Annex I-a

Outline of the demonstration of MCD dioxin destruction technology in Bien Hoa and/or Phu Cat

Background

Dioxin contaminated hotspots at military bases

Viet Nam has experienced the worst dioxin pollution in the world. Large quantities of herbicides, most of which were contaminated with dioxin, were used in the armed conflict over the period of 1961-1971. The soil dioxin concentration in sprayed areas has declined to background level; however, a few sites at airports where the herbicides, mainly Agent Orange (AO), were stored and/or handled are still highly contaminated. To date, dioxin 'hotspots' with contamination levels exceeding national dioxin limits (1,000 pg I-TEQ/g) have been identified on three airports that were used as military bases during the war, namely Bien Hoa, Da Nang and Phu Cat airbase, .

Environmental Remediation Project in Viet Nam

In 2009 the Global Environment Facility (GEF) approved the project "Environmental Remediation of Dioxin Contaminated Hotspots in Viet Nam". The objective of the project is "to minimise the disruption of ecosystems and health risks for people from environmental releases of TCDD contaminated hotspots". One of the key components of the Project is demonstration of prospective dioxin destruction technologies at practical scale to evaluate their feasibility.

Technology Selection

To date, various types of dioxin destruction technologies have been developed and tested in several countries but still there is no international experience with the remediation of the large volume and high degree of dioxin contamination found at the hotspots in Viet Nam. A series of technology assessments and further updates have been conducted in the past 4 years with national and international experts on the potential and costs of known technologies.

The UNDP project called "*Capacity Building and Completion of the Overall National Plan for Environmental Remediation of Dioxin Contaminated Hotspots in Viet Nam*" was implemented by MONRE in 2007 and 2008. The Project conducted an extensive technology assessment for selection of potential destruction technologies that might be applicable to dioxin remediation in Viet Nam. It was essentially an update of the UNEP report to GEF Senior Technical Advisory Panel (STAP) submitted in 2004. All known non-combustible technologies (20 different technologies in total including biological process) were assessed for the adaptation of the technologies to Viet Nam and the adaptation of Viet Nam to the introducing technologies. The technology assessment covers: destruction efficiency, throughput capacity, release of wastes (gas, water and solid), pre-/post-treatment requirement, capital and running cost, scalability, commercialization stage, etc. The country adaptability assessment covers: requirement of resources (such as power, water, labour, and technicians), local cost, safety criteria, complexity of construction and operation, etc. The report finally recommended MCD technology in combination with bio-reactor landfill.

The GEF approved the Project proposal in September 2009 and the Project Document (ProDoc) was signed in June 2010. The ProDoc includes the technical review and update done during the "Roundtable Meeting" in February 2009, which prioritised the technologies requiring the field tests as follows:

- Bio-remediation (various approaches)

- Mechano-chemical Destruction (MCD)
- Thermal Desorption Destruction (in pile)
- Copper-mediated Destruction (CMD) preceded by in-vessel Thermal Desorption

During the inception period of the project, the technology review was further updated in December 2010 by expanding the assessing technology to 27, which included the emerging technologies that might be applicable to the Vietnamese hotspots. The report recommended MCD or Thermal Desorption in combination with bio-reactor landfill. The review was presented to the Inception Workshop in December 2010 and the Inception Report was prepared to summarise the progress and agreement made during the period. CMD technology was dropped from short-listed technology because of the insufficient level of the commercialization to date.

The Fifth Annual Bilateral Joint Advisory Committee (JAC) Meeting on Agent Orange/ Dioxin, a bilateral talk between USA and Viet Nam, held in July 2010. The meeting recommended/ endorsed the application of Thermal Desorption technology, which is one of the shortlisted technologies, in full scale to Da Nang hotspot funded by US Government and implemented by USAID.

Objective of Technology Demonstration

This activity will provide the concrete evidence of applicability of the MCD as a dioxin remediation technology under real Vietnamese condition using soil and sediment from contaminated site and operating in the country. It will also contribute to the capacity strengthening of Vietnamese professionals in technical/engineering field who are/will be involved in the dioxin and other chemical pollution issues.

Basics and Applications of Mechano-Chemical Destruction (MCD) Technology

Principle of Destruction

The technology uses mechanical energy to initiate chemical reaction that eventually decomposes halo-organic compounds including dioxin. Shattering of soil crystals breaks the crystals' chemical bonds leaving reactive unpaired electrons on the fresh surfaces. The silicon-oxygen bonds in quartz yield free radicals and ions with radical pathway dominant along the fracture line. The radicals and ions react with organic compounds reducing them to essentially amorphous carbon and inorganic salts.

Process of MCD employs POPs wastes placed in a ball mill with a hydrogen donor compound in the presence of an alkali metal (magnesium, sodium, etc). Reductive dehalogenation occurs due to mechano-chemical process yielding. The system has the potential capability to process a wide range of wastes without pre-treatment,. Ball mill operates as closed system so releases should be contained. Reduced organics plus metal salts are the by-products of the process. Some trial achieved Destruction Efficiency (DE) 99.99% of dioxin with single step destruction.

Development of Commercial Scale Applications

Based on the available information, it appears that potentially three commercial vendors would be available to offer a demonstration proposal for this technology. Tribochem (Germany) has been executing pilot tests since mid 1990s in Europe mainly for PCB destruction. Environmental Destruction Ltd (EDL) founded in New Zealand in 1998 has pioneered a continuous process of on-site ex-situ soil remediation through this technology. The trademarked technology known as MCD^{TM} is patented to EDL in New Zealand and other countries and Vietnamese patent office received the application from EDL in 2007. EDL have operated a commercial scale facility in New Zealand and USA and performed a number of demonstrations in Japan, Hong Kong, USA, etc.

Radicalplanet Technology is offered by Radical Planet Research Company Ltd (Japan). It operates on essentially the same principle as the MCD^{TM} technology except it is a batch rather than continuous process. The full scale system is able to destroy all types of POPs in various forms, e.g. solid, powder, liquid, PCB in fluorescent ballast, carbon paper, admixture of contaminated soil with pebbles,

concrete debris, metals, fly ash from incineration plant, etc. The quoted destruction performance of dioxin is less than 1 pg-ITEQ/g.

Considerations to be assessed by the Demonstration

1. Destruction efficiency

The MCD technology has demonstrated to remediate various types of contaminants including dioxin. Some trial test results indicate successful destruction below government remediation criteria (i.e. 1,000 pg I-TEQ/g). Some other experiments, however, failed to meet the criteria or TEQ value even increased because the intermediate products had higher TEF than their original forms. So far, the information characterising the residues and releases from the process are still limited. The soil contamination reaches more than 50,000 pg I-TEQ/g in average in some place including as high as a half million pg I-TEQ/g sample so DE should never be lower than 99%.

2. Overall throughput

The volume of the contaminated soil required for remediation is significant in hotspots in Viet Nam. Technologies to be used for the remediation must be capable to treat significant volume of soil with acceptable timeframe (expected overall throughput for full scale configuration is a range of 10,000 – 30,000 m3 per year). Increasing loading volume or shortening reaction/treatment time to improve the throughput may result in incomplete destruction of dioxin. If the overload condition creates incomplete destruction, it may become more toxic as the intermediate products may have higher TEF.

3. Maintenance and system reliability

Commercial experience of the processing of POPs wastes is limited for this technology. The system reliability to cope with various situations to be encountered in actual implementation has not been fully proven. Frequent replacement of consumable may require system shut down and lowers the overall throughput. Power supply in Viet Nam is not as stable as one in developed countries and the adverse effects of the power failure has not been assessed. The reliability of ancillary system should also be proved.

4. Secondary contamination

Heavy metals existing in soil and/or introduced by MCD process may cause the secondary contamination. Due to the MCD process, the heavy metals become more soluble and may be released to surrounding environment. A metal stabilization post-treatment is introduced in some MCD system configuration. Other substances (e.g. dioxin and other POPs, etc.) which were associated in soil may also be released to air and/or water during the treatment.

5. Soil texture/content after treatment

Information of soil texture after treatment (nutrient, organic matter, heavy metal, etc.) is necessary to determine the use of the soil after treatment. The mechanical turbulences and associated heat will destroy the ecosystem and all living creatures are died off. Other non-vital organic substances may also be decomposed which makes the treated soil very sterile. If the soil is used for structural purposes (e.g. road construction, etc.), the physical property should be improved from its powdery form to more solid form.

Tasks to be Completed

Detailed Demonstration Design including Volume of Soil to be treated

Based on the considerations and concerns to the MCD technology, a demonstration plan will be developed. The demonstration will be split into a series of 'runs' with specific objective and configuration. They will include (but not limited to): 1) a series of runs with different retention time; 2) a series of runs with different loading; 3) a series of runs with different soil and sediment types (e.g. laterite from Phu Cat, sandy clay from Bien Hoa, sandy from Da Nang, etc.); 4) a continuous run for extended period to assess system stability and reliability; 5) a recovery test from power failure; etc. The specifications of demonstration system will be developed to enable proposed trials and proper

samplings. Approximately 100 m3 of contaminated soil and sediment will be used for the demonstration. Detailed sampling schedule will be included in the demonstration design.

Site Preparation and Installation of the Demonstration System

Demonstration equipment will be imported and installed by the Technology Demonstration Firm. The demonstration site should be determined and allocated to the firm. Proper access road to the demonstration site suitable for heavy vehicles (if necessary) will be provided by the GEF Project (through sub-contracting). Site enclosures and other protective measures will be furnished by the firm. Temporary utility lines (i.e. electricity, water and drainage) will also be provided by the Project based on the specification.

Operation of the Demonstration System

A site manager will be appointed by the Technology Demonstration Firm who looks after whole operations of the demonstration including safety measures and environmental monitoring. Periodical work planning and reporting mechanism will be introduced. Some experiments extend to more than 24 hour operation, which requires overnight stay in site with appropriate staff rotation. Collected samples are transferred to entrusted institution(s) to analyze their physical and/or chemical properties specified by the demonstration design. The site office shall expect frequent visitors and oversight from relevant personnel.

Soil Transport and Disposal

A Civil Work Firm will be engaged to excavate and transport soil from contaminated site to demonstration site. The firm will also construct a landfill site to dispose the treated soil and/or unused soil from demonstration site. The specification of the landfill design will be developed. The firm must comply with safety and health guidelines developed by the Project during the transport and disposal of soils. Sample soil from other hotspots will be transported to the demonstration site with sealed stainless container to avoid any spillage and dust emission along the way. The work may be combined with the soil containment work in Phu Cat or Bien Hoa if the time schedule matches, which will reduce the cost of civil works. The containment work for Phu Cat airbase will start in later 2011 and for Bien Hoa in late 2012.

Dismantling and Site Clearance

After the completion of the demonstration, all facilities and equipment are dismantled and removed by the Technology Demonstration Firm. The firm retains the ownership and keeps the equipment under its custody. The demonstration site is cleared and graded (if necessary) and returned to airbase.

Safety Measures and Environmental Monitoring

A 'Health and Safety Plan and Onsite Worker Training Plan' will be developed to protect site workers, neighboring residents and airbase officials. The site workers involved in the demonstration must understand the need for the protective measures and comply with the guidance. The plan includes: 1) a description of tasks to be performed; 2) required hazard monitoring; 3) engineering control of dust; 4) safety procedure for soil transport (including long transport from other hotspots); 5) personal protective equipment requirements; 6) decontamination procedures; 7) emergency information; and 8) emergency response procedures. If the demonstration is conducted together with the soil containment works either in Phu Cat or Bien Hoa, the same plan can be used for both activities.

Evaluation of the Demonstration

The Technology Demonstration Firm will prepare a report on the demonstration including the result of the data analysis. An independent evaluator will be engaged to verify the results and feasibility/applicability of the demonstrated technology/

Training and Technology Transfer

During the demonstration, trainings and other types of technology transfer activities will be arranged. It may include lecture type trainings and site visits. Also, the Project may assist young engineers to

stay and work in demonstration site for apprenticeship to acquire in depth operation skills of the remediation technology.

Institutional Arrangements

Principles

A group of experts is formed to provide advisory function to the demonstration. Technology Demonstration Firm, Civil Work Firm and Analytical Institution are engaged and provide substantive inputs to the demonstration. The Project Management Unit (PMU) takes logistic, coordinating and administration function of the activity. An independent professional will evaluate the results of the demonstration. Roles and responsibilities of key parties are described below:

Advisory group

Selected technical experts involved in dioxin issue provide advices to the GEF Dioxin Project to determine the demonstration design and evaluation of the results. It will meet upon the invitation by Office 33/MONRE and:

- Advise the concept and detail of the technology demonstration,
- Review health and safety plan,
- Participate technology transfer activities, and
- Review the evaluation of the demonstration.

Project Management Unit (PMU)

PMU in GEF Dioxin Project has overall responsibility of the activity and coordinates and facilitates the individual tasks. They will include to:

- Engage all necessary individuals and firms to conduct the activity,
- Arrange logistics for technical advisory gatherings,
- Arrange logistics for technology transfer trainings,
- Obtain permission to access demonstration sites,
- Arrange any documentations required for overseas shipment (both import and export), and
- Settle all financial matter required for the activity.

International Technology Demonstration Firm

A firm who conduct demonstrations of dioxin destruction technology is engaged to evaluate the performance and feasibility of the technology. The main tasks of Technology Demonstration Firm are to:

- Prepare detailed demonstration design and sampling schedule,
- Inform temporary utility requirement and chemical usage,
- Import, transport, install and dismantle demonstration facilities and equipment,
- Operate demonstration facility based on the demonstration design,
- Collect and ship necessary samples in compliance with agreed sampling procedures,
- Develop health and safety plan and implement measures in compliance with the developed plan,
- Conduct technical transfer trainings, and
- Analyze the demonstration result and prepare activity and evaluation report.

Local Civil Work Firm(s)

The civil works associated with the technology demonstration is conducted by local contractor(s). It may be sub-divided into two contracts, designing part and site work part depending on the local expertise and availability. The tasks to be conducted are to:

- Develop drawings and specifications of temporary utility supply (electric transmission line, water and drainage pipes), access road and site grading, soil excavation and stockpile, landfill construction and soil disposal, etc.

- Procure materials/items for excavation and landfill, utility supply, and other works specified in the design document,
- Conduct civil works and utility supply works including dismantling temporary facilities,
- Conduct workers safety trainings in compliance with the health and safety plan, and
- Record soil management/transfer data and submit to PMU.

Analytical Institution

Dioxin and other substances as well as physical properties of collected samples are analyzed by analytical institutions. On-site analysis (if specified in the detailed demonstration design) will be conducted by Technology Demonstration Firm. Dioxin and other items may be analyzed by different laboratories depending on the analytical capacity of the institution(s) to be engaged. The role will include to:

- Review sampling and shipping procedures in detailed demonstration design,
- Submit laboratory procedures and methodologies per analytical items and media,
- Receive collected samples and store them in cold storage,
- Analyze dioxin and furan congeners based on the agreed schedule,
- Analyze other chemical and physical properties of collected samples per specifies in detailed demonstration design,
- Conduct internal and external QC/QA practices, and
- Submit analysis datasheets and report to PMU.

Evaluation Expert (third party evaluation)

The consultancy is carried out by a technical expert with extensive knowledge of environmental remediation from chemical contamination. The tasks to be conducted are to:

- Verify the demonstration process and sample collection,
- Assess the analytical results of demonstration,
- Analyze the feasibility and applicability of the demonstrated technology in Viet Nam context, and
- Recommend actions to Vietnamese Government.

Implementation Schedule

Followings are the indicative timeline for the implementation excluding bidding, recruitment and other administrative processes:

- Detailed demonstration design, health and safety design (2 months)
- Site preparation and installation (2 months)
- Demonstration (3 months)
- Dismantling and site clearance (0.5 month)
- Laboratory analysis (1.5 months)
- Final Report and third party evaluation (2 months)

Other Considerations

Site access and permission

Demonstration site is the property of MOD and access permission must be obtained. In addition, supervising/controlling officers from MOD should be appointed. Office 33 will make all necessary arrangements for the site access.

Import/export permission for equipment and materials

Import and export of the equipment and materials will be facilitated by the Government. If duty free import is possible, the application will be submitted by Technology Demonstration Firm. Office 33 and PMU will take the leading role to clear all necessary arrangement.

Ownership of the original data

Office 33 and Technology Demonstration Firm are the co-owners of the demonstration result and both party mutually agree the other to use the data further for its own purpose.