Ministry of Natural Resources and Environment, Malaysia

JABATAN ALAM SEKITAR MALAYSIA

Multilateral Fund for the Implementation of the Montreal Protocol

UNDP

PROTECTING THE OZONE LAYER

MALAYSIA IMPLEMENTING THE MONTREAL PROTOCOL

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Foreword

The energy-intensive lifestyle of those living in developed countries is now being adopted among rapidly developing Asian countries. Industrialization and modernization are spreading everywhere, at differing paces and with different consequences. Alongside increased GDP, reduced poverty, and rising inequality, there is increasing fossil fuel use, natural resource depletion, and loss of biodiversity. This means increasing emissions from automobiles and factories, resulting in global warming and climate change.

Given the increased scale of global economic activity, international trade is a major driver of environmental change. Advancing economic growth and modernization require intensifying the use of finite natural resources and substances harmful to the environment leading to ecological disequilibrium.

Although the ozone is a very small part of our atmosphere, its presence is vital to human well-being. It provides a protective shield that absorbs some of the potentially harmful ultraviolet (UV) radiation from the sun that can cause skin cancer and damage vegetation. In the 1970s, scientists discovered significant levels of ozone depletion in the stratosphere, producing a phenomenon commonly known as the 'Ozone Hole'. By the 1990s, the total ozone was less than half its value during the 1970s and this depletion has continued until today.

In response to the threat to the ozone, in 1987 the governments of the world agreed to the United Nations Montreal Protocol as a means to address global environmental challenges. Malaysia's involvement with the Montreal Protocol began as early as 1987 when the country was invited to attend the Conference of Plenipotentiaries on the Protocol on Chlorofluorocarbons (CFCs) at the Vienna Convention for the Protection of the Ozone Layer, which was held in Montreal. Malaysia, recognizing the importance of the Conference, particularly with regard to its socio-economic implications, responded with an outline of its future environmental strategies and action plans, and subsequently ratified the Vienna Convention and the Montreal Protocol on 29 August 1989.

Malaysia's commitment to the Protocol was further demonstrated when the Public Services Department set up an Ozone Protection Section (OPS) under the Department of Environment in January 1997. The OPS serves as the national focal point and one-stop agency for coordinating, monitoring, and implementing all of the Montreal Protocol Ozone-Depleting Substances (ODS) phase-out activities. Since ratification, the Government has formulated policies and strategies to restrict and limit the use of ODS, and it closely monitors the importation and consumption of controlled substances. It also promotes the use of non-ODS substitutes and alternatives in existing industries.

Malaysia's success in implementing the Montreal Protocol can be seen both in declining imports and consumption of CFCs, from 3,442 metric tonnes in 1995 to 662 metric tonnes in 2005, and in the institutional framework, particularly the establishment of the Ozone Protection Section. Globally, the Montreal Protocol is seen as one of the most successful International Conventions and Malaysia has made substantial progress in implementing the Protocol.

This publication is the third in a series that reports on UNDP Malaysia's work in the energy and environment practice area. The series of publications is available through UNDP's website, http://www.undp.org.my.

I would like to thank the Multilateral Fund for the Implementation of the Montreal Protocol for funding the ODS projects. I would also like to thank the UNDP Montreal Protocol Unit in New York, and the Ozone Unit, Department of Environment, in the Ministry of Natural Resources and Environment, for their guidance and support. Special thanks and appreciation are extended to members of the Study Team for their hard work in putting this publication together. I hope that it will be widely read and will help to increase awareness of the critical importance of good environmental management. It is hoped that other countries may learn from Malaysia's experiences, and that greater efforts and commitment will be shown towards reducing the use of ODS.

Richard Leete Ph.D
Resident Representative
United Nations Development Programme
Malaysia, Singapore and Brunei Darussalam

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Boxes

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Abbreviations

ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
CETEC	Centre for Environmental Technology
CFC	Chlorofluorocarbon
FMCA	Federation of Malaysian Consumers Association
FMM	Federation of Malaysian Manufacturers
FRIM	Forest Research Institution of Malaysia
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
LCD	Liquid Carbon Dioxide
LIA	Low Index Additive
MAC	Mobile Air Conditioner
MACRA	Malaysian Air Conditioning and Refrigerating Association
MDG	Millennium Development Goal
MEA	Multilateral Environmental Agreements
MIDA	Malaysian Industrial Development Authority
MITI	Ministry of International Trade and Industry
MLF	Multilateral Fund
MNRE	Ministry of Natural Resources and Environment
MOSTE	Ministry of Science, Technology, and Environment
NCFCP	National CFC Phase-Out Plan
NGO	Non-Governmental Organization
NOU	National Ozone Unit
NSC	National Steering Committee
ODP	Ozone Depletion Potential
ODS	Ozone-Depleting Substances
OPS	Ozone Protection Section (of the Department of Environment)
PCC	Panel on Climate Change
PFC	Perfluorocarbons
PIC	Prior Informal Consent
PMU	Project Management Unit (of the Department of Environment)
QPS	Quarantine and Pre-Shipment
SEAP	South-East Asia and Pacific
SIRIM	Standard and Industrial Research Institute of Malaysia
SME	Small and Medium-Sized Enterprises
TEAP	Technology and Economic Assessment Panel (of UNEP)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UV	Ultraviolet
UVA/UVB/ UVC	Types of Ultraviolet Radiation (by wavelength)
WB	World Bank
WMO	World Meteorological Organization

Stakeholders

Institutional Stakeholders

Customs Department
Department of Agriculture
• Crop Protection Division
• Pesticides Board
Department of Environment, Ministry of Natural Resources and Environment
• Ozone Protection Section (OPS)
Department of Statistics
Forestry Research Institute of Malaysia (FRIM)
Meteorological Department
Ministry of International Trade and Industry (MITI)
Multilateral Fund (MLF)
National Steering Committee (NSC)
United Nations Development Programme (UNDP)
United Nations Environment Programme (UNEP)
United Nations Industrial Development Organization (UNIDO)
World Bank

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Norzilla Mohamed, UNDP Programme Associate

Industry Stakeholders

The large number of Suppliers and Manufacturers involved makes it impractical to acknowledge individually all the companies that have participated in the wide range of measures for the implementation of the Montreal Protocol in Malaysia. The following list of Consultants and Associations embraces the majority of participating companies:

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), Malaysian Chapter
Aurora Chemicals Sdn Bhd
Baseline Technology Sdn Bhd
Centre for Environmental Technology (CETEC)
Federation of Malaysian Consumers Association (FMCA)
Federation of Malaysian Manufacturers (FMM)
KP Quality Product Manufacturing Sdn Bhd
Malaysian Air Conditioning and Refrigerating Association (MACRA)

THE ISSUE: PREVENTING CONTINUED OZONE DEPLETION

What is Ozone?

The earth's **atmosphere** is composed of several layers. The closest to earth is the **troposphere** where we live, where most of our clouds and weather occur, and subsonic aircraft fly. Above that is the **stratosphere** where supersonic aircraft fly, and it is here, at altitudes between about 15 and 50 km, that ozone forms a layer that is thinnest in the tropics, especially around the equator, and denser towards the poles.

Ozone is a gas in which each molecule is made up of three atoms of oxygen (O_3). Ozone occurs naturally but undergoes large seasonal variations. It is created when ultraviolet radiation, or sunlight, strikes the stratosphere splitting oxygen molecules (O_2) to atomic oxygen (O) that quickly combines with further oxygen molecules to form ozone. The splitting and reformation of ozone molecules is a continuous natural process.

In the stratospheres the ozone layer provides a protective shield absorbing some of the potentially harmful ultraviolet (UV) radiation from the sun that can cause skin cancer and damage vegetation. Ironically, at ground level, ozone is a health hazard when it occurs as a major constituent of photochemical smog.

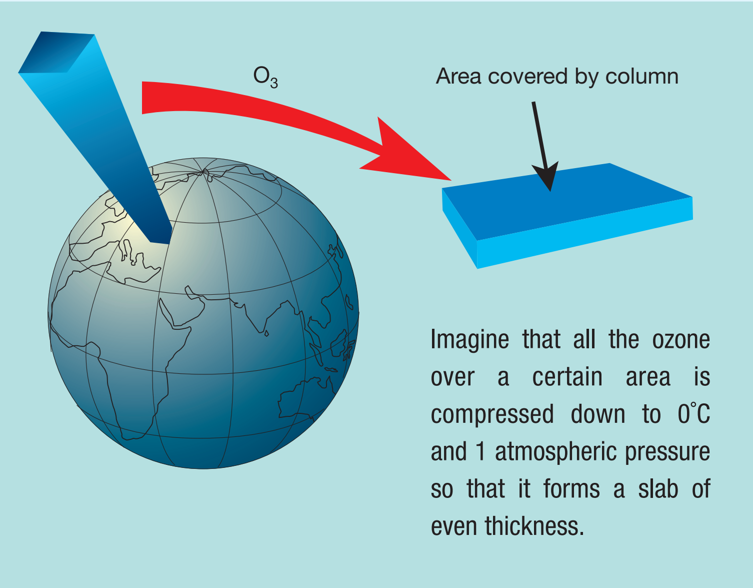
The Ozone Hole

Since the mid-1970s, over Antarctica, and more recently over the Arctic, stratospheric ozone has recorded significant levels of depletion at certain times of the year—producing a phenomenon commonly known as the 'Ozone Hole'. Although mid-latitude depletion has also been observed, the loss is most dramatic in the lower stratosphere over the Antarctic continent during the Antarctic spring (October). By 1994, the total ozone in October was less than half of its value during the 1970s and this depletion has continued. Despite some optimism in 2005, when the situation appeared to be stabilizing, it was reported that from 21 to 30 September 2006, the ozone hole extended for 10.6 million square miles, the largest ever recorded (UNEP Conference, New Delhi, November 2006).

The atmosphere behaves differently from year to year, and even though the same processes that lead to ozone depletion occur every year, the effect they have on the ozone layer depends on the meteorology of the atmosphere above Antarctica at a given time. This variability leads to changes in the amount of ozone depleted and the period of depletion in any given year.

Although the loss of ozone is greatest over the Antarctic where there has been a near total loss of ozone at some altitudes, depletion has also been occurring in mid-latitudes, but the loss here has been much less and much slower. However, this is a serious trend and a major cause for concern and for continued scientific investigation.

Figure 1 The Dobson Unit



- The Dobson Unit is the standard measure of ozone in the earth's atmosphere.
- The illustration shows a column of air that is 10° by 5° over Labrador, Canada. The amount of ozone in this column (i.e. covering the 10 by 5° area) can be measured in **Dobson Units**.
- If all the ozone in this column were to be compressed to standard temperature and pressure (STP, which is 0°C and 1 atmospheric pressure) and spread out evenly over the area, it would form a slab approximately 3 mm thick. Because 1 Dobson Unit (DU) is defined as 0.01 mm thick at STP, this means that the ozone layer over Labrador is 300 DU.

Source: Based on Centre for Atmospheric Science, University of Cambridge, 'The Ozone Hole Tour', Dobson Unit Definition.

Measuring Ozone in the Atmosphere

Scientists have been studying ozone since the 1920s. Measurements are made in Dobson Units, named after one of the first scientists to investigate atmospheric ozone (Figure 1). He designed the Dobson spectrometer which measures ozone from the ground. Developments in instrumentation no longer require viewing the atmosphere from an isolated ground station but provide coverage and profiles of ozone in the atmosphere by a variety of airborne methods. Balloons, rockets, and aircraft carry instruments into the atmosphere providing more accurate and detailed measurement. However, the most consistent and comprehensive data are provided by satellites capable of observing the atmosphere in all types of weather and over the most remote regions of the earth. They are capable of measuring ozone levels, ozone profiles, and many elements of atmospheric chemistry.

How Human Activities Deplete the Ozone Layer

The dramatic fall in ozone is mainly due to the release of man-made chemicals containing chlorine such as chlorofluoro-carbons (CFCs), but is also attributable to compounds containing bromine, other related halogen compounds and nitrogen oxides. CFCs are a common industrial product used in refrigeration systems, air conditioners, aerosols, and solvents, and in the production of some types of packaging. Nitrogen oxides are a by-product of combustion processes such as aircraft emissions.

No significant natural sources have ever been identified for these compounds so there is little equivocation over their origin: their presence in the atmosphere is almost entirely attributable to human manufacture. When such ozone-depleting chemicals reach the stratosphere, they react with ultraviolet light to release chlorine atoms that act as a catalyst to break down ozone molecules before eventually being removed from the stratosphere (see Figure 2). Because of the longevity of CFC molecules, recovery times from their impact are measured in decades.

Natural causes or events are unlikely to have contributed significantly to ozone depletion. Volcanic eruptions are powerful events and capable of injecting hydrogen chloride high into the atmosphere. Oceans produce large volumes of sea salt which contains chlorine. If these compounds accumulated in large quantities in the stratosphere, they might result in ozone depletion. However, the majority of volcanic eruptions are too weak to reach the stratosphere and remain in the troposphere.

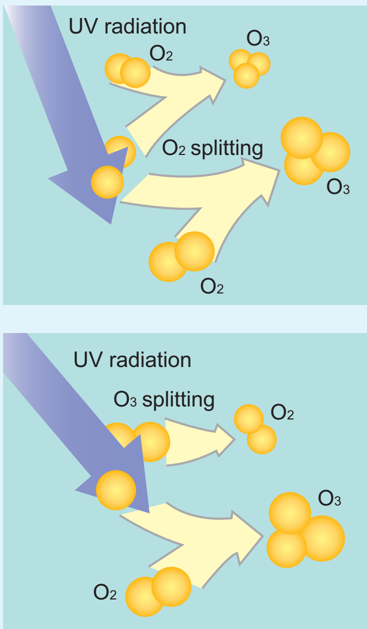
Ozone-Depleting Substances and Ozone-Depleting Potential

Because not all chemicals affect the ozone layer in the same way, scientists have established a common benchmark called Ozone Depleting Potential (ODP) against which each ozone-depleting substance can be measured. The benchmark used is that of the chlorofluorocarbons CFC-11 and CFC-12, both of which have a reference level of 1.0.

Other substances are assigned values in relation to how much more or less a comparable weight would deplete the ozone layer. For example, methyl bromide* has an ODP of 0.6, meaning that a tonne of methyl bromide would have 60 per cent of the impact on the ozone layer as a tonne of CFC-11 or CFC-12. The use of ODP as a standard measure makes it possible to compare how scientific projects that focus on assessing the impact of different chemicals will affect the ozone layer.

* The elimination of the use of CFCs and methyl bromide in Malaysia is discussed later in the section on the Phase-Out Experience in SMEs.

Figure 2 **How Oxygen Molecules Split Apart**



In the stratosphere, oxygen molecules that absorb high-energy UV rays split apart. Each of the oxygen atoms released in the process can join with O_2 to form O_2. When an ozone molecule absorbs UV rays, it breaks apart, leaving an oxygen molecule and a single oxygen atom, which can go on to join another O_2 and form O_2 once again.

Table 1 Ultraviolet Radiation

Spectrum	Wavelength (nanometres)	Atmospheric Absorption	Applications	
			Positive	Negative
UVA	320–400	Little	Synthesizes Vitamin D	Suppression of immune system, cataracts
UVB	290–320	Partial	Synthesizes Vitamin D	Skin cancer, cataracts
UVC	220–290	Total	Germicidal treatment	Burns

UV radiation is the portion of the electromagnetic spectrum between x-rays and visible light. The sun is the primary natural source of UV radiation but artificial sources of UVA and UVC are utilized for various purposes such as tanning (UVA) and killing bacteria (UVC). UVB is the form of UV radiation most affected by the variations in the intensity of the ozone layer.

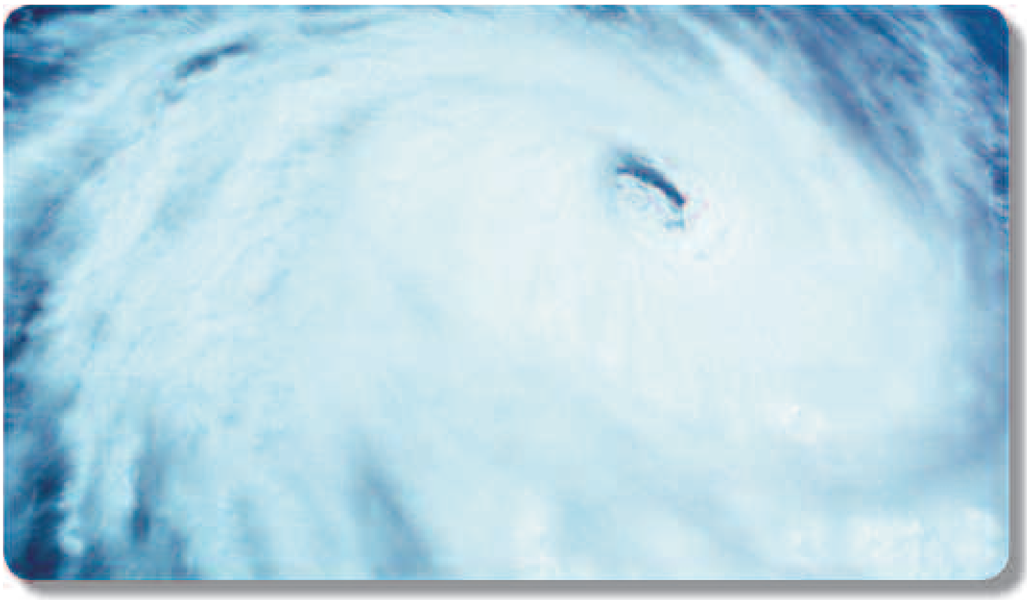
Sea salt is also released at low levels in the atmosphere. The compounds from such natural sources would have to remain airborne for 2–5 years to be carried up to the stratosphere. But, unlike CFCs, both hydrogen chloride and sea salt are extremely soluble in water and rain effectively cleans the troposphere, removing both of these forms of chlorine.

Why is Ozone Depletion a Threat?

The main concern regarding the depletion of ozone in the atmosphere is the impact of UV radiation on human health (Table 1). The ozone layer acts as a natural atmospheric filter and the depletion of ozone means that its protective effectiveness is reduced significantly, increasing the amount of surface UV worldwide. This phenomenon is particularly serious in southern parts of Australia, New Zealand, and South America, in the regions closest to the expanding Antarctic Ozone Hole, which is still showing severe depletion.

UV radiation is generally recognized to be a major contributory factor to skin cancers. Some cancers such as carcinomas are relatively mild and rarely fatal, but may be disfiguring and require reconstructive surgery. Malignant melanoma, although less common, is far more dangerous and is likely to prove fatal in about 20 per cent of cases diagnosed. UV radiation is also known to affect the human immune system and to cause eye damage, including cataracts.

UV radiation can affect plant growth and productivity. Plants have the ability to resist a single stress but if this is combined with another stress such as warming or nutrient or water deprivation, the impact can be serious. A number of economically important species of plants such as paddy



depend on particular UV-sensitive bacteria residing on their roots for the retention of nitrogen. Phytoplankton, the microscopic plants that constitute the basis of the marine food chain, are particularly susceptible to increases in UV radiation and reduction in their numbers has a negative impact on other marine species, including commercial fish stocks.

Impacts of UV radiation are not only biological, affecting human health and plant life, but also include accelerated deterioration of such essential products as plastics, wood, paper, cotton, and wool.

Conserving the Ozone Layer

As early as 1974, the first scientific evidence was emerging that connected depletion of the ozone layer with the occurrence of CFCs in the atmosphere, a discovery of such importance that the researchers—Paul Crutzen, Mario Molina, and Sherwood Rowland—were subsequently awarded the 1995 Nobel Prize for Chemistry.

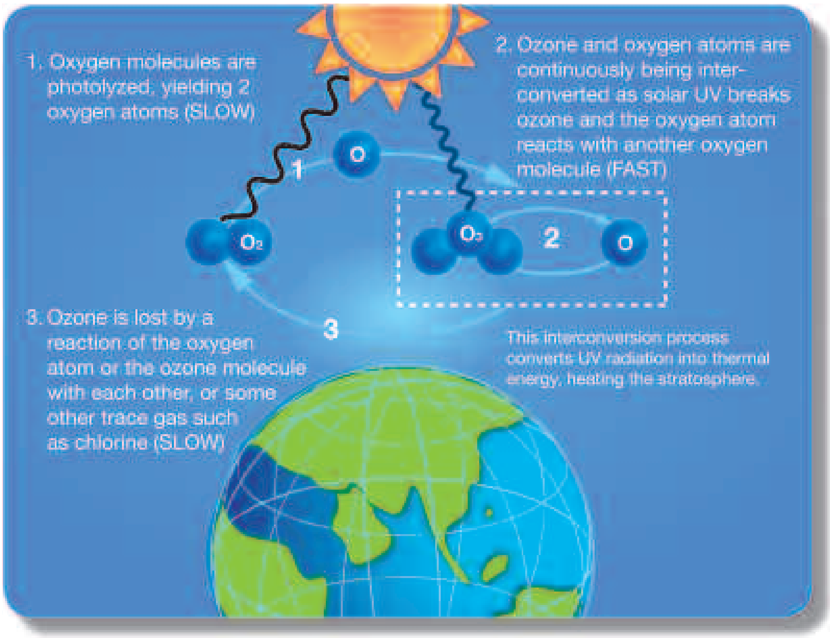
The issue of ozone depletion was first discussed by the United Nations Environment Programme (UNEP) in 1976, and in 1977 UNEP convened a meeting of experts on the ozone layer. UNEP and the World Meteorological Organization (WMO) set up the Coordinating Committee of the Ozone Layer to periodically assess ozone depletion. Intergovernmental negotiations for an international agreement to phase out ozone-depleting substances started in 1981 and concluded with the adoption of the Vienna Convention for the Protection of the Ozone Layer in March 1985. The urgency of the need for appropriate measures to be taken was forcefully confirmed by the mid-1980s' discovery of the Ozone Hole over the Antarctic and the severe levels of ozone depletion occurring in many parts of the globe's atmosphere.

INTERNATIONAL DEVELOPMENT OF THE MONTREAL PROTOCOL

The rising awareness of these issues during the 1970s and 1980s persuaded many nations of the need for international agreement and cooperation to protect the ozone layer in the interests of countries worldwide. Nevertheless, as the lengthy Preamble to the Vienna Convention indicates, gaining agreement even among the limited group of nations that were the early movers on these issues was not easy.

A number of issues combined to prolong the negotiations despite agreement on the commonly held goals of protecting human health and the environment against the adverse affects resulting from modification of the ozone layer. These included

- the sovereign right of each country to exploit its own resources;
- the disparate needs of developing countries;
- the World Plan of Action on the Ozone Layer of the United Nations Environment Programme;
- existing measures for protection of the ozone layer already in place; and
- the incomplete understanding of the scientific processes involved.



The Vienna Convention for the Protection of the Ozone Layer

Despite the initial difficulties, in 1985 in Vienna, after four years of preparation, 20 nations signed the agreement to take 'appropriate measures … to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the Ozone Layer', initiating the first formal attempts for comprehensive international cooperative measures that eventuated in the Vienna Convention.

The main thrust of the Convention was to encourage research and overall co-operation among countries and to promote the exchange of information, but even so, the signatories took some time to ratify the agreement. The Vienna Convention also provided for future protocols and specified procedures for amendment and dispute settlement.

The Vienna Convention set an important precedent. For the first time, nations agreed in principle to tackle a global environmental problem before its effects were felt or even comprehensively and scientifically demonstrated. However, coincidentally in the same year as the initial signing of the Convention, scientists were reporting exceptionally severe ozone depletion over the Antarctic. These findings were soon verified by satellite observation, confirming the unprecedented scale of ozone depletion and highlighting the need for urgency in addressing the problem.

The Montreal Protocol on Substances That Deplete the Ozone Layer

As a consequence of these developments and the obvious necessity for decisive action, the signatories to the Vienna Convention developed specific measures for dealing with this situation and in 1987 the Montreal Protocol was agreed and signed (Box 1). By 2006, 189 states had signed as Parties to the Montreal Protocol.

Since the initial signing, in keeping with the expectation that scientific knowledge and political circumstances would change, there have been a number of adjustments and amendments to the original treaty—amendments identified as 'London 1990', 'Copenhagen 1992', 'Vienna 1995', 'Montreal 1997', and 'Beijing 1999'.

The Montreal Protocol was structured around several categories of substances that have been shown to contribute to ozone depletion, each described in an Article in the Protocol. For each category of substance, the Protocol specified a timetable for an initial 'consumption freeze' and an ultimate 'phase out'. Differing targets were set for developed and developing (Article 5) countries in recognition of the latter's need for accelerated industrial development and relatively small production and use of Ozone-depleting Substances (ODSs). The Protocol requires all Parties to the Protocol to ban exports and imports of controlled substances to and from non-Parties.

Box 1 The Rationale for the Montreal Protocol

The Preamble states that the Parties to the Protocol, among other issues,

- recognize that world-wide emissions of certain substances can significantly deplete and otherwise modify the ozone layer in a manner that is likely to result in adverse effects on human health and the environment;…
- are determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge, taking into account technical and economic considerations and bearing in mind the developmental needs of developing countries;…
- acknowledge that special provision is required to meet the needs of developing countries, including the provision of additional financial resources and access to relevant technologies;…
- agree to a series of steps limiting the production and use of substances that deplete the ozone layer.

Production and consumption of CFCs, halons and other ozone-depleting chemicals have been phased out in industrialized countries and a schedule is in place to eliminate the use of methyl bromide, a pesticide and agricultural fumigant. Parties may agree to approved but limited exemptions for 'critical uses' where there are no feasible alternatives to a substance's use.

As Table 2 shows, developing countries agreed to freeze most CFC consumption from 1 July 1999 based on 1995–7 averages; to reduce this consumption by 50 per cent by January 2005; and to fully eliminate these CFCs by January 2010. Other control measures apply to ODSs such as halons, carbon tetrachloride, and methyl chloroform. For methyl bromide, used primarily as a fumigant, developed countries froze their consumption at 1995 levels and will eliminate all use by 2010, while developing countries committed to freeze consumption by 2002 based on average 1995–8 levels and to completely phase out use by 2015.

The provisions of the Protocol include the requirement that the Parties to the Protocol base their future decisions on the current scientific, environmental, technical, and eco-nomic information that is assessed through panels drawn from the worldwide community of experts (Box 2). To provide that input to the decision-making process, advances in knowledge and under-standing on these topics have been assessed in a series of reports entitled 'Scientific Assessment of Ozone Depletion', in 1989, 1991, 1994, 1998, 2002, and 2006. This information, which helped to support discussions among the Parties that led to the subsequent amendments earlier and provided new policy-relevant insights into the roles of ozone-depleting gases, has been achieved by recent research and confirmed by the findings of the 'Scientific Assessment of Ozone Depletion: 2006'.

Box 2 A Historic Achievement of International Cooperation

The Montreal Protocol marked a globally historic achievement and a milestone in environmental policy development. It was the first legally binding international environment agreement

- to develop a strategy to address a shared environmental issue that is agreed to or approved by both developing and developed countries;
- to adopt a precautionary principle of setting out a strategy for immediate action even before all of the scientific ramifications were known;
- to impose trade sanctions to achieve its goals;
- to differentiate between developed and developing countries in recognizing the origins of the problem and distributing responsibility accordingly for solving it.

Table 2 Implementation Schedule for Control Measures Under the Montreal Protocol

Protocol Article and Substance	Developed Countries		Developing Countries	
	Consumption Freeze	Phase Out	Consumption Freeze	Phase Out
2A Chlorofluoro-carbons (CFCs)	1 July 1989	1 Jan 1996	1 July 1999	1 Jan 2010
2B Halons	–	1 Jan 1994	1 Jan 2002	1 Jan 2010
2C Other Fully Halogenated CFCs	–	1 Jan 1996	–	1 Jan 2010
2D Carbon Tetrachloride	–	1 Jan 1996	–	1 Jan 2010
2E Methyl Chloroform	1 Jan 1993	1 Jan 1996	1 Jan 2003	1 Jan 2015
2F Hydrochloro fluoro-carbons (HCFCs)	1 Jan 1996	1 Jan 2030	1 Jan 2016	1 Jan 2040
2H Methyl Bromide	1 Jan 1995	1 Jan 2010	1 Jan 2002	1 Jan 2015

Source: UNDP Montreal Protocol website.

The Ozone Secretariat of the United Nations Environment Programme

The Ozone Secretariat is the secretariat for the Vienna Convention for the Protection of the Ozone Layer and for the Montreal Protocol on Substances That Deplete the Ozone Layer. The main duties of the Secretariat include

- arranging for and servicing the conferences of the Parties, their meetings, committees, the bureaux, working groups, and assessment panels;
- arranging for the implementation of decisions resulting from these meetings,
- monitoring the implementation of the Convention and the Protocol;
- reporting to the meetings of the Parties and to the Implementation Committee;
- representing the Convention and the Protocol;
- receiving and analyzing data and information from the Parties on the production and consumption of Ozone-Depleting Substances; and
- providing information.

The Secretariat is based at the United Nations Environment Programme (UNEP) offices in Nairobi, Kenya.

International Information on Ozone Depletion and Related Issues

Among the services provided by UNEP and related organizations is access to information about ozone depletion, the current scientific status of the ozone layer, measures and procedures being implemented to minimize human impact through the use of ozone-depleting substances, and other related issues. Two types of reports dealing with such information are

1. **'Scientific Assessment of Ozone Depletion: 2006'**, prepared by the Scientific Assessment Panel of the Montreal Protocol on Substances that Deplete the Ozone Layer, released in August 2006 by the World Meteorological Organization and UNEP. Assessments of this type have been carried out every 2–3 years since the introduction of the Montreal Protocol. An Executive Summary can be found at
   http://ozone.unep.org/Publications/Assessment_Reports/

2. Technology reports prepared by the Technology and Economic Assessment Panel (TEAP) of UNEP related to the alternative technologies that have been investigated and employed to make it possible to virtually eliminate the use of ozone-depleting substances (ODSs), such as chlorofluorocarbons, halons, methyl bromide, and the like, which harm the ozone layer. Online reports are listed at
   http://ozone.unep.org/teap/Reports/index.asp

The Multilateral Fund for the Implementation of the Montreal Protocol

The Multilateral Fund (MLF) began operating in 1991 and is managed by an Executive Committee comprising an equal number of members from developed and developing countries. The main objective of the Fund is to assist the 143 developing countries whose annual per capita production consumption of ozone-depleting substances (ODS) is less than 0.3 kg (known as Article 5 countries) to comply with the control measures of the Protocol.

Contributions to the Multilateral Fund from the 49 industrialized countries (including countries with economies in transition; these are all non-Article 5 countries) that are assessed according to the United Nations scale of assessment. As at April 2006, contributions by industrialized countries had totalled over US$2 billion. About $41.6 billion of this amount has been disbursed for over 4,600 projects in 134 countries through the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the United Nations Industrial Development Organization (UNIDO), and the World Bank. Funds are used to finance the conversion of existing manufacturing processes, train personnel, pay royalties and patent rights on new technologies, and establish national ozone offices.

The implementation of these projects in developing countries will result in the phase-out of the consumption of more than 226,855 Ozone Depletion Potential (ODP) metric tonnes and in the phase-out of production of about 156,342 ODP metric tonnes of ozone-depleting substances. Of this total, about 190,688 ODP tonnes of consumption and 116,197 tonnes of production had already been phased out by approved projects as of December 2005.

The Implementing Agencies

The work that the MLF finances in recipient developing countries is managed by four implementing agencies

- United Nations Environment Programme (UNEP),
- United Nations Development Programme (UNDP),
- United Nations Industrial Development Organization (UNIDO), and
- World Bank (WB)

Generally, investment-oriented projects are led by UNDP, UNIDO, and WB. Non-investment projects, especially those focused on training, networking, and information sharing, are usually led by UNEP. In addition there are numerous bilateral agreements between developed and developing countries that provide financial and technical support for projects involving ODS reduction.

The UNDP Montreal Protocol Unit

UNDP's Montreal Protocol Unit works with public and private partners in developing countries to assist in meeting the scheduled targets for the control measures. Partners include

- national and local governments;
- industrial enterprises irrespective of size;
- representative organizations (e.g. refrigeration and air-conditioning associations, agricultural institutions); and
- individual and collective members of civil society (farmers, NGOs).

UNDP's Multilateral Fund activities are conducted by the UNDP Montreal Protocol Unit located at UNDP headquarters in New York.

MALAYSIA'S RATIFICATION AND IMPLEMENTATION OF THE MONTREAL PROTOCOL

Map 1 Malaysia in South-East Asia

Ratification of the Montreal Protocol in 1989

Malaysia was not one of the founding signatories to the Montreal Protocol in 1987, but first became involved as a participant in the Conference of Plenipotentiaries on the Protocol on CFCs to the Vienna Convention in Montreal that same year. Strong concern was expressed at the Conference by Malaysia's head of delegation, Dr Abu Bakar Jaafar, over what he perceived as the unfairness of the various control strategies, trade restrictions, discrimination against non-Parties, and economic implications for developing countries. Malaysia also voiced its disapproval over the issue of annual per capita consumption of CFCs and halons which were considered to be unfair to developing countries.

Despite these misgivings, the Government of Malaysia recognized the importance of the Protocol and its serious socio-economic implications especially for the developing industrial sector, and immediately outlined its future strategies and plan of action.

The Montreal Protocol: Working Towards an MDG

In his recent report to the United Nations General Assembly on the progress made towards achieving the MDGs ('In Larger Freedom', 21 March 2005), Kofi Annan highlighted the implementation of the Montreal Protocol as a noteworthy example of success: 'We fundamentally depend on natural systems and resources for our existence and development. Our efforts to defeat poverty and pursue sustainable development will be in vain if environmental degradation and natural resource depletion continue unabated. At the country level, national strategies must include investments in improved environmental management and make the structural changes required for environmental sustainability… We already have an encouraging example showing how global solutions can be found. Thanks to the Montreal Protocol on Substances That Deplete the Ozone Layer, the risk of harmful radiation appears to be receding — a clear demonstration of how global environmental problems can be managed when all countries make determined efforts to implement internationally agreed frameworks.'*

Malaysia's Country Statement in 1988

In the Country Statement, Dr Abu Bakar Jaafar characterized the treaty as 'inequitable'. He wrote that the developing nations 'had been "had" at Montreal' because they were 'unaware of the full socio-economic implications of the Protocol'. He stated that there had been insufficient time for reviewing the 'lengthy and legalistic English-language Protocol' before it had been 'rushed to the plenary session for signature'. He criticized the Protocol for allotting a lower per capita consumption quota to developing countries than to industrialized countries. He also contended that the treaty's trade provisions amounted to 'trade war by decree'.

Source: Cited from Department of Environment Malaysia, 1999, p. 7.

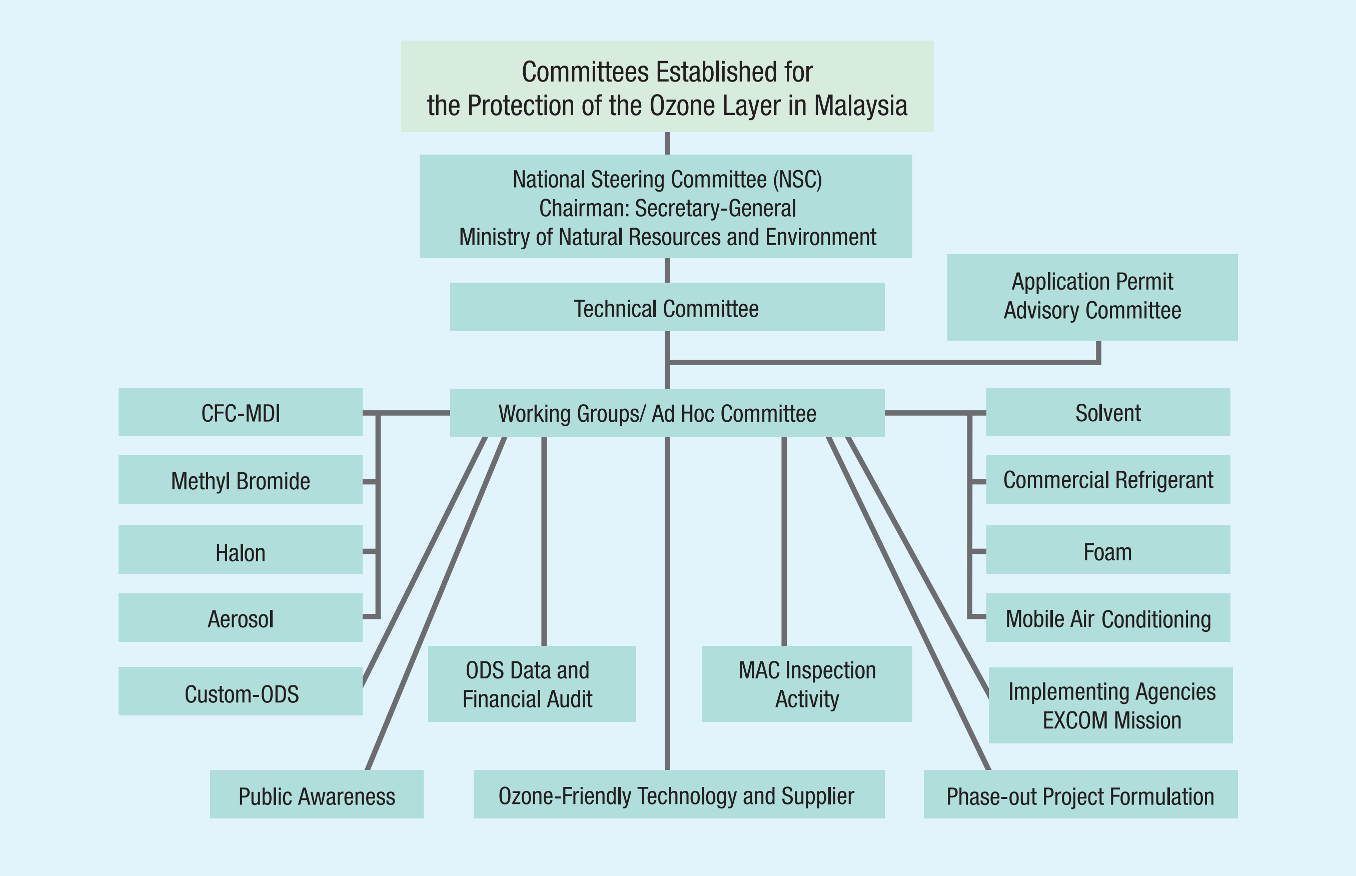
Establishing an Institutional Framework

Aware of the commitment it would be making by becoming a signatory, the Government of Malaysia set up a National Steering Committee (NSC) on the Protection of the Ozone Layer, replacing an Ad Hoc Technical Committee set up in 1986 to consider these issues. In 1989, on the recommendation of the NSC, Malaysia ratified the Vienna Convention and the Montreal Protocol and it has also ratified all subsequent amendments.

The NSC is composed of representatives from various ministries and agencies including the Ministry of Natural Resources and Environment (MNRE), Ministry of International Trade and Industry (MITI), Malaysian Industrial Development Authority (MIDA), and the Customs Department. The NSC comprises a Technical Committee and Industrial Working Groups set up to deal with the main problematic substances such as solvents and aerosols, and with others added later to match the Protocol's amendments (Figure 3).

* UNDP, UNEP, UNIDO, and World Bank (2005), The Montreal Protocol: Partnerships Changing the World.

Figure 3 Committees Established as Part of Malaysia's Institutional Framework for the Protection of the Ozone Layer

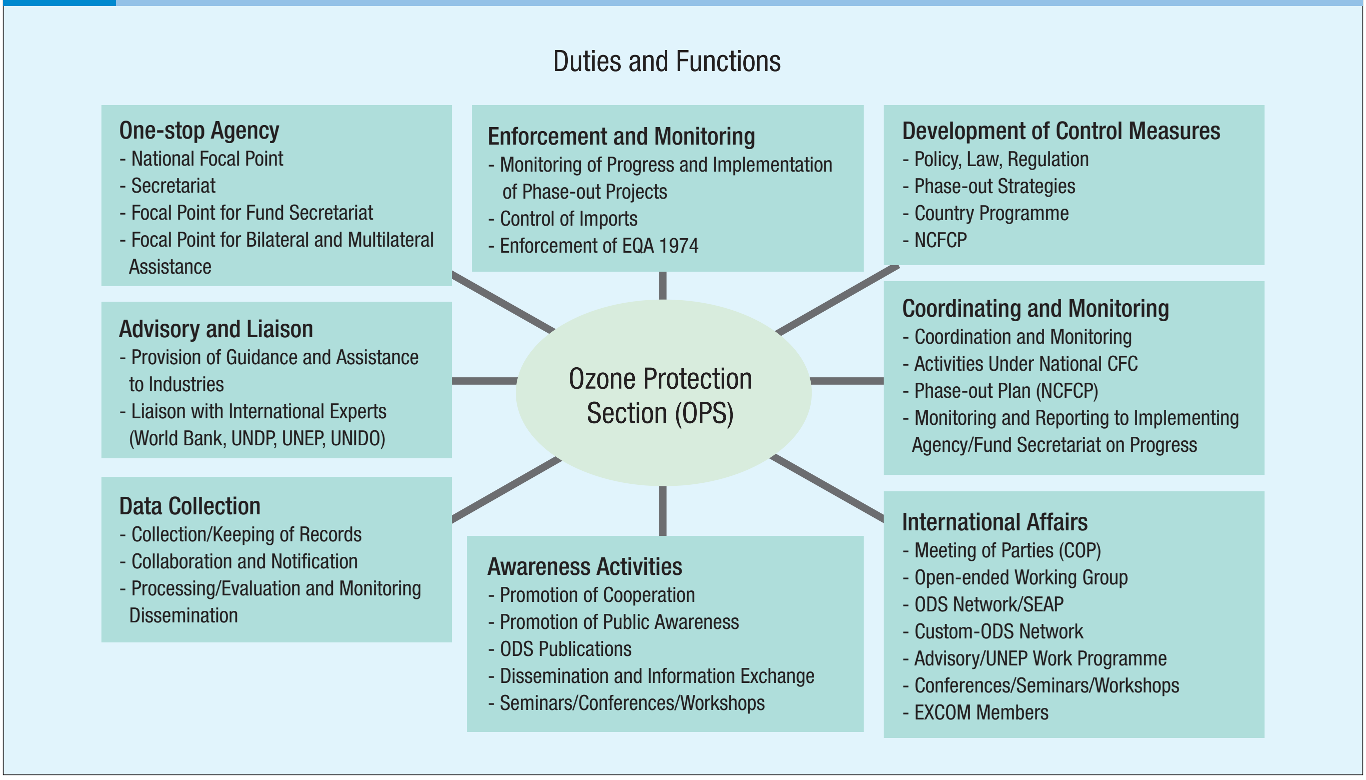


The NSC is responsible for overseeing the National Action Plan on ODS, and the Department of Environment serves as the secretariat to the NSC. An Ozone Protection Unit, established within the Department of Environment in 1996, operates as the project management office monitoring Malaysia's substance phase-out activities. This Unit was renamed 'Ozone Protection Section' in 2003 and a Project Management Unit was set up within the Section in 2004.

Establishment of the Project Management Unit (PMU) within the Department of Environment in conjunction with the OPS has been part of a capacity-building measure to provide resources for promoting awareness of ozone issues and for monitoring and verifying project implementation. In particular, the PMU is responsible for the management of the NCFCP and for related financial recording and auditing.

The Ozone Protection Section (OPS) has eight broad areas of responsibility (Figure 4). These include providing a focal point for obtaining information and assistance; coordinating liaison between institutions offering expertise and the industries affected; collecting and disseminating statistical data;

Figure 4 **The Ozone Protection Section (OPS), Department of Environment**



monitoring the phase-out process and ensuring enforcement; raising industrial and public awareness through conferences, seminars, and workshops; promoting policy and regulations, especially as they relate to phase-out procedures; coordinating, monitoring, and reporting progress under the phase-out plan; and supporting international connections and networks.

Malaysia demonstrated exceptional commitment and leadership in furthering the interests of all Article 5 (developing) countries in the negotiations for the establishment of the Multilateral Fund (MLF) in 1991. As a result of its strong commitment and convictions, Malaysia was one of the first and longest serving developing-country members on the MLF's Executive Committee and in 2006, after a short absence from the Executive Committee, it assumed the position of joint chair.

Integrating stakeholders through creating partnerships with the industrial sector has been a key ingredient in the success of the Malaysian experience of phasing out ozone depleting substances and adopting alternatives. The active involvement of civil society and non-governmental organizations (NGOs) has also contributed significantly to the successful implementation of the plan of action. The Department of Environment has initiated a number of activities during the phase-out process with the industrial working groups, manufacturers, suppliers, and users.

Importation and Consumption of Ozone-Depleting Substances

Over recent decades, as in most countries of the world, Malaysian farmers, industrialists, and the public at large have been enthusiastic users of chemical formulations that have been developed for fumigation, eradication of rodents and pests, and use as refrigerants, aerosol propellants, fire retardants, solvents, and other such purposes. However, as is now well known, many of the substances used for these legitimate practices have been depleting the atmospheric ozone layer and consequently increasing human exposure to damaging ultraviolet radiation.

Malaysia has long been a consumer but not a manufacturer of ozone-depleting substances (ODS) which, until recently, have been imported mainly from the United States, the United Kingdom, Germany, Italy, Greece, and Japan. More recently, ODSs such as CFC-12 have been imported from India and China. With worldwide awareness of the ozone depletion problem and global agreement to implement preventative measure under the provisions of the Montreal Protocol, patterns of consumption have been changing, often in response to goals set under the Protocol for eradication of ODS use and the substitution of more benign products that achieve similar results.

Although the Montreal Protocol lists a substantial number of ODSs that need to be discarded or replaced, many of these are largely confined to developed countries for specialized industrial and other purposes. Others, such as halons used in portable fire extinguishers, were more widespread. Halon portable fire extinguisher manufacture in Malaysia was quickly and easily modified by conversion to dry powder or CO_2 portable fire extinguishers, but disposal of existing halon equipment was more problematic. Generally, however, in Malaysia as in most developing countries, the main ozone-depleting substances in widespread use are CFCs.

Malaysia's imports of CFCs have generally been declining since 1995

Six Programmes Carried Out Under the NCFCP

The NCFCP programmes are as follows:

- CFC free metered-dose inhalers awareness programme for asthma patients promoted by the National Pharmaceutical Control Bureau and supported by the Ministry of Health;
- Customs ODS training programme for customs officers handling the potentially illegal import of CFCs, being offered by the Department of Environment and the Malaysia Customs Academy;
- mobile air conditioning (MAC) vehicle inspection and training manual for officers of the Department of Environment and PUSPAKOM (a private inspection company appointed as a government agency) to monitor and enforce replacement of refrigerant CFCs;
- air conditioning servicing programme and the establishment of certification of service technician training;
- CFC phase-out programme for foam and solvent projects under which all remaining users are required to submit proposals for CFC replacement and applications for financial assistance;
- support for the CFC phase-out programme for the refrigerant service sector by establishing a certification course for service technicians who are refrigerant operators, air conditioning service contractors, and owners of commercial refrigerant operations, and the licensing of authorized training programmes and workshops.

Table 3 **Malaysia's Importation and Consumption of CFCs, 1995–2010 (metric tonnes)**

Year	Actual Imports	Under Montreal Protocol Control	Permit Allocation[1] for NCFCP Commitment	Year	Actual Imports	Under Montreal Protocol Control	Permit Allocation* for NCFCP Commitment
1995	3,442			2003	1,174	3,271	1,566
1996	3,048			2004	1,116	3,271	1,136
1997	3,351			2005	662	1,635	699
1998	2,351			2006		1,635	579
1999	2,040	3,271		2007		491	490
2000	1,651	3,271		2008		491	401
2001	1,538	3,271		2009		491	332
2002	1,606	3,271	1,855	2010		0	0

** Approved Permits for importation.*
Source: Ozone Protection Section, Department of Environment Malaysia, 2003.

(Table 3) although there was a marked upsurge in 1997 in anticipation of the implementation of the Montreal Protocol control in 1999. In the event, actual imports were well within the limits imposed by the Protocol regulations and continued to decline ahead of the maximum allowed. Under the National CFC Phase-Out Plan, fewer approved permits for the importation of CFCs are being granted and will no longer be available from 2010 onwards.

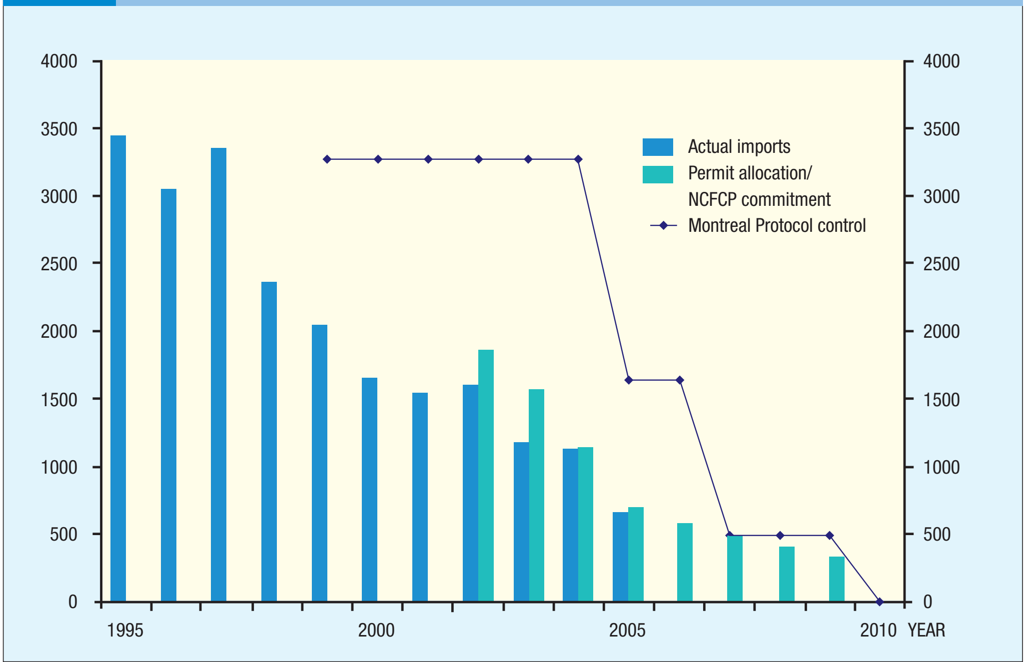
The trend in consumption of imports, the amounts permitted under the Montreal Protocol, and the Malaysian achievement of substantial reductions in CFC consumption ahead of the requirements through to 2007, are depicted in Figure 5. Malaysia is expecting to fulfil its obligations under the Protocol with the final phase-out completed as scheduled in 2010.

Adoption of Control Measures and National Monitoring

Following ratification of the Montreal Protocol, Malaysia implemented the National Action Plan which provided for Phase 1 of the ODS Country Programme to be carried out during the period 1992–2001. Phase 2 is the National CFC Phase-Out Plan (NCFCP) 2002–2010, currently being implemented.

The main objective of the NCFCP is to assist the Government of Malaysia to phase out completely its CFC consumption in accordance with the phase-out schedule of the Montreal Protocol. A total consumption of 2,092 ODP metric tonnes (as of 2000) of chemicals such as CFC-11, CFC-12, CFC-

Figure 5 **Trends in Malaysia's CFC Consumption, 1995–2010 (metric tonnes)**



113, CFC-114, and CFC-115 is being phased out under this programme. In addition, consumption of 331 metric tonnes of 1,1,1-trichloroethane is also being phased out.

To achieve these objectives, the National CFC Phase-out Plan utilizes a combination of policies, regulations, and financial support to subsidize the phase-out cost of the industrial sector; and promote refrigerant recovery/recycling, training and technical assistance activities to minimize and eventually eliminate the import of CFCs. The programme includes a technical assistance component for strengthening capacity of the industry and concerned agencies in order to carry out investment, regulations, and public awareness and participation activities. It also introduces an innovative implementation modality, including a monitoring programme, to ensure the successful and effective implementation of the complete CFC phase-out programme.

Most of the reduction in consumption of CFCs through the 1990s and into the early years of the twenty first century has been achieved in the manufacturing sector with a focus on medium to large enterprises that are readily identified, enabling the country to easily achieve its 2005 consumption target of 1,635 metric tonnes (Figure 5). (The reference to 'manufacturing' in this section is to the consumption of ODSs in the process of manufacturing refrigerators, air conditioners, foam, and other products, and not to the manufacture of ODSs themselves.) The recent economic slowdown that has reportedly caused significant amounts of manufacturing equipment to remain idle may prove to hinder the achievement of subsequent goals.

A further concern experienced by manufacturing was that in the solvent sector there had not been any legislation to control consumption, with the result that demand for CFCs recorded an increase from 1998. While some of this was almost certainly attributable to stockpiling in case regulations changed, it was only with the introduction of legislation that effective control of consumption became feasible.

The challenge, as the NCFCP proceeds, is to phase out the use of CFCs in Small and Medium-Sized Enterprises (SMEs), especially those in the service sector, as the performance in the later stages of the phase-out up to the Montreal Protocol deadline of 2010 largely depends on the impact that can be made in that sector. The most critical component for Malaysia is the demand for CFC-12 to service mobile air conditioners (MACs). A conservative estimate suggests the demand in 2007 could be about 823 ODP metric tonnes, which is almost double the target of 491 metric tonnes that Malaysia is expected to reduce to.

Considering this multifaceted approach, the Malaysian Government is expected to adopt a flexible approach to the implementation of the strategies outlined in the NCFCP, especially in relation to the complex and dynamic nature of SMEs.

The Government of Malaysia has requested financial assistance of US$11,400,380 from the MLF to cover the greater part of the phase-out costs. This amount will be disbursed by the MLF over a period of nine years. With 422 ODP metric tonnes to be phased out from projects already approved and funded by the MLF, this funding request will phase out a further 1,670 ODP metric tonnes (i.e. the total of 2,092 metric tonnes cited above) plus 33 metric tonnes of 1,1,1-trichloroethane. The overall cost effectiveness of the National CFC Phase-Out Plan is US$6.67 per kg ODP.

The strategies adopted for the programmes completed or currently being undertaken include awareness and promotion campaigns; CFC import control through the approved permit system; technical assistance and training; and subsidies and enforcement of regulations for controlling CFCs under the Environment Quality Act.

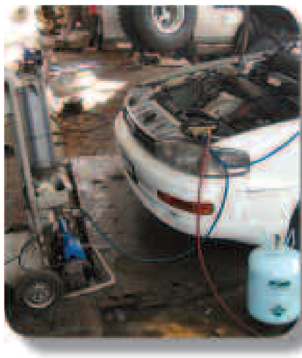
Mobile Air Conditioner (MAC) Refrigerants

- By 1999 all MAC manufacturers in Malaysia had converted to supplying only HFC-134a (also known as R-134a) refrigerant systems to the local vehicle manufacturing industry for installation in new vehicles. These systems, replacing CFC-12 (or R-12), have zero ozone-depleting potential.

- The MAC servicing industry has been the biggest consumer of CFCs through the maintenance of the R-12 MACS installed in vehicles.

- To be certain that the population of CFC-based MACs continues to decline as old vehicles are put out of service, steps had to be taken to ensure that
  - no retrofitting of CFC-free MACs with CFC refrigerant occurred;
  - only CFC-free new MACs are being supplied to the local vehicle manufacturing plants.

- For all vehicles registered from 2005 onwards
  - installation of CFC-12 MAC systems has been banned;
  - inspection of vehicles includes the inspection of the MAC refrigerant being used;
  - owners of vehicles continuing to use CFC refrigerants are liable to be fined.



Phase-Out Experience in Small to Medium-Sized Enterprises (SMEs)

Between 1993 and 2004, a total of 77 SMEs in Malaysia received assistance from the MLF to change their production methods, technology, and equipment, and to learn the requisite skills for operating the new equipment. The enterprises involved were utilizing methods and substances for manufacturing foam, aerosols, solvents, refrigerants, and halons. A sum of over US$20 million was disbursed within this period resulting in the phasing out of 2,357.2 metric tonnes of ODPs from these sources.

Halons

The phase-out of halon fire extinguishers in Malaysia was initiated in 1990 by the Fire Services Department and the Department of Environment. Conversion of the manufacturing facilities from halon portable fire extinguishers to dry (ABC class) powder or CO_2 portable fire extinguishers was completed in 1996 when the last company involved, producing about 56,000 extinguishers per year, finally made the changeover.

Chlorofluorocarbons (CFCs)

Most of the following SME projects were initiated in the mid-to-late 1990s and, following formal proposals, consultation with the companies concerned, and granting of the requisite funds for implementation, have been carried out over a period of 3–4 years up to 2004.

Adoption of Alternative Technologies

Considerable care has been exercised in the selection of alternative technologies that have consistently been based on the following considerations:

- proven and reasonably mature technology;
- cost-effective conversion;
- local availability of substitutes;
- support from local systems suppliers;
- maintenance of critical properties in the end product;
- enforcement of stablished standards on environment and safety.

SME Project Phasing Out Residual Aerosol CFCs

This project finally eliminated the use of a residual 250 metric tonnes of aerosol CFCs through conversion to hydrocarbon aerosol-filling technology, completing the ODS phase-out for the entire aerosol sector in Malaysia. The project inputs included provision of filling equipment, fire protection, gas detection systems, civil works, and technical assistance.

The project was carried out on a group implementation basis. Eight small enterprises underwent individual plant conversion as they were not capable of offering central filler facilities for other users. Another company was also converted as a stand-alone entity as it was the sole remaining insecticide aerosol manufacturer and, because of the risk of product contamination, was considered unsuitable to provide a centralized filler facility. Eight enterprises agreed to convert to non-CFC aerosol filling and to act as contract central filler agencies.

An MLF funding grant of US$1,486,660 was allocated for this project, with enterprises that agreed to offer a contract filler facility receiving a greater subsidy than the stand-alone enterprises. The funding provided for technical assistance to implement, coordinate, and oversee the project in consultation with the Department of Environment and UNDP.

SME Projects Phasing Out Foam CFCs

A shift in technology has been widespread throughout the SMEs involved in the Malaysian foam manufacturing industry. The MLF provided funding for both of the conversions outlined in the following case studies through UNDP with the Department of Environment Malaysia as the national implementation agency on behalf of the government of Malaysia.

Case Study 1: Unique Field

Unique Field Sdn Bhd is a one hundred per cent Malaysian-owned enterprise. Founded in 1981, it is located in Seremban, Negeri Sembilan, and operates two production plants that function as an integrated entity. The objective of this project was to phase out the use of CFCs in the manufacture of flexible moulded polyurethane foam for interior trim parts used in the transportation industry. These included motorcycle seats, truck and automotive back cushions (comprising 70 per cent of production), and headrests and seat cushions (30 per cent). All production is for domestic consumption.

In 1998, the company was using 18.5 metric tonnes of CFC-11 annually for its manufacturing operations. The alternative technology chosen was direct-injection Liquid Carbon Dioxide (LCD), a non-ODP solution for the lower-density foams, and a water-based technology for high-density foams. The project required the replacement of some types of equipment. The funding covered the cost of trials, technology transfer and training, contingencies, and incremental operating expenses for two years.

The changeover to LCD technology for the lower-density foam incurred lower incremental costs as a consequence of the conversion, whereas the conversion to water-blown technology for the higher–density foam increased operating costs. However, overall the change resulted in a net incremental operating benefit.

In this instance the MLF funding grant amounted to US$109,990 administered through UNDP.

Case Study 2: Syarikat Heng Huat

Syarikat Heng Huat is a one hundred per cent Malaysian-owned enterprise established in 1991, located in Seberang Perai, Penang. The objective of this project was to phase out the use of CFC-11 in flexible polyurethane box foam and flexible moulded polyurethane foam applications such as mattresses, pillows, and cushions. Production is split evenly between the high resilience flexible moulded foam (slab stock) and the flexible box foam which is produced in seven different formulations.

Substitution of methylene chloride has long been the standard replacement technology for CFCs in the manufacture of flexible polyurethane slab stock/box foam. Its utilization has, however, been limited by regulatory restrictions based on its toxic character and consequential processing problems when used in large quantities. Introduction of further restrictions on methylene chloride and permissible concentrations in the workplace led to an active search for an alternative.

Under this project, Syarikat Heng Huat eliminated the annual average use of 46.2 metric tonnes of CFC-11 and the need to use methylene chloride by substituting Low Index Additive (LIA) technology for the box foam and LCD technology for the flexible moulded foam/slab stock. The interim solution using HCFC-141b, while technically feasible, was not adopted owing to the availability and demonstrated reliability of these other permanent solutions.

In this instance, the MLF funding grant amounted to US$272,235, administered through UNDP.

SME Projects Phasing Out Refrigerant CFCs

Case Study 3: Phasing Out CFC-11 and CFC-12 in Eleven SMEs

The location of Malaysia in the humid tropics necessitates widespread, efficient and reliable cooling and freezing facilities in both domestic and commercial contexts. Conversion of the CFC-reliant technologies used in manufacturing for this market has therefore been a priority, particularly amongst SMEs that are less likely than large companies to be aware of the issues or adequately resourced to make this transition without assistance from independent sources.

This project involved eleven SMEs engaged in the manufacture of commercial refrigeration equipment of various sizes and uses such as chest freezers, display cabinets, bottle coolers, and the like. The companies are located in a number of towns scattered throughout Peninsular Malaysia.

All are well established, financially viable enterprises, and 100 per cent Malaysian owned. Each employs between 10 and 35 workers and production is wholly for the domestic market.

At the time the project was launched, these companies had a combined annual production of approximately 34,250 refrigeration units. The production of these units consumed a total of 52.54 metric tonnes of CFC-11, used to produce foam for refrigerator/freezer cabinet linings, and 16.16 metric tonnes of CFC-12 that constitutes the refrigerant injected into hermetic compressors.

For the foam operation, polyurethane chemicals were imported, the CFC-11 was premixed with polyol (a chemical compound used for custom-made rigid polyurethane systems with applications for insulation) minimizing evaporation, and the foam chemicals were mixed manually to produce a moulded foam density of about 32–36 kg per cubic metre. The eleven enterprises all used CFC-12 in a range of brands of imported hermetic compressors.

These SMEs all phased out the use of CFC-11 and CFC-12 in their manufacture of commercial refrigeration equipment by converting the foam operations from CFC-11 to HCFC-141b based systems (as an interim conversion with the expectation of a further future conversion to a totally CFC-free technology) and the refrigerant operations from CFC-12 to HFC-134a.

The HCFC-141b technology was adopted, despite HCFC-141b being an ozone-depleting substance, because it was an improvement on the higher level of depletion of CFCs. The only zero-ODP technology alternatives available for the foam operations were hydrocarbon-based systems. Because the SMEs concerned are all located in congested industrial or commercial localities, the implementation of the requisite elaborate monitoring, safety, and fire mitigation systems to counter the fire and explosion hazards associated with the use of hydrocarbons was not practicable in their current locations.

The changes that were implemented generated significant impacts on both the plant and the processes involved so that much of the consequential cost was directed at factory modification as well as the purchase of new equipment and components. Of the total project cost of about US$1.1 million, over $960,000 was provided as a grant by the MLF to enable the transitional modifications to be made.

As in the case studies of foam manufacturers, the MLF funding for these conversions was administered through UNDP, with the Malaysian Department of Environment as the national implementation agency on behalf of the Government of Malaysia.

Table 4 **Malaysia's Importation and Consumption of Methyl Bromide, 1990–2005 (metric tonnes)**

Year	Imports and Consumption	Year	Imports and Consumption
1990	24	1998	61
1991	34	1999	93
1992	52	2000	101
1993	58	2001	120
1994	63	2002	182
1995	56	2003	166
1996	42	2004	184
1997	46	2005	270

Source: updated from Pesticides Board, Malaysian Department of Agriculture, cited in Ridzuan and Khairun, 2006.

Methyl Bromide

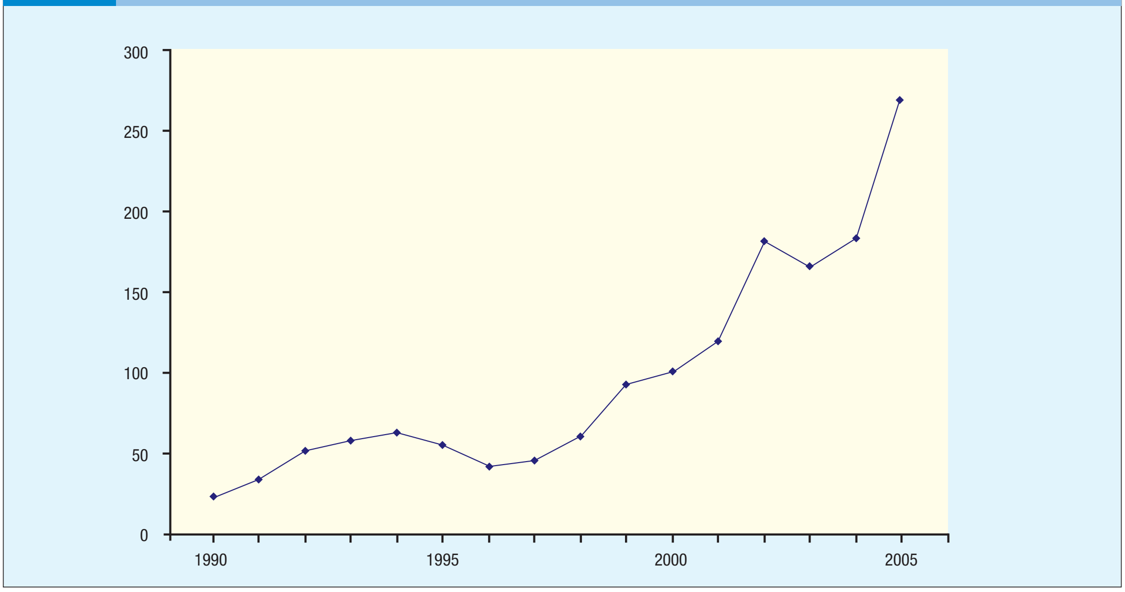
Methyl bromide is a broad-spectrum pesticide that has been commercially used for more than 50 years to control a wide spectrum of pests including fungi, bacteria, soil-borne viruses, insects, mites, nematodes and rodents. Its characteristics as a fumigant also mean that it is versatile, penetrative, and convenient for reaching relatively inaccessible storage locations in buildings and vehicles. The treatment period, including ventilation and aeration, can vary from 2–3 hours to 4 days depending on the targeted pests, the concentrations required for efficacy, and various specifications and regulations. Its damaging effect on the Earth's ozone layer was recognized only at the beginning of the 1990s.

Methyl bromide was the last substance but one to be added to the initial list for which production and consumption are regulated under the Montreal Protocol. Methyl bromide was first included in the schedule of ODSs in the Protocol via the Copenhagen Amendment 1992. At a subsequent meeting

in Montreal, control measures for methyl bromide were established for Article 5 countries. These controls required developing countries to freeze production and consumption in 2002 at 1995–8 levels, with a 20 per cent reduction by 2005 and total phase-out by 2015 (Table 2).

Malaysia does not produce any methyl bromide itself but imports its requirements mainly from Belgium and China. The importation of all pesticides in Malaysia is regulated under the Pesticides Act 1974 as amended in 2004, and monitoring of

Figure 6 **Malaysia's Importation and Consumption of Methyl Bromide, 1990–2005 (metric tones)**



Source: Updated from Pesticides Board, Malaysian Department of Agriculture, cited in Ridzuan and Khairun, 2006.

this particular substance is relatively straightforward since only two importers of methyl bromide are registered under the Pesticides Act.

Malaysia recorded an increase in the use of methyl bromide from 1990 to 1994 but then experienced a reduction through 1995 to a mere 42 metric tonnes in 1996. However, this modest level was followed by a steep increase to 2002, and a further large increase to 270 metric tonnes in 2005 (Table 4).

The substantial increase in Malaysia's importation and consumption of methyl bromide over the period of just 10 years from 1996 to 2005 is dramatically illustrated in Figure 6.

QPS and Non-QPS Uses

Exemptions for 'critical use' are under consideration for non-Article 5 (i.e. industrialized) countries, but would not apply to Article 5 (i.e. developing) countries until their total phase-out date. The 'critical use' exemption is granted only where no viable, proven alternative is available. Quarantine and pre-shipment (QPS) uses of methyl bromide are currently exempt from these controls to allow fumigation of pests not present in a destination country and to meet phytosanitary regulations before (pre-shipment) or after (quarantine) delivery. QPS uses are estimated to constitute about 22 per cent of global methyl bromide use.

As noted above, the four years 1995–8 were critical for Malaysia (and other developing countries) in determining the benchmark against which usage from 2002 to 2004 would be set, with a 20 per cent reduction by 2005 (and total phase-out by 2015). In those years Malaysia used only 205 metric tonnes of methyl bromide, an

Table 5 **Uses of Methyl Bromide in Malaysia, 2002–2005**

Quarantine and Pre-Shipment	Year (per cent)			
Types of Commodities Treated	**2002**	**2003**	**2004**	**2005**
Timber and timber products	40.9	45.4	37.9	25.7
Grain (rice, wheat, maize)	4.5	4.0	1.0	2.0
Animal feed	0.3	0.6	0.2	–
Growing media (vermiculite, compost, cocoa peat)	1.9	1.3	0.9	0.6
Equipment and shipping containers	38.7	33.9	35.2	22.1
Gunny sack	0.4	0.2	0.1	–
Pallet and crate (wood packaging material)	3.3	6.6	14.2	38.0
Fruit for export	–	–	1.8	–
Imported				
– fruit and vegetables				0.7
– bulbs, corms, tubers, and rhizomes				0.4
– seeds				0.5
– nursery stock				1.1
– dried foodstuffs				2.1
Total Quarantine and Pre-Shipment (QPS) (per cent)	90.0	92.0	91.3	93.2
Non-Quarantine and Pre-Shipment (non-QPS) (per cent)	10.0	8.0	8.7	6.8
Total Methyl Bromide used (metric tonnes)	182	166	184	270

Source: Pesticides Board, Malaysian Department of Agriculture.

average of 51.25 metric tonnes a year. However, since QPS uses are exempt from these restrictions, most of the escalation in use was unaffected by the Montreal Protocol controls on methyl bromide. Total usage and specific QPS applications of methyl bromide from 2002 (the year in which the restrictions were implemented) to 2005 under the super-vision of the Plant Quarantine Authority are listed in Table 5.

As Table 5 demonstrates, non-QPS uses (those subject to the controls) were only 10 per cent of the total usage in 2002 and comprised less than that percentage share of total use in the following years. The actual amounts being used are relatively small and far less than the permissible levels under the Montreal Protocol controls as shown in Table 6.

The strategies being adopted in Malaysia for risk reduction from methyl bromide use involve the Department of Agriculture, other government departments, research institutions and other agencies utilizing both legislative and non-legislative measures.

Presently, there are two laws in operation in the country for the control of metyl bromide. The Pesticide Act 1974, which is implemented by the Department of Agriculture, is the main Act that controls importation of methyl bromide and the Hydrogen Cyanide (fumigation) Ordinance 1953 which controls the fumugation of premises including ships (the license is

Table 6 Non-Quarantine and Pre-Shipment (non-QPS) Use of Methyl Bromide in Malaysia, 2002–2005

Types of Use and Permissible Usage	Year (metric tonnes)			
	2002	2003	2004	2005
Non-Quarantine and Pre-Shipment (non-QPS) use	18.24	13.31	16.70	18.06
Permissible non-QPS use (1995–8 average and 20% reduction, i.e. 11.68 metric tonnes, by 2005)	24.3	24.3	24.3	19.4

Source: Pesticides Board, Malaysian Department of Agriculture.

Table 7 Examples of Alternatives to the Use of Methyl Bromide

Crops and Commodities	Alternative Processes and Procedures
CROPS	
Crops	Alternative farming methods with broad applicability to horticultural production includes organic farming, hydroponics, and fertigation (the application of nutrients through irrigation systems), especially in the production of vegetables
Tobacco	Establishing tobacco plant seedlings using a soil-less plant technology at the nursery stage has been widely achieved using a float system. Most growers have already adopted alternative control methods to replace the use of methyl bromide for fumigating the soil.
Cut flowers	For floriculture, Basamid Granular soil fumigant is activated by contact with moisture. The active ingredient is transformed into a gas that possesses broad-spectrum soil sterilizing properties against undesirable soil organisms.
DURABLE COMMODITIES	
Stored Products	For stored durable commodities, phosphine is an effective fumigant commonly distributed in pellet and sachet forms and readily available in Malaysia.
Timber	The main potential alternatives to methyl bromide for timber treatment are phosphine and heat treatment.

issued by the Ministry of Health).

For example, UNDP is assisting the Malaysian Government in implementing two projects to phase out all remaining uses of methyl bromide in timber, turf nurseries, and golf-course maintenance. The projects aim to identify potential alternatives to methyl bromide and to develop protocols for their safe use. Looking to the longer term, a phase-out strategy is also being developed for non-QPS uses involving the development of a legal framework and identification of alternative measures that will be effective for fumigation and pest-control purposes (Table 7).

The key to identifying alternatives is to focus on the pests that methyl bromide is being used to control and then to identify equally effective substances or measures to replace it.

ISSUES AND CHALLENGES IN IMPLEMENTING THE MONTREAL PROTOCOL

Difficulties with Halon Phase-Out Projects

While modifications to the production technology in the manufacturing sector proceeded relatively expeditiously, the disposal of existing equipment has proved much more problematic. A recovery and recycling project was approved early in 1992 and implemented by the World Bank. A programme initially introduced to address the serious problem of phase-out and disposal of more than one million fire extinguishers with 2,000–3,000 metric tonnes of halon-1211 was subsequently expanded to include halon-1301 disposal as well. Problems ensued with accumulation of extinguishers at fire stations, leaking of discarded appliances, and breakdown of recovery and storage equipment.

Malaysia has until the beginning of 2010 to complete the phase-out of all halon appliances but achieving this schedule will depend on the efficiency of the recovery and recycling equipment, capacity of holding tanks, recycling capabilities, and availability of the necessary technical backup.

Benefits and Advantages of Adoption of Non-Ozone-Depleting Substances

- Quality of products and services has improved.
- Better technologies and methods of production have been introduced.
- Consultants have
  - recommended more efficient methods of production;
  - provided training on the use of new equipment.
- Book value of a company's assets has increased as old equipment has been replaced.
- Public awareness of ODP has been raised and evidence provided in the local market of environmentally friendly practices through
  - CFC-free labelling;
  - accreditation by Standard and Industrial Research Institute of Malaysia (SIRIM) of company use of eco-friendly CFC-free products in the manufacture of goods.

Monitoring Disposal of Redundant and Phased-Out Substances and Equipment

There are difficult issues facing all developing countries as they attempt to meet the schedule of the Montreal Protocol phase-out requirements. Limited allocation of scarce resources for implementation of the phase-out process makes efficient monitoring and enforcement difficult. Generally, the manufacturing sector is relatively easy to regulate and oversee, partly because numbers of manufacturers are not large, but also because factories are readily identifiable and direct imports of equipment and chemicals can be tracked.

Monitoring and enforcement among consumers and the servicing sector, and supervision of recovery and recycling activities are more problematic. Hoarding to postpone the switch to alternative technologies; banking of redundant chemicals; and difficulties in decontaminating, recycling, and otherwise disposing of obsolescent equipment all represent recurrent problems for Malaysia and other countries in the region.

Consolidating Structures and Achievements

Malaysia has not only played an active role within the UNEP and MLF, participating in the MLF's Executive Committee to safeguard and promote the interests of Article 5 (developing) countries, but also contributed to networking on ozone protection in the region particularly through the South-East Asia and Pacific (SEAP) Network. At a Network meeting in October 2006, the group identified challenges still ahead for countries in the region and these are outlined in the following sections. Since progress to date varies significantly between countries, applicability in detail may also vary, but the fundamental principles and overall aims are relevant region-wide.

Efficacy of Recovery and Recycling Procedures

- Recover and recycle ODS waste, including obsolescent equipment, appropriately and efficiently:
  - prevent indiscriminate dumping of old CFC-based equipment;
  - provide appropriate procedures for handling and disposing of any contaminant and unused ODSs;
  - provide appropriate procedures for the disposal of old equipment and spare parts.
- Prevent illegal trade in ODSs:
  - follow the Prior Informal Consent (PIC) procedure for any legal trade in hazardous industrial chemical and hazardous pesticides.

Sustainability of Structure

- Mainstream the Montreal Protocol implementation procedures into government institutions:
  - seek government funding of the National Ozone Unit (in Malaysia, the Ozone Protection Section) without continued support from the MLF or other external agencies;
  - expand resources for enforcement of ODS regulations at local/state level;
  - strengthen regional cooperation through improved networking.
- Maintain annual data collection, analysis, and reporting.
- Deploy National Ozone Unit (Ozone Protection Section) resources to support implementation of other Multilateral Environmental Agreements (MEAs).
- Raise public awareness of issues.
- Publicize updates of ozone science and research.
- Include ozone science in education curricula.

Sustainability of Achievements

- Manage sector servicing remaining CFC-based equipment:
  - maintain industry/product standards in monitoring and surveillance of non-CFC usage in motor vehicles and related products;
  - identify and recommend alternative refrigerants with minimal environmental impact.
- Achieve comprehensive monitoring and enforcement of regulations:
  - enhance performance and monitoring of effectiveness of national policy to comply with global obligations;
  - improve monitoring of equipment and labelling of refrigerants and prevent export of discontinued ODSs;
  - strengthen legal enforcement framework to control mislabelling, dumping, and trading in prohibited goods;
  - strengthen institutional enforcement by local government inspectors, police, the judiciary, and the prosecution.

While acknowledging the desirability of achieving all these objectives in an efficient and timely way, all countries in the SEAP Network suffer from a severe shortage of resources, including personnel, devoted to this task. National Ozone Units are severely understaffed and in most instances have no scientific or technical support at all. The consequence of this is that a few administrators are responsible for identifying local issues like banking and hoarding, dumping and trading, recovery and recycling, regulation and enforcement, raising awareness and offering professional advice—without adequate professional, technical or legal back-up. The clear implication is that capacity building should be high on the list of priorities in each of these countries, many of which otherwise have the institutional structure in place, to fulfil the wide range of roles and responsibilities that the regulatory provisions require.

Capacity Building

The MLF supports the provision of funding to developing countries specifically to strengthen partner institutions as part of the process of implementing the Montreal Protocol. Funding is provided through the supporting agencies (UNEP, UNDP, UNIDO, and WB) to support the institutions created to phase out ODSs. Capacity building also extends to the enterprise level through technical assistance aimed at introducing new processes, improving the quality of manufactured products, or implementing best practices.

Capacity building allows governments to implement the following

- permits for production, import or export of ODSs;
- bans or controls on use of ODSs;
- certification of technicians qualified to use or recycle ODSs;
- economic incentives, taxes, and fees to encourage reductions in ODSs;
- procurement preferences for products free of ODSs, especially by government agencies and the military;
- mobilization of industry through workshops, networking, working groups, sectoral associations, and company pledges;
- campaigns to raise public awareness through advertising and other promotional campaigns;
- labelling requirements empowering consumers to make appropriate choices;
- support for research and development into and approval of alternatives to ODSs;
- promotion of new standards to limit use of ODSs;
- revisions to health and safety regulations;
- creation of ‘banks’ of controlled substances from which industry can draw its quotas
- provision of professional advice and enforcement of regulations.

SAFEGUARDING THE OZONE LAYER AND THE GLOBAL CLIMATE SYSTEM

In a report by the Intergovernmental Panel on Climate Change (IPCC), in collaboration with the Technology and Economic Assessment Panel (TEAP), it was noted that emissions of CFCs and their replacements are being reduced successfully and that they can be further minimized by:

- improving the containment of chemicals to prevent leaks, evaporation, and emissions of unintended by-products;
- reducing the amounts needed in any particular type of equipment;
- promoting more end-of-life recovery, recycling, and destruction of substances;
- increasing the use of ammonia and other alternative substances with a lower or zero global warming potential;
- using various emerging technologies that avoid gases that deplete the ozone or contribute to climate change.

Ozone Depletion and Global Warming

Although climate change and ozone depletion are essentially different issues, the widespread human use of certain chemicals links them together. Ozone depletion is primarily due to a release of gases that catalytically destroy the ozone whereas global warming is due to a build-up of gases that absorb outgoing infrared radiation, especially CO_2. It is therefore essential that there should be continuous monitoring, research and improved management of this group of extremely useful substances that are implicated in two of the major environmental issues of the early twenty first century.

Consequently, after 20 years of protecting the ozone layer with a new generation of chemicals, governments have been confronted by the fact that these ozone-friendly substitutes for CFCs are also greenhouse gases that contribute to global warming.

Phasing Out Transitional Alternatives to Ozone Depleting Substances

As CFCs, halons, and other destructive chemicals are phased out under the Montreal Protocol, the world's governments are replacing them with alternative substances less damaging to the ozone layer. Because hydrofluorocarbons (HFCs) and perfluoro-carbons (PFCs) contain no chlorine or bromine (the main ozone-depleting substances), they have been among the alternatives considered for the long term. However, like the CFCs themselves, some of these substitutes such as hydrochlorofluorocarbons (HCFCs), HFCs and PFCs are also powerful greenhouse gases and must therefore eventually be phased out under the Montreal Protocol.

Intergovernmental Panel on Climate Change

Recognizing the problem of potential global climate change, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) established the Intergovernmental Panel on Climate Change (IPCC) in 1988. It is open to all members of the United Nations and WMO.

The role of the IPCC is to assess on a comprehensive, objective, open, and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific evidence of risk of human-induced climate change, its potential impacts, and options for adaptation and mitigation.

The main activity of the IPCC is to provide at regular intervals an assessment of the state of knowledge on climate change. The IPCC also prepares for members special reports and technical papers based on the published scientific literature, and supports the United Nations Framework Convention on Climate Change through its work on methodologies for National Greenhouse Gas Inventories. The IPCC's Fourth Assessment Report is scheduled for release in 2007.

The Scientific Situation in 2006

Our basic understanding that anthropogenic ozone-depleting substances have been the principal cause of ozone depletion over the past decades has been strengthened. The following data indicate that the Montreal Protocol is working:

- There is clear evidence of a decrease in the atmospheric burden of ozone-depleting substances and some early signs of stratospheric recovery.
- Ozone-depleting substances are clearly decreasing in the lower atmosphere.
- Equivalent effective stratospheric chlorine has also started to decrease.
- The depletion of the global ozone layer has not worsened.
- UV radiation has decreased since the late 1990s in accordance with ozone increases at those sites.

The unusually small 2002 Antarctic ozone hole was characterized by a smaller area and higher ozone levels than observed during the past decade. This was due to major stratospheric sudden warming and not to changes in ozone-depleting gases; the 2003 and 2005 ozone holes still exhibited severe depletions.

Bromine is now estimated to be approximately 60 times as effective as chlorine in global ozone depletion, on a per-atom basis. This value is larger than the effectiveness of 45 used in the 2002 assessment and increases the effectiveness of the Ozone Depletion Potential of bromine-containing compounds.

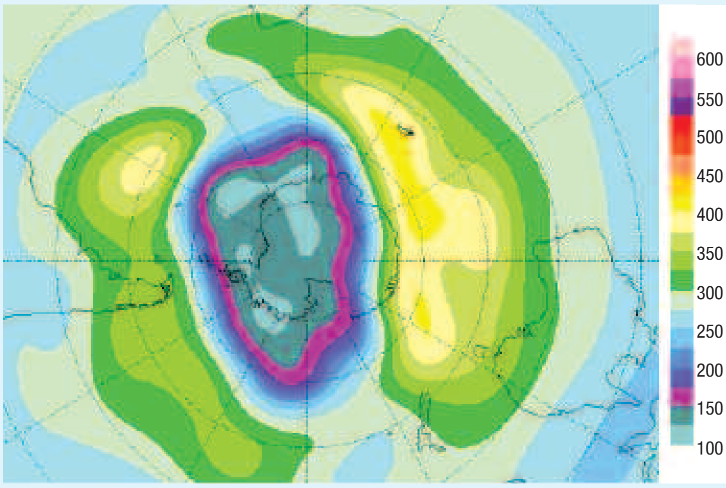
Long-term recovery of the ozone layer from the effects of ozone-depleting substances is expected to span much of the twenty first century, and is now estimated to occur later than projected in the 2002 assessment. The date when equivalent effective stratospheric chlorine at mid-latitudes returns to pre-1980 levels is now calculated to be 2049 or about 5 years later than projected in the 2002 assessment.

The return to pre-1980 conditions of equivalent effective stratospheric chlorine for the Antarctic vortex is projected to occur around 2065, more than 15 years later than the return of mid-latitude equivalent effective stratospheric chlorine to pre-1980

Contribution of Ozone-Depleting Substances to Global Warming

In 2005, it was estimated that the contribution currently made to global warming by CFCs, their replacements, and other ozone-depleting substances was about 10 per cent of the contribution from fossil-fuel-related carbon dioxide emissions, or about 5 per cent of humanity's total greenhouse gas emissions.

Figure 7 **The Ozone Hole, September 2006, Dobson Units**



Source: www.theozonehole.com/ozonehole.2006 levels. Potential options for accelerating the recovery of the ozone layer have been identified and evaluated, and upper limits established for achievable improvements if:

- global anthropogenic production of ozone-depleting substances were to stop after 2006;
- emissions were eliminated from existing banks at the end of 2006; or
- global anthropogenic emissions of ozone-depleting substances were to stop after 2006.

Some options show greater effectiveness for accelerating recovery of the ozone layer than in previous assessments. Failure to comply with the Montreal Protocol would delay, or could even prevent, recovery of the ozone layer.

The role of very short-lived halogenated substances in stratospheric depletion is now believed to be of greater importance than previously assessed. Understanding the interconnections between ozone depletion and climate change is crucial for projections of future ozone abundance.

The above information is drawn from the 'Scientific Assessment of Ozone Depletion 2006', Executive Summary, prepared by the Scientific Assessment Panel of the Montreal Protocol on Substances That Deplete the Ozone Layer and released by the World Meteorological Organization and United Nations Environment Programme, August 2006.

Short-Term: 2007–2010

Servicing Sector

- Minimize risks of alternative refrigerants contaminating refrigeration and air conditioning equipment.
- Improve servicing practices by introducing labelling requirements, certification, and dissemination of information.
- Sustain the recovery and recycling programme for unwanted ODSs and ODS-containing equipment.

Methyl Bromide

- Implement a licensing system to control importation of methyl bromide.
- Track and monitor sale and use of methyl bromide to prevent QPS imports being diverted to non-QPS uses.
- Establish an effective research and development facility to develop
  - alternatives for both QPS and non-QPS applications;
  - training programmes in effective fumigation methods (e.g. using phosphine) for control of pests;
  - cost-effective heat treatment to meet the phytosanitary requirements of

ISPM-15 (a stipulated international standard for export of timber packing, pallets, etc.).

Metered-Dose Inhalers

- Develop a transition strategy for patients.
- Raise awareness of the issue with doctors, pharmacies, and other stakeholders.

Long-Term: Post–2010

Disposal of Waste

- Prevent dumping of old CFC-based equipment.
- Prevent illegal trade in ODS.
- Facilitate disposal of old equipment and spare parts.
- Provide for and coordinate contaminant and unused ODS disposal.

Post-2010 Obligations

- Sustain 20 per cent reduction in methyl bromide and achieve complete phase-out by 2015:
  - address possibility of controlling QPS usage;
  - find optimal alternatives for both QPS and non-QPS applications.
- Achieve HCFC freeze commencing in 2016.
- Formulate subsequent HCFC phase-out strategy.

The Kyoto Protocol

Because of their implications for global warming, governments included HFCs and PFCs in the 1992 United Nations Framework Convention for Climate Change and in its 1997 Kyoto Protocol (activated in 2005), under which developed countries are to reduce their collective emissions of six specified greenhouse gases by the period 2008–12 (Figure 6).

Although the provisions of the Kyoto Protocol relate mainly to developed countries, most members of the United Nations have signed and ratified the treaty. The two major exceptions are the United States and Australia, which have both signed but not ratified the treaty.

While there is widespread agreement that global warming is occurring, there is less consensus on either the role of human intervention in climate change or what measures, if any, should be taken to ameliorate change. This variation in viewpoint and indecision over appropriate action result partly because scientific knowledge of climate change is far from complete, and also because interpretations of the available data are contradictory.

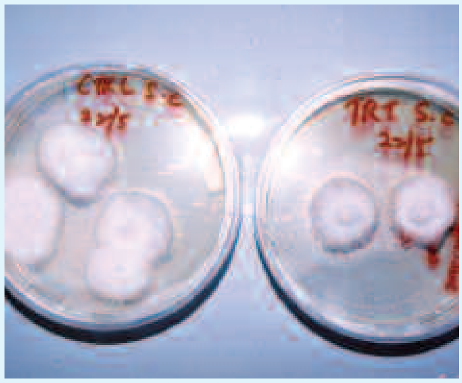
Furthermore, the high cost of under-taking effective measures to lower carbon emissions is often cited as an overwhelming objection to implementing official measures. This argument suggests that unfavourable economic repercussions would be evidenced in such negative impacts as increased unemployment and unacceptable price increases for consumers. In a major report commissioned by the British Government, *The Stern Review: The Economics of Climate Change* (initially released in October 2006), it was argued that postponement of appropriate measures to combat the causes of climate change would result in irreversible damage and in direct and indirect costs many times greater than the still daunting cost of immediate intervention.

Figure 8 **Greenhouse Gases Identified by the Kyoto Protocol**

The six greenhouse gases specified in the Kyoto Protocol for emission reduction are as follows:

Carbon dioxide (CO_2)
Carbon dioxide comes from the decay of materials, respiration of plant and animal life, volcanic and thermal venting, and the natural and human-induced combustion of materials and fuels. It is removed from the atmosphere through photosynthesis and ocean absorption.

Methane (CH_4)
Methane is a more effective heat-trapping gas. It comes from the decay of matter without the presence of oxygen. Primary sources include wetlands, *padi* fields, animal digestive processes, fossil fuel extraction, and decaying garbage.



Nitrous oxide (N_2O)
Soils and oceans are the primary natural source of nitrous oxide. Humans contribute through soil cultivation and use of nitrogenous fertilizers, nylon production, and the burning of organic material and fossil fuels.

Hydrofluorocarbons (HFCs) and Perfluorocarbons (PFCs)
These gases, collectively known as halocarbons, are human-produced chemical compounds containing members of the halogen family (bromine, chlorine, and fluorine) and carbon. They are some of the most effective heat-trapping greenhouse gases of all, but most of them are already regulated under the Montreal Protocol. These newer gases are regulated under the Kyoto Protocol because although they are ozone-friendly, they are greenhouse-unfriendly.

Sulphur hexafluoride (SF_6)
Sulphur hexafluoride is emitted by the electric power industry in circuit breakers, gas-insulated substations, and switchgear. The electricity industry uses a significant percentage of the 6,500–7,500 metric tonnes produced worldwide each year.

Approximately 25 other gases, such as chloroform and carbon monoxide, qualify as climate-changing greenhouse gases, but only the six listed are released in sufficient quantities to justify regulation under the Kyoto Protocol. Water vapour is a very important greenhouse gas, but is not controllable by human intervention.

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