5

Solid Waste Management

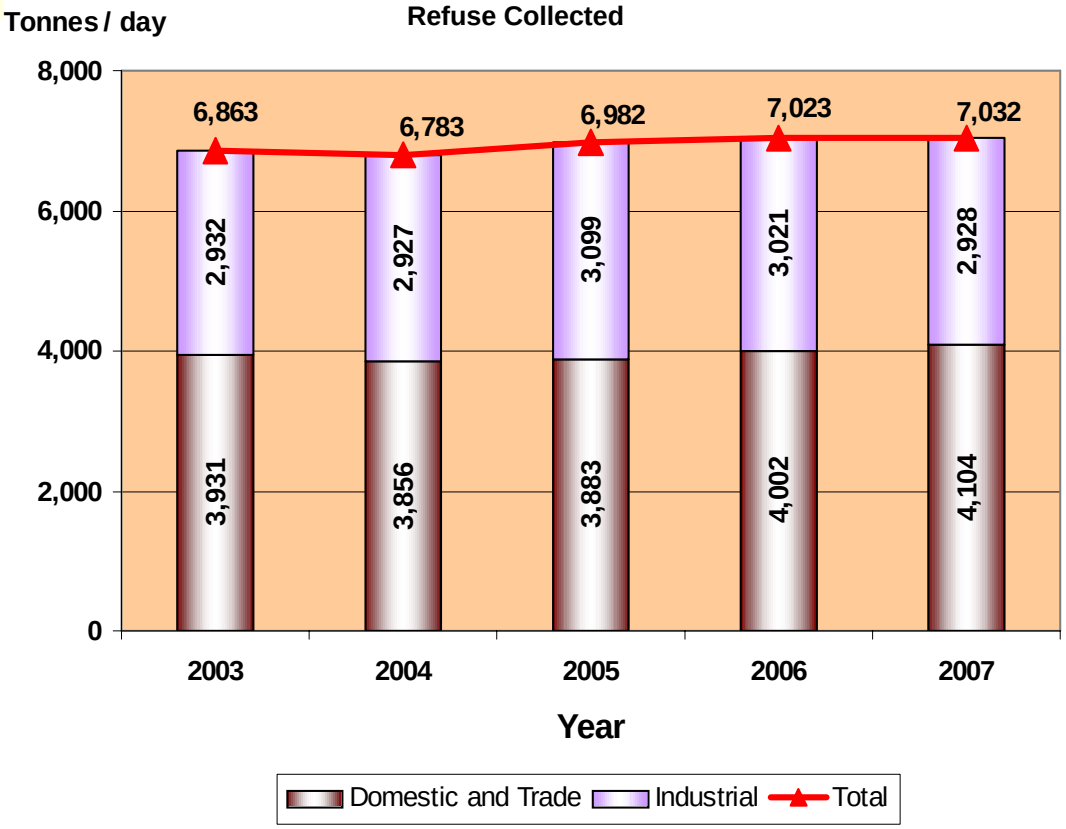
SOLID WASTE MANAGEMENT

With limited land available for waste disposal, NEA's policy for solid waste management is to reduce the volume of waste that goes to the landfill by incinerating all incinerable waste at Singapore's four Waste-to-Energy Plants. The remaining waste, which are not incinerable such as sludge, silt, shipyard waste, construction and demolition waste as well as incineration ashes, are disposed of at the offshore Semakau Landfill.

A daily average of 7,032 tonnes of refuse per day was collected in 2007, an increase of 0.13% as compared to the amount in 2006. This was achieved through NEA's active promotion of waste minimisation in all sectors of the industry and community to reduce waste generation and increase waste recycling. The amount of refuse collected per day from 2003 to 2007 is shown in **Chart 10**.

Chart 10

Refuse Collected



SOLID WASTE MANAGEMENT

Solid Waste Collection System

The huge amount of municipal solid waste generated daily necessitated the setting up of a highly efficient system for proper collection and disposal. Over the years the waste management system in Singapore has evolved into one of the most efficiently operated refuse collection services in the region.

Public Waste Collection Scheme

The waste collection service was privatised in 1999. The public waste collection areas in Singapore are divided into nine geographical sectors for pre-qualified waste collection companies to bid for the licence to provide refuse collection services for residential and trade premises in each sector. A second round of contracts for the nine sectors was called in 2004 to 2006 period. A map of the nine sectors is shown in the map in **Chart 11**. The PWCs for the 9 sectors and the expiry date of their respective licences are listed in **Table 16**.

In January 2007, NEA conducted a biennial customer satisfaction survey of the refuse collection services provided by the four appointed Public Waste Collectors. The refuse collection services were rated with a score of 7.2 out of 10. This was an improvement compared to the last survey rating of 6.7.

Chart 11

Public Waste Collection for the 9 Sectors

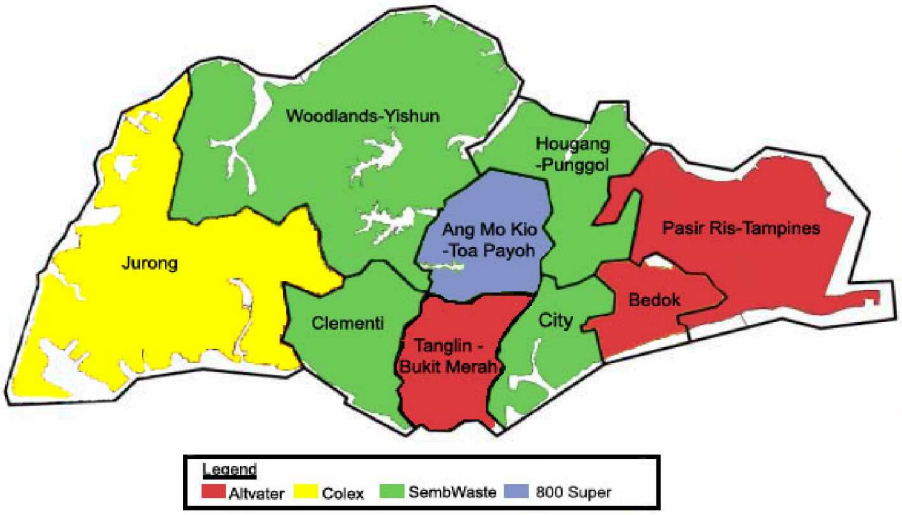


Table 16
The Public Waste Collectors for the 9 Sectors

No	Sector	PWC	Licence Expiry Date
1	Pasir Ris – Tampines	Altvater Jakob Pte Ltd	30 June 2011
2	Bedok	Altvater Jakob Pte Ltd	31 October 2011
3	Jurong	Colex Holdings Ltd	31 March 2013
4	Clementi	SembWaste Pte Ltd	30 June 2013
5	City	SembWaste Pte Ltd	30 September 2013
6	Ang Mo Kio – Toa Payoh	800 Super Waste Management Pte Ltd	31 December 2013
7	Hougang-Punggol	SembWaste Pte Ltd	28 February 2014
8	Woodlands – Yishun	SembWaste Pte Ltd	31 May 2014
9	Tanglin – Bukit Merah	Altvater Jakob Pte Ltd	31 August 2014

Licensed General Waste Collectors

WMD licenses and monitors the collection of refuse by licensed general waste collectors, who mainly serve commercial and industrial premises. It is an offence for any person or company to collect or transport waste as a business without a valid General Waste Collector Licence. Licensed general waste collectors may refer to 'The Code of Practice for Licensed General Waste Collectors' for work protocols and guidelines on good practices in the waste collection business.

The Code of Practice is available in the website at
http://app.nea.gov.sg/cms/htdocs/category_sub.asp?cid=101

The application for the General Waste Collector Licence is available online at the following website:
https://licences.business.gov.sg/SHINE/sop/WebPageHandler?p=OASIS&pn=SelectLicences&LicenceID=80

SOLID WASTE MANAGEMENT

Refuse Disposal Facilities

Singapore's fifth Waste-to-Energy Plant – Keppel Seghers Tuas Waste-to-Energy Plant is under construction and it is expected to start operation in mid 2009. This Plant will provide incineration services to NEA for a period of 25 years under the Design-Build-Own-Operate (DBOO) scheme. It will be able to handle 800 tonnes of refuse per day and it will replace the Ulu Pandan Waste-to-Energy Plant that is nearing the end of its operational lifespan. NEA's solid waste disposal facilities comprise three other Waste-to-Energy Plants – Tuas Waste-to-Energy Plant, Senoko Waste-to-Energy Plant and Tuas South Waste-to-Energy Plant, as well as an offshore landfill at Semakau.

Keppel Seghers Tuas Waste-to-Energy Plant (Artist Impression)

A total of 2.57 million tonnes of waste was disposed of at the refuse disposal facilities in 2007, or about 7,032 tonnes per day. Approximately 2.38 million tonnes or 92.7% of the refuse was incinerated while the remaining refuse was landfilled. **Table 17** shows the amount of refuse disposed of at the landfill and the Waste-to-Energy Plants over the last 10 years.

The total effective incineration capacity of the four existing Waste-to-Energy Plants is 8,200 tonnes per day, which is sufficient to handle all incinerable wastes currently generated in Singapore.

Table 17
Refuse Disposed of at Authorised Sites (1998 – 2007)

Year	Landfill ('000 tonnes)	Waste-to-Energy Plants ('000 tonnes)	Total Refuse Disposed Of ('000 tonnes)
1998	958.1	1,884.1	2,842.2
1999	756.2	2,036.3	2,792.5
2000	357.2	2,440.1	2,797.3
2001	251.3	2,550.9	2,802.2
2002	204.3	2,421.3	2,625.6
2003	193.8	2,311.2	2,505.0
2004	219.6	2,263.0	2,482.6
2005	270.1	2,278.6	2,548.7
2006	234.5	2,329.1	2,563.6
2007	187.3	2,379.5	2,566.8

About 954 million kWh of electricity was produced from the waste heat of the incineration process and this represented about 2 to 3% of the total electricity generated in Singapore.

The quantity of scrap metal recovered in 2007 amounted to 14,000 tonnes. These were sold to a local steel mill for reprocessing into steel products.

Semakau Landfill – A Landfill with a Difference

In 2007, 187,314 tonnes of refuse and 552,825 tonnes of incineration ash were not the only 'visitors' to the Semakau Landfill. A total of 6,281 students, members of public and foreigners visited Semakau Landfill to learn about waste management in Singapore while another 1,385 visitors participated in various activities organised by the four interest groups listed in **Table 18**.

Briefing during an educational visit at Semakau Landfill

Table 18
Breakdown of interest groups with activities on Semakau Landfill

Activity	No. of trips	No. of visitors
Intertidal Walk Raffles Museum of Biodiversity Research (RMBR)	23	987
Sport Fishing Sport Fishing Association of Singapore (SFAS)	13	236
Bird Watching Nature Society Singapore (NSS)	5	63
Stargazing The Astronomical Society of Singapore (TASOS) that organised its first stargazing trip on 18 Nov 06	4	99

Semakau Landfill has, through innovative engineering design and careful maintenance, transformed from a landfill into an attractive eco-tourism site coexisting with vibrant marine biodiversity. As such, it has attracted attention from local and international media. CNN, AFP, South China Morning Post, The Standard of Hong Kong, CBC Radio Vancouver, the New Scientist are among those which have reported on the uniqueness of Semakau Landfill.

SOLID WASTE MANAGEMENT

To attract even more visitors and to improve further the quality of educational and recreational activities, the construction of a Visitor Centre was completed in December 2007. The Centre is equipped with briefing room, lounge, information gallery and pantry to serve the visitors better with a cosy and friendly environment. The information gallery has one interactive Semakau Landfill model and three groups of informative posters, covering the development of solid waste management in Singapore; construction, operation and management of Semakau Landfill; as well as strategies to sustain Semakau Landfill. All these information will provide a holistic learning experience for visitors. The Visitor Centre also serves as a rest area to visitors staying overnight at Semakau Landfill.

Visitor Centre

6

Radiation Protection and Nuclear Science

RADIATION PROTECTION AND NUCLEAR SCIENCE

Formation of CRPNS

In August 2005, Singapore signed the Additional Protocol (AP) [4] with the International Atomic Energy Agency (IAEA) and the MEWR and NEA were appointed as the lead agency and national authority respectively for the AP.

In order to discharge its additional responsibilities on nuclear matters, NEA set up the Nuclear Science & Technology Unit (NSTU) in 2006. Meanwhile, the Centre for Radiation Protection (CRP) under HSA continued to be the licensing authority for radioactive and nuclear materials since 1970s. There was significant overlap and duplication as the 2 agencies (HSA and NEA) were building up capability and expertise separately in a highly specialised area.

To streamline control on radioactive and nuclear materials and to ensure that Singapore would be able to meet its obligations under the AP, the CRP was transferred from HSA to NEA on 1 July 2007 to form a new department under NEA called the Centre for Radiation Protection and Nuclear Science (CRPNS).

CRPNS Functions

The key functions of CRPNS are as follow:

a) Control the safe use of ionising and non-ionising radiation;
b) Implement international conventions relating to nuclear and radioactive materials;
c) Administer and enforce the Radiation Protection Act (RPA) and regulations;
d) License the import, export, sale, possession, use and transport of radioactive materials and irradiating apparatus;
e) Control disposal of radioactive waste;
f) Provide personal radiation dose monitoring for radiation workers; and
g) Provide radiation-related services and consultancy e.g. calibration of survey meters, radioactivity testing, training.

Highlights of CRPNS work in 2007

Ionising Radiation

In Singapore, the manufacture, handling, sale, possession, use, transport, import and export of radiation apparatus and radioactive materials are controlled under the Radiation Protection Act 2007 (RPA) and its regulations. The control is enforced by requiring the dealers, owners, and users to apply for the necessary licenses. The table below gives a breakdown of ionising radiation licences issued in 2007.

[4] In 1997, IAEA introduced the Additional Protocol (AP) as a supplementary agreement to the Comprehensive Safeguards Agreement (CSA) on nuclear safeguards. The AP is designed to strengthen and expand the IAEA's ability to verify non-nuclear-weapon states' compliance with the Non-Proliferation Treaty (NPT) on Nuclear Weapons.

Table 19

Licence Type	Description	Number Issued
Ionising Radiation Licences		
L1	Manufacture, possess for sale or deal in ionising radiation irradiating apparatus	168
L2	Manufacture, possess for sale or deal in radioactive materials	155
L3	Keep or possess ionising radiation irradiating apparatus for use (other than sale)	3,352
L4	Keep or possess radioactive materials for use (other than sale)	366
L5	Use an ionising radiation irradiating apparatus (other than sale)	1,847
L6	Use radioactive material (other than sale)	496
L6a	Transport radioactive materials	56
L7A	Import a consignment of ionising radiation irradiating apparatus	2,062
L7B	Export a consignment of ionising radiation irradiating apparatus	1,898
L8A	Import a consignment of radioactive materials	1,475
L8B	Export a consignment of radioactive materials	654
R1	Register as a radiation worker to perform radiation work under the supervision of a licensee	8,061
Non-Ionising Radiation Licences		
N1	Manufacture, possess for sale or deal in non-ionising radiation apparatus	320
N2	Keep or possess non-ionising radiation irradiating apparatus for use (other than sale)	4,684
N3	Use an non-ionising radiation irradiating apparatus (other than sale)	3,260
N4A	Import a consignment of non-ionising radiation irradiating apparatus	2,417
N4B	Export a consignment of non-ionising radiation irradiating apparatus	1,450

In 2007, CRPNS carried out 552 inspections, of which 287 were on industrial radiation facilities and 265 were on medical, dental and veterinary premises.

In 2007, about 3,730 thermoluminescent dosimeters (TLDs) were issued to radiation workers in Singapore every month. This was to ensure that the occupational dosages received by radiation workers were within the permissible limits stipulated in the RPA and regulations.

It is a requirement under the RPA and regulations that all radioactive sealed sources be leak tested. This is to ensure the safe use of these radioactive sources. CRPNS performed 550 leak tests for radioactive sealed sources in 2007.

It is also a requirement under the RPA and regulations that all survey meters for radiation monitoring be calibrated at least annually. In 2007, CRPNS calibrated 300 radiation meters at its Secondary Standards Dosimetry Laboratory.

As one of its laboratory services, CRPNS carries out radioactivity analysis of food samples to certify that these samples are free from radioactive contamination and are fit for human consumption. 1,450 food samples were tested by CRPNS in 2007.

Non-Ionising Radiation

The manufacture, handling, possession, use, transport, import and export of non-ionising radiation apparatus are controlled under the RPA. In particular, the Radiation Protection (Non-ionising Radiation) Regulations specify that the following types of equipment that generate non-ionising radiation are subject to control:

Group 1
- UV lamps for medical use
- Microwave ovens

Group 2
- Medical and industrial ultrasound apparatus
- Magnetic resonance imaging (MRI) apparatus
- Entertainment laser
- Class 3b and Class 4 lasers

The control of these equipment is enforced through the dealers for Group 1 equipment, and through both the dealers and owners for Group 2 equipment, by requiring them to apply for the necessary dealer and owner licences. Users of Class 3b and Class 4 lasers are also required to apply for user licences. All these licences come with attached conditions to ensure safe use. In addition, licences are required for import and export of NIR equipment. **Table 19** gives a breakdown of non-ionising radiation licences issued in 2007.

In 2007, CRPNS made 38 inspections on facilities which emit non-ionising radiation (NIR) and carried out measurements at these sites.

Nuclear Science and Technology

The 51st International Atomic Energy Agency General Conference (IAEA GC) was held at the Austria Center in Vienna, Austria from 17 to 21 Sep 2007. CEO led the five-member delegation comprised officers from NEA, MEWR and MFA, to the GC. More than 100 IAEA member states and over 1,500 delegates attended the five-day event.

CEO NEA delivers the National Statement at the 51st IAEA GC

This GC is particularly significant as it commemorates the 50th anniversary of the setting up of IAEA in 1957. Since then, IAEA has been working tiredlessly with its member states to promote safe, secure and peaceful use of nuclear technologies. CEO delivered Singapore's national statement at the Conference's plenary session on 20 Sep 2007. The statement reflected Singapore's views and positions on various nuclear issues and reiterated Singapore firm support of IAEA and its programmes.

CRPNS served as the Regional Co-operative Agreement (RCA) Coordinator for Singapore and the national focal point to IAEA's Technical Cooperation Department (TCD). The Regional Co-operative Agreement is an intergovernmental agreement for East Asia & Pacific region, under the auspices of the IAEA, in which the Government Parties undertake efforts to promote and co-operate on research and development (R&D) and training projects in nuclear science and technology.

IAEA has allocated a grant of US$300,000 from 2007 to 2011 for the development of Singapore's human resources in nuclear science and technology. The National Project is "SIN/9/016: Strengthening Human Capacity in Nuclear Science and Technology with Emphasis on Safety and Emergency Response Planning". Under the ambit of this national project, IAEA will assist to arrange for fellowship attachments and scientific visits to be conducted for Singapore officers to developed countries and send expert missions to Singapore to conduct trainings for local officers and advise on nuclear matters.

In December 2006, MEWR/NEA requested IAEA to conduct an IAEA SSAS Advisory Service (ISSAS) Mission to guide Singapore in the implementation of the Additional Protocol (AP). With the recommendations from the ISSAS mission, MEWR and NEA worked with AGC to amend the Radiation Protection Act to make provisions for ratification of the AP and Modified SQP and their implementation thereafter. The existing Radiation Protection Act was repealed and re-enacted on 1 Jul 07 to incorporate provisions to fulfill the AP safeguards obligations.

RADIATION PROTECTION AND NUCLEAR SCIENCE

As nuclear science and technology is a highly specialised area, NEA has set up an Advisory Committee in 2006, chaired by Prof Bernard Tan of NUS Physics Dept, to guide NEA and CRPNS in developing its strategic directions and programmes. The Advisory Committee had played a key role in facilitating the transfer of the former Centre for Radiation Protection from HSA to NEA in July 2007, by providing advice on various technical matters.

7

Multilateral Environmental Agreements

MULTILATERAL ENVIRONMENTAL AGREEMENTS

Climate Change

Climate change is one of the major global environmental challenges of our time. There is general scientific agreement that the climate is changing at an unprecedented rate, and that the observed climatic changes are very likely due to the increased emissions of greenhouse gases due to human activity.

Singapore has been a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) since 1997 and acceded to the Kyoto Protocol (KP) of the UNFCCC on 12 April 2006. NEA has been appointed as Singapore's Designated National Authority (DNA) for Clean Development Mechanism (CDM) projects under the KP. The CDM of the KP allows greenhouse gas emission reductions from registered projects implemented in non-Annex I countries, such as Singapore, to be used to offset emissions of Annex I countries, such as Japan and the EU. According to the UNFCCC Secretariat, CDM is anticipated to produce carbon emission reductions totaling more than 2.7 billion tonnes of CO_2 equivalent by the end of 2012.

Protection of the Ozone Layer

Singapore has been a party to the Montreal Protocol since 5 January 1989. On 2 March 1993, Singapore acceded to the London Amendment to the Montreal Protocol and more recently, the Copenhagen Amendment and the Montreal Amendment on 22 September 2000.

The Montreal Protocol deals with control measures and phase-out schedules for various Ozone Depleting Substances (ODS) such as chlorofluorocarbons (CFCs), Halons and methyl bromide. Some of these ODS, namely CFCs, Halons, carbon tetrachloride and methyl chloroform, have already been phased out in Singapore. In addition, industries that are currently using hydrochlorofluorocarbons (HCFCs) or methyl bromide are encouraged to replace them with non-ozone depleting substitutes wherever practicable.

The control measures implemented by Singapore are summarised in **Table 20.**

Table 20
Summary of Measures to Phase Out Ozone-Depleting Substances

Date	Measure
5 October 1989	Quota Allocation System implemented for Chlorofluorocarbons (CFCs).
5 February 1991	Prohibit the import and manufacture of non-pharmaceutical aerosol products and polystyrene sheets/products containing controlled CFCs.
1 January 1992	(a) Prohibit the use of Halon 1301 for new fire-protection systems. (b) Prohibit the import of Halon 2402.
1 January 1993	Prohibit the import of new air-conditioning and refrigeration equipment using CFC 11 and CFC 12.
1 January 1994	Prohibit the import of Halon 1211 and Halon 1301.
15 April 1994	Prohibit the import of fire-extinguishers filled with Halon 1211.
1 January 1995	All new cars must be equipped with non-CFC air-conditioning systems.
1 April 1995	Prohibit the import of HBFCs.
1 January 1996	Prohibit the import of CFCs, carbon tetrachloride and 1,1,1-trichloroethane (methyl chloroform).
1 January 2002	Freeze the consumption of Methyl Bromide (MeBr) for non-quarantine and pre-shipment (non-QPS) applications*.

*Note: Quarantine applications - Include treatments to prevent the introduction, establishment, and/or spread of quarantine pests, or to ensure their official control.
Pre-shipment applications — These include non-quarantine methyl bromide applications within 21 days prior to export that are required to meet the official requirements of the importing or exporting countries.

The import and export of ODS are regulated under the Environmental Pollution Control Act (EPCA) and the Environmental Pollution Control (Ozone Depleting Substances) Regulations. Under the Act and its Regulations, a licence is required for the import and/ or export of ODS listed in the Schedule of the Act and its Regulations **(Appendix 16).**

In addition, PCD controls the import, possession for sale, sale or offer for sale of any ODS through licences granted by PCD for such purposes under the EPCA. During the year, PCD issued 28 Hazardous Substances Licences for the import and export of ODS, and electronically processed 972 inward and outward declarations for the import and/or export of ODS through the TradeNet computerised network system.

In addition, PCD prosecuted 2 companies for illegally importing CFCs. The 2 companies were convicted and fined for the offence committed.

MULTILATERAL ENVIRONMENTAL AGREEMENTS

Control on Export, Import and Transit of Hazardous Wastes (Basel Convention)

Singapore acceded to the Basel Convention on 2 January 1996. The Hazardous Waste (Control of Export, Import and Transit) Act and its Regulations were enacted and came into operation on 16 March 1998. The Act and its Regulations enable Singapore to fulfil its obligations under the Basel Convention. Under the Act and its Regulations, any person wishing to export, import or transit any hazardous waste scheduled under the Basel Convention is required to apply for a permit from PCD.

During the year, PCD processed and issued 11 import, 22 export and 68 transit permits under the Basel Convention.

Control of Persistent Organic Pollutants

The Stockholm Convention seeks to control and ultimately eliminate the release of persistent organic pollutants (POPs) into the environment. It sets out control measures on the production, import, export, disposal, and use of 10 commercially produced POPs (8 pesticides and 2 industrial chemicals) and 2 unintentional by-products (furans and dioxins) from waste incinerators and chemical plants. The Stockholm Convention entered into force on 17 May 2004, ninety days after France submitted the fiftieth instrument of ratification, acceptance, approval or accession to become a Party to the Stockholm Convention on 17 February 2004.

Singapore has banned the use of the 10 commercially produced POP chemicals in Singapore well in advance of the deposition of its instruments of ratification and accession with the Secretary-General of the United Nations in New York on 24 May 2005. The Convention entered into force for Singapore on 22 Aug 2005 (i.e. the 90th day after the date of deposit of the instruments). Singapore has already taken measures to limit the emission of furans and dioxins from our incineration plants. In keeping with internationally accepted practices to control such emissions, we have introduced air emission standards under the EPC (Air Impurities) Regulations 2000 to limit dioxins and furans releases.

In addition, the development of a National Implementation Plan (NIP) is one of the obligations under the Stockholm Convention which a Party to the Convention must fulfil. . Each Party must transmit their NIP to the Conference of Parties within two years of the date on which the Convention comes into force for the Party. In order for Singapore to fulfil this obligation, NEA had in Aug 2006 formed a multi-stakeholder working group comprising of 10 organisations viz. Agri-food Veterinary Authority (AVA), Ministry of Manpower (MOM), Ministry of Health (MOH), National University of Singapore (NUS), Nanyang Technological University (NTU), Waste Management and Recyclers Association of Singapore (WMRAS), the Singapore Chemical Industry Council (SCIC), Singapore Pest Management Association (SPMA) and the Singapore Environment Council (SEC). The stakeholders are selected so as to solicit balanced views and inputs in the implementation of the various programmes under the Stockholm Convention.

The Working Group then met several times to develop the NIP and finally completed and submitted the NIP on 22 Aug 2007. The NIP has been developed in accordance with the guidelines provided by the Stockholm Convention Secretariat. The NIP presents Singapore's current status with respect to POPs management, control and monitoring and thereafter focuses on the development and implementation of POPs monitoring in Singapore, and includes activities related to research and development, awareness-raising and information dissemination.

Control on International Trade in Hazardous Chemicals and Pesticides (The Rotterdam Convention on Prior Informed Consent Procedure)

The Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade seeks to regulate the international trade of 27 highly dangerous pesticides and industrial chemicals using the Prior Informed Consent (PIC) procedure. The Convention had entered into force on 24 February 2004 and the list, after further review, now contains 39 hazardous industrial chemicals and pesticides.

None of the chemicals, except Ethylene Oxide (ETO), is produced in Singapore. The ETO produced is exported for approved medical and clinical sterilisation uses only.

On 24 May 2005, Singapore deposited its instruments of ratification and accession with the Secretary-General of the United Nations in New York. Similar to Stockholm Convention, the Rotterdam Convention entered into force for Singapore on 22 Aug 2005. PCD is the Designated National Authority for the control of the import and re-export of these 39 highly dangerous pesticides and chemicals. PCD will only grant a licence to a company to import and re-export any of the 39 controlled chemicals if it abides by the PIC procedure.

During the year, PCD approved 3 applications of export of chemicals controlled under the Rotterdam Convention. The exports were granted in accordance with the PIC procedure under the Rotterdam Convention.