"Universal participation : Ozone protection unifies the world"

THE MONTREAL PROTOCOL
INDIA'S SUCCESS STORY

सत्यमेव जयते

Ozone Cell

Ministry of Environment and Forests

Government of India

New Delhi, India

2009

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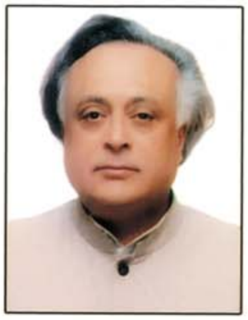
जयराम रमेश
JAIRAM RAMESH



राज्य मंत्री (स्वतंत्र प्रभार)
पर्यावरण एवं वन
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NEW DELHI - 110 003

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FOREWORD

The Montreal Protocol on Substances that Deplete the Ozone Layer has since been recognized as an extraordinary environmental success in global cooperation to protect the ozone layer. The Montreal Protocol has completed more than 20 years of its progress.

India being a Party to the Montreal Protocol and all its amendments has been successfully implementing the Country Programme since 1993 with the help of financial support received from the Multilateral Fund and well-established regulatory and fiscal measures. As a result, we have been able to fulfill our commitments to the Protocol.

India took a proactive step in the beginning of 2008 to accelerate the phase-out of Chlorofloro Carbons (CFCs) by 1st August, 2008, 17 months ahead of schedule. However, keeping in view the health requirements of the citizens of India, CFC use for Metered Dose Inhaler (MDI) will be allowed until 31st December, 2009. Further, a National Strategy for Transition to Non-CFC MDIs and Plan for Phase-out of CFCs in the Manufacturing of Pharmaceutical MDIs in India is also being implemented.

Based on the decision taken at 19th Meeting of the Parties (MOP) to the Montreal Protocol in 2007 to advance the phase-out of HCFCs from 2040 to 2030, a comprehensive Road Map describing the long term vision and action plan for phasing out of production and consumption of HCFCs in India has been developed.

On the occasion of the 15th International Day for Preservation of the Ozone Layer, we reiterate our commitments to protect the ozone layer that protects all life on earth from Sun's ultraviolet rays.

(Jairam Ramesh)

CONTENTS

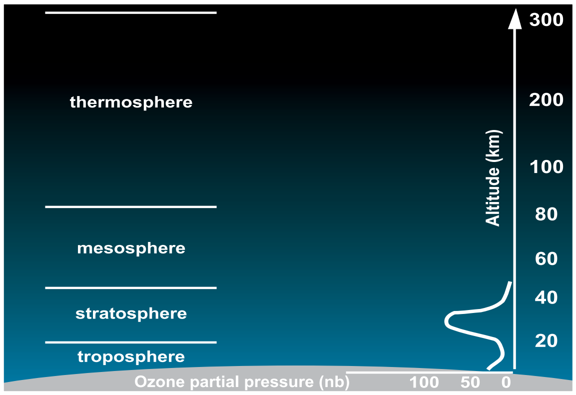
1 Ozone Layer

The small blue and green planet we call home is a very special and unique place. We live on the only planet in our solar system and possibly in the galaxy where life is known to exist. All life exists within thin film of air, water, and soil. This spherical shell of life is known as the biosphere. The biosphere can be divided into three layers; the atmosphere (air), the hydrosphere (water), and the lithosphere (rock and soil). It is the unique attributes of the Earth's atmosphere that allow it to be a habitable place for humans, animals, microbes and plants as we know them.

The atmosphere is a mixture of gases and particles that surround our planet. When seen from space, the atmosphere appears as a thin seam of dark blue light on a curved horizon.

The Earth's atmosphere is divided into several layers. The lowest region, the troposphere, extends from the Earth's surface up to about 10 kilometers (km) in altitude. The height of Mount Everest is only 9 km. virtually all human activities affect the troposphere. The next layer, the stratosphere, continues from 10 km to about 50 km. Most commercial airline traffic occurs in the lower part of the stratosphere.

Earth's Atmospheric Layers



Concentration of Ozone in the atmosphere

Ozone is a tri-atomic molecule of oxygen instead of the normal two. It is formed from oxygen naturally in the upper levels of the Earth's atmosphere by high-energy ultraviolet radiation (UV) from the Sun. The radiation breaks down oxygen molecules, releasing free atoms, some of which bond with other oxygen molecules to form ozone. About 90 per cent of all ozone formed in this way lies between 15 and 50 kilometers above the Earth's surface – the part of the atmosphere called the stratosphere. Hence, this is known as the 'Ozone Layer'. Even in the ozone layer, ozone is present in very small quantities; its maximum concentration, at a height of about 17-25 kilometers, is only ten parts per million.

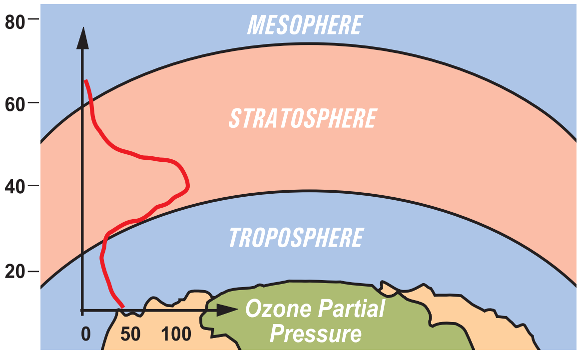
Since solar radiation is strongest over the tropics, the global ozone is formed here. However strong solar radiation also causes rise of air to high altitudes and ozone is transported away from the equator towards the poles where it accumulates in the cold sub-polar regions. At the equatorial region formation and photochemical depletion of ozone take place simultaneously and ozone cannot accumulate. In the polar region there is accumulation of ozone because, photochemical depletion is low and due to transport of ozone from equator. Therefore in winter the highest ozone values are observed over the Polar Regions as long as there is no other disturbing influence.

Total Ozone over any point from Earths surface to Stratosphere (45Km) is quantified in Dobson units (DU) : 100 DU equals the quantity of ozone that would form a layer 1mm thick at sea level if compressed at Standard Temperature and Pressure (STP).

Typical Distribution of Ozone is about 240 DU year round near the equator with early spring maxima at high latitudes of about 440 DU in the Arctic and 360 DU in the Antarctic, When the concentration over any are falls below 200 DU we call it Ozone Hole.

Ozone is an unstable molecule. High-energy radiation from the Sun not only creates it, but also breaks it down again, recreating molecular oxygen and free oxygen atoms. The concentration of ozone in the atmosphere depends on a dynamic balance between how fast it is created and how fast it is destroyed.

Concentration of Ozone in Stratosphere



Ozone is also present in the lower levels of the atmosphere (i.e. the troposphere), but at even lower concentrations than in the stratosphere. Close to the Earth's surface, most of the Sun's high-energy UV radiation has already been filtered out by the stratospheric ozone layer, and therefore the main natural mechanism for ozone formation does not operate at this low level. However, elevated concentrations of ozone at ground level are found in some regions, mainly as a result of pollution. Burning fossil fuels and biomass, releases compounds such as nitrogen oxides and Volatile organic compounds, usually found in car exhausts, which react with sunlight to form peroxy intermediates which catalyses to form ozone. This is bad ozone. It forms smog, affects plants and crops and causes health especially respiratory problems in humans and damage to plastics specially rubber.

There is little connection between ground-level ozone and the stratospheric ozone layer. Whereas stratospheric ozone shields the Earth from the Sun's harmful rays, ground-level ozone is a pollutant. Ozone formed due to pollution at the Earth's surface cannot replenish the ozone layer. In addition, though ground-level ozone absorbs some ultraviolet radiation, the effect is very limited.

How is Ozone measured in the atmosphere?

Ozone is spread from the surface of earth up to the top of stratosphere (about 40-45 km) as a very thin layer with maximum concentration at a height of 17-25 km. The question often asked is how is the concentration of ozone in this thin layer is measured and quantified reasonably accurately.

Atmospheric ozone is measured both by remote sensing and by in-situ techniques.

Generally three characteristics of atmospheric ozone are routinely measured by various monitoring systems:

(a) Surface Ozone (b) Total Ozone over an area and (c) The vertical profile of Ozone

Surface ozone is generally measured by in-situ techniques using optical, chemical or electro chemical methods. The most convenient method is the optical method which depends upon the strong absorption of UV light at 254nm. The absorption is measured in a UV cell at 254 nm against another cell containing air free from ozone. By comparing the two irradiation signals it is possible to determine the concentration of ozone from 1 to 1000 parts per trillion by volume (pptv).

Total ozone is measured by remote sensing methods using ground based instruments measuring the intensity of absorption spectrum of ozone between 300 and 340 nm using direct sun or direct full moon light and satellite based instruments measuring the solar UV radiation scattered back to space by the Earth's atmosphere. The most commonly used ground based instruments used by World Meteorological Organization (WMO) ozone network are the Dobson and Brewer ozone spectrometers. The most accurate and the best defined method for determining total ozone is to measure direct solar radiation from ground at UV wave bands between 305 and 340 nm.

Dobson instrument measures spectral intensities at three wave length pairs and the Brewer spectrophotometer at five operational wavelengths. Moon light as a source of UV radiation can also be used but the accuracy is reduced due to lower intensity of light. For accuracy and comparison all spectrometers are calibrated regularly at National Oceanic and Atmospheric Administration (NOAA's) subtropical high altitude observatory at Mauna Loa, Hawaii where other interfering air pollutants like SO_2, NO_x, aerosols etc. are absent.

Vertical profile of ozone is measured with (a) Ozone sondes (b) ground based Dobson and Brewer spectrophotometers using light form zenith sky during twilight using the Umkher inversion method and (c) laser radars (LIDAR).

Ozone sondes measure the concentration of ozone as a function of height by a wet chemical method (ozone liberating iodine when bubbled through potassium iodide solution and measured electro chemically) during its balloon bourne ascent to an altitude of about 35 Km (mid stratosphere). They operate regularly in all climatic regions and have been the back bone of ozone profiling since 1960.

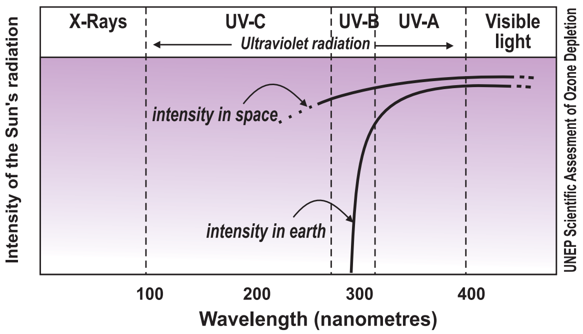
The latest method of vertical profiling of ozone is the LIDAR (optical radar) system in which a short laser pulse at a wave length in the UV ozone absorption spectrum is sent towards the zenith. Back scattered radiation is measured as a function of time which gives the height and its intensity gives the concentration of ozone. Two wavelengths are used, one of which is absorbed by ozone, other is not and serves as a reference. The concentration of ozone measured at different heights thus gives the vertical profile.

What is Ultraviolet Radiation?

The sun emits radiations of varying wavelengths known as the electromagnetic spectrum. The ultraviolet radiation is one form of radiant energy coming out from the Sun. The various forms of energy, or radiation, are classified according to wavelength (measured in nanometers where one nm is a millionth of a millimeter). The shorter the wavelength, the radiation are more energetic. In order of decreasing energy, the principal forms of radiation are gamma rays, x-rays, ultraviolet radiation (UV) rays, visible light, infrared rays, microwaves, and radio waves. The ultraviolet radiation, which is invisible, is so named because of its wavelengths are less than those of visible violet radiations.

Of these, UV-B and C being highly energetic are dangerous to life on earth. UV-A being less energetic is not dangerous. Fortunately, UV-C is absorbed strongly by oxygen and also by ozone in the upper atmosphere. UV-B is also absorbed by ozone layer in the Stratosphere and only 2-3% of it reaches the earth's surface. The ozone layer, therefore, is highly beneficial to plant and animal life on earth by filtering out the dangerous part of sun's radiation and allowing only the beneficial part to reach earth. Any disturbance or depletion of this layer would result in an increase of UV-B and UV-C radiation reaching the earth's surface leading to dangerous consequences for the life on earth.

Ozone Layer: The Earth's Sunscreen

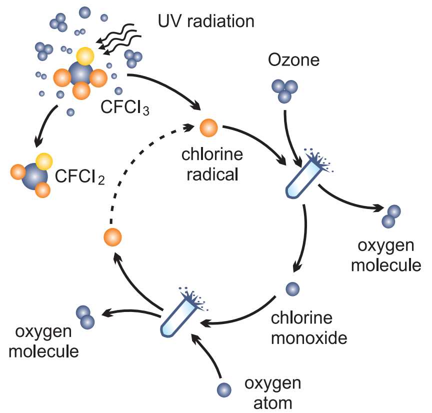


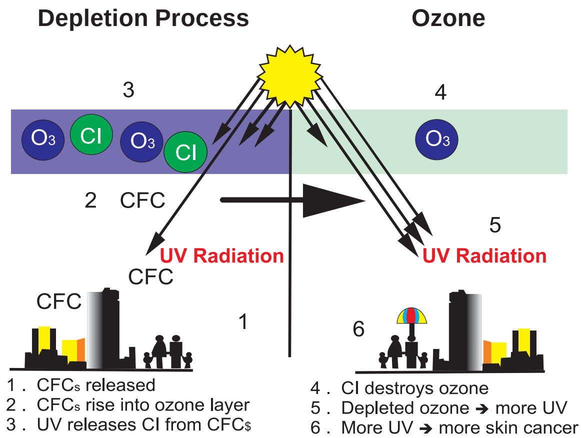
Ozone Depletion

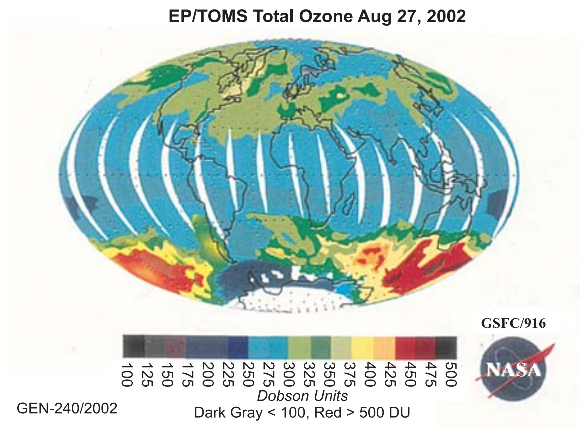
At any given time, ozone molecules are constantly formed and destroyed in the stratosphere. The total amount, however, remains relatively stable. The concentration of the ozone layer can be thought of as a stream's depth at a particular location. Although water is constantly flowing in and out, the depth remains constant.

While ozone concentrations vary naturally with sunspots, seasons, and latitudes, these processes are well understood and predictable. Scientists have established records spanning several decades that details normal ozone levels during these natural cycles. Each natural reduction in ozone levels has been followed by a recovery. Recently, however, convincing scientific evidence has shown that the ozone shield is being depleted well beyond changes due to natural processes.

Reaction of Chlorine with Ozone



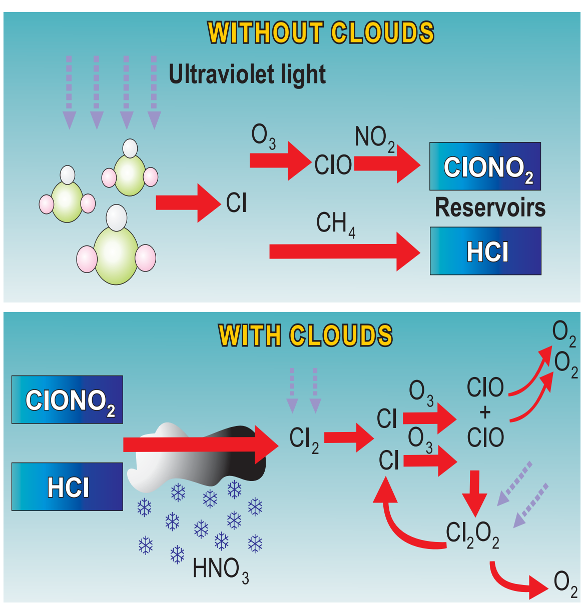




Ozone depletion occurs when the natural balance between the production and destruction of stratospheric ozone is shifted towards destruction. An upset in this balance can have serious consequences for life on Earth, and scientists are finding evidence that the balance has changed. As a result, the concentration of Ozone within the protective ozone shield is decreasing.

When very stable man-made chemicals containing chlorine and bromine enter into the atmosphere, and reach the stratosphere, these chemicals are broken down by the high energy solar UV radiation and release extremely reactive chlorine and bromine atoms. These undergo a complex series of catalytic reactions leading to destruction of ozone.

Process of destruction of ozone



Beginning of Threat to Ozone Layer

For over fifty years, Chloro Fluoro Carbons (CFCs) were thought of as miracle substances. These have been used in many ways since they were first synthesized in 1928. They are stable (inert), non-flammable, low in toxicity, and inexpensive to produce. Over time, CFCs found uses as refrigerants, solvents, foam blowing agents, aerosols and in other smaller applications. Other chlorine-containing compounds include methyl chloroform, a solvent, and carbon tetrachloride (CTC), an industrial chemical. Halons, extremely effective fire extinguishing agents, and methyl bromide, an effective fumigant used in agriculture and grain storage.

All of these compounds have atmospheric lifetime long enough to allow them to be transported by winds into the stratosphere.

During the past few decades, Ozone Depleting Substances (ODS) including CFCs have been released into the atmosphere in sufficient quantity to damage the ozone layer. The largest losses of stratospheric ozone occur regularly over the Antarctic every spring, leading to substantial increase in ultraviolet levels over Antarctic region. A similar, though weaker, effect has been found over the Arctic. There is now evidence that ozone levels decrease by several percent in the spring and summer in both hemispheres at middle and high latitudes. They also fall during the winter at these latitudes in the southern hemisphere. Levels of ozone damage were generally higher during the 1980s than the 1970s.

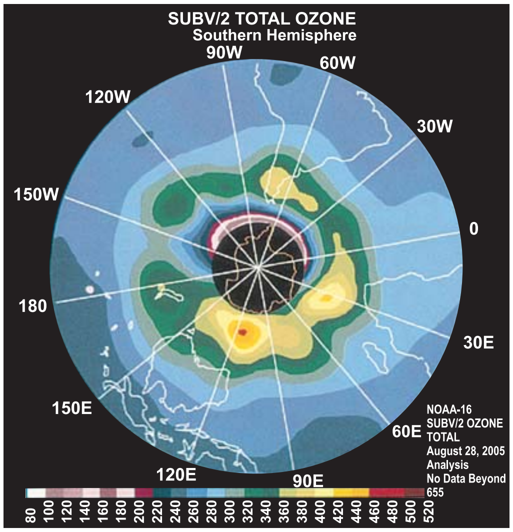
In the early 1970s, researchers began to investigate the effects of various chemicals on the ozone layer, particularly CFCs, which contain chlorine. They also examined the potential impacts of other chlorine sources. Chlorine from swimming pools, industrial plants, sea salt, and volcanoes does not reach the stratosphere. Chlorine compounds from these sources readily combine with water. In contrast, CFCs are very stable and do not dissolve in rain. Thus, there are no natural processes that remove the CFCs from the lower atmosphere. Over a period of time, the CFCs diffuse into the stratosphere where they meet UV rays of short wave length with breaks them.

The CFCs are so stable that only exposure to strong UV radiation breaks them down. When that happens, the CFC molecule releases atomic chlorine. One chlorine atom can destroy over 100,000 ozone molecules. The net effect is to destroy ozone faster than it is naturally created. To return to the analogy comparing ozone levels to a stream's depth, CFCs act as a siphon, removing water faster than normal and reducing the depth of the stream.

No one could imagine that these miracle chemicals could one day turn out to be harmful substance to life on Earth. It all began when at the first United Nations Environment Conference at Stockholm in 1972, questions were asked about the effect of jet aircrafts on upper atmosphere. It was known that the high temperature jet exhausts contain an appreciable amount of nitrous oxide and it was also known that this substance can catalytically decompose ozone. The conference authorized United Nations Environment Programme (UNEP) to address this issue and focus on the possible damage to the ozone layer by hundreds of supersonic aircrafts that were expected to be in operation by the late 1980s. They were also entrusted with the task of finding out the effect of release of nitrous oxide from fertilizer manufacturing units on the ozone layer. These investigations did not make much headway and were dismissed as false alarms.

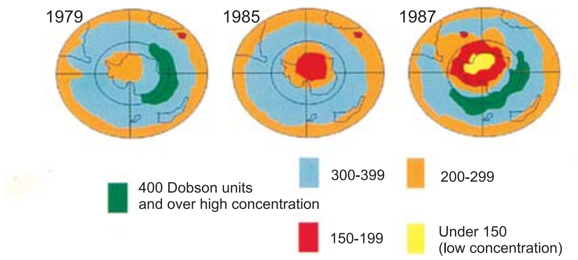
The Antarctic Ozone Hole

The term "ozone hole" refers to a large and rapid decrease in the concentration of ozone molecules in the ozone layer. The Antarctic "ozone hole" occurs during the southern spring between September and November. The British Antarctic survey team first reported the hole in May 1985. The team found that for the period between September and mid November, ozone concentration over Halley Bay, Antarctic, had declined 40% from levels during the 1960s. Severe depletion has been occurring since the late 1970s.



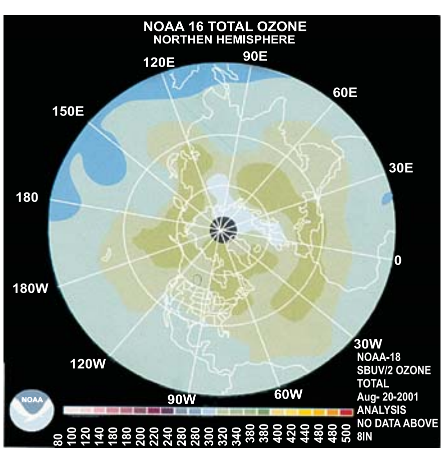
The problem is worst in this part of the globe due to extremely cold atmosphere and the presence of polar stratospheric clouds. The land under the ozone depleted atmosphere increased steadily to more than 20 million sq km in the early 1990s and in the Antarctic spring of 1998, the area of the ozone hole exceeded 26 million sq kms and also covered some populated areas of the southern hemisphere. The total ozone dropped to about 97 Dobson units on 1 October 1998.

Evolution of the Antarctic Ozone hole (1979 – 1987 October)



The Antarctic ozone hole grew to 28.4 million sq. km in 2000. In the year 2002 a peculiar effect was seen. The ozone hole split into two but the total coverage was only 15 million sq. km and it was also one of shortest duration. Recent monitoring in the year 2005 has shown that the ozone hole has again increased to 27.0 million sq. km which is the third largest so far. The Ozone hole over Antarctic grew in 2008 to the size of North America and is the fifth largest on record. NOAA reported that ozone hole reached maximum on 12-09-2008 extending to 27.2 million Sq. km. On September 2008 the total column of ozone dropped to its lowest count of 107 Dobson units.

In addition, research has shown that ozone depletion occurs over the latitudes that include North America, Europe, Asia, and much of Africa, Australia, and South America. Thus, ozone depletion is a global issue and not just a problem at the South Pole. It was also reported that some ozone depletion also occurs in the Arctic during the Northern Hemisphere spring (March-May), wintertime temperatures in the Arctic stratosphere are not persistently low for many weeks and this results in less ozone depletion.



Environmental Effects of Ozone Depletion

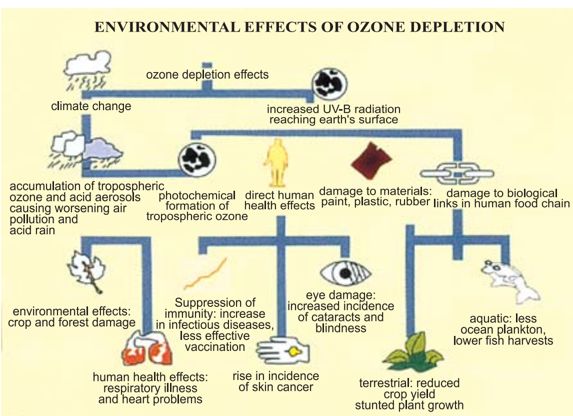
Ozone acts as a shield to protect the Earth's surface by absorbing harmful ultraviolet radiation. If this ozone becomes depleted, then more UV rays will reach the earth. Exposure to higher doses will have effects on human health and impact on flora and fauna of terrestrial as well as aquatic eco systems.

- **Human health effects**:
  - o Sunburns, premature aging of the skin.
  - o UV radiation can damage several parts of the eye, including the lens, cornea, retina and conjunctiva.
  - o More cataracts leading to damage to the eye vision resulting in blindness.
  - o Cataracts (a clouding of the lens) are the major cause of blindness in the world. A 10% thinning of the ozone layer could cause 1.6 to 1.75 million more cases of cataracts worldwide every year. (WHO, 2002).
  - o Weakening of the human immune system (immunosuppression). Early findings suggest that too much UV radiation can suppress the human immune system, which may cause non-melanoma and skin cancer.

- **Adverse impacts on agriculture, forestry and natural ecosystems**:
  - o Several of the world's major crop species are particularly vulnerable to increased UV, resulting in reduced growth, photosynthesis and flowering. As a result, food production could be reduced by 1% for every 1% increase of UV-B radiation.
  - o The effect of ozone depletion on the Indian agricultural sector could be significant.
  - o Many agricultural crops sensitive to the UV-B radiation of the Sun are rice, wheat, soybean, corn, sweet corn, barley, oats, cowpeas, peas, carrots, cauliflower, tomato, cucumber, broccoli etc.
  - o A few commercially important trees have been tested for UV-B sensitivity. Results indicate that plant growth, especially in seedlings, is more vulnerable to intense UV radiation.

- **Damage to marine life**:
  - o Plankton are the first vital step in aquatic food chains. In particular, plankton (tiny organisms on the surface layer of oceans) is threatened by increased UV radiation.
  - o Decreases in plankton could disrupt the fresh and saltwater food chains, and lead to species shift.
  - o Marine fauna like fish lings, juvenile stages of shrimp and crab have been threatened in recent years by increasing UV-B radiation under the Antarctic region. Loss of biodiversity in oceans, rivers and lakes could impact on aquaculture prospects.

- **Materials**:
  - o Wood, plastic, rubber, fabrics and many construction materials are degraded by UV radiation.
  - o The economic impact of replacing and/ or protecting materials could be significant.



Ozone Depletion Process

Large fires, certain types of marine life and volcanic eruptions also produce chlorine molecules. Being chemically active most of it gets converted into water soluble inorganic compounds which gets washed down by rain and only traces reach the stratosphere. However, United States Environment Protection Agency (USEPA) experiments have shown that CFCs and other widely used chemicals produce roughly 85% of the chlorine in the stratosphere, while natural sources contribute only 15%.

Large volcanic eruptions can have an indirect effect on ozone levels. Although Mt. Pinatubo's 1991 eruption did not increase stratospheric chlorine concentrations, it did produce large amounts of tiny particles called aerosols (different from consumer products also known as aerosols). These aerosols increase chlorine's effectiveness at destroying ozone.

The aerosols only increased depletion because of the presence of CFC- based chlorine. In effect, the aerosols increased the efficiency of the CFC siphon, lowering ozone levels even more than would have otherwise occurred. Unlike long-term ozone depletion, however, this effect is short-lived. The aerosols from Mt. Pinatubo have already disappeared, but satellite, ground-based, and balloon data still show ozone depletion occurring closer to the historic trend.

The Real Alarm

In 1974, two United States (US) scientists Mario Molina and F. Sherwood Rowland at the University of California were struck by the observation of Lovelock that CFCs were present in the atmosphere all over the world more or less evenly distributed by appreciable concentrations. They suggested that these stable CFC molecules could drift slowly upto the stratosphere where they may breakdown into chlorine atoms by energetic UV-B and UV-C rays of the sun. The chlorine radicals thus produced can undergo complex chemical reaction producing chlorine monoxide, which can attack an ozone molecule converting it into oxygen and in the process regenerating the chlorine atom again. Thus the Ozone-destroying effect is catalytic and a small amount of CFC would be destroying large number of ozone molecules. Their basic theory was put to test by the National Aeronautic Space Authority (NASA) scientists and found to be valid, ringing alarm bells in many countries and laying the foundation for international action.

Measurements by the European Space Agency's Envisat Satellite using an ultra sensitive Sciamachy spectrometer which can detect oxides of nitrogen in parts per billion (PPB) has produced a high resolution map of global atmospheric nitrogen dioxide pollution which vividly illustrates how human activities affect air quality. Nitrogen dioxide is released from Power Stations, Heavy Industries and Transport. There are swathes of high nitrogen concentration across industrial belts in North America, Europe, China and Korea. In India heavy nitrogen dioxide (NO2) concentration is to be found over U.P. and Eastern Bihar or North Bengal. It is well known that nitrogen oxides are ODSs and the effects of such high concentration of nitrogen oxides will be detrimental to the ozone layer in the long run.

The decline of ozone layer over North Pole has also been reported. The effect has been ascribed to solar flares and record frigid temperatures working with manmade chemicals. According to reports published in **geophysical research** letter, the arctic ozone level declined more precipitously than ever in upper atmosphere.

As a result of implementation of provisions/ measures under the Montreal Protocol, the atmospheric concentration of some of these man-made substances has begun to decline. Chlorine/bromine should reach maximum levels in the stratosphere in the first few years of the 21st century, and ozone concentrations should correspondingly be at their minimum levels during that time period. It is anticipated that the recovery of the Antarctic Ozone Hole can then begin. But because of the slow rate of healing, it is expected that the beginning of this recovery will not be conclusively detected for a decade or more, and that complete recovery of the Antarctic ozone layer will not occur until the year 2050 or later. The exact date of recovery will depend on the effectiveness of present and future regulations on the emission of CFCs and their replacements. It will also depend on climate change in the intervening years, such as long-term cooling in the stratosphere, which could exacerbate ozone loss and prolong recovery of the ozone layer.

International Action

The first international action to focus attention on the dangers of ozone depletion in the stratosphere and its dangerous consequences in the long run on life on earth was initiated in 1977, when in a meeting of 32 countries in Washington D.C. a World Plan on action on ozone layer was adopted with UNEP as the coordinator.

As experts began their investigation, data piled up and in 1985 in an article published in the prestigious science journal, "Nature" by Dr. Farman, pointed out that although there is overall depletion of the ozone layer all over the world, the most severe depletion had taken place over the Antarctic. This is what is famously called as "the Antarctic Ozone Hole". His findings were confirmed by Satellite observations and offered the first proof of severe ozone depletion. These findings stirred the scientific community to take urgent remedial actions. A framework for such actions were designed and agreed in an international convention held in Vienna on March 22, 1985.

This, subsequently, resulted in an international agreement in 1987 on specific measures to be taken in the form of an international treaty known as the Montreal Protocol on Substances that Deplete the Ozone Layer. Under this Protocol the first concrete step to save the Ozone layer was taken by immediately agreeing to completely phase out CFCs, Halons, CTC and Methyl chloroform (MCF) as per a given schedule.

Evolution of the Montreal Protocol

The urgency of controlling the ODSs particularly CFCs was slow to pick up. The CFCs were so useful that society and the industry were reluctant to give up consuming them. However, even as the nations adopted the Montreal Protocol in 1987, new scientific findings indicated that the Protocol's control measures were inadequate to restore the ozone layer. In addition, the developing countries had a special situation as they needed the technology of substitutes as well as financial assistance to enable them to change over to non ODS substances.

Meanwhile, the report of the scientific panels entrusted with the task of finding the extent of ozone depletion showed that the actual harm to the ozone layer was much more than predicted by theoretical models and the control measures envisaged by the Protocol in 1987 would not stop the process. More urgent action was therefore necessary. Therefore, at the 2nd Meeting of the Parties in London in 1990, 54 Parties as well as 42 non-Party countries agreed on a package of measures satisfactory to all. It was agreed in this meeting that the 5 important CFCs and Halons would be phased out by the year 2000 and other minor CFCs and CTC would be controlled and eventually phased out. A special provision was made to fund the developing countries with an annual consumption of CFCs and Halons of less than 0.3 kg per Capita (also called as Article 5 countries) in their efforts to phase out these harmful chemicals. These countries were also given a grace period of 10 years to phase out ODS.

In 1991, more alarming reports came up to show that the depletion of ozone is continuing in all altitudes except over the tropics. It was recognized that it is not enough to control emissions of CFCs and Halons. Other fluorocarbon chemicals like Hydro chlorofluorocarbons (HCFCs) and Methyl bromide, which are also ODS need to be controlled. They have also been brought under the ambit of the Protocol in 1992.

S. No.	Particulars	Date of Enforcement	No. of Parties
1	Vienna Convention 1985	22.09.1988	196
2	Montreal Protocol, 1987	01.01.1989	196
3	London Amendment, 1990	10.08.1992	186
4	Copenhagen Amendment, 1992	14.06.1994	178
5	Montreal Amendment, 1997	10.11.1999	156
6	Beijing Amendment, 1999	25.02.2002	130

Multilateral Fund (MLF)

With a view to assist the developing countries in their phase out efforts, a MLF has been established. This is known as the Montreal Protocol Multilateral Fund (MPMF). The Fund will finance incremental cost of ODS phase out. The incremental cost include, cost of transfer of technology, purchase of capital equipment and operational costs for switching over to non ODS technologies for enabling the developing countries to phase out controlled substances. Enterprises using ODS technology are eligible for funding for conversion to non-ODS technology from MPMF.

India being an Article 5 country is entitled to this assistance from MLF in its efforts to phase out ODS and switch over to non-ODS technologies.

Alternatives to currently used Ozone Depleting Substances

During the last two decades intensive research has yielded a large number of substitute chemicals as replacements to currently used CFCs, Halons, CTC and Methyl chloroform. These are summarised below on end-use basis:

Technology Options for Phaseout in Refrigeration and Air-conditioning Sector

Sub-sector	ODS used at present	Preferred alternatives / substitutes
Domestic refrigerators	Refrigerant CFC-12	HFC-134a Isobutane, HC blend Drop-in HFC/ HCFC, HC blends (for servicing)
	Foam Blowing CFC-11	Cyclopentane HCFC-141b HFC-245fa, Methyl Formate, Methylal
Refrigerated Cabinets (Deep Freezer, Ice-cream cabinets, Bottle coolers, Visi coolers)	Refrigerant CFC-12	HFC-134a Blends of HC-290 and HC-600a
	Foam Blowing CFC-11	HCFC-141b Cyclopentane HFC-245fa, Methyl Formate, Methylal
Water Coolers	CFC-12	HFC-134a Blends of HC-290 and

	HCFC-22 (for bigger capacity)	HC-600a HC-290, R-407C, R-410A
Mobile (car, bus, van, refrigerated trucks, train)	CFC-12	HFC-134a
	HCFC-22 (train)	R-407C, R-410A
Central A/C plants	CFC-11, CFC-12	HFC-134a HCFC-123 HCFC-124
	HCFC-22	HC-600a, Ammonia, R-410A, R-407C, HC-290
Process Chillers	CFC-12	Ammonia, R-404A, HC-290
Ice Candy Machines	CFC-12	HFC-134a R-404A
Walk-in Coolers	HFCF-22, CFC-12	HFC-134a R-404a
Room A/C	HFCF-22, CFC-12	R-410A, HC-290
Packaged A/C	HCFC-22	R-410A, R-407C, HC-290
Shipping	HFCF-22, CFC-12	HFC-134a, R-410A

Alternatives with zero ODP like HFC-134a, R-404A, R-407C, R-410A and R-507A are now being introduced. For large size refrigeration systems, CO2 is emerging both as heat transfer fluid and refrigerant in US, Japan and Europe. However, CO2 is not being used especially in high ambient conditions.

HCFCs are scheduled now for accelerated phaseout by 2030. Potential alternatives for some of the commonly used HCFCs are:-

(a) HCFC-245 fa, Methyl Formate, Methylal and Cyclopentane for HCFC-141b

(b) R-410A, R-407C and HC-290 for HCFC-22

Technology Options for Phaseout in Aerosol Sector

Sub-sector	**ODS used at present**	**Preferred alternatives / substitutes**
Perfumes, shaving foams, insecticides, pharmaceuticals, paints, etc.	CFC-11/12	HAP. (Di-methyl Ether) Small, Tiny & Cottage sectors use contract fillers, establish common filling facility for a cluster of units and switch to not-in-kind substitutes. (destenched LPG)
Metered Dose Inhalers	CFC-12	Hydrofluoro-alkanes (HFA)
Dry Powder Inhalers (DPIs)		No need of propelling agent.

Technology Options for Phaseout in Foam Sector

Sub-sector	**ODS used at present**	**Preferred alternatives / substitutes**
Flexible PUF Slabtstock	CFC-11	Methylene Chloride
Flexible Moulded PUF	CFC-11	Water blown technology
Rigid PUF General Insulation (other than refrigeration)	CFC-11	HCFC-141b Cyclhopentane Methyl Formate Methylal
Thermoware	CFC-11	Current-HCFC-141b Long term - HCFC-free systems (water blown) Methyl Formate Methylal
Integral Skin PUF	CFC-11	HCFC-141b
Thermoplastic	CFC-11	Hydrocarbons

Foams - EPE/EPPN Foams - EPS Foams	CFC-12	CO_2
Phenolic Foams	CFC-11	Hydrocarbons

CFC-11 (ODP-1.0) as a foam blowing agent was substituted first by HCFC 141-b (ODP-0.11). The trend now is to replace HCFC-141b with zero ODP foam blowing agents like HFC-245 fa (pentafluoro propane) in USA and EU (2003) and Japan (2004). A similar substitute, pentafluoro butane (HFC-365 mfc) for foam blowing has also been considered in some countries which are banning foam products manufactured with HCFC-141b. Both these new substitutes are made from CTC as feed stock. The next generation foam blowing agents will be low GWP like Methyl formate, Methylal and Cyclopenpane.

Technology Options for Phase-out in Fire Extinguishing Sector

Sub-sector	ODS used at present	Preferred alternatives / substitutes
Fire Extinguishers	H-1211, H-1301, H-2402	Portable type - ABC powder, CO_2
		Fixed type - FM200, HFCs, NAF- SI/SIII

A good substitute for Halon-1211 used in portable fire extinguishers was not available. M/s DuPont (USA) has recently developed hexafluoro propane (HFC-236 fa) as an excellent substitute for Halon-1211 fulfilling a long felt need. It is now being manufactured in USA and China using CTC as feed stock.

Technology Options for Phaseout in Solvent Sector

Sub-sector	ODS used at present	Preferred alternatives / substitutes
Electronic and precision cleaning	CFC-113	DI Water
	CTC	Aqueous cleaning process
	Methyl chloroform	Semi-aqueous cleaning process, organic non-halogenated & halogenated, solvents, perfluoro-carbons
Coatings	CFC-113 Methyl chloroform	Aqueous solvents Tri chloro ethylene
Manufacture of pesticides and pharmaceuticals	CTC	Ethylene-dichloride Monochloro-benzene
Metal cleaning	CTC	Tri chloro ethylene
Chlorinated	CTC system	Aqueous rubber
Textile cleaning	CTC	Aqueous system, chlorinated solvents

During the last several years due to intensive R&D efforts new solvent systems are being discovered as alternatives to CFCs solvents used earlier. First hydroflouroethers (HFEs) were considered as alternative solvents. Although, satisfactory in many respects, these were very high cost alternatives. Recently Servisol, an UK based company, has come out with alternative solvents for electrical cleaning specially for tape head and disk drives (Video 40), flux removal and PCB cleaner (Deflex 160); degreasing agent (Cold kleen 110); adhesive sticker removing, computer disk cleaning (CD-150) etc. Although, these are patented products and their chemical compositions are not available but the trend is good. Future may see many more alternative solvents readily available in the market so that the absence of Ozone depleting solvents like MCF and CFC-113 will not be felt.

2 India's Commitment to the Montreal Protocol

India became party to the Montreal Protocol on 17th September 1992. The per capita consumption of ODS in India did not cross 20 g between 1995-97 (base line) as against 300 g permitted under the Protocol. India was self sufficient in production of CFCs. India was mainly producing and used nine of the 95 substances controlled under the Montreal Protocol. These are CFC-11, CFC-12, CFC-113, HCFC-22 Halon-1211, Halon-1301, CTC, Methyl Chloroform and Methyl Bromide.

India had prepared a detailed Country Programme (CP) in 1993 to phaseout ODS in accordance with its National Industrial Development Strategy. The objectives of the CP were to phaseout ODS without undue economic burden to both consumers and industry manufacturing equipments using ODSs and provided India with an opportunity to access the Protocol's Financial Mechanism. The other objectives of the CP also include minimisation of economic dislocation as a result of conversion to non-ODS technologies, maximisation of indigenous production, preference to one time replacement, emphasis on decentralised management and minimisation of obsolescence.

The Government of India has entrusted the work relating to ozone layer protection and implementation of the Montreal Protocol to the Ministry of Environment and Forests (MoEF). The MoEF has set up an Ozone Cell as a national unit to look after and to render necessary services to implement the Protocol and its ODS phaseout programme in India.

The MoEF has also established an Empowered Steering Committee (ESC), which is supported by two Standing Committees, namely the Technology and Finance Standing Committee (TFSC) and the Monitoring and Evaluation Committee. The ESC is responsible for the implementation of the Montreal Protocol provisions, review of various policy and implementation options, project approvals and project monitoring.

Although these miracle chemicals were used in large scale in the developed countries since 1930s, India was slow to derive benefits from their use. The early use of these chemicals in India was in refrigeration and air-conditioning and CFCs needed for this sector were imported. The use of CFCs in refrigeration industry can be traced back to 1960s. Other industries using CFCs such as foam manufacturing industry, aerosol industry etc., were developed only during the last 20 to 25 years in India. With the availability of CFC-11 and CFC-12 from indigenous production, the growth of these industries consuming CFCs increased very rapidly.

When the country programme was prepared, use of ODS as solvents is estimated to account for the maximum consumption, both in metric tonne (MT) as well as Ozone Depleting Potential (ODP) tonne . Refrigeration & Air-conditioning and Foam are next large user sectors, followed by Aerosol. The consumption of ODS in fire extinguisher sector was relatively small in terms of MT.

Status of ODS Phase-out in India

India is in the process of phasing out ODS both in the end-use consumption sector and production sector. A total of 299 projects have been approved and funded by the MLF. A total amount of USD 246,022,839 has been approved by the Executive Committee of the MLF to phase out 47,085 ODP tonne.

Sector-wise Approved Projects as on 31.8.2009

Sector wise break-up of the funds approved by the MLF for ODS phase-out projects in India is given in the table below:

Sector-wise Approved Projects as on 31.8.2009

No	Sector	No. of Projects	Grant Amount (US $)	Phase out of ODP (in Tonnes)
1.	Industrial Aerosol	27	3,227,739	689
2.	Medical Aerosol (MDIs)	1	10,202,267	704.03
3.	Foam	159	34,785,641	4373
4.	Halon	18	2,639,389	2162
5.	RAC	49	32,254,823	3203
6.	Solvent	41	71,007,980	12,966
7.	Production Sector	3	91,335,000	22,988
8.	HPMP*	1	570,000	-
	Total	**299**	**246,022,839**	**47,085**

SECTOR PHASE-OUT PLANS

CFC production sector phaseout project in India

The Executive Committee of the MLF in its 29th Meeting held in November 1999, approved the India's CFC Production Sector gradual phaseout project for total grant amount of US $ 82 million. The grant amount US $ 80 million was to be provided as a performance based grant to CFC producers for meeting the CFC production phaseout targets. The remaining US $ 2 million was for Technical Assistance Component to establish Project Management Unit (PMU) under the Ozone Cell to develop and implement monitoring, auditing and reporting mechanism in addition to conducting awareness and training programmes. The World Bank is the Lead Implementing Agency for the project. UNEP has been designated as the implementing agency for Technical Assistance Component. In this project, it has been agreed to reduce total CFC production in accordance with an agreed upon schedule.

Agreed Schedule

Year	CFC Production Quota (MT)	Phaseout Amount (MT)
1999	22,588	-
2000	20,706	1,882
2001	18,824	1,882
2002	16,941	1,883
2003	15,058	1,883
2004	13,176	1,882
2005	11,294	1,882
2006	7,342	3,952
2007	3,389	3,953
2008	2,259	1,130
2009	1,130	1,129
2010	0	1,130

Accelerated Phaseout of CFC

The Executive Committee at its 54th meeting held from 7th to 11th April, 2008 Montreal, Canada decided to accelerate the phase-out of CFCs by 1st August. 2008. As per the decision, India agreed that it will produce no more than 690 MT of CFC primarily for the manufacturing of Metered Dose Inhalers (MDI) up until 1st August, 2008. India's CFC producers would sell no more than 825 MT tones of CFCs for MDI production in the years 2008 and 2009, comprising 690 MT tons of new production and 135 MT tons reprocessed from existing stock. In addition India would not import any more CFCs.

As part of the accelerated phase-out of CFCs, India has completely phased out CFCs with effect from 1st August. 2008, 17 months ahead of the agreed phaseout schedule.

Accelerated Phase-out of HCFC

India being a Party to the Montreal Protocol and its amendments needs to phase-out ODS including HCFCs as per the reduction schedule specified in the Protocol. The control schedule of the

Montreal Protocol for Article 5 parties for phaseout of HCFCs prior to the 19th Meeting of the Parties (MOP) was as follows:

Consumption

- Base-level-2015
- Freeze- January 1, 2016
- 100% reduction January 1, 2040

Production

- Base-level-Average of production and consumption in 2015
- Freeze- January 1, 2016, at the base level for production
- 100% reduction January 1, 2040.

The 19th MOP took a decision to accelerate the phase-out of HCFC production and consumption for developed and developing countries. The new phase-out schedule for Article 5 parties as per the decision of the 19th MOP is as follows:

- Base-level for production & consumption: the average of 2009 and 2010.
- Freeze= 2013 at the base-level
- 10% reduction in 2015
- 35% reduction in 2020
- 67.5% reduction in 2025
- 100% reduction in 2030 with a service tail of 2.5% annual average during the period 2030-2040.

The implementation of the accelerated phase out schedule for HCFCs is a challenging task to achieve 2013 freeze and 10 percent reduction in 2015, especially in emerging economies like India where there is a high growth in the use of these chemicals in refrigeration, air-conditioning, foam manufacturing and other fields to cater the needs of growing industrialization and GDP of the country. The annual growth is in the range of 10 to 15 percent. In actual sense this sets the phase-out targets of 30 to 40 percent by 2015 which is quite significant reduction in a very short time frame. This would require a long term vision and planning to successfully meet the obligations of phasing-out the HCFCs as per the revised schedule of the Montreal Protocol.

Based on the decision of the 19th MOP, the Executive Committee of the MLF has initiated discussions on guidelines for preparing HCFC Phase-out Management Plans (HPMP) and policy guidelines for determining the cost for phasing out of HCFC in different applications. The 54th Ex-Com vide its decision 54/39 approved the guidelines for HPMP.

Considering the future activities relating to phase-out of HCFC production and consumption in India to meet the compliance target as per the accelerated phase-out schedule, the Empowered Steering Committee of the MoEF at its 33rd meeting held on 21st November, 2007 decided to involve the World Bank, UNDP, UNIDO, UNEP, Government of Germany and France etc. UNDP has been designated as Lead Agency for the HCFC Phaseout Management Plan. Accordingly, all the agencies have included activities to phase-out HCFCs in their respective business plans for 2008-2010.

A Roadmap for phasing-out of HCFCs has been developed describing the long term vision and action plan including the policy instruments for phasing out of production and consumption of HCFCs in India in accordance with 19th MOP to the Montreal Protocol vide Decision XIX/6.

The 56th meeting of the Executive Committee held in November, 2008 approved the preparation of HPMP for India with UNDP as the lead implementing agency in association with UNEP, UNIDO, the World Bank and GTZ. Subsequently, the Action Plan for implementation of the Roadmap for phasing out of HCFCs in India has been developed indicating the responsibilities of agencies and the timeline for its smooth and effective implementation.

A National Stakeholders Workshop on Roadmap for Phasing out HCFCs in India is scheduled to be held in October, 2009 at New Delhi with an objective to create awareness among the stakeholders and take them on board especially the industry producing and consuming HCFCs from the preparatory phase of the HPMP.

Halon Production and Consumption Sector Phase-out project in India

The Executive Committee of the MLF in its 34th meeting held in Montreal, 2001 had approved US $2.6 million for phasing out halon production and remaining consumption of halons. The enterprises producing halons have dismantled their production plants and rendered them incapable of producing halons.

At present, there is no halon production in India. The phaseout activities at all enterprises have been completed.

Industry Structure: There was a wide variety of firefighting technologies in India, identified at the time of preparation of the Country Program such as ABC powder, aqueous systems, CO2-based and foam-based systems, etc. There were about 200 manufacturers of firefighting equipments, of which over 85% were manufacturers of portable fire extinguishers. Halons, which are potent ODS, were used in about 5% of the firefighting applications.

As of 1991, there was only one producer of halons having two halon plants one for producing Halon-1211 and another for Halon-1301. The total installed production capacity of halons was 500 MT.

ODS Consumption: In 1991, the total consumption of Halons in India was 750 MT equivalents to 3,650 ODP Tonnes. This constituted 7.2% of India's total ODS consumption and almost 28% of the total ODP consumption. Imports accounted for 550 MT of the total, while 200 MT was indigenously produced. The growth rate in this sector was forecasted at 15% annually.

Technology: As noted earlier, the use of Halons in firefighting constituted about 5% of the firefighting applications in India. There were no drop-in replacement technologies identified. The alternative technologies identified were ABC powder, inert gases, HFC-based systems, aqueous systems, CO2-based systems, fast-response sprinklers, etc. Among the priority actions identified to address the ODS phase-out in this sector were:

- Revision of national fire-extinguisher codes and standards to promote Halon alternatives
- Halon conservation programme to limit emissions
- Establishment of a Halon management program including Halon banking

The production of halons has been phased-out globally at the early stage of the Protocol because of high ODP values of halons. Moreover, there is a large quantity of halons banked in fire extinguishing equipment.

The MoEF has established National Halon Banking Facility at Centre for Fire, Explosive and Environment Safety (CFEES), Defence Research and Development Organization (DRDO), Ministry of Defence, New Delhi with the financial assistance from the MLF of the Montreal Protocol. This facility has the capability to recover, recycle and store the halons for future use in the existing equipment. It is worth mentioning that all the three Defence forces have also established their own Halon Banking Facility to meet the future requirements.

Foam Manufacturing Sector Phase-out Project

The Executive Committee of the Montreal Protocol at its 37th meeting held in July 2002 approved the foam sector phase-out plan at a total funding level of US$ 5,424,577 to phase-out 612 ODP tons of CFC-11 by 31st December 2006. UNDP is responsible for implementation of this project.

A total of 122 foam manufacturing enterprises under this sector plan have phased-out 702 MT of CFC from their process. The project is successful in completely phasing out the CFCs in Foam manufacturing sector in the country.

Industry Structure: The survey of the Foam Sector carried out at the time of the original Country Program, identified about 235 manufacturers foam in India, using CFCs as blowing agents. About 20% of the enterprises were large/medium-size, while the rest were Small and Medium Enterprises (SMEs) in the unorganized and informal sectors.

The sub-sectors identified were rigid polyurethane foam, flexible polyurethane foam, integral skin polyurethane foams, thermoplastics foams (extruded polyethylene and polystyrene foams) and phenolic foams. An important sub-sector in the Foam sector, namely, the flexible slabstock foam mostly converted from CFCs to methylene chloride as the blowing agent during the 1980s due to economic reasons. The domestic refrigerator manufacturers were important users of CFCs in the rigid polyurethane foam sub-sector. Another important sub-sector within the Foam sector, namely rigid polyurethane foam used in the production of insulated thermo-ware (flasks, casseroles, water-bottles, lunch-boxes, etc), was considered important due to the large number of SMEs involved.

There were four major producers of polyol systems, who formed the main upstream source of raw materials for the polyurethane foam manufacturers and met about half of the total demand. The remaining half of the raw material demand was met through imports.

ODS Consumption: In 1991, the Foam sector consumed 1,580 MT of CFCs (predominantly CFC-11), which amounted to about 31% of India's total CFC consumption at that time. It was estimated that the demand for foam products would grow at 15-20% annually until 2010. The Foam sector was therefore identified as a priority sector in India for initiating phase-out activities.

Technology: The following substitute technologies were identified for phasing-out ODS in the Foam sector at the time of preparation of the Country Program:

Sub-sector	Interim Technology	Long Term Technology
Flexible Molded PU Foam	Water-based	Water-based
Integral Skin PU Foam	HCFCs and HFCs	Hydrocarbons, Water, Methyl Formate and Methylal
Rigid PU Foam	HCFCs and HFCs	Hydrocarbons, Water, Methyl Formate and Methylal
Phenolic Foams	HCFCs and HFCs	Hydrocarbons, Methyl Formate, Methylal
Thermoplastic Foams	HCFCs and HFCs	Hydrocarbons, Methyl Formate, Methylal

It was considered strategically important to support the conversion of manufacturing facilities of the polyol system producers on a priority basis, to enable them to customize non-CFC formulations, thus facilitating ODS phase-out in the downstream foam manufacturers more economically. Also, ODS phase-out in the large number of SMEs operating in this sector, many of which were not identified at the time of the Country Program preparation, was considered to be a challenge.

The accelerated phase-out of HCFCs would require conversion of foam manufacturing facilities from HCFCs to non-HCFCs like hydrocarbons, HFCs, Methyl Formate, Methylal etc.

Commercial Refrigeration Sector (Manufacturing)

The Executive Committee of the Montreal Protocol at its 38th meeting held in November 2002 approved the Commercial Refrigeration Sector (manufacturing) phase-out plan at a total funding level of US$ 3,609,186 to phase-out 535 ODP tons of CFC-11. UNDP is responsible for implementation of the commercial refrigeration component and UNIDO is responsible for implementation of the transport refrigeration sub-sector under this sector-plan.

A total of 157 enterprises for commercial refrigeration have phased out 593 MT of CFC-11 and 258 MT of CFC-12. In transport refrigeration, 39 enterprises have phased out 138 MT of CFC.

Industry Structure: The Refrigeration and Air Conditioning sector in India has a long history from the early years of last century. Major investments in establishing manufacturing capacities started in 1950s. On the upstream side, there are two manufacturers of hermetic compressors and several manufacturers of open-type compressors. Many of the other components of refrigeration systems are manufactured in the country.

ODS Consumption: In 1991, the total ODS consumption in the Refrigeration & Air Conditioning sector in India was 1,990 MT. This constituted about 39% of India's total consumption of CFCs. About two-thirds of this consumption was estimated to be used in servicing of existing equipment. The growth rate in this sector was forecast at 10-20% annually until 2010. The Refrigeration & Air Conditioning sectors were therefore identified as a priority sector in India for initiating phase-out activities.

National CFC Consumption Phase-out Plan (NCCoPP)

The Executive Committee of the Montreal Protocol at its 42nd meeting held in March 2004 approved the commercial refrigeration sector (manufacturing) phase-out plan at a total funding level of US$ 6.388 million to phase-out 1502 ODP tons of CFCs by 31st December 2009. The Government of Germany is responsible for implementation of this project as the lead Implementing Agency. The Government of Switzerland is responsible for training activities and UNDP is responsible for procurement of equipment. UNEP is responsible for creation of awareness. Besides, UNEP is organizing customs and policy training activities in collaboration with National Academy for Customs, Excise and Narcotics (NACEN).

The project's main scope is on training of refrigeration servicing technicians in servicing refrigeration and air-conditioning equipments based on ODS and non-ODS alternatives. It also covers training for Mobile Air-Conditioning (MAC), Open Type Compressor (OTC) and specifically targets the Railways as a key institutional user of CFC refrigerants. The project adopts a multi-pronged approach to achieve its targets. In addition to training, it includes equipment support, awareness building and information dissemination, and capacity building of customs officers on illegal ODS trade.

Information dissemination and creating awareness regarding CFC phase-out in India is of utmost importance to ensure the project's success. Various methods are being employed to create awareness viz. video film, posters, newsletter, flyers, dealer workshops, equipment support workshops, articles in newspapers and dedicated website.

NCCoPP is funded by the MLF of the Montreal Protocol. NCCoPP takes over from the Indo-Swiss Human and Institutional Development in Ecological Refrigeration (HIDECOR) project. The HIDECOR operation, initiated in 1998, was geographically restricted to selected states and the target group was limited to Micro and Small and Medium-sized service Enterprises in the RAC sector. NCCoPP currently has a presence in 15 States of India. It aims to encourage good servicing practices among all Refrigeration Service Enterprise, with a special focus on those firms consuming more than 50 kg CFC per annum. The project is scheduled to end by 31 December 2009.

A total of 955 units were distributed through UNDP in four phases till December 2008. The work plan targets for the year 2008 were achieved. Awareness generation workshops initiated for small servicing enterprises so that most of the enterprises across the country can participate in the project and get the advantage of assistance provided under the Montreal Protocol to phase-out ODS in servicing sector. Equipment support to another 120 Industrial Training Institutes (ITI) has also been provided.

A focal activity of NCCoPP is training of Refrigeration Service Enterprise technicians. During training the participants/technicians are taught how to handle the alternative refrigerants, good servicing practices and emphasis is laid on recovery of CFCs. Therefore the training programs have helped in creating a demand for recovery and reclaiming of refrigerants. With over 20,000 technicians already trained under NCCoPP and its forerunner projects, the requirement of CFCs for servicing is being addressed through reclamation of used CFCs. A number of reclamation centres are in operation at various locations in the country like Bangalore, Chandigarh, Hyderabad, Ahmedabad, Jaipur, Kolkatta, and Lucknow. The reclamation units have also been provided to Indian Railways and Defence forces.

National CTC Phase out Plan

The Executive Committee of the MLF at its 40th meeting held in November/December, 2003 approved the CTC National Phase out Plan at a total funding level of US$ 52 million to phase-out 11535 ODP tons of CTC production and 11525 ODP tons of CTC consumption by 31st December 2009. This includes US$ 10 million under the bilateral assistance program with the Governments of Germany, France and Japan contributing US$ 2 million, US$ 3 million and US$ 5 million respectively.

Out of the total funds, US$ 28.5 million will be utilized for CTC production phase-out, US$ 21.5 million will be utilized for CTC consumption phase-out and US$ 2 million will be made available for technical assistance component. The World Bank is the lead Implementing Agency, the Governments of Germany, France and Japan and UNIDO are cooperating agencies for Implementation of the National CTC consumption phase-out activities. Besides, UNDP on behalf of Government of Japan is responsible for executing conversion activities in large and medium metal cleaning sub-sectors.

Production Sector: The CTC producing enterprises namely M/s. SRF Limited, New Delhi, M/s. Chemplast Sanmar Limited, Chennai, M/s. Gujarat Alkalies and Chemicals Limited, Vadodara have signed the performance agreement and submitted an Indemnity bond for meeting the production phase-out targets. M/s. ShrIram Rayons Limited, Rajasthan, M/s. NRC Limited, Mumbai, have already closed down their production facilities.

Consumption Sector: CTC was used as feedstock primarily in the production of CFCs and DV Acid chloride. CTC is also used in India as a process agent and a solvent. For process agents, CTC is used in sectors such as chlorinated rubber, chlorinated paraffin, pharmaceutical, and agro-industries. As a solvent, CTC is used in the textile and garment industries, metal-cleaning industry and as a chemical solvent.

In 2006, a total of 103 CTC projects covering both process and solvent applications were identified and were placed under the responsibility of the agencies. The 41 completed projects plus the eight under implementation would phase out 2,080 ODP tonnes of CTC. With respect to the four solvent projects under UNDP installation of equipment is in progress and would be completed by December 2009. In spite of this, CTC consumption was already terminated in 2005 in these plants.

During 2009, technical assistance was provided to replace CTC used in stain removal work for small garment manufacturers and metal cleaning. The fast reduction in the supply of CTC has increased the CTC price significantly in the country and enabled many SMEs to move away from CTC. GTZ has done extensive work in testing alternatives that meet health, safety and environment standards. The achievement of the CTC phase-out in these two widely dispersed industry sectors that is garment and metal cleaning, would mostly be realized through government policy measures, especially those which will influence the pricing of CTC and its alternatives.

In 2009, the Government of India continued to implement a number of policies related to activities in the CTC sector plan, such as registration of CTC producers, importers, and exporters, and an import quota system for CTC.

Of the total approved funding of US $ 52 million, approximately US $ 48.7 million had been disbursed as of end of 2008.

Strategy for Solvent Sector to phaseout ODS in SMEs in India

The Executive Committee of the Montreal Protocol approved the "Overall Strategy for the Solvent Sector to support the phase out of ODS in the SMEs in India" project at a cost of US $ 169,500 at the 35th Meeting of the Ex-Com to be implemented by UNEP-DTIE in consultation with World Bank and UNIDO. This project proposes to assist India in developing an overall strategy for the solvent sector which would cover both non-investment and investment activities to support the phaseout of ODS in the solvent sector in India and assist India in meeting its 2005 and 2007 commitments for the solvent sector. The aim of the project, at the operational level, is to develop approaches for assisting small and medium enterprises which use solvents in India through training, Solvent Alternative Technology Service (SATS), information dissemination and investment and non-investment activities.

The project has been completed by UNEP and submitted to Ozone Cell and the World Bank. The inputs provided through the Strategy document was incorporated in the National CTC Phaseout Plan prepared by the World Bank. The Project Completion Report (PCR) has been submitted by UNEP. As such there are no major observations recorded in the PCR and a balance amount of US $ 10140 has been returned to the MLF at the 50th Ex-Com Meeting.

Aerosol Sector Phaseout Project

Aerosols are widely used in several applications involving propellants including perfumes, shaving foams, insecticides, pharmaceuticals, paints and inhalers. Twenty three projects were supported covering 44 enterprises to phase out CFC-11 and CFC-12 in this sector. India developed the National Transition Strategy for phase-out of CFCs in MDIs, with UNDP as the lead agency and submitted to the 56th Executive Committee of the MLF in November, 2008 and the same was approved by the Executive Committee with a total funding of US $ 10.2 million. This project articulates India's national strategy for transition to non-CFC MDIs gradually without affecting the Asthma and Chronic Obstructive Pulmonary Disease (COPD) patients and the elimination of CFC consumption in manufacturing of MDIs in India by 2013.

Industry Structure: The total production of aerosol containers in 1991 was estimated to be 45 million, of which over 90% used CFCs as propellants. About 200 aerosol manufacturers were identified, concentrated mainly in the western and northern parts of India. All enterprises were in the private-sector. A significant majority of these enterprises (about 70%) were SMEs, many of which were in the informal sector, principally manufacturing personal care products such as perfume and deodorant sprays.

ODS Consumption: In 1991, the Aerosol sector consumed 1,100 MT of CFCs (about 40% CFC-11 and 60% CFC-12), which amounted to about 22% of India's total CFC consumption at that time. It was estimated that the demand for aerosol products would grow at 20% annually until 2000, 18% annually until 2005 and 15 % annually until 2010. These estimates were based on considerations such as emerging customer base for personal care products, entry of multinational corporations in India leading to expansion of the manufacturing base in this sector, reduction in taxes on cosmetics, etc.

Technology: Hydrocarbon-based aerosol propellants were identified in most of the aerosol sub-sectors as the preferred substitute technology for phasing out CFCs, specifically, butane, destenched liquefied petroleum gas (LPG), etc.

The SMEs predominantly used locally developed manual propellant filling machines, which, were suitable for CFC propellants, but considered unsafe and unsuitable for hydrocarbon-based substitute propellants. Moreover, many of the SMEs had manufacturing facilities in locations which could be considered unsafe for handling hydrocarbon-based propellants. Thus, safety measures for handling hydrocarbons including safety training and audits were identified as important inputs in addition to investments needed for conversions.

Fiscal Measures

The Government of India has granted full exemption from payment of Customs and Excise duties on capital goods required for ODS phase out projects funded by the MLF since 1995. In 1996, the Government further extended the benefit of Customs and Excise duty exemptions for ODS phase-out projects which were eligible for funding under the MLF, but not funded. The benefit is available subject to the condition that enterprises give clear commitment to stopping use of ODS in all future manufacturing operations after the projects are implemented.

The benefit of duty exemption has been extended for new capacity with non-ODS technology since 1997. These benefits are available for the financial year 2009-2010.

The Indian financial institutions have decided not to finance/re-finance new ODS producing/consuming enterprises.

The Tariff Advisory Committee (TAC) - A statutory body under the Insurance Act, 1938 - has decided to grant suitable discounts on fire insurance premiums if alternative fire extinguishing agents are used in place of halons in fire extinguishing systems.

Ozone Depleting Substances (Regulation and Control) Rules 2000

In accordance with the National Strategy for ODS phase-out, the MoEF, Government of India, has notified Rules covering various aspects of production, sale, consumption, export and import of ODS.

Important provisions of the Ozone Depleting Substances (Regulation and Control) Rules 2000

These Rules prohibit the use of CFCs in manufacturing various products beyond 1.1.2003 except in MDI and for other medical purposes. Similarly, use of halons is prohibited after 1.1.2001 except for servicing. Other ODS such as CTC and methyl chloroform and CFC for MDIs can be used upto 1.1.2010. Further, the use of methyl bromide has been allowed upto 1.1.2015. Since HCFCs are low-ODP substances and are also used as interim substitutes to replace CFC, these are allowed to use upto 1.1.2030 as per the Montreal Protocol accelerated phase-out schedule.

The Rules also provide for compulsory registration of ODS producers, manufacturers of ODS based products, importers, exporters, stockist and sellers and the same provision is applicable to manufacturers, importers and exporters of compressors. They are also required to maintain records and file periodic reports for monitoring production and use of ODS. Enterprises which have received financial assistance from MLF for switchover to non-ODS technology have to register the date of completion of their project and declare that the equipment used for ODS has been destroyed. Creation of new capacity or expansion of capacity of manufacturing facilities of ODS and ODS based equipment has been prohibited. Purchasers of ODS for manufacturing products containing ODS, are required to declare the purpose for which ODS is purchased. All imports and exports of ODS and products containing ODS require a licence.

As per the Advance Licensing scheme duty free imports of inputs & consumption are allowed for manufacture of export product. The licence is under actual user condition i.e. materials imported cannot be transferred. Inputs are exempted from basic customs duty, additional custom duty, education cess and anti dumping duty. All items can be imported under Advance Licence Scheme except prohibited items. It is now required to obtain the consent of the MoEF before issuing an advance license for ODS

These rules also indicate specific phase-out dates for manufacturing products using ODSs.

Trade in ODS with non-Parties is banned. The import and export of ODS are subject to licensing requirement. The export of ODS to Non-Article-5 Parties is also banned. This regulatory measure is part of the Ozone Depleting Substances (Regulation and Control) Rules 2000 which have been notified in the Gazette of India on July 19, 2000.

Amendments

Registration is compulsory under the ODS Regulation and Control (Amendment) Rules, 2004. This amendment was issued so that all enterprises using CTC and HCFC for manufacturing activities are required to register with the designated authority vide amendment Rules, 2004 on or before 31 December, 2005. The rules were further amended on 18th September, 2007. As per the amended rules, registration for all ODS will be open till 31st December, 2009 and the existing registered enterprises need not apply for renewal. The ODS Rules and Regulations are being amended to align with the accelerated phase-out of HCFCs.

AWARDS

Best Implementers Award

The Ozone Secretariat considering the best performance of India in respect of Implementation of Ozone Depleting Substances (ODS) phase-out projects, development of regulations and fiscal incentives to comply with the reduction schedule as prescribed in the Protocol, selected the Ozone Cell of India for the Best Implementer's Award. The award was given on 16th September, 2007.

In addition to this, Ecological Refrigeration (ECOFRIG), Human and Institutional Development in Ecology Refrigeration (HIDECOR) and National CFC Consumption Phase-out Plan (NCCOPP) were also given the Montreal Protocol Exemplary Project Recognition Award.

Two Industries, M/s Kirloskar Copeland Ltd. and M/s Satya Deeptha Pharmaceuticals also got the Montreal Protocol Exemplary Project Recognition Award.

USEPA 2008 Stratospheric Ozone Protection Award

The United States Environmental Protection Agency (USEPA) honoured 39 individuals, organizations and companies from around the world for their outstanding efforts to protect the earth's climate and stratospheric ozone layer.

Dr. A. Duraisamy, Director, Ozone Cell has been awarded "2008 United States Environmental Protection Agency (USEPA) award for Protection of Stratospheric Ozone Layer" at the special ceremony held on the afternoon of Monday, 19th May, 2008 at The Kennedy Center for the Performing Arts in Washington DC.

Awareness Generation

The National Ozone Unit (NOU) has undertaken comprehensive public awareness campaign to ensure that both the public and the companies responsible for actually phasing out the ODS understand and support the policies to protect the ozone layer.

The International Ozone Day for the year 2008 was celebrated in Delhi. During the celebrations, a pledge was taken by participants for protection of environment and following environment friendly measures and practices:

A sticker, poster and India's Success Story are being brought out for distribution every year on the International Ozone Day.

Ozone Friendly equipment and products are being exhibited during Ozone Day celebrations every year.

A bimonthly newsletter Value Added Technical Information Service (VATIS) is published and distributed to about 2000 individuals and institutions in collaboration with United Nations Asia Pacific Centre for Technology Transfer. This newsletter covers the latest technologies and developments relating to ozone layer protection.

States play a key role in Montreal Protocol implementation by virtue of their geographic proximity to the industries consuming ODSs particularly SMEs and their ability to control and monitor activities relating to phasing out ODSs. To increase awareness of State authorities on Ozone related matters, the PMU, under Technical Assistance component for CFC production sector phaseout project, conducted workshops in all 25 States during last 5 years. This has also been followed up through periodic dialogue and meetings with the State authorities with primary focus on implementation of projects for SMEs and remaining ODS consuming industries and regulation implementation. Awareness workshops were organised with following objectives:

- To create awareness about the present and future of Foam and Refrigeration Sector
- To inform the HCFC accelerated phase out
- Demonstration of a successful projected implementation by a field visit and on hands training and troubleshooting
- To take stock of lessons learnt from the implementation of sector plans.
- Provide technical assistance, information and technical resources as may be required related to application of sustainable alternative technologies
- To discuss the future technology to replace HCFC
- To acquire input for the National Phase out plan

Workshops on Good Servicing Practices and Retrofitting of Ice Candy Plants with OTC

Two Workshops on Good Servicing Practices and Retrofitting of Ice Candy Plants with Open Type Compressors (OTC) from CFC-12 to HCFC-22 were organised by the Project Management Unit (PMU), Ozone Cell as per the schedule given under:-

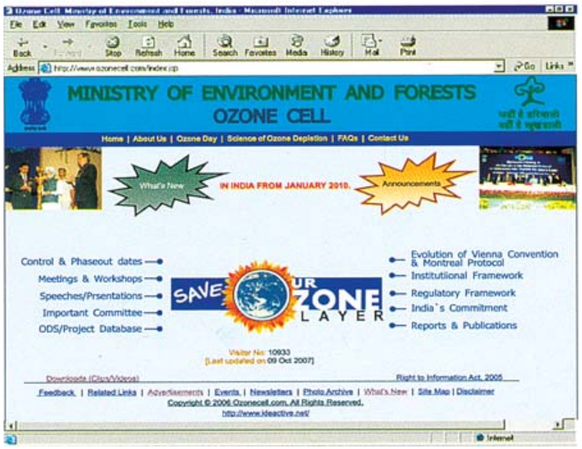
SNo	Date	Place	State
1	29.11.2008	Srinagar	J&K
2	13.12.2008	Bhopal	Madhya Pradesh

The workshops were attended by a total of 67 participants from the two places.

In addition to this, Workshops and Seminars are also being organised on a regular basis for interaction with industry, Government bodies etc.

Website

The Ozone Cell first launched its website in the year 1999. An interactive website of ozone cell has been re-developed and uploaded on the web in public domain for viewing and retrieving information. www.ozonecell.com



Monitoring System in India

A detailed monitoring mechanism has been established by the Ozone Cell to ensure that the funding support provided from the MLF through implementing agencies, is being fruitfully utilized by the enterprises. The key aspects relating to monitoring mechanism are given below:

A Monitoring and Evaluation Sub Committee set up under the Chairmanship of Special Secretary/ Additional Secretary, MoEF, including representatives from four implementing agencies, other line Ministries and industry associations, regularly monitors the implementation of ODS phase out programme. The Sub-Committee is an advisory body to the ESC on the Montreal Protocol, which is fully responsible for the implementation of the Protocol in India.

The Director (Ozone Cell) has been convening regular meetings with representatives of WB, UNEP, Bilateral Agencies, UNDP, IDBI and UNIDO with a view to note the progress of implementation and to sort out short term problems, which might occur during the implementation process. Further, Director, Ozone Cell is holding periodic meetings with industries to monitor their implementation progress for ODS phaseout.

Site inspections of the projects under implementation are carried out. Normally, during the course of the year, implementing agencies send three to four missions to visit sites where project implementation work is going on and where projects have been completed and handover protocols are to be signed. An officer of MOEF is accompanying the mission of the implementing agency with a view to evaluate the work being done by the enterprises. It is also proposed to send a team of officers to the project sites to ensure that the enterprises have not reverted back to using ODS and that the new technologies in the respective enterprises have been put in place. These visits are being planned on a quarterly basis.

Key to Success

India attributes its success in achieving rapid progress of ODS phase out to the following:

- Identifying the priority sub-sectors for early phase-out.
- Choosing wisely a project portfolio with the right mix of investment and non-investment activities.
- Involving key stakeholders early in the phase-out process at both the planning and implementation level.
- Sending clear messages from the Government to various stakeholders by notifying appropriate regulations and policies.
- Awareness raising activities for key target audiences.
- Recognizing early the importance of building local capacity through training.
- Increasing the capacity of the Ozone Cell by its active involvement in the Regional Network of ODS officers and other international fora.
- Implementation of National Strategy for Transition to Non-CFC MDIs and Plan for Phase-out of CFCs in the Manufacturing of Pharmaceutical MDIs in India.
- The Essential Use Nominations (EUN) for CFCs for manufacturing of MDIs for catering the needs of Asthma and Chronic Obstructive Pulmonary Disease (COPD) patients during the transition period.
- Preparation of HCFC Phase-out Management Plan (HPMP) for the 2013 freeze, average of 2009 and 2010 production and consumption respectively and 10% reduction in 2015.
- To create awareness among the stakeholders producing and using HCFCs.
- Monitoring of production and consumption sectors for complete phaseout of ODS.
- Mechanism for more involvement of State level organizations in ODS phaseout activities.

3 How Can You Help To Protect The Ozone Layer

"Being Ozone friendly" means taking individual action to reduce and eliminate impacts on the stratospheric ozone layer caused by the products that you buy, the appliances and equipment that your household or business uses, or the manufacturing process used by your company. Products made with, or containing ODSs such as CFCs, CTC, HCFCs, halons, methyl chloroform and methyl bromide can contribute to ozone layer depletion.

Actions individuals can take to help protect the ozone layer:

Be an Ozone-friendly consumer

Buy products (aerosol spray cans, refrigerators, fire extinguishers, etc.) that are labelled "ozone friendly" or "CFC free". The product labels should indicate that they do not contain ODSs such as CFCs or halons. Ask for more information from the seller to ensure that the product is ozone friendly. Tell your neighbour that you are the proud owner of "ozone friendly" products.

Be an ozone-friendly homeowner

Dispose of old refrigerators and appliances responsibly. CFC and HCFC refrigerants should be removed from an appliance before it is discarded. Portable halon fire extinguishers that are no longer needed should be returned to your fire protection authority for recycling. Consider purchasing new fire extinguishers that do not contain halon (e.g. dry powder) as recommended by your fire protection authority.

Be an ozone-friendly farmer

If you use methyl bromide for soil fumigation, consider switching to effective and safe alternatives that are currently being used in many countries to replace this ozone damaging pesticide. Consider options such as integrated pest management that do not rely on costly chemical inputs. If you don't currently use methyl bromide, don't begin to use it now (you will have to get rid of it in the future).

Be an ozone-friendly refrigeration servicing technician

Ensure that the refrigerant you recover from air conditioners, refrigerators or freezer during servicing is not "vented" or released to the atmosphere. Regularly check and fix leaks before they become a problem. Help start a refrigerant recovery and recycling programme in your area.

Be an ozone-friendly office worker

Help your company identify which existing equipment (e.g. water coolers, air conditioners, cleaning solvents, fire extinguishers), and what products it buys (aerosol sprays, foam cushions/ mattresses) use ODSs, and develop a plan for replacing them with cost-effective alternatives. Become an environmental leader within your office.

Be an ozone-friendly company

Replace ODSs used in your premises and in your manufacturing processes (contact your National Ozone Unit to see if you are eligible for financial and technical assistance from the MLF. If your products contain ODSs, change your product formulation to use alternative substances that do not destroy the ozone layer.

Be an ozone-friendly teacher

Inform your students about the importance of protecting the environment and in particular, the ozone layer. Teach students about the damaging impact of ODSs on the atmosphere, health impacts and what steps are being taken internationally and nationally to solve this problem. Encourage your students to spread the message to their families.

Be an ozone-friendly community organizer

Inform your family, neighbors and friends about the need to protect the ozone layer and help them get involved. Work with Non-Governmental Organizations (NGOs) to help start information campaigns and technical assistance projects to phase out ODSs in your city, town or village.

Be an ozone-friendly citizen

Read and learn more about the effects of ozone depletion on people, animals and the environment, your national strategy and policies to implement the Montreal Protocol, and what the phase out of ozone depleting substances means to your country. Get in touch with your country's National Ozone Unit and learn how you can get involved on an individual level.

Website: **www.ozonecell.com**

4 Ozone in Our Atmosphere

Twenty Questions and Answers about the Ozone Layer

Q.1. : What is ozone and where is it in the atmosphere?

Ozone is a gas that is naturally present in our atmosphere. Each ozone molecule contains three atoms of oxygen and is denoted chemically as O3. Ozone is found primarily in two regions of the atmosphere. About 10% of atmospheric ozone is in the troposphere, the region closest to Earth (from the surface to about 10-16 kilometres (6-10miles)). The remaining 90% of ozone resides in the stratosphere, primarily between the top of the troposphere and about 50 kilometres (31 miles) altitude. The large amount of ozone in the stratosphere is often referred to as the "ozone layer".

Q.2. : How is ozone formed in the atmosphere?

Ozone is formed throughout the atmosphere in multistep chemical processes that require sunlight. In the stratosphere, the process begins with the breaking apart of an oxygen molecule (O2) by ultraviolet radiation from the Sun. In the lower atmosphere (troposphere), ozone is formed in a different set of chemical reactions involving hydrocarbons and nitrogen-containing gases.

Q.3. : Why do we care about atmospheric ozone?

Ozone in the stratosphere, absorbs some of the Sun's biologically harmful ultraviolet radiation. Because of this beneficial role, stratospheric ozone is considered "good ozone". In contrast, ozone at Earth's surface that is formed from pollutants is considered "bad ozone" because it can be harmful to humans, plants and animal life. Some ozone occurs naturally in the lower atmosphere where it is beneficial because ozone helps remove pollutants from the atmosphere.

Q.4. : Is total ozone uniform over the globe?

No, the total amount of ozone above the surface of Earth varies with location on the time scales that range from daily to seasonal. The variations are caused by stratospheric winds and chemical production and destruction of ozone. Total ozone is generally lowest at the equator and highest near the poles because of the seasonal wind patterns in the stratosphere.

Q.5. : How is ozone measured in the atmosphere?

The amount of ozone in the atmosphere is measured by instruments on the ground and carried aloft in balloons, aircraft, and satellites. Some measurements involve drawing air into an instrument that contains a system for detecting ozone. Other measurements are based on ozone's unique absorption of light in the atmosphere. In that case, sunlight or laser light is carefully measured after passing through a portion of the atmosphere containing ozone.

Q.6. : What are the principal steps in stratospheric ozone depletion caused by human activities?

The initial step in the depletion of stratospheric ozone by human activities is the emission of ozone-depleting gases containing chlorine and bromine at Earth's surface. Most of these gases accumulate in the lower atmosphere because they are unreactive and do not dissolve readily in rain or snow. Eventually, the emitted gases are transported to the stratosphere where they are converted to more reactive gases containing chlorine and bromine. These more reactive gases then participate in reactions that destroy ozone. Finally, when air returns to the lower atmosphere, these reactive chlorine and bromine gases are removed from Earth's atmosphere by rain and snow.

Q.7. : What emissions from human activities lead to ozone depletion?

Certain industrial processes and consumer products result in the atmospheric emission of "halogen source gases". These gases contain chlorine and bromine atoms, which are known to be harmful to the ozone layer. For example, the CFCs and HCFCs, once used in almost all refrigeration and air conditioning systems, eventually reach the stratosphere where they are broken apart to release ozone-depleting chlorine atoms. Other examples of human-produced ozone-depleting gases are the "halons", which are used in fire extinguishers and contain ozone-depleting bromine atoms. The production and consumption of all principal halogen source gases by human activities are regulated worldwide under the Montreal Protocol.

Q.8. : What are the reactive halogen gases that destroy stratospheric ozone?

Emissions from human activities and natural processes are large sources of chlorine-and bromine-containing gases for the stratosphere. When exposed to ultraviolet radiation from the Sun, these halogen source gases are converted to more reactive gases also containing chlorine and bromine. Important examples of the reactive gases that destroy stratospheric ozone are Chlorine Monoxide (ClO) and Bromine Monoxide (BrO). These and other reactive gases participate in "catalytic" reaction cycles that efficiently destroy ozone. Volcanoes can emit some chlorine-containing gases, but these gases are ones that readily dissolve in rainwater and ice and are usually "washed out" of the atmosphere before they can reach the stratosphere.

Q.9. : What are the chlorine and bromine reactions that destroy stratospheric ozone?

Reactive gases containing chlorine and bromine destroy stratospheric ozone in "catalytic" cycles made up of two or more separate reactions. As a result, a single chlorine or bromine atom can destroy many hundreds of ozone molecules before it reacts with another gas, breaking the cycle. In this way, a small amount of reactive chlorine or bromine has a large impact on the ozone layer. Special ozone destruction reactions occur in Polar Regions because the reactive gas chlorine monoxide reaches very high levels there in the winter/ spring season.

Q.10. : Why has an "ozone hole" appeared over Antarctic when ozone-depleting gases are present throughout the stratosphere?

Ozone-depleting gases are present throughout the stratospheric ozone layer because they are transported great distances by atmospheric air motions. The severe depletion of the Antarctic ozone layer known as the "ozone hole" forms because of the special weather conditions that exist there and nowhere else on the globe. The very cold temperatures of the Antarctic stratosphere create ice clouds called Polar Stratospheric Clouds (PSCs). Special reactions that occur on PSCs and the relative isolation of Polar stratospheric air allow chlorine and bromine reactions to produce the ozone hole in Antarctic springtime.

Q.11. : How severe is the depletion of the Antarctic ozone layer?

Severe depletion of the Antarctic ozone layer was first observed in the early 1980s. Antarctic ozone depletion is seasonal, occurring primarily in late winter and spring (August-November). Peak depletion occurs in October when ozone is often completely destroyed over a range of altitudes, reducing overhead total ozone by as much as two-thirds at some locations. This severe depletion creates the "ozone hole" in images of Antarctic total ozone made from space. In most years the maximum area of the ozone hole usually exceeds the size of the Antarctic continent.

Q.12. : Is there depletion of the Arctic ozone layer?

Yes, significant depletion of the Arctic ozone layer now occurs in some years in the late winter/spring period (January-April). However, the maximum depletion is generally less severe than that observed in the Antarctic and is more variable from year to year. A large and recurrent "ozone hole", as found in the Antarctic stratosphere, does not occur in the Arctic.

Q.13. : How large is the depletion of the global ozone layer?

The ozone layer has been depleted gradually since 1980 and now is about an average of 3 % lower over the globe. The depletion, which exceeds the natural variations of the ozone layer, is very small near the equator and increases with latitude toward the poles. The large average depletion in Polar Regions is primarily a result of the late winter/spring ozone destruction that occurs there annually.

Q.14. : Do changes in the Sun and Volcanic eruptions affect the ozone layer?

Yes, factors such as changes in solar radiation, as well as the formation of stratospheric particles after volcanic eruptions, do influence the ozone layer. However, neither factor can explain the average decreases observed in global total ozone over the last two decades. If large volcanic eruptions occur in the coming decades, ozone depletion will increase for several years after the eruption.

Q.15. : Are there regulations on the production of ozone-depleting gases?

Yes, the production of ozone-depleting gases is regulated under a 1987 international agreement known as the "Montreal Protocol on Substances that Deplete the Ozone Layer" and its subsequent Amendments and Adjustments. The Protocol, now ratified by 196 nations, establishes legally binding controls on the national production and consumption of ODSs.

Production and consumption of all principal halogen-containing gases by developed and developing nations will be significantly reduced or phased out before the middle of the 21st century.

Q.16. : Has the Montreal Protocol been successful in reducing ozone-depleting gases in the atmosphere?

Yes, as a result of the Montreal Protocol, the total abundance of ozone-depleting gases in the atmosphere has begun to decrease in recent years. If the nations of the world continue to follow the provisions of the Montreal Protocol, the decrease will continue throughout the 21st century. Some individual gases such as halons and HCFCs are still increasing in the atmosphere, but will begin to decrease in the next decades, if compliance with the Protocol continues. By mid-century, the effective abundance of the ozone-depleting gases should fall to values before the Antarctic "ozone hole" began to form in the early 1980s.

Q.17. : Does depletion of the ozone layer increase ground-level ultraviolet radiation?

Yes, ultraviolet radiation at Earth's surface increases as the amount of overhead total ozone decreases, because ozone absorbs ultraviolet radiation from the Sun. Measurements by ground-based instruments and estimates made using satellite data have confirmed that surface ultraviolet radiation has increased in regions where ozone depletion is observed.

Q.18. : How will recovery of the ozone layer be detected?

Scientists expect to detect the recovery of the ozone layer with careful comparisons of the latest ozone measurements with past values. Changes in total overhead ozone at various locations and in the extent and severity of the Antarctic "ozone hole" will be important factors in gauging ozone recovery. Natural variations in ozone amounts will limit how soon recovery can be detected with future ozone measurements.

Q.19. : When is the ozone layer expected to recover?

The ozone layer is expected to recover by the middle of the 21st century, assuming global compliance with the Montreal Protocol. Chlorine and bromine-containing gases that cause ozone depletion will decrease in the coming decades under the provisions of the Protocol. However, volcanic eruptions in the next decades could delay ozone recovery by several years and the influence of climate change could accelerate or delay ozone recovery.

Release of Sticker on the occasion of International Ozone Day-2008 celebrated on 16th September, 2008 at FICCI Auditorium, New Delhi

Distribution of prizes to school children on the occasion of International Ozone Day-2008 celebrated on 16th September, 2008 at FICCI Auditorium, New Delhi

National Seminar for Information Dissemination on ODS Phase-out in Military applications organized by Ozone Cell, UNEP and Headquarters Technical Group EME held on 29th April, 2009 at New Delhi

Dr. A. Duraisamy, Director, Ozone Cell presenting a paper on "Implementation of Montreal Protocol in India" at the National Seminar on Combating Climate Change by Management of ODS in Defence Applications held on 29th April, 2009 at New Delhi

POSTER COMPETITION (04-09-2009)

Ist Prize
Mohit, Evergreen Public School, New Delhi

2nd Prize
Nivea Bari, B.B.P. School, New Delhi

3rd Prize
Shweta, J.N.V,, Modi Nagar, U.P.

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