the implementation of repairing and treatment projects of POPs contaminated sites, environmental impact evaluation system should be insisted on. Besides, the following procedures should be done: prior to the project, investigate the site; analyze and evaluate the concrete measures' influences on the environment during the implementation process; analyze the economic loss of the environment during the implementation process; ensure that the sites are disposed in an environmentally sound way. Centralized control system and limit control system can also be reflected in the disposal and management of POPs contaminated sites, and the POPs contaminated soil or premises should be managed differently under the different levels of pollution. For that seriously contaminated soil, it should be disposed through ectopic repair processing to eliminate the pollution.

Compared with developed countries, China is insufficient in the risk evaluation model of contaminated sites and construction of base value of risk evaluation, and has not established benchmarking and risk evaluation system for the environmental risk of the soil contaminated sites, which restrict risk evaluation and management of the contaminated sites. At present, China only has a series of basic laws and regulations and standards related to the environmental management and remediation of the contaminated sites, like Solid Waste Pollution Prevention Law of the People's Republic of China, the soil environmental quality standards, risk evaluation benchmarks of soil environmental quality for industrial enterprises, etc. Legal framework based on risk evaluation of contaminated sites has not been established.

By studying the risk evaluation methods for the contaminated sites of the United States and the European Union, using risk evaluation model for contaminated sites, calculating the health risk through the baseline value of the typical soil contaminants of different countries and regions, using the base values (10^{-4}-10^{-6}) and the linear regression of the health risk value of soil pollutants and establishing the quantitative relationship between the above two values, we can study the construction and evaluation of baseline values of the environmental risks in contaminated sites in China and thus provide the basis for our risk evaluation and management and soil quality evaluation of contaminated sites.

4.2 Systematic Framework of Risk Evaluation for Obsolete Pesticide POPs Contaminated Sites

In essence, the management of contaminated sites is a kind of risk management. Under the current technological and economic conditions, the realization of risk minimization of contaminated sites is a fundamental objective for the management of contaminated sites. In order to reduce the environmental risks of contaminated sites, management of the contaminated sites should follow certain administrative procedures, and contaminated sites should be put into the Government's management program. Contaminated sites management process is as shown in Figure 40.

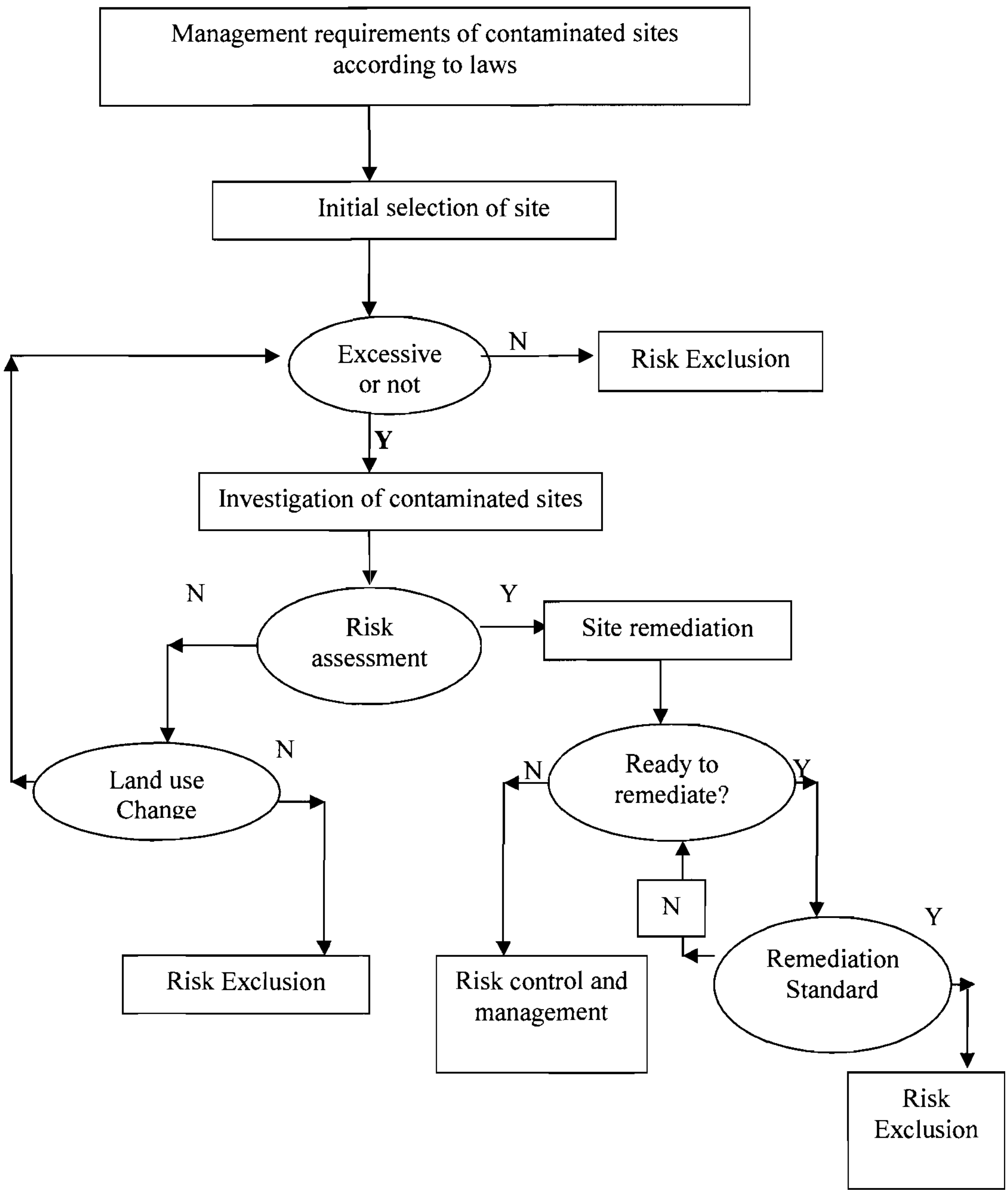


Figure 40 Technical system Framework of Risk Evaluation of Contaminated Sites

From **Figure 40**, it can be seen that the management of contaminated sites is a systematic project, and its core areas should include screening, investigation, evaluation and remediation. How to determine the grading and classification of contaminated land is the key to the management of contaminated sites and the basis for promoting screening, investigation, evaluation and remediation during the management of contaminated sites.

Based on the status quo of the health risk evaluation of contaminated sites and practical problems in China, relevant recommendations should be proposed for the construction of evaluation system of health risk of obsolete pesticide POPs contaminated sites. Related laws and regulations on the health risk evaluation of pollution should be formulated as soon as possible, and the status of the health risk evaluation of contaminated sites should be defined at the national law's level. Besides, Choose a typical contaminated sites and develop demonstration sites for the health risk evaluation, explore risk evaluation method, so as to provide practical experience for the health risk evaluation of the contaminated sites.

Drawing on the experience of foreign countries, gradually establish and improve guides and technical details of the health risk evaluation of contaminated sites, establish a database for the physical and chemical properties and toxicity of the soil, surface water, air pollution and pollutants, so as to provide adequate data for the risk evaluation. The establishment of risk evaluation system of contaminated sites should be combined with health risks and ecological security to carry out research on technologies and methodologies. Framework of risk evaluation technical system of obsolete pesticide POPs contaminated sites as shown in Figure 42.

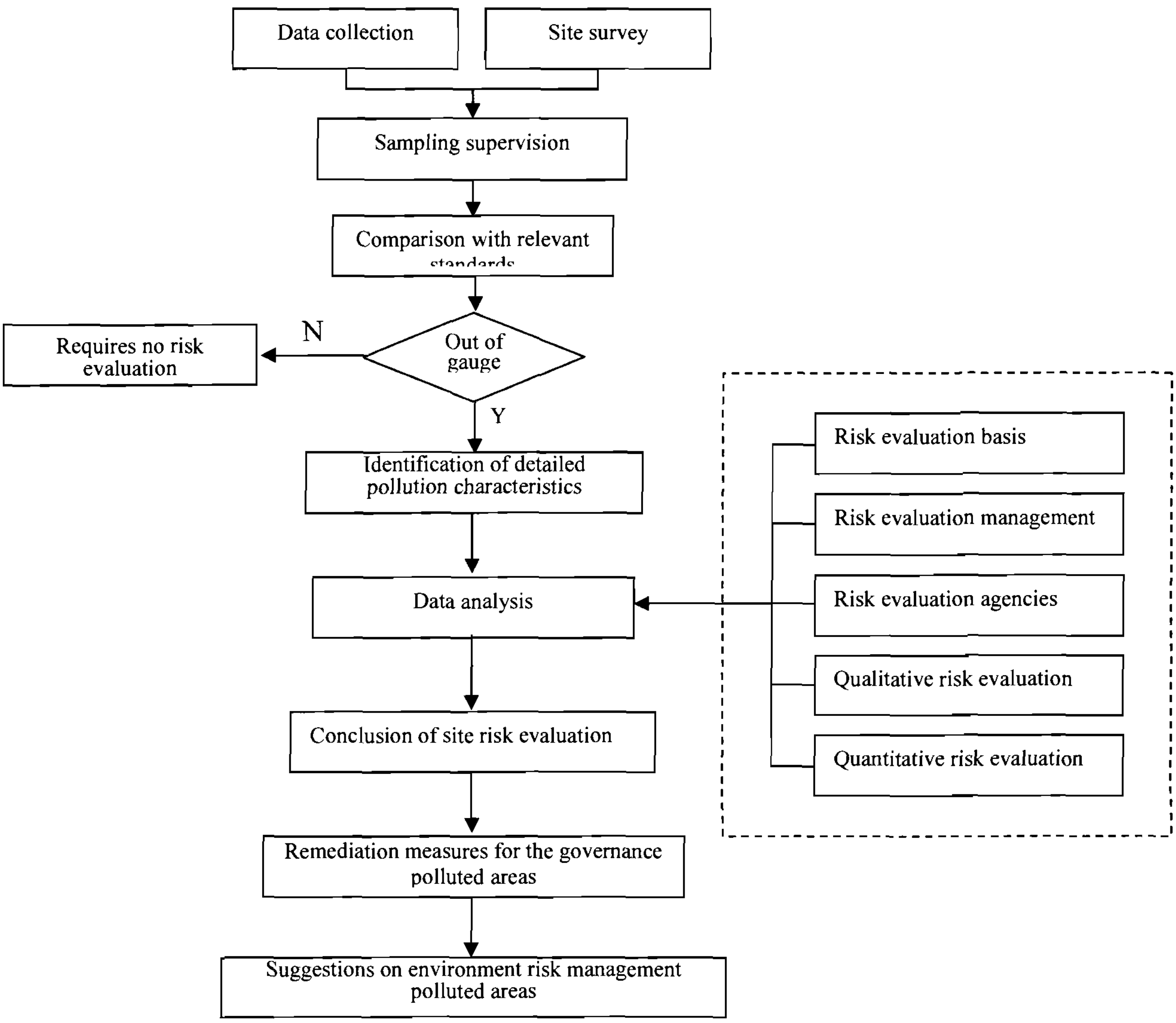


Figure 41 Framework of Risk Evaluation Technical System of Pesticide POPs Contaminated Sites

Proposals for the further improvement of the framework include the following aspects:

- improve policies and regulations related to risk evaluation of contaminated sites
- build the necessary environmental standards system for risk evaluation of contaminated sites
- develop implementation procedures of the risk evaluation of contaminated sites

- build risk evaluation methods of contaminated sites
- Develop guidelines for risk evaluation techniques of contaminated sites
- strengthen institutional capacity-building
- improve the risk management mechanism of contaminated sites
- carry out case studies and system verification of risk evaluation of contaminated sites

4.3 Risk Evaluation Models and Methods of Obsolete Pesticide POPs Contaminated Sites

4.3.1 Risk evaluation basis of obsolete pesticide POPs contaminated sites

Currently, as to the management of contaminated sites, although China has relevant provisions related to the contaminated sites and soil pollution in the Environmental Protection Law, Land Management Law and solid Law, some main policies, regulations and standards for the risk evaluation of contaminated sites are not perfect, and relevant key cycle for the management of contaminated sites is still very weak. Relevant referential standards during the project implementation include:

Soil environmental quality evaluation standards for Exhibition land (temporary) (HJ 350-2007)

- Quality Standard of Soil Environment (GB 15618-1995)
- Environmental quality risk evaluation criteria for soil of manufacturing facilities (HJ/T25-1999)
- Identification standards for hazardous waste - Leaching Toxicity Identification (GB 5085.3-2007)
- Quality standard for ground water (GB/T 14848-93)
- Environmental Quality Standard for Surface Water (GB 3838-2002)
- Ambient quality standard (GB 3095-1996)

4.3.2 Technical methods of risk evaluation of obsolete pesticide POPs contaminated sites

4.3.2.1 Investigation and analysis of the characterization of obsolete pesticide POPs contaminated sites

Through the systematic analysis of a typical case of contaminated sites with the actual situation of China's contaminated sites, investigate and analyze the domestic pollution features of different types of contaminated sites from such aspects as the basic social environment, natural conditions, and the corresponding management measures through separate selection of site contaminated by single POPs, and sites contaminated by both heavy metals and POPs. By summing up the characteristics of domestic contaminated sites, initially form a list of pesticide POPs contaminated sites, including the locations of contaminated sites, possible contaminated area, focused on area of storage points, measures for the original pollution control, site parameters, and exposure factors, etc.

(1) Related data collection

Before risk evaluation of the sites, information related to their history and environmental pollution collected from relevant environmental protection departments units should include:

- Historical background on contaminated sites

- Relevant information provided by environmental protection department;
- National and local's relevant laws, regulations and standards guidelines

Based on the investigation of the above-mentioned documents, analyze the possibility of sites being contaminated and identify the main focus of site investigation.

(2) Site visiting

Send a questionnaire to the previous land users, operators and residents around and also verify the investigation. The field research should ensure compliance with safety regulations, procedures and requirements.

The field research should focus on the collection and observation of the pollution characteristics of contaminated sites, the determination of carrying containers and container damaged condition of relevant pollutants, contaminants, the situation of sewage facilities, the main source of obsolete pesticide POPs of the sites.

- The basic situation of contaminated sites, such as floor plan, GIS images, satellite images and a variety of historical documents and related environmental data of production activities, etc., in order to understand the change of site land-use, and thus analyze possible historical production activities causing pollution;
- During the production, be aware of the existence of such pollution phenomena as running, dripping, draining and leakage.
- Related information and records of use of raw materials, pollution-generating cycle, and status of pollutant discharge, discharge destination and historical environmental incidents during the existing or previous production process.
- Investigate the list of site chemicals, as for a variety of waste found in the sites, ask relevant unit or the parent department for the material source and check relevant records and particularly understand whether it is obsolete pesticide POPs.
- Observe the environmental protection facilities of the temporary dumps for obsolete pesticide POPs, so as to determine whether the facility is perfect, and whether there is leakage, etc.
- Focus on identifying the applying methods, storage methods, storage capacity emissions and handling records of obsolete pesticide POPs
- Hydro-geological data of the site and its surrounding environment,
- Environmental impact report, sewage Declaration and Registration Form, environmental monitoring record and other relevant documents of the construction project in contaminated sites.

The questionnaire shown in Annex 2, investigate the pollution of obsolete pesticide POPs contaminated sites

(3) Relevant investigation of departments

During the field investigation, it needs to communicate with relevant government departments, such as provincial and municipal-level environmental protection departments, scientific research institutions, monitoring agencies, upper management departments, etc., to complement related materials of the contaminated sites, such as the past and present state of the environment of contaminated sites, environmental monitoring records, the sewage situation, potential pollution, records of environmental accidents, disposal of pollution incidents and other related information; meanwhile, ask the planning types and uses of the contaminated sites for the planning department and land department.

4.3.2.2 Qualitative Risk Analysis of obsolete pesticide POPs contaminated sites

(3) Systematically analyze relevant information collected during the conduction of research and investigation

According to the original use of contaminated sites, related production activities and the contents of the original monitoring data, initially identify pollutant types and the general scope of the pollution in contaminated sites, Identify and containers of contaminated materials and carrying container's damaged condition, sewage facilities, the main source of pesticide POPs e waste, to provide the basis for further detailed and standard site monitoring. According to research data, analyze and determine the damage or disturbance of surface soil conditions, describe the scope and depth and understand and summarize the situation of environmentally sensitive factors in and around contaminated sites. Make environmental quality evaluation on the risks produced through soil, surface water, groundwater and the atmosphere with obsolete pesticides POPs.

Meanwhile, focus on the characterization of the surrounding population; define the human activities in contaminated sites and the surrounding areas, including population and population density within and around the contaminated sites, the economic situation of the community, age distribution, the average physical condition, and related exposure time and route of exposure related to contaminated sites.

(4) Identify the environmental characteristics, pollutant concentration and distribution characteristics of contaminated sites through monitoring

Exposure environment identifies the characteristics of exposure the crowd can have impact on, the location of pollution sources, style of the activities, the presence of sensitive factors, and the qualitative analysis of the risk for the existing and future people.

(a) First, based on the original relevant characteristics of the environmental media, carry out standard monitoring and analysis of parameter indicator related to risk evaluation and management of contaminated sites. Based on risk evaluation, focus on near-depth investigation and system monitoring of soil, groundwater, surface water and atmosphere to determine relevant parameter indicator and further reveal the exposure environment.

- Identify relevant indicators of the soil from the physical, chemical and biological aspects

Physical indicators of the Soil include: soil structure, soil texture and particle size distribution, soil thickness, soil bulk density, porosity and pore distribution, soil moisture, soil water retention characteristics, permeability and hydraulic conductivity, soil drainage, soil aeration and soil temperature, etc.;

Chemistry indicators of the soil include: soil organic carbon, total nitrogen and phosphorus, and soil background value of organic matter related to obsolete pesticide, soil pH and so on.

Biological indicators of the soil: biological indicators of soil quality include microbial biomass carbon and nitrogen, potentially mineralizable nitrogen, total biomass and so on.

- Relevant physical and chemical parameters of groundwater

Including groundwater density, the flows, temperature changes, depth of groundwater levels, hydraulic conductivity, aquifer, vadose zone, environmental background values of organic matter related to groundwater and obsolete pesticide POPs and other related indicators of characteristic parameters.

- Relevant physical and chemical indexes near the surface water and the atmosphere

Include such parameter indicators as the distances from surface water to contaminated sites, the flow direction, the supplement relationship between surface water and groundwater within contaminated sites, atmospheric dispersion parameters, the flow direction and amount, and the seasonal change of temperature parameters.

(b) Secondly, through the systematic monitoring for sampling, determine the existence form, concentration, and contamination scope of various pollutions.

- Soil sampling monitoring

Soil sampling, analysis and quality assurance can refer to " technical specifications of soil environmental monitoring " (HJ/T 166-2004). Sampling must be clear about the distribution of sample points, depth and sampling frequency, so as to determine the pollution sources, shape, distribution and the migration and spread of pollutants of the contaminated sites.

Through the soil monitoring, specifically determine the following contents: Pollution sources, the morphology and existing form of specific obsolete pesticide POPs, the nature and behavioral characteristics of the pollutants in the environment, the number and pollution range of heavily contaminated sites.

- Groundwater sampling

Just like the identification principles of soil sampling analysis project, focus on the analysis of chemicals or toxic substances related to obsolete pesticide POPs with within the contaminated sites. In the contaminated sites, according to the relative relationship among sources of pollution, heavy pollution and the flow direction of groundwater, carry out well sampling layout and groundwater monitoring and observe the effects of soil contamination on groundwater. The setup, sampling, analysis, sample transportation and quality assurance of the underground water monitoring wells should refer to “technical specifications of environmental monitoring of groundwater” (HJ / T 164-2004).

(3) Make comparison with the corresponding standards

- Make comparison with national standards

Compare the concentration of obsolete pesticide POPs of the soil from monitoring results with our existing "Environmental quality standard for soils” (GB 15618-1995) and the “Soil environmental quality evaluation standards for land use of exhibition" (HJ 350-2007), and make graphical representation for relevant distribution of excessive land in contaminated sites.

Compare the concentration of obsolete pesticide POPs in groundwater with China's current "Groundwater Quality Standard" (GB 14848-93), and make graphical representation for relevant distribution of excessive land in contaminated sites.

Table 33 Lists of Relevant Standard Grade Limits

Standard names	limit value
Environmental quality standard for soils(GB 15618-1995)	Third grade standard:HCB≤1.0mg/kg,DDT≤1.0mg/kg
Soil environmental quality evaluation standards for land use of exhibition(HJ 350-2007)	Grade A: PCBs≤0.2mg/kg, HCB≤1.0mg/kg, DDT≤1.0mg/kg, Aldrin≤0.17mg/kg, Dieldrin≤0.18mg/kg, Hexadrin≤61mg/kg; B level: PCBs≤1.0mg/kg, Aldrin≤0.04mg/kg, Dieldrin≤0.04mg/kg, Hexadrin≤2.3mg/kg.
Groundwater quality standard (GB 14848-93)	Class Ⅳ water standards:666≤5.0μg/L,DDT≤1.0μg/L
Surface water environmental quality standard(GB3838-2002)	Class III water standards: HCB≤5.0μg/L,DDT≤1.0μg/L,Lindane≤2.0μg/L,PCBs≤0.02μg/L
Identification standard for hazardous waste - Leaching Toxicity Identification(GB 5085.3-2007)	Limits for the concentration of leaching liquid: HCB≤0.5mg/L, DDT≤0.1mg/L, Mirex≤0.05mg/L, Toxaphene≤3.0mg/L,

● Identification of the leaching concentration and concentration of volatile of obsolete pesticide POPs in the soil

Accordance with the "identification standard for hazardous waste - Leaching Toxicity Identification" (GB5085.3-2007), "Identification technical specifications of Hazardous Waste" (HJ / T 298-2007) and the " soil environmental quality evaluation standards for land use of exhibition " (HJ 350-2007), identify the leaching concentration and volatile concentration of obsolete pesticide POPs in the soil

Comparing the determination of the leaching concentration and the volatile concentration with the corresponding "Integrated Wastewater Discharge Standard" (GB 8978-1996), “environmental quality standard for surface water (GB 3838-2002), " Comprehensive Discharge Standard for Air Pollutant " (GB 16297-1996) and the " quality standard for Ambient Air "(GB3095-1996), Namely, for the identified obsolete pesticide POPs substances in the soil, assess whether contaminants are a threat to the environment and human through migration and transformation when the temperature, humidity, precipitation and other environmental conditions change to a certain extent.

(4) Analysis of Environmental Impact

Analyze the possible pollution and corresponding environmental impacts caused by obsolete pesticide POPs of contaminated sites. By comparison the results monitoring with national standards, local standards, namely the comparison of the corresponding background value, determine the degree of pollution. Through Summarization of results of the analysis, if the sampling identified the sites were free from contamination, that further quantitative evaluation can be ignored in the condition that there is no pollution or pollution levels are very low based on the full description of the sampling activities and analytical results.

After the confirmation of the venue there is pollution, to sum up the location and types of pollutants, providing the exact level of pollution and in accordance with the current activities of the venue, the existing sewage situation

4.3.2.3 Characterization of quantitative risk of obsolete pesticide POPs contaminated sites

After the preliminary analysis and research on the foreign models and methods of risk evaluation of contaminated sites, this part will initially establish risk evaluation model of contaminated sites and corresponding parameters of the conclusion, and make further improvement based on the real situation.

The risk impact of the site pollution depends on the environmental pollution degree of the sites and their future use. The direction of future land use should be considered when determining the risk. In general, the future land use can have three purposes: Industrial and commercial land, agricultural land and residential land. When the purpose of the future land use can not be determined, it is proposed to carry out risk evaluation of the sites in accordance with the requirements of residential land in urban areas, because it's the most safe and conservative choice to evaluate the purpose of future land use in accordance with residential land in urban areas.

(1) Exposure Analysis

(a)Exposure analysis includes the identification of potential exposed populations, exposure pathways and exposure degree. Describe relevant situation on how pollutants from the source to potential exposure to the population through the characterization of pollution sources. Analyze potentially exposed populations and environmental receptor, and calculate exposure levels and so on.

The soil contaminants is the soil where human inhales air or the soil dust that human skin has contact with or soil contaminants with direct contact, or contaminants produced by the fruits around the soil areas. According to particular sites, determine the specific route of exposure.

Exposure analysis refers to qualitative and quantitative evaluation of the exposure amount, exposure frequency, and exposure duration and exposure mode and can be summarized as three steps: description of exposure background, identification of exposure pathways and exposure amount. According to collected data and field investigation, analyze the physical characteristics of the site, identify pollution sources and means of pollutant emissions, the path of pollutants migration and transformation, and exposure points and exposure mode of the population, establish all possible exposure pathways of pollutants from the source to the human body, and determine the population exposure frequency and exposure period. On this basis, as for different groups, estimate the pollutant concentrations and human intake of exposure points with various exposure modes according to the exposure paths.

Pollutant concentration of the exposure point is determined mainly based on routine monitoring data or be predicted through model of pollutant migration and transformation. Intake of pollutants is based on different doses, and expressed by weight unit and unit time. Respiratory pathway and dietary means commonly use potential dose to estimate, and the way to skin contact is estimated through the absorbed dose. See Figure 43.

(b) When calculating the average daily intake of residents in the site, it is needed to assume the living or exposure time of the residents in the site. Generally, it can be assumed two situations: 1. under the usual or average conditions, the average living time of residents in a fixed place of residence; 2. the possible maximum average exposure or living time.

(c) Intake calculations

There are many ways for site evaluation, and the ones recommended by this guideline are more commonly used in the site evaluation. During the site evaluation, the evaluators can also adopt other methods based on specific circumstances. The parameters in the annex are mainly the ones used in the formula according to the U.S. experience, and specific site evaluation should be adjusted according to actual conditions.

After determining the pollution sources of sites, analyze the health risks of residents in the site by calculating the intake of soil contaminants of the residents. Generally, the residents ingesting soil contaminants have the following ways: direct and accidental ingestion; skin contact with contaminated soil; inhalation through the respiratory system and eating fruits on the site.

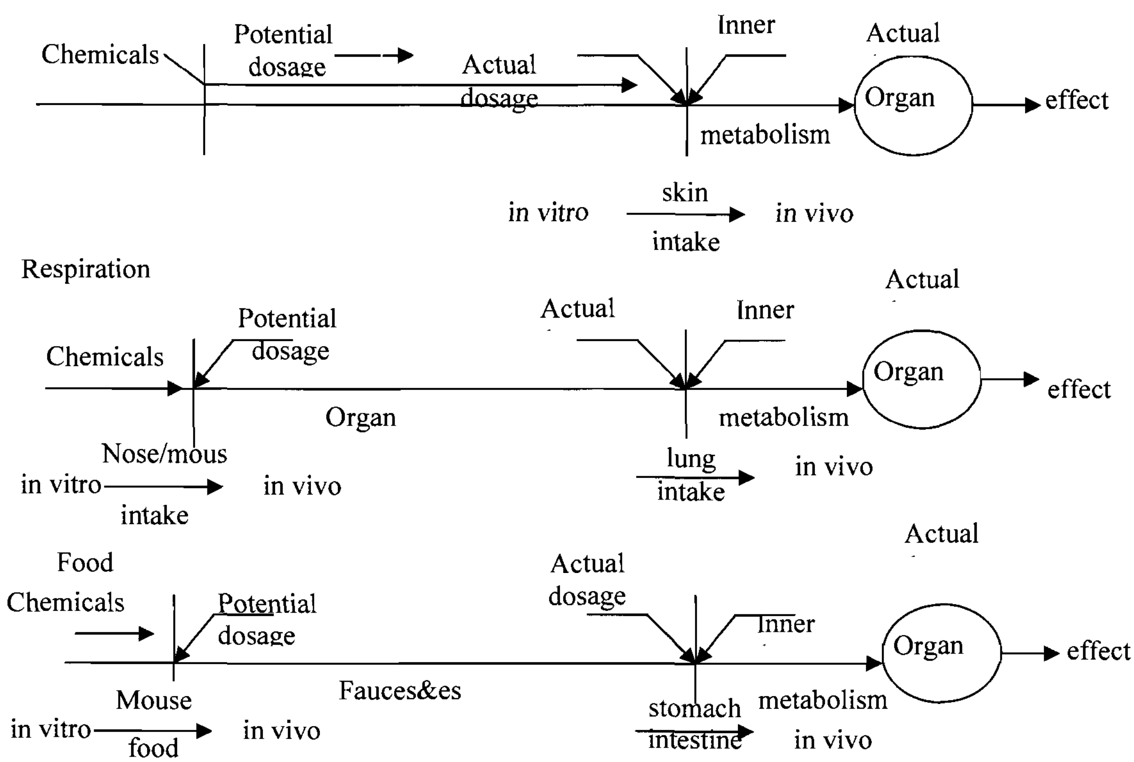


Figure 42 Diagram of Human Ingestion of Contaminated Materials under a variety of ways

When calculating the average daily intake of residents in the site, it is needed to assume the living or exposure time of the residents in the site. Generally, it can be assumed two situations: 1. under the usual or average conditions, the average living time of residents in a fixed place of residence; 2. the possible maximum average exposure or living time. The examples in the table are assuming that under normal circumstances, the average residence time is 9 years, including two years for childhood, seven years for adults. The possible maximum average exposure time is for 30 years, six years for childhood period, and 24 years for adult period.

Exposure calculation parameter values given in the annex mainly refer to the relevant ones of foreign bibliography related to site evaluation. During the specific evaluation process, site evaluation can be adjusted in light of specific conditions

- Direct ingestion of contaminated soil EDI(mg/(kg•d))

$$EDI_{direct\,intake} = \frac{CS \times IR \times CF \times EF \times ED}{BW \times AT}$$

CS-Concentration of chemicals in Soils mg/kg

IR-intake from Soil mg/d

CF-Conversion factors kg/mg

EF-exposure frequency d/a

ED-exposure duration a

BW-weight kg

AT-average time d

Reference value for directly ingesting from contaminted soil is shown in **Table 34.**

Table 34 Reference Value of the Exposure Calculation Parameter When Directly Ingesting into the Contaminated Soil

Parameters	Children (normal situation)	Children (extreme situation)	Adult (normal situation)	Adult (extreme situation)
CS	Concentration of more than 95% cumulative Frequency	Concentration of more than 95% cumulative Frequency	Concentration of more than 95% cumulative Frequency	Concentration of more than 95% cumulative Frequency
IR/mg·d—1	200	200	100	100
CF/kg·mg—1	10^{-6}	10^{-6}	10^{-6}	10^{-6}
EF/d·a—1	350	350	350	350
ED/a	2	6	7	24
BW/kg	15	15	57	57
AT Non-carcinogenic effects	365d/a×2	365d/a×6	365d/a×7	365d/a×24
AT carcinogenic effects	70×365	70×365	70×365	70×365

- Skin contact

$$EDI_{skin\ contact} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

CS-Concentration of chemicals in soils mg/kg

CF-Conversion factors kg/mg

SA-Possible skin area exposure to the soil cm^2/d

AF-Skin Adsorption coefficient of soil mg/cm^2

ABS-Skin absorption coefficient(no unit)

EF-exposure frequency d/a

ED-exposure duration a

BW-weight kg

AT-average time d

Reference value for skin contact from contaminted soil is shown in **Table 35**.

Table 35 Reference Value of the Exposure Calculation Parameter of Skin Touch

Parameters	Children (normal situation)	Children (extreme situation)	Adult (normal situation)	Adult (extreme situation)
CS	Concentration of more than 95% cumulative Frequency	Concentration of more than 95% cumulative Frequency	Concentration of more than 95% cumulative Frequency	Concentration of more than 95% cumulative Frequency
$AF/mg{\cdot}cm^{-2}$	0.2	1	0.2	1
$CF/kg{\cdot}mg^{-1}$	10^{-6}	10^{-6}	10^{-6}	10^{-6}
$EF/d{\cdot}a^{-1}$	350	350	350	350
ED/a	2	6	7	24
BW/kg	15	15	57	57
AT Non-carcinogenic effects	365d/a×2	365d/a×6	365d/a×7	365d/a×24
AT carcinogenic effects	70×365	70×365	70×365	70×365
$SA/cm^2{\cdot}d^{-1}$	1800	1800	5000	5000
ABS	0.1Organic substances 0.001 Inorganic substances	0.1Organic substances 0.001Inorganic substances	0.1Organic substances 0.001Inorganic substances	0.1Organic substances 0.001Inorganic substances

- Direct inhalation of soil dust through the respiratory system

$$EDI_{soil\ intake} = \frac{CS \times \left(1/_{PEF}\right) \times IR \times EF \times ED}{BW \times AT}$$

CS-the concentration of chemicals in soils mg/kg

IR-intake by respiration mg/d

PEF-Particles effluence factor m^3/kg

EF-exposure frequency d/a

ED-exposure duration a

BW-weight kg

Reference value for inhalation intake from contaminted soil is shown in **Table 36**.

Table 36 Refence Value For Inhalation Intake From Contaminted Soil

Parameters	Child (usual condition)	Child (extreme condition)	Adult (usual condition)	Adult (extreme condition)
CS	Concentration of 95% accumulation frequency	Concentration of 95% accumulation frequency	Concentration of 95% accumulation frequency	Concentration of 95% accumulation frequency
$IR/m^3 \cdot d^{-1}$	5	5	20	20
$PER/m^3 \cdot kg^{-1}$	1.32×10^9	1.32×10^9	1.32×10^9	1.32×10^9
$EF/d \cdot a^{-1}$	350	350	350	350
ED/a	2	6	7	24
BW/kg	15	15	57	57
AT non-carcinogenic effect	365d/a×2	365d/a×6	365d/a×7	365d/a×24
AT carcinogenic effect	70×365	70×365	70×365	70×365

- Eating fruits grown on the site

In the villa or rural areas, residents may eat the fruits or vegetables of their own gardens, therefore, it is needed to evaluate the possible risk for children and adults to absorb harmful elements by eating the fruits of their own garden in the contaminated soil.

The amount of chemical elements through consumption of the fruit on the site EDI (mg / (kg • d)) is calculated as follows:

$$EDI_{\text{fruit intake}} = \frac{(CL \times IRL + CFR \times IRF + CR \times IRR) \times (CF \times FI \times EF \times ED)}{BW \times AT}$$

CL-contaminants amount in leafy vegetables, mg/kg;

IRL-Food intake of the leaf, g/d;

CFR-amount of contaminants in fruits, mg/kg;

IRF-fruit intake factor, g/d;

CR-pollutant amount in root vegetables, mg / kg;

IRR-intake of root vegetables, g/d;

CF-Conversion factors kg/g

FI-ratio of the eating amount of the fresh fruits and vegetables to the total income of fresh fruits and vegetables of their own garden;

EF-exposure frequency d/a

ED-exposure duration a

BW-weight kg

Reference value for skin intake from contaminted soil is shown in **Table 37**.

Table 37 Refence Value For Fruit-Eating Intake From Contaminted Soil

Parameters	Child (usual condition)	Child (extreme condition)	Adult (usual condition)	Adult (extreme condition)
CF/mg·kg^{-1}	Concentration of 95% accumulation frequency of vegetable leaves	Concentration of 95% accumulation frequency of vegetable leaves	Concentration of 95% accumulation frequency of vegetable leaves	Concentration of 95% accumulation frequency of vegetable leaves
IRL/g·d^{-1}	17	17	36	36
CFR/mg·kg^{-1}	Concentration of 95% accumulation frequency of fruit	Concentration of 95% accumulation frequency of fruit	9 Concentration of 95% accumulation frequency of fruit	Concentration of 95% accumulation frequency of fruit
IRF/g·d^{-1}	25	25	42	42
CR/mg·kg^{-1}	Concentration of 95% accumulation frequency of vegetable root	Concentration of 95% accumulation frequency of vegetable root	9 Concentration of 95% accumulation frequency of vegetable root	9Concentration of 95% accumulation frequency of vegetable root
IRR/g·d^{-1}	31	31	44	44
CF/kg·g^{-1}	10^{-3}	10^{-3}	10^{-3}	10^{-3}
FI	0.5	1	0.5	1
EF/d·a^{-1}	350	350	350	350
ED/a	2	6	7	24

(2) Health Risk Evaluation

Health risk evaluation makes qualitative and quantitative analysis of environmental and health risks of contaminated sites.

(a) Carcinogenic risk evaluation

Cancer risk evaluation values are calculated through the average daily intake of EDI of the entire life cycle multiplied carcinogenic slope factor (CSF) inhaled directly through the mouth or the skin, namely:

Cancer risk =EDI×CSF

EDI = average daily intake (Generally based on total life-cycle of 70 years)

CSF = carcinogenic slope factor (CSF) inhaled directly through the mouth or the skin

The total risks are all the ones generated by a variety of cancer-causing pollutants through this route. The total risks for the entire individuals are all the ones generated through the above routes. EPA is regarded 10-6 of carcinogenic risk of pollution as the benchmark for soil treatment, and some experts believe 10-6-10-4 are acceptable. As to potential classification of the carcinogenic chemicals and the respiratory slope through mouth, and the skin, see EPA's Integrated Risk Information System (http://www.epa.gov/iris/index.html), where can be found other respiratory slope of cancer-causing chemicals through mouth and skin.

(b) Non-carcinogenic risk evaluation

Non-carcinogenic risk value is defined as the daily intake (an average of the entire exposure period) divided by chronic oral reference dose of every means.

Non-carcinogenic risk evaluation= EDI/RfD

HQ-Risk value

EDI-daily intake (an average of the entire exposure period) mg/ (kg·d)

RfD-Reference Dose mg / (kg • d)

The total non-carcinogenic risks of each chemical substance are the sum of all the non-cancer risk values through a variety of means. Non-carcinogenic hazard is agreed as no harm to sensitive populations in this exposure level. If the exposure level exceeds the extremum (unity), it must be concerned about the potential non-carcinogenic hazard. The non-carcinogenic substances should be distinguished long-term, medium, short-term exposure time. For the Superfund project, (exposure of 7 years to the whole of life) (e.g. 2 weeks to 7 years) (less than two weeks).

In theory, when the non-cancer risk value of the chemical elements is less than 1, they will have significant adverse non-carcinogenic health effects on the residents of the site. For some chronic oral reference dose of chemical substances, see Annex 8. On the EPA's Integrated Risk Information System (http://www.epa.gov/iris/index.html) can find chronic oral reference dose of some other elements.

(c)Carcinogenic quantitative risk exposed to more than one substance

The total risk of each approach is the sum of risks generated b cancer-causing pollutants through this means. The total risks for the entire individuals are all the ones generated through the above means. This is an approximation, ignoring the same carcinogenic possibility arising from various risks. However, because the cancer risk is less than 0.1, the differences between the total risk and precise equation can be ignored

(d)Non-carcinogenic quantitative risk exposed to more than one substance

For the non-cancer risk of materials, any kind of chemical exposure levels bigger than the toxicity value can cause the overall risk value greater than the standard value. Even without exposure of a single chemical exceeding its reference dose, it can cause the total values greater than the standard values.

As mentioned above, the current health risk evaluation methods of contaminated sites mainly include single pollutant risk, multi- pollution risk and multi-channel exposure integrated risk. The total and overall risks are based on the assumption that the pollutants do not have the antagonistic and synergy effects with bigger uncertainty. As to the case of multi-channel exposure, it is needed to calculate the cumulative health risks of the same pollutants to the same population through various exposure pathways. This will not only rule out the influences of different pollutants' antagonistic effect and synergy on the evaluation results, but also can clearly express the cumulative risk of some kind of pollutants on populations, which is conducive to develop targeted pollution control standards.

There exist certain of uncertainty in determining the exposure factor and toxicity reference data. As China has not yet identified a set of exposure factors and toxicity data, the main data is referred to the United States and Europe. Taking into account the differences of exposure time of the population, the skin adhesion factor and exposure frequency, and the uncertainty of combined toxic effects of various pollutants, the evaluation results can be influenced to some extent.

4.4 Implementation Recommendations of Risk Evaluation of Obsolete Pesticide POPs Contaminated Sites Under Frameworkof the Full-Pay Project

Although China has launched revision work of related policies, regulations and standards of some contaminated sites, and improved their management system, the current technology system of risk evaluation of contaminated sites is not yet mature, especially POPs contaminated sites, there are still big gap in the POPs contaminated sites. This needs to establish and improve the framework of clean-up and disposal technical system of contaminated sites in accordance with the current overall international developing tendency of risk evaluation of contaminated sites and drawing on advanced experiences from European countries and the United States from which China can risk evaluation methods and related control measures extract suitable to China's national conditions, so as to explore technological management system of risk evaluation for China's contaminated sites, and make key recommendations for the implementation of risk evaluation.

4.4.1 Risk evaluation procedures of obsolete pesticide POPs contaminated sites

As for the current existing obsolete pesticide POPs contaminated sites, they should be preliminarily listed with different pollution levels based on certain criteria in the whole the country, and made initial analysis of the known contamination characteristics based on the relevant collected information and research, so as to further define the conditions for risk evaluation of obsolete pesticide POPs contaminated sites and relevant follow-on work. The corresponding site conditions and characteristics of risk evaluation are as followed in Table 38 shows.

Table 38 Risk Evaluation Level And The Corresponding Conditions Of Contaminated Sites

Level	Category	Conditions
1	Free from risk evaluation	Small stocks, storage in good condition, complete facilities, perfect management system, no environmentally sensitive spots around the surroundings.
2	Carry out risk evaluation with abilities	Stocks below 10t, no environmentally sensitive point around the surroundings, poor condition of storage facilities.
3	Propose to carry out risk evaluation	Stocks below 50t, good storage conditions, complete facilities, but sensitive to the surrounding environment, storage time is more than 10 years.

Level	Category	Conditions
4	A must for risk evaluation	Stocks above 50t, or complicated geological structure of the storage of point, failed to take effective measures, sensitive to the surrounding environment.

After determining the risk evaluation, relevant work for the risk evaluation can be carried out according to the following procedures.

First Stage – Recognition of the Pollution Features

(1) make background checks of the environmental status quo of the contaminated sites through the collection of information, on-site investigation and other methods, including the project profile of the original site and the surrounding environmental conditions. The project profile includes purpose, size, technology, products, raw materials and layout maps.

Categorize the obsolete pesticide POPs contaminated sites and further identify the soil types of contaminated sites, including soil, construction waste, and cement floor, etc. Determine the features of such aspects as geographic location, regional maps, geo-environmental features, topography, climate factors, surface water, groundwater, soil, air, flora and fauna and other environmental elements, and the background values;

(3)Determine the population distribution of the region, economic conditions, traffic conditions, and other sensitive factors around the surrounding and other socio-economic conditions, including characteristics of the surrounding population healthy conditions.

(4)Carry out preliminary surveillance on the site, and initially determine the pollutant concentration and the pollution areas in contaminated sites.

Second stage - Risk Analysis

(1) Qualitative analysis

Identify the environmental characteristics, pollutant concentration and distribution characteristics of contaminated sites by monitoring. Clearly determine the POPs concentration of the soil, the pollution area and depth in different regions, and determine whether the groundwater has been polluted. Based on the degree of soil pollution and the characteristics of indicators, determine whether there has air pollution. Analyze possible migration means with various environmental factors, the corresponding harm categories and the probability.

(2) Quantitative analysis

On the basis of the systematic analysis of background information and preliminary recognition data of the pollution features, conduct systematic research on risk evaluation methods of contaminated sites in Europe and the United States, and further determine the risk evaluation models and methods of obsolete pesticide POPs contaminated sites. Then, carry out detailed monitoring for the standard samplings of contaminated sites, and calculate and determine the corresponding parameters in the quantitative analysis through investigation and analysis, finally implementing quantitative risk evaluation of the contaminated sites.

(3)Analysis of the environmental consequences

According to the results of qualitative and quantitative analysis, estimate the probability of adverse effects on human and the entire environment caused by corresponding obsolete pesticide POPs substances in the environment during migration and spreading process.

Third stage - evaluation conclusions

Summarize all the information of the site environmental risk evaluation of every stage; analyze the risk characterization of the results; determine the credibility of relevant key pollutants and the pollutant concentrations; sum up the key route of exposure, the credibility of estimates of corresponding exposure calculations and the selected conditions of relevant exposure parameters; describe the carcinogenic and non-cancer risks of different contaminated sites and give qualitative data of toxicity not included in the quantitative evaluation; describe relevant treatment target value for carcinogenic and non-carcinogenic risks caused by a variety of obsolete pesticide POPs substances; finally, form the report of risk evaluation for the commission and relevant departments as reference.

Fourth stage - Environmental Risk Management

Environmental risk management is a process of environmental decision-making and analytical judgment based on the evaluation results. On the basis of the analysis of risk benefit alleviation, select effective control technologies based on appropriate laws and regulations, determine the acceptable risk level and develop appropriate management measures to monitor the implementation. Not only should the important risks that need controlling be determined and method of risk reduction be proposed, but also contingency measures should be made when the environmental risks occur.

Based on the qualitative and quantitative evaluation of various risk factors, and according to effects of risk factors on the region, develop solution for risk control. according to the focus point of risks needing control, identify ways and countermeasures to reduce risks, for example, strengthening control of man-made risks , improving technology and equipment to reduce the risk of the project itself and developing appropriate contingency measures. Technical Overview Of The Management Of Contaminated Sites As Shown In **Table 39**.

Table 39 Summarization Of Pops Contaminated Site Disposal Technologies

Category	Technologies	Maturity	Adaptability	Removal efficiency	Cost
In-situ	In-situ thermal disposal	mature abroad	any depth, and soil, batch operation	below detection limit	90-430 US$/t
	SVE	mature abroad	soil of low clay, high permeability, and high water table	greater than 99.9%	20-50 US$/t
	vitrification	mature abroad	low water content, contamination depth less than 6m	greater than 99.9%	430-950 US$/t
	Bio-venting	new	low clay	greater	5-65 US$/t

Category	Technologies	Maturity	Adaptability	Removal efficiency	Cost
		technology	content, depth less than 1m	than 90%	
Ex-situ	Incineration	mature at home	all liquids solid POPs waste and contaminated soil	greater than 99.99%	260-860 US$/t
	cement co-processing	mature at home	all POPs waste and soil	greater than 99%	100-180 US$/t
	thermal desorption	mature abroad	all POPs waste and soil	greater than 99.99%	86-360 US$/t
	Compost	mature abroad	POPs soil	greater than 99%	127-166 US$/t

4.4.2 Management of risk evaluation of obsolete pesticide POPs contaminated sites

4.4.2.1 Management recommendations for evaluation implementing agency

In order to ensure that the risk evaluation of obsolete pesticide POPs contaminated sites can effectively be developed, and evaluation findings are able to become the direct basis for the remediation and re-use of such contaminated sites, it is proposed to divide the evaluation of contaminated sites into management and evaluation agencies. Management and evaluation agencies should develop evaluation work under the unified guidance and management of Environmental Protection Department. Management body, assigned by the Ministry of the Environment, is responsible for the selection of the management agency, coordination of local management agencies and the identification of evaluation findings. The evaluation body of contaminated sites is the third-party organization, and can be undertaken by units that have technology and personnel identified by management agency or those that hold qualifications for environmental risk evaluation. Evaluation agencies commissioned by the governing body to develop the evaluation of contaminated sites should clearly determine the environmental risk and health risk evaluation conclusion of the contaminated sites and give rationalization proposals for the re-use and remediation of targeted contaminated sites. During the risk evaluation process, sample monitoring data should be provided by relevant units that hold monitoring qualification, shown in Figure 43.

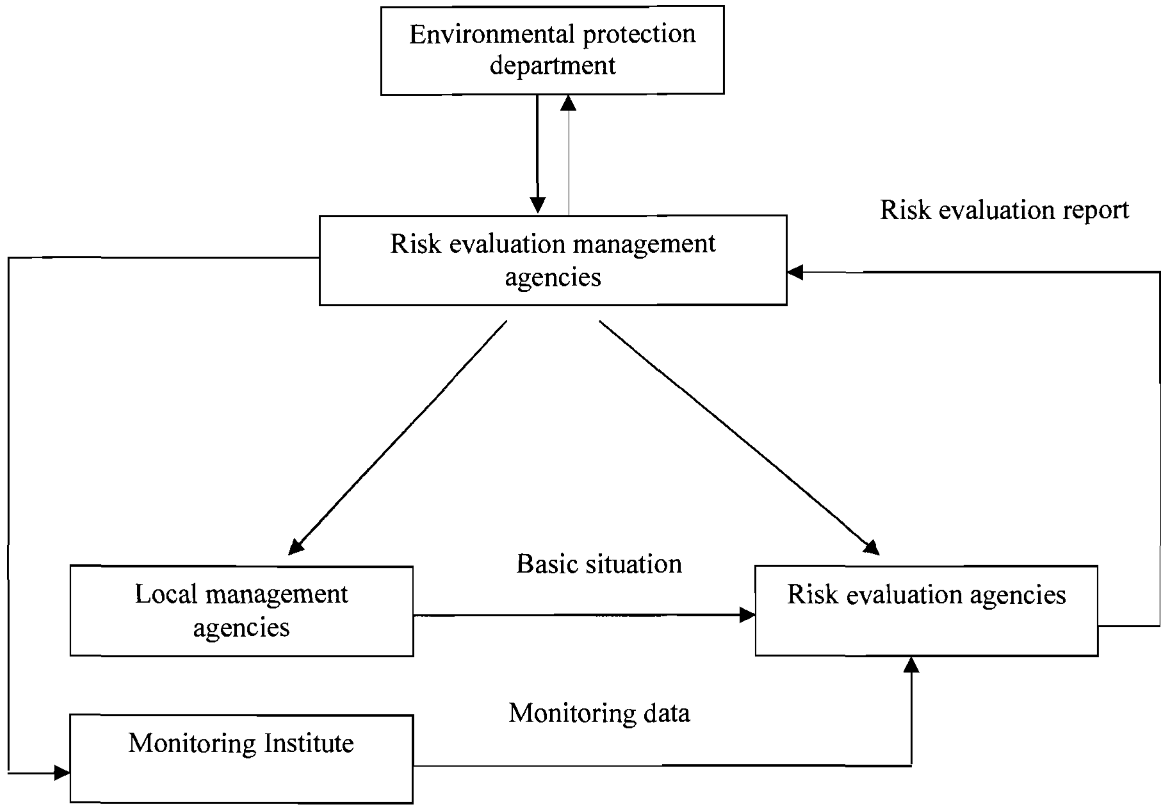


Figure 43 Schematic Diagram Of Evaluation Management And Implementation Agencies

4.4.2.2 Recommendations of evaluation report content

The conclusions of risk evaluation should include such information as the class types, characteristics, morphology, and concentration, form of existence, storage capacity, and storage locations of the identified obsolete pesticide POPs hazardous waste. The soil pollution level in the storage areas contaminated by obsolete pesticide POPs determines whether there exist heavily contaminated soil. After the research and investigation, summarize the waste of the obsolete pesticide POPs and their packaging, calculate the total amount of heavily contaminated soil, and define the amount of the soil that needs management and the range of the safe soil.

According to the environmental quality standards of the groundwater, determine the pollution extent of groundwater; by comparing the concentration of the leaching pollutants in contaminated soil and the environmental quality standards of the surface water, define the risk of surface water pollution, and identify the obsolete pesticide POPs' routes for atmospheric pollution.

After the analysis of the track, characteristic and the associated environmental risks of the pollution, propose relevant measures, including the current pollution control range, repair and managing measures for different soil pollution levels.

The determinate outline of the risk evaluation report based on the current situation of China's management of obsolete pesticide POPs contaminated sites, see annex 2, and the chapters of the risk evaluation report can be appropriately added contents according to the different circumstances of the contaminated sites.

5. Characteristic Identification and Disposal Technology Application Analysis for Incineration Fly Ash of Hazardous Waste in China (Including Medical Waste)

Hazardous waste, due to the characteristic of complicated chemical component, high toxicity and causticity, is the important pollution source of water, atmosphere and soil. Contamination accidents have taken place in many countries because of improper disposal or discharge, for example, during the 50s of last century, in Jinzhou of Liaoning Province China, the disposal of Chromium residue resulted in well contaminated accidents in the scope of about 70 square kilometers, in the 60s, in Yunnan Province, an old lake contaminated by Arsenic residue caused 3000 residents subacute poisoning, and Itai-itai disease (Cadmium pollution) in Japan and so on. All these accidents demonstrate in many countries the issue of hazardous waste has always been prominent (Yuwen Guo, 2006). Incineration is a kind of high temperature heat treatment technology which can apply to various combustive waste. At 800-1000°C, combustible component in waste can react severely with oxygen in the air, and then tune into combustion gas with high temperature and seldom solid residue with steady property. Injurious ingredient in solid waste can be decomposed completely by high temperature incineration, and eliminate pathogenic bacteria thoroughly, especially for combustible cancerogen, virulence pollutant and hypertoxicity organic matter, incineration is almost the only effective processing method. Incineration is the universally adopted technology in the treatment of medical waste. Incineration technology has lot of advantages, such as reducing volume and weight remarkably, fast processing speed and recoverable heat energy, but fly ash produced during the process of medical waste incineration can cause serious secondary pollution to environment.

Fly ash of medical waste incineration is produced in the process of waste incineration, and the residue collected in the gas cleaning system and heat reutilization system, is mainly:

1) Fine particles are blew by air and gas;

2) Combustible material such as insufficiently burned carbon;

3) Matters such as poisonous contaminant-dioxin and furan organic pollutants, produced during the cooling and condensed or chemical reaction by salts and heavy metal which can be volatile at high temperature.

The threat of fly ash to environmental is mainly dioxin and furan organic matter pollutants and heavy metal pollution, dissolved salt pollution. Because waste contain high concentration dioxin-like hypertoxic organic pollutants and heavy metals, these contaminants can be directly into the air, water and soil, causing the direct environment pollution; also can transport among atmosphere, water and soil, leading to indirect contamination of various environmental factors. Dioxin-like and heavy metal pollutants can difficultly or hardly can be degraded by microorganism, intermigration among various forms, it is often difficult to eliminate this kind pollution and it is time-consuming. The ultimate disposal of fly ash is landfill, because it contains high level of dioxin and heavy metal pollutants, if it is to bury directly, by the erosion effect in the natural environment, it can be easy to immerse back into the environment and ground water source and harmful to human (Wang Zhengyu, 2007).

The hazardous waste incineration fly ash is classified as hazardous waste, therefore its disposal method should follow the key control principle of hazardous waste in People's Republic of China on the prevention and control of environmental pollution by solid waste through on 1995 October 30. On account of hazardous waste, this regulation also contains some effective management regulations. These systems include separate collection system, register system of industrial solid waste, solid waste environmental impact evaluation and control measures, the "three simultaneity" system, the charge system for discharging, management system, undertaking treatment within limit system, accreditation system of imported waste, administration substitute performance system of hazardous waste, operation permitting system and hazardous waste transfer report system. The laws and regulations about dangerous waste disposal enacted in other countries are as follows: The Resources Conservation and Recovery Act enacted by U.S. environmental protection agency in January 1983, which contains a series of regulations about the design and operation for hazardous waste landfill; Law on waste disposal enacted in 1975, corrected in 1992 by France; The waste Disposal and Public Cleaning Law, the provision to landfill disposal of waste. To strengthen the control and management of hazardous waste in China, not only is the urgent need to protect the ecological environment and human health, but also carry out the international convention. In article 26 second quarter chapter 3 of the law of People's Republic of China prevention and control of environmental pollution by solid waste promulgated on 1995 October 30, there is a regulation as follows: The administrative department of environmental protection under The state council should collaborate economic department and other relevant departments to formulate the definition of the industrial solid waste pollution to environment, and to make the technology policy of prevention and control of environmental pollution by industrial solid waste, and organize to popularize advanced production technology and equipment.

5.1 Characteristics Identification of Hazardous Waste Incineration Fly Ash (Including Medical Waste)

5.1.1 Review on characteristics identification of hazardous waste incineration fly ash (including medical waste)

There are many factors to impact characteristics of incineration fly ash, including: waste type, composition and properties; the types of incinerator, incineration conditions (temperature, mixed condition, air excess ratio), the types of gas processing system, etc. The harm of fly ash is mainly manifested in the following aspects: pollution of poisonous dioxin and furan organic pollutants, heavy metal pollution and solubility salt pollutant.

On the part of physical characteristics, the total hole area of fly ash is relatively small than that of slag, but the average diameter is higher than that of slag, so it can be speculated material supports smaller resistance during the internal diffusion in fly ash. When SEM is used to observe ESP fly ash, we can find the fly ash contains mass crystal structure and hollow balls, wrapping the spheres within diameter approximately 1 μm or smaller, and parts of them may rupture by compression to be empty. Under high magnification, crystal growing phenomenon can be observed on the sphere surface, at the same time it can be found the spherical particles come into the non-crystalline matrix, so in accordance with this principle, hollow spheres are available to wrap other small size ball. This kind porous structure in fly ash makes it easy to absorb volatile heavy metal compounds, the dioxin, furan organic pollutants, etc, and finally fly ash has high concentration of heavy metal and dioxin.

Incineration fly ash of hazardous waste (including medical waste) has a distinctive feature, the high concentration of dioxin, also contains high concentrations of heavy metal pollutants. Therefore the domestic study on the fly ash characteristics are mainly concentrated on the garbage fly ash, and the characteristics analysis mainly focus on the fly ash physical properties, such as size, specific surface, morphology, etc. On the other hand, the research on leaching metal from fly ashes mainly is the metal type, concentration, while minority literatures study the distribution and configuration of heavy metals. The study on the dioxin in fly ash is less, partly because dioxin analysis needs expensive and complex equipments and sophisticated operators, and the charge for analysis is also expensive (such as the quotation of Jiankeyuan: 8,000 yuan/sample). Furthermore, the incineration fly ash dioxin study on hazardous waste (including medical waste) is less. **Table 40** shows the number of published foreign literature and **Table 41** from the enterprise survey data, both are as follows:

Table 40 Content Of Dioxin In Incineration Fly Ash (Ng/G)

	Electric power plant fly ash	Garbage fly ash	Medical waste fly ash
TCDD	0.03	0.87	19.3
PeCDD	0.1	3.17	52.6
HxCDD	0.06	6.32	86
HpCDD	0.02	12.11	57.1
OCDD	0.01	23.85	2106
TCDF	0.01	6.76	146
PeCDF	0.01	6.86	190
HxCDF	0.01	5.61	156
HpCDF	0	3.05	55.8
OCDF	0.01	1.18	48.9
Total PCDDs	0.21	46.27	2321
Total PCDFs	0.04	23.46	597
Total PCDD/Fs	0.25	69.8	2918

Table 41 Toxicity Equivalent Value Of Dioxin In Incineration Fly Ash(TEQ,Pg/G)

	Electric power plant fly ash	Garbage fly ash	Medical waste fly ash
2378TCDD	0.00	43.34	830
12378PeCDD	0.00	37.10	0.00
123478HxCDD	0.00	18.90	228
123678HxCDD	0.34	60.35	380
123789HxCDD	0.21	20.19	547
1234678HpCDD	0.09	59.64	288
OCDD	0.01	23.83	2106
2378TCDF	0.10	32.71	0.00
12378PeCDF	0.02	21.17	418
23478PeCDF	0.88	375.60	9666
123478HxCDF	0.19	57.60	1602

Based on the last table, incineration fly ash content of dioxin in medical waste is already far beyond that of national emission standard of solid waste. As to the concentration of dioxin, toxicity equivalent value, fly ash content of dioxin from medical waste is 4-5 order of magnitude more than that of electric power plant and garbage incinerator, therefore, hazardous waste incineration fly ash (including medical waste) is a kind of first level dangerous waste.

Table 42 is the dioxin analysis results in the fly ash from a medical waste device. And as shown in **Table 42**, dioxin toxicity equivalent value in fly ash is as high as 27.0 ng TEQ/g, so medical waste incineration fly ash as hazardous waste must be disposed properly, fly ash emissions from this incineration device contain dioxin 2566.1mg TEQ/year and the capacity of treating medical waste is 400 kg/h.

Table 42 Dioxin Analysis Results in the Fly Ash from Medical Waste Device

	1# analysis result ngTEQ/Nm^3 ng/g	1# analysis flow Nm^3/h	output flow in 1# analysis mgTEQ/year	2# analysis result ngTEQ/Nm^3 ng/g	1# analysis flow Nm^3/h	output flow in 1# analysis mgTEQ/year
First sample after heat exchanger before half-dried	130.0	4365	2247	79.0	5745	1797.3
Second sample after heat exchanger before half-dried	130.0	4156	2140	-	-	-
First sample at chimney site	74.0	6573	1926	1.9	7042	53.0
Second sample at chimney site	42.0	3727	620	4.3	2190	37.3
Chimney discharge as incinerator suspending	91.0	4197	1512	-	-	-
Fly ash(ng/g)	21.0	24 kg/h	1996	27.0		2566.1
residue (ng/g)	0.003	100kg/h	1.2	0.03		10.7
Operating time (330 days,12 hours/day)	3960					
Input weight kg/h	400					

Heavy metal is the main harmful inorganic matter in fly ash. Heavy metal in waste after high temperature burning, can be changed by phase, increasing the dynamic behavior, and through the particulate formed, with the change of external environment, leading to heavy metal concentrated on particle surface. The main reaction methods include evaporation in heavy metal; transmit among heavy metal particles, condensation of heavy metal steam, and coacervation of heavy metal granular, steam and sedimentation of granular and chemical interaction. By the mechanism of volatile-condensation, we can learn the metal distribution, perhaps on maternal particles or on the surface. And the main cause of this condition is the boiling point of metal. The elements contained in fly ash can be divided into four classes by the boiling point :(Li Jianxin, 2006).

The first class: Al, Ba, Ca, Co, Fe, Mn, Mg, K, Si, and Ti. These elements have high boiling point. In the combustion process, they will not volatilize, so they deposed few on the surface of fly ash. So this kind of elements is mainly distributed in the fly ash matrix.

The second class: As, Cd, Cu, Pb, Sb and Zn. These elements volatilize in the combustion reaction, these metal or its compounds will condense on the fly ash particles surface when combustion emissions come out of incinerator. Due to their high volatile, the contents in the furnace are small too.

Third class: Hg, Cl, and Br. Such elements are in gas phase during the whole combustion process. In the combustion process, they also can produce volatile reaction, but can not be cooled at the condensation section.

Forth class: Elements may also have the properties contained in the above classifications.

By the classification, the common harmful heavy metals existing in fly ash as Pb, Zn and Cd, belong to volatile metals.

As the incinerator fly ash collected in bag filter, for example, heavy metals content, particle size distribution characteristics and heavy metal content distribution characteristics in different particle size range for fly ash were studied, and the results are shown in **Table 43** (Liu Fuyao, 2007).

Table 43 Heavy Metals Content In Fly Ash (Mg/Kg)

Type of metal	Cu	Zn	Pb	Cd	Ni
Content of metal	80	6210	800	24	360

(1) The highest content of heavy metal in fly ash is Zn, followed by Pb, Ni and Cu, and Cd is the lowest one. This is related to heavy metal elements and the boiling point of compounds and the chlorine content in waste components. The lower the boiling point of heavy metal is, the higher the content of heavy metals in fly ash is; the higher the chlorine content in waste components, the higher the content of heavy metals in fly ash. Therefore, for high chlorine amount of medical waste, in China the content of heavy metals in fly ash has far exceeded the toxicity identification standard of hazardous waste leaching.

(2) The majority of particle size distribution in fly ash is the particles with larger diameter, particle size above 10 μm accounts for 80.6% of the total of fly ash, while the proportion of small size fly ash is smaller.**Figure 44** shows the mass distribution of the fly ash within the scope of different particle size.

(3) The contents of heavy metal elements in different sizes fly ash each are not identical. With the fly ash size larger, the contents of heavy metals approximately decrease. The content of heavy metal in small size fly ash is large than that in large size fly ash, but due to the small size fly ash taking the smaller proportion, the corresponding heavy metal content is not large either.

(4) Changes amplitude of each metal in different particle size fly ash is different, metal particle contents of Zn, Pb and Ni decrease fewer with the particle size increasing, while the content of Cu and Cd heavy metals decrease much more as particle size increase (Liu Fuyao 2007).

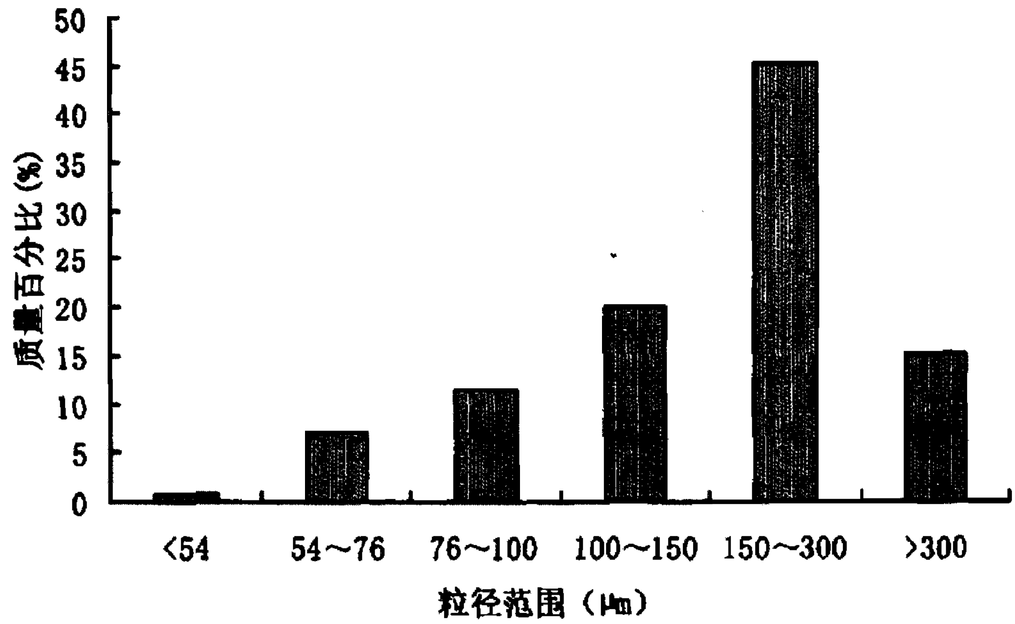


Figure 44 Mass Distribution of Fly Ash in Different Particle Size Range

Leaching-out toxicity analysis result is to determine whether the fly ash is hazardous waste, leaching-out toxicity results for incineration fly ash of medical waste are as follows:

(1) With GB and TCLP methods, leaching experiments of heavy metals in fly ash, showed similar discipline, that means metal leaching rate of Zn highest, followed by Cd, Pb and Cu, and Ni with the lowest leaching rate. But when using TCLP leaching method, we found leaching rates for each heavy metal are higher than those in GB method. This is because TCLP leaching method needs more rigorous conditions and more strict toxicity identification requirements.

(2) Leaching concentrations of Zn, Pb and Cd heavy metals from fly ash are higher than the leaching-out toxicity identification standard from hazardous waste. We must carry on the harmless treatment.

(3) With fly ash size increasing, leaching contents of heavy metals shows a trend of decrease, but leaching changes amplitudes for each metal from different particle size fly ash are different. Heavy metal Ni has the greater variation, the highest leaching quantity (54<μm) is 1.24 times to the lowest one(> 300μm); leaching amount of heavy metal Pb in different particle size fly ash differs least, and the highest leaching quantity (54<μm) is 1.07 times to the lowest one(> 300μm).

(4) As leaching time increases, heavy metals leaching concentration and leaching rate have a trend of increase. Zn is easiest to leach with leaching rate 71.56%;while heavy metal Ni has the lowest leaching rate, only 1.11%. The peak leaching ratios of other three heavy metals Cu, Pb and Cd, are 9%, 23.7 % and 69.58%, respectively.

(5) As the increase of the liquid-solid ratio, leaching concentrations of heavy metals decreased gradually. More than 40 in the liquid-solid ratio, this kind of change gets gently. This shows when the liquid-solid ratio is more than 40, it influences the leaching

concentration less. But the leaching rates of heavy metals as the liquid-solid ratio increases were increased. Cd has the highest leaching rate, that of Zn is second, in the liquid-solid ratio of 80, they are 86.67% and 73.82%, respectively. While Ni with the lowest leaching rate, is only 2.14% at peak.

(6) Initial pH change of leaching rate impact on the leaching rate of heavy metals is similar to that impact on leaching concentration of heavy metals. With the increase of the initial pH value, leaching concentration and leaching rate of each metal have a trend of decrease (Tan Zhongxin, 2008).

In general, heavy metals under the acid condition, are easy to leach, while leaching less in alkaline environment. Among them, Zn is easiest to leach out, and the leaching rate is as high as 76.47%; second one is the heavy metal Cd, with leaching rate 71.25%. These two kinds of heavy metals are easy to leach after soaking in landfill leachate, and then endanger the environment.

5.1.2 The harm of incineration fly ash hazardous waste (including medical waste)

Hazardous waste (including medical waste) contains all kinds of metals such as Cu, Zn, Pb, Cd and Ni etc, in burning process they will not be destroyed or regenerated, and finally be distributed on fire wall ash, gray, bottom ash and fly ash. As to the dioxin, enrichment of dioxin in fly ash is more than that in bottom ash, smoke and fire wall ashe; to heavy metal, heavy metal enriched in fly ash has longer residence time in the atmosphere. Dioxin and heavy metals are difficult or cannot be decomposed by microbiology, and can be enriched in microbiology, leading to cumulative effects or other more harmful compounds. In the environment, dioxin and heavy metals will transmit by geological and biochemical double circular, to harm human through the channels of atmosphere, water and food. Dioxin and heavy metals produce negative impacts on human body, and the mutation, carcinogenic and teratogenesis role to tissue and organs. At the same time, burning changes the type of heavy metal, and makes it in the easier transferred form. The furnace wall ash, fly ash and bottom ash are the carrier of dioxin and heavy metals and their compound, the content of heavy metals and dioxin are lower in furnace wall ash and bottom ash, while the contents of dioxin and heavy metal in fly ash are higher than those in bottom ash and furnace wall ash. Therefore, the content of dioxin and heavy metal in fly ash is relatively high, if the fly ash is directly landfilled, these pollutants are likely to re-enter environment, and by the effect of geology and biochemical role, these pollutants will cause great harm to the environment, and eventually harm to humans. (Peng Zheng, 2003; Zhongcan Yang, 2007).

5.2 Disposal Technology Evaluation of Hazardous Waste Incineration Fly Ash (Including Medical Waste)

5.2.1 Hazardous waste incinerator fly ash (including medical waste) disposal technology overview

At present, the fly ash treatment process used mainly include: (1)Cement solidification, asphalt solidification, melting solidification, chemicals solidification /stabilization and so on. The products of solidification/stabilization treatment can be landfilled or resource recycling, if which are satisfied with leaching toxicity standard or resource recycling standard.(2) Extracting heavy metals from fly ash: acid extraction, alkaline extraction, biological and biological agents, high temperature extraction and so on. Extracted heavy metals can be utilized as a resource. Solidification /Stabilization, as one of main treatment methods of toxic or hazardous waste internationally, have been the rapid development since the 1980s. The purpose of solidification /stabilization is to make all pollutants in hazardous waste present chemical inactive or tolerant, facilitating transport, utilization and disposal. Heavy metals may leach easily from incineration fly ash through weathering and erosion under natural conditions because of non-degradable nature of heavy metals contained in medical waste incineration fly ash. It will make a great impact on surroundings if this incineration fly ash are directly landfilled or used as construction timber. Therefore, Medical waste incineration fly ash must be placed on pre-treatment prior to disposal at the landfill, in order to prevent secondary pollution.

5.2.1.1 Fly ash solidification/stabilization technology

(1) Stabilization/ solidification technology principles and basic requirements

The primary purpose of Hazardous waste stabilization / solidification treatment is to make all kinds of pollution components contained in the hazardous waste present chemical inactive or tolerant, so as to transport, utilization and disposal. Under normal circumstances, the stabilization process is to choose a suitable additive, which mix and react with the waste in a specific operating conditions, reducing the toxicity of pollutants and the mobility from the waste to the ecosystem , so that harmful components (such as heavy metals)in the waste present chemical inertness and Lower activity. Thus it is a method of making pollutant fixed in whole or in part on supporting media and binders, pharmaceutical stabilization method stabilize hazardous constituents in the waste more through chemical methods. Solidification Process is a use of additives (such as cement) to change the engineering properties of waste (such as permeability, compressibility and strength, etc.) process. Solidification can be considered as a particular stabilization process but also can be understood as a part of stabilization, but there are conceptual differences between both. Solidification method includes harmful components of hazardous waste mainly by physical method to achieve the purpose of solidification. Whether stabilization or solidification, the aim of both are reducing waste toxicity and mobility as well as improving the engineering properties of the object being processed.

The basic requirements of stabilization/solidification are:

- Solidified body formed by solidifying treatment of hazardous waste should have better anti-permeability, anti-leaching resistance, wet and dry, anti-freeze-thaw sexual and adequate mechanical strength, etc., preferably as a resource to be exploited, such as making Building the foundation and embankment materials, etc.;
- Material and energy consumption must be low in the solidification process, solubilization ratio (that is the ratio of the solidification body volume and the volume of waste solidified) should be low;
- solidification process is simple, easily operated, there should be effective measures to reduce the escape of harmful substances;
- solidification agent is of abundant source, cheap and easy to get;
- Treatment cost is low.

Most the requirements above are Principled. In fact, none of solidification/ stabilization methods and products meets these requirements. However, if the result of its comprehensive comparison is still better, it can be applied and developed in practice.

(2) Cement solidification technology

Cement is an inorganic cementing agents, which can form a hard cement blocks through the hydration reaction, can gravel so that firmly bond gravel and harmful ingredients together. The principle is that, heavy metals can be solidified into the fly ash through the physical containment and chemical solidification of cement hydration products; thus reducing its permeability to achieve the purposes of stabilization and detoxification.

Cement solidification is a commonly used method of converting toxic hazardous solid waste into non-hazardous substances. Cement is one of the most commonly used stabilizers of hazardous waste. The technology is mixing the waste with cement and form hard cement solidification body through the hydration reaction so as to achieve the purpose of reduction of hazardous constituents leaching from the waste. The actual cement solidification process is very complicated and has not yet a thorough theoretical explanation.

Generally, the mechanism is that the cement hydrates form a solid solution with the hazardous substances through the cement powder calcium silicate hydrate colloid adsorption on toxic substances, thus binding hazardous substances within the hardened cement organization. The basic principle is to reduce the surface area and reduce permeability through solidification inclusion to achieve the purpose of stabilization and detoxification.

Many varieties of cement can be used as solidified agents, usually including ordinary Portland cement, slag Portland cement, volcanic gray Portland cement, cement and zeolite cement alumina.

Cement Variety Selection bases on the solidified waste type, nature and the performance requirement of the solidified agent.

There is also research showing that of cement matrix solidification / stabilization mechanism of the following(heavy metals may be linked with OH-or silicate to form calcium salts because of high pH of the cement paste , adsorbed on high surface area of the C-S-H particles and into the crystal structure. Yousuf et al. found that, in the hardening of cement C-S-H structure, Zn will replace the Ca in the C-S-H or reaction with Ca on the C-S-H surface to form oxides of containing Ca and Zn. Pb is commonly found on the surface of cement clinker particles and inhibits the hydration of cement, which is mainly due to Pb compounds such as carbonate, sulfate, are insoluble while the surface energy are low. Cu is usually formed insoluble sediments on the surface of cement particles, thus delaying the hydration of cement. Lin et al. studied on CuO binding mechanism in the CZS hydration system, and found that some of CuO was bonded by CZS through physical interaction, while the majority formed a compounds containing Cu-Ca-Si. Cr is absorbed into the hydration products, particularly in the C-S-H gel. , However, Cd was precipitated and incorporated into the Ca (0H) 2. Due to the special nature of the composition of waste, Cement curing process often encountered mixed uneven, premature or late solidification, difficult operation control, high leaching rate product, the lower the strength of solidified body issues. And the fly ash incorporation to some extent slowed down the hydration process of cement.

To perfect the curing conditions and improve the performance of cured body, the curing process of waste need mixing the right amount of additives subjecting to the nature and quality requirements for product. Additives commonly used include adsorbent (such as activated aluminum oxide, clay, vermiculite, etc.), retarder (such as tartaric acid, citric acid, boric acid salts, etc.), accelerator (such as water glass, sodium aluminate, sodium carbonate, etc.), and water reducing agent (surface active agent), etc., According to the final disposal or utilization requirements, solidification Product performance can be controlled by the regulation of waste water-cement-additive ratio. For the solidified body which is landfilled ultimately l or storied in the waste barrels, its compressive strength requirements is lower, generally controlled in the 980.7-4903.3kPa; Solidified substrates are preprated for the construction based-materials , whose compressive strength are higher, and generally control more than 10MPa. Leaching rate of curing body should be as low as possible, at least the concentration of pollutants in leachate is lower than the corresponding pollutants leaching toxicity identification standard. Cement solidification is a relatively mature hazardous waste disposal methods, which has the advantages of the process equipment simple and easy to operate, wide material sources, inexpensive, high strength solidification product. In recent years, Japan and Western countries generally use this approach as a final disposal method of toxic, hazardous and solid waste. However, the disadvantage is that the volume increase in multiple large, generally solubilization ratio is up to 1.5-2, and the anti-leaching properties of solidified body is worse than asphalt solidification body.

Cement solidification technology has been widely used to handle with all kinds of heavy metals (such as fluorine, chromium, copper, lead, nickel and zinc, etc.) of hazardous waste, and have acquired a more mature experience. Lots of compounds interfere cement curing process. For example, manganese, tin, copper and other soluble salts will extend the cement solidification time and greatly reduce the physical strength of solidified body. Besides, organic matter, silt, clay and other impurities will also delay clotting time. Studies have shown that the reasons for this phenomenon is that when impurities and other insoluble particles small enough to pass 200 mesh sieve, the larger waste particles will be wrapped up and weaken between the waste and cement bonding(Xu et al., 2007).

(3) Medicament stabilization technology

Traditional cement solidification technologies present some inconvenient problems, such as the waste volume is increased to different extent after solidification, and some will be multiplied. And with the requirement of solidification body improved stability and reduced leaching rate, it need using more coagulant when treating the waste, which not only increases the treatment cost of solidification/stability , but also further increases the treated solidification body volume ; Another important problem is long-term stability of the waste. It will cause some unforeseeable effect if the waste enter into environment again. In view of these questions, internationally proposed in recent years uses the highly effective chemical stabilization agents to carry on the heavy metal waste detoxification processing,, and the treatment method has been a research hotspot in the field of harmless disposal of heavy metal. In Japan, the law has regulated definitely that the waste incineration fly wash must be disposed by landfill after medicament stabilization treatment. At the same time, there has been certain researches and reports on medicament stabilization treatment of fly ash. In our country, due to the problems in traditional stabilization technology, development and application of new heavy metal chelating agent in treatment of heavy metal waste will be with a broad market and practical value in China and internationally. The basic principle is the process of converting toxic and hazardous substances into the low solubility, low mobility and low toxic substances through a chemical reaction.

Medicament stabilizing technology used to treat hazardous waste may realize waste harmlessness disposal as well as less or no compatibilization, thus improve the overall efficiency and economy. Moreover , it also enhances chemical chelating reaction between the chelating agent and hazardous constitutes in the waste by changing the structure and performance of the chelating agent, further improving long-term stability of stabilizing product and reducing the impact of stabilizing product on environment. According to the heavy metal species contained in the waste, the stabilization agents can be used in the medicament stabilization technology include: gypsum, bleaching powder, sodium thiosulfate, sodium hydroxide, sodium sulfide, and organic polymer stabilizers (such as heavy metal chelating agent, phosphate, etc.). The greatest feature of medicament stabilization is that its compatibilization ratio is far lower than conventional stabilization / solidification method after the hazardous waste is treated (Lin et al., 2006).

(4) heavy metal chelating agent dealing with incineration fly ash

The chelating agent can be acquired by using different types of polyamine or polyethylene imines to react with carbon disulfide. The chemical bonding force between medicament and heavy metal form stable chelating compounds precipitation. Stabilized products are not leached under the landfill condition, stabilizing fly ash with heavy metal chelating agent may achieve the purpose of less or no compatibilization. This method can get a good stabilizing effect.

(5) Phosphate Stabilization technology

Phosphate (P3O4-) may form more than 300 kinds of minerals existing in nature with the more than 30kinds of elements in the incineration fly ash and debris. These substances have a very high stability for the pH value and redox potential (Eh). The reaction mechanisms of Phosphate stabilizing heavy metal include surface adsorption, precipitation and replacement. The specific process is related to the physical characteristics of phosphate, heavy metal concentrations and the occurrence and many other factors.

(6) Ferrous sulfate stabilization technology

Lu torpetal. invented a method of using a very cheap medicament $FeSO_4$ to treat flying ash, and named it as Ferrox-Proeess. this method solidified heavy metal in the process of oxidizing the mixture of FeS suspension solution and fly ash into Reddish-brown, high specific surface area of iron oxides under alkaline conditions. It was particularly notable for lead and fluorine, but did not show a stable effect on chromium. Chen et al. improved the process of the stability Later, realizing the stability of the majority of heavy metals besides chromium.

The main principle of Ferrous sulfate stabilizing fly ash is that divalent iron ions generate ferric iron under the action of oxygen and water. FeooH produced in reaction has greater specific surface area and bind heavy metals in fly ash by means of chemical bond attract and physical adsorption , thus achieve the purpose of stabilizing heavy metals in fly ash. The amount needed in treatment using copperas (, a major commodity of ferrous sulfate, a byproduct of sulfuric acid method is about the one of 10-30% fly ash.

(7) sodium sulfide (Na_2S) Stabilization Technology

Sodium sulfide is a relatively wide applied heavy metal stabilization agents. It may react with heavy metals and generate insoluble metal sulfides precipitate. Moreover, Heavy metal ions and has a strong affinity with sulfide ions (S^{2-}), and produced metal sulfide solubility product is very small as well as stable. Therefore, it is a broadly applied heavy metals stabilization agents. This is precisely the use of the nature of Na2S to handle fly ash so that the concentration of heavy metals in fly ash can be down to very low for stabilization.

The comparison of treatment effects among four kinds of stabilization agents is presented in the **Table 21** below. It shows by comparison that the overall effect of ferrous sulfate treatment is well, easy and economical and worth popularizing. The biggest characteristic of medicament stabilization treatment technology is that compatibilization ratio of treated hazardous waste is lower than the conventional stabilization / solidification method. Such as the compatibilization ratio of cement solidification body is up to 1.5-2. It will increase the land use area if using the landfill as a means of final disposal, and further improve waste disposal cost.

According to Shenzhen Hongmei experience in hazardous waste landfill, only landfill construction costs amounted to more than 600 yuan per cubic meter capacity. Hazardous waste treatment and disposal facilities, construction, operation and management costs proposed in Beijing will be as much as 4000-8000 yuan/square meter. Relatively speaking, the compatibilization ratio of medicament stabilization treatment technology is 1or even less than 1 in some particular cases, which greatly reduces the subsequent transport, storage and disposal costs, and significantly reduces disposal of storage capacity. In addition, medicament stabilization treatment technology form chelating compounds precipitate through chemical bond force between heavy metals and medicament, and stabilized products do not be leached. From these sense, it will be more practical value to carry out the research in the field of new technologies of medicament stabilization of hazardous waste treatment and disposal associated with the actual situation in our country. (Yu Luo,2004).

Table 44 Comprehensive Comparison of Common Fly Ash Chemical Stabilization Medicaments

<table>
<tr><th>Method</th><th>Effect</th><th colspan="3">Medicament market price in 2005 (industry grade)</th><th>Drug consumption</th><th>Economy</th></tr>
<tr><td>Organic chelating agent</td><td>Well, effective for all heavy metals, full effect but high pH requirement</td><td colspan="3">22000-25000 yuan/ton</td><td>2-4‰</td><td>The medicament price is about 50-132 yuan/ton dry ash, which is affordable. But there are some environment al and economic problems in. The produce of chelating agent, thus it must be further improved.</td></tr>
<tr><td>Ferrous sulfate</td><td>Well, effective for all heavy metals, full effect.</td><td colspan="3">300-550 yuan/ton</td><td>25-100g copperas/kg dry ash</td><td>The medicament price is about 50-132 yuan/ton dry ash, which is the lowest price. Ferrous sulfate is a by-product of Titanium industry, which is an economic environment-friendly approach.</td></tr>
<tr><td>Sodium sulfide</td><td>Better effect, apple broadly</td><td colspan="3">1800 yuan/ton</td><td>50-200g sodium sulfide/ kg dry ash</td><td>The medicament price is about 90-360 yuan/ton dry ash, which is slightly higher. But sodium sulfide is a important material applied in Leather industry, papermaking industry, dyeing industry, pharmaceutical industry, chemical industry and other industries. Market demand is large.</td></tr>
<tr><td rowspan="3">Phosphate</td><td rowspan="3">Better effect, particularly on Pb</td><td rowspan="3">Taking the sodium salt for example</td><td>Sodium phosphate</td><td>2300 yuan/ton</td><td rowspan="3">0.31935-0.6451mol/ kg dry ash</td><td rowspan="3">Take DSP for example, The medicament price is about 243-810 yuan/ton dry ash, which is much higher.</td></tr>
<tr><td>DSP</td><td>3500 yuan/ton</td></tr>
<tr><td>MSP</td><td>6500 yuan/ton</td></tr>
</table>

(8) high temperature stabilization (zhengpeng Sun,2006)

- Melting and Solidification Technology

Sintering method is to use different surface energy of sintered particles to make atom in the Sintering of particles mobile, aggregate towards contact point among particles , thus reducing the energy, melting the neck among particles, generating particle collisions as well as the neck growing rapidly, and producing densification phenomenon, forming a certain intensity of the stabilized the sintered body. Hazardous waste to be treated mix with small glassy mixture and form HLW glass in the 1000-1100 °C temperature after mixed grain shape. The vitreous dense crystalline structure ensures the permanent stability of solidification body. Due to the sintering processing technology presents the same treatment effects with heavy metal stabilization, it can change the leaching of heavy metals to meet environmental regulations. Chan studied the Properties of the sintered body after aluminum powder is sintered in nitrogen. The results found that forming pressure is inversely proportional to the porosity of sintered body. That is, the higher the level of the sample densification, the better mechanical properties of sintered body. Kunsheng Wang discussed the different sintering conditions on the burning characteristics of sintered fly ash in terms of sintering processing features of municipal solid waste incineration fly ash. The results showed that the greater forming pressure, the greater compressive strength of sintered bodies.

Skrifvars pointed out in the study of ash sintering characteristics that the viscous flow sintering occurred mainly in the ash when its Si content is high. When the temperature reaches 985 °C, 50% will form a liquid phase in the SiO_2-K_2O-Al_2O_3-phase system. In the composition of liquid phase, the amount of SiO_2, Al_2O_3 and K_2O accounted for 79.7%, 11.1% and 9.2%, respectively. It will cause a large number of non-crystalline glass phase when the temperature is cooled to room temperature. Therefore, fly ash is sintered in high temperature environment. The main transmission mechanism is that it considers viscous flow sintering as the material. (Rundong Li,2002; Yan Zhang, 2005)

Melting method is heating Fly ash up to about 1400 °C by using the fuel in the fuel furnace or electric with the purpose of converting the fly ash into slag after melting and a certain cooling process. And the slag can be used as building materials, realizing ash "harmlessness, stabilization, resource-utilization."

Melting solidification needs heating a large number of materials up to above melting point. Therefore, whether it use electric or other fuel as the fuel, energy and costs are quite high. Compared with other processing techniques, the greatest advantage of the melting solidification is that it can acquire high-quality building materials. The melted residue is a glassy substance before, and the intensity is so low that it limits its effective use. To address this problem, Japan has developed an efficient fly ash melting process in order to make the melted residue get a higher level with the same intensity of stone.

Katsunori Nishida et al carried out the experiment in Chiba Prefecture and Kamagaya City, and treated waste incineration fly ash by high melting process above1450°C. The results showed : a) more than 99.9% of dioxins was broken down in high-temperature melting process; b) the glassy substance after melting completely compiles with the standard in Japan through the detection of heavy metals; c) the mechanical strength of the substance has reached Japan's similar material requirements (Chunsong He .2002). High temperature treatment method presents the advantages of high volume reduction rate, slag stabilization, non-leaching of heavy metals and others, which has been widespread concern. Varieties of melting furnace treatment technology of waste incineration fly ash have been studied abroad, but only used in Japan and Europe.

High-temperature melting process need consuming a lot of energy, and Pb, Cd, Zn and other volatile heavy metals need to be carried out the strict flue gas treatment. The high treatment costs is quite high and energy consumption is large. Therefore, this method still has some difficulties in the economy if applied in our country (Fuyun Yang, 2005).

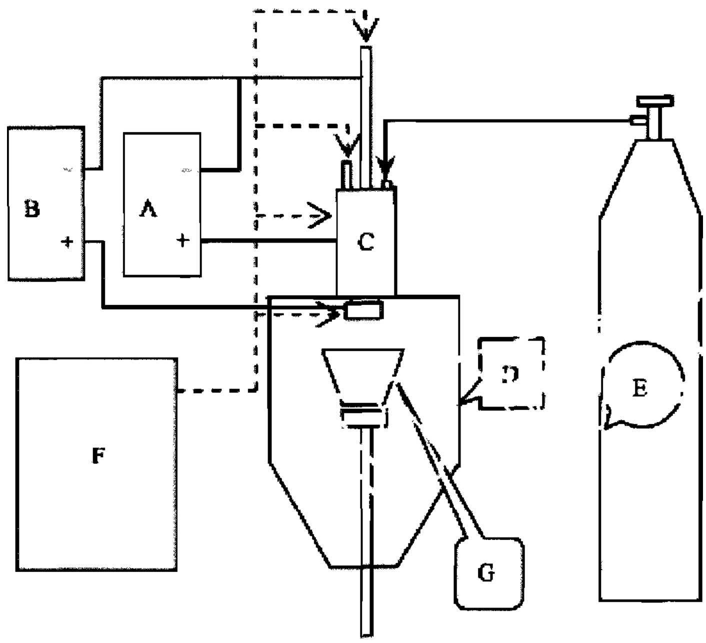
- Plasma Technology

Other methods can not disposal of highly toxic dioxin except melting, and they mainly solidify and stabilize the heavy metal in fly ash. Moreover, the products acquired through other treatment methods can only be as the intermediate product of incineration fly ash treatment, and they must be transported to the landfill for final disposal. Therefore, the landfill can not be effective in reducing the burden. It can use heat treatment techniques to decompose high-concentration toxic fly ash dioxin, such as applying sinter and melt processing to treat fly ash, which solidify heavy metals in fly ash into glassy slag, and decompose dioxin-like substances in the high temperature. These technologies are accepted by various countries. The plasma technology is taken seriously among these technologies because of its wide application and thoroughness in disposal of hazardous waste and medical waste and other kinds of waste.

Principles of high-temperature plasma technology: Inert gas Argon is filled in between the anode and cathode electrodes. An extremely small amount of argon ions move directionally under the electric field force. Directional movement of ions enhance the force of the electric field and ionizing more of the argon gas, resulting in more electrically charged ions and doing the same directional movement. This chain reaction makes argon gas conductive. The same number of anions and cations and their reverse movement makes this region into a plasma area of carrier argon (other gases, such as air, can be used as carrier gas under certain condition).

The conductivity of argon conducts positive and negative electrode, thus discharging intensely and generating electric arc. This phenomenon is also known as arc-discharge. The characterization of arc plasma is low-voltage, high current, accompanied by strong light and high heat. The temperature can reach about 20,000 °C in the center of the plasma while 5000-20000 °C in the whole plasma. Waste samples will be added to the aforementioned plasma area. Any organic matter will be broken in an instant into the atomic states in the high temperature of more than 12000 °C. The high temperature decomposition is very thorough. Moreover, arc discharge results in partial super-high temperature, which make quite high power utilization rate and not require any fuel or oxygen (Xuetao Wang, 2005).

Plasma melting facilites: it includes following several parts: plasma generator and plasma dc power supply, melting reactor and gas, etc.It is shown in **Figure 46**.



A. the first group of power; B. the second group of power; C. Plasma torch; D. Melting furnace; E. Gas bottle; F. cooling system; G. crucible

Figure 45 Plasma Melting Furnace

Figure 46 Treated Slag by Plasma

Dioxin in the he original fly ash is broken down mostly after melt processing. Fly ash slag melted has a good fixed effect on the heavy metals. The leaching concentration of the heavy metal in melted slag is far below the TCLP Standard, and fly ash slag melted even can be used as building material or subgrade materials. Melted slag by fly ash show non-crystalline nature of the glassy crystalline structure after the XRD analysis.

(9) Lime solidification

Lime solidification based on these materials, such as lime, fly ash, cement kiln dust and furnace slag, which are in the nature of Pozzolanic Reaction carries out hazardous waste solidification/stabilization. Pozzolanic Reaction produced in appropriate catalytic circumstances adsorbs heavy metals in the waste on generated colloidal crystallization. But Pozzolanic Reaction is different from Cement hydration action, which is less used alone due to the structure strength is worse than the one provided by lime solidification treatment.

(10) Plastic material solidification method

Plastic materials are organic solidification stabilization / solidification treatment technology. It is divided into thermoset inclusion and thermoplastic inclusion according to the different of the performance materials used.

- Thermosetting plastic inclusion

Thermosetting plastics are such materials are hardened into a solid material from the liquid when heated, and still maintain its solid state when reheating and cooling.

At present, the thermosetting materials for treating waste disposal include pulse formaldehyde and polybutadiene, etc. Phenolic resin and epoxy resin are also used within a small range of cases. This technique is mainly used to handle radioactive waste. When applied to the handling of hazardous waste, its scope is subjected to certain restrictions. It can mainly handle the waste containing chlorine, organic acids, paints, cyanide and arsenic. In addition, there are reports about using formaldehyde to deal with pulse plating sludge, nickel / tin battery waste

- Thermoplastic materials inclusion

Thermoplastic material is defined as organic plastic which can be repeated soften and harden when heating and cooling. Commonly used materials are asphalt, paraffin wax and polyethylene and so on. It need waste pre-treatment of drying or dehydrating in order to improve the quality of the waste solidification when using thermoplastic tolerant technology. After that, then it mixes with the polymer at higher temperatures. Thermoplastic inclusion technology can be used to treat electroplating waste sludge and other heavy metals waste, paints, oil refinery sludge, incineration fly ashes, fiber residues and radioactive waste. Thermoplastic material commonly used is asphalt. As stabilization agents, asphalt mixes uniformly with hazardous waste in a certain temperature and generates solidification reaction, forming hazardous waste a solidification body in asphalt. The advantage of Asphalt solidification is small void, high density and difficult water permeability of solidification product. Compared with the cement solidification products, leaching rate of hazardous substances is smaller by one order of magnitude. The leaching rate is 10^{-4}-10^{-5} g/cm Zd. Regardless of the nature and type of waste, it can be given stable solidification body. Besides, the asphalt solidification can be solidified immediately after treatment while the cement solidification must be through 20-30d conservation. On the other hand, due to poor thermal conductivity of asphalt and not high heating evaporation efficiency, there will be foaming phenomenon and entrainment phenomenon, which is easy to incidents of contamination by exhaust gas if the moisture content of the waste is greater. Moreover, the asphalt is flammable, and it must take not overheating during heat evaporation into account. We should also take appropriate fire prevention measures in the storage and transportation because asphalt is easy to fire in overheating.

- Authigenetic solidification

Authigenetic solidification is a method which uses cementitious waste to complete solidification. The technology is mainly used to handle the waste which are rich in calcium sulfate and calcium sulfite, such as phosphorus gypsum, flue gas desulfurization sludge and flue gas cleaning sludge, etc. First waste is usually calcinated under controlled temperature, and then mixed with special additives and fillers into slurries, forming the authigenetic solidification body after condensation and hardening. The solidified body has the advantages of high anti-permeability, anti-microbial degradation and pollution and low leaching rate.

- Large-scale encapsulation technology

Large-scale encapsulation technology is using an impermeable protective layer to encapsulate the treated or basically untreated waste. The stability of this treatment is usually more reliable. Waste are generally carried out the stabilization / solidification treatment before large-scale encapsulation technology. The external coverage becomes a remediation method of overcoming the stabilization / solidification defects. The technology is an attractive stabilization / solidification technology from the security point of view. However, the application of the technology is still not wide. Large-scale encapsulation technology has been used to handle hazardous waste, including plating sludge, flue gas cleaning sludge, incineration ash, and Polychlorinated biphenyls (PCBS) and so on. At present, most countries including China have developed and promulgated on incinerator fly ash handling laws, regulations and standards. It can be said that the harmlessness disposal of incinerator fly ash has become a very urgent task, but so far there is not a widely accepted technology.

The above mentioned types of stabilization / solidification technologies have their own unique physical and chemical properties and application objects. The technologies of solidification and thermal solidification applied more have drawbacks, and even don't eliminate environmental hazard of heavy metals. As can be seen from the table, in the most effective in dealing with large quantities of hazardous waste goal, chemical stabilization techniques, especially chemical stability technology which heavy metals are as stabilization agents, eliminate the potential threat of heavy metals on the environment. Therefore, it is a brightly applied prospect technology of fly ash disposal techniques.

5.2.1.2 Landfill disposal

Landfill disposal is one of the most commonly used disposal way disposaling of hazardous waste. It includes and isolates hazardous waste in order to minimum the immediate and long-term human health and the environment threatening. Landfill design, construction, operation and maintenance must be carried out according to certain criteria to achieve these goals. Many countries have set minimum standards in laws, regulations and technical guidelines. Hazardous waste landfills are the highest protection requirement compared with other various types of landfill sites. Toxic and harmful constitutes of hazardous waste often have non-degradable properties, so there is no stabilization period in hazardous waste landfill. Therefore, it also require maintain a safe and no damage in hazardous waste landfill as long as possible. And hazardous waste landfill site raised a very high demand, which Require the groundwater level less than 3m of the impermeable layer and adequately thick impervious layer basis; which require setting double-lining, zoning landfill in terms of the characteristics of waste. At the same time, it also proposes a very high standard for closure and maintenance of landfill. The three basic types of landfill sites are: area type, troughing type and pit type, and also have this type of combination of three types of evolution. The construction of hazardous waste landfill need to consider the following factors: location, waste limits, design, operation, closure field and post-closure maintenance, monitoring, inspection, and cost accounting.

(1) Area method

It is appropriate to apply area method when the ground surface is unsuitable for excavating and dumping solid waste. In accordance with operation methods, the waste was unloaded and paved elongated strip on the ground, and piled up layer.The thick of each slice is ranging from 40 - 75cm. Each layer of the landfill should be compacted in the process of landfill every day. According to the waste type, at the end of daily operation. It is required covered with 15 - 30cm thick cap rock material on the waste in landfill, preventing and resolving the risks of waste being exposed to environment.

(2) Troughing method

Troughing method applies to the lower ground water level area as well as suitable covering soil depth. Usually, the waste is piled up in the trench. The length of trench is 30 - 120m, the depth is 1 - 2m, and the width is 4 - 8m. Daily landfill trench length should meet reaching the final height of the landfill units at the end of the daily operation. The width of the trench should be sufficient to avoid the situation of waste transport vehicles waiting for discharging. Covering materials is acquired through the excavation of adjacent trench or used directly previously excavated soil piled in a nearby trench.

(3) Pit method

Landfill operation can effectively use the naturally formed or man-made excavation pit, such as canyons, gullies, borrow pit, and quarry. The stacking and compacting technology of the pit landfill varies from different landfill geometric shape, covering characteristics, hydrology and geology conditions.

The incineration fly ash must be solidified and stabilized before entering the long-term landfill of hazardous waste landfill in accordance with international regulations. The leaching toxicity standard values of national general sanitary landfill are shown in **Table 45** (ie, leaching toxicity must be less than the limits in **Table 45**). Leaching toxicity standard limits of hazardous waste landfill are presented in **Table 46**. In addition, the pH of waste leaching solution taken into landfill must be 7.0-12.0(Xiaodong Li,2008).

Table 45 Leaching Toxicity Identification Standard Value Regulated in GB5085.3

Items	The maximum allowable concentration of leaching solution(mg/L)	Items	The maximum allowable concentration of leaching solution(mg/L)
Inorganic Fluoride(excluding CaF_2)	50	Cyanide(by CN^-)	1.0
Arsenic and its Compounds	1.5	Cadmium (by total Cadmium)	0.3
Nickel and its Compounds	10	Lead (by total lead)	3

Barium and its Compounds	100	Mercury and its Compounds (by total Mercury)	0.005
Beryllium and its Compounds	0.1	Organic Mercury	not detected
Zinc and its Compounds	50	Hexavalent Chromium	1.5
Copper and its Compounds	50	Total Chromium	10

Table 46 Limitation Value of Permitting Hazardous Waste Landfill to Enter the Control Zone Provided by GB18598-2001

No.	Items	Control limits of stabilization(mg/L)
1	Organic Mercury	0.001
2	Mercury and its Compounds (by total Mercury)	0.25
3	Lead (by total lead)	5
4	Cadmium (by total Cadmium)	0.5
5	Total Chromium	12
6	Hexavalent Chromium	2.5
7	Copper and its Compounds	75
8	Zinc and its Compounds	75
9	Beryllium and its Compounds	0.2
10	Barium and its Compounds	150
11	Nickel and its Compounds	15
12	Arsenic and its Compounds	2.5
13	Fluoride(excluding CaF_2)	100
14	Cyanide(by CN^-)	5

Notes: 1. the table data are taken from the relevant provisions of the leaching toxicity in GB18598 - 2 (X) 1; 2. In addition to leaching toxicity, the waste that the pH value is less than 7.0 and greater than 12.0, the reactive and flammable waste, the waste that moisture content is above 85% and liquid waste can not go directly to hazardous waste landfill.

5.2.1.3 Extraction

Extraction methods of heavy metals in fly ash include acid extraction, alkaline extraction, high-temperature extraction, bio-leaching, and other pharmaceutical extraction. Since the equipment and maintenance management used for these extraction methods are complex, spin-drier wear is faster, and processing cost is correspondingly higher, thus they are not suitable for disposal of a large number of incineration fly ash (Shimin Ding, 2007) .

5.2.2 Chinese hazardous waste (including medical waste) incineration fly ash disposal technology proposions

Table 47 lists the various advantages and disadvantages of fly ash processing technologies.

Table 47 Comparison of Various Treatment Methods of Fly Ash

Processing technology	Advantages	Disadvantages
Cement and lime solidification	1.Wide resource and cheap price of cement. 2.Simple treatment processing and operation 3.Low processing cost 4.The solidification effect is well and preventing dust explosion 5.All fly ashes possessing different physical and chemical can be treated by cement solidification 6.The compressive strength of solidification body can be adjusted by controlling the additive amount of cement.	1.Relatively large cement requirement. 2.Heavy metals and soluble chloride, sulfide presented in fly ash will affect the cement hydration process. 3.Cement and other additives will increase the weight and size of solidification body 4.As the final solidification body will continue to exist heavy metals, heavy metals in solidification body, may be leached back into the environment in different chemical conditions, causing unforeseen effects.
Melting solidification	1. Fly ash volume reduction effect is well. The volume of fly ash can be reduced more than 75% after melt processing. 2.Heavy metals leaching rate of slag generated by the fly ash melting processing is very low, and solidification effect is good. 3. Slag can be used as aggregate and bricks and other building materials, resource re-use can be achieved. 4. It can decompose Dixon effectively.	1.It is required to maintain the high-temperature conditions (>1200 ℃), so spending a lot of energy and expensive operation. 2.Melting process produces the dust containing a large number of heavy metals and acid gas, increasing the system complexity. 3.The processing cost is very high due to complex equipment systems and the investment of building a Melting and processing costs are also higher.
Plasma technology	1. Volume reduction of fly ash effect is good; 2.Dioxins of high concentrations in fly ash can be completely or nearly completely	1.Investment in equipment costs are high; 2.Higher treatment costs.
Chemical solidification agent	1. Efficient trapping of heavy metals and trap many kinds of heavy metals. 2. A wide range of dealing with the type of waste containing heavy metals. 3.Treated fly ash reach the heavy metal waste landfill standard, the final stabilization product is affected external environment smaller	1.Expensive Stabilizers. 2.Expensive processing costs.

Processing technology	Advantages	Disadvantages
Acid or other solvent elution method	1.Soluble salts in fly ash that can be dissolved in water, can enhance the treatment effect, and also can increase the stability of treated things. 2.Heavy metals in fly ash are converted into stable compound after treatment. Disposed material contains less soluble salts. 3.Disposed substance shape is dehydrated cake-like, easy to operate, handling and landfill disposal. 4.Process is relatively simple and low-cost.	1.It is necessary to disposal of soluble salts shifted from a fly ash into the water. 2.It is necessary to disposal of slurry containing heavy metals when draining. 3.It is necessary to consider equipment piping blockage, equipment wear and corrosion when designing. 4.It is necessary to take adequate measures from the fly ash slurry sometimes produce harmful gases.

Note: the most respected disposal way of incineration ash is melting solidification processing technology by environmental protection department in the United States, Germany, Japan and other developed countries. Because the technology not only allows ash volume reduction by 2/3 or more, which reduces the burden on landfill sites, but also can recover valuable metals in the ash, decompose dioxins and other harmful materials; And it achieve the purpose of the safely recycling utilization of molten slag. It can be used as raw materials in building materials, road construction materials and so on, realizing reduction, harmless and resource of waste incineration ash

As shown in **Table 47**, the required materials and operating costs are low and operation is easy in the use of cement solidification and bitumen solidification processing. But if the waste contains special salts, it will cause solidification disrupter. It could easily lead to cracks during the decomposition of organic matter, increasing permeability and reducing structural strength, but also leading to the leaking of heavy metals because of an increase in chlorine content. The main obstacle faced of using chemical agents to stabilize heavy metals in incineration fly ash is that difficult acquirements of simple preparation method and inexpensive chemicals. The long-term environmental stability of the fly ash treated by chemicals is not yet clear, and the cost of chemicals is high, the stable action on dioxins and dissolved salts is narrower. The melting treatment is the best in the above several ways. Compared with other processing technologies, although it requires a higher energy and cost, the biggest advantage is that the dioxins in fly ash can be broken down and receive high-quality building materials. While the effectiveness on weight loss and capacity reduction is well, and the slag is stable, no heavy metals are leached. Therefore, the melting solidification technology will be the most promising approach in the field of fly ash treatment.

5.3 Proposed Implementation on Disposal of Fly Ash from Hazardous Waste (Medical Waste Included) within the Framework of the Project

5.3.1 The overall design concept and goals of project

In order to manage the hazardous waste (medical waste included) fly ash which is rich dioxin, the following principles should be abided: "Nearby disposal "and" cooperation". Nearby disposal: such fly ash should be transported to the nearest hazardous waste plant referring to existing condition of hazardous waste (Medical waste included) disposal facilities. Nearby disposal can decrease costs, reduce the risk of leakage and achieve economic optimization as well. Cooperation: in the construction of disposal facilities for POPs insecticides waste, treatment of such fly ash must be incorporated into planning control. The selected processing technologies and disposal facilities have to dispose such fly ash, that is to say, treatment of POPs insecticides waste and fly ash should be cooperated. However, priorities should be given to the disposal of POPs insecticides waste. Overall planning can reduce costs, make full use of available resources and achieve a comprehensive, balanced and sustainable development.

The disposal objectives for such fly ash are: considering project cycle, upgrade disposal facilities in three years to adapt to treat such fly ash. The overall processing capacity should achieve 1000 tons in three years.

5.3.2 Disposal requirements for fly ash from hazardous waste (including medical waste)

Based on project design, fly ash disposal technologies not only can treat dioxin, but also can deal with POPs insecticides waste. Thus, a wide-spetrum technologies should be applied to disposal of two types of waste that designed in the project. The detail requirement is equal to pesticides POPs disposal.

5.3.3 Application recommendations on disposal of fly ash from hazardous waste (medical waste included)

The Analysis above shows that hazardous waste disposal technologies, including cement kinl co-processing, calcium oxide aid melting-solidification, plasma, chemical solification, extraction by acid and other solvents are all suitable technolgies for fly ash disposal. However, based on project design, fly ash disposal should untilize existing pesticide POPs dipsoal techologies under the overall project, and it is considered as a polit disposal technologies. So, comprehensive considering, the most appropriate technologies for fly ash are plasma and melting treatment.

5.3.4 Technical standards and technical options

5.3.4.1 Technical standards

Disposal techniques for fly ash from hazardous waste (medical waste included) have to abide following principals:

Cooperation: Used technologies for POPs insecticides waste can apply in treatment of fly ash.

Nearby disposal: Choose the nearest facilities in order to reduce costs.

Economical efficiency: Considering emission reduction of PCDD/PCDFs, we have to reduce disposal costs.

Above these, technical options should under the premise that disposal facility location has been determined. Make an option considering regional characteristics and local actual situation of hazardous waste management, furthermore.

5.3.4.2 Suggestions of disposal of fly ash

Disposal fly ash belongs to exploratory research, its disposal requirements should coordinate with disposal requirements of POPs insecticides waste. The steps are choosing a disposal facility nearby first, gather incineration fly ash and dispose them then. The detailed issues will be discussed in the project later.

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Conclusion

The project is one of the important outputs in the full sized projectpreparation stage of environmentally sound management and disposal of obsolete POPs pesticide classes of dioxin-rich fly ash waste. Through carrying out this project, the one hand, it provides technical support for the preparation of the project documents; the other hand, it also provides the basis for application of material and work-oriented with the technical option and application of the full follow-up project implementation.

During the project implementation process, the project team propose the selection scheme of disposal technologies and technology applications through serious study and learn the basic approach in the disposal of POPs pesticides technical aspects from foreign developed countries, but also a combination of research and development of China-related disposal technologies, applications and even the disposal facilities, construction and operation of state proposed project.

Of course, with being continuously improved in the disposal technologies and management systems of pesticide POPs and, with the community's deepening awareness and understanding in disposal of POPs pesticides treatment technology and management mode, there will be a new understanding in the full project-specific implementation of the model. Pressed forBased on the relationship between time and capacity, it may contain a certain amount of shortcomings and deficiencies, please give us criticism and correction.

Attachments

1 Patents And Equipment Of Disposal Technologies in China

No	Patent No.	Name of the patent	Applic -ation place	Type	brief introduction	contact information
1	CN 02156590.2	facility and method of a pyrolysis technology for the disposal of solid waste	China	Pyrolysis	The invention reveals the facility and method of a pyrolysis technology for the disposal of solid waste, which can defuse the solid waste with fuel value into combustible gases through the pyrolysis technology. The remaining 5-10% of the solid waste is used as soil for the flowers and agriculture. There is no need to classify the disposed materials or conduct pre-treatment, and no emission of pollutants occurs during the treatment process. The invention can truly achieve sound processing results of the resourcezation and waste minimization. The invention includes the main reactor and the reactor associated with it, and the solid waste can be disposed through drying, pyrolysis, gasification and other processes. Its pyrolysis process is run under anoxic conditions, with the lowest pyrolysis temperature above 400 degrees Celsius. Therefore, it can realize innocuous treatment since there is no condition for the generation of dioxin. Meanwhile, it can meet standards for resourcezation and waste minimization, for the generated gas can have economic values. If the daily waste are disposed on the spot, the transport and disposal expenses can be saved and the traffic tension and secondary pollution can be avoided, which results in apparent social and environmental benefits.	Tianjin Univerty, No. 92, Weijin Road, Nankai District, Tianjin Postcode: 300072 http://www.tju.edu.cn/
2	CN 99243273.1	solid waste pyrolysis unit combined by rotary kiln - fluidized bed	China	Pyrolysis	A solid waste pyrolysis unit combined by rotary kiln - fluidized bed. Its main structure includes: seal sets of horizontal cyclone separator outside the external-heat rotary kiln; back feeder between Fluidized bed and the separator; feed mixer between rotary kiln and fluidized bed. This unit can recover heat in the waste-heat boiler after the hot flue gas generated in the fluidized bed when burning the char produced by solid waste through pyrolysis heats the solid waste in the rotary kiln. Its pollutant emission is very low, and the destruction rate of such organic pollutants as PCBs, PCDD, PCDF is very high. The removal efficiency of dioxin is up to 99.9999%, the solid waste has been reduced to a large degree, and the small amount of generated residue and inert debris and dust can be used as road construction materials and metals for recycling.	Li Aimin Department of Secure Engineering, Shenyang Institute of Aviation Engineering No. 52, Yellow River North Avenue, Huanggu District, Shenyang, Liaoning Province Postcode: 110034
3	CN 00212730.X	solid waste pyrolysis unit of externally heated multi-chamber fixed-bed	China	Pyrolysis	A solid waste pyrolysis unit of externally heated multi-chamber fixed-bed. It mainly includes: multiple parallel pyrolysis furnace chamber, valve, grate, regenerative air preheater and quench gas purification device; a number of fixed-bed pyrolysis chambers is arranged side by side, with the adjacent two-chambers sharing one furnace wall. On the top of the furnace Room is set with a sealed door, while underneath has a grate and on the bottom has sealed slag door. Each furnace chamber is equipped with gas export, connected with gas collector and flue gas collector through the valve. The device produces gas with high calorific value; the single room is for intermittent external thermal pyrolysis, and the overall thermal solution for the continuous operation. It is apt to large scale operation with less heat loss and expenses; the toxic gas emission is very low; the molten ash can be recycled with good minimization so as to avoid heavy metal pollution.	Li Aimin Department of Secure Engineering, Shenyang Institute of Aviation Engineering No. 52, Yellow River North Avenue, Huanggu District, Shenyang, Liaoning Province Postcode: 110034

No	Patent No.	Name of the patent	Applic -ation place	Type	brief introduction	contact information
4	CN 200520057812.6	reactor with steam plasma pyrolyzing organic waste	China	Pyrolysis	The utility model involves a reactor with steam plasma pyrolyzing organic waste, including a furnace set with a plasma jet that can reach the inner furnace. There is a feed opening, a gas outlet and a quenching device connected to the gas outlet on the furnace wall. At the bottom of the furnace has a liquid slag mouth, and the reactor adopts steam as the working gas. The plasma jet can be set either on the furnace cover or on the furnace wall vertically with the feed opening. This new applicable reactor can respond to a large space, and the solid, semi-solid, liquid organic waste can be pyrolyzed by the plasma at a high temperature. Since the steam is the working gas for the plasma, and has no limitation for the water content and ingredients of the organics, there is no need to pre-treat the organic waste, which can save the operating expenses. The plasma pyrolysis of organic waste can generate recyclable and combustible gases including hydrogen and carbon monoxide, and also restrain the production of toxic materials.	Guo Wenkang Room 603, Building No. 30, Sub-lane 9, Lane 1324, Shuidian Road, Hongkou District, Shanghai Postcode: 200000
5	CN 200520024349.5	a pyrolysis gasification incinerator of solid waste	China	Pyrolysis	The new type invention reveals a pyrolysis gasification incinerator of solid waste, part of environmental protection facility. Currently, the daily garbage and industrial solid waste has become serious social hazards. CN2447644Y publicizes a converter-type pyrolysis gasification incinerator of solid waste. The incinerator has such disadvantages as unstable operation, high error rate and incomplete burning. The new invention provides a pyrolysis gasification incinerator of solid waste, including a pyrolysis gasification furnace, a secondary gas combustion chamber and smoke flue. The furnace contains feed bin, twin-roll feeder, fixed furnace cover, furnace body, furnace block, lamination rotary grate, the rotary platform, slag on the slag-type machine and air blower. It owns such advantages as reasonable structure, convenient operation and maintenance and dependable performance, which can help realize the resourcezation, innocuity and minimization of the solid waste.	Jiu Yushan No. 8, Baling North Street, Taiyuan, Shanxi Province Postcode: 030009
6	CN 99800393.X	Ash melting furnace and the ash fusion method	China	Melting	A kind of ash melting furnace and the ash fusion method. In order to provide an ash melting furnace with high efficiency and stabel operation, when heating and melting the main ash and fly ash in the furnace at the same time, the main ash is on the above layer, which the fly ash is at the lower layer, and the ash should be layer-like provided. Besides, when using oxygen-rich burner, the amount of added oxygen should be properly controlled, and according to the heating and melting state of the ashes resulted from the burning of the oxygen-rich burner, change the fuel supply, as well as the oxygen concentration and make it possible to aptly control the needed ash supply.	Takehiro Kitta Mitsubishi Heavy Industries Ltd Tokyo Prefecture, Japan http://www.mhi.co.jp/
7	CN 2241446.0	A melting furnace for waste incineration	China	Melting	A melting furnace for waste incineration, including a main furnace body with an incineration furnace and secondary combustion furnace. The incineration furnace has a combustor equipped with a heavy oil burner. One side is connected to inlet of the waste and the other side is set with the waste exit. As to the secondary combustion furnace, it is set with a smoke flue connected to the incineration furnace, located higher than the furnace. Within it, there is a burner that can re-incinerate the unburned light smoke. The temperature of the furnace can reach 1800℃-2800℃ which can remove all the toxic materials and the reduction amount of the clinker can reach above 2/3.	Hong Wenhu; Li Junxian Taiwan, China
8	CN 200410044191.8	a treatment method of fly ash after the incineration of household waste	China	Melting	This invention relates to a treatment method of fly ash after the incineration of household waste. treatment method of cyclone furnace high-temperature melting for the fly ash is completed through the following steps: 1. mix the fly ash generated from garbage incineration and the coal powder at the proportion of 15 - 25:75 - 85, and then send them into the cyclone combustion furnace 6 and burn to high-temperature melting; 2. make the burning in the furnace 6 remains the restore state; 3. heavy metals	Bie Rushan Harbin Institute of Technology No. 92 Xidazhi Street Nangang District, Harbin,

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					in the fly ash fall sink into the bottom of slag pool 9, recycle them after discharged, while the slag floating on the liquid metals flows out the slag pool through recycling exit 11, and reuse them as cement or construction materials after being rapidly cooled down with water. The method can not only recycle the valuable metals in the fly ash, decompose the dioxin and recycle extra heat for power, but also recycle the slag to be used as cement or construction materials with low expenses. Or, if the cyclone combustion furnace 6 can remain oxidation state, the excess air ratio keeps at 1.1-1.2, we can only recycle the cooled vitreous.	Heilongjiang Postcode: 150001 http://www.hit.edu.cn/
9	CN 200510047774.0	Novel melting method and equipment for treatment of fly ash from waste incineration	China	Melting	Novel melting method and equipment for treatment of fly ash from waste incineration. The method can soundly dispose the fly ash with heavy metals and dioxins generated from waste incineration, and it belongs to hazardous waste treatment and disposal technology. The method includes: First, extract the chlorine from the fly ash of waste incineration with high level the chloride; the moisture content of the extracted fly ash is 30-50%, put them into the melting furnace and finish the ash drying and melting in one furnace; add flux to make the melting process even easier; Continuous liquid slag discharge and use water-cooled closed collection devices to collect. It features include: a side wall arrangement of burners; different flowing directions for the slag discharge, that is, the direction of the flame ejection opposite to slag flowing direction. This invention can make significant decline in energy consumption, decompose the dioxin-like pollutants that damage the raw materials and fix the heavy metals in the melted materials. The disposal cost is below 1000 Yuan/ton.	Institute of Clean Energy and Environmental Engineering, Shenyang Institute of Aeronautical Engineering No. 52, Yellow River North Avenue, Huanggu District, Shenyang, Liaoning Province Tel.: 024-89723733 Postcode: 110034
10	CN 200480007261.0	The invention subjected by providing lining of the melting furnace which has excellent unshaped refractory materials without chromium but durable just like chromium products	China	Melting	The invention is subjected by providing lining of the melting furnace which has excellent unshaped refractory materials without chromium but durable just like chromium products. This unshaped refractory materials without chromium used in the melting furnace can compose raw materials containing yttrium oxide and the alumina raw materials. The chemical analysis value is expressed as $Y2O3$:0.3-15%; $Al2O3$:85% or higher.	Tsuda Hideyuki Krosaki Harima Corporation Fukuoka Prefecture, Japan
11	CN 200410101493.4	One fly ash melting additive when implementing waste incineration	China	Melting	One fly ash melting additive when implementing waste incineration. By weight, it contains $B2O3$(30-50%), $SiO2$(25-40%), $CaF2$(7-20%), MgO(7-20%). Ground them into a 106-256 mesh blending. In the above blending materials can be added 2-5% of $ZrO2$. this invention requires to add a proper amount of fly ash melting additive which can effectively reduce the melting temperature, reduce the volatilization of inorganic salts, increase the curing effect of heavy metals in the vitreous, enhance various physical properties of molten slag, make more conducive to the resource utilization of molten slag, and promote the fly ash melting solidification technology.	Xi Beidou Chinese Research Academy of Environmental Sciences No. 8, Da Yang Fang Stree, Beijing Postcode: 100012

No	Patent No.	Name of the patent	Applic -ation place	Type	brief introduction	contact information
12	CN 200610047497.8	a kind of arc-melting treatment system and a method of waste incineration ash disposal	China	Melting	This invention relates to a kind of arc-melting treatment system and a method of waste incineration ash disposal. It includes: feed system, flue gas emission control system, cooling system and electric arc furnace. The structure of the electric arc furnace includes: a furnace as molten pool; a water-cooled lid set in the furnace body; a bracket on the water-cooled lid; top electrode in the bracket and Its electric discharge side can stretch into the furnace through the water-cooled lid body; at the bottom of the furnace is the bottom electrode, corresponding to the discharge side of the top electrode and connected to the power's output electrode with the top electrode; the feed opening is set at the side of the furnace; the furnace slag exit is at the bottom of the furnace; the smoking exit is in the furnace. The disposal steps are as follows: 1. materials processing step; 2. feeding step; 3. electric arc furnace melting step; 4. waste gas purification processing step; 5. slag cooling step. The invention has apparent volume reduction, can thoroughly decompose the dioxins in the ash and solidate and reuse the heavy metals in the slag and reduce environmental protection.	Cai Jiuju Northeastern University No. 11, Third Lane, WenHua District, Shenyang, Liaoning Province Postcode: 110004 http://www.neu.edu.cn/
13	CN 200480043304.0	a vent structure, as well as a blowing method for flammable dust.	China	Melting	The invention provides a vent structure, as well as a blowing method for flammable dust. It enables the flammable dust from the waste melting furnace to be burned thoroughly before coming out of the air outlet, and reduces the use of coke. Put the waste, coke and limestone into the furnace, and blow into air or oxygen-enriched air for the waste's drying, thermal decomposition, combustion, and melting. As to waste melting furnace, the vent exit (20) is designed as three-tier tube structure, including inner tube (22) that supplies combustible dust and air or oxygen-enriched air; middle tube that supplies fire fuel of combustible dust (23), and outer tube that supplies ignition fuel combustion oxygen (24); the front sides of every tube are conducted.	Nishi Takeshi Nippon Steel Engineering Tokyo Prefecture, Japan
14	CN20071002713 1.9	a swirl gasification melting system of hazardous waste	China	Melting	This invention relates a swirl gasification melting system of hazardous waste, set with the main combustion chamber I and combustion chamber II. The combustion chamber I is a swirl burner, equipped with feeder of hazardous waste 1, inlet of additives, fly ash and combustion fuel 2, combustion air inlet 3 and gas-assisted fuel inlet 8. The combustion chamber II is equipped with secondary air entrance 4, slag disposal tube 5, air outlet 6. the bottom of the main combustion chamber I is the tapered part. The Section design of the combustion chamber II is a rectangular shape, and its angle changes between 0 ° - 45 °. An inertial separator 7 can be set in the front of the air outlet 6 in the combustion chamber II. The invention features simple structure, convenient operation and low expense. It combines the incineration of hazardous waste and ash melting, and can melt the slag generated from incineration.	Yan Changfeng GuangZhou Energy Research Institute of Science Academy of China No. 1, Nengyuan Road, Wushan Park, Guangzhou, Guangdong Province Postcode: 510640
15	CN 200520039468.8	fly ash melting furnace	China	Melting	The utility model involves a fly ash melting furnace, including: One vortex source burner (1) placed in the upper shell (100), one placed in the shell (100) on one or both sides that conveys fly ash and granular residue, a throat combustion chamber (2) connected to the vortex burner (1). Under the throat combustion chamber (2) is set with a molten liquid pool (3) by side of which is arranged with a target plate-type smoke window. Below the molten liquid pool (3) is equipped with a water-cooling box (13). The advantages of this utility model are as follows: melt the hazardous fly ash and granular residue, and the molten liquid water can be formed into glassy particles after being cooled down; the dioxins are destroyed and the leaching rate of heavy metal is less than the GWKB3-2000 standard requirements; disposal expenses are relatively low; cheap price. This invention can separately dispose fly ash (or granular residue) -class hazardous materials, and also can be used with large-scale waste incinerators.	Shanghai Baoer Power Equipment Co. Ltd. No. 1155, Jian Chuan Road, Minhang District, Shanghai Tel.: 59737111 Postcode: 200240

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16	CN 200310115200.3	method of hazardous waste by using plasma arc technology	China	plasma	The invention discloses disposal method of hazardous waste by using plasma arc technology, including: 1. pre-treat the solid waste, and put them into the plasma arc furnace intermittently or continuously through conveying system; 2. implement cracking disposal within the plasma arc furnace, the working gas for the cracking disposal can be reducing gas or other gases. The ratio of oxygen content of the working gas and the oxygen demanded for complete waste response is less than 0.3, the cracking temperature is 1200K-3500K; 3. gases from the plasma arc furnace after cleavage enter into the exhaust gas treatment system, and follow the usual exhaust gas quench cooling, purification, acid gas processing, and particle separation process. 4. recycle the particles and gases obtained from the step 3. The invention also includes corresponding device, like plasma arc furnace. It costs less, consumes less working gas, produces less exhaust gas and can handle a variety of waste not suitable for burning.	Sheng Hongzhi Institute of Mechanics, Chinese Academy of Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914 Postcode: 100080
17	CN 200310113485.7	a method related to plasma-enhanced decomposition of organic waste and a plasma furnace	China	plasma	This invention a method related to plasma-enhanced decomposition of organic waste and a plasma furnace. The plasma furnace includes furnace body, a feed inlet and a plasma torch on the furnace wall, at the bottom of the furnace is the slag exit, at the top has the air vent. The plasma torch is set on the rotating device or the furnace wall on which has at least one gas inlet 3 which is connected with the cylinder through the pipeline with a control valve. The method of plasma-enhanced decomposition of organic waste refers to pre-handle the solid, semi-solid, liquid or gaseous organic waste and pyrolyse them in the plasma furnace in this invention and then make the second combustion after purification of the pyrolysed gas, or conduct the purification after the second combustion of the pyrolysed gas. This method is less power consumption, equipment investment saving, low operation cost, stable operation, and suitable to various methods of plasma-enhanced decomposition of organic waste.	Sheng Hongzhi Institute of Mechanics, Chinese Academy of Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914 Postcode: 100080
18	CN 200310115199.4	a plasma multi-level lysis method and device which can simultaneously handle a wide range of organic waste	China	plasma	This invention relates to a plasma multi-level lysis method and device which can simultaneously handle a wide range of organic waste. The method consists of a pyrolysis furnace using reducing plasma working gas. The generated exhaust gas is combustible gas, and it enters into the second-level cracking furnace to provide auxiliary energy for the second-level cracking furnace. The second-level cracking furnace adopts oxidizing working gas which can save power consumption; If the parallel arrangement is adopted, the cracking furnace and the second level cracking furnace can use one set of exhaust gas treatment equipment. The exhaust gas from the first level cracking furnace in the tandem arrangement can be used as auxiliary energy for the second-level cracking furnace after neutralizing the acid gas. The combustible gases emitted from the second-level cracking furnace enter into the burner or generators. The bottom of the second-level cracking furnace in this invention has at least one air inlet, so the more gas can be supplied to increase the cracking temperature, so that energy and time can be saved. Two-level cracking furnace can follow the integration of design, and form a combination-type furnace.	Sheng Hongzhi Institute of Mechanics, Chinese Academy of Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914 Postcode: 100080
19	CN 200310121342.0	A Pyrolysis Facility and method Combining Plasma-Arc and Joule-Heat for Organic Waste	China	plasma	This invention relates to the pyrolysis facility and method combining plasma-arc and joule-heat for organic waste. The plasma arc furnace, with lining of fire-proof material, heat barrier material and water cooling jacket inside, should has an feed inlet, an air exhaust and a slag notch. Besides, there should also be a working gas inlet and at least two oblique cutting poles connected with electrical sources on top of the furnace as well as a crucible at the bottom. There should be independent heating element on the crucible and connected with the electrical source. A thermocouple is needed outside the furnace to measure and control temperatures. This invention adopts the pyrolysis facility and technics combining	Sheng Hongzhi Institute of Mechanics, Chinese Academy of Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914

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					plasma-arc and joule-heat for organics. With the independent heating element designed on the crucible, waste can be heated through Joule effect and needn't electric conduction which depends on slag. Therefore, the pyrolysis temperature can be controlled with 1273-1773K, which may save power consumption. Besides, because ohmic heating doesn't need to translate power into plasma before the heating of waste, the electrothermal efficiency can reach 100%.	Postcode: 100080
20	CN 200310103200.1	A Set of Waste Pyrolysis Facilities of Alternating Current Plasma	China	plasma	This invention discloses a set of waste pyrolysis facilities of alternating current plasma. The system mainly includes a feeding equipment, a alternating current plasma pyrolysis facility and an exhaust emission equipment, with the alternating current plasma pyrolysis facility as the hardcore of the system. The pyrolysis facility is made up of integrated plasma generator and reactor (together called plasma furnace), with feed inlet, gas inlet, and three oblique cutting and movable poles on the top of it. These three poles connected to electrical sources can generate electric arc which can ionize working gas and produce plasmas with high temperature. The three poles incline to each other at an angle of 120±15. The plasma reactor is a container which uses the plasma technology to pyrolyse waste. This invention use high temperature plasmas to pyrolyse waste, which can improve the destroying efficiency and reduce secondary pollution. It is a quick, clean and environment-friendly method to pyrolyse waste. Besides, the feeding equipment has been designed to be of highly automatic and have functions of security isolation and defense. Therefore, the operation can be safe and reliable.	Sheng Hongzhi Institute of Mechanics, Chinese Academy of Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914 Postcode: 100080
21	CN 200320122193.5	A Plasma-Arc Technology Facility for Hazardous Waste Treatment	China	plasma	This invention discloses a plasma-arc technology facility for hazardous waste treatment. The furnace , with lining of fire-proof material, heat barrier material and water cooling jacket inside, should has an feed inlet, an air exhaust and a slag notch. Besides, there should also be a working gas inlet and at least two oblique cutting poles connected with electrical sources on top of the furnace as well as a crucible at the bottom. There should be an arc starting locating device which can locate the two poles and assist arc starting. This invention of small investment and low cost can reduce the consumption of working gas, and production of emissions. Therefore, it can be be adopted to all kinds of waste which are unsuitable to be disposed by incineration.	Sheng Hongzhi Institute of Mechanics, Chinese Academy of Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914 Postcode: 100080
22	CN 200320121907.0	a plasma pyrolysis furnace for the enhancement of decomposition of organic waste	China	plasma	The utility model involves a plasma pyrolysis furnace for the enhancement of decomposition of organic waste, including furnace body. On the furnace wall is set up inlet and plasma torch; at the bottom of the furnace wall has the slag exit; on the top is the gas outlet. The plasma torch is set up on the rotating devices or the furnace wall on which is set with at least one air inlet 3. It is connected to the gas cylinder through the channel. The method for enhancing plasma-decomposition of organic waste needs to pre-treat solid, semi-solid, liquid or gaseous organic waste, and then proceed pyrolysis in the plasma furnace. After those steps, the pyrolysis gas is post combusted after purification or proceed purification after post combustion of the pyrolysis gas.This device has no stringent requirements for the composition of raw materials, so that the utilization of the equipment can substantially be increased with less production costs. The plasma furnace can perform a consecutive 24-hour operation or intermittent operation according to differnet needs.	Sheng Hongzhi Institute of Mechanics, Chinese Academy of Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914 Postcode: 100080
23	CN 200320122194.X	an integrated multi-level plasma pyrolysis	China	plasma	The utility model involves an integrated multi-level plasma pyrolysis furnace that can simultaneously dispose a variety of organic waste, including a first-lesvel plasma arc furnace and a second-level plasma torch furnace. The two furnaces share one furnace wall and become integrated furnace. On the	Sheng Hongzhi Institute of Mechanics, Chinese Academy of

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		furnace that can simultaneously dispose a variety of organic waste			first-lesvel pyrolysis furnace has a switchableair exit which is linked to the inlet of the purification device of the first-level furnace, while the outlet of the purification device is connected to the inlet of the second-level pyrolysis furnace. The sharing furnace wall is built one channel which can be the outlet of the first-level pyrolysis furnace and the inlet of the plasma torch furnace at the same time. The channel is equipped with baffle switch. When the first-level furnace uses the channel to emit gas, the outlet is closed, vice versa, which forms the series of the pyrolysis furnace. Or, the first-level furnace exhaust port is connected to the outlet of the second-level pyrolysis furnace through the channel, which forms the parallel circuit of the pyrolysis furnace. the bottom of the second-level pyrolysis furnace in this utility mode has at least one inlet port, which can save energy and time by increasing the pyrolysis temperature by adding the supply of gas.	Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914 Postcode: 100080
24	CN 200320127919.4	an installment involving organic waste pyrolysis through plasma arc and electric heat	China	plasma	The utility model refers to an installment involving organic waste pyrolysis through plasma arc and electric heat, including plasma arc furnace inside which has refractories, insulation materials, and cooling water jacket. On the furnace is equipped with feed port, exhaust port and slag exit. At the top of furnace has a working gas exit and at least two electrode conntected to the power source. At the bottom of the furnace has crucible on which is set with independent heating components which is connected to the power. On the furnace wall is equipped with thermocouple that can measure and control temperature. The device uses plasma arc furnace. On its crucible is set up an independent heating element. Since the independent heating has no need to rely on electrical conductivity of molten slag, joule heating effect is used for the waste heating. Therefore, the Pyrolysis temperature can be controled within 1273-1773K to save power consumption. The joule heating can achieve 100% heating efficiency without requiring electrical energy transforming into plasma for waste heating.	Sheng Hongzhi Institute of Mechanics, Chinese Academy of Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914 Postcode: 100080
25	CN 200320103141.3	a complete installation of alternating plasma pyrolysis waste	China	plasma	The invention discloses a complete installation of alternating plasma pyrolysis waste, mainly comprising a feeding device, alternating plasma cracker and exhaust emission device. Its core part is the alternating plasma cracker which consists of integrated plasma generator and reactor (collectively referred to as plasma furnace). At the top of it is set with feed port, intake port and three slant and movable electrodes. This three electrodes are used to generate electric arc, ionization working gas and high temperature plasma. They are linked to alternating current power and be distributed 120 ± 15-degree angle to each other. The plasma reactor is the container for the plasma pyrolysis of waste. The invention uses the high-temeperature plasma for the pyrolysis of waste, featuring the high efficiency of destruction, less secondary pollution, and fast, clean, green waste pyrolysis. The feeding device has security isolation protection with a high degree of automation control and safe operation.	Sheng Hongzhi Institute of Mechanics, Chinese Academy of Sciences No. 15, West Road, North 4th Ring Road, Beijing Tel.: 86-10-62560914 Postcode: 100080
26	CN 02158856.2	a device and technology for special waste disposal	China	High temperature incineration	This invention relates to a device and technology for special waste disposal, especially clinker burning furnace and related method for hazardous and medical waste disposal. Hazardous or medical waste enter into the oxygen-poor combustion pyrolysis furnace, and be heated, dried, pyrolysed, and gasified by the high-temperature gas flow generated from oxygen-poor combustion. The generated cracked gas enters into the second burning chamber; solid residues after the pyrolysis decrease to a suitable temperature and enter the slag furnace where the residual carbon is gasified. The melt slag in the furnace come out of the furnace and become water granulated slag, which can be made down-stream product by the factories of cement or construction material. steam produced by high-temperature flue gas can promote the turbine to	Anshan Research Institute of Thermo-Energy co., ltd. No. 43 ,Green Street, Tiedong District, Anshan, Liaoning Province Email:anshanrd@sinosteel.com Tel.: 86-412-5233388

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					generate power. In the tail of extra heat boiler, the flue gas enters purification equipment through the quench and be emitted after meeting the purification standard. The invention's advantages include high thermal efficiency of incineration, less waste disposal expenses and it can make hazardous waste and medical waste thoroughly harmless.	Postcode: 114004
27	CN 03213537.8	An industrial hazardous waste incineration line sudden cooler	China	High temperature incineration	An industrial hazardous waste incineration line sudden cooler, used for the incineration line flue gas cooling and purification system of industrial hazardous waste, especially for the cooling and purification of PCBs incineration flue gas. The utility model is designed and manufactured according to the Principles of venturi tube, consisting of entrance cylindrical section, conical convergent section, throat section and conical diffuser section. The entrance cylinder, on the top of incineration line sudden cooler, is the water-cooled jacket, and outside it is set with four Inlet ports. At the bottom of the entrance cylindrical section is linked to conical diffuser section within which is set with dual nozzles that could be dismantled outside. Between the conical contraction section and conical diffuser is the throat section. At the lower end of conical diffuser is the exit round section. The combination of spray-type water cooling and recycled water type cooling can make high-temperature flue gas quench.	Shenyang Orient Titanium Industry Co., Ltd. No. 137, Nan Ta Street, Dongling District, Shenyang, Liaoning Province Tel.: 024-24523069 Email:stdfty@sydfty.com Postcode: 110016
28	CN 02235414.X	incineration system of industrial hazardous waste	China	High temperature incineration	The utility model involves an incineration system of industrial hazardous waste, mainly comprising vertical rotary furnace, horizontal rotary furnace, the second combustion chamber and flue gas treatment equipment. The system has a wide range of application with complete burning, safe operation, low cost, simple technology and equipment, and low pollutant emission. It applies to incineration of solid, liquid and other industrial hazardous waste or mixed waste.	Wu Tong Room 1121, Tower 2, Bright China Chang An Building, No. 7, Jianguomen Nei Avenue, Dong Cheng District, Beijing Postcode: 100005
29	CN 200420030895.5	a exhaust sudden-cooling device of solid waste incineration	China	High temperature incineration	The utility model belongs to the field of solid waste treatment equipment, specially involving a exhaust sudden-cooling device of solid waste incineration. It includes: tower (1), above which is set with a venturi (2). The lower channel of the venturi is connected to the bottom of the tower (1). At the bottom of the tower is equipped with air outlet (3). At the bottom of the venturi is a nozzle A (4), and at the bottom of the tower is a spare nozzle. The utility model's structure is simple and can effectively inhibit thc synthesis of dioxins and reduce environmental pollution.	Shenyang Institute of Environmental Sciences No. 139, Nan Ta Street, Dongling District, Shenyang, Liaoning Province Postcode: 110016
30	CN 200420030896.X	a solid waste incineration device	China	High temperature incineration	The utility model is a waste incineration technology, specially involving a solid waste incineration device including medical waste. It includes: ozone generating device (1), incineration furnace (2); the air outlet of the above mentioned ozone generating device (1) is connected with the incineration furnace (2) through the gas pipeline road (3). In the end of the above gas pipeline road (3) is set with a deflector body (4). The utility model's structure is simple, low environmental pollution, and can effectively inhibit the generation of dioxins and to reduce CO emissions.	Jin Chongyang Shenyang Institute of Environmental Sciences No. 139, Nan Ta Street, Dongling District, Shenyang, Liaoning Province Postcode: 110016
31	CN 200420118648.0	a rotary-kiln incinerator of hazardous waste	China	Rotary kiln	The utility model reveals a rotary-kiln incinerator of hazardous waste, including a horizontal rotary-kiln type incineration furnace body at the end of which is connected to the head-end of the fixed kiln and above which is set with the feed inlet. At the other end of the incineration furnace is connected to the back-end of the kiln, and above it is the feed outlet. The outside of the kiln incinerator is the metal	Beijing Zhongji Lugu Ecological Technology Co., Ltd. Room 1012, China

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					furnace wall on which is equipped with several Y-type metal hooks. Their bifurcation side is targeted the inside of the furnace, and fixed on the metal furnace wall, inside which has one refractory layer. At the metal hook is built a refractory protrusion. The cross section of the protrusion inside the refractory layer wall has the shape of a trapezoid. This rotary-kiln incinerator of hazardous waste can effectively avoid certain adverse problems when waste turn over in the kiln body by setting protrusion. Besides, since the protrusion is fixed by the "Y"-type hook, it is firmly linked to the furnace wall. Besides, the secondary combustion chamber in the combustion furnace is in horizontal structure, reducing the height of the equipment, easy for maintenance.	Construction First Building, No.52, West 4th Ring Road, Beijing Tel.: 010-83982161 Email:support@eco-sinobase .com Postcode: 100073
32	CN 03143479.7	Method to use cement kiln to handle liquid, solid, semi-solid hazardous waste	China	Cement Kiln	Invention refers to a simple and reasonable way to use cement kiln to handle liquid, solid, semi-solid hazardous waste. As to liquid hazardous waste, it is mainly conveyed through pumps, and incinerated after entering into cement kiln through the kiln. For solid hazardous waste, it can be used as resources and fuel according to its heat value or incinerated after entering into cement kiln through the top and the end of the kiln. As for the semi-solid hazardous waste, it can be put in one container, and injected into the prepared area of the cement kiln through specific waste conveying device and then be incinerated. This invention can make the hazardous waste treatment system as simple and reasonable as possible under the premise that security is guaranteed.	Shanghai Wanan Enterprises No.4338, Tingfeng Road, Jinshan District, Shanghai Tel.: 021- 57321086 Postcode: 201500

2 Patents And Equipment Of Disposal Technologies in Foreign Countries

No.	Technology	Patent No.	Register district	type	Statement	Contact
1	PACT Plasma Arc Centrifugal Treatment	US 4,770,109	The United States, Germany, Russia, Switzerland and other European countries	Plasma arc	The waste temperature in where the region of it impart,has reached 1,200-1,600 °C by The use of Plasma Arc Centrif ugal Treament(PACT), the main reaction ocurrs in a sealed water-cooled centrifugal furnace body which contained Plasma Arc Centrifugal, the reactor by the rotating centrifugal force generated by the material from the reactor center into the plasma torch of the affected zone. At the end of the main reaction, the reaction stops rotating, slag discharge, collection cooled to form a solid glass.	R.K. Womack, Retech Services, Inc., P.O. Box 997, Ukiah, California 97482; (707) 467-1721; fax (707) 467-1638; e-mail ronald.k.womack@lmco.com.
2	PCS Plasma Converter System	US 5,887,554	The United States, Japan, Australia, China	Plasma arc	In the cylindrical reactor, using nitrogen Plasma Converter System produces a plasma area where the temperatures can reach as high as 16000 °C. Waste will pass the reactor at one end ,then enter through the plasma zone to reach the other side, the material at high temperature is decomposited to the element. The molten material which formed in the reactor discharged from the reactor at the bottom to form inert materials, including metals and silica.	Startech Environmental Corp. 15 Old Danbury Road Wilton, CT. 06897-2525 (203) 762-2499 (888) 807-9443 Fax: (203) 761-0839 starmail@startech.net
3	PEM™ Plasma Enhanced Melter™	US 6,630,113	The United States, Japan, China	Plasma arc	Using two sets of heat source: DC arc system is used to generate Plasma to decomposite the waste. AC resistance system is used to heat molten glass directly. In the aim of energy conservation ,when the system is idle, we can only *maintain AC to surpply the power,and adjust the ratio of two* heat sources according to the Waste feature and improve energy efficiency	The IET company of United state (Integrated Environmental Technologies,LLC)
4	High Temperature Incineration	US 5,632,210	The United States, Britain, Finland	Burning	In order to eliminate the POPs pollution,we can make use of the process of high temperature oxidation, the POPs will be oxidated and decomposited into water, carbon dioxide, as well as fly ash,slag and other non-combustible solid material.	Burn center of Shenyang
5	(BCD) Base-catalyzed decomposition	US 5,064,526	Australia, the Czech Republic, Japan, Mexico, and the United States	Chemical Reduction	We can add the Alkaline chemicals which the form is aqueous solution or a high boiling point solvent into pollutants,after dehydration, the media then heated for some time in the temperature between 200and 400 ℃to achieve the reducted decomposition of halides and non-halogenated organic pollutants	BCD Technologies PtyLtd ;Narangba,Queensland Australia4504 Rex Williamsor Martin Krynen 61732033400 Facsimile:61732033450 marius@gil.com.au
6	Sodium Reduction	Us 6,984,767	North America, Germany, France, Iran, Spain, Japan, Canada, the United States, the United Kingdom	Chemical Reduction	To deal with the alkali metal waste. Basic metals can react with the chlorine in the halogenated waste to produce salt and non-halogenated waste.	

No.	Technology	Patent No.	Register district	type	Statement	Contact
7	Cement Kiln co-precessing	Us 5,123,364	Germany, Japan, the United States and other European countries	Burning	We can make use of the waste as a cement raw material or fuel substitution,Only the full use of its calorific value or the mineral , can the pollutants not only converte into cement pollutants, but also realized its environmentally less hazardous waste disposal	Cement company of Germany ;
8	GeoMelt™ High-temperature melting technologies	Us 7,048,961	The United States, Japan and Australia	Heat/ Melting	The contaminated soil which will be molten can be inserted into two pairs of large carbon electrode. When the current flows through the soil , the electricity is converted into heat, the soil gradually melting,and then forming non-toxic, non-leaching and the material of glass block of good stability. Continuing electricity, the region depth and breadth of the soil have gradually increased, until it reaches the required processing capacity.	Grand Ledge, Michigan, Battelle Memorial Institute the Parson chemical Super Fund
9	DARAMEND® Bioremediation	US 5,618,427	Canada, Montgomery, Montgomery, Alabama	biology	The first is to add the solid phase DARAMEND of a specific particle size distribution and nutrient profile ® organic soil improvement agent, zero-valent iron and water to create a hypoxic environment. Re-cultivate the soil regularly in order to promote the formation of aerobic environment. Finally repeated hypoxia - oxygen cycle until it reaches the clean target.	Mississauga, Ontario, Canada Adventus repair techniques (ART), Illinois, Bloomingdale's Adventus Americas
10	FeIII photocatalytic degradation	Us 5,205,940	The United States	Chemical oxidation	It Include: sunlight destruction of pollutants, photochemical degradation,UV photocatalytic destruction and photocatalytic degradation, its existence promotes the degradation of HCB,and its role in promoting is the most distinguished in the 5 mg / l	Inventors: Graetzel;Michael(St.Sulpice,CH) Assignee:EMS-Inventa AG(CH)
12	MnOx / TiO_2 - Al_2O_3 catalyst degradation			Chemical oxidation	MnOx/TiO2-Al2O3,which is prepared from injected MnOx in the modified $Al_2O_3$by TiO_2 is a highly active catalyst.TiO2 distributied in the TiO2-Al2O3 single-layer substrate, MnOx highly dispersed in the TiO2-Al2O3 substrates. As the catalyst, . Chlorobenzene and o-dichlorobenzene can reach complete oxidation in the speeds of 8000h-1 .in the temperature of 300 ℃ and 250 ℃	No commercial
13	Sonic	Us 4,428,828	The United States, Canada	Physics / leaching	An ectopic POPs disposal technologies, including the Terra-Kleen solvent extraction and Sonoprocess ™ dealing:.in the the Terra-Kleen process, contaminated soil mixture with the solvent first, and then under the effect of sound energy, the mixture will be shaked , the PCBs which contained in the soil is extracted and then suspended in the solvent; the main technical-of Sonic -Sonoprocess ™ is a technology that use chemical methods to destroy liquid or sludge PCBs and other persistent organic pollutants,in the process of Treatment, the solvent mixed with the sodium ,and use the sound energy to	Mr. Paul Austin Sonic Environmental Solutions Inc. 1066 West Hastings Street, Suite 2100 Vancouver,British Columbia,Canada V6E 3X2 (604) 736-2552 Fax: (604) 736-2558

No.	Technology	Patent No.	Register district	type	Statement	Contact
					make solvents PCBs activately dechlorination. The solvent used can be recycled through the system regeneration. Exhaust can be dealted by condensation, fog removing and multi-level carbon filtration treatment	paustin@sesi.ca
14	Thermal desorption - Oxidation TDR-3R™	Us 5,193,934	Hungary, the United States	Buring	Contaminated soil is heated in a vacuum furnace under the 0-50Pa in the 300-350oC temperature In some instances, when the POPs is processed, the furnace is heated to a higher temperature. The pollutants in the soil is evaporated and released in the furnace. The contaminants evaporated in the furnace recovered, and combusted at least 2 seconds in the thermal oxidation device at a temperature of up to 1,250°C. The exhaust gas in the Thermal oxidation device is cooled rapidly, pass throught a moisturc Venturi scrubbers and then released.	Mr. Edward Someus Terra Humana Clean Technology Engineering Ltd. 1222 Budapest, Szechenyi 59 Hungary (36-20) 201 7557 Fax: (36-1) 424 0224 edward@terrenum.net
16	(SCWO) Supercritical water oxidation	US 5,571,423	the United States	Chemical / oxidation	the waste is disposaled in a closed system,, it uses an oxide (such as oxygen, hydrogen peroxide, nitrite, nitrate, etc.) in the water, the temperature and pressure used are above the critical point of water and near the critical point of water (370 °C and 262 atmospheres). Under these conditions, organic pollutants becomes highly soluble in water and are oxidized to produce carbon dioxide, water and inorganic acids or salts.	General Atomics P.O. Box 85608 San Diego, CA 92186-5608 (858) 455-3000 Fax: (858) 455-3621
17	Ozonation / electrical discharge destruction	Us 4,461,744	the United States	Chemical oxidation	the VOC-containing dioxins and furans can be dealted with the electrical flow directly, or the flow can be indirectly dealed with the ozone generated by the electrical discharge, electrical discharge treatment could not only reduce NO/NO2 and SO2 either in a directly or indirectly way but also deal with dioxin and furan in the flue gas, indirect treatment can remove 90% of the dioxin-like in the practical industrial gases, and can also further complete treatment of NO/NO2, SO2, and dealing with dioxins and furans	
18	Catalytic hydrogenation	Us 4,182,721	Germany, Australia	Chemical Reduction	At the appropriate temperature and pressure, the waste oil can be hydrogenated moderately in an enclosed catalytic reactor in this condition, hydrogen can react with the heterocyclic atoms in the waste oil but also occur the reactions of organic chlorine.	C Australia's Commonwealth Scientific and Industrial Research Organization (CSIRO)Lucas Heights laboratories The company of Kohleol - Anlage Bottrop in Germany

No.	Technology	Patent No.	Register district	type	Statement	Contact
19	Electrochemistry enhanced microbialdegradation	Us 6,004,451	the United States	biology	Based on high-pressure enhanced green reaction,we can make use of magnesium to decomposite organic halide pollutants in the soil components, magnesium may be either pure magnesium or alloy. Because the product of the hydrolysis of magnesium organic halides can combine with the halogen initial released by the pollutants. The regeneration of the surface of magnesium can be further decomposition of pollutants, which has complished by connecteing the magnesium electrodes d to the generator, providing continuous or pulsed power, the best is repeatedly clean the magnesium electrode electrochemical. Soluble chromium (VI) can also be similarly turned into zero-valent chromium at a low oxidation state ,and thus less toxic.	
20	Photochemically enhanced microbial degradation	Us 5,342,779	the United States	biology	And to use microbial degradation in combination. In the moderate-intensity ultraviolet radiation ,it can enhance the growth of white-rot fungi and the capacity of degradation, while also play an important role in the photodegradation of pollutants	Professor Matsumura and Fumio in The University of California
21	Electrochemistry enhanced microbialdegradation	Us 6,699,707	The United States, Japan	biology	the two steps which contains added reductant into contaminants and subordinate in nutritional nutritional source of anaerobic microorganisms. Reducing agent contains the reduced iron, cast iron, iron - silicon alloys, or water-soluble compounds. This method could be achieved through the combination of chemical reactions and microbial to decomposite organic pollutants.of Chlorophenols	Ebara Corporation of Japan
22	MCD Mechano-chemical dehalogenation (MCD)/ Ball Milling	Us 6,382,537	The United States	Chemical Reduction	The POPs waste, hydrogen donor agents and alkali metal mixture will be Mechanochemical dehalogenation . In the effect of mechanical and chemical forces, POPs waste and other reagents occurred reductive dechlorination reaction	Mr. Bryan Black Environmental Decontamination Ltd. P.O. Box 58-609 Greenmount Aukland, New Zealand (649) 274-9862 Fax: (649) 274-7393 bryan@manco.co.nz
23	TiO2-based V2O5/ WO3 catalysis		The United Kingdom, the United States	Chemical oxidation	TiO2 of the anatase structure as carrier, the catalyst of vanadium as the main active ingredient is most widely used in the project, and its technical development is the most mature which its activityis range is between of 300 - 400 °C. Adding	

No.	Technology	Patent No.	Register district	type	Statement	Contact
					WO3 into The catalyst, can increase the catalytic activity and its thermal stability, to prevent sintering of the anatase and loss of surface area. In addition, the added WO3 competited with SO3 about the TiO2 surface basic site, and to replace it, to prevent it sulfation. With the increase of ammonia, the catalyst can be combinated to destruct dioxins and NOx.	
24	AEA Silver II™ Mediated electrochemical oxidation	Us 7,479,215	the United States	Chemical oxidation	SilverII ™ is very similar with the method of CerOx ™ ,using of the Ag2 + in solution as organic oxidants. the design of system is also similar with CerOx ™, except to add a hydrocyclone between the reactor and the electrolytic cell which can reduce the problem of solid feed.	
25	CerOx™ Mediated electrochemical oxidation	Us 5,516,972	the United States	Chemical oxidation	Ce4 + ions is generated by the electrolytic cell, after mixtured with waste,it pass into a liquid phase reactor. as the oxidant, Ce4 + reacts with the POPs to produce CO2, neutral salts and weak acid solution. This process is occurred in the condition of low temperature (90-95 °C) and close to atmospheric pressure. The waste fluid that discharged from the reactor can regenerated after returned into the electrolytic cell. the Ce4 + will oxidate the remainder of organic matter when the gas pass through the countercurrent gas-liquid packed bed reactor	Mr. Matt van Steenwyk or Mr. Norvell Nelson CerOx Corporation 2602 Airpark Drive Santa Maria, CA 93455 (805) 925-8111 Fax: (805) 925-8218 mattvs@cerox.com/njnelson@cerox.com
26	Enzyme degradation			biology		
27	Gas-phase chemical reduction(GPRC)	Us 6,422,002	Canada, Australia, Japan	Chemical Reduction	The organic ingredients can be reacted with the use of hydrogen by the gas-phase chemical reduction method in the condition of above 850 °C. Feed does not require dehydration, for the water can be used as heat exchange agent and the hydrogen source. Water-transfer reaction would convert the methane and water into hydrogen, carbon monoxide and carbon dioxide. To produce hydrogen more efficiently, in the condition of the exsistance of catalyst, the product gas of methane-rich gas at high temperature can re-use through the system of washing supply	the Company of ELIEcoLogic International,Inc in Ontario of Canada
28	Prolysis			Pyrolysis		
29	SET™ Solvated electron technology		the United States	Chemical Reduction	the organic component can be reduced into the metal salts and its parent molecule (dehalogenation) by dissolving Solvated electron solution. Solvated electron solution is a strong reducing	Commodore Solution Technologies

No.	Technology	Patent No.	Register district	type	Statement	Contact
					agent that is formed by dissolved the caustic alkali or alkaline earth metal (such as sodium, calcium and lithium) into anhydrous liquid ammonia solvent.	
30	Molten metal		Germany, the United States	Melting	This treatment technology is to make use of the ordinary blast furnace and steel converter or the use of molten metal or slag to heat to destruct the POPs waste	Wells Rotary Kiln (www.bus-steel.com) Germany (www.na-ag.com 和 www.berzelius.de)
31	Molten salt oxidation	Us 7,288,234	the United States	Melting	similarly with the molten metal, molten salt act both as a reaction solvent and as a catalyst. Waste together with the oxygen injected into the melting pool, which can be destructed and degradated a harmless state of small molecules ain the conditions of high temperature, catalytic and oxidation	U.S. Department of Defense and the Department of Energy, use this technology to deal with more than 30 kinds of chemical waste. during 1997 to 1999
32	Molten Slag		Japan	Melting	the steel waste that would be dealt mixtures with the ashes to form foaming slag on the electric arc furnace when the feeding temperature is about 1500 ˚ C after extracted. After the waste into slag phase, like Molten Slag, the metal oxides have been reduced to metal, all the organic material have been reduced to the basic elements	Nippon Steel Technical Report N0.92 July 2005
33	Bioremediation / Fenton reaction	Us 7,335,246	The United States, South Korea, China	biology	Based on the Fenton reaction which is generated by free radical ,it can react with iron produced by bacteria. In the environment of alternating aerobic and anaerobic, the iron ion valence change, based on Fenton reaction, through the electronic and hydroxyl free radicals to destroy the benzene ring structure, so as to achieve the purposes of degradation of Chlorophenols organic pollutants	pro.Nam Kyoungphile of South Korea's Seoul National University
34	Xenorem™		The United States	biology	an exsitu bioremediation technology that has been used to treat low-strength waste containing chlordane.Xenorem™ uses an enhanced composting technology consisting of aerobic and anaerobic Treament cycles. Organic amendments such as manure and wood chips are added to contaminated soil, which can increase the final amended soil volume by as much as 40 percent .	Mr. Michael Klerkin Technology Transfer Corporation University of Delaware Newark, DE 19716 (302) 831-4230 http://www.udel.edu/
36	In-situ theral desorption/destruction	Us 5,674,424	The United States	Thermal decomposition / burning	The use of the method of heating ,volatile and semi-volatile compounds and elements (most commonly oil, hydrocarbons, etc.) can be separated from the contaminated media (the most commonly is the soil excavated from the ground, etc.)	
37	In situ bioremediation of soils	Us 5,458,747	The United States	biology	DDT anaerobic biological can be converted into the non-toxic compounds by mix pollutants, bacteria, surfactants and reducing agents together . If you do not through In situ bioremediation, DDT would lose a chlorine and convert into the	

No.	Technology	Patent No.	Register district	type	Statement	Contact
					DDD	
38	Phytoremediation		The United State,Canada	biology	Plants can absorb organic pollutants directly, and then remove these substances through different ways, it can also secrete kinds of enzymes,and convert or degradate of organic pollutants through the catalysist of enzyme. At the same time, plants can adsorb the organic pollutants on the surface of root, through and the synergies action of rhizosphere microorganisms to achieve the degradation of organic pollutants.	Phytotech Division of Edenspace Systems Corporation;Thomas Consultants, Inc.;Verdant Technologies, Inc.;Viridian Environmental LLC
39	SPHTD Chemical enhanced microbial degradation	Us 5,342,779	United States, Italy	Unknown	anexsitutechnologyusedtotreatstockpilescontainingHCBcontamination.HCBcontainingstockpilesaremixedwithcalciumhydrideor calciummetal,andthemixtureisplacedinareactionchambercontainingatungstencoil.Additionofpurifiedargongascausesthereactionchambertobecomepressurized,andanelectricalpulsetothetungstencoilinitiatesthereaction.Thereactionchambercanreachatemperatureof3,727°C,whichcreatesthermochemicalconditionsthatconvert HCBtocalciumchloride,carbon,and hydrogen.	CentroStudi SulleReazioniAutopropagantiin Italy. HTTP://WWW.IHPA.INFO/LIBRARYNATO.HTM.

Annex 7

List Survey and Policy Research Project of Document Preparation Sub-project of Environmentally Sound Management of obsolete POPs pesticides and other POPs wastes in China

Necessity & Feasibility Study Report on Special Management & Uniform Disposal for Pesticide POPs Wastes in China

Sub-project Client: Foreign Economic Cooperation Office, Ministry of Environmental Protection

Sub-project Executer: Institute of Solid Waste Management, Chinese Research Acadamy of Environmental Science

October, 2009

Contents

1. Necessity of Pesticide POPs Waste Special Management & Uniform Disposal in China

1.1 Risk Analysis on Environmental Pollution of Pesticide POPs Waste in China

According to Stockholm Convention on POPs, put into effect on May 17 of 2004, the first 12 categories of Persistent Organic Pollutants (POPs for short) under control include 9 kinds of pesticide POPs, such as Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, HCB, Mirex, Toxaphene, and DDT, as well as 12 kinds of toxic organic pollutants, including PCDDs and PCDFs (both called Dioxin hereafter).

Due to the chemical structure and composition of POPs, it has many special properties, such as long residual property, biological accumulative property, semi-volatile property and high toxicity. Therefore POPs can transfer a long distance in air and deposit on earth, which can seriously endanger human health and the environment. POPs are capable of resisting biological metabolism, photodegradation and chemical decomposition in natural environment. Once discharged in the environment, POPs are hard to decompose and thus they can stay in media, such as water, soil and sludge, for several years even tens of years or longer. They also can enter into the air from water or soil in the form of vapor, and then transfer in various forms. Therefore POPs may be detected on land, deserts, oceans as well as north and south poles around the globe. Studies show that POPs are even found in the mammals lived in sparsely peopled arctic regions and the content is relatively high.

The harm of POPs is that they are easy to dissolve in fat and thus biological accumulation occurs in fat tissues. Studies show most POPs are highly toxic for human and animals. Recent researches show that even the exposure of slight amount of POPs may lead to cancer, damaging the central and autonomic nervous systems, inducing immune system disease, reproductive system disorder, disturbing the normal growth of baby and kids, and directly threatening human survival, reproduction and sustainable development Dioxin chemical is one of the representative of POPs and WHO ranked it as Grade 1 cancer-causing substance as early as 1997. 7 out of 12 representative POPs listed by UNEP are ranked as potential human cancer-causing substances. In recent ten years, environment pollution accidents associated with POPs emerge one after another, e.g. on July 1976, in Italian Seveso Chemical Plant, a explosion took place and 2kg Dioxins were released, leading to poultry in surrounding area died in large amount, blisters appeared on the checks of kids and over 700 people moving away; in Japan in 1968 and in Taiwan 1979, thousands of people were poisoned by eating rice bran oil polluted by PCBs, and the babies born 7 years later by mothers who contacted PCBs are disturbed by over pigmentation, nail and tooth distortion, as well as underdevelopment at age of 7 and absurd behaviors; in 1999, in Brussels of Belgium, there were chicken containing too much Dioxins and the Dioxincontent in milk powder are rather high, which once aroused the panic of consumers all over the world and the Belgium Cabinet was forced to resign in a body.

Therefore, from chemical structure and pollution features, pesticide POPs wastes are highly toxic, seriously threatening environment and human health and highly risky to environment, and shall be managed specially.

1.2 Results and Existing Problems in Pesticide POPs Waste Preliminary Survey in China

1.2.1 Pesticide POPs waste preliminary survey and estimating

During the compliance of National Implementing Program (NIP), pesticide POPs were investigated preliminarily in production field and circulation field respectively, and then the total amount in China was estimated. The survey covers the production field of pesticide POPs and product application filed.

For the production field of pesticide POPs, in the 58 enterprises which were once involved with pesticide POPs productions, comprehensive survey was applied to 44 enterprises except the universities and institutes which never dealt with mass production. The results show that, in the nine kinds of pesticide POPs, 94% is DDT in China, which is the major waste of pesticide POPs in China. In the production field, there are 3840~4380t wastes, including 2400~2800t DDT, 60~70t HCB/PCP-Na and 1380~1510t Chlordane and Mirex. In the total 3840~4380t wastes, the location and quantity of 2228~2458t, about 60%, have been confirmed and the rest 40% (1612~1922t) will be determined after the search strategy is made.

In the circulation field of pesticide POPs, the circulation in Chongqing was investigated comprehensively and the results show that, the total amount of POPs pesticide in circulation filed in Chongqing is 124.776t (see Table 1). 10 counties were selected as pesticide POPs pilots, that is, Shuangyang District of Changchun, Dehui City, Jiaohe City, Dongliao City, Fusong County, Zhenlai County, Shuangliao City, Dunhua City, Fuyu City and Jian City. According to the preliminary survey of local environmental protection departments, in the 10 pilots, 3 POPs wastes storage sites were found, Shuangyang District of Changchun (5t), Dehui City (21t) and Zhenlai County of Baicheng City (5.1t), and altogether 31.1t wastes were found. In Jiangsu Province, the survey pilots are ten counties, cities (districts) including Taicang, Jiangyin, Liyang, and Jinchang District of Suzhou in south, Dantu District of Zhenjiang, Haian, Gaoyou, Baoying and Xinghua in middle, and Huaiyin District of Huaian in north. In the 10 pilot cities and counties, 3 POPs wastes storage sites were found: 8t liquid pesticides (unidentified category) in agrotechnology promotion station of Yuanji Town, Huaiyin District of Huaian, 7t PCP-Na stored in the disease control center of Haian County, Nantong City, and 5.6kg PCP-Na stored in the disease control center of Dantu District of Zhenjiang, the latter two of which are valid stock.

Table 1 Farmland Area and Waste Amount in Chongqing Survey

District	Farmland Area (Mu)	Waste Amount (kg)
Yuzhong District	0	7.5
Jiangbei District	54390	530
Shapingba District	149685	50104
Qianjiang District	428085	4.7
Qijiang County	551910	22416
Tongnan County	742860	24
Kai County	991680	25616
Wushan County	721875	24000
Wuxi County	816150	2000
Shizhu autonomous county	34900	35
Nanchuan City	464925	40
Chongqing	20077138	124776

The survey of 43 districts and counties in Chongqing is comprehensive and thus the data quality is relatively high. The estimation is made with data from Chongqing and the total amount of POPs wastes in China is calculated from the statistics of farmland. An equation is obtained from the linear regression between farmland area and waste amount:

$$Wa=104.136+0.006Pa \qquad [1-1]$$

where:

Wa — amount of mixed POPs waste in survey region

Pa — farmland area in survey region

From latest data of National Bureau of Statistics' statistical yearbook (2007), the regular farmland in China now is 0.13 billion hectares With Equation [1-1], it is estimated that the amount of pesticide POPs wastes is 11000t.

1.2.2 Existing problems in POPs waste survey in China

However, due to the limitation of POPs waste preliminary survey, in production field, the wastes whose location and quantities have been confirmed are only 2228～2458t, about 60% of the total amount, in this survey while the rest 40% (1612～1922t) is waiting for further survey. The investigation of pesticide POPs wastes in circulation field is more difficult. In the 63 districts and cities of the three pilot provinces (including Chongqing), less than 200t were found and there are much more pesticide POPs wastes waiting for further survey, which is an important task for China to perform.

1.3 Current Situation POPs Waste Management and Existing Problems in China

1.3.1 Current situation of POPs waste management in China and performance analysis

(1) Present solid waste management system is the base for POPs waste management

Since the issue of *Laws on Prevention of Environmental Pollution Caused by Solid Waste* in 1995, the development on solid waste pollution control management and legislation is rather rapid, for example, carrying out solid waste declaration and registration as well as survey on production sources; compiling solid waste identification systems including national catalogue of hazardous wastes and identification standards; compiling pollution control standards and disposal technology codes for large amount solid wastes; compiling measures for hazardous waste transfer form management, regulations on medical waste management, measures for hazardous waste operation license management, regulations on environmental protection and management of wastes' importation, regulations on hazardous waste management, measures on waste chemical management and so on; accomplishing the basic principles, systems and policies for solid waste management; and strengthening the importation and exportation of chemicals, the importation and exportation of wastes, the management of special wastes, and etc. Together with the basic laws on environmental protection as well as other laws and regulations, more completed solid waste management regulations, systems and policies are formed, which plays an importation role on controlling solid waste pollution and environmental protection.

Furthermore, the construction of solid waste management institutes as well as other capacities is improved. Personnel engaged in solid waste supervision and management is increasing. For national level, there is Solid Waste Section under Department of Pollution Prevention and Control of Ministry of Environmental Protection; for provincial level, there are pollution control departments (solid waste departments); for district level, there also are solid waste management institutes under environmental protection departments. Meanwhile in counties or county level cities, there are also solid waste functions. National solid waste management centers and provincial (municipal) centers (already established in some places) will undertake large amount of technology research and supporting tasks for solid waste management, and are the basic management system for solid waste environment supervision and management. The state, local governments and enterprises will input large amount fund for the management of solid waste.

All above activities have prepared a better foundation for POPs waste management and disposal in China. During the compliance and implementation of POPs waste management strategies, the existing management regulations, systems and standards must be referred completely.

(2) Analysis on the deficiencies of present laws, regulations and systems on solid waste management

Some problems still exist in solid waste environment management in China, for example, incomplete solid waste environment statistic system, deficient investigation methods, and unclear solid waste sources; For the solid wastes left over by history with no owner or person in charge, especially POPs waste management and disposal, there is no distinct management regulation by laws and there is also no distinct requirement on corresponding responsibilities; there is no clear requirement on waste production investigation and statistics by laws; there is no basis for the exempt management of hazardous waste to relay on; for the propaganda of solid waste management and environment pollution, the detailed instruction and supporting is lacking; the declaration and registration system is made for current industrial enterprises but there is no distinct regulation for the waste generated during circulation and left over by history.

(3) Deficiencies of POPs waste management

In China, POPs waste management and harmless disposal are still young and the domestic enterprises are generally incapable of processing POPs waste. Meanwhile strict countermeasures are not applied to prevent secondary environmental pollution by POPs wastes. Therefore, the promotion of POPs waste disposal needs powerful supporting from laws, regulations and policies. The key points are strengthening compulsory disposal and treatment within a prescribed limit of time, waste declaration, pollution investigation, research and assessment, fund supporting and input, cooperation between different levels of authorities and environmental protection institutes, and intensifying propaganda.

In the existing solid waste incineration and landfill pollution control standards and solid waste analytical standards in China, there is no systematical standard limits and methods for the 12 categories of POPs, but only limit values and analytical methods for PCB, Dioxins in waste disposal facility pollution control standards; there are little items and insufficient analytical methods for POPs limit values and analysis in comprehensive discharge standard for sewage, environmental quality standard for soil and groundwater quality standard, which are not totally applicable for POPs waste control and analysis. At the same time, overall management codes for POPs waste production, reduction, collection, transportation, disposal, monitoring and supervision are also lacking, which is against the environment-friendly management and harmless disposal of POPs waste.

The capacity of POPs waste supervision and management need urgent improvement and large quantity of training is also needed. In addition, enhance the propaganda and improve the recognition and vigilance on POPs waste of the whole society.

The comparison and analysis between POPs waste management in China and POPs conventions are shown in Table 2, which explains and compares the factors of legislation and management.

1.3.2 Existing problems in POPs waste management in China

In China, most people know little about POPs wastes, which may lead to improper disposal of POPs wastes and thus cause secondary pollution as well as harms to human body and environment.

Now it is found lots of improper management on pesticide POPs stocks, which are not sealed and treated specially. Especially for the disposal of POPs polluted soil by some previous producers, there is no related regulation on whether the POPs polluted soil shall be treated as hazardous waste, and therefore the polluted soil will be managed with existing hazardous waste regulations. Due to the different usage of soil in polluted sites, most of them were buried or excavated and transported outside by the producers. Those improper disposals increase the risks of POPs on environment.

It is of great difficulty to carry out extensive survey of pesticide POPs waste and to find out the accurate amount. The enterprises with pesticide POPs waste may worry about the disposal responsibility and expenses, and thus it is common that we cannot get the actual information during investigation. If special management is adopted for pesticide POPs waste, namely uniform disposal, the performances of search and uniform disposal can be finished by the joint efforts of environmental protection system and other social forces.

1.4 Specialty of Pesticide POPs Waste Disposal Technology in China

The chlorine content in waste pesticide POPs and Dioxins-rich wastes are relatively high and thus the disposal is difficult and requires higher technology. The incineration facilities for common hazardous wastes cannot be used to dispose those special wastes.

According to the requirements of BAT/BEP technical guidelines for POPs waste disposal by UNEP, with incineration facilities and cement kilns co-processing for hazardous wastes, the discharge concentration of Dioxins in tail gas shall be less than 0.1ng-TEQ/Nm3 (standard condition, 11% dry smoke). According to USA standards for hazardous waste incineration, the destruction and removal efficiency (DRE) of each major hazardous organic pollutant shall be as high as 99.9999% if the hazardous waste contains substances specified in F020, F021, F022, F023, F026 or F027, and the discharge concentration of Dioxins in tail gas shall be less than 0.17ng-TEQ/Nm3 (standard condition, 11% dry smoke). According to EU standards, in POPs waste incineration, the DRE of POPs shall be above 99.9999%, and the discharge concentration of Dioxins in tail gas shall be less than 0.1ng-TEQ/Nm3.

In China, standards for hazardous waste incineration only stipulate the pollution controls of PCBs, that is, the incinerator temperature must be above 1200℃, the staying time shall be over 2 seconds, the DRE of POPs shall be above 99.9999%, and the discharge concentration of Dioxins in tail gas shall be less than 0.5ng-TEQ/Nm3. At present, only the National Center for Hazardous Waste Disposal in Shenyang can process PCBs. There is no special regulation and requirement on the incineration of waste pesticide POPs and Dioxins-rich wastes, and all those specifications shall be considered when compiling disposal standards for POPs wastes or amending the existing standards for hazardous waste incineration. It is said that standards for hazardous waste incineration and pollution control are under amending, and that the amended standards will be more close to European and USA standards. Therefore, it is needed to establish or select qualified POPs waste disposal facilities to carry out the disposal according to uniform standards.

1.5 POPs Waste Disposal NIP Performing Schedule

According to the NIP for POPs disposal, the objectives of reducing or eliminating POPs stock and waste discharge are:

- By 2010, environment harmless management system for POPs stock and wastes has been established;
- By 2010, environment harmless management and disposal have applied to 30% of the recognized pesticide POPs waste in China
- By 2015, the survey and updating of POPs stock in China has been finished and harmless disposal has been achieved.
- By 2015, environment harmless management and disposal have applied to the recognized Dioxins wastes discharged by key industries.

As it is shown, according to the program of POPs NIP, in the following 5~7 years, the survey and updating of all POPs stock in China will be finished and harmless disposal will be achieved. The national survey and disposal need large amount of manpower and materials. To accomplish the POPs NIP performance in a short time, it is necessary to carry out special management and uniform disposal nationwide.

1.6 Uniform Disposal Favorable for Solving the Problem of Pesticide POPs Waste Left-over by History

The waste pesticide POPs stock in China are problems left over history for a long time. The POPs stock stored all over the country are like time bombs and are huge potential environmental risks. Once the POPs are released or dissolved in water, the people' lives and properties will be threatened and therefore the POPs waste shall be disposed as soon as possible. As it was, the waste pesticide POPs stock in China are problems left over history for a long time and it is impossible to find out the person in charge, which leads to improper disposal. POPs control and reduction is not only the promise on POPs conventions of our government to international communities, but also the opportunity to reduce future financial loss and environment health risks. Therefore, special management and uniform disposal of existing pesticide POPs waste can efficiently solve the problems left over history.

2. Feasibility Analysis of Pesticide POPs Waste Uniform Disposal

To analyze the feasibility of pesticide POPs waste uniform disposal in China, we must know the current situation of pesticide POPs waste disposal technologies, and evaluate the application situations. Then combined with the distribution of related disposal facilities and local economic, technological level, we can put forward implementing plan ideas

2.1 Current Situation of POPs Waste Disposal in China

The existing POPs wastes in China are mainly left-over wastes that cannot be handled or those handled improperly due to technical limitations. The main disposal methods include long-term closed storage, simple landfill and high-temperature incineration.

2.1.1 Long-term closed storage

At present, most hazardous wastes in China are in a state of long-term closed storage. Exactly speaking, long-term closed storage is not a POPs waste disposal technology in the real sense, but a temporary solution in case of absence of other suitable technologies or due to limitations of necessary condition. Generally a safe location is selected to place collected pesticide POPs wastes which have been sealed until a safe and permanent solution is available.

Because the storage site is closed, the pollution to surrounding environment is relatively small with this method but the pollution situation inside is severe. Besides, the original authorities may not be able to strictly manage the storage, which will bring potential diffusion risk, and once the POPs waste is released, the consequence will be beyond imagination.

Long-term closed storage is not a technology capable of completely disposing POPs wastes, but only can postpone the occurrence of environmental pollution. Therefore, it is needed to apply capable technologies to completely destroy pesticide POPs wastes in a timely manner.

2.1.2 Safe landfill

Due to the imperfect pesticide POPs wastes disposal technologies, the weak understanding on POPs waste risks, and insufficient supervision at early age, a lot of POPs wastes were disposed in the method of simple landfill. For POPs wastes, landfill is more like a storage method rather than a disposal method. Simple landfill causes relatively great risks, as the POPs substances may displace with the movement of the groundwater. Therefore, more environmental risks may be caused compared with not disposed POPs wastes. For pesticide POPs wastes, the disposal shall refer to the safe landfill methods of hazardous wastes.

2.1.3 High-temperature incineration

Now China has begun using high-temperature incineration method to dispose pesticide POPs waste. At present, only the National Center for Hazardous Waste Disposal in Shenyang can process POPs, which has totally disposed about 1000t of POPs wastes since 1995. Other completed incineration facilities are located at hazardous waste disposal centers in areas like Tianjin, Chengdu, etc, which have also treated a small number of POPs wastes. In addition, some regions are planning to use cement kilns for disposal of pesticide POPs waste but for the lack of uniform cement kiln incineration standards, large scale disposal is not possible.

2.2 Comprehensive assessment of pesticide POPs waste disposal technology

After years of research, a variety of POPs waste disposal technology has been developed. In accordance with the disposal principles, POPs disposal technologies can be summarized as physical, chemical and biological methods. Table 2 indicates the comprehensive assessment on the disposal capacities of different technologies for pesticide POPs waste.

Table 2 POPs Waste Disposal Technologies

Principles	Technology Name	Maturity degree	Objective	Cost
Physical isolation	Secure landfill	Available in China	POPs-contaminated buildings, soils, etc	High pretreatment cost
	Deep well injection	Mature in foreign countries	liquid POPs wastes	Very high siting and evaluation costs
Physical solidification	In-situ vitrification		POPs wastes and contaminated soils	High running costs
Pyrolysis	High-temperature incineration	Mature in China	Various POPs wastes	High Investment
	Cement Kiln Co-disposal	Mature in China	Various POPs wastes, especially liquid wastes	Low investment
	Plasma – arc	Mature in foreign countries	Liquid POPs wastes	High
	Molten metal pyrolysis	experimental stage	Organometallic compound insecticides	High
Thermal separation	Thermal desorption	Mature in foreign countries	POPs-contaminated soils	High pre-treatment cost
Chemical reduction	Base-Catalyzed Dechlorination	Mature in foreign countries	Halogen-containing organic POPs wastes	Very high.
	Alkali metal reduction process	Mature in foreign countries	Halogen-containing organic POPs wastes	Very high.
	Solvated electron reaction	Mature in foreign countries	Halogen-containing organic POPs wastes	High
	Gas-phase chemical reduction	Mature in foreign countries	Halogen-containing organic POPs wastes	High
	Catalytic hydrogenation	Mature in foreign countries	Halogen-containing organic POPs wastes	High
	t - BuOK process	Mature in foreign countries	PCBs	High

Physical - chemical oxidation	Supercritical water oxidation	Mature in foreign countries	POPs wastes with organic content of lower than 20%	High
	Ultrasonic Oxidation	experimental stage		High
Chemical Oxidation	Wet Anaerobic Digestion	Mature in foreign countries	Waste water containing high levels of POPs	High
	Molten Salt Oxidation	experimental stage	Untreatable dried pesticide or polluted soils, liquid wastes	High
Electrochemical Oxidation	Electrochemical Oxidation	experimental stage		High
Pyrolysis - photochemical oxidation	Photocatalytic oxidation	experimental stage		Very low
Physical - chemical changes	Ball milling	experimental stage	POPs polluted containers	Using original equipment, low cost

2.3 Factors Affecting the Selection of Pesticide POPs Waste Disposal Technology

In selecting appropriate POPs waste treatment technologies, the main factors to consider include pesticide POPs wastes types, quantities, locations, available types of technologies, transportation and operation license conditions, as well as economic factors.

2.3.1 Disposal objectives

In the selection of appropriate POPs waste disposal technologies, the first thing to confirm is the basic characteristics of disposal objectives, and the types, quantities, and compositions of POPs wastes have decisive influences on the selection. For example, most of chlorinated organic compounds POPs cannot be dealt with in small incinerators, and the content of chlorine is also one of the factors restricting the application of incineration facilities. Regular high temperature incinerator requires that the chlorine content shall be less than 0.5%. In addition, generally pesticide POPs waste less than 1000 tons should not be treated in mobile incinerators.

2.3.2 Disposal conditions

Conditions that affect the selection of POPs waste disposal technologies include the surrounding environment of disposal facilities, local climatic conditions, construction conditions of the infrastructure and the qualities of technical staff.

2.3.3 Disposal fund

In selecting POPs waste disposal technologies, local economic development should also be taken into consideration. Within acceptable range of finances, the technologies with optimum ratio between disposal efficiency and disposal cost (cost performance) should be the first choice.

2.4 Principles for Selecting Pesticide POPs Waste Disposal Technology

When selecting POPs waste disposal technologies, our pesticide POPs waste disposal strategy should be paid to the latest trends and developments of the international new technologies, and meanwhile, considerations should be given to the actual level of our economic, technological development, specific conditions of existing facilities construction and application.

The detail selection principles are:

(1) With advanced international disposal facilities, POPs wastes shall be completely destructed; measure shall be taken to prevent secondary pollution in the POPs wastes disposal and to ensure that the discharge of disposal tail gas can meet the applicable requirements of national standards;

(2) In selecting appropriate POPs waste treatment technologies, the degree of maturity of the technologies shall be given priority and mature technology shall be adopted; the generation conditions of POPs wastes should be taken into consideration;

(3) The requirements of applicable national standards, laws and regulations shall be met;

(4) Comprehensively consider the existing qualified hazardous waste disposal facilities and the implementation of construction planning.

2.5 Available Pesticide POPs Waste Disposal Facilities in China

(1) Units with operation license of pesticide POPs waste

According to the statistics of Ministry of Environmental Protection, by the end of 2007, there were 13 enterprises obtained hazardous waste operation license issued by Ministry of Environmental Protection but the number of enterprises capable of disposing pesticide wastes are only 3, namely Hangzhou Dadi Environmental Protection Co., LTD, Tianjin Hejia Veolia Environmental Services Co., LTD and Swire SITA Waste Services Limited. In addition, the rotary kiln of National Center for Hazardous Waste Disposal in Shenyang can process PCBs waste.

There are some other enterprises with "hazardous waste operation license" issued by local competent administrative authorities of environmental protection. The operation range of 34 enterprises in them covers the disposal of pesticide waste (as shown in Table 1, which can serve as backup facilities for pesticide POPs waste disposal.

(2) Distribution of cement plants with technical conditions to carry out POPs waste co-processing

In 2005, there are 6846 cement enterprises in China with a cement output of 1.236 billion tons and the cement output is ranked first for twenty consecutive years. The average production capacity is 0.2 million tons and the enterprises with capacity over 10 million tons are only 10, whose output is only 15% of the total. However, not all the cement kiln is applicable for pesticide POPs waste disposal and only new dry-process rotary kiln can be used for that rotary kiln has various features, such as high temperature (1600℃), long smoke staying time (as long as 6s) and strong oxidizing alkaline environment in kiln. For pesticide POPs waste disposal in cement kiln, the single line production capacity shall be over 2000t/d and the management of production facilities is relatively better (prior to enterprises with ISO9000/14000 certificate). By 2005, there are 615 new dry-process production lines and the cement kilns with single line capacity over 2000t/d are 331 (as shown in Table 3).

Table 3 Scale of New Dry-process Production Line and Annual Clinker Output in 2005

Province	Annual output	Production Lines				
	10000t/a	<1000t/d	1000-1999 t/d	2000-3999 t/d	≥4000 t/d	Total
Beijing	725.4		7	6		13
Tianjin	204.6		2	2		4
Hebei	2197.9	3	7	16	5	31
Shanxi	757.95	4	15	2		21
Inner Mongolia	570.4	1	3	6		10
Liaoning	849.4	1	9	3	2	15
Jiling	1088.1	2	3	6	3	14
Heilongjiang	753.3		7	5	1	13
Shanghai	139.5		2	1		3
Jiangsu	4188.1	4	11	18	14	47
Zhejiang	6045	1	33	34	15	83
Fujian	626.2	1	4	6		11
Jiangxi	1739.1	2	11	12	3	28
Anhui	5142.9	3	9	19	18	49
Shandong	4054.8	1	14	21	12	48
Henan	2197.9	3	17	8	6	34
Hubei	1847.6	3	7	11	6	27
Hunan	632.4		3	3		6
Guangdong	2176.2	2	6	10	7	25
Guangxi	1199.7		4	4	5	13
Hainan	294.5			2	1	3
Chongqing	762.6	1	6	7		14
Yunnan	1134.6	2	23	3	1	29
Shaanxi	1193.5	1	6	5	4	16
Gansu	675.8	4	12	5		21
Qinghai	155		2	1		3
Ningxia	263.5		3	1		4
Xinjiang	440.2	1	2	5		8
Sichuan	722.3	1	7	3	1	12
Guizhou	325.5		7	1		8
Tibet	93		1	1		2
Total	43197	41	243	227	104	615

According to the statistics of Ministry of Environmental Protection, during the special project of tetramine treatment in 2003, the number of cement plants that can dispose hazardous wastes is about 40 (details in Fig. 2-1).

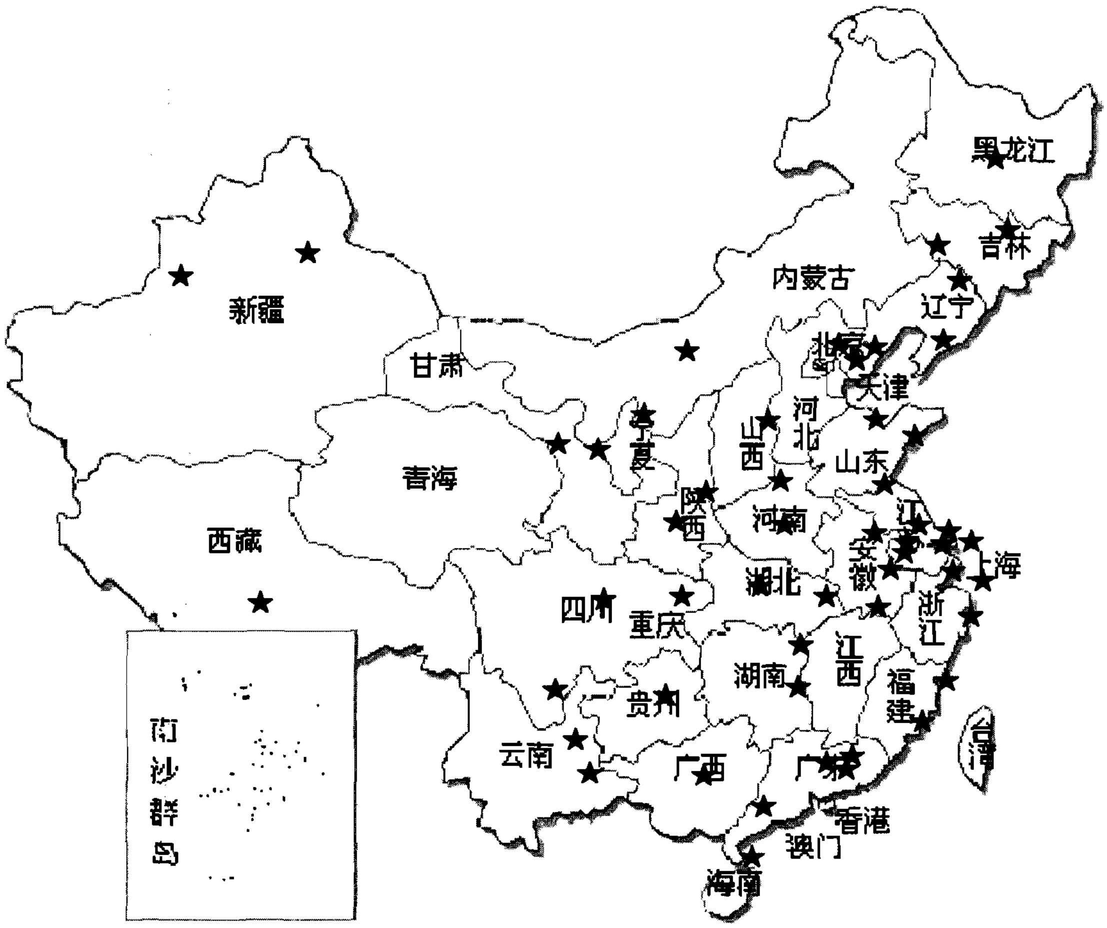


Fig. 2-1 Distribution of part of cement plants capable of disposal hazardous wastes

(3) Projects in the planning of national hazardous waste disposal facility construction

In 2004, the State Council approved *Planning of Hazardous Waste and Medical Waste Disposal Facility Construction in China*, compiled by National Development and Reform Commission and Ministry of Environmental Protection. According the *Planning*, the state shall build 31 full-fledged comprehensive hazardous waste disposal centers. The increased disposal capacity for hazardous waste is 2.82 million t/a and the detailed distribution of hazardous waste disposal facilities is indicated in

Fig.2-2. The construction standards for hazardous waste disposal facilities are relatively high, and with proper operation and management, they can satisfy the requirements of POPs waste disposal.

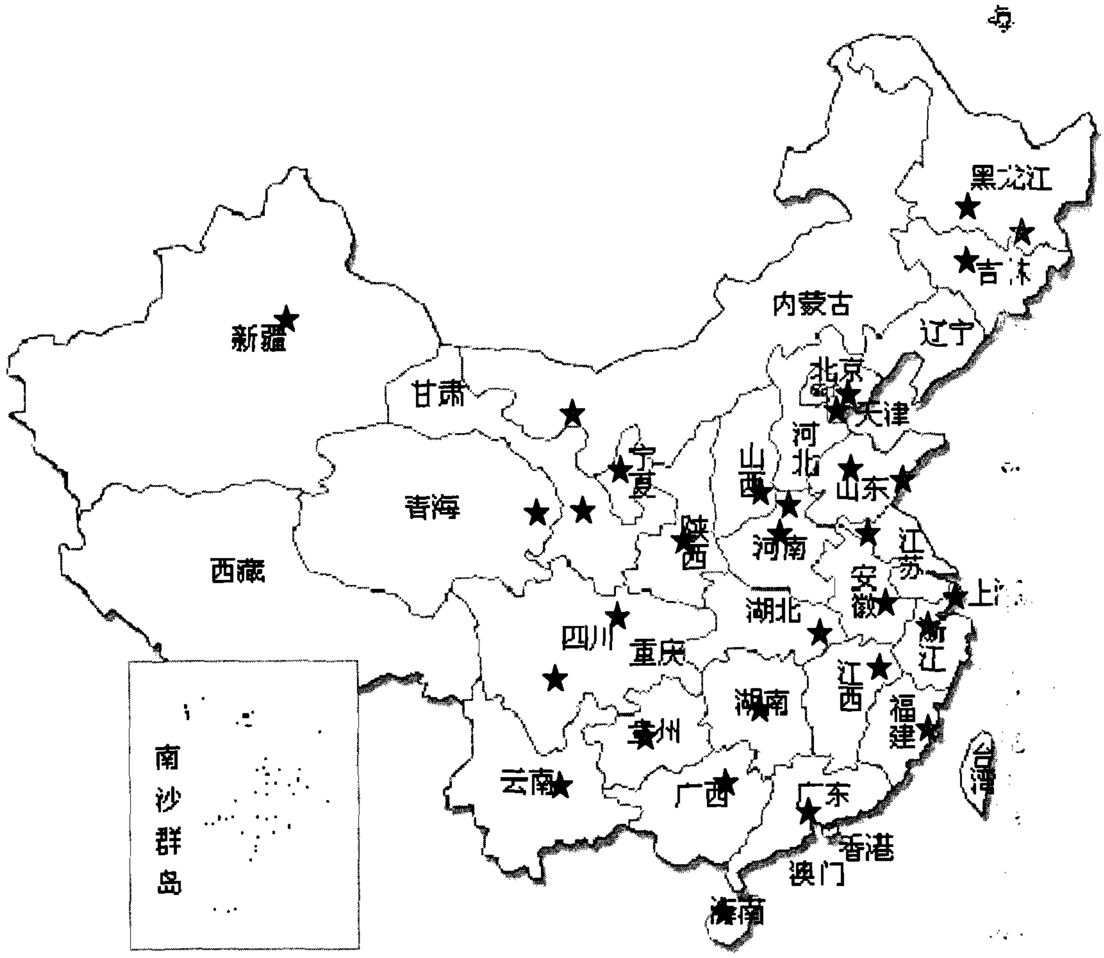


Fig.2-2 National hazardous waste disposal facility construction planning project

2.6 Financial Support for Developing Uniform Disposal

2.6.1 Domestic fund supporting

According to NIP, the program implementation needs RMB33.9 billion by preliminary estimation: 2.15 billion for the activities and measures of reducing POPs stock and waste discharge; 0.139 billion for finding out POPs stock, POPs contained materials and waste strategy; 0.07 billion for POPs stock management, activities and measures for disposing POPs contained materials. The supporting fund includes the budget for search, management POPs stocks and disposal pesticide POPs waste. The fund will be raised through central finance, local finance, enterprises, private capital and international multilateral fund, bilateral fund.

2.6.2 International community fund supporting

On the aspect of POPs reduction and elimination, international community provides lots of support, for example, fund and technical supporting from international institution and organization, such as World Bank, UNIDO and NUDP, as well as Italy, Canada, USA and Japan.

Waste Pesticide POPs & Dioxins-rich Ashes Harmless Management and Disposal Full-size Project receive fund and technology supporting from GEF. International advanced POPs waste harmless disposal and experiences shall be referred to solve the problems in our POPs waste harmless management and disposal, and thus to successfully finish the program in time.

2.7 Ideas on Pesticide POPs Waste Uniform Disposal Plan

(1) Through comprehensive survey of pesticide POPs waste in each province, establish database, which contains the category, quantity and geography distribution of pesticide POPs waste.

(2) Build or select disposal facilities that can meet technical standards and requirements; establish distribution of facilities capable for POPs waste harmless disposal and supporting facility

(3) According to the category, quantity and geography distribution of pesticide POPs waste, considering the factors such as the specific location of pesticide POPs waste and the distance from surrounding available qualified disposal facilities, determine specific disposal facility for pesticide POPs waste from different units as well as the disposal location and mode.

(4) through analysis on the sensitivity of surrounding environment of pesticide

POPs producers, confirm the disposal sequence for different POPs waste according the location sensitivity; carry out uniform disposal in stipulated time according to the disposal sequence and disposal program.

3. Conclusions

In conclusion, according to the features of pesticide POPs waste, such as high toxicity, high environmental risk and difficult to manage, regular management and disposal for hazardous waste shall not be adopted. Special management shall be applied for uniform survey, collection, transportation and disposal. Pesticide POPs waste shall be included as special hazardous waste.

From the results of existing hazardous waste disposal facilities and planning analysis, according to the category, quantity and geography distribution of pesticide POPs wastes and comprehensively considering the specific location of pesticide POPs waste and surrounding qualified facilities, it is feasible to build or select existing disposal facility that can satisfy the technical standards and requirements, to establish reasonable distribution for pesticide POPs waste harmless disposal facilities and to carry out uniform disposal.

Table 1 List of institutes capable of disposing pesticide wastes in China by the end of 2007

No	Province	Institute Name	Institute Address	Facility Location	Permitted operation mode	Permitted operation scale	Period of license
1	Beijing	Beijing Mangrove Environmental Technology Engineering Co., Ltd.	Room 608 of Beikong Technology Plaza, 2# Building, 10 of Baifuquan Road, Changping Sector of Zhongguancun Science Park	Inside Beijing Cement Plant, Beixiaoying Village, Machikou Town, Changping District, Beijing 110114	Collection,storage and disposal	9000	2010.3
2	Shanghai	Shanghai Julang Industrial Trade Co., LTD	No 885, Xingli Road, Baihe Town, Qingpu District	No 885, Xingli Road, Baihe Town, Qingpu District (310118)	Collection, storage, disposal	4000	2007.12
3	Shanghai	Shanghai Wanan Enterprises	No 4338, Tingfeng Highway, Jinshan District	No 4338, Tingfeng Highway, Jinshan District (310116)	Collection, storage, disposal	6000	2008.8
4	Shanghai	Shanghai Solid Waste Disposal Center	No 2491, Jiazhu Highway, Zhujiaqiao Town, Jiading District	No 2491, Jiazhu Highway, Zhujiaqiao Town, Jiading District (310114)	Collection, storage, disposal	20000	2008.9
5	Shanghai	Shanghai Solid Waste Disposal Center	No 2491, Jiazhu Highway, Zhujiaqiao Town, Jiading District	No 2491, Jiazhu Highway, Zhujiaqiao Town, Jiading District (310114)	Collection, storage, disposal	20000	2008.9
6	Jiangsu	Taixing Fuchang Solid Waste Disposal Co., LTD	No 10 of Tongyuan Road, Taixing Economy Developing Zone	No 10 of Tongyuan Road, Taixing Economy Developing Zone 321283	Incineration	4500	2008.5

7	Jiangsu	Suzhou New District Environmental Protection Service Center	Beside, Suliu Road, Huangshan Village, Xinqu, Suzhou	No 56 of Sanlian Street, Xinqu, Suzhou 320500	Incineration	12[illegible]00	2008.6
8	Jiangsu	Suzhou Rongwang Environmental Protection TEchnoloty Co., LTD	Xidai Road, Huangdai Town, Xiangcheng Districy, Suzhou	Xidai Road, Huangdai Town, Xiangcheng Districy, Suzhou 320507	Incineration, comprehensive usage and collection (storage)	29[illegible]80	2007.12
9	Jiangsu	Heshun Enterprise Environmental Protection Service Co., LTD	No 18 of Chengpu Road, Shengpu Town, Suzhou Industrial Park	No 18 of Chengpu Road, Shengpu Town, Suzhou Industrial Park 320500	Collection, storage, disposal	9100	2008.3
10	Jiangsu	Qinxing Fuchang Solid Waste Disposal Co., LTD	No 10 of Tongyuan Road, Taixing Economy Developing Zone	No 10 of Tongyuan Road, Taixing Economy Developing Zone 321283	Incineration	4500	2008.5
11	Jiangsu	Wujiang Taihu Industrial Waste Disposal Co., LTD	No 88 of Jingyi Road, Bache Industrial Park, Songling Town, Wujiang	No 88 of Jingyi Road, Bache Industrial Park, Songling Town, Wujiang 320584	Incineration/ disposal/ collection	5250	2008.3
12	Jiangsu	Nanjing Huifeng Waste Disposal Co., LTD	No 888 of Jiaozishan Road, Qilin Town, Jiangning District, Nanjing	No 888 of Jiaozishan Road, Qilin Town, Jiangning District, Nanjing, 320115	Incineration	6000	2007.12
13	Jiangsu	Zhenjiang Xinyu Soild Waste Disposal Co., LTD	Zhencheng Road, Chemical Subdistrict, Xinqu, Zhenjiang	Zhencheng Road, Chemical Subdistrict, Xinqu, Zhenjiang	Incineration	2500	2010.7

14	Jiangsu	Wujiang Lvyi Solid Waste Recycle and Disposal Co., LTD	Pongdong Village, Songling Town, Wujiang	Pongdong Village, Songling Town, Wujiang	incineration /collection	7000	2008.3
15	Jiangsu	Lianyungang Lingmu Waste Disposal Co., LTD	Dapu Industrial Zone, Lianyungang Economy Development zone	Dapu Industrial Zone, Lianyungang Economy Development zone	Disposal and recycle of hazardous waste	4000	2008.6
16	Jiangsu	Wuxi Industrial Waste Safe Disposal Co., LTD	Qinglongshan Village (Taohua Mountain) Wuxi	Qinglongshan Village (Taohua Mountain) Wuxi , 320200	Incineration	11000	2008.3
17	Jiangsu	Changzhou Annaide Industrial Waste Disposal Co., LTD	Jiangbian Industrial Park, Wei Village, Chunjiang Town, Xinbei District, Changzhou	Jiangbian Industrial Park, Wei Village, Chunjiang Town, Xinbei District, Changzhou	Incineration	6400	2008.5
18	Jiangsu	Taizhou Yuxin Solid Waste Disposal Co., LTD	Technology Park, Gaogang District, Taizhou	Technology Park, Gaogang District, Taizhou	Incineration	2300	2008.3
19	Jiangsu	Taicang Kelin Solid Waste Disposal Co., LTD	Sanli Village, Liujiagang Town, Taicang	Sanli Village, Liujiagang Town, Taicang	Incineration	4000	2007.11
20	Jiangsu	Yancheng Yuxin Solid Waste Disposal Co., LTD	Group 3 of Xindun Village, Yancheng Economy Development Zone	Group 3 of Xindun Village, Yancheng Economy Development Zone, 320901	Incineration	1700	2010.7
21	Jiangsu	Jiangyin Industrial Solid Waste Disposal Co., LTD	Huaguo Village, Nanzha Town, Jiangyin	Huaguo Village, Nanzha Town, Jiangyin	Incineration	10500	2008.6

22	Jiangsu	Kunshan Liqun Solid Waste Disposal Co., LTD	Taoqiao Village, Qiandeng Town, Kunshan	Taoqiao Village, Qiandeng Town, Kunshan，320583	Incineration	7200	2007.12
23	Fujian	Fujian Solid Waste Disposal Co., LTD	No 33 of East Street, Gulou District, Fuzhou	Qingpuling Village, Qingkou Town, Minhou County, Fuzhou	Disposal	20000	
24	Shandong	Jinan Hanyang Solid Waste Disposal Co., LTD	Room D, Builing 14, B Zone of Jiaheng Plaza, No 1825 of Hualong Road, Jinan	No 1 of Hehua Road, Jinan，370112	Collection, storage, disposal	8700	2008.5.31
25	Guangdong	Guangzhou Lvyou Industrial Waste Recycle and Disposal Co., LTD	Hexing Road, Changsha Village, Hengli Town, Fanyu District, Guangzhou	Hexing Road, Changsha Village, Hengli Town, Fanyu District, Guangzhou	Collection, storage, recydle, disposal	239500	2010.1
26		Shenzhou Hazardous Waste Disposal Station	No 181 of Longwei Road, Xiameilin, Futian District, Shenzhen	No 181 of Longwei Road, Xiameilin, Futian District, Shenzhen	Collection, storage, recydle, disposal	350000	2010.1
27	Chongqing	Chongqing Solid Waste Management & Service Center	No 212 of Renmin Road, Yuzhong District, Chongqing		Collection, storage, disposal	3000	2009.10
28		Chongqing Tianzhi Environmental Protection Co., Ltd	No 7 of Zhishenggong, Yuzhong District, Chongqing		Collection, storage, disposal	3000	2009.9
29	Hainan	Hainan Bailai Industrial Trade Co., Ltd	E Zone, 18th Floor of Longzhu Plaza, No 2 of Kunbei Road, Haikou	Lizhigou, Sanya (Chahe Town, Jianchangjiang County) Changjiang Lizu autonomous county /Code: 469031	Collection, incineration	19000	2009.10

30	Helongjiang	Haerbin Industrial Waste Exchange Center	No 495 of Tongda Street, Daoli District	Limin Development zone 230111	Disposal	500	2007.11
31	Qinghai	Qinghai Cement Co., Ltd	No 21 of Liming Road, Qiaotou Town, Datong County, Qinghai	No 21 of Liming Road, Qiaotou Town, Datong County, Qinghai, 630121	incineration	2t/d	2010.9
32	Guangxi	Liuzhou Golden Sun Industrial Waste Disposal Co., Ltd	No 16, South Gaoxin Road, Liuzhou, Guangxi	No 62 of Liutai Road, Taiyangcun Town, Liunan District, Liuzhou	incineration	5000	2010.3
33	Shanxi	Taiyuan Shitou Group Waste disposal Co, Ltd	No 1 Kaicheng Avenue, Wanbolin District, Taiyuan	No 1 Kaicheng Avenue, Wanbolin District, Taiyuan 140109	incineration	2000	2008.12
34	Jilin	Jilin Lantian Solid Waste Disposal Center Co., Ltd	Weizigou Village Yingjun Town, Erdao District, Changchun	Weizigou Village Yingjun Town, Erdao District, Changchun , 220105	collection, storage, recycle and incineration	6000	2010.1

Annex 8

Feasibility study and proposal on stakeholder and public-private partnerships on POPs waste management under Full Sized Project of Environmentally Sound Management and Disposal of Obsolete Pesticide POPs and Other POPs waste in China at PPG Stage

(Final Report)

Submitted to

Foreign Economic Cooperation Office

Ministry of Environmental Protection, China

EnviSolve Consulting

December 9th, 2009

Table of Contents

1 Background

Since 1998, China has taken part in the negotiation of Stockholm Convention, and signed the convention on May 23th, 2001, and the Standing Committee of the Tenth National People's Congress ratified on 25 June 2004. The convention entered into force on November 11th, 2004 in China. The Stockholm Convention on Persistent Organic Pollutants aims to reduce, eliminate, and prevent POPs pollution with the objective to protect human health and the environment.

Pursuant to the provisions of Article 7 of Stockholm convention, the Chinese 'National Implementation Plan' was submitted to the Conference of Convention Parties in April 2007. The National Implementation Plan was divided into three chapters. The first chapter introduces the process of China's participation in the Convention, the main requirements and the summary of the POPs problems, and includes the objectives and principle of National Implementation Plan constitution, the constitution mechanism and the negotiation process of relative beneficiaries, and the uncertainty in the National Implementation Plan and relative updating and emendatory illustration. The second chapter introduces the basic situation of relative convention implementation countries, including the situation of POPs waste and relative research and management, and the requirements in the construction of institution, policy and capability building in solving these problems. The third chapter definitudes the specific action plan pursuant to the requirement of the convention and the strategic objectives of China's convention implementation, and the capacity building and the fund demand in the plan implementation.

Very low exposure to POPs can be carcinogenic and can cause serious damage to the central and peripheral nervous system, as well as causing immune system diseases and disruption. This is particularly evident in foetal development and the growth of infants. Persistent Organic Pollutants (POPs) are chemicals that persist in the environment and resist degradation. They are lipophilic (bioaccumulate in fatty tissues) resulting in their biomagnification through the food chain. They are subsequently transferred from lactating mothers to their offspring through breast milk.

POPs are multi-media chemicals that can be found in air, water and soil, and can be classified as intentionally produced, e.g. DDT, and unintentionally formed, e.g. dioxins. However some POPs belong to both categories, e.g. PCBs, which can be intentionally produced for industrial purposes but can also be unintentionally formed as a combustion by-product. Long term exposure to the chemicals may cause endocrine dysfunctions, cancer and tumors at multiple sites, neurobehavioral impairment, immune system changes, reproductive deficits, shorten period of lactation in nursing mothers, endometriosis and diabetes. Short term acute exposure to some of the POPs pesticides may result in fatigue, dizziness, blurred vision, respiratory effects, skin irritation, nausea, headaches.

Their continuous releases and persistence in the environment exacerbate bioaccumulation and thus threaten human health for many years after the initial contamination. Since many countries worldwide continue to use POPs, there will be a continuous emission of these chemicals long after they have stopped being produced and used. This has prompted the international community to take action, which resulted in the Stockholm Convention on Persistent Organic Pollutants (POPs).

China is a large agriculture country and has massively produced and used pesticide mainly organ chlorine pesticides during the period from 1960s-1980s, there are nine types of pesticides listed in Stockholm Convention, and 5 kinds of products among them including DDT, heptachlor, chlordane, toxaphene and hexachlorobenzene are produced in large scale, and DDT, heptacholor, miren and hexachlorobenzene are still producing and using now.

Because of production, application, stockpile of massive POPs waste and the POPs contaminated soil and dioxin-rich fly ash and insufficient concern on the serious impacts and threaten to human health and environment, it should be destroyed or disposed in a safe, environmental and complete manner. There are 4000-6000 tonnes of obsolete POPs waste and 2000 tonnes fly ash, and the contaminated soil are dispersed all over the country and specific data is unclear.

According to the above reasons, China should make more effort to conduct a sound environmentally disposal of POPs waste, in order to aid to complete the mission of the NIP and the commitment to international society. The purpose of this research is to study actively the PPP model in the application of sound environmental disposal of POPs waste, and to reach the optimal effect of POPs disposal and to alleviate the government financial burden, to guarantee the enterprises to make profit and to make the public to get a better life environment.

The method of this research is to conduct a comparison study between national and international successful experiences of hazardous waste and sewage treatment by the study of the application of PPP models in the urban sewage and hazardous waste. It will set up one or several nationwide operation companies and cooperate with the hazardous waste facilities of counties and regions all over the country to make a sound environmentally treatment and disposal of POPs waste storage and share cost, risk and profit. For there is not any experience in the aspect of POPs waste disposal in China, the project will first set up a successful demonstration and then disseminate the successful experiences to the whole country.

2 Project objectives

The project will enable environmentally sound management and disposal of targeted obsolete POPs pesticides and associated wastes in fulfillment of China's commitments under the Stockholm Convention.

The presence of geographically dispersed stockpiles of obsolete POPs pesticide waste and PCDD/PCDF rich incinerator fly ash presents an ongoing pathway risk to environmental receptors (water , land and so on) especially groundwater and surface water resources. The scale of this risk and its global consequences make it a uniquely Chinese issue with significant transboundary impact.

In accordance with the Stockholm Convention and Basel Convention guidelines, the project will directly provide treatment of a minimum of 10,000 tonnes of identified targeted POPs pesticide wastes and 1,000 tonnes of PCDD/PCDF rich fly ash. The project will also introduce regulatory reforms and strengthen national capacity to identify, assess, manage, and treat other such wastes in an environmentally sustainable manner by use of new analytical and organizational techniques such as qualitative environmental risk assessment and public-private partnerships.

3 Methodology

The recommended model is to establish one or more nationwide operational company to cooperate with the POPs disposal centers, the former provides the personnel training, the latter is under the charge of POPs waste collection, transportation and storage. The former will cooperate with the latter for the environmentally sound management and disposal of POPs stockpiles with mobile or fixed equipments. They altogether share costs, risks and also profits. The former should ensure the adopted disposal technologies to be in line with the relevant national and international standards and norms and the operating license granted by the authority of the State Environmental Protection Department. As there has not accumulated any experiences in china in POPs waste disposal, the project will promote the successful models and experience to the whole nation after a successful demonstration by means of BAT/BEP in one province or several provinces.

4 Feasibility Study on the Application of PPP for the Sound Management of POPs Waste Disposal

4.1 Necessity

The bottleneck for the urban environmental infrastructure development is the difficulties always faced by the public sectors in the urban environmental infrastructure construction and operation management. These problems are the shortage of construction fund, the high operation management cost, the low operation efficiency caused by the low recovery, the limited personnel and technological resources and the impact from bureaucracy and other administrative system.

The biggest challenge of the environmental infrastructure construction in developing countries is the shortage of funds. The cost for the urban environmental infrastructure facility as the public utility comes from government finance (tax revenue). There needs enormous investment in the early period of the urban environmental infrastructure construction, the projects are large and have a long recovery period with low governmental financial capacity. Even if the project has a reasonable recovery rate, it is difficult for the government to provide enough funds to support these facility constructions. In addition, the charging free system of the sewage and waste treatment is not sufficient and sound, it is difficult to repay the construction investment cost depending only on the free system. In the development period of the urban environmental infrastructure, even if there is the construction plan, for the low governmental financial capacity, the work focus is always on the economic infrastructure construction, the focus of the environmental protection work is always on the industry pollution control but not on the urban life pollution control.

Issuing national bond is the commonly used means of financing in the urban environmental infrastructure construction, but the low project economic efficiency and inefficient use of funds cause the risks enabling to repay the investment. Though the local government faces the enormous demands for the urban infrastructure construction, it has the low financial capacity and has no independent financing permission, such as issuing the local bond; it is difficult to finance enough funds. At present the urban infrastructure constructions in most developing countries rely on the government development assistance projects and international development financial organization. Under this background, the introduction of the private investment in PPP model becomes one of the feasible policy options.

The second problem is the inefficient operation of the public sectors. the infrastructure operations of most public sectors are at loss, the two main factors causing loss are : The production operation and maintenance cost of the sectors are very high because of the inefficient use of the personnel and other resources, outdated technology and high input-output ratio; The second factor is the difficulty in the recovery of costs, because of the lack of the consciousness in applying input-output management principle and the result is that the fee is not charged properly. The key of the inefficient operation is lack of the reasonable system and market mechanism. The introduction of PPP model is to promote the operation efficiency, reduce costs and improving the charging status.

The third problem is the limited personnel and funds resources. Comparing to the central and provincial department, the urban departments have limited resources to use. The urban department always has few qualified staff and a low technical capacity. There always existing the problem of the personnel resource shortage or over burden of too much municipal department staff in managing the complex engineering like water supply and sewage treatment.

The interference from bureaucracy and administrative system is another important problem. The problem course the discussion of the separation of powers. The municipal department officials may be subjected to the provincial and central government, the mobilization among the municipal departments or with other departments leads to the decreasing of the responsibility. In most developing countries, the changes in administrative system and the management personnel lead to the fruitless result of many project and plans. But PPP model will keep out from the impact of the bureaucracy an administrational department. There is the comparison of main problems among different types of investment and management from the perspective of different investment subject in Table 1-1.

The revenue-sharing system, also called the federalism, is to divide all national taxes among the central and local governments so as to ascertain the revenue range in the central and local finance as a finance management system. The essence of the system is to determine the corresponding financial distribution of the central and local government according to their authorities so as to form a revenue system of the central and local authorities by the compartmentalization of the taxes. It is a commonly adopted system of fiscal management model. The deficiency of the revenue-sharing system courses the strained local budgets.

The government or public sectors shall provide the urban environmental infrastructure service, as the same time the private sectors have great opportunities to participate the work. The problem is how to arrange reasonable the distribution of the roles among the public and private sectors so as to provide high-quality, efficient service. The analysis of the advantages and disadvantages of the public and private sectors in the development of the urban environmental infrastructure construction。

Table 1-1 The Key problems in different investment and management styles

Public sectors	Private sectors	PPP
The funds restriction government has insufficient funds to invest new or operate the existing facilities.	Public good (the affordability) It is hard for individuals to enjoy enormous private commodities beyond their affordability, but everybody shall enjoy the commodities with public goods attributes.	Affordable commodities The government subsidy enables these service affordable services. The private investment can achieve other policy objectives.
Operation inefficiency: Too many employees and other inefficient productional behaviors cause the high cost of unit production.	Operation efficiency Achieve the law cost of the unit production by the analysis of fees and benefits.	Operation efficiency The production can operate in low costs under the management of the private management.
Loss and cost recovery : The loss of the facilities and systems causes the high leakage. Charging fee has low ratio to make up the costs	Tax collection and cost recovery It is difficult to make home service for collecting fees, especially without the support of the regulation system and government.	Pricing and fee system The pricing under the circumstances with reasonable burden and the support of government , it can assist to recovery costs.
System expansion: No investment can expand the range of service.	Enormous investment It is difficult for the private sectors to make a long-term investment with a low yield.	Transaction costs The process of institution and management of contract takes long time and high costs leads to the transaction costs.
Human resources The labor production is low because of the low payment, low level of technology and low initiative.	Long recovery period Sometimes the private sectors have to wait a whole project circle of 30 years	Sponsion and Incentive Governments can provide the special guarantee to encourage the public sectors'participation in the field.
Technology In many places, the outdated technology is not replaced.	Uncertainty and risk The investment in this field comparing with other fields has more risks because of uncertainty.	Rules and regulations The successful PPP relies on the legal system and the effective regulations and institutions.
Impact from administration system The impact from the level of management and leaders is enormous and leads to the inefficiency and non-scientific decisions and programmes.	Borrowing security In this field finances, most financing institution needs the guarantee of government.	Sustainability For the alleviation of the financial difficulties and effective operation systems, the facilities may provide a longer service.

Centralized management: It is difficult to judge the requirement of the customers and the decision-making and implementation take a very long time.	The ability of enterpriser The private sectors with high level of enterprise operation enable to reverse the loss system or industry to a profitable system or industry.	The ability of enterpriser The private sectors manage and operate project under contracts with high degree of the corporation operation, which is good for the technical reformation.

Table 1-2 Advantages and Disadvantages of Public Sectors and Private Sectors in Municipal Infrastructures Construction

Project	Advantages	Disadvantages
Public sectors	A. Implement the construction closely with all relative government policies and their plans. B. Enforce law and monitoring coordinating better with the government department. C. Institute and implement the government authority in the fee charging of the POPs disposal. D. Make an enormous financing relying on the credit of the government, such as issuing the national and local bond or getting loan from foreign governments and international financial organization loan. E. Taking comprehensively the regional economic differences and the social fairness into consideration in the process of development.	A. Lack of the competitive mechanism (consider less economic benefits, difficult to take advantage of the function of the price mechanism), have the problem of the insufficient efficiency (have the low input-output rate) B. The stagnancy of the technology reformation and low level of service because of the government department monopoly. C. Lack of the human resources development for the promotion of the service level and the stagnancy of the technology improvement. D. The expansion of government financial deficit.
Private sectors	A. Attach importance to the economic benefits and improve the investment efficiency. B. Improve the service level and meet the need of the requirement of diversification under the competitive mechanism. C. Implement the technology reformation and develop the environmental protection industry through the market mechanism. D. Achieve the financing from the investors of different sectors.	A. The possibility of formation of the monopoly pattern of a district or an industry because of the service property. B. More difficulties in government controlling. C. The impact of service levels because of the blindness in the pursuit of enterprise's benefits. D. The problem of the government-oriented which is easy neglected in environmental protection and regional resources management. E. The expansion of the providing service differences led by the regional or class differences. F. The regional public service and environmental management under the long control of foreign countries especially for foreign investment.

It is extremely necessary to establish the private and public partnership in order to expand construction funds and improve operation efficiency; According to the long-term economic development trend, the funds strength in the public and private sectors will gradually grow stranger and stranger, as a result, the government departments need to estimate the long-term economic development trend and institute a long-term investment plan.

There are two ways to consider: The public departments institute the debt repayment plan in the perspective of long-term development and expand the construction investment financing channels under the guidance of the public departments. The construction financing not only invest from the tax revenue but a variety of other financing channels, such as national bond and local bond, foreign government or international organization loan and policy financing, the repayment of principal and interest should accord with national economic development.

The market is open to the private sectors and makes full of their roles. Many countries such as in France, England and a lot of South-Eastern Asia and Latin American countries have already started the work; this thought is generally called the public and private partnership (PPP). In this system, the government department is in charge of public utilities, at the same time, the private sectors can participate in it, the financing of PPP mainly comes from the loan of the commercial banks, stock market and enterprise bond.

Japan adopted the first method and implemented and accelerated the municipal infrastructure construction in a planned way across the whole country, but in the late period, the unlimited expansion in the scale of public utilities led to a serious deficit of the Japanese government. The drawback of this method is easy to cause inefficiency investments-one of the performances of "government failure". Considering the adverse policy effect of government failure, for the most Asian developing countries, the participation of the private sectors is a effective and practical method.

Under the framework of the PPP model, governments realize a long-term instalment in the form of treatment fee to the private sectors of facility construction and take hold of the exact expenditure of full-sized cycle, and to institute the average annual payment amount and repayment planning according to the government financial ability. Government solves the problem of present financial shortage by handing over the financing for the enormous construction funds to the private sectors. Though the economic development is in its early stage, the financial capability is insufficient; the government can start to construct the municipal environmental infrastructure facility.

In addition, because the private sector calculates its income by input-output, it is possible to realize the promotion of efficiency comparing with the public sectors. The PPP model can not only solve the government financial problem but promote operational management efficiency by bringing in the management and technical resources of the private sectors.

In general, the PPP aims at the reduction of the government burden and devolve the responsibility of investment and the design, construction and operation of public service facilities to the private sectors, the private sectors shall take full account of all risk that they will face in all stages of the project and to sign contracts and implement the responsibilities in the contract so as to promote the government department and the quality of public service.

Other policy effects: Charging the POPs disposal fee is the most important condition for the completion of the PPP, so the PPP model needs a establishment of fee charging system in the early stage of the construction of the POPs disposal facility. The reasonable charging system in the early stage of development through the price mechanism encourages water saving and reduction of behavior to abandon garbage. it develops effectively the form of environmentally sound consumption mode and is also good for the sustainable development. In addition, the market need of the municipal environmental infrastructure drives the rapid development of the environmental protection technology and industry and becomes one of the main industries in the economic development of the Asian developing countries.

The disposal of POPs waste and the control of rich-dioxin fly ash will need the support of a great amount of fund, there is a funds gap of about thousand billion RMB. The experience over years has testified that it is far from enough to rely only on the government insufficient financial strength in POPs waste management and disposal.

Governments in many countries gradually realize that they could not only rely on their own financial capacity to complete the environmentally sound disposal of POPs waste and the control of rich-dioxin fly ash emission in incineration. So they have to seek other effective financing channels. After the 80s of the last century, some developing countries are rebuilding their lame government finance, promoting government department effectiveness and improving the quality of public service. They try to replay their existing construction and operation mode of government department with some modes with innovation and flexibility in order to improve the further development of infrastructure construction.

The disposal facility of POPs waste is defined as quasi-public goods and the implementation of the polluter-pay principle improves the establishment of fee system and makes the participation of private sectors possible. In addition, the application of PPP model in POPs waste management and disposal field can introduce the advanced technology and experience of private enterprises (including foreign enterprises) to reach the purpose of sound POPs waste management and disposal; At the same time, in the rapid economic developing area, the economic affordability of citizens and the promotion of requirement of life condition spur the participation of private sectors. So the introduction of PPP model may improve the condition of funds shortage and enhance the effectiveness of POPs management and disposal and the control of rich-dioxin fly ash emission in incineration and realize the sustainable and coordinated development of environment, economy and society.

4.2 Stakeholder Analysis

The objectives of the project is to conduct the study on the environmentally sound management of POPs disposal, so the study on the stakeholders is especially necessary in the implementation of PPP project of the POPs environmentally sound treatment and disposal. During the process of POPs disposal or the implementation of PPP project, we can see the coordination of the stakeholders attach great importance in the successful completion and making profit. The violation of PPP project contract regulations or irresponsibility or negligence of any part of the stakeholder may course immeasurable loses and failure of projects or the state's property loses even the hurt of public life.

Table 4-3 Stakeholders roles

Stakeholders	**Role descriptions**
Obsolete or producing pesticide plants.	Obsolete and now pesticide producing plants are playing the most important role in the course of PPP project and POPs disposal and take main responsibility. They produce or are producing pollution to social environment, natural environment and hurt to public health, they should take social and economic responsibilities. They are the most funds resources of PPP projects. If they have the capability and aptitude to take the responsibility of POPs disposal, they will do it, otherwise the environmentally sound treatment of POPs waste will be handed over to the qualified enterprises with aptitude.
Sales Units	Sales sectors of hazardous waste are one of the most important links in the whole process-'from birth to death' of hazardous disposal, sales sectors have responsibility to know hazardous chemicals' context and sign in manifest bills. They should guarantee no leakage during provisional storage of hazardous waste, otherwise they should pay the responsibilities of polluting sectors.
Public	Public is the indirect beneficiary of POPs waste disposal, for they will get a safe residence environment after POPs waste environmentally sound management and disposal, they have to pay rational free for POPs disposal. Beside they enjoy the safe, clean and environmentally friendly environment; they have an obligation to assist government to monitors and surprises all links of the POPs disposal.
Waste Incineration Enterprises	The incineration enterprise of waste and medical waste is an important idiographic executor for hazardous, waste management and disposal. It composes of workers, technical staff, management personnel and enterprise leaders. They play an important role in the successful completion of projects. After the completion of hazardous waste and life waste management and disposal project, they obtain both a social benefit and comparatively high economic benefit beyond costs. They have obligation to operate safely during waste incineration and are strictly self-disciplined, if they cause pollution, they shall take a responsibility as the polluting enterprises.
Equipment Supplier	Their functions are to provide incineration facility for waste and hazardous waste. Their functions are to provide incineration facilities with low costs and high quality (the incineration with high tech.). If the facilities are selected by collective procurement and there is no corruption during the process, procured equipments should have two characteristics. Government should supervise the procured equipments that they have provided.
Government Department	Government (refers to the government agencies and the government appointed corporations) is always the sponsor of the infrastructure project of PPP model, they do not own and operate project, but they support project construction, development and financing arrangement by providing the project some franchise and some amount of project funds or loan guarantees. In most models, government is the ultimate owner of projects.
Environmental Protection Department	Environment department refers to state environmental protection department and local environment protection sectors responsible for issuing laws, regulations and standards and providing environmental protection policy and consultant and so on. It takes the function of supervision.
Price Department	Price department refers to Price Bureau responsible for the institution,

	implement, and supervision. It institutes the principle of the charging standards of POPs treatment fee with standards of cost-plus and maximum price cap. It regulate the charging fee and yield limit and ensure that they will not arbitrarily charge more fees and damage consumers and the state' benefit.
Finance Department	The Ministry of finance is the state financial department responsible for drawing out and carry out the development strategy, principles and law, mid and long term programme, reformation programme and other relative policies on finance and tax. It participates in constituting all macro-economic policies and put forward the application of financial and tax policy, the implement of macro-control and the suggestion of overall balance of social financial resources. It can draw out and implement the distribution policy between central and local government, the state and enterprise. It manages central public financial expenditure. In the PPP project, it can provide the support of funds and loan guarantees and supervise the finance of POPs project.
Tax Department	The administration of taxation takes the functions of improving tax law and tax guarantees. In the implement of PPP project it shall provide reasonable tax revenue and institute policy and take function of tax revenue leverage.
Land Department	Department of land resources: It takes function of the programme, management, protection and rational use of land resources, mineral resources and marine resources, and takes responsibility of land remediation and rational use of land after remediation and provide political suggestions and directions for remediation, development and use of the polluted land.
Transportation Department	Transportation Ministry institutes regulations and standard of transport equipments in the process of hazardous waste.
Development and Reformation Department	National Development and Reformation Committee institutes' plans and programmes in state infrastructure construction.
Construction Department	Construction Ministry institutes environmental protection standards, and provides support in policy and technology.
Securities Institutions	Securities institution will raise funds for project by the listing of environmental protection corporation and provide capital support for POPs disposal, land remediation and the emission reduction of dioxin-rich incineration.
Investment fund	Investment fund is the main funds resources for POPs disposal and provides funds support for project.
Bank	Financial institutions include banks and investment funds. In PPP model, the banks providing loans to project are international institution, commercial banks, trust investment institutions and so on. Among them policy loans including government export trust institutions and World Bank or regional development bank take a very important function. The main function of banks and financial institutions in the project is to provide funds and credit guarantees for the successful implement of projects.
Beneficiary	Beneficiaries refer to land developers and public. Land developers are land owners and make profit by development after POPs waste has been disposed and land has been restored. Public is who will enjoy environment. According to the users pay principle. Beneficiaries of disposal project have obligation to pay fee for the treatment.
Intermedium Institutions	While a project is under way, there will appear all kinds of agencies. They are environment assessment consulting company, feasibility assessment company, consulting company, bidding company and building construction unit and so on. Intermediary institutions specialize to provide professional consulting and suggestion for projects. Projects need the introduction of intermediaries including consulting company, management company and

	consultant company for directing project operation during total life cycle of project
Equipment Suppliers	When building POPs waste disposal equipments, government procures equipments from equipment suppliers. The role of equipment suppliers is to provide POPs equipment with large disposal capacity and high technical content.
Operators	Government own infrastructure by the way of franchise and hand over to operators for operation and operators may be a special project corporation. They get franchise of construction and operation of project from government or relative institutions and is responsible for whole process operation of project from investment, design and construction and operation to final handover of project to government. SPC composes of private or private entity. Under special circumstances, government or other enterprises can buy its shares, but they are always small shareholders. Operators should ensure service quality and providing satisfactory service to public and government.

Stakeholders of PPP project and their relation: Stakeholders refers to those who actively take part in a project or the individuals and organizations whose benefits are influenced by the project. Stakeholders in public-private partnership (PPP) include government at all levels, private service suppliers of public utility, lending institution, consumer, labor organization and multilateral or bilateral institution. But the main stakeholders are government at all levels, consumer, labor organization and executor in private engineering,

The objective of the project is to study POPs waste sound management, so it is extremely necessary to analyze stakeholders in POPs waste sound disposal. In the process of our analysis, we can see the coordination among the stakeholders is extremely important for the successful construction and operation in municipal infrastructures construction projects of POPs management and disposal.

The obsolete or producing pesticide plants take a very important role both in the PPP projects and in the process of POPs disposal and it is the main body in the POPs disposal projects. They are producing pollution to social environment, natural environment and the hurt of human health, so they should take social and economic responsibilities. They are the main source of funds income for PPP projects. If they have ability and aptitude, they will conduct POPs waste treatment obligations. If they do not have them, they will entrust other authorized enterprises to carry out the sound management and disposal of POPs waste.

Governments (government agencies or government-designated corporation) are usually the sponsors for infrastructure project of PPP model, legally they do not own and operate project.

- Government is the determiner of choosing project and main development subject.
- Government's guarantee for project include two parts: Guarantee for logistic supply and project income.
- Government has obligation to monitor and supervise projects.
- Government can directly invest or loan for projects.
- Government has obligation to provide credit guarantees and take project risks.
- They provide legal guarantee and policy support.

- In order to improve private capital entrance to public field, government should create
- Legal and political environment.

SPC (Special Purpose Company) is a specialized organization of the project corporation and it is a project executor composed of government, private or a combination of several private sectors. SPC gets the concession of construction and operation of project from state government or relative institutions and are responsible for whole process operation from the financing, designing, construction and operation to the ultimate transfer of project. SPC is composed of private or private entity, under special circumstances, government or other enterprises can buy shares of corporation and the shares they take are usually small.

In the process of project operation, the functions of SPC mainly include: SPCs are responsible for the bidding and negotiation. After government ventilates relative documents, with the help of consulting agency, SPC makes the feasibility study of the project, after confirming the feasibility of the project, SPC will work out the bidding document and take part in the bidding. After it wins the bid, SPC negotiates the relative contents of the project with government and signs a PPP contract (a concession contract).

SPC is responsible for project development, operation and transfer. After SPC signs contract, it will be fully responsible for the development of project and complete the investment, design and construction by signing relative contracts agreement with cooperative units-banks and financial institute, design sector, construction sector and consulting agency. After the completion of the project, SPC will carry out the operation of the project during the concession period and pay back loans with project profits, turn in taxes and distribute profit to every member. After the expiration of concession period, SPC will transfer the project to government in accordance with the contract.

SPC should insure the service quality of project. Public and governments are the service object for the operation of infrastructure project under PPP model, so during the operation of project, SPC should try their best to meet the need of users and insure the service quality of public goods.

Under PPP model, banks providing loans to project mainly are international financial institution, commercial banks, trust and investment institution and so on, in which the political loans – such as government export credit agencies and World Bank or regional development banks take an important function. The main functions of bank and financial institutions are to provide financial support and credit guarantee for the successful implementation of project.

Banks and financial institutions are responsible for financial support in the financing structure of project, the loans and bond capitals from banks and financial institution are the important guarantee for the successful operation. In PPP project funds, the proportion of the direct investment from private or private entities and government is usually comparatively small, most of investment is from banks and financial institution and the loans are long-term loans. Under normal circumstances, the investments of this kind of infrastructure project are huge, the recovery of project loan depends on long successful operation and the risk of loans is big, so besides the loan from general commercial banks the funds from international financial institutions – such as World Bank, Asian Development Bank is pivotal for successful project finance.

Banks and financial institutions provide credit guarantee for SPC. There are many stakeholders to participate SPC, so these participators' credit standing, technology capability, economic strength and performing performance will directly related to the failure or success of project. To guarantee the successful recovery of project loans, lenders usually require SPCs or participators

The operation of infrastructure projects with PPP model has many stakeholders and cooperators, complicated funds construction, comparatively long project development period, big risks and they are much more complicated than traditional financing projects. Consulting agencies provide SPC for political advices on industry policy, tax policy and financial policy. Consulting agencies

Beside above stakeholders, designing unit, insurance company, operational company, construction sector, material supplier and so on. They all play an important role in the operation process of PPP model, their coordination and closely cooperation with SPC and all partners is an important factor for project success. The relationship among stakeholders reaches a result of final balance after stakeholders chase their own interests-the social interest, collective interest or individual economic interest.

Whether all stakeholders of POPs management and disposal have already been ready and their jumping-off place and implementation result of all parties have gone towards to the desired objectives will determine whether the effort of all stakeholders can fundamentally solve the problem of POPs management and disposal. The hazardous waste project of Sander group investment in Gansu, Jilin and Hubei province in China has been successfully managed and operated with PPP model up till now. Their successful experience is to deal with the relationship among all stakeholders well and they have their unique understanding towards the stakeholders in waste management and disposal.

Sanders' successful experience in the POPs management and disposal process under the management mechanism of PPP model thought that all stakeholders in any parties should not pursue short term interests in the POPs waste disposal field especially for investors and operators. They should take it as a career and focus on long-term social and economic interests. At present some enterprises show great enthusiasm to be project general contractor to acquire profit in project construction and they have not enough foresee ability and confidence. However, both for the enterprises and society the true meaning of the hazardous waste disposal is its operation and thus acquires social and economic benefits.

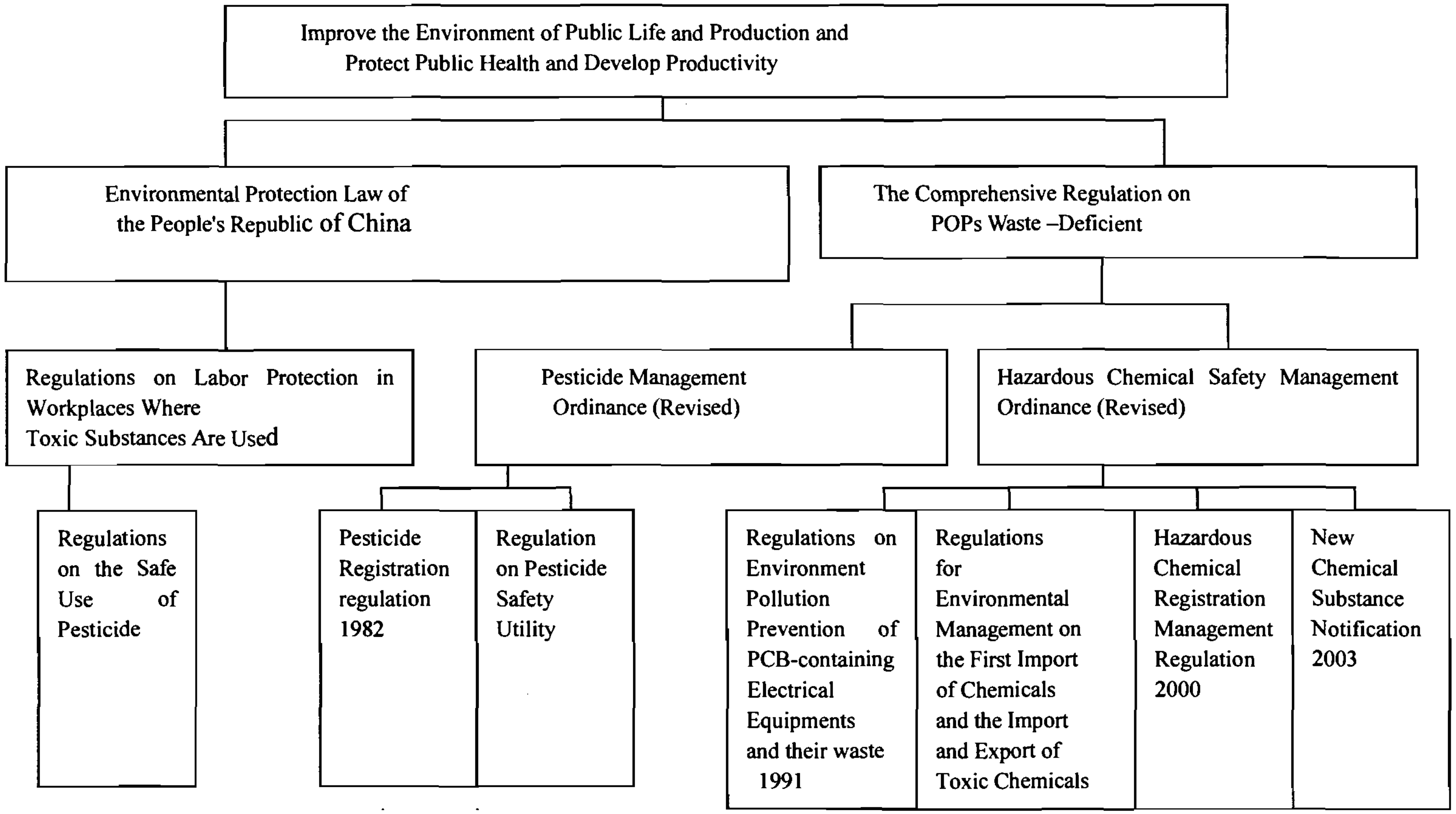
Comparing to other projects the stakeholders in the project and engineering of POPs waste management and disposal and the emission reduction of rich-dioxin fly ash in incineration pay more attention to contract compliance and social benefit of projects, any mistakes and failure may cause the immeasurable and irreparable loss for society. The POPs waste disposal process under PPP contract should be the process of faithful operation to reach the objectives of sound management and disposal of POPs waste in the social, public and moral constraints.

4.3 Barrier Analysis and Feasibility to Remove the Barriers

4.3.1 Lack of a consistent regulatory framework

For the international society realize the environmental risk of POPs in the recent years, there is no relative special law in Chinese low system to regulate and restrict the production of POPs waste. The POPs wastes are the general name for the substances with the property of persistence, bioaccumulation and long-distance migration including pesticide, industry production and by-product categories. So when analyzing the Chinese law system framework, it is necessary to make a comprehensive analyze on the existing laws of pesticide, hazardous chemicals and environmental protection in order to get the law framework for POPs management and disposal.

Figure 4-2 Law System Framework Relating to POPs Waste Including Law, Byelaw, Rule and Standard



But we can find from table 4-2, there is no specific law or ordinance on POPs substances management aspect. That is to say besides the department regulation and rules, there is no separate law on controlling and eliminating POPs waste. The dealing of majority incidents is carried out in accordance with the Dangerous Chemical Safety Management Ordinance (No.344 Statute From State Department), Pesticide Safety Management Ordinance and Prevention and Control of Environmental Pollution by Solid Waste. For a variety of laws themselves exist germination and intercross, unsystematic, difficult to operate and easy to conflict, so they can not meet the need of current POPs substances management and control.

Risks of POPs waste cause many countries' attention, international organization called for the global activities to reduce and eliminate these substances. Some laws and standards were promulgated one by one to protect human health and the safety of ecosystem, 90 countries signed the Stockholm Convention on Persistent Organic Pollutants, this means that human being start a formal declaration to POPs wastes.

This research start from the function of chemicals so as to understand the corresponding relation between the structure and function of relative POPs regulations in our country and analyze the development process of POPs management policy and control degree and probe into the strategic framework of POPs waste disposal and provide the scientific basis for government policy institution.

Table 4-3 Laws, regulations, and technical standards relating to POPs waste management

Noticed Field	Name of Law	Promulgation Year	Categories	Promulgation Agency
Comprehensive Type	Pesticide Management Ordinance (Revised)	1997	Ordinance	State Department
Comprehensive Type	Hazardous Chemical Safety Management Ordinance (Revised)	2002	Ordinance	State Department
Registration, management	Hazardous Chemical Registration Management Regulation	2002	Regulation	State Economic and Trade commission
Produce	Regulation of the People's Republic of China on the Administration of Production License for Industrial Products	1984	Ordinance	State Department
Registration, Produce, management	Measures for Environmental Management of New Chemical Substances	2003	Regulation	The Ministry of State Environmental protection
Utility, Management	Regulations on the Safe Use of Pesticide	1982	Regulation	Ministry of Agriculture
Produce, Utility, Management	Regulations on Labor Protection in Workplaces Where Toxic Substances Are Used	1997		Labour and Social Security
Produce, Utility, Management	Measures for Environmental Management of New Chemical Substances	2001	Ordinance	State Department
Disposal	Regulations on Environment Pollution Prevention of	1991	Regulation	Ministry of State Environment

	PCB-containing Electrical Equipments and their waste			Protection
Pollution Prevention	Environmental Protection Law of the People's Republic of China	1988	Law	The NPC Standing Committee
Pollution Prevention	Safety Production Law of the People's Republic of China	2005	Law	The NPC Standing Committee

At present the state has already established a law framework system with the core of the Law on the Prevention and Control of Environmental Pollution by Solid Wastes of the People's Republic of China with supporting regulations and standards and well-coordinated operable local regulation, rules and regulations as a supplementary of laws, regulations and policy standards. The current hazardous waste environment management has already made these laws, regulation system come into effect. Stress the sources is the most effective and economic management approach for implementation waste management, the first principle for waste management is the reduction of hazardous waste, in the process of disposal, strict management should be conducted otherwise hazardous waste will be used and dispose in disorder and cause secondary pollution and influence the healthy development of disposal industry.

There is key management system and many requirements related to hazardous waste producing units, among them four are important.
Declaration system: The hazardous waste producing units must declare and register according to State relative regulations.

- Institute and submit hazardous waste management scheme.
- Institute and submit the prevention measures and emergency response plan incidents
- Declare and register

The operation license system means the hazardous waste producing units will provide and entrust other hazardous waste disposal units with operation permission license engaging in the operation activities of collection, stockpile, utilization and disposal.

- In the manifest of transfer and interregional permission system of hazardous waste regulates that Interregional transfer of hazardous waste should report and ask of approval of authority according to law.
- Engaging in the operational activities of collection, stockpile, utilization and disposal should accord with the Regulation on Operation license.
- Regularly report the situation of their operative activities of hazardous waste.
- Prevent the forgery, alteration and transfer of the operative license of hazardous waste.
- Establish the recording books for the operation situation of hazardous waste to record factually the matters such as the collection, stockpile and the category, source and whereabouts and the number of accidents of hazardous waste disposal.
- Before the abandon and transformation of operation infrastructure facilities, they should be soundly treated.

The management and disposal system for hazardous waste producers (principals) Hazardous waste producing sectors should manage and dispose the hazardous waste in accordance with relative state regulations and are not allowed to dump and stack arbitrarily(The 55th article of the Law on the Prevention and Control of Environmental Pollution by Solid Wastes of the People's Republic of China).

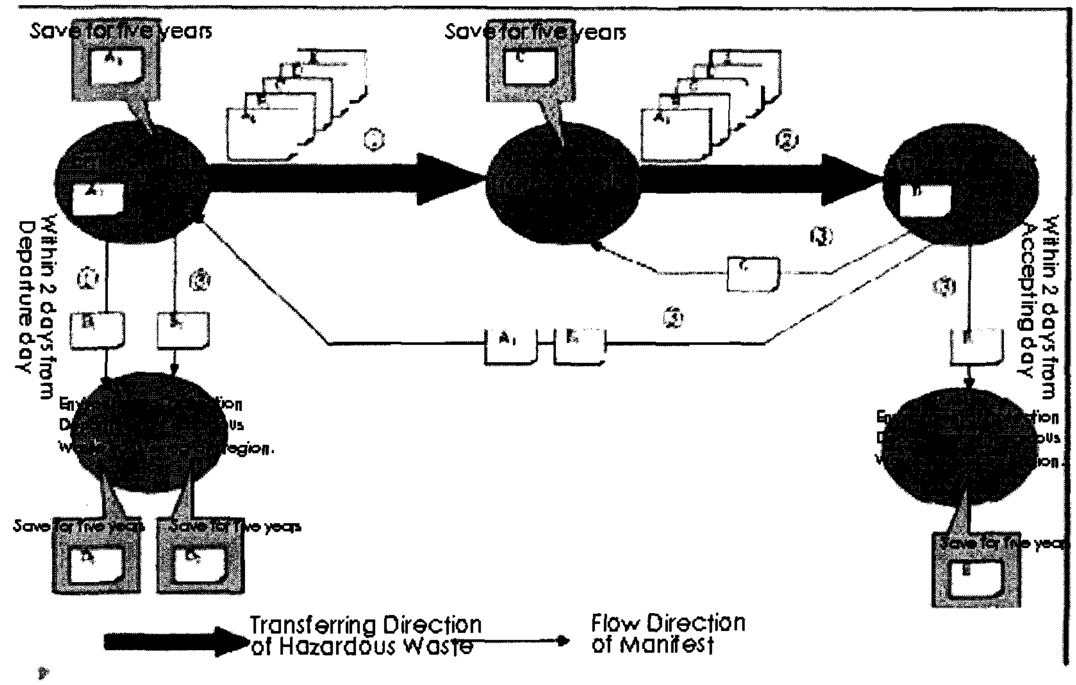
Those hazardous waste producers who don't dispose their produced hazardous or pay the disposal free that they should pay in accordance with the relative law, the administrative authority of environmental protection in local government above the county level will order them to neaten within a time limit and they will be fined disposal fee from more than one time to less than three times of the former disposal fee because the waste disposal will be commissioned to other sectors (The 76th article of the Law on the Prevention and Control of Environmental Pollution by Solid Wastes of the People's Republic of China).

The waste producing units construct the hazardous waste treatment and disposal facilities for the treatment and disposal of their units or other units must apply and obtain the License on Hazardous Waste Operation. The hazardous waste producing units can not dispose arbitrarily the high hazardous wastes with high toxic, teratogenic, carcinogenic and mutagenic and government encourages hazardous waste producing units to transfer hazardous waste to the certified unit for recovery and use of the hazardous waste but complying with the relative conditions.

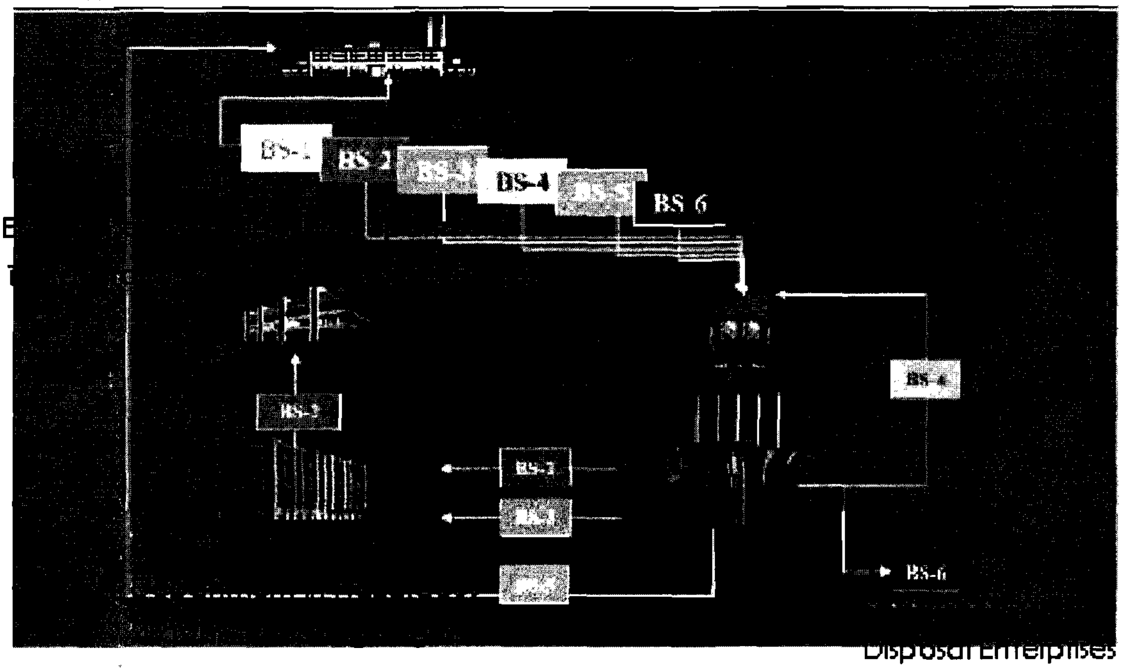
The purpose of this system: The implementation of manifest system of hazardous waste transfer is to control the flow direction of hazardous waste, get hold of the dynamic change, supervise transfer activity and control the pervasion of hazardous waste pollution. ... those who provide hazardous waste to or entrust the units engaged in operation but without operation licenses; those who do not fill in the manifest of hazardous waste transferring or transfer hazardous waste arbitrarily without authorizing will be fined more than 20 thousand and less than 200 thousand RMB. (The 75th article of the Law on the Prevention and Control of Environmental Pollution by Solid Wastes of the People's Republic of China)

Table 4-5 Manifest System

Manifest System of Hazardous Waste Transferring in China (Seven Manifests)



Manifest System of Transferring Hazardous Waste in Germany(Six Manifests)



The substitutive execution system of hazardous waste:" Hazardous producing units must dispose hazardous waste in accordance with the relative state rules and regulations, the authority of environment protection of local people's government over the county level order to correct their behavior within the time limit; For those which do not dispose in accordance with the relative regulation, the authority of environment protection of local people's government over the county level will entrust the designated units to conduct substitutive dispose in accordance with the relative regulations, the dispose fee will be paid by the hazardous waste producing units." (the 46th article in the Law on the Prevention and Control of Environmental Pollution by Solid Wastes of the People's Republic of China). The substitutive dispose system is a kind of administrative enforcement measure, it guarantees that hazardous waste can be dispose appropriately; At the same time " the polluters pay" principle regulates the hazardous waste producing units will pay the disposal fee.

4.3.2 Risks analysis

The fundamental purpose of PPP project is to promote the quality of public product or service, to realize the value for money, to promote the development of public utilities, to reach the objectives and create a "win-win" situation of the public and private sectors by the effective cooperation between the public and private sectors

But the PPP project organization forms are completed. Because of the difference between the operational mechanisms of public and private sides, increase the coordination difficulties in management. Especially PPP mechanism is new financing model, it is not utilized for a long period and there are no successful cases in the real sense that can be referenced. So in adoption of PPP model in public utility constructions, the possible existing risk should be confronted and circumvented, so that the PPP project can be implemented healthily.

PPP model services projects, it may meet the risks that projects meet, there are several risks as follows in infrastructure projects

- Risks in political aspect: In the process of project implement, the change in government policies will influence the project's benefit capability. It has associated with political system and government's integrity.
- Risks in rate: The local acquiring funds revenue can not exchange the foreign exchange with predicting exchange rate.
- Risks in technology: This kind of risks associates with the actual construction and operation.
- Risks in finance: The revenue of project operation can not afford its debt and interest, this may cause creditor force the project corporation to go bankruptcy and lead to the failure of application of PPP project.
- Risks in operation: these may mainly come from the uncertainty of finance income, the project profitability can not meet the predicted level of private cooperation party.
- Risks in political aspect: Since the project construction and operation can reach the predicted and due public function purposes or the coordination of stakeholders' relationship during the project implementation in the original public project may cause social and political problem.
- Moral risks: Project co-operations do not obey integrity principles and lead moral risks.
- Uncontrollable risks: In the project operation, the uncontrollable (flood, war and so on) factors cause the reduction of financial profitability

Other risks: Because PPP projects do not develop only for a short time with a long project concession operation, the present PPP projects are in the early stage of implementation. So there is no successful case in its real sense. This is where risks lie in. In England there are controversy opinions. These reasons for the controversy opinion are the problems and risks of PPP projects. These problems are:

- Project mechanism can be changed and as a result it influences all project staff to cha
- And the government wants to improve PPP projects and public departments underestimate the needed costs of projects.
- Public sectors pursue operational return and enlarge the base number of competitive bidding. Because a project investment increases and the return rate decreases, the government has to give additional subsidy to the operator of project.
- Project contract period is long, government have to take the risk of long term investment recovery and commit guarantee of project investment of recovery, these will become the government's burden.
- Along with the project implementation, the project may be privatized, the government then sells the land and equipment, the government does not transfer the risk completely to private sectors as they hope to do by concession operation.
- Project may not reach the expected service level; the government may lose the control for the project equipments and services and then has to expire the contract.
- Public sectors control and direct social and public requirements but not to meet these requirements.
- For the government hope to improve the efficiency of PPP projects, private sectors increase their efficiency not because of their good management, on the contrary they improve their investment recovery by trimming the staffs and cutting their pay. But doing so may cause social problems.
- The implementation of project may produce corruption for the public-private linkage.

Table 4-6 Matrix Table of Breakdown Structure of PPP Project risk and Risk-sharing

Levels of risks	A	Overall risk of PPP Project												
	B	Risk in Project Financial Phase												
		2.1									2.2			
	C	Systematic risk									Non-systematic risk			
		2.1.1			2..1.2				2.1.3		2.2.1		2.2.2	
	D	Credit risk			Financial risk				Macro Environ-ment		Design risk		Budget risk	
	E	Credit level	Adaption And	Sponsion risk	Current inflation risk	Foreign exchange risk	Exchange rate risk	Tax rate risk	Political risk	Policy risk	Financial	Wrongful financial scheme	Project Cost budget	Budget
	Gov				X	X	ü	X	X	X				
	SPC										X	X	X	X

	Pin													
		X	X	X	X	X	X		X	X				

A	Overall risk of PPP project																	
B	4. Risks in operation and maintenance phase																	
	4.1									4.2								
C	Systematic									Non-systematic risk								
	4.1.1					4.1.2				4.2.1			4.2.2					
D	Market risk					Macro environment				Manager diathesis			Operation risk					
E	Market price	Market competition	Market requirement	Market production	Policy Risk	Economic development	Exchange rate risk	Delay risk	Industry Instruction	Management Capability	Management Seniority	Present work capability	Quality risk	Over-expenditure of cost	Financial risk	Organization risk	Communication coordination	Operation Environment
Risk: Gov			X	X	X	X	X	X	X									X
Risk: SPC	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Risk: Pin	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

The finance innovation opinion of risk management oriented leads the new re-examination of investment and financing of infrastructures and found that when risks can not be identified and controlled, the government's commitment and guarantee become the only way to control risks for commercial finance introduction in infrastructure. To be brief, once risks are identified and controlled in technology but not in concept, once they are identified in process details but not in overall profile construction, the risks in infrastructure investment and financing will be distributed in public and private sectors.

These can meet or partially meet the need of social capitals of risks preference into infrastructure barriers, risks will decrease a lot. In this sense, PPP model should not only be a model of partnership but a process of of risks consideration and assessment by the way of insurances of project objectives. Along with the rapid development of scientific technology and social productivity, the large scale of projects and complication of organization management highlights the complexity and difficulty.

As a important part of project management, all countries all over the world paid more and more attention to the science of project risk management and gradually become popularized and make people have sense to realize, control, decrease and shift risks. Enterprises can acquire the greatest security and reduce risks loss to the minimum with the least investment and guarantee the successful implementation of operation and realization of project objectives and increase productivity. Risk management is not only of great importance for enterprises, but promotes social development. It is the important content of scientific decision-making of project investment and powerful tools for project economic benefits. It has theoretical and realistic significance for avoidance of investment loss, making a good use of resources and reduction of risk loss. The study, popularization and utilization of project risk management have realistic instructive significance for project organization.

Its function can be reflected as following aspects: The key for the success of PPP project is its effective and fair procedures. Effectiveness is the power guarantee for the stakeholders in PPP project to develop its advantages and avoid its disadvantages and risks. These are mainly the government actions. Under PPP model, government has duel positions, on one hand, government is a party of contract; On the other hand, government should provide a stable political and legal environment for project operation.

Under PPP model, the function of government will change and adjust, the main performance is that it should provide legal guarantee for the specific operation of project and not interfere the normal specific project operation activities of SPC. It provides proper economic support, is cautious enough to commit in specific projects and leaves some rooms for the adjustment of follow-up activities. The functions of government must confirm a clear boundary including the boundary of assets, such as market admittance, price general service and so on. Taking the efficiency as the effective precondition and guarantee, government must confirm a commitment mechanism, guarantee the safety of assets and reduce the costs of project financing, guarantee the sustainability of project production and operation, ensure enough income for project operation, pay necessary investment costs and costs happened during operation process and ensure a reasonable recovery. PPP project has a long cooperative period and a close relation with people's interests then should have comparatively high reliability and government should carefully examine projects. It should establish reasonable, scientific and transparent procedures suitable for project development and construct a effective framework.

The stakeholders enter procedures and retain the third party of intermedium agency as consultants, provide advice to make procedure fair. To make procedure fair, there must be the transparency of legal, regulation and political environments. In England and Brazil there are specific state laws to confirm the legal position of PPP. To follow the principal of market competition, government should choose their partnership by market mechanism and evaluate the partners capability for public utility project construction and operation management and choose a better cooperators. This is a good way to avoid risks to the maximum extent.

Both of public and private sides are the fundamental guarantee for avoidance of risks. Construction and operation projects should take a series of risks, such as the rise in construction costs, security expenditure more than expected, political risks (including the legal change in operation period), technology risk, exchange rate and financial risk, operation risk and the increase, decrease in the demand for service supply, moral risk and so on, all these risks will directly influence project profits and investment recovery of private sectors. In traditional public project mechanism, governments take risks completely. But in PPP mechanism, these risks defined by concession contract will partially or even mostly be taken by private sectors. But if these risks happen, projects will carry out with great difficulty even cause failure in the end. No doubt governments will be the victims of project failure, especially the political risk, so government should take responsibility to assist the private sectors to avoid risks, guarantee the successful operation and reach the expected project.

For the instruction of PPP model, management mechanism change, requirement for pursuing high benefit, adjustment or optimization of personnel resources, change in former personnel resources benefit, all these may cause the adjustment risks in personnel resources and become unsteady factor. Of course, this innovation in management mechanism is necessary pain. Government should lead and direct private sectors in face of the benefit reformation in personnel resources adjustment to decrease adverse impact and avoid social and political risks. The public and private sectors should entrust independent intermediary agencies to supervise the implementation of cooperative project and guarantee operational effect and avoid moral risk in the process of operation. Of course during the process of project operation, the loss caused by the risk of financial profit capability decrease, also called irresistible risks should be taken by both the private and public sectors.

4.3.3 Difficulty in finance of environmental protection facility

In the rapid development period of urbanization in China, the present urbanization rate is 37 percent, China's urbanization rate is 37% in a period of rapid development and will reach 46% and 55% in 2010 and 2020 respectively. Number of cities and their scales grow and expand rapidly and this leads to increase in municipal life sewage and waste production. In recent 10 years, the emission amount of Chinese urban life sewage increase at a rate of 5%, in 1999, it exceeded industrial sewage emission. The urban life sewage emission volume reached 23.22 billion tonnes in 2002 and grew at a rate of 5%-8%. In 2002, the municipal life waste production volume reached 0,136 billion tones. It is estimated that the municipal sewage and waste production volume will increase by about 1.3 times and 2 times respectively.

Municipal life sewage and waste treatment infrastructure construction are serious lagging behind. By the end of 2001, the rate of national municipal life sewage treatment is only 36.49% in which the rate of second treatment is only 18%. The rate of national life waste treatment is only 8.2%, and the rate of environmentally sound treatment is only about 10%. According to "10^{th} five-year environmental plan, by 2005, the centralized treatment rate of municipal life sewage should reach 45%. And cites with population of 500 thousand should reach 60% having a newly increased sound treatment capacity 150 thousand t/d. In order to reach this objective, the national municipal sewage treatment infrastructure construction need up to 100 billion RMB funds and waste treatment facility construction investment 45 billion. It is estimated that during "11^{th} five-year", the investment in two fields need about 170 billion RMB.

The disposal objective of the project is to eliminate 10 thousands tones of pesticide POPs and 1 thousand tones of dioxin-rich fly ash in medical waste incineration. According to the requirement of national regulations on hazardous waste management and disposal, pesticide POPs waste should be disposed with environmental safe and sound treatment. So, the disposal of POPs waste with other hazardous waste consist a long-term disposal market. Referring to the fee charging standard in foreign treatment and disposal market, the disposal fee of POPs waste is 10000-3000 RMB. According to this, it is estimated, within future 10 years the market scale of POPs disposal in China will reach 1.1-3.3 billion RMB, the investment for the infrastructure construction of disposal industry should be more than 1 billion.

The construction completion and operation of infrastructure will lay a solid foundation for the future POPs waste disposal. But considering the special demand for the environmentally sound disposal of POPs waste, on the base of present hazardous waste disposal system, additional 0.6 billion RMB should be invested.

Enterprises financing refers to a kind of economic activity for guarantee of future operational development of enterprises by a certain kind of channel and way for financing for the need of development of enterprises. From the implementation of the National Plan for the Construction of Disposal Facilities for Hazardous Waste and Medical Waste, The sectors for investment construction and operation of hazardous waste disposal facilities are the small and medium enterprises. The development funds of small and medium enterprises are the following resources: The first one is self-accumulation; the second is direct financing; The third is indirect financing.

Self-accumulation: The small and medium enterprises have little funds themselves It is investigated that small and medium enterprises produce average annual output value of 0.405 million a year taking about one eightieth of large enterprises. Small and medium enterprises have little funds and self- accumulation, so small and medium enterprises develop with great difficulties only by their self-accumulation.

Direct financing: Direct financing refers to the forms of publicly financing funds by bonds and stocks from the communities, the present direct financing channels for enterprises in China are rare and take small proportion. The capital markets have no special arrangement for the financing funds of small and medium enterprises, financing policy mainly tend to nation-owned enterprises reorganization. And the most small and medium enterprises themselves have great difficulties to reach the criterion of listing. At present only less than 3 percent in all listing enterprises in China are non-state-owned small and medium enterprises. It is estimated that the financing of Chinese enterprises by valuable securities takes the proportion of less than 10 percent of all external financing.

Indirect financing: Indirect financing mainly include a variety of short-term and long-term loans. Loan ways mainly are mortgage loan, guaranteed loan and credit loan. The financing of Chinese small and medium enterprises relies on bank loans to the most extent. According to the survey made by Shanghai cooperative bank on the situation of small and medium enterprises financing, the enterprises taking bank loan as the principal financing channel take 72 percent. But four large commercial banks monopolizing 80 percent of credit funds put their development strategy on 'large industry and large enterprises'. The loan for small and medium enterprises is small in number.

4.3.4 Difficulty in pricing

According to the National Hazardous Waste Category, POPs pesticide waste is listed into HW04 of National Category of Hazardous Waste. The waste containing PCDD and PCDF are listed into HW43 and HW44 respectively in National Hazardous Waste Category. In order to solve the problem of lack of disposal capability and the situation of environmental pollution and improve the industrialization of hazardous waste disposal, the state will carry out the charging system of hazardous waste disposal. According to the five ministries promulgated the Circular on Hazardous Waste Disposal Industry Improvement and hazardous waste charging system Implementation, government will institute rational changing standards of hazardous waste disposal to improve the disposal capability of hazardous waste.

The changing fee of hazardous waste disposal is operational service fee, the changing standard will compensate the disposal costs of hazardous waste and it will be checked and ratified according to the principal of rational profit. The notice defined that the medical waste will be charged by the volume of productivity and bed number of medical institution on a month base. Industrial hazardous waste and social source hazardous waste will be charged according to the weight of waste. Disposal units of hazardous waste should sign the centralized disposal service agreement within the charging standard set by the pricing authorities in order to make clear the relation of responsibility, power and interests of both sides. The notice required to change the model of separated disposal to reach the centralized disposal of hazardous waste as quick as possible.

The principles and approach of changing hazardous waste disposal fee should be instituted by the authorities of the provinces, autonomous region and municipalities and submit to the urban people's government to be approved and take into effect and reported to the provincial pricing authority for record. The circular requires giving a fully play of the basis function of market resources allocation and encourages the use of national and international funds, including the investment of private enterprises for the disposal infrastructure construction and operation of hazardous waste and establish the operation mechanism for hazardous waste disposal in accordance with market economic requirement.

The pricing of hazardous waste disposal fee is very difficult, its performances as follows:

- In the price structure, the existing relative laws, regulations are lack of clear stipulations for public utilities in price constitution, the determination of key factors in price constitution and its range are usually arbitrary and this leads the constraint softening in the costs of public enterprises. We can see from the relative regulations in the prices of urban water supply, the stipulation of relative price constitution is very crude and is not operable. And this mainly reflects the high pays and high welfare wide spreading in the public utilities in our country.
- There are problems in the way and means for pricing and its adjustment. Because of insufficient competition or no competition at all, the initial price usually only reflect the specific costs but not the average social costs. At present, in the option of the investors for the public enterprises restructure and newly built project, the concession operators are usually determined by the way of one-to-one negotiation and agreement without bidding competition, so the determination of the initial price completely depends on the bargaining capability of government and franchise operators not market competition.

- The hearing system of price adjustment is distempered. And institutions usually are obedient. Project subcontract, especially for the subcontract of soft service, the concession operators will set price by themselves, this will lead to transferring of profits of concession operators by the related-party transaction prices to raise costs arbitrally.
- In the price construction, the government fee and resource taxes fee are commixed together in order to make confusion firstly, it is not convenient to social supervision. Secondly it creates the condition for operation enterprises to raise prices. In addition, and the mix the concept of political pricing and operation pricing is easy to cause the distortion of price mechanism.

Whether pricing is rational or not will relate to the success or failure of PPP projects. If pricing is high, users will raise doubt, refuse to pay disposal fee and make the project stop or even failure. But if pricing is over-low, the benefits of private sectors and their enthusiasm will get hurt. These two results may influence the public service provided to social public. The purpose of government to service the people can not be reached. The principles of pricing and proper charging fees are the most important issue for the sustainable development of finance in the urban environmental infrastructure construction.

For the level of charging waste emission fee in a certain period both the stimulation function of environmental economy to reflect the polluters pay principle and the affordability of pollution emission enterprises should be considered; Both the realization of environmental purpose and many policy problems should be considered. The principles for pollution emission pricing are follows:

- Principle of protection and improvement of environment quality;
- Principle of consistency of laws and regulations;
- Principle in accordance with economic stimulation;
- Principle of economic rationality and technology feasibility;
- Principle of simple and practicable;

The standard for pollution emission charging was instituted by the State environmental protection administration in accordance with the following procedures;

- Determine the objectives of environmental quality and pollution emission.
- Choose the specific control measures and technologies of a certain POPs waste.
- Choose the approach of charging factor, charging model and standard institution.
- Collect relative data and propose the initial charging standard scheme.
- Conduct feasibility analysis for the proposed initial charging standard scheme.
- Put forward the final pollution emission charging standard scheme for the decision of decisive-making departments.

4.3.5 Commitment of unreasonable return rate

In order to reach the purpose of public and private partnership, both of the private sectors and private sectors will exaggerate their promises. This leads to the unrealistic fantasy for recovery, especially economic recovery. Public always expects the public good and service with high quality and low costs, private investors expect to acquire more profits, this will make government fall into typical predicament of "insert in the middle". From the perspective of private sectors, they expect rational and more investment recovery, so they have the impulse of raising the prices of public goods and services, They usually complain that government set the prices low, and raising prices is difficult and costs a lot of time. In the early stage of project with high capital input and low operative costs, they have to face the risk that they could not raise the price when operation costs increase.

Some projects fall into predicament because government sets price low and does not give price subsidy, for example a sewage treatment works run by a private enterprise in Shenzhen was falling into this kind of situation. From the position of public, they can only see continuous rise of price of public utility such as water and electricity and they thought investors and operators are blinded by gains and government takes the laissez-faire attitude. Government on the one hand lacks of the rational analysis for the possible costs of services provided by private enterprises, the promise for price rising of the ultimate consumers is difficult to fulfill; On the other hand they have to face the blames and complaints for raising prices. Promise in investment recovery refers to the actual acquired yield of investment after deducting costs.

PPP projects have a long construction cycle and a huge investment and will face a lot of uncertainty, so project investors usually ask for providing the guarantee of fixed investment recovery. The state government defined governments at all levels can not promise fixed investment recovery to foreign investors, it will restrict investment recovery rate to get a rational recovery but not to acquire super profit.

PwC (2002) is entrusted by the Ministry of commerce to conduct a different test. The corporation analyses the case of yield of a series of private initiative finance project to confirm that the expected profit in management and risk-bearing has reached or exceed the estimated profit in the market competition formed by every party. The relative yield rate that we mentioned in the former part, public and private partnership and private initiative sole-investment in tender market need the introduction of furious competition so as to guarantee private sectors entity to provide the most competitive bid and reach the best value of money provided by government.

The report indicates in the very beginning only with competition the internal yield rate of project can reflect the actual yield required by diversified investors, just as it can be showed by weighted average cost of capital. In order to review the truth of investigated situation, it choose 64 examples of private initiative finance projects covering all kinds of activities of private initiative finance taking, accounted for 23% in the total value of construction of all private initiative finance project.

As the approach of measuring the predicted private sectors yield, the report adopts the predicted internal return rate after nominal tax and after the completion of finance. And then it compares the project return with weighted average cost of capital, project return should be the expected return acquired by diversified investors in accordance with project risks forecast. This yield is acquired by a great deal of information from public information channel (mainly the relative public utility department) of similar commercial activities. The approach is to get the corresponding equity costs by use of CAPM (Capital Asset Pricing Model) and weighted average cost of capital with debt costs of every project figured out with financial model. CAPM supposes that the investors of equities will ask for more compensation than risk-free rate in order to compensate the relative risks of their investment, in which risk premium has considered the function of investment systematic risks.

The research found that in all example projects the average yield rate per year is 7.7%. After comparison, the estimated value of acquired weighted average cost of capital is 5.3% per year. So the margin between them is 2.4% per year. This margin is the estimated value of total extra expected yield exceeding finance costs in private initiated finance projects. Notice that the equity yield and the project yield (beforehand) are expected profit. Not all projects in their entire life cycle (afterwards) will acquire this kind of profit because the development of projects may be better than expectation or may be worse. Though most projects can gain success, a lot of projects do not acquire expected profit and on the contrary make the possibility of deficit of investors' capital.

The report of PWC said that, even if project has expected profit, only a part of difference is the excess profit of investors, the reasons for these phenomena: Firstly the average proportion of bid cost is 0.7-1.3% (An average 1%). The bid cost in private initiative finance model is higher than the bid cost with other procurement approach. All project bidders expect to recover all costs before it makes profit-including the costs produced after the failure of bidding. For these projects in the examples, before the preferred bidder is announced the produced average cost is about £1000 thousand.

The average bidding rate is one thirds or one fourth, but the financial expectation of a specific project providing the basis of PWC research only indicates the bidding cost of wined specific project. So they have not clearly reflected other failure bidding costs, at least a part of these costs will be received by the return of equity. Secondly in the 25-30 years contract of private initiative investment, bidders set price for target earning with fixed rate adopted in traditional Capital Asset pricing model (CAPM), for example prices can be settle by use of swap rate but not interbank rate. In equity costs it adopts swap rate but not interbank rate as risk-free rate and increases the average capital cost from 5.3% to between 5.75%--6.25%.

So in the difference of 2.4% per year, the following two factors take 1.7%:

- The unrecovered bidding costs in other projects (approximately 1%)
- The basic rate cost of private sectors loan is higher comparing with the loan of public sector, this is caused by the difference between swap rate and interbank rate (Approximately 0.7%)

After considering two factors, the estimated value of expected super profit of project investors is about 0.7%. These super profits are caused by the 'structural problem' because of the restriction of market competition of private initiative finance in the past. For example, people thought that the procurement time limit and bidding costs spend by private sectors in private initiative finance model are still the barriers for private sectors to enter infrastructure market.

4.3.6 Lack of supervision and oversight

It is said in the Micro regulation and System Economics: generally speaking, the content is roughly divided into two parts: The economic regulation and social regulation. The economic regulation refers to the field of natural monopoly and existing information unbalance, in order to prevent the happening of the inefficient resources collocation and ensures the fair utilization by users, the government agencies with legal authority regulates the private sectors behaviors of entrance and exit, price, quality and quantity of their services, investment, and financial accountants. It mainly refers that government implements all kinds of restricted regulation in the aspect of price, yield, entrance and exit.

The purpose of the social regulation is to guarantee the safety, health, sanitation and environmental protection of the customers and prevent disasters and institute rules and standards for products and services and all kinds of accompanied activities when they are provided, and the regulation of forbidden and restricting special behaviors. Zhicaoyi divide social regulation into four categories: a. Guarantee of health and sanitation; b. Guarantee of safety; c. Prevention of pollution and protection of environment; d. Insurance of education, culture and welfare. Specific to the municipal public utilities, it mainly includes the aspects of market admittance, price, exit, technology and quality and general service.

A. Supervision on Market admittance

Market admittance mainly supervises and manages the range for private sectors' entrance to the municipal utility industry, investment proportion and the aptitude of corporation for entrance into this industry, performance, financial strength, financial structure, entrance mode, competition. Government institution control the entrance number to municipal public industry according to the development planning of municipal public utility in its scope of domination to ensure the effective competitive state and review the competence of enterprise by auditing and control the aptitude, performance and experiences of enterprise with a certain standard into field and by competitive way to choose adaptive enterprises to enter a certain field and sign franchise contract, in the franchise contract it specifies the obligation that enterprises should take and follow business regulations of price, service quality, operation time limit and fair deal.

Diversification increases the possibility for government to choose more investors, but sometimes most investors have funds, they know little about technology facilities and operation, they always take part in bidding for project with technical partner and operation partner or after the project construction, project facility will be transferred to other enterprise, so government will face great risks. The combination of three parts-investor, technological sectors and operators in the supervision of three part should monitor and supervise the project, government should pay more attention and give more support to the investors with investment capability and professional operation capability.

B. The supervision on Price

The supervision on Price is the supervision and management of determination and adjustment of the prices of product and service provided by the municipal public utility enterprises. Municipal public utility facility possesses a certain characteristic of monopoly. Operators are very likely to form monopolistic price by use of monopoly position and power. The government is responsible for the price of municipal public facility and service and periodical price adjustment to protect the benefit of consumers and stimulate enterprises to enhance productivity.

So, price is a complicated problem. To insure the supplier to provide a reasonable service price for consumers, this reasonable price will reach two purposes one is to push service provider to provide effective service and instruct consumers to use the service effectively. The supervisors should not only prevent the enterprises from making use of the power of monopoly to pursue economic benefits and raise price or decrease the level of products quality standard and service as a result these will affect the overall economic order and hurt the benefits of consumers, but also consider the relationship of the affordability of residents and the financial subsidy. So, government necessarily instructs, supervises and manages pricing and price adjustment in the aspects of time, procedure, approach, level and so on.

For price directly relates to the benefit distribution of regulated enterprises and consumers, price is the core in the structure of municipal public utility regulations. Regulators can effectively stimulate the regulated enterprises the degree and direction of behavior. There are two types of incentive. One is cost-plus, another is price ceiling.

Cost-plus mechanism is also called investment return. Under this mechanism, enterprise will submit a copy of its operation costs and the inventory of its capital costs, in which there is the investment return equal to or greater than capital costs, or after the verification and adjustment, these including the costs of profit-plus will be transferred to the prices asked from consumers. Under the cost-plus mechanism, the operation costs of enterprises may be subsided and cause a fair rate of return for its overall capitals, and this may effectively stimulate the investment of enterprises.

But it is lack of the stimulation to the costs reduction for enterprises. So because when enterprises make effort to reduce costs, the improvement of costs efficency causes benefits and the price reduction in buying products and service, all of benefit is transferred to customers. The benefits of enterprises could not increase. On the contrary, if the operation costs of enterprises ascend, prices will also go up, enterprises still acquire a fixed rate of return. For enterprises and operators do not have the residual profit claim for the incremental revenue for cost efficiency improvement, the behaviors of costs waste can be effectively punished, enterprises incremental revenue and the irrelevance of enterprises and operators decides the indifference for the costs rising and decrease the effort of reducing costs.

The limitation and control is for prices but not profit, so its most advantage is to encourage the internals of enterprises to improve efficiency, If enterprises increase productivity to the level of x stipulated in contract, the heightened part will be granted to enterprises as recompense, so as to improve production efficiency. At the same time, the price reduction below the price cap is the freedom of enterprises, it is easy for enterprises to solve the problems of competition of price reduction within the competitive fields and this is helpful for the efficiency improvement of resource allocation and consumers' residual, accord with the establishment of development of incentive mechanism to meet the need of customers and take into account both the interests of both supply and demand sides and the situation of market. Generally speaking, it encourages the reformation and innovation, costs reduction and efficiency improvement of enterprises on the one hand, and protect users legitimate rights and interests and reflect that the properties of public utilities are basal and of welfare. Comparing with cost-plus, the complex prices auditing can be avoided to the great extent in price adjustment and significantly reduce costs.

Prices should comply on municipal price supervision management system

- Under the leading of authority, establish diversified composite decision-making subjects composed of enterprises' representative, consumers' representative, and professional consumers' union representative of public utilities and form a constraint mechanism of mutual checks and balances and information communication mechanism among the authority of price forming sectors, public utility enterprises and consumers.
- Establish price management and control institution with complete functions, the basic requirement is to realize the integration of price examination and approval and costs supervision and control, reference to international popular practices, take the price regulation as center and merger the price regulation institution, market admittance and running regulations, establish the regulation institution for public utility.
- Establish the law system for price management of public utilities, institute Price Management Law on Public Utility Prices, define the scope of public utilities, political objectives (including at least price equity, rational costs bearing and consumption rationalization) and organization institution and so on, the institution in charging of implementation should make the pricing procedure and level of public utilities public in an open and equity way and accept the supervision of the community.
- Develop a social supervision system with practical efficiency.

C. Supervision

The operator withdraws from municipal public facility have two situations: One is the expiration of contract another situation is to exit for breach of contract and other reasons before the expiration of project contract.

After the expiration of contract, operator will transfer asset and withdraw from operation according to the regulation of contract, for the long operation of decades, enterprises guarantee to provide continuous service complying with standards, during the operation, in order to provide service consistent with standards, operators have to constantly invest more funds into project, so after the expiration of contract, some assets will transfer to government freely, but some assets will be brought by the new comer, and sometime the original operators may go on to apply for the contract extension.

Government usually asks concession operators to provide the maintenance, preservation and replacement scheme for the maintenance facility and equipment of project, and it will be defined in the concession contract that operators should not only guarantee the normal operation of project facility but stably and continuously provide water supply or sewage treatment service, more important thing is that government could get normal operative project facility from operators when the expiration and premature termination of project. So before the transferring of contract expiration, supervisors usually ask project corporations to conduct a "restorative overhaul" for project facilities including: a. Check the users and maintenance manual of project equipment manufacturers; b. Eliminate the actual defects and replace the vulnerable consumable parts of equipments.

4.3.7 Lack of competent human resources and institutions

For the long neglect or inadequate attention to the hazardous waste disposal, the whole process from the institution of the policies and regulations to the construction and operation of the facilities need to be improved, from the research and development of the disposal technology to the industrialization and services commercialization is in the process of exploration and in the initial stage, professional personnel in all aspects is insufficient, the staff engaged in the collection, stockpile, transportation and disposal of hazardous disposal do not have enough professional training, establishing a professional disposal team and realizing the corporation management is the strong guarantee of the improvement of performance of the hazardous disposal enterprise.

In addition, a good PPP project needs the relative policy support and the training institution of the financial service, technical, project consulting and professional personnel and the auxiliary service of the guild and intermediary organization; In the POPs waste disposal, the personnel resources in all these fields should be integrated, but there are few personnel with the professional attainment and work experiences in these fields.

5 Proposal for creating PPPs for POPs waste disposal

Table 4-1 Comparative Table of Activity Tasks on Public-Private Relationships

Public Sectors	Private Sectors	Public- private Relationships
➢ Investigate locations, volume and environmental impacts and risks of all kinds of POPs waste, and establish an inventory database of POPs waste, and incorporate collection, transportation and stockpile and disposal into the relative national and local environmental management plan.	➢ Investment by all kinds of ways: Make loans from national commercial banks and policy banks. Strive for the support of national fund and attract international grants and at the same time invest directly with its own accumulative fund.	➢ Manage and disposal, package and transport obsolete pesticide POPs waste safely and effectively. Give priority to establish the potential polluted land inventory. And complete the environmentally sound management of rich-dioxin fly ash.
➢ Study and assess the existing environmental quality standards, emission standards, engineering technology regulations, facility monitoring and supervising management regulations and establish supervision management	➢ Construct facilities and conduct trial operation in accordance with the relative national rules and regulations and contracts.	➢ Enhance law, bylaw and standard and regulation construction. Ensure private sectors to carry out the POPs waste diposal with them rigorously.

system.		
➢ Choose a proper pricing model, price test run and pricing setting procedure of ultimate price, and establish a fee system according to the principle of technology renovation, the most cost-effective, profit-maximizing and sustainable development to enhance the POPs management and disposal.	➢ Provide actively cost composition data and sign a substitutional dispose contract with polluting enterprises, government or beneficiaries. Establish a cost-recovery method.	➢ Public and private sectors cooperate to establish a rational and practical fee system so as to achieve a win-win result.
➢ Train the central and local government officials at all levels to promote the supervision level and ability of law enhancement on the building facilities and to monitor the operation of the built facilities and to audit the construction and operation under the supervision of the independent third part audit	➢ Put forward new technology requirements to the treatment technology, equipment R&D enterprises and relative R&D departments and provide the fund for the treatment technology, equipment R&D enterprises and technology for new technology/ facilities tests.	➢ Carry out technology transfer and achieve technology assessment on POPs waste treatment. Make an arrangement on equipment construction, testifying, operation and supervision.
➢ Provide the financial and policy support for the construction of POPs waste treatment and disposal facility and implement the exemption system for their operation licences. Establish a best method on the compensation and incentive mechanism for the law-abiding behavior.	➢ Promote government to renew the POPs waste inventory and plan, enlarge the POPs waste collecting and disposal range and market.	➢ With the help and induction of the public sectors, the private sectors have a sustainable development disposal market and ability in accordance with national standards.
➢ Promote the public participation of the system construction in urban, rural and remote areas. Establish and complete the environmental education in primary and middle school and college, and open specialized courses		➢ Public and private sectors cooperate to construct and maintain the proper internet-based information processsing, display and communication system.

5.1 Roles and Responsibilities of the Public Sector

5.1.1 Inventory and Plan

A. Objective: Make a full and aborative investigation on locations, volumes and environmental impacts and risks of all kinds of POPs wastes, and establish an inventory database of POPs waste, and incorporate collection, transportation and stockpile and disposal into the relative national and local environmental management plan.

B. Barrier Analysis: There is lack of a complete inventory and the production and pollution resources in China. The existing producing and pollution resources of POPs waste are unclear and the POPs waste inventory is insufficient. Some of the central and local governments are lack of awareness on the current situation, seriousness and risks of POPs waste pollution. There are serious problems in every link in collection, transportation, storage and disposal.

I. Institute the methodology on the investigation of current situation and impact of all kinds of POPs waste.

A. *Objectives:* Institute the methodology on the investigation of current situation and impact of all kinds of POPs waste according to the relative international conventions and relative national laws, regulations, standards and guidelines.

B. *Activity:* Reviewing "Basel Conversion", "Rotterdam Convention" and POPs Convention", and relative technical guidelines on POPs waste management and disposal, and relative national technical regulations on HW11 and HW43 category waste. Form an investigation methodology on the situation of quantity, location, the ways of storage, emission, the states of safety and people arrivals of POPs waste.

C. *Schedule:* 2009-2011

D. *Stakeholders:* Ministry of Environmental Protection, Ministry of Foreign Affairs, Development and Reform Commission, Science and Technology, Ministry of Finance, Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD), Ministry of Foreign Affairs, Ministry of Agriculture, Ministry of Commerce, Ministry of Health, the Customs Department, Bureau of Electrical Supervisor

E. *Capital requirement estimation:* 0.5 million USD.

II. Investigate particularly the location, quantity, environmental impacts and risks of all kinds of POPs waste.

A. Objective: According to the requirement of Stockholm Convention and National Implementation Plans in China, Investigate particularly the location, quantity, environmental impacts and risks of all kinds of POPs waste.

B. Activity: According to the requirement of Stockholm Convention and relative technical guideline on BET/BAP of POPs waste management and disposal and National Implementation Plans, and through the study of relative national and international survey experience of POPs hazardous waste, investigate particularly the location, quantity, environmental impacts and risks of all kinds of POPs waste. Establish a method system on how to carry out effective risk evaluation and prevention.

C. Schedule: 2009-2011

D. Stakeholder: Ministry of Environmental Protection, National Development and Reform committee, Ministry of Science and Technology.

E. Capital Requirement Estimation: 0.2 million USD

III. Establish an inventory database.

A. Objective: Study the international experience and take advantage of national resources, establish an inventory database.

B. Activity: According to the international experiences, take a full use of the computer database resources, establish a professional and movable archives and an inventory database on POPs waste. Establish basic database containing basic information such as name, producing quantity, management and flow directions. Establish a special investigation on the declaration and key sources of production of POPs waste.

C. Activity Schedule: Period from 2009-2012

D. Stakeholders: Ministry of Environmental Protection, Ministry of Science and Technology, National Computer Center, POPs Waste Producing Enterprises, Local Government.

E. Financial Requirement Estimation: 0.2 million USD

IV. Incorporate collection, transportation and stockpile and disposal of POPs waste into the relative national and local environmental management plan.

A. Objective: According to international conventions and National Implementation Plan, enhance the study on the collection, transportation, storage and disposal management and bring it into national and local environmental management planning and provide the possibility suggestion.

B. Activity: Make a fully study on the National Implementation Plan and local environmental treatment implementation plan, point out problems and put forward suggestions, and take compulsive measures. Incorporate collection, transportation and stockpile and disposal of POPs waste into the relative national and local environmental management plan and make it an important part of work behavior.

C. Activity schedule: 2009-2014

D. Stakeholders: The central and local environmental departments, Ministry of Industry, Consultant Company.

E. Financial requirement estimation: 0.3 million USD.

5.1.2 Technical and Engineering Specifications

A. Objectives: According to the guideline of Stockholm Convention and the requirement and guidance of BAT/BEP, through the study of international technical standard and engineering specifications, study and assess the existing environmental quality standards, emission standards, engineering technology regulations, facility monitoring and supervising management regulations and establish supervision management system. Make suggestions on national standard and specification system, confirm the principle for standard institution, and constantly improve the original management and technical specification, and establish a complete system of environmental quality standard, emission standard, engineering technical specification, facility monitoring management specification of POPs waste disposal.

B. Barrier Analysis: The standard and specification of POPs treatment and disposal are distempered and lack of systematic POPs monitoring technical specification, sampling and sample preparation specification, analysis method standard, standard samples, and the lab and assessment system are distempered. There is a lack of identification standards and stockpile management and the engineering technical specification on environmentally sound management and disposal of POPs waste and moreover lack of the action and supervision of implementation standard and specification.

I Improve the system of environmental quality standards during the collection, storage, transportation and disposal process of POPs waste.

A. Objective: According to the requirement of BAT/BEP of Stockholm Convention and the research and application work on BAT/BEP in China, establish and complete the system of environmental quality standard.

B. Activity: According to the requirements of "Basel Convention" and "POPs Convention" and the study and application in China related to BAT/BEP solve the pollution problems of the facility of hazardous waste and POPs treatment and disposal when POPs waste is disposed, and establish and improve the preparation, institution and implementation system on environmental quality standard. Not only prepare and institute strict environmental quality standards but study the feasibility of these standards. This study should be in accordance with the requirements of Chinese national management policy, and bring it into the guideline of BAT/BEP, technical policy and technical specification and evaluation, demonstration and promotion of Chinese pollution prevention as the main contents in national environmental technical management system.

C. Activity Schedule: Period from 2009 to 2012.

D. Stakeholder: National Development and Reform Committee, Ministry of Environmental Protection, Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD),Consultant Company.

E. Financial requirement estimation: 0.3 million USD

II Pursuant to the provision of international convention and Chinese environmental protection law about POPs waste, establish and improve an emission standard system.

A. Objective: Achieve emission reduction with the application of the guidance of

BAT/BEP demanded by Stockholm Convention, take measures to reduce and eliminate intended release and use of POPs waste; Set up an emission stardand system.

B. Activity: Achieve emission reduction with the application of the guidance of BAT/BEP demanded by Stockholm Convention, take measures to reduce and eliminate intended release and use of POPs waste; (Article 3, for chemicals in Annex C); to reduce and eliminate the unintentionally producing emission of POPs waste (Article 5, for chemicals in Annex C); to reduce and eliminate the emission from stockpile and POPs waste (Article 6, for chemicals in Annex A, B and C). Study the international standards, actively adopt the advanced national and international standard. According to national environment quality standard and national technical, economic condition, establish and improve China's standard system of POPs emission. Regulate the standard system of environmental protection industry in China, the requirement for POPs emission standard include the POPs category, emission way, concentration limits, emission rate or load, POPs removal rate, POPs emission monitoring location, monitoring frequency and operation conditions and so on. After the emission standard is instituted, the specialists should stipulate the technology and management measures of implementation standard and incarnate the features of environment technical regulation.

C. Schedule: Years from 2009-2014

D. Stakeholder: Ministry of Environment Protection, National Housing and Urban-rural Development of PRC, Ministry of Science and Technology.

E. Capital Requirement Estimation: 0.2 million USD.

<u>III According to the requirement of BAT/BEP principle in international convention and national policy, regulations and guidelines, establish and improve sound engineering construction specifications.</u>

A. Objective: According to the requirement of BAT/BEP principle in international convention and national policy, regulations and guidelines, establish and improve sound engineering construction specifications.

B. Activity: According to the requirement of BAT/BEP guidelines in 'Basel Convention' and 'POPs Convention', and carry out the Solid Pollution Prevention Law of People Republic of China, the Standards of Incineration Pollution Control of the Hazardous Wastes and the national laws regulations and standards in other POPs areas. Realize the goal of resource utilization, quantitative reduction and of POPs waste, institute economic and feasible technical specifications in engineering construction.

C. Activity Schedule: Period from 2009 to 2014

D. Stakeholders: Ministry of Environmental Protection, National Housing and Urban-Rural Development of PRC, Ministry of Science and Technology, Waste disposing enterprises.

E. Capital Requirement Estimation: 0.3 million USD.

IV. According to the requirement of BAT/BEP guidelines in international convention and national laws, regulations and technical guidelines, establish and improve the system of facility supervision management specification.

A. According to the requirement of BAT/BEP guidelines in international convention and national laws, regulations and technical guidelines, establish and improve the system of facility supervision management specification

B. Objective: According to the requirement of BAT/BEP guidelines in international convention and national laws, regulations and technical guidelines, establish and improve the system of facility supervision management specification. Be Dedicated actively to the study and applied work with BAT/BEP in POPs area and have a purpose to realize the safe disposal of POPs waste by management and technical means. Apply a system with more strict standards institution and feasible management specification of facility operation supervision and management. This system will determine the main responsible body, links and specific content of supervision and management during the process of facility operation. Improve the system of management and technology standard in POPs waste disposal.

C. Activity Schedule: Period from 2009 to 2014

D. Stakeholders: Ministry of Environmental Protection, National Housing Urban-Rural Development of PRC. Ministry of Science and Technology, Waste disposing enterprises.

E. Capital Requirement Estimation: 0.3 million USD.

5.1.3 Fee system

A Objective: According to the national law, regulation and guidelines, .Choose a proper pricing model, price test run and pricing procedure of ultimate price, and establish a fee system according to the principle of technology renovation, the most cost-effective, profit-maximizing and sustainable development to enhance the POPs management and disposal.

B Barrier Analysis: In order to solve recent problem of environmental pollution because of the insufficient capacity of hazardous waste disposal, promote the industrializaion of hazardous waste disposal, government carry out a fee charging system of hazardous waste. The pricing for POPs management and disposal is very difficult. Firstly, there is a big arbitrary in the determination of the factors of pricing composition and the range of supervision. Secondly, there are problems in the ways and means of price determination and adjustment. For market competition is insufficient or there is no competition, the initial prices always reflect the individual cost of enterprises, but not the social average cost. The hearing system for price adjustment is imperfect; Some supervision institutions are always captured. The franchisees always make prices by themselves in project subcontracts special that of so-called 'soft service', they are in the range of supervision. Moreover, there is a conceptional confusion between government stipulated fees and resource taxes. First, it will be easy to get confused and difficult to surpervise, and secondly it creates a convenient condition for increasing prices.

I. Estimate engineering costs and operation costs.

A. Objective: According to the international and national selected and advanced experiences, establish an effective and practical methodology for engineering cost and operation cost estimation.

B. Activity: According to the international and national selected and advanced experiences, establish an effective and practical methodology for engineering cost and operation cost estimation. Establish and improve a financial methodology for a rational estimation in whole process of POPs waste disposal, such as engineering planning, designing, construction and operation.

C. Activity Schedule: Years from 2009 to 2010

D. Stakeholders: Ministry of Environmental Protection, National Housing and Urban-Rural Development of PRC, Price Bureau, Construction units , Designing units, Operation units.

E. Capital Requirement Estimation: 0.2 million USD.

II. Choose a proper and rational pricing model.

A. Objective: Make a full research on intentional and national pricing models; Establish a suitable pricing model for POPs waste disposal.

B. Activity: Make a full research on international advanced pricing model and national sewage, hazardous waste pricing models, and absorb their advantages and give up their defects, establish, adjust and institute pricing models of POPs waste treatment and disposal.

C. Activity Schedule: Years from 2009-2011

D. Stakeholders: Ministry of Environment Protection, National Housing and Urban-Rural Development of PRC, Disposing units.

E. Capital Requirement Estimation: 0.1 million USD.

III. Trail operation of price

A. Objective: Under the participation and guidance of relative department and specialists, establish demonstrative engineering stimulation and test the established pricing models, in order to achieve the purpose to establish best pricing model and to popularize and make use of it.

B. Activity: Under the participation and guidance of relative department and specialists, through preference to sewage and hazardous waste pricing models, absorb the advantages and give up the defects of all models, carry out the simulation test of the established demonstration model of engineering pricing, in order to achieve the purpose to establish best pricing model and to popularize and make use of it. Trace and make record of the whole process of the established best pricing model and apply the best model in PPP model.

C. Activity Schedule: Years from 2009-2011

D. Stakeholders: Ministry of Environmental Protection, National Housing and Urban and Rural Development of PRC, Finance.

E. Capital Requirement Estimation: 0.2 million USD.

IV. Determine the ultimate price.

A. Objective: Listen to extensively the suggestions from relative international and national specialists; Determine the final price by demonstrating it time after time.

B. Activity: Listen to the options of relative specialists especially on the engineering and financial areas and the opinion from national authority departments; analyze the bilateral best ordering strategy in the supply chain of a single manufacturer and two suppliers. Firstly, by constituting a riskless capital combination method, establish a general model of producing project value by manufacturers, and then get resolution from the model and finally calculate and find the validity of simulation test model and its resolution. The optional price and pricing model are used in PPP model, form a overall unit with the other parts of this action plan and cooperately establish a PPP financing model of POPs waste management and disposal with BEP principle , make this model the leverage function with price and make all stakeholders to participate in the POPs treatment and disposal.

C. Activity Schecule: Period from 2009 to 2011

D. Stakeholders: Ministry of Environmental Protection, National Development and Reform Committee, National Housing Urban-Rural Development of PRC. Ministry of Finance, Accounting firms, Consulting Firms.

E. Capital Requirement Estimation: 0.1 million USD.

5.1.4 Supervision over facility construction and operation

A. Objective: Train the central and local government officials at all levels to promote the supervision level and ability of law enhancement on the building facilities and to monitor the operation of the built facilities and to audit the construction and operation under the supervision of the independent third part audit.

B. Barrier Analysis: The supervision ability in the facility construction and operation of hazardous waste and POPs waste treatment and disposal are not strong in China, the supervision ability of central and local government officials is weak and insufficient. The supervision for market admittance is not strict and sometimes there are poor supervisions for construction and operation. The third independent supervision unit usually complies with the construction and operation sectors. The purpose of private sectors are always to pursue profit and strive for the low prices at the expenses of the lost of facility's quality.

I. Train the government and local officials

A. Objective: According to the requirement of capacity building in NIP, train the central and local government officials to promote their supervision capability.

B. Activity: According to the requirement on capability construction in the international practice and China's NIP, train the central and local government officials to promote the supervision capability on law enforcement, quality management and safe operation management and risk awareness management. Carry out regular examination for the central and local officials at all levels and recruit the qualified officials and dismiss the unqualified ones, choose the capable and outstanding persons to be on posts. The department such as National Supervision and Management Bureau of Safe Production will organize and give instructions to the operational units to be trained on safe production and responsible for organizing and instituting the general training outline and assessment standard for the main responsible personnel, safe production management personnel and business personnel and recommending teaching material.

C. Activity Schedule: Years from 2009 to 2013

D. Stakeholders: Ministry of Environmental Protection, National Development and Reform committee, Ministry of Education, Central and local governments

E. Capital Requirement Estimation: 0.2 million USD.

II. Supervision and law enforcement in constructing facility.

A. Objective: According to international convention and national law, regulation, standard, specification and technical guideline, aid relative national departments to supervise and enforce laws to constructing facilities.

B. Activity: According to the requirements on BAT/BEP and national law, regulation, standard and specification, aid relative national department to supervise the constructing facilities and enforce the laws. Supervise the fund of constructing facilities, technical admittance and the quality of the engineering facility entity. Implement the 'three simultaneity' system of constructing facilities. Determine the method to supervise the constructing facilities and enhance laws.

C. Schedule: Years from 2009 to 2012

D. Stakeholders: Ministry of Environmental Protection, Ministry of Science and Technology, Supervision Bureau, Quality Inspection Department, Disposing enterprises.

E. Capital Requirement Estimation: 0.1 million USD.

III. Supervise the operation of built facilities.

A. Objective: According to the requirement of international requirement and national law, regulation, standard, specification, technical guidelines and NIP, Supervise the operation of built facilities.

B. Activity: According to the regulation of BAT/BEP in international convention and national law, regulation, standard, specification, technical guidelines and specification on HW11and HW43, supervise the built facilities to implement strict technical and treatment and emission compliance monitoring. Enhance the risk education for facility running units and the emergency reaction capacity to critical incidents, implement the online monitoring measures for the second emission specially dioxin emission during the period of operation and deal with it in time. Establish a supervision system for the built facilities.

C. Activity Schedule: Years from 2009 to 2014

D. Stakeholder: Ministry of Environmental Protection, Supervision Department, National Housing Urban-Rural Development of PRC, Technology and Quality Department.

E. Capital Requirement Estimation: 0.2 million USD.

IV. Introduce the third independent audit system in facility construction and operation.

A. Objective: According to the experience in many country and relative law, regulation and guideline, introduce the third independent audit system in facility construction and operation.

B. Activity: According to the experience in many country and relative law, regulation and guideline, introduce the third independent audit system in facility construction and operation. The third independent units establish and improve the performance audit, safety audit, economic audit systems independently, transparently with law enforcing. Establish a movable archives and monitoring database on facility and its operation.

C. Activity Schedule: Years from 2009 to 2011

D. Stakeholders: Ministry of Environmental Protection, Supervision department, National Housing Urban-Rural Development of PRC, Technology and quality department, Disposing enterprises, Finance department.

E. Capital Requirement Estimation: 0.2 million USD.

V. Evaluate the situation of facility construction and operation

A. Objective: In strict accordance with the requirement of BAT/BEP and relative national standard and technical specification on HW11 and HW43 and POPs disposal, evaluate the situation of facility construction and operation on a regular base.

B. Activity: Determine an evaluation method for the situation of facility construction management, construction objective achievement and operation objective achievement (environmental objective achievement situation, economic benefit achievement situation).

C. Activity Schedule: Years from 2009 to 2011

D. Stakeholders: Ministry of Environmental Protection, Quality inspection department, National Housing and Urban-Rural Development of PRC.

E. Capital Requirement Estimation: 0.2 million USD.

5.1.5 4.1.5. Subsidy and incentives

A. Objective: In order to respond and carry out national NIP, provide financial and political support in POPs waste treatment and disposal facility construction, institute and implement subsidy policy for facility operation, implement the operation franchise license exemption system, encourage public participation, establish the optional and rule-based subsidy and incentive method for the legal behavior of all stakeholders.

B . Barrier: In whatever system the public sector, private sector or public-private partnership, there is no or insufficient subsidy and incentives, this will lead to the lack of restrictive specification for pursuing profit and motive incentives and lead to the cost overrun, extension and loss of facility operation in public and private sectors.

I. Provide financial and policy support in POPs treatment and disposal facility construction.

A. Objective: According to the environmental strategy in our country and relative guideline and policy, provide financial and policy support in POPs treatment and disposal facility construction.

B. Activity: According to the environmental strategy in our country and relative guideline and policy, provide financial and policy support in POPs treatment and disposal facility construction. For the good projects that can loan from bank, make profit and pay back the loan, government should increase the strength of investment and policy support in form of direct investment, cash subsidy, loan guarantee, mortage loan, simplified application and approval process of special fund, franchise right subsidy, land development compensation in the facility construction of POPs waste treatment and disposal. Determine the effective investment and financing system.

C. Schedule: Years from 2009-2012

D. Stakeholder: Ministry of Environmental Protection, National Housing and Urban-Rural Development of PRC, Ministry of Finance.

E. Capital Requirement Estimation: 0.2 million

II. Institute and implement subsidy policy for facility operation.

A. Objective: In order to realize the commitment of application of BAT/BEP in international convention and the strategy for development of environmental protection cause, institute and implement subsidy policy for facility operation,

B. Activity: In order to realize the commitment of application of BAT/BEP in international convention and the strategy for development of environmental protection cause, institute and implement subsidy policy for facility operation, including the establishment of rational price and fee mechanism, according to the "operation cost+taxes+retional profit" principle, improve price hearing system, regulate pricing behavior. Invest and operate environmental facility by adopting variety of ways. Establish an effective subsidy policy.

C. Schedule: Years from 2009-2012

D. Stakeholder: Ministry of Environmental Protection, Statute department, National Housing and Urban-Rural Development of PRC, Facility operation enterprises.

E. Capital Requirement Estimation: 0.3 million USD.

III. Implement the exemption system of operation license for the law-abiding enterprises

A. Objective: According to international advanced experience and in national law, regulation and subsidy mechanism, implement the exemption system of operation license for the law-abiding enterprise.

B. Activity: According to international advanced experience and in national law, regulation and subsidy mechanism, implement the exemption system of operation license for the law-abiding enterprise. The selection and determination of law-abiding enterprises should be open in information and fair.

C. Schedule: Years from 2009-2011

D. Stakeholder; Ministry of Environmental Protection, Law and regulation department, National Housing Urban-Rural Development of PRC, Facility operation enterprises.

E. Capital Requirement Estimation: 0.1 million USD.

5.1.6 Public participation

A. Objective: Study the international mature and advanced experience, Promote the public participation of the system construction in urban, rural and remote areas. Establish and complete the environmental education in primary and middle school and college, and open specialized courses to promote the early public participation in POPs elimination activity. The focus of those activities is to innovate by the ways and means of public participation and social management of POPs waste elimination.

B. Barrier Analysis: Firstly, the system of public participation and government decision-making is imperfect, the procedures are not transparent, and the enthusiasm for public participation is not high comparing to that of foreign countries. The public in China have comparatively much smaller influence and drive power for government in the environmental protection and public decision-making aspects. Secondly, the enthusiasm of government for public participation and investment input are small, and publicity is not enough. Public right to know environment affairs and supervise is insufficient. Secondly, citizens have little fixed time to participate environmental affairs and the attention of 80 percent of them is on the surface of environmental protection.

I. Learn the advanced experience in international public participation and system construction, enhance the system construction of urban public participation and

POPs elimination.

A. Objective: Learn the advanced experience in international public participation and system construction, enhance the system construction of urban public participation and POPs elimination.

B. Activity: Learn the advanced experience in international public participation and system construction; enhance the system construction of urban public participation and POPs elimination. Make lectures on POPs elimination on a regular base. The emphases of activity lies in the system construction of participation in government decision-making, hearing, information open, participation in environmental impact evaluation and environmental litigation.

C. Schedule: Years from 2009-2013

D. Stakeholder: Ministry of Environment Protection, National Development and Reform Committee, Ministry of Education, Ministry of Finance, Courthouse.

E. Capital Requirement Estimation: 0.5 million

II. Promote the public participation in rural and remote areas.

A. Objective: According to our national development policy and circumstances in rural and remote areas, promote the public participation in POPs elimination activities in rural and remote areas in our country.

B. Activity: According to our national development policy and circumstances in rural and remote areas, promote the public participation in POPs elimination activities in rural and remote areas in our country. The emphasis of these activities is to establish the system of information opening, environmental education and environmental litigation in rural and remote areas. Make public have more rights to know environmental affairs, education and commonweal litigation. Improve the mechanism of public participation in democracy, science and regulation.

C. Schedule: Years from 2009-2013

D. Stakeholder: Ministry of Environment Protection, National Development and Reform Committee, Ministry of Education.

E. Capital Requirement Estimation: 0.3 million USD.

III. Educate the primary and middle school students the environmental knowledge.

A. Objective: According to the education reform guidelines concerning to national environmental subjects, conduct the basic environmental education for primary and middle school students.

B. Activity: According to the education reform guidelines concerning to national environmental subjects, conduct the basic environmental education for primary and middle school students. Train environment-friendly children by means of discussing the environmental protection behaviors of middle school students, training the environment-friendly habit of behavior, Prepare the outline for Primary and middle school students' education and holding environment knowledge contests.

C. Schedule: Years from 2009-2010

D. Stakeholder: Ministry of Environment Protection, Ministry of Education.

E. Capital Requirement Estimation: 0.1 million USD.

IV. Open the environment education course for national college student.

A. Objective: Imitate the outstanding nonesuch of international college environmental education, and improve the environmental education of national college students.

B. Activity: Imitate the outstanding nonesuch of international college environmental education, improve the environmental education of national college students by the way of college student lecture and professional lecture, the construction of environmental bases, and organize healthy environmental social groups of college students.

C. Schedule: Years from 2009-20011.

D. Stakeholder: Ministry of Environmental Protection, Local government, Ministry of Education.

E. Capital Requirement Estimation: 0.2 million USD.

V. Open the specialized courses of POPs waste treatment and disposal in the environment college of universities.

A.Objective: Learning advanced experience of international education in all countries, open the specialized courses of POPs waste treatment and disposal in the environment college of university; Lay solid foundation to promote the reach level and awareness of POPs management and disposal.

B. Activity: Learning advanced experience of international education in all countries, Open the specialized courses of POPs waste treatment and disposal in the environment college of university, lie a solid foundation to promote the reach level and awareness of POPs management and disposal, by the ways of inviting specialists on POPs waste treatment and disposal, and scholars to lecture on a regular base and discuss the information received and establishing the specialized journals on POPs waste elimination. And setting up a regular academic communication and personnel training with the environmental specialized college in foreign countries. This will lay a solid personnel foundation of reach level of POPs treatment and disposal.

C. Schedule: Years from 2009-2012

D. Stakeholder: Ministry of Environmental Protection, Ministry of Education, Environment College.

E. Capital Requirement Estimation: 0.1 million USD.

5.2 Roles and responsibilities of the private sector

5.2.1 Capital investment

A. Objective: Reviewing international mature financing experience and relative national regulation and guidance on PPP financing model, invest by all kinds of ways: Make loans from national commercial banks and policy banks. Strive for the support of national fund and attract international grants and at the same time invest directly with its own accumulative fund.

B. Barrier Analysis: There are difficulties in private sectors and small and medium enterprises, because the private enterprises have been looked down upon for a long time in China, the self-accumulating fund for POPs treatment and disposal has a big gap with what they need, they also have difficulties in financing without the sponsion of their country and government. At present the Private sectors are restricted in using the funds of POPs management and disposal.

I. Strive for loan from national commercial banks

A. Objective: According to relative national regulation and guidance on PPP financing model, make loans from national commercial banks.

B. Activity: According to the law, rules and guidelines of financing and PPP, Strive for the national commercial bank loan. Create actively advantages to arose the enthusiasm of the commercial banks to provide loans to them, specially create more conditions for country or government to guarantee the loans- such as the performances of eliminating POPs waste, scientific and technical creations, energy-saving scientific and technical inventions, and create more good projects that can make loan and produce profit and pay back the loan to the bank, this will be the award conditions for the country to give loan. Determine a series of conditions and a methodology for the small and medium enterprises to loan from national commercial banks.

C. Activity Schedule: Years from 2009 to 2011

D. Stakeholders: Ministry of Environment Protection, Bank, Pollution generating enterprise, pollution disposing enterprises.

E. Capital Requirement Estimation: 0.1 million USD.

II. Loan from National Policy Banks

A. Objective: Make full study on national financing policy, regulation and the policy, guideline on policy bank loan, loan From National Policy Banks.

B. Activity: Make full study on national financing policy, especially the preferential policy of PPP financing, make good enterprises, and promote profit and payment capability. Establish a method of striving for the loan from national policy loan.

C. Activity Schedule: Years from 2009 to 2011.

D. Stakeholders: Ministry of Environmental Protection, Bank, Consulting Firms, Polluting generating enterprises, Pollution disposing enterprises.

E. Capital Requirement Estimation: 0.1 million USD.

III. Apply the foreign grants

A. Objective: Reviewing and learning the international grants management experience, actively strive for international grants.

B. Activity: Establish a good international image in accordance with the international standards, actively apply for international institutional grant and manage them with advanced international management experience and with more transparency, make full play of consulting institution to get international grants.

C. Schedule: Years from 2009 to 2012

D. Stakeholder: Ministry of Environmental Protection, Bank, Consulting Firms, Disposing enterprises.

E. Capital Requirement Estimation: 0.1 million USD.

IV. Use self-accumulating fund.

A. Objective: Pursuant to relative national financing policy, regulation and action guidance, complete the enterprise fund accumulation. Improve the profitability of the enterprise's participation in project; promote the economic strength of enterprises. Enlarge constantly production scale, renew the equipment requirement range, adjust constantly production structure, adopt new technology, and develop new productions. Increase and complete self-owned fund accumulation.

B. Schedul: Years from 2009 to 2012

C. Stakeholder: Ministry of Environmental Protection, National Housing and Urban-Rural Development of PRC, Disposing enterprises.

D. Capital Requirement Estimation: 0.1 million USD.

V. Strive for national financial support

A. Objective: According to international convention and national incentive policy, regulation and guideline, strive for national financial support.

B. Activity: According to international convention and national incentive policy, regulation and guideline, strive for national financial support. Create conditions to strive for the national financial support

5.2.2 Facility construction and operation following regulations and contracts

A. Objective: Reviewing the relative technical guidance in 'Basel Convention'

'Rotterdam Convention' and 'POPs Convention' on POPs waste management and disposal, and the relative national technical specification on HW11 and HW43 institution, prosecute the equipment construction and operation in accordance with national rules and contracts.

I. Implement the equipment construction and operation in accordance with enterprises' production management specifications.

A. Objective: Reviewing international convention and national law, rule, standard and specification, implement equipment construction and operation according to the enterprise production management specifications.

B. Activity: Institute the management specifications of enterprise production and implement the equipment construction and operation. Confirm the methodology on equipment construction and operative specifications, such as the prospecting, designing, constructing, supervision and procuring bulk material and equipment in construction engineering. The institution of specification will focus on the strict supervision in every links in the equipment construction and running as it purport.

C. Schedule: 2009-2013

D. Stakeholder: Ministry of Environmental Protection, National Development and Reform committee, National Housing and Urban-Rural Development of PRC, Supervision Bureau

E. Capital Requirement Estimation: 0.3 million

II. Recruit and train management and operational personnel.

A. Objective: Summarize and reviewing international experience and relative national management specification on management and operation personnel, recruit and train management and operational personnel.

B. Activity: Summarize and reviewing international experience and relative national management specification on management and operation personnel, recruit and train management and operational personnel. Recruit or the incumbency personnel should take professional training, such as principal responsible persons (including executives), safe production management personnel (including full time and part time personnel), business personnel and equipment operation personnel and so on, and later they should pass qualification examination and get certificate on safety management and operation and work.

C. Schedule: Years from 2009 to 2010

D. Stakeholder: Ministry of Environmental Protection, Ministry of Science and Technology, Ministry of Education

E. Capital Requirement Estimation: 0.1 million USD

III. Maintain and renew the old and outdated equipments.

A. Objective: According to the requirement of international convention and national law, rules, standard, technical specification and supervision, maintain and renovate the existing equipment.

B. According to the requirement of international convention and national law, rules, standard, technical specification and supervision, maintain and renew those equipments which are old and could not reach national standard and meet the national engineering specification of POPs disposal. Determine the systematic specification of the maintenance, renewal, inspection and evaluation of equipments and the method for instituting the specification for the construction, testing and operation conditions of new equipments.

C. Schedule: Years from 2009 to 2012

D. Stakeholder: Ministry of Environmental Protection, Ministry of Science and Technology, National Housing and Urban-Rural Development of PRC, Disposing enterprises.

E. Capital Requirement Estimation: 0.2 million USD

5.2.3 Cost recovery

A. Objective: Provide actively cost composition data and substitutive disposal contract with the waste generating enterprises, government and treatment beneficiary. Establish a methodology for cost recovery.

B. Barrier Analysis: Lack of the awareness of applying the input-output management principle. This leads to the difficulty in charging the fee of disposal and cost recovery.

I. Provide actively the cost composition data

A. Objective: Reviewing the requirement of international convention and national policy, rules and guidelines, supply actively the cost composition data.

B. Activity: Reviewing the guidance on BEP in international convention and the national policy, rules guidance on PPP of POPs treatment and disposal, provide actively the cost composition data under pragmatic, honest and faithful principle. Establish and improve the method and means for providing the cost composition data.

C. Schedule: 2009-2011

D. Stakeholder: Pollution Generating Enterprises, Government, Pollution Controlling Enterprises

E. Financing Requirement Estimation: 0.3 million USD

II. Sign a substitutive disposal agreement with waste generating enterprises, government or treatment beneficiary.

A. Objective: According to national policy, rules and guidance in PPP of POPs treatment and disposal, Sign a substitutive disposal agreement with waste generating enterprises, government or treatment beneficiary.

B. Activity: According to national policy, rules and guidance in PPP of POPs treatment and disposal, Sign a substitutive disposal agreement with waste generating enterprises, government or treatment beneficiary. Settle the method to sign these agreements with mutual benefit, co-win and risk-sharing and sustainable development principle. Sign rational substitutive disposal contracts and guarantee the executor of contracts to recover their cost as soon as possible and find a method to gain 8-10 percent profit.

C. Schedule: Years from 2009 to 2012

D. Stakeholder: Waste Generating Enterprises, Government, Treatment Beneficiary, Waste Disposing Enterprises.

E. Capital Requirement Estimation: 0.5 million USD.

5.2.4 Technological improvements

A. Objective: Put forward new technology requirements to the treatment technology, equipment R&D enterprises and relative R&D departments and provide the fund for the treatment technology, equipment R&D enterprises and technology for new technology/ facilities tests. Devoted to create a set of method to improve the technical innovation development.

B. Barriers Analysis: The innovation in POPs treatment and disposal technology includes the equipment supplier's technical improvement and technical level, but the technical improvement input some equipment suppliers are insufficient. The Self-discipline of some equipment suppliers and the supervision of government are imperfect. The existing regulation and standard are not specific and strict enough. At the same time the enthusiasm of unit owners for improving management level and efficiency are not very high.

I. Put forward the technical requirement for treatment technology, equipment D&R enterprises and the relative department in charge of scientific research

A. Objective: According to the requirement of international convention and national technical specifications and the "Eleventh Five-Year " national scientific support plan, put forward the technical requirement for treatment technology, equipment D&R enterprises and the relative department in charge of scientific research.

B. Activity: Reviewing the technical requirement on BAT/BEP in international convention, national technical specification on HW11 and WH43 and 'Eleventh Five-Year' national scientific support plan, put forward the technical requirement for treatment technology, equipment D&R enterprises and the relative department in charge of scientific research.

C. And study, digest and use the applied technology according to strict technical specification.

D. Schedule: Years from 2009 to 2013

E. Stakeholder: Ministry of Environmental Protection, National housing and Urban-Rural development of PRC, Ministry of Supervision, Ministry of Science and

Technology, Disposal enterprises.

F . Capital Requirement Estimation: 0.3 million USD.

II. Supply capital and new technology and equipment D&R for disposal technology and equipment D&R enterprises

A. Objective: According to the national preferential policy for high-tech enterprises and 'Eleventh Five-Year' scientific development plan, Supply capital and new technology and equipment D&R for disposal technology and equipment D&R enterprises

B. Activity: According to the national preferential policy for high-tech enterprises and 'Eleventh Five-Year' scientific development plan, and deduce capital and their profit as much as possible within the permission range of policy in order to invest them to the new technology and equipment D&R of treatment technology and equipment D&R enterprises. Establish a fund for disposal technology and equipment D&R enterprises to provide stable financial support enabling the enhancement of enterprises' innovation ability.

C. Schedule: 2009-2013

D. Stakeholder: Ministry of Environmental Protection, Ministry of Science and Technology, National Housing and Urban-Rural Development of PRC, Ministry of Finance, Disposing enterprises.

E. Capital Requirement Estimation: 0.3 million USD.

III. Supply the technical support for new technology and equipment test

A. According to the requirement on BAT/BEP in international convention, and national technical specifications on HW11 and HW43, and national 'Eleventh Five-Year' scientific development plan and study the experience of international new technical and equipment test and supply technical support.

B. . Objective: According to the requirement on BAT/BEP in international convention, and national technical specifications on HW11 and HW43, and national 'Eleventh Five-Year' scientific development plan and study the experience of international new technical and equipment test and supply technical support. Carry out scientific test, filtrate, validate the existing technology and Develop and research new technology by the means of enlarging the financial input of scientific research and content.

C. . Schedule: 2009-2013

D. .Stakeholder: Ministry of Environmental Protection, Ministry of Science and Technology, Ministry of Finance, Disposing enterprises.

E. . Capital Requirement Evaluation: 0.2 million USD

IV. Popularize and apply actively new technology and equipments.

A. Objective: According to international convention and national technical specifications and '11th Five-Year' and '12th Five-Year' scientific development planning, popularize and apply actively new technology and equipment.

B. . Objective: According to international convention and national technical specifications and '11th Five-Year' and '12th Five-Year' scientific development planning, popularize and apply actively new technology and equipment. Establish the advanced and applied, mature and reliable technologies; guarantee the effective means for realizing and popularizing the new disposal technology and equipment.

C. . Schedule: Years from 2009 to 2013

D. . Stakeholder: Ministry of Environmental Protection, Ministry of Science and technology, Ministry of Finance, Disposing enterprises, Treatment beneficial enterprises.

E. . Capital Requirement Estimation: 0.3 million USD

5.2.5 Market expansion

A. Objective: By summarizing the international disposal experience and analyzing and study China's National Implementation Plan, promote the government to refresh the waste inventory and planning, enlarge collection and disposal range and then the market of POPs disposal.

B. Barrier Analysis: In order to achieve the commitment to the international community, the POPs inventory listed in National Implementation Plan including the total amount of 4-6 thousand tones POPs and 2.5 thousand tones DDT, and an action plan to eliminate POPs waste. There are big financing gaps.

I. Promote government to renew the waste inventory and planning.

A. Objective: Promote government to renew the waste inventory and planning, and summarize the shortage in the inventory and planning within National Implementation Plan, promote the government to renew POPs inventory and planning.

B. Activity: Promote government to renew the waste inventory and planning, and summarize the shortage in the inventory and planning within National Implementation Plan, supplement the inventory and planning, promote government to renew the waste inventory and planning, and enlarge the effective ways and means for the POPs waste treatment and disposal market expansion.

C. Schedule: Years from 2009 to 2015

D. Stakeholder: Ministry of Environmental Protection, National Development and Reform committee, National Housing and Urban-Rural Development of PRC.

E. Capital Requirement Estimation: 0.3 million USD.

II. Enlarge the POPs waste collection and disposal scale.

A. Objective: According to the requirement of international convention and China's NIP, enlarge the POPs waste treatment and disposal range.

B. Activity: According to the requirement of international convention and China's NIP, enlarge the POPs waste treatment and disposal range and market need with the support to POPs waste disposal.

C. Schedule: Years from 2009 to 2013

D. Stakeholder: Ministry of Environmental Protection,

E. Financial Requirement Estimation: 0.1 million USD