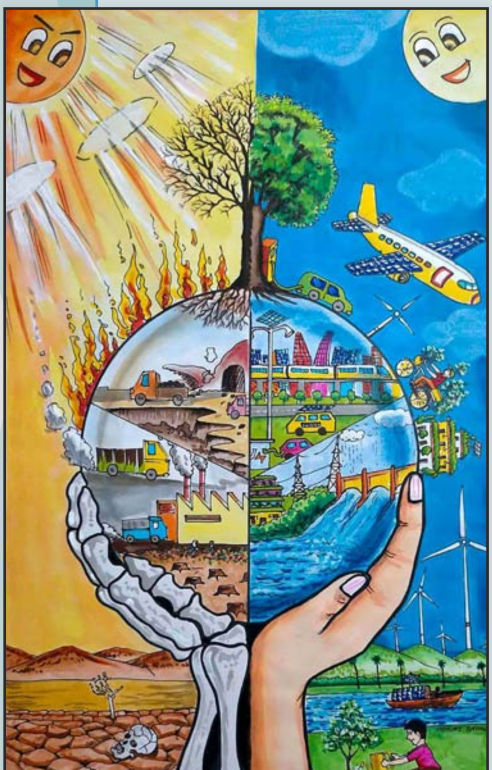
Montreal Protocol: fixing the ozone layer and reducing climate change

THE MONTREAL PROTOCOL INDIA'S SUCCESS STORY

सत्यमेव जयते

OZONE CELL
MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE
GOVERNMENT OF INDIA
NEW DELHI, INDIA

Poster Making Competition



1ST PRIZE

Moturi Sathwik

Sri Chaitanya Techno School,
Aryapuram, opp. Fire Station,
Rajamahendra Varam, East Godavari,
Andhra Pradesh

2ND PRIZE

Devika Dev

Sacred Heart
Public School (SHPS),
S H Mount P. O.,
Kottayam, Kerala

3RD PRIZE

Pranshi Sharma

DAV Public School
Sector – 14, Gurugram ,
Haryana

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INDIA'S SUCCESS STORY

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OZONE CELL
MINISTRY OF ENVIRONMENT,
FOREST AND CLIMATE CHANGE
GOVERNMENT OF INDIA
NEW DELHI, INDIA
SEPTEMBER, 2023

मंत्री
पर्यावरण, वन एवं जलवायु परिवर्तन
और
श्रम एवं रोजगार
भारत सरकार

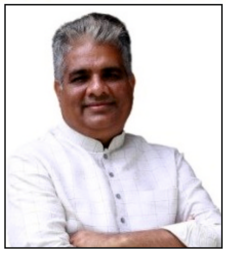
सत्यमेव जयते

MINISTER
ENVIRONMENT, FOREST AND CLIMATE CHANGE
AND
LABOUR & EMPLOYMENT
GOVERNMENT OF INDIA

स्वच्छ भारत
एक कदम स्वच्छता की ओर

भूपेन्द्र यादव
BHUPENDER YADAV

आज़ादी का अमृत महोत्सव



MESSAGE

The Montreal Protocol, an international environmental treaty for protection of the Stratospheric Ozone Layer, has been and will continue to be instrumental in protecting human health, nature and the climate, through phasing out production and consumption of controlled substances. By eliminating ozone-depleting substances and allowing the ozone layer to slowly recover, the Montreal Protocol has protected millions of people from skin cancer and eye cataracts, thus safeguarding ecosystems.

India, as a Party since 1992, has been proactively implementing the Montreal Protocol through setting up well established regulatory and policy measures in the country, besides following a structured and effective implementation framework. India has not only successfully fulfilled all its commitments to the Protocol, but also has been ahead of target of the Montreal Protocol.

During the year 2023, India will start implementation of stage III of the Hydrochlorofluorocarbons (HCFCs) Phase out Management Plan (HPMP), which will go on till 2030, by that time complete phase out of HCFCs has to be achieved for controlled applications. Phase out of HCFCs in manufacturing of new HCFC based equipment has to be achieved by 31.12.2024. Implementation of HPMP Stage-III will enable India to achieve compliance targets of HCFCs for the years 2025 and 2030 under the Montreal Protocol. In addition, GHG mitigation benefits are expected to be accrued by the implementation of HPMP Stage-III are of 7,250,223.75 t.CO2- eq.

Towards preparing for HFC phase down to be implemented by India from 2032 to 2047, the Ministry of Environment, Forest and Climate Change is working on developing of a National strategy for HFC phase down, to be completed by end of 2023. To implement HFC phase down in a sustainable way without undue burden to the industry or economy, the Ministry is developing a road map along with an action plan to encourage domestic manufacturing of next generation low GWP refrigerants, cooling appliances along with safety standards and upgradation of skill of the existing manpower for wider adoption of such refrigerants during the phase down of HFCs under the Kigali Amendment. The implementation of the recommendations of the India Cooling Action Plan (ICAP) will also go on in parallel towards achieving sustainable cooling, following an integrated approach.

India's achievements in the implementation of the Montreal Protocol are highlighted through the publication "India's Success Story" released each year on the World Ozone Day.

World Ozone Day is an occasion to celebrate the success achieved in the Montreal Protocol implementation and on the 29th World Ozone Day, India reiterates its commitment to protect the Ozone layer.

Date: 14 .09.2023 **(Bhupender Yadav)**

पर्यावरण भवन, जोर बाग रोड़, नई दिल्ली-110003, फोन : 011-20819190, 011-20819225, फैक्स: 011-20819299
Paryavaran Bhawan, Jor Bagh Road, New Delhi-110003, Tel.: 011-20819190, 011-20819225, Fax : 011-20819299
ईमेल / E-mail : mefcc@gov.in

अश्विनी कुमार चौबे
Ashwini Kumar Choubey

सत्यमेव जयते

आहारशुद्धौ सत्त्वशुद्धिः

स्वच्छ भारत
एक कदम स्वच्छता की ओर

राज्य मंत्री
पर्यावरण, वन एवं जलवायु परिवर्तन
उपभोक्ता मामले, खाद्य और सार्वजनिक वितरण
भारत सरकार
MINISTER OF STATE
ENVIRONMENT, FOREST AND CLIMATE CHANGE
CONSUMER AFFAIRS, FOOD & PUBLIC DISTRIBUTION
GOVERNMENT OF INDIA

संदेश

ओजोन परत का क्षय करने वाले पदार्थों से संबंधित मॉन्ट्रियल प्रोटोकॉल को सबसे सफल अंतर्राष्ट्रीय पर्यावरण संधि माना जाता है। मॉन्ट्रियल प्रोटोकॉल के तहत, वैज्ञानिकों और उद्योगपतियों ने एक साथ मिलकर रेफ्रिजरेटर, एयर-कंडीशनर और ऐसे ही कई अन्य उत्पादों में प्रयोग होने वाले सभी ओजोन-क्षयकारी पदार्थों को 99 प्रतिशत तक हटाने के लिए काम किया। जिसके कारण ओजोन परत अब ठीक हो रही है और इसके वर्ष 2060 तक वर्ष 1980 से पहले के स्तर तक पहुंच जाने की उम्मीद है।

वर्ष 2019 में हुआ किगाली संशोधन, मॉन्ट्रियल प्रोटोकॉल एक महत्वपूर्ण संशोधन है। जिसके अंतगर्त हाइड्रोफ्लोरोकार्बन (एचएफसी) जैसी ग्रीनहॉउस गैंसों को कम करने का प्रावधान किया गया है, जिससे विश्व को पर्यावरण संरक्षण के कार्य में एक सकारात्मक दिशा मिलेगी। वैकल्पिक गैर-एचएफसी और कम-ग्लोबल वार्मिंग पोटेंशियल (जीडब्ल्यूपी) प्रौद्योगिकियों को परिपक्व होने के अभाव में हाइड्रोफ्लोरोकार्बन (एचएफसी) को कम करना एक चुनौतीपूर्ण कार्य है। विभिन्न क्षेत्रों में प्रशीतन का उपयोग बढ़ता जा रहा है, जो कि एक विकासपरक आवश्यकता बन गई है और इसे सतत विकास के लक्ष्यों को प्राप्त करने की प्रक्रिया से जोड़कर देखा जाता है।

विश्व ओजोन दिवस मॉन्ट्रियल प्रोटोकॉल के कार्यान्वयन की उपलब्धियों का अवलोकन करने और प्रमुख वैश्विक चुनौतियों को हल करने का एक अवसर है, जो विज्ञान द्वारा निर्देशित सभी पक्षों के सामूहिक निर्णयों और कार्यों के कारण संभव हुआ है।

मॉन्ट्रियल प्रोटोकॉल, भारत की सफलता की कहानी का एक ऐसा उपयोगी दस्तावेज है, जो समतापमंडलीय ओजोन परत के संरक्षण की दिशा में भारत के योगदान के साथ-साथ इसकी उपलब्धियों को भी दर्शाता है।

(अश्विनी कुमार चौबे)

कार्यालय: 5वां तल, आकाश विंग, इंदिरा पर्यावरण भवन, जोर बाग रोड, नई दिल्ली-110003, दूरभाष: 011-20819418, 011-20819421, फैक्स: 011-20819207, ई-मेल : mos.akc@gov.in
Office : 5th Floor, Aakash Wing, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi-110003, Tel.: 011-20819418, 011-20819421, Fax : 011-20819207, E-mail : mos.akc@gov.in
कार्यालय: कमरा नं.173, कृषि भवन, नई दिल्ली-110001, दूरभाष : 011-23380630, फैक्स: 011-23380632
Office : Room No. 173, Krishi Bhawan, New Delhi-110001, Tel. : 011-23380630, Fax : 011-23380632
निवास: 30, डॉ. एपीजे अब्दुल कलाम रोड, नई दिल्ली-110003, दूरभाष : 011-23794971, 23017049
Residence : 30, Dr. APJ Kalam Road, New Delhi-110003, Tel.: 011-23794971, 23017049

लीना नन्दन
LEENA NANDAN

सत्यमेव जयते

सचिव
भारत सरकार
पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय
SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT, FOREST
& CLIMATE CHANGE

MESSAGE

The Montreal Protocol has been a heartening story of effective international cooperation leading in turn to the successful implementation of a global agreement. The swiftness with which the world community acted for eliminating the ozone depleting substances has been a remarkable achievement. The phase out of Ozone Depleting Substances, besides protecting the ozone layer, has the additional benefit of protecting the climate.

India has taken progressive measures to phase out designated controlled substances and is in compliance with the Montreal Protocol control schedule. During the technology transition phase, India leapfrogged to non-ozone depleting substances and low-global warming potential alternative technologies, taking into account national circumstances and industry needs, thus showing responsibility and commitment towards achieving its development goals in an environmentally sustainable manner. The launch of the India Cooling Action Plan and implementation of its recommendations through specific action points has resulted in India taking a leadership position with respect to efforts for achieving sustainable cooling.

Besides phase out of Hydrochlorofluorocarbons (HCFCs) in the manufacturing of new equipment by December 31, 2024, strengthening the servicing sector will be a key area. Unified training and certification of the Refrigeration and Air-conditioning (RAC) service technicians and developing capacities on handling flammable and toxic refrigerants will be taken up on priority. This would enable the servicing sector to be sustainable by 2030, by which time the complete phase out of HCFCs for controlled applications would have been achieved in line with the Montreal Protocol schedule.

World Ozone Day is an occasion to show-case achievements in the implementation of the Montreal Protocol and the country's commitment towards protecting the Ozone Layer, as well as its proactive approach towards addressing the challenges of climate change.

(Leena Nandan)

New Delhi,
September 12, 2023.

इंदिरा पर्यावरण भवन, जोर बाग रोड़, नई दिल्ली-110 003 फोन : (011)-2081-9408, 2081-9308, फैक्स : (011)-2081-9238
INDIRA PARYAVARAN BHAWAN, JOR BAGH ROAD, NEW DELHI-110 003, PH. : 011-2081-9408, 2081-9308, FAX : 011-2081-9238
E-mail : secy-moef@nic.in, Website : moef.gov.in

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 a 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 attribute of the earth's atmosphere that allows 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.

Earth's Atmospheric Layers

Troposphere

The troposphere starts at the earth's surface and extends 8 to 14.5 kilometers (km) high (5 to 9 miles). This part of the atmosphere is the most dense. Almost all weather is created in this region.

Stratosphere

The stratosphere starts just above the troposphere and extends to 50 km (31 miles) high. The ozone layer, which absorbs and scatters the solar ultraviolet radiation, is in this layer.

Mesosphere

The mesosphere starts just above the stratosphere and extends to 85 km (53 miles) high. Meteors burn up in this layer.

Thermosphere

The thermosphere starts just above the mesosphere and extends to 600 km (372 miles) high. Aurora occur and satellites orbit in this layer.

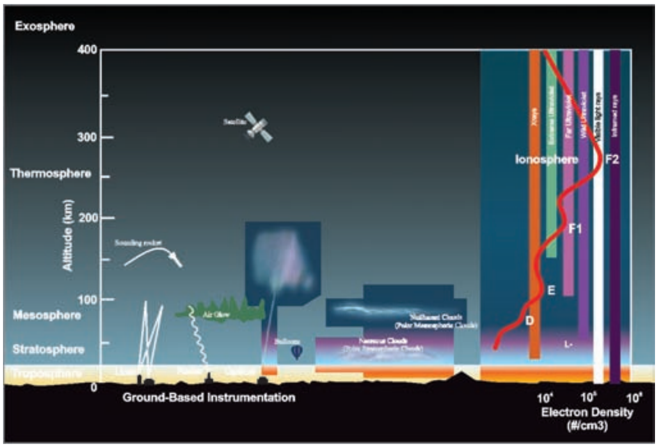
Ionosphere

The ionosphere is an abundant layer of electrons and ionized atoms and molecules that stretches from about 48 km (30 miles) above the surface to the edge of space at about 965 km (600 miles), overlapping into the mesosphere and thermosphere. This dynamic region grows and shrinks based on solar conditions and divides further into the sub-regions: D, E and F, based on what wavelength of solar radiation is absorbed. The ionosphere is a critical link in the chain of sun-earth interactions. This region is what makes radio communications possible.

Exosphere

This is the upper limit of our atmosphere. It extends from the top of the thermosphere up to 10,000 km (6,200 miles).

Earth's Atmospheric Layers

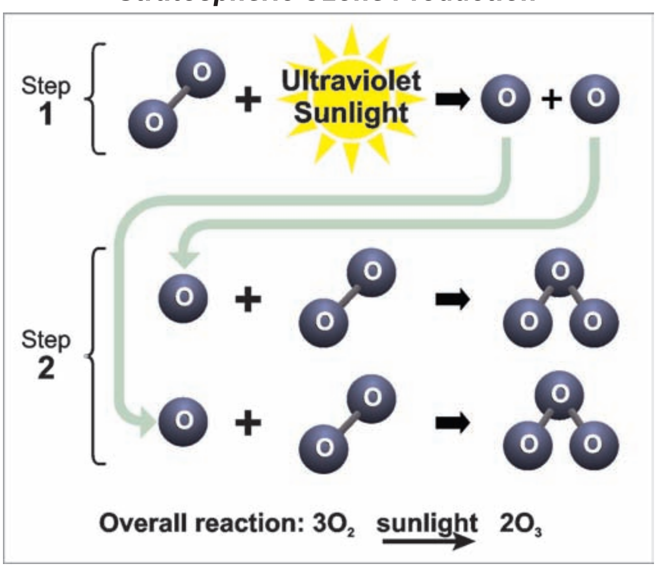


Source: The National Aeronautics and Space Administration (NASA)

Concentration of Ozone in the Atmosphere

Ozone is a tri-atomic molecule of oxygen formed from oxygen in the upper levels of the earth's atmosphere by high- energy ultraviolet (UV) radiation from the sun. The radiation breaks down oxygen molecules, releasing free atoms, some of which bond with other oxygen molecules to form ozone.

Stratospheric Ozone Production



About 90 per cent of all ozone formed in this way lies between 10 km and 50 km above the Earth's surface – this part of the atmosphere is 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 km, is only 1 parts per million. The ozone layer was discovered in 1913 by the French physicists Charles Fabry and Henri Buisson.

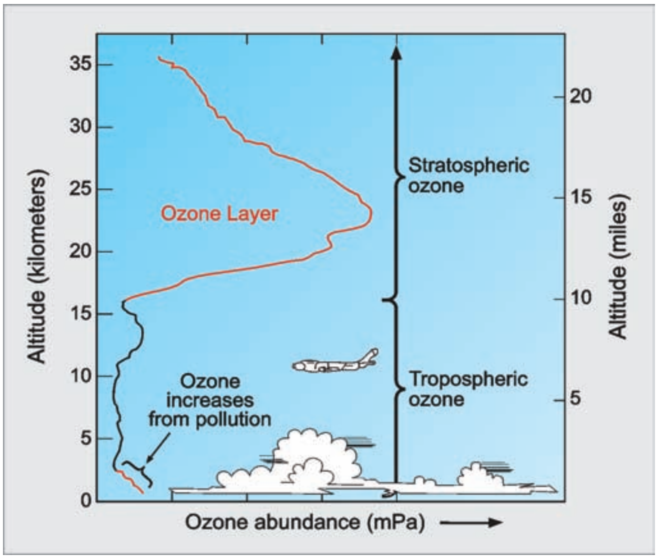
Since solar radiation is the strongest over the tropics, the global ozone is formed in tropics. However, strong solar radiation also causes rise of air to high altitudes and ozone is transported away from the equator towards the poles where it accumulates in the cold sub-polar regions. At the equatorial region formation and photochemical depletion of ozone take place simultaneously and ozone cannot accumulate in this region. In the polar region there is accumulation of ozone because photochemical depletion is low and due to transport of ozone from the 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 at any point from the earth's surface to the Stratosphere is quantified in Dobson Units (DU). One hundred DU equals the quantity of ozone that would form a 1mm thick layer at sea level if compressed at Standard Temperature and Pressure (STP).

Typical distribution of ozone is about 240 DU near the Equator with a maximum of 440 DU during early spring at high latitudes in the Arctic and 360 DU in the Antarctic. When the concentration of ozone, over any area, falls below 220 DU, we call it an Ozone Hole.

Ozone is an unstable molecule. High-energy radiation from the sun not only creates ozone, but also breaks itto oxygen, recreating molecular oxygen and free oxygen atoms. The concentration of ozone in the atmosphere depends on a dynamic

Concentration of Ozone in the Atmosphere



balance between creation and destruction of ozone.

What is the Ozone Layer?

The ozone layer is a term used to describe the presence of ozone molecules in the stratosphere. The layer stretches around the earth like a bubble and acts as a filter for the harmful UV radiation (UV–B). UV–B radiation is a highly energetic light that originates from the sun and has severe impacts on human health and the environment.

Good and Bad Ozone

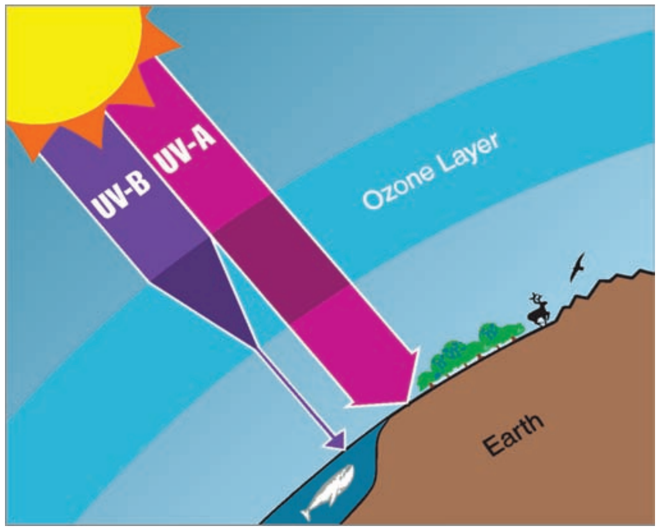
"Good" ozone is produced naturally in the stratosphere and is good because it blocks harmful UV radiations from reaching the earth's surface.

Ozone is also present in the lower levels of the atmosphere (i.e., the troposphere), but in much 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 exist in the troposphere.

However, elevated concentrations of ozone at ground level are found in some regions, mainly as a result of pollution. Burning of 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. Bad ozone is an air pollutant and is bad because it is harmful to breathe and can damage crops, trees, other vegetation, plastics, rubbers etc.. Ground-level ozone is a main component of urban smog.

There is little connection between ground-level ozone and the stratospheric ozone layer. Whereas

UV Protection by the Ozone Layer



the 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 UV radiation, the effect is negligible.

Why is the ozone layer so important?

Ozone absorbs UV-B radiation from the sun. When an ozone molecule absorbs UV-B, it breaks apart into an oxygen molecule (O2) and a separate oxygen atom (O). Later, the two components can reform the ozone molecule (O3). By absorbing UV-B in the stratosphere, the ozone layer prevents harmful levels of this radiation from reaching Earth's surface.

Measurement of Ozone in the Atmosphere

Ozone is spread from the surface of earth upto the top of the stratosphere, 50 km, as a very thin layer. The question often asked is how is the concentration of ozone in this thin layer measured and quantified with reasonable accuracy.

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

Generally, the following 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 254 nanometers (nm). 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 (ppt) by volume.

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 sunlight or direct full moonlight and satellite-based instruments, measuring the solar UV radiation scattered back to space by the earth's atmosphere. The most commonly ground-based instruments by the World Meteorological Organization (WMO) global ozone network are the Dobson and Brewer Spectrophotometers.

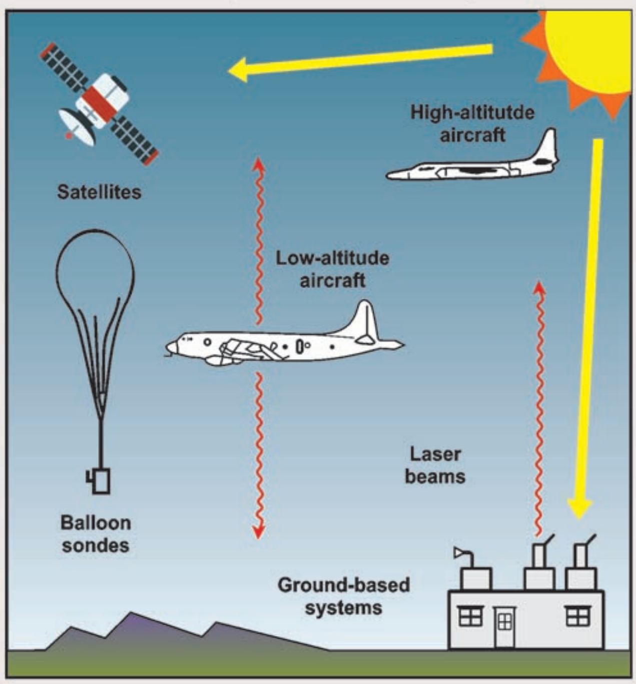
The most accurate and best defined method for determining total ozone is to measure direct solar radiation from ground at UV wave bands between 305 and 340 nm.

Dobson instrument measures spectral intensities at three wavelength pairs and the Brewer spectrophotometer at five operational wavelengths. Moonlight 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 the National Oceanic and Atmospheric Administration (NOAA) subtropical high-altitude observatory at Mauna Loa, Hawaii where other interfering air pollutants like Sulfur dioxide (SO_2), Nitrous Oxide (NOx), aerosols etc. are absent.

Vertical profile of ozone is measured with (a) Ozonesondes (b) Ground-based Dobson and Brewer Spectrophotometers using light from zenith sky during twilight using the Umkher inversion method and (c) laser radars (Light Detection and Ranging (LIDAR)).

Ozonesondes 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-borne ascent to an altitude of about 35 km (mid-stratosphere). They operate regularly in all climatic regions and have been the backbone of ozone profiling since 1960.

Measuring Ozone in the Atmosphere



The latest method of vertical profiling of ozone is the LIDAR system in which a short laser pulse at a wavelength 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, and the other is not which serves as a reference. The concentration of ozone measured at different heights thus gives the vertical profile.

Ozone Measurement over India

Indian Meteorological Department (IMD) is the nodal agency to measure ozone levels in India. The IMD has established a National Ozone Centre. The centre maintains and controls a network of Ozone Monitoring Stations located at New Delhi, Ranichauri, Guwahati, Nagpur, Pune, Kodaikanal, Thiruvananthapuram, Vanarasi, Port Blair and Maitri (Antarctica). The ozone data measured is regularly sent to the World Ozone Data Centre, Canada.

Ozone Monitoring Network

The IMD National Ozone Centre is designated as a secondary regional ozone centre for Regional Association II (Asia). The centre maintains a network of ozone monitoring stations including Maitri and Bharati in Antarctica.

- Total columnar ozone measurement using Brewer and Dobson spectrometer at five locations.
- Surface ozone monitoring through a network of ten stations.
- Measurement of vertical distribution of 0zone using IMD Ozonesonde

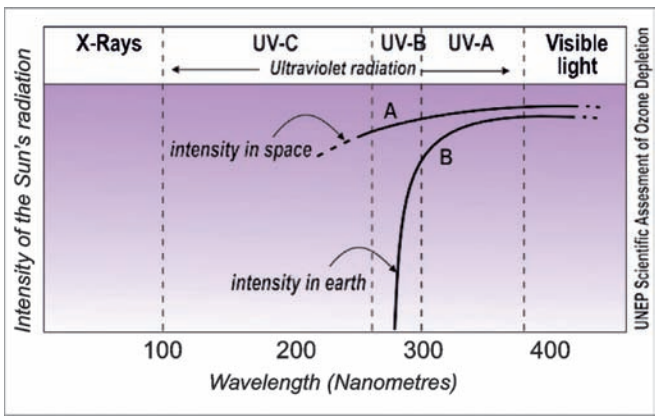
(Source: India Meteorological Department)

What is UV Radiation?

The sun emits radiation of varying wavelengths in the form of anelectromagnetic spectrum. The UV radiation is one form of radiant energy coming out of the sun. The various forms of energy, or radiation, are classified according to wavelength measured in nm. The shorter the wavelength, the more energetic the radiation. In order of decreasing energy, the principal forms of radiation are gamma rays, X-rays, UV rays, visible light, infrared rays, microwaves, and radio waves. The UV radiation, which is invisible, is so named because its wavelengths are less than those of visible violet radiation.

Of these, UV-B and UV-C being highly energetic, are harmful to life on earth; UV-A radiation being less energetic is relatively less harmful. Fortunately, UV-C radiation is absorbed strongly by oxygen and also by ozone in the upper atmosphere. As UV-B radiation is absorbed only by the stratospheric ozone (ozone layer) only 2-3% of it reaches the Earth's surface. The ozone layer, therefore, is essential for protection of life on earth by filtering out the dangerous part of the 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 life on earth. The ozone layer, therefore, acts as the earth's sunscreen.

Range of Wavelengths of UV Radiations



A - Undisturbed Ozone Layer

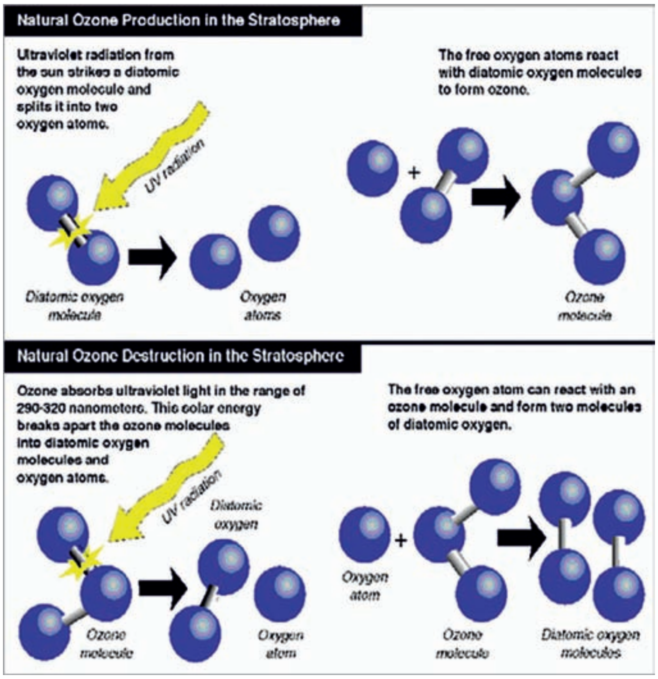
B - Disturbed Ozone Layer

Ozone Depletion

At any given time, ozone molecules are constantly being formed and destroyed in the stratosphere.

The total amount, however, remains relatively stable. The dynamic equilibrium between creating and breaking down ozone molecules depends on temperature, pressure, energetic conditions and molecule concentrations. 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.

Natural Formation and destruction of Ozone

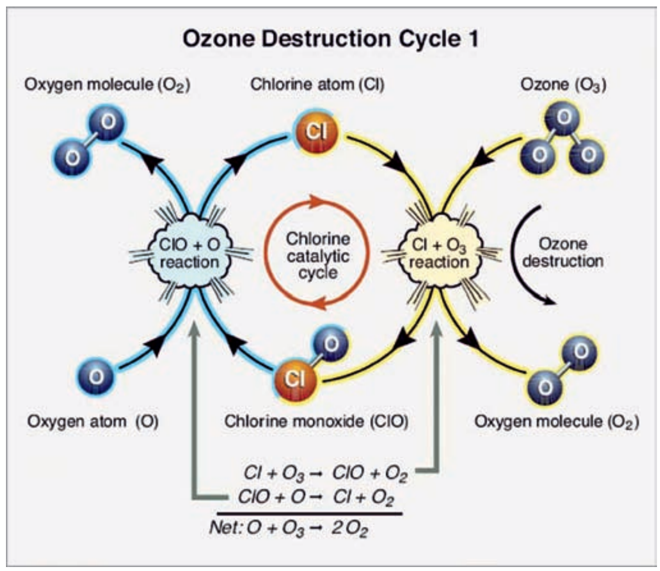


The concentrations of ozone vary naturally with sunspots, seasons, and latitudes. The processes of variation of ozone are well understood and predictable. Scientists have established records for several decades which show distribution of ozone during the natural cycles. It has been observed that each natural reduction in ozone levels has been followed by a recovery cycle. However, convincing scientific evidences have shown that the ozone layer is being depleted well beyond changes due to natural processes.

Ozone depletion occurs when the natural balance between the production and destruction of stratospheric ozone is shifted towards destruction. The equilibrium can be disturbed for instance by other molecules which react with the ozone molecules, thereby destroying them. If this destruction process is fast and the creation of new molecules is too slow to replace the destroyed ozone molecules, the equilibrium is upset. As a result, the concentration of ozone molecules is reduced. An upset in this equilibrium can have serious consequences for life on earth. Scientists are finding evidence of the changed balance. As a result, the concentration of ozone within the protective ozone shield is decreasing.

The balance between the natural processes of ozone production and destruction maintains a consistent ozone concentration in the stratosphere.

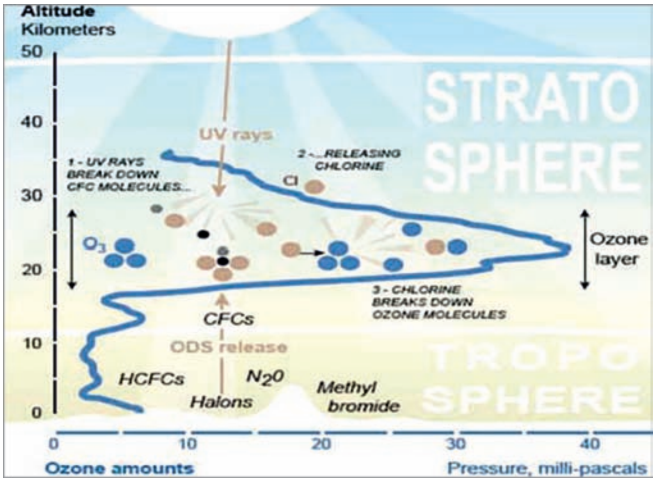
Reaction of Chlorine with Ozone



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.

Large fires, certain types of marine life and volcanic eruptions also produce chlorine molecules. These are chemically active but most of it gets converted into water soluble inorganic compounds which gets

Process of Destruction of ozone



washed down by rain and only traces reach the stratosphere. However, United States Environment Protection Agency (USEPA) experiments have shown that Chlorofluorocarbons (CFCs) and other widely used chemicals produce roughly 85% of the chlorine in the stratosphere.

It was also believed that large volcanic eruptions can have an indirect effect on ozone levels. Although, Mt. Pinatubo's 1991 volcanic eruption did not increase stratospheric chlorine concentrations, it did produce large amount of tiny particles called aerosols. These aerosols increase chlorine's effectiveness in destroying ozone.

The aerosols only increase depletion because of the presence of CFC-based chlorine. In effect, the aerosols increase the efficiency of the CFC siphon, lowering ozone levels even more than that would have otherwise occurred. Unlike long-term ozone depletion, this effect is however 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.

Beginning of Threat to Ozone Layer

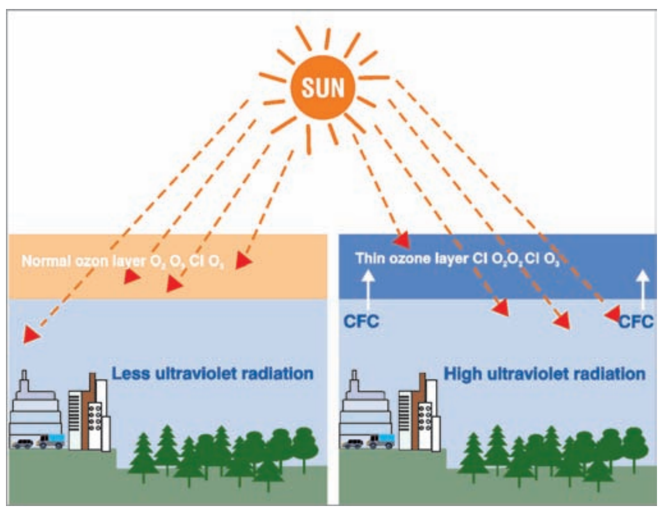
For over 50 years, CFCs were thought of as miracle substances. The first CFCs were created in 1928 as non- toxic, non-flammable refrigerants, and were first produced commercially in the 1930's by DuPont. The first CFC was CFC-12, a single carbon with two chlorines and two fluorines attached to it.

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 the period, CFCs have been used as aerosols, refrigerants, solvents and foam blowing agents in other smaller applications. Other chlorine and bromine-containing compounds include methyl chloroform, a solvent, Carbontetrachloride (CTC), an industrial chemical, halons, extremely effective fire extinguishing agents, hydrochlorofluorocarbons (HCFCs) mainly used as a refrigerant and foam blowing agent and methyl bromide, an effective fumigant used in agriculture and grain storage.

All of these compounds have very long atmospheric life which allow them to be transported by winds into the stratosphere.

During the past five decades, Ozone Depleting Substances (ODS) including CFCs, have been emitted into the atmosphere in large quantity resulting in depletion of the ozone layer and increased UV-B radiations on the earth's surface.

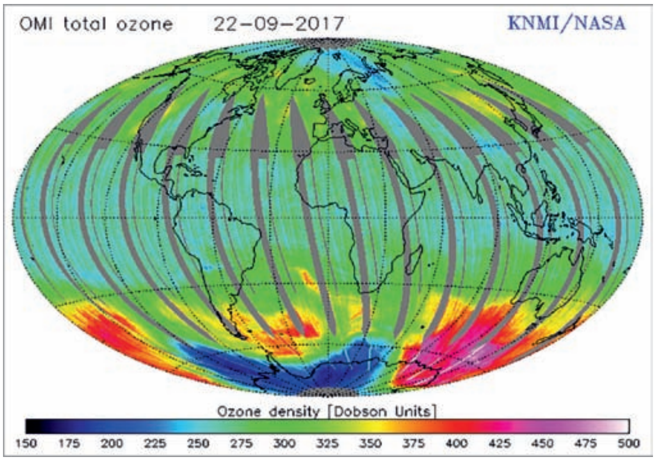
UV Radiations on Earth's Surface



The largest losses of stratospheric ozone occur regularly over the Antarctica every spring, leading to substantial increase in UV levels over the region.

A similar, though weaker, effect has been observed over the Arctic. There was enough evidence that ozone levels decrease by several percent in the spring and summer in both hemispheres at middle and high latitudes.

Status of Global Stratospheric Ozone : September, 2017



There is also a fall in ozone levels during the winter at these latitudes in the southern hemisphere. Higher levels of loss of ozone have been noticed since late 1970s.

In the early 1970s, researchers began to investigate the effect of various chemicals on the ozone layer, particularly CFCs, which contain chlorine. They also examined the potential impacts of other chlorine sources like chlorine from chlorination of water, industrial plants, sea salt and volcanoes etc. The chlorine released from such sources and from other sources readily combines with water and other chemicals and form compounds which do not reach the stratosphere. 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 these interact with UV rays of short wavelength which breaks them down.

The CFCs are so stable that only exposure to strong UV radiation breaks them down. When that happens, the CFC molecule releases atomic chlorine. It has been estimated that one chlorine atom can destroy over 100,000 ozone molecules. The net effect is the destruction of ozone faster than its natural creation. 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.

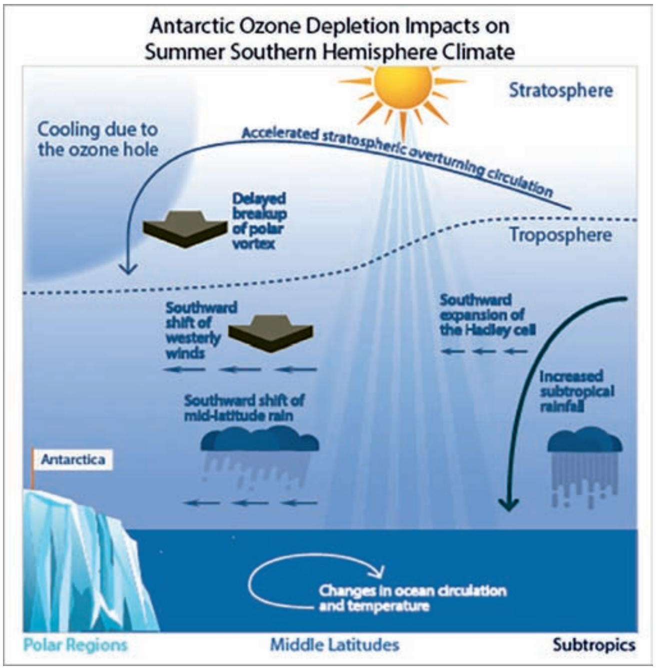
No one could imagine that these miracle chemicals could one day turn out to be substances harmful to life on earth. It all began when, at the first United Nations Human Environment Conference at Stockholm in 1972, questions were asked about the effect of jet aircraft on the upper atmosphere. It was known that 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 the 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. UNED was 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. When the concentration of ozone over any area falls below 220 DU, it is called ozone hole. The Antarctic Ozone Hole occurs during the southern spring between September and November each year. 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 by 40% from levels during the 1960s. Severe depletion has been occurring since late 1970s.

The problem is worst in this part of the globe due to the extremely cold atmosphere and the presence of polar stratospheric clouds. The land under the ozone depleted atmosphere increased steadily to

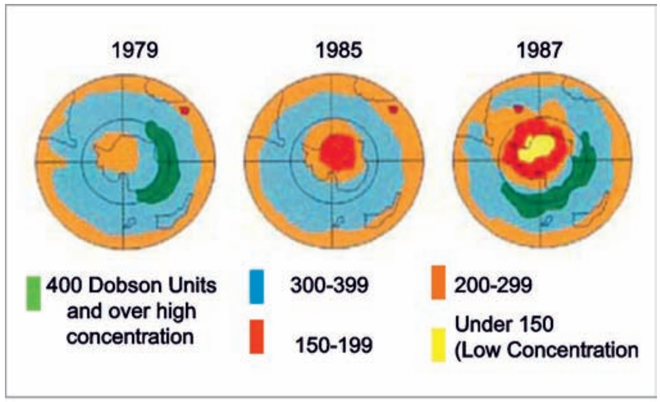


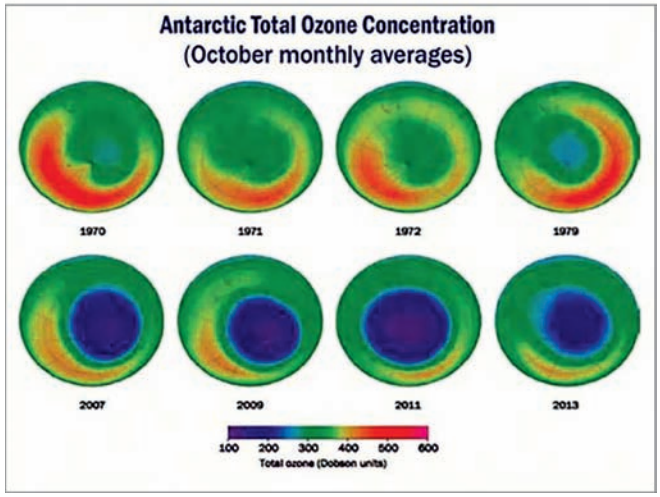
Schematic illustration of Southern Hemisphere climate impacts in austral summer associated with Antarctic ozone depletion. Ozone depletion has cooled the Antarctic stratospheric, leading to a delayed breakup of the stratospheric polar vortex and an accelerated stratospheric overturning circulation. Impacts have extended into the troposphere with the region of strong westerly winds and associated rainfall shifted southward, affecting the ocean circulation. The subtropical edge of the tropical circulation has also expanded poleward, leading to reduced precipitation in mid-latitudes and enhanced precipitation in the subtropics.

Source: World Meteorological Organization (WMO), Executive

Summary: Scientific Assessment of Ozone Depletion: 2018, World Meteorological Organization, Global Ozone Research and Monitoring Project - Report No. 58, 67pp., Geneva, Switzerland, 2018.)

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



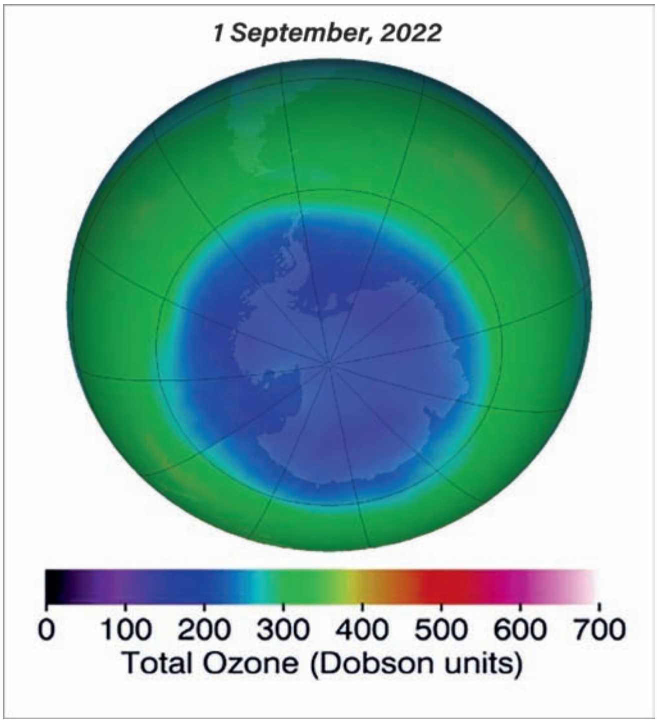


Changes in Ozone Concentration over Antarctica (1970-2013)

more than 20 million square (sq) km in the early 1990s and in the Antarctic spring of 1998, the area of the ozone hole exceeded 26 million sq km and also covered some populated areas of the southern hemisphere. The total ozone dropped to about 97 DU on 1 October 1998.

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. In the year 2005, the size of ozone hole again increased to 27 million sq km. The ozone hole further grew to an extraordinary size, 29.3 million sq km in 2006. The size of ozone hole slightly started declining and in 2008 became equivalent to the size of North America and NOAA reported that ozone hole reached to 26.5 million sq km in September 2008. It was also observed that the total column of ozone dropped to its lowest count of 100 DU in September 2008. The size of Antarctic ozone hole in September 2009, September 2010, September 2011, September 2012, September 2013 and September 2014 were reported to be 24 million sq km, 22.2 million sq km, 25 million sq km, 18.5 million sq km, 21 million sq km and 24.3 million sq km respectively.

In the latest false-colour view of total ozone over the Antarctic pole the purple and blue depict show least ozone, and the yellows and reds more ozone.

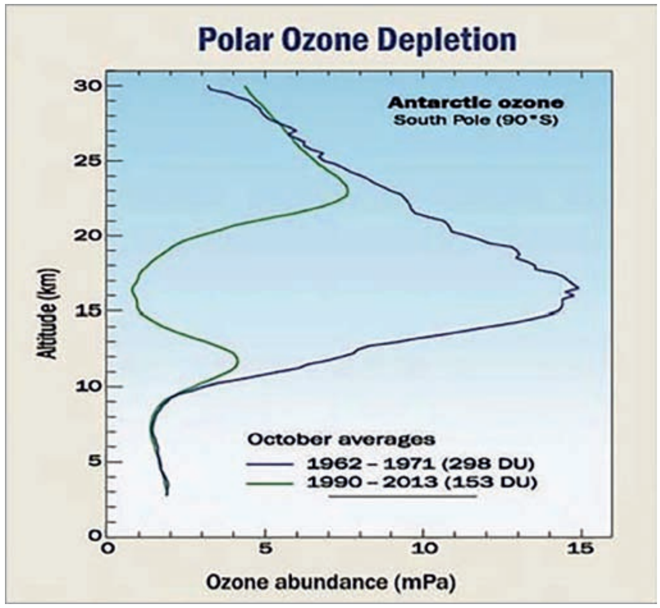


This indicates that the Montreal Protocol is working effectively and there is a gradual recovery of the ozone layer.

The decline of the ozone layer over the North Pole has also been reported. The effect has been ascribed to solar flares and record frigid temperatures in conjnction with manmade chemicals.

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 spring in the northern hemisphere (March-May). Winter temperatures in the Arctic stratosphere are not persistently low for many weeks and this results in less ozone depletion.

Recent observations and several studies have shown that the size of the annual ozone hole has stabilized and the level of ODS has decreased by 4% since 2001. But chlorine and bromine compounds have long atmospheric life. Recovery of stratospheric ozone is not likely to be noticeable until 2020 or little later.



Environmental Effects of Ozone Depletion

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

- **Human health effects:**

- Sunburns, premature ageing of the skin.
- UV radiation can damage several parts of the eye, including the lens, cornea, retina and conjunctiva.
- As per World Health Organization (WHO) 2002 report, a 10% decrease in stratospheric ozone could cause an additional 300,000 non-melanoma and 4,500 melanoma skin cancers in the world.
- More cataracts leading to damage to the eye resulting in blindness. Cataracts (a clouding of the lens) are the major cause of blindness in the world. Ten percent thinning of the ozone layer could cause 1.6 to 1.75 million more cases of cataract worldwide every year (WHO, 2002).
- Early findings suggest that exposure to UV radiation results in suppression of the human immune system, which may cause non-melanoma and skin cancer.

- **Adverse impact on agriculture, forestry and natural ecosystems:**

■ Several of the world's major crop species are particularly vulnerable to increased UV radiation, resulting in reduced growth, photosynthesis and flowering. Food production may reduce by about 1% for every 1% increase of UV-B radiation.

■ The effect of ozone depletion on the Agriculture sector could be significant. 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.

■ A few commercially important trees have been tested for UV-B radiation sensitivity. Results indicate that plant growth, especially in seedlings, is more vulnerable to intense UV radiation.

- **Damage to marine life:**

■ Planktons are the first vital step in aquatic food chains. In particular, plankton (tiny organisms on the surface layer of oceans) are threatened by increased UV-B radiation.

■ Decrease in plankton could disrupt the fresh and saltwater food chains, and lead to species shift.

■ Marine fauna like lings (a variety of fish), 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.

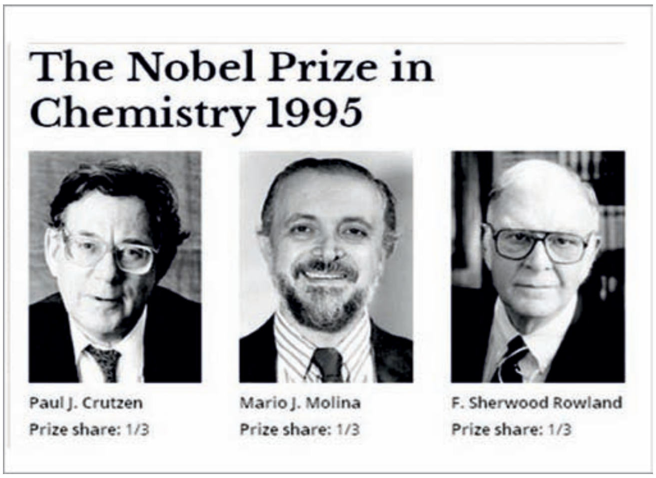
- **Materials:**

■ Wood, plastic, rubber, fabrics and many construction materials are degraded by UV-B radiation.

■ The economic impact of replacing and/or protecting materials could be significant.

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 a British scientist, James 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 up to the stratosphere where they may breakdown into chlorine atoms by energetic UV-B and UV-C radiations of the sun. The chlorine radicals thus produced can undergo a 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 CFCs could destroy a large number of ozone molecules. Their basic theory was put to test by the National Aeronautics and Space Administration (NASA) scientists and found to be valid, ringing alarm bells in many countries and laying the foundation for international action.



The Nobel Prize for Chemistry in 1995 was awarded to Sherwood Rowland, Mario Molina and Paul Crutzen for their pioneering work in atmospheric chemistry, particularly concerning the formation and decomposition of ozone.

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. A meeting of 32 countries in Washington D.C., USA initiated a Work Plan on action on protection of ozone layer 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 was overall depletion of the ozone layer all over the world, the most severe depletion had taken place over the Antarctic. His findings were confirmed by satellite observations and offered the first proof of severe depletion of the ozone layer. These findings stirred the scientific community to take urgent remedial actions. A framework for such actions was designed and agreed in an international convention held in Vienna on 22 March 1985.

This, subsequently, resulted in an international agreement on 16 September 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 the production and consumption of CFCs, halons, CTC and methyl chloroform as per the agreed schedule by the Parties to the Montreal Protocol.

Evolution of the Montreal Protocol

The urgency of controlling the ODS, particularly CFCs, was slow to pick up. The CFCs were so useful that society and industry, all over the world, were reluctant to give up the use of CFCs. 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 technical and financial assistance to change over to non-ODS technologies.

Montreal Amendment enters into force

In response to the prospect of increasing ozone depletion, the governments of the world crafted the 1987 United Nations Montreal Protocol as an international means to address this global issue.

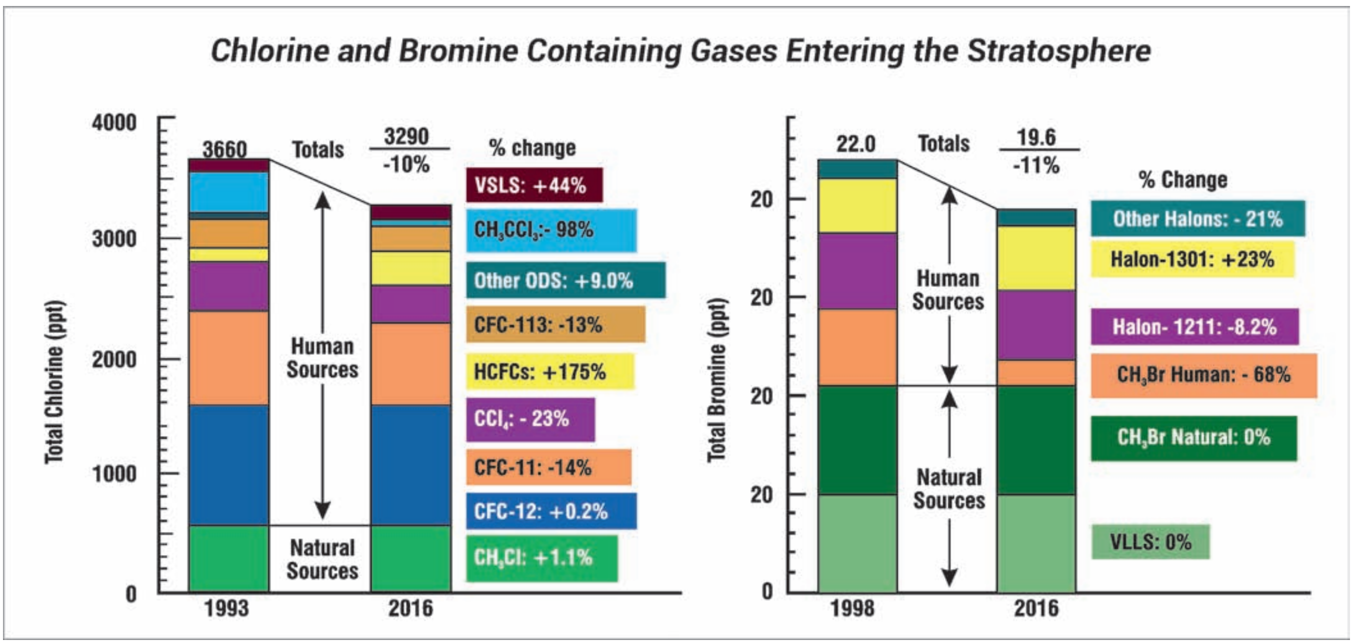
As a result of the broad compliance with the Protocol and its Amendments and adjustments and, of great significance, industry's development of "ozone-friendly" substitutes for the now-controlled chemicals, the total global accumulation of ODS has slowed and begun to decrease. In response, global ozone depletion is no longer increasing, and initial signs of recovery of the ozone layer have been identified. With continued compliance, we can expect substantial recovery of the ozone layer by the middle of the century. The day the Montreal Protocol was agreed upon, 16 September, is now celebrated as the International Day for the Preservation of the Ozone Layer.

Meanwhile, the report of the Scientific Assessment Panel (SAP) of the Montreal Protocol, 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. The control measures envisaged by the Protocol in 1987 would not be sufficient to arrest the depletion of the ozone layer. More urgent action was, therefore, necessary. Therefore, at the 2nd Meeting of the Parties (MOP) to the Montreal Protocol, 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 that the 5 CFCs and 3 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 provide financial and technical assistance to the developing countries with an annual consumption of CFCs and halons 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.

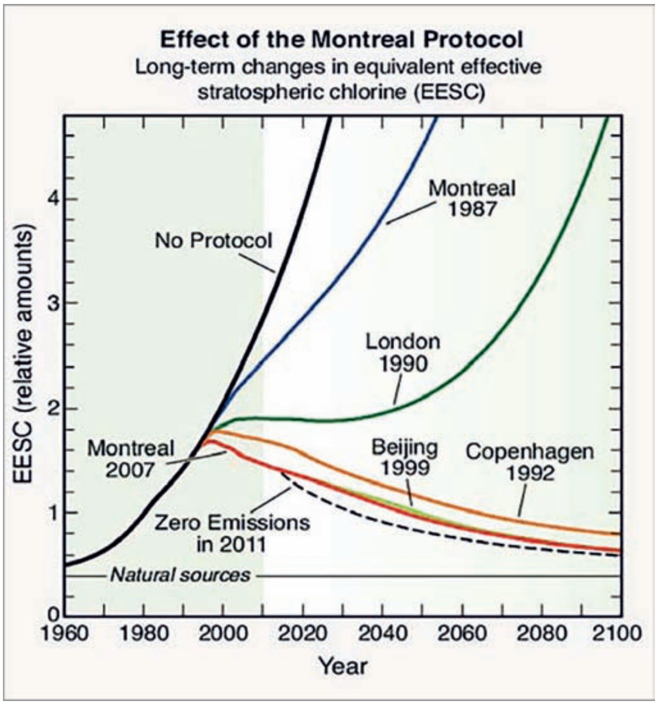
In 1991, more alarming reports came up to show that the depletion of ozone is continuing in all altitudes except over the tropics. It was recognized that the phase-out of production and consumption of CFCs and halons would not be enough to control the depletion of ozone layer. Other fluorocarbon chemicals like HCFCs and methyl bromide, which are also ODS, need to be controlled. They have also been brought under the ambit of the Montreal Protocol in 1992 through Copenhagen amendment and defining the schedule of phase-out of HCFCs in 1999 through the Beijing Amendment. Further, the phase-out of production and consumption of HCFCs was accelerated in 2007 through an adjustment.

Equivalent Effective Stratospheric Chlorine (EESC)

The EESC is a metric for representing ODS levels in the stratosphere. It is calculated based upon three factors: surface atmospheric concentrations of individual ODS and their number of chlorine and bromine atoms, the relative efficiency of chlorine and bromine for ozone depletion, and the time required for the substances to reach different stratospheric regions and break down to release their chlorine and bromine atoms. As EESC continues to decrease in response to Montreal Protocol provisions, stratospheric ozone is expected to increase. The EESC does not include chlorine and bromine from very short-lived substances (VSLS).



Source: World Meteorological Organization (WMO), Executive Summary: Scientific Assessment of Ozone Depletion: 2018, World Meteorological Organization, Global Ozone Research and Monitoring Project - Report No. 58, 67pp., Geneva, Switzerland, 2018.)



Recovery of Ozone Layer

As a result of implementation of provisions/ measures under the Montreal Protocol, the atmospheric concentration of man-made substances containing chlorine and bromine has begun to decline. Chlorine/ bromine reached have the maximum levels in the stratosphere in the first decade of the 21st century, and ozone concentrations should correspondingly have been at their minimum levels during that time period. It is anticipated that the recovery of the Antarctic ozone hole has begun. But there is a slow rate of healing because of long atmospheric life of manmade chemicals like CFCs, CTC, halons, methyl chloroform, methyl bromide etc. January 2010 marked the end of global production of CFCs and halons under the Protocol, and January 2013 the universal control of ODS production and consumption.

Healing of ozone layer confirmed

The scientific assessment of ozone depletion in 2014 confirms that the ozone layer is healing and will return to pre-1980 levels by mid-century, thanks to actions taken by Parties under the Montreal Protocol.

The ozone layer today

The Montreal Protocol is widely lauded as a huge environmental success. Whilst the damage we have done to the ozone layer has not yet been undone, thanks to this agreement and the collaborative effort of nations around the world, there is scientific evidence that the ozone layer is healing itself and is expected to recover by the middle of this century.

The Montreal Protocol has also considerably reduced climate warming because many ozone-depleting substances are also potent greenhouse gases (GHG) that contribute to climate forcing when they accumulate in the atmosphere. Montreal Protocol controls have led to a substantial reduction in the emissions of ozone-depleting substances over the last two decades. These reductions, while protecting the ozone layer, have the additional benefit of reducing the human contribution to climate change. Without Montreal Protocol controls, the climate forcing due to ozone-depleting substances could now be nearly two-and-a-half times the present value.

Source: ozone secretariat

Status of Ratification of Vienna Convention, Montreal Protocol and Amendments

S.No.	Particulars	Date of Enforcement	No. of Parties
1	Vienna Convention 1985	22.09.1988	198
2	Montreal Protocol, 1987	01.01.1989	198
3	London Amendment, 1990	08.10.1992	197
4	Copenhagen Amendment, 1992	14.06.1994	197
5	Montreal Amendment, 1997	10.11.1999	197
6	Beijing Amendment, 1999	25.02.2002	197
7	Kigali Amendment, 2016	01.01.2019	152

Multilateral Fund

With a view to assist the developing countries in their phase-out efforts, a Multilateral Fund (MLF) for the implementation of the Montreal Protocol was established in June 1990. The Fund is supported by a Secretariat, co-located with UNEP, but directly accountable to an Executive Committee (Ex-Com) consisting of seven non-Article 5 Parties and seven Article 5 Parties. This governance structure accomplished several key objectives. First, by co-locating the MLF Secretariat with UNEP but retaining its independence in a policy context, the Parties and their appointed Ex-Com were provided with direct control over the Fund's policies. Second, the balance of non-Article 5 and Article 5 Parties on the Ex-Com signalled a major departure from the historic donor-driven nature of funding bodies that reflected the spirit of equality.

The Fund is financing incremental costs for ODS phase out in Article 5 Parties. This provision of incremental costs, including cost of transfer of technology, incremental capital costs and incremental operating costs for switching over from ODS to non-ODS technologies enables the developing countries to phase out controlled substances. Enterprises which were using ODS-based technologies prior to cut-off dates are eligible for funding for conversion from ODS to non-ODS technology from the MLF for the implementation of the Montreal Protocol.

Establishment of a financial mechanism to provide technical and financial support to the developing countries to meet their compliance obligations to the Montreal Protocol, proved as the key to the success of the Montreal Protocol.

India being an Article 5 Party is eligible for technical and financial assistance from MLF to phase out ODSs 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 CFCs, halons, CTC, methyl chloroform, methyl bromide and HCFCs.

These are summarised below on end-use basis:

Technology Options for Phase-out in Refrigeration and Air-conditioning (RAC)

Sub-sector	ODS used	Preferred alternatives / substitutes
Domestic refrigerators	Refrigerant: CFC-12 Foam: CFC-11 HCFC-141b	Refrigerant: HFC-134a, HC-600a, Isobutane, HC blend, HFO-1234yf Foam Blowing Agents: Cyclopentane HFC-245fa, HFC-365mfc, HFO-1234ze Methyl Formate, Methylal, Solstice-LBA, FEA-1100
Refrigerated Cabinets (Deep Freezer, Ice-cream cabinets, Bottle coolers, Visi coolers)	Refrigerant: CFC-12 Foam: CFC-11 HCFC-141b	Refrigerant: HFC-134a, HC-600a HC-blend, CO_2Foam Blowing Agents: Cyclopentane, HFC-245fa, HFC-365mfc, HFO-1234ze, Methyl Formate, Methylal, Solstice- LBA, FEA-1100

Water Coolers	CFC-12 HCFC-22 (for bigger capacity)	HFC-134a, HC-blend, HC-290, HFO-1234yf
Mobile (car, bus, van, refrigerated trucks, train)	CFC-12 HCFC-22 (train)	HFC-134a, HFC-1234yf HFC-152a, CO_2 R-290, HFC-134a, HFO-1234yf, R-407C, blends of HFCs and HFOs
Central A/C Plants	CFC-11, CFC-12, HCFC-123, HCFC-22	HFC-134a, R-410A, R-407C, HFO-1234yf, HC-600a, Ammonia, HC-290
Process Chillers	CFC-12, HCFC-22	HFC-134a, R-404A, R-407F, Ammonia
Ice Candy Machines	CFC-12, HCFC-22	HFC-134a, R-407F, R-290, R-404A
Walk-in Coolers	CFC-12, HCFC-22	HFC-134a R-407F R-404A
Room A/C	HCFC-22	R-410A, HC-290, HFC-32, blends of HFCs and HFOs
Packaged A/C	HCFC-22	R-410A, R-407C, HFC-32, HC-290, HC-1270
Shipping	CFC-12, HCFC-22	HFC-134a, R-410A, CO_2

Alternatives with zero ODP viz. Hydrofluorocarbon - 134a (HFC-134a), R-404A, R-407C, R-410A and R-507A have been used in various applications in many countries especially in non-Article 5 countries. The low-Global Warming Potential (GWP) refrigerants like ammonia, Carbon-dioxide (CO_2) and hydrocarbons are also used in some applications. Attempts are being made to use hydrocarbons like HC-290 and HC-1270 in a number of applications, including small capacity room air-conditioners. Recently, low-GWP HFCs, also known as hydrofluoroolifins (HFOs) are being applied in some applications.

Technology Options for Phase-out in Aerosol Sector

Sub-sector	ODS used	Preferred alternatives / substitutes
Perfumes, Shaving Foams, Insecticides, Paints, etc.	CFC-11/ CFC-12	Hydrocarbon Aerosol Propellant (HAP), destenched LPG, Di-methyl Ether
Metered Dose Inhalers	CFC-11 CFC-12	Hydrofluoro-alkanes (HFAs)

Technology Options for Phase-out in Foam Sector

Sub-sector	ODS used	Preferred alternatives / substitutes
Flexible Polyurethane Foam (PUF) Slabstock	CFC-11	Methylene Chloride
Flexible Moulded PUF	CFC-11	Water blown technology
Rigid PUF General Insulation	CFC-11 HCFC-141b	Cyclopentane, HFC-245fa, HFC-365mfc, HFO-1234ze, HFO-1233zd(E), Methyl Formate, Methylal , Solstice- LBA, FEA-1100
Thermoware	CFC-11 HCFC-141b	HFC-245fa, HFC-365mfc, Water, Methyl Formate, Solstice-LBA, FEA-1100
Integral Skin PUF	CFC-11 HCFC-141b	HFC-245fa, water, hydrocarbons Solstice-LBA, FEA-1100
Thermoplastic Foams -EPE/EPPN Foams -Phenolic Foams	 CFC-11, CFC-12 CFC-11	Hydrocarbons, CO_2
Phenolic Foams	CFC-11	Hydrocarbons

The CFC-11 with ODP of 1.0 as a foam-blowing agent was substituted first by a transitional technology based on HCFC-141b with 0.11 ODP. The HCFC-141b is now being replaced by zero-ODP and low-GWP foam blowing agents like cyclopentane, methyl formate and methylal. The HFC-based blowing agents like HFC- 245fa and HFC-365mfc have also been used in non-Article 5 countries. The proposed next generation of low-GWP foam blowing agents are likely to be HFOs-1234ze, HFO-1233zd(E), methyl formate, methylal, Solstice-LBA, FEA-1100 and Hydrocarbons.

Technology Options for Phase-out in Fire Extinguishing Sector

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

Substitutes like ABC powder and HFC based for halon-1211 used in portable fire extinguishers have also been developed and used. Some global chemical producers have developed hexafluoro propane (HFC-236fa) as an excellent substitute for halon-1211 fulfilling a long felt need. It is now being manufactured commercially.

Technology Options for Phase-out in Solvent Sector

Sub-sector	ODS used	Preferred alternatives / substitutes
Electronic and Precision Cleaning	CFC-113 CTC Methyl chloroform	DI Water Aqueous cleaning process Semi-acqueous cleaning process, organic non-halogenated, solvents, perfluorocarbons

Coatings	CFC-113 Methyl chloroform	Aqueous solvents Trichloro ethylene
Manufacture of pesticides and pharmaceuticals	CTC	Ethylene-dichloride Monochloro-benzene
Metal cleaning	CTC	Trichloroethylene
Chlorinated	CTC	Aqueous rubber
Textile cleaning	CTC	Aqueous system, chlorinated solvents

During the last several years, due to intensive Research and Development (R&D) efforts, new solvents have been discovered and used as alternatives to ODS. First Hydroflouroethers (HFEs) were considered as alternative solvents. Although, satisfactory in many respects, these were very high-cost alternatives. Some patented non-ODS products have also been promoted as alternative solvents for electrical cleaning especially 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.

2 INDIA'S COMMITMENT TO THE MONTREAL PROTOCOL

India became Party to the Vienna Convention for the Protection of the Ozone Layer on 18 March 1991 and the Montreal Protocol on Substances that Deplete the Ozone Layer on 19 June, 1992. The per capita consumption of the controlled substances in Annex A of the Montreal Protocol did not cross 20 g during 1995-97 (baseline), as against 300 g per capita limit for Article 5 Parties under the Protocol. India was self-sufficient in production of chemicals like CFCs, CTC, halons and HCFCs. India was mainly producing and using 9 of the 96 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 played a key role in the establishment of the MLF–the financial mechanism established under the Montreal Protocol through its London Amendment in 1990. India also played a pro- active role in the implementation of Montreal Protocol in the country. India had prepared a detailed Country Program (CP) in 1993 to phase-out ODS in accordance with its National Industrial Development Strategy. The objectives of the CP were to phase-out ODSs by accessing the Protocol's financial mechanism without undue economic burden to consumers, producers and equipment manufacturers using ODS. The other objectives of the CP were minimization of economic dislocation as a result of conversion to non-ODS technologies, maximization of indigenous production, preference to one-time replacement, emphasis on decentralized management and minimization of obsolescence. The CP was updated in 2006 taking into account the decisions of the Montreal Protocol and national policies.

The Government of India has entrusted the work relating to ozone layer protection and implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer, to the Ministry of Environment, Forest and Climate Change (MoEF&CC). The MoEF&CC has set up the Ozone Cell as a National Ozone Unit (NOU) to render necessary services for effective and timely implementation of the Protocol and its ODS phase-out activities in India.

The MoEF&CC also constituted an Empowered Steering Committee (ESC), which is supported by two Standing Committees, namely the Technology and Finance Standing Committee (TFSC) and the Standing Committee on Monitoring. The ESC is Chaired by the review of policies and implementation of projects/ plans and monitoring.

Although, ODS, especially CFCs and HCFCs were used in large scale in the developed countries since the1930s, India was slow to adopt these chemicals. The early use of these chemicals in India was in the

Refrigeration and Air Conditioning (RAC) sector and CFCs and HCFCs needed for this sector were imported in the country. The use of CFCs and HCFCs in the refrigeration industry can be traced back to 1960s. Other industries using CFCs and HCFCs, such as the foam manufacturing industry, aerosol industry etc., were developed only during last 35 to 40 years in the country. With the availability of CFC-11 and CFC-12 from indigenous production, started in 1968, the growth of consumption of CFCs and industry increased very rapidly.

When the CP was prepared, use of ODS as solvents is estimated to account for the maximum consumption, both in Metric Tonnes (MT) as well as Ozone Depleting Potential (ODP) tonne. The sectors RAC and Foam were the next large users, followed by Aerosol sector. The consumption of ODS in the Firefighting sector was relatively small in terms of MT.

Status of ODS Phase-out in India

India has phased out the production and consumption of CFCs, CTC and halons as of 1 January 2010 (except the use of pharmaceutical grade CFCs in manufacturing of Metered Dose Inhalers (MDIs) for Asthma and Chronic Obstructive Pulmonary Diseases (COPD) patients). India has also phased-out production and consumption of Methyl Chloroform and Methyl Bromide. A total of 384 projects have been approved and funded by the Ex-Com of the MLF for Implementation of the Montreal Protocol. A total amount of US$ 304,909,305 has been approved by the Ex-Com of the MLF to phase-out 47,662 tonne of ODSs.

Structured implementation framework supported by a robust regulatory framework and fiscal measures along with active cooperation of industry have led to India successfully meeting all the ODS phase-out targets of the Montreal Protocol, including the phase out of production and consumption of CFC, CTC, Halons, Methyl Chloroform as on 1 January 2010 for controlled applications.

Sector-wise Approved Projects as on 31 August 2023

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

Sector	No. of Projects	Funding (US$)	Phase out of ODP (in Tonne)
Aerosols Sector (CFC)	38	13,705,006	1,702
Foams Sector (CFC)	163	37,880,185	5,074
Firefighting Sector (Halons)	21	5,176,701	2,719
Institutional Strengthening	12	2,738,166	–
Refrigeration & Air Conditioning Sector (CFC)	87	31,827,256	3,983
Solvents Sector (including CTC production)	41	61,358,042	12,966
Production Sector (CFC and Halons)	15	84,228,000	20,107
HPMP Stage-I Preparation	1	570,000	–
HPMP Stage-I (HCFC-141b and HCFC-22)	1	21,294,490	342
HPMP Stage-II Preparation	1	490,000	–
Demonstration Project in Foam Sector Preparation (HCFC-141b)	1	30,000	–
HPMP Stage-II (HCFC-141b and HCFC-22)	1	44,911,459	769
HPMP Stage-III Preparation	1	450,000	–
Enabling activities for Hydro-fluorocarbons (HFC) phasedown under the Kigali Amendment	1	250,000	–
HPMP Stage-3	1	25,157,632	580
Preparation of 3 HFC Projects to demonstrate low GWP technologies	1	90,000	-
Project preparation for development and pilot testing of R-290 compress or manufacturing and design and development of micro-channel condensers for R-290 room air-conditioners	1	30,000	-
Total	**387**	**330,186,937**	**48,242**

Sector Phase-out Plans

CFC Production Sector Phase-out Project in India

The Ex-Com of the MLF in its 29th meeting held in November 1999 approved India's CFC Production Sector gradual phase-out project with a total grant amount of US$ 82 million to phase-out production of 22,588 ODP tonne of CFCs. The amount US$ 80 million was to be provided as a performance-based grant to CFC producers for meeting the CFC production phase-out targets. The remaining US$ 2 million was for the Technical Assistance (TA) component to establish a Project Management Unit (PMU) under the Ozone Cell to develop and implement monitoring, auditing and reporting mechanisms, in addition to conduct awareness and training programs. The World Bank was the lead implementing agency for the project. The has been designated as the implementing agency for the TA component. In this project, it was agreed to reduce total CFC production in accordance with the following agreed schedule:

Agreed Schedule for Phase-out of CFC Production

Year	CFC Production Quota (MT)	Phase-out Quantity (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 Phase-out of CFCs

India agreed at the 54th meeting of the Ex-Com of the MLF held from 7 to 11 April 2008 in Montreal, Canada to accelerate the phase-out of production of CFCs by 1 August 2008 with an additional grant of US$ 3.17 million to the CFC producers. As per the decision, India agreed that it will produce not more than 690 MT of CFCs until 1 August 2008 primarily for the manufacturing of MDIs. India's CFC producers would sell no more than 825 MT of CFCs for MDI production in the years 2008 and 2009, comprising 690 MT of new production and 135 MT reprocessed from existing stock. In addition, India would not import any more CFCs.

India has completely phased-out the production and consumption of CFCs with effect from 1 August 2008, 17 months ahead of the agreed phase-out schedule except the use of pharmaceutical grade CFCs in manufacturing of MDIs. The Ex-Com of the MLF has released the total grant of US$ 3.17 million, the grant approved for accelerated phase-out of CFCs.

The National Strategy for Transition to Non-CFC MDIs and Plan for Phase-out of CFCs in the Manufacture of Pharmaceutical MDIs has been implemented successfully by United Nations Development Program (UNDP) as lead implementing agency, UNEP and the Government of Italy as cooperating agencies in close cooperation with the MDI manufacturing industry under the guidance of Ozone Cell, MoEF&CC.

Halon Production and Consumption Phase-out in India

The phase-out of consumption of halons in India was initiated as early as 1994. The 13th meeting of the Ex-Com of the MLF approved a demonstration project for evaluation of alternative technologies for halon, fire protection system and technical assistance for sectoral strategy with a funding of US$ 309,000. It followed with the approval of 14 individual investment projects by the Ex-Com of the MLF from 1995 to 1999 which resulted in phase-out of 1,768 ODP tonne of halons. These projects were successfully completed in 2001.

Subsequently, the Ex-Com of the MLF in its 34th meeting held in 2001 at Montreal approved US$ 2.6 million for complete phase-out of the production and remaining consumption of halons in the country. This project was successfully implemented and achieved the objective of complete phase-out of production and consumption of halons in India, as early as 2003.

The enterprises, producing halons have dismantled their production plants. At present, there is no halon production in India. The phase-out activities of production and consumption of halons in all the enterprises have been successfully completed.

Firefighting Industry Structure: There were two halon production facilities in India at M/s Navin Fluorine International Ltd. (NFIL) and M/s SRF Ltd. M/s SRF was producing halon-1211 and halon-1301, while M/s NFIL was producing only halon-1211. The total production capacity of halon in the country was 800 MT.

There were about 200 manufacturers of fire extinguishing equipments, of which over 85% were manufacturers of portable fire extinguishers in the country. Halons, which are potent ODS, were used only in about 5% of the fire extinguishing applications.

Halon Consumption: In 1991, the total consumption of halons in India was 750 MT, equivalent to 3,650 ODP tonne. This constituted 7.2% of India's total ODS consumption and almost 28% of the total consumption in ODP tonne. Imports accounted for 550 MT of the total consumption, 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 equipments constituted only about 5% of the fire-fighting applications in India. There were no drop-in replacement technologies identified. However, a wide variety of fire-extinguishing technologies were identified at the time of preparation of the CP, viz., ABC powder, carbon di-oxide (CO_2)-based systems, foam-based systems, inert gases, HFC-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 program to limit emissions;
- Establishment of a halon management program, including halon banking.

Establishment of Halon Banking Facility: 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 equipments. The MoEF&CC has established National Halon Banking Facility at the 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 halons in existing equipment for future use. It is worth mentioning that all the three defence forces have also established their own halon banking facilities to meet future requirements.

CFC Phase-out in Foam Manufacturing Sector

The Foam Manufacturing sector was one of the major ODS-consuming sectors in India predominantly using CFC-11 as blowing agent. As of June 2002, 158 projects and activities were approved by the Ex-Com of the MLF to phase-out 4,401 ODP tonne of CFCs with a funding of US$ 29.36 million. These projects/ activities were successfully implemented and achieved the phase-out of CFCs in this sector.

The Ex-Com of the MLF, at its 37th meeting held in July 2002 approved the foam sector phase-out plan with a total funding of US$ 5.42 million to phase-out the remaining 612 ODP tonne of CFC-11 in Foam Manufacturing sector. The UNDP was responsible for implementation of this plan. A total of 122 Foam Manufacturing enterprises under this sector plan have phased-out 702 MT of CFCs from their processes. The foam sector CFC phase-out plan has been successfully implemented and use of CFCs has been completely eliminated in Foam Manufacturing sector in the country.

Industry Structure: The survey of the Foam Manufacturing sector carried out at the time of preparation of CP in 1993 identified about 235 foam manufacturers in India using CFCs as blowing agents. About 20% of the enterprises were large/ medium size, while the rest were Micro, Small and Medium Enterprises (MSMEs) in the unorganized and informal sector.

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 slab-stock foam mostly converted from CFCs to methylene chloride as the blowing agent during 1980s due to economic reasons. The domestic refrigerator manufacturers were large and main users of CFCs in the rigid polyurethane foam sub-sector. Another important sub-sector within the Foam Manufacturing sector, the 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 MSMEs involved.

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

ODS Consumption in Foam Sector: In 1991, the consumption of CFCs in Foam Manufacturing sector was 1,580 MT, predominantly CFC-11, which amounted to about 31% of India's total CFC consumption in the country. 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.

It was considered strategically important to support the conversion of manufacturing facilities of the polyol systems house(s) on a priority basis, to enable them to customize non-CFC formulations, thus facilitating CFC phase-out in the downstream foam manufacturers more economically. It was also recognized that there were large number of MSMEs operating in this sector, which could not be identified at the time of preparation of the CP. However, these were addressed subsequently.

The HCFCs like HCFC-141b, HCFC-142b and HCFC-22 are commonly used as interim substitutes to phase-out CFCs in foam manufacturing sector. The accelerated phase-out of HCFCs, as agreed at the 19th Meeting of the Parties (MOP) held in September, 2007, would require conversion of foam manufacturing facilities from HCFCs to non-ODS technologies, viz., hydrocarbons, hydrofluoroolefin (HFO), methyl formate, methylal etc.

CFC Phase-out in RAC Sector

The phase-out of CFCs in RAC sector in India was initiated as early as 1993. As of July, 2002, a total of 47 investment and technical assistance projects were approved with a total funding of US$ 22.3 million leading to a total phase-out of 1,821 ODP tonne of CFCs. Subsequently, the Ex-Com of the MLF in its 38th meeting held in November 2002 approved a multi-year performance-based sector phase-out plan covering the Refrigeration (manufacturing) sector with a total funding of US$ 3.6 million to phase-out the remaining CFC consumption of about 535 ODP tonne. The UNDP was responsible for implementation of the commercial refrigeration component and the United Nations Industrial Development Organization (UNIDO) was responsible for implementation of the transport refrigeration sub-sector under this sector plan. A total of 157 enterprises for Commercial Refrigeration (manufacturing) sector and 39 enterprises in Transport Refrigeration (manufacturing) sector were identified during the implementation of the plan. The sector phase-out plan has been successfully implemented and phased out the use of CFCs completely in the Refrigeration (manufacturing) sector in the country.

RAC Industry Structure: The RAC sector in India has a long history from the early years of the last century. Major investments in establishing manufacturing capacities started in 1950s. On the upstream side, there were only two compressor manufacturers exclusively for hermetic compressors. In addition, there were some appliance manufacturers dedicated facilities for manufacturing of hermetic compressors. However, there were several manufacturers of open-type compressors. Many other components of refrigeration systems were also manufactured in the country.

ODS Consumption in RAC Sector: In 1991, the total ODS consumption in the RAC sector in India was 1,990 MT. This constituted about 39% of India's total consumption of CFCs. About two-third of this consumption was estimated to be used in servicing of existing equipment. The growth rate in this sector was forecasted at 10-20% annually until 2010. The RAC sector was, therefore, identified as another priority sector in India for initiating phase-out activities.

National CFC Consumption Phase-out Plan (NCCoPP)

The Ex-Com of the MLF at its 42nd meeting held in April, 2004 approved the NCCoPP for the RAC servicing sector at a total funding level of US$ 6.388 million to phase-out 1,502 ODP tonne of CFCs. The Government of Germany (bilateral implementing agency) was responsible for implementation of this project as the lead Implementing Agency along with UNDP, UNEP, UNIDO and Government of Switzerland as cooperating implementing agencies. The Government of Switzerland was responsible for training activities and UNDP was responsible for equipment support. The UNEP was responsible for creation of awareness activities. Besides, UNEP was organizing customs and policy training activities in collaboration with National Academy for Customs, Indirect Tax and Narcotics (NACIN). The UNIDO jointly with UNDP was responsible for implementation of CFC phase-out activities in transport refrigeration.

The project's main focus was on training of refrigeration servicing technicians who were involved in servicing of RAC equipments based on CFCs and non-ODS alternatives. It also covered training for mobile air-conditioning (MAC), RAC equipments using open-type compressor (OTC) and specifically targeted the Railways as a key institutional user of CFC refrigerants. The project adopted a multi-pronged approach to achieve its targets. In addition to training and equipment support, awareness creation among the stakeholders and capacity building of customs officers on illegal ODS trade were included.

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

NCCoPP funded by the MLF for implementation of the Montreal Protocol, took over from the Indo-Swiss-German Project "Ecological Refrigeration (ECOFRIG)" and Indo-Swiss Project "Human and Institutional Development in Ecological Refrigeration (HIDECOR)". ECOFRIG began within the framework of Indo-Swiss-German Cooperation in 1992 with an objective to evaluate the hydrocarbon technology in RAC appliances for replacing CFCs. Both ECOFRIG and HIDECOR established a training setup including well-developed excellent training modules and a pool of trained trainers throughout the country. The HIDECOR's activities, initiated in 1998, were geographically restricted to selected states and the target group was limited to micro, small and medium size servicing enterprises in the RAC sector. The NCCoPP established training infrastructure including training cells in 15 states of India. It aimed to encourage good servicing practices among all RAC servicing enterprises, with a special focus on firms consuming more than 50 kg of CFCs per annum. A total of 955 recovery, recycling units were provided to the enterprises in four stages. Equipment support to 120 Industrial Training Institutes (ITI) was also provided.

Awareness generation workshops were conducted for servicing enterprises, so that most of the enterprises across the country could participate in the project and get the advantage of assistance provided under the Montreal Protocol to phase-out CFCs in the Servicing sector.

As stated earlier, the focus of NCCoPP activities was on training RAC servicing technicians. During training, the participants/ technicians were taught how to handle the alternative refrigerants, good servicing practices and emphasis was laid on recovery, recycling, reclamation and reuse of CFCs. Therefore, the training programs helped in creating a demand for recovered and reclaimed refrigerants. Over 20,000 technicians were trained under NCCoPP and its forerunner projects, ECOFRIG and HIDECOR. The requirement of CFCs was substantially decreased because of training on good service practices. The remaining requirement for servicing was addressed through reclamation and reuse of CFCs. A number of reclamation centres have been established at various locations in the country, viz., Bangalore, Chandigarh, Hyderabad, Ahmedabad, Jaipur, Kolkata, and Lucknow. The reclamation units have also been provided to the Indian Railways and defence forces.

The NCCoPP has been successfully implemented as per the schedule and achieved its objective of complete phase-out of CFCs.

Strategy for Solvent Sector to Phase-out ODS in MSMEs in India

The Ex-Com of the MLF in its 35th meeting held in December 2001, approved a project to prepare "Overall Strategy for the Solvent Sector to support the phase out of ODS in MSMEs in India" at a total cost of US$ 169,500 implemented by UNEP in consultation with the World Bank and UNIDO. This project was to assist India in developing an overall strategy for the solvent sector which would cover both non-investment and investment activities to support the phase-out of ODS in the solvent sector in India and assist India in meeting its 2005, 2007 and 2010 commitments for the solvent sector. The aim of the project, at the operational level, was to develop approaches for assisting MSMEs which use solvents in India through training, Solvent Alternative Technology Service (SATS), information dissemination and investment and non-investment activities.

The project was completed successfully by UNEP and submitted the report to the Ozone Cell and the World Bank. The outcomes of the strategy document were incorporated in the preparation of the National CTC Phase-out Plan prepared by the World Bank.

National CTC Phase out Plan

The Ex-Com of the MLF at its 40th meeting held in July 2003, approved the National CTC Phase out Plan at a total funding level of US$ 52 million to phase-out 11,553 ODP tonne of CTC production and 11,505 ODP tonne of CTC consumption. This included 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 amount, US$ 28.5 million was allocated for CTC production phase-out, US$ 21.5 million for CTC consumption phase-out and US$ 2 million allocated for the TA component. The World Bank was the lead implementing agency, the governments of Germany, France and Japan (bilateral agencies) and UNIDO were cooperating agencies for implementation of the National CTC consumption phase-out activities. Besides, UNDP, on behalf of the Government of Japan, was responsible for executing conversion activities from CTC to non- ODS technologies in large and medium enterprises in metal cleaning sub-sectors.

Production Sector: The CTC producing enterprises, M/s. SRF Ltd., New Delhi, M/s. Chemplast Sanmar Ltd., Chennai, M/s. Gujarat Alkalies and Chemicals Ltd., Vadodara signed the performance agreement and submitted an Indemnity bond for meeting the production phase-out targets. M/s. Shriram Rayons Ltd., Rajasthan and M/s. National Rayon Corporation (NRC) Ltd., Mumbai have already closed down their production facilities. The production of CTC in the country was successfully phased out as of 1 January 2010, except co-production of CTC during the production of chloromethane. The co-produced CTC is being used only for feedstock applications.

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

In 2006, a total of 103 CTC projects, covering both process agent and solvent applications were identified and the phase out of CTC in these applications was taken up by the implementing agencies. The CTC consumption phase-out projects were successfully implemented and resulted in phase out of 2,080 ODP tonne of CTC. The consumption of CTC was phased out completely in the country since 1st January 2010, for controlled applications as per the Montreal Protocol schedule.

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 increased price of the CTC significantly in the country and that motivated the MSMEs to move away from CTC. Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) carried out extensive work in testing of alternatives that meet health, safety and environmental standards. A countrywide survey was carried out to identify MSMEs using CTC in the metal cleaning sub-sector. The survey identified 51 eligible MSMEs which were using CTC in metal cleaning. These enterprises were provided funding towards incremental capital and operating costs for phasing out of CTC in metal cleaning sub-sector. The achievement of CTC phase-out in two widely dispersed industry sectors, namely, garment manufacturing and metal cleaning has also been realized through awareness programmes and policy measures, especially those which influenced the availability and pricing of CTC and its alternatives.

The production and consumption of CTC completely phased-out for controlled applications as of 1 January 2010. Subsequently, the Ozone Cell, MoEF&CC carried out technical assistance activities, including awareness for sustaining the phase-out of CTC in different applications, except in feedstock use.

CFC phase-out in Aerosol Sector

Aerosols are widely used in several applications involving propellants, including perfumes, shaving foams, insecticides, pharmaceuticals, paints and inhalers. Both CFC-11 and CFC-12 were commonly used as propellants in this sector. By the end of 2002, a total of 26 investment and technical assistance projects were completed with a total funding of US$ 6.5 million, leading to a total phase-out of 637 ODP tonne of CFCs in the Industrial Aerosol Sector. The Ex-Com of the MLF in its 38th meeting held in November 2002, approved a terminal umbrella project in this sector with a funding of US$ 0.58 million to phase-out remaining CFC consumption of about 52 ODP tonne in this sector. The consumption of CFCs in the Aerosol sector had been completely phased-out as early as December 2003.

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, concentrating 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 MSMEs, many of which were in the informal sector, principally, manufacturing personal care products such as perfume and deodorant sprays.

ODS Consumption in Aerosol Sector: 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 cosmetic aerosols, 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 MSMEs 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 MSMEs 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.

The consumption of CFCs in the Aerosol sector was completely phased out as early as December 2003, except use of pharmaceutical grade CFCs in manufacturing medical aerosols, MDIs for asthma and COPD patients.

National Strategy for Transition to non-CFC MDIs and Plan for Phase-out of CFCs in Manufacturing of Pharmaceutical MDIs

The "National Strategy for Transition to Non-CFC MDIs and Plan for Phase-out of CFCs in manufacturing of Pharmaceutical MDIs" was approved by the Ex-Com of the MLF in its 56th meeting held in November 2008, with a total funding of US$ 10.2 million to phase-out 704.03 ODP tonne of CFCs. This project articulated India's national strategy for transition to non-CFC MDIs gradually without affecting the asthma and COPD patients and the elimination of CFC consumption in manufacturing of MDIs in India.

The National Strategy for phase-out of CFCs in MDIs had been implemented successfully by UNDP as lead implementing agency in association with Government of Italy (bilateral agency) and UNEP, in close cooperation with the MDI manufacturers under the guidance of Ozone Cell, MoEF&CC.

National Awareness Workshops were organized for the stakeholders, especially the MDI manufacturers and physicians treating asthma and COPD patients. A workshop on "Phase-out of CFCs in MDIs Transition Strategy Implementation and Adoption of CFC free Alternatives in India" was held on 5 October 2009, at the All India Institute of Medical Sciences (AIIMS), New Delhi in collaboration with Ministry of Health and Family Welfare (MoHFW) and UNEP. Another National Consultative Workshop on Policy and Regulations was organized on 20 May 2010, at Central Drugs Standard Control Organization, MoHFW, New Delhi. A regional awareness workshop on phase-out of CFCs in manufacturing of MDIs was organised on 1 October 2010, at Pune. These workshops were well attended by the stakeholders, including medical representatives. The medical representatives are the key stakeholders to create awareness among physicians across the country. During the workshops the MDI manufacturers shared that a number of CFC-free MDIs have been developed and placed in the market.

The pharmaceutical grade CFCs were needed during transition phase in 2010 and beyond by the MDI manufacturing industry. The same were obtained through the Essential Use Nomination (EUN) process of the Montreal Protocol for 2010. India submitted the EUN for 2010 for 350.6 MT of pharmaceutical grade CFCs and the 21st MOP held in November, 2009 approved 343.6 MT of CFCs for India for 2010. India had also submitted the EUN for the year 2011 for 192.3 MT, but the same was withdrawn in consultation with MDI manufacturers as the progress made by MDI manufacturers was commendable and the MDI manufacturers decided not to seek any CFCs for manufacturing of MDIs for 2011 and beyond. The MDI manufacturers have converted all CFC-based MDI formulations to CFC-free and placed in the market. Currently, all the formulations of MDIs available in the market are CFC-free since 2011.

The 22nd MOP held in November 2010 congratulated India for its outstanding achievement in early phase-out of the use of pharmaceutical grade CFCs in manufacturing of MDIs.

The UNDP, as lead implementing agency, carried out an independent verification through a MDI International Expert in November 2012 for all the four MDI manufacturing facilities to verify the phase-out of use of CFCs in manufacturing of MDIs. The verification confirmed that conversion from CFC based MDIs to CFC-free MDIs has already been achieved in India.

A verification-cum-review of progress made by each of the manufacturers was undertaken by the MLF through an independent expert along with UNDP to ascertain the implementation of CFC phase-out in the manufacturing of MDIs in February 2014. It was reported that CFCs have been phased-out in manufacturing of MDIs in the country.

Accelerated Phase-out of HCFCs

The control schedule of the Montreal Protocol for Article 5 Parties for phase-out of HCFCs prior to the 19th MOP was as follows:

Consumption

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

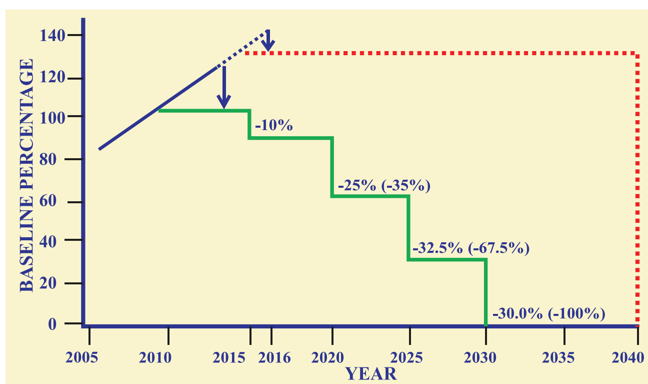
Production

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

The 19th MOP held in September 2007, took a decision to accelerate the phase-out of production and consumption of HCFCs for developed and developing countries. The new phase-out schedule for Article 5 Parties (developing countries) as per the decision of the 19th MOP is as follows:

- Base level: average of 2009 and 2010.
- Freeze: 1January 2013
- 10% reduction: 1 January 2015
- 35% reduction: 1 January 2020
- 67.5% reduction: 1 January 2025
- 100% reduction: 1 January 2030 with a service tail of 2.5% annual average during the period 2030-2040.

The accelerated phase-out schedule of HCFCs for Article 5 parties is also depicted below:-



Allowing for servicing an annual average of 2.5% during the period 2030-2040

The implementation of the accelerated phase out schedule for HCFCs was a challenging task, especially the Stage-I targets, the 2013 freeze and 10% reduction in 2015, in emerging economies like India where there was growth in the use of these chemicals. These chemicals are widely used in various applications including RAC manufacturing, foam manufacturing, RAC servicing and other sectors. There was a lack of availability of technically proven, economically viable and environment friendly technologies. The annual consumption growth of these chemicals has been in the range of 10% to 15%. In actual sense, this amounted to phase-out of 30% to 40% by 2015, which was quite significant reduction in a very short time frame. This necessitated a long-term vision and planning to successfully meet the obligations of the accelerated phase-out schedule of HCFCs.

India's 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 UNDP was designated as the Lead Implementing Agency for HCFC phase-out in consumption sector and UNEP, World Bank and bilateral agencies comprising of the governments of Germany and France etc., as cooperating implementing agencies.

HPMP Stage-I

The 56th meeting of the Ex-Com of the MLF held in November 2008 approved the preparation of HPMP Stage-I for India. Soon thereafter, detailed stakeholder consultative meetings including sectoral working group meetings for the foam manufacturing, RAC Manufacturing and RAC servicing sectors were held. Based on the outcome of these meetings, a "Roadmap for phase-out of HCFCs in India" describing the long-term vision and action plan including the policy instruments for phasing out of production and consumption of HCFCs in India was developed and launched in October 2009.

The HPMP Stage-1 for India was approved at the 66th meeting of the Ex-Com of the MLF held in April 2012 for achieving a total phase-out of 341.77 ozone depleting potential (ODP) tonnes from the starting point of 1,691.25 ODP tonne. The implementation of the Stage I was completed by 31 December 2017. The highlights of the achievements HPMP Stage-I include:

- **Polyurethane Foam manufacturing sector**: 15 large-sized enterprises in the Foam Manufacturing sector were assisted to phase-out their use of HCFC-141b. In addition, 15 system houses were also assisted in developing HCFC-free polyol formulations with low GWP blowing agents. These activities were implemented by UNDP in close cooperation with the Ozone Cell, MoEFCC.
- **Servicing Sector**: Under this sector training on good servicing practices was imparted to 11,276 technicians and 50 trainers on room air conditioners up to 2 refrigeration tons capacity. Training programs were also organised for institutional users like Defence and Indian railways, that have substantial inventory of HCFC-based equipment/appliances. The Servicing sector activities were implemented by GIZ in close cooperation with the Ozone Cell, MoEFC.
- **Enabling Activities**: In collaboration with the NACIN, training materials were developed, 93 trainers were trained, 320 supervisory officers of Customs were trained, Refrigerant identifiers were procured and supplied to the priority customs ports border check points, AC-R Service sector training videos were developed in five regional languages, Newsletter and videos on RAC servicing best practice were developed and distributed and Refrigeration and Airconditioning Service Sector Society (RASSS) was supported. The enabling activities were implemented by UNEP in close cooperation with the Ozone Cell, MoEFCC.

Through its HPMP Stage I, India successfully met the 2013 target of freeze of HCFC Production and Consumption and 10% phase-out targets of HCFCs in 2015, resulting in an environmental benefit of net direct emission reductions of 3,071,260.5 t.CO_2-eq.

HPMP Stage-II

Stage II of HPMP for India was approved at the 77th meeting of the ExCom of the Multilateral Fund for Implementation of the Montreal Protocol (MLF), for the period 2016 to 2023, to reduce HCFC consumption by 60% of the baseline of 1,608.20 ODP tonne. For HPMP Stage-II, the implementing agencies remained the same as for HPMP Stage-I. The UNDP is the lead implementing agency as also the agency for technology conversion from HCFC to non-HCFC and low GWP technologies in the foam and room air-conditioning manufacturing sectors. The GIZ is the implementing agency for servicing sector activities and UNEP for the enabling activities. All the three agencies implement the respective activities in close cooperation with Ozone Cell, MoEFCC. The highlights of the achievements of HPMP Stage-II include the following:

- **Polyurethane Foam Manufacturing sector**: Consistent with the Ex-Com guidelines and the ODS (Regulation and Control), 2000 Amendment Rules 2014 of India, the Polyurethane foam sector was prioritized for phase-out actions for complete phase out of HCFC-141b by 1 January 2020. The blowing agents cyclopentane (C5), hydrofluoroolefins (HFO) and methyl formate (Ecomate) were selected for the conversions in the Foam Manufacturing sector. A total of 158 enterprises were assisted to phase-out for 2,630.11 mt of HCFC-141b. All companies were subject to on-site verification upon achieving the completion of conversion activities. In addition, a technical institute, Centre for Petrochemicals Engineering and Technology (CIPET) Government of India, having expertise in PU foam technologies was on-boarded to provide hand-holding technical support to the participating foam manufacturing enterprises under HPMP Stage-II. The technical institute along with Ozone Cell, MoEF&CC provided technical support to enterprises under a competency enhancement framework.

- **Air Conditioning Manufacturing Sector**: In this sector, India phased-out 1,140 MT of HCFC-22 consumption in six (6) air-conditioning manufacturing enterprises that volunteered to participate in the HPMP Stage-II activities. The participating enterprises completed their conversions and are supplying HFC-32 based room air conditioners to the local market.

- **Servicing Sector**: 1,250 MT of HCFC-22 was also phased-out through activities in the servicing sector. Training on good servicing practices for 17,000 RAC service technicians was completed. Sixty trainers were trained through Training of Trainers (TOT) Programmes, knowledge products were developed, printed and widely disseminated, including among the training partners across the country. Syllabus for RAC service trade (ITIs) were updated to include alternative refrigerants including flammable refrigerants and good service practices.

- **Enabling activities**: Under the Customs and Enforcement capacity-building component a Memorandum of Agreement has been signed between the Ozone Cell and NACIN for undertaking activities under customs and enforcement capacity-building. Workshops were organized for the customs and enforcement personnel. In addition, the field customs establishments were also sensitized through NACIN on the prohibition of HCFC-141b imports in the country. The following knowledge products were developed and widely disseminated.

    - Study on Public Procurement Policies for RAC equipment using non-ODS based refrigerants;
    - Study on application of non-ODS and low GWP alternatives in building sector;
    - Simulation study for development of national standards by Bureau of Indian Standard (BIS) for low-GWP Refrigerants;

- o Study on Good Management Practices for energy efficient buildings by introducing Passive Cooling designs;
- o Study on Good Management Practices for Cold Storage (warehouse) infrastructure used in e-commerce business highlighting application of non-HCFC and low GWP alternatives;
- o Study on Public Procurement policies for hiring trained and certified RAC service technicians;
- o Quarterly e-newsletter for RAC service technicians on the importance of good servicing practices including handling of different types of refrigerants, related safety issues and updates on refrigerant transition under the Montreal Protocol.

Implementation of HPMP-Stage-II will result in sustainable reductions of 8,190 MT or 769.49 ODP tonne of HCFC consumption from the starting point of 1,691.25 ODP tonnes by 2023, contributing to India's compliance well in advance with the control targets for HCFCs under the Montreal Protocol. The ongoing implementation of Stage-II will result in net direct CO2-equivalent emission reductions of about 8,530,900 MT CO2 eq. per year from 2023 onwards.

HPMP Stage-III

Stage-III of the HPMP will be last of the HPMPs, to be implemented during the period 2023-2030. As per the Ozone Depleting Substances (Regulation and Control) Rules, as amended in 2014, the manufacture of air-conditioners, manufacture of other Refrigeration and Air-Conditioning (RAC) products (excluding compressors), manufacture of fire extinguisher or fire-extinguishing systems and manufacture of all other equipment or products using HCFC is to be phased out by 1 January 2025. Accordingly, the use of HCFCs in all manufacturing sectors should be completed by 31 December 2024. The activities in the RAC servicing sector would continue beyond 31 December 2024 and will go on till 2030.

The UNDP will continue to be the lead implementing agency for HPMP Stage-III and the agency for the investment component, i.e., technology conversion from HCFC to non HCFC and low Global Warming Potential (GWP) alternative technologies in the refrigeration, air-conditioning manufacturing sectors. It will also be the implementing agency for the enabling activities and Deutsche GesellschaftfürInternationale Zusammenarbeit (GIZ) Proklima, Government of Germany, for the RAC servicing sector along with UNDP.

To oversee the preparation of HPMP Stage-III, a Committee under the Chairmanship of Joint Secretary (Ozone Cell) MoEF&CC and comprising the following has been constituted with the approval of Secretary (EF&CC) and Chairperson, ESC:

- o Department of Promotion of Industry and Internal Trade (DPIIT);
- o Department of Chemicals and Petrochemicals;
- o Ministry of Micro, Small and Medium Enterprises (MMSME);
- o Ministry of Skill Development and Entrepreneurship (MSDE);
- o Department of Science and Technology (DST);
- o Additional Director/Scientist 'E', Ozone Cell – Member Secretary.

The HPMP Stage-III was prepared in accordance with project preparation guidelines and decisions approved by the Ex-Com of the MLF and involved the following steps.

- o Development of preliminary survey questionnaire or onboarding all eligible enterprise operating in the refrigeration and air-conditioning manufacturing sectors'
- o Shortlisting of eligible enterprises based on the eligibility criteria decided by the Ex-Com of the MLF'
- o Designing and conducting six regional stakeholder consultation workshops at

Ahmedabad, Chandigarh, Delhi, Kolkata, Mumbai and Hyderabad through hybrid mode, with both physical and virtual participation to promote awareness on HPMP Stage-III, the eligibility criteria, funding principles and encourage potential enterprises to participate in HPMP Stage-III;

- Shortlisting eligible enterprises based on the survey information by applying the eligibility criteria of the MLF;
- Conducting physical site verification of eligible enterprises and obtain all the required information for the project preparation including consumption of HCFCs, baseline equipment used, etc.;
- Development of technology conversion projects for all eligible enterprises in the refrigeration and air-conditioning manufacturing sectors including proposing alternative non-HCFC and low GWP alternative technologies, and costs of conversion;
- Development of sectoral strategy for HCFC phase out and transition to non-HCFC and low global warming potential alternative technologies for the refrigeration and air-conditioning manufacturing sectors;
- Development of strategies for the RAC servicing sector and enabling activities forming part of HPMP Stage-III;
- Development of overarching strategy for HPMP Stage-III;
- Discussion of the above said sectoral strategies and overarching strategy in national stakeholder consultation workshop with all the concerned stakeholders, nodal line Ministries/departments, CPCB SPBCs and all participating enterprise;
- Discussion of the draft HPMP Stage-III after discussion in the overseeing Committee for its views and recommendation for approval;
- Finalization of HPMP Stage-III.

The HPMP Stage III for India was approved in the 91st meeting of the Ex-Com of the MLF to phase out 10,678.87 MT or 579.99 ODP tonne of HCFCs consumption from the starting point, contributing to India's compliance with the 2025 and 2030 control targets HCFCs under the Montreal Protocol.

The HPMP Stage-III will be the last of the HPMPs for India, for assisting the country in achieving compliance with the Montreal Protocol 2025 and 2030 control targets for consumption of Annex C Group 1 substances (HCFCs) with complete phase-out of HCFC-22 by 1 January 2025 in all manufacturing sectors as per the Ozone Depleting Substance (Regulation and Control) Rules 2000, as amended in 2014. A total of 48 enterprises in the refrigeration manufacturing sector and 16 enterprises in the air-conditioning manufacturing sector are participating in HPMP Stage-III.

In addition, HPMP Stage-III addresses phase-out of HCFC-22 in the RAC Manufacturing sector, Servicing sector, capacity building, project activities, policy and regulations, enforcement training, etc., for the successful and sustainable implementation of complete phase-out of HCFCs by 2030, with a service tail of 2.5% of the baseline of HCFCs.

Implementation of HPMP-Stage-III will result in net direct CO_2 equivalent emission reductions of 19,239,929 tonnes CO2-eq. from 2030 onwards.

The meeting of the Local Project Appraisal Committee to consider the approval for implementation of HPMP Stage-III was held on 22 June 2023 under the chairmanship of Deputy Director General, Department of Economic Affairs, Ministry of Finance, Government of India. The Committee after review and discussions, accorded approval for the implementation of HPMP Stage-III.

Fiscal Measures

The Government of India has granted 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 of India further extended the benefit of Customs and Excise duty exemptions for ODS phase-out projects which were not funded by the MLF. The benefit is available subject to the condition that enterprise gives clear commitment for stop using the ODSs in all future manufacturing operations after the completion of implementation of project(s).

The benefit of duty exemption has been extended for new capacity as well as expansion of capacity with non-ODS technologies since 1997.

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&CC, Government of India, has notified ODS (Regulation & Control) Rules, 2000 in the *Gazette of India* on 19 July 2000, covering various aspects, viz., production, consumption, export and import of ODSs. These rules have been subsequently amended from time to time. Most recent amendment being in 2019.

Important provisions of the ODS (Regulation and Control) Rules, 2000

These Rules prohibited the use of CFCs in manufacturing various products beyond 1 January 2003 except in MDIs and for other medical purposes. Similarly, use of halons was prohibited after 1 January 2001 except for servicing. Other ODS such as CTC and methyl chloroform and CFC for MDIs were allowed to be used upto 1January 2010. Further, the use of methyl bromide has been allowed upto 1January 2015. Since HCFCs are low-ODP substances and are also used as interim substitutes to replace CFCs, these are allowed to be used upto 1 January 2030 as per the Montreal Protocol accelerated phase-out schedule.

As per these Rules, there is a need for compulsory registration of ODS producers, manufacturers of ODS-based products, importers, exporters, stockists and sellers and the same provision is applicable to manufacturers, importers and exporters of compressors and other products containing ODS. They are also required to maintain records and file periodic reports for monitoring production and consumption of ODS. Enterprises which have received financial assistance from MLF for the implementation of the Montreal Protocol for switch over to non-ODS technology have to register the date of completion of their project(s) and declare that the equipments used for ODS have been destroyed. Creation of new capacity or expansion of capacity of manufacturing facilities of ODS and ODS-based equipment have been prohibited. Purchasers of ODS for manufacturing products containing ODS, are required to declare the purpose for which ODS are purchased. All imports and exports of ODS and products containing ODS require a license.

The recommendation of the MoEF&CC is essential before issuing any license for import and export of ODS and products containing ODS by the DGFT, Ministry of Commerce and Industry.

These rules also specify phase-out dates for different ODS in manufacturing of products using these ODS. In addition, these Rules also ban trade in ODS with non-Parties.

Amendments

The ODS (Regulation & Control) Rules, 2000 have been amended in 2001, 2003, 2004, 2005, 2007, 2014 and 2019.

The 2001 Amendment extended the last date of registrations from one year to two years after the commencement of the Rules. The Amendment 2003 refers to a correction of a typographic error. The amendment 2004 specified the date of registration for substances listed in Group IV of Schedule I (CTC) and for substances listed in Group VI of Schedule I (HCFCs) on or before 31 December 2004 and on or before 19July 2007 respectively. Subsequently, the Rules were amended in 2005, the registration date for substances listed in Group IV of Schedule I (CTC) was extended upto 31 December 2005. The Rules were further amended on 18 September 2007. As per the amended rules, registration has been extended for substances listed under Group I, Group II, Group III and Group IV upto 31 December 2009, in case of substances in Group VI upto 31 December 2039 and in case of substances in Group VIII upto 31 December 2014 and the existing registered enterprises need not apply for renewal.

The ODS (Regulation and Control) Rules, 2000 have been amended to align with the accelerated phase-out of HCFCs. A draft amendment of ODS Amendment Rules, 2014 was prepared by the Ozone Cell, MoEF&CC and circulated among the concerned stakeholders, including industry associations, DGFT etc. Subsequently, a consultative meeting was organized in October 2012 where a large number of stakeholders participated in the meeting to further discuss the salient features of the amendment.

The draft of amendment of ODS (Regulation and Control) Rules was published in the *Gazette of India* in May 2013 for inviting comments/suggestions from the public on the draft Rules. Subsequently, the ODS (Regulation and Control) Amendment Rules, 2014 were published on 4 April 2014 in the *Gazette of India*. The salient features of the ODSs (Regulation and Control) Amendment Rules, 2014 are:

- The production and consumption of Group VI substances (HCFCs) has been proposed to be controlled according to the accelerated phase-out.
- Introduction of quota system by the Government for production and consumption of Group VI substances (HCFCs) for non-feedstock applications and monitoring and reporting system for all feedstock applications including use of CTC in order to comply with phase-out targets of the production and consumption of Group VI substances (HCFCs).
- Prohibition of issuance of license for import and export for Group I, Group II, Group III, Group IV and blends containing ODS including Group VI substances except recovered, recycled and reclaimed ODS or for EUN, if any or ODS for destruction or for feedstock applications.
- Prohibition of issuance of license for import of pre-blended polyols containing Group VI substances (HCFCs).
- Ban on creating new capacities to manufacture products made with or containing Group VI substances (HCFCs).
- In order to control the inventory of HCFC based refrigeration and air-conditioning equipments and reduce the consumption of HCFCs in servicing of these equipments in future years, import of air-conditioning and refrigeration equipments and other products using HCFCs from 1 July 2015 has been prohibited.
- Exemption for production of Group VI substances (HCFCs) for the Protocol approved feedstock uses in manufacturing of other chemicals, with negligible emissions, if any.

The 2019 amendment of the ODS (Regulation and Control) Rules, 2000, was published in the Gazette of India on 31 December 2019, inter alia prohibiting the issuance of import license for HCFC-141b from 1 January 2020.

Kigali Amendment to the Montreal Protocol

The Kigali Amendment to the Montreal Protocol was decided by the Parties to the Montreal Protocol at its 28th meeting held in October 2016 at Kigali, Rwanda for phase down of hydrofluorocarbons (HFCs), which were introduced as a non-ozone depleting alternative to support the timely phase-out of ODS, CFCs, HCFCs, etc. The HFCs are now widely used substances globally in various applications like air-conditioners, refrigerators, aerosols, foams and several other products and industrial processes. While HFCs do not deplete the stratospheric ozone layer, they have high global warming potential ranging from 12 to 14,800.

As per the agreed phase-down of HFCs under the Kigali Amendment, India will have to complete its phase down the production and consumption of HFCs in four steps from 2032 onwards with reduction of 10% from the baseline of production and consumption in 2032, 20% in 2037, 30% in 2042 and 85% in 2047 respectively. The baseline constitutes the average of production and consumption of HFCs for the period 2024-2026 and the freeze applicable for India is 2028. The details of the elements of the agreed HFC phase-down schedule for both developing and developed countries is as follows:

Details of the elements of the agreed HFC phase-down schedule are provided in table below:

	A5 parties (developing countries) - Group 1	A5 parties (developing countries) - Group 2	Non-A5 parties (developed countries)
Baseline formula	Average HFC consumption for 2020-2022 + 65% of hydrochloro-fluorocarbon (HCFC) baseline	Average HFC consump-tion for 2024-2026 + 65% of HCFC baseline	Average HFC consump-tion for 2011-2013 + 15% of HCFC baseline*
Freeze	2024	2028	-
1st step	2029 (10%)	2032 (10%)	2019 (10%)
2nd step	2035 (30%)	2037 (20%)	2024 (40%)
3rd step	2040 (50%)	2042 (30%)	2029 (70%)
4th step	-	-	2034 (80%)
Plateau	2045 (80%)	2047 (85%)	2036 (85%)

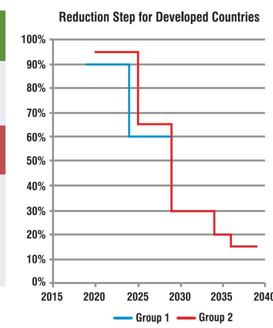
** For Belarus, Russian Federation, Kazakhstan, Tajikistan, Uzbekistan, 25% HCFC component of baseline and different initial two steps (1) 5% reduction in 2020 and (2) 35% reduction in 2025*

Notes

1. Group 1: Article 5 parties not part of Group 2
2. Group 2: Bahrain, India, the Islamic Republic of Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia and the United Arab Emirates
3. Technology review in 2022 and every five years.
4. Technology review four to five years before 2028 to consider the compliance deferral of two years from the freeze of 2028 of Article 5 Group 2 to address growth in relevant sectors above certain threshold.

HFC Phase-down Schedule for Developed Countries

Group1	Baseline (Production & Consumption)	2019	2024	2029	2034	2035
Most developed Countries	HFC (Avg. 2011-2013* 15% of HCFC basline*	90%	60%	30%	20%	15%
Group 2	**Baseline (Production & Consumption)**	**2020**	**2025**	**2029**	**2034**	**2036**
Belarus, the Russian, Federation Kazakhstan, Tajikistan, and Uzbekistan	HFC (Avg 2011-2013)* 25% of HCFC basline*	95%	65%	30%	20%	15%

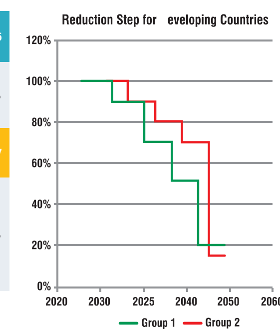


Group 1 Phase-down Start: 2019 15%
Tail: 2036
Group 2 Phase-down Start: 2020

*HCFC baseline for non-A5 Parties is equal to HCFC (1989) + 2.8% CFC (1989)

HFC Phase-down Schedule for Developing Countries

Group1	Baseline (Production & Consumption)	2024	2029	2035	2040	2045
Most Developed Countries	HFC (Avg. 2020-2022* 65% of HCFC basline*	100%	90%	70%	50%	20%
Group 2	**Baseline (Production & Consumption)**	**2028**	**2032**	**2037**	**2042**	**2047**
Bahrain, India, Iran, Iraq, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, and UAE	HFC (Avg 2024-2026)* 65% of HCFC basline*	100%	90%	80%	70%	15%



Group 1 Compliance Start: 2024 20%
Tail: 2045
Group 2 Compliance Start: 2028 15%
Tail: 2047

NCFC baseline for A5 Parties is equal to average of 2009-2010

In September 2021, the Government of India ratified the Kigali Amendment after approval by the Union Cabinet. It was also decided that a National Strategy for the implementation of phase-down of HFCs, in consultation of Industry and other stakeholders, would be developed by 2023.

The Kigali Amendment came into force for India on 26 December 2021, the date on which the instrument of ratification was deposited with the UN Secretary General. In accordance with the Montreal Protocol provisions, the framework for licensing system and reporting obligations has been put in place after the first national stakeholder consultation held on 20 January 2022. The DGFT, Ministry of Commerce and Industry, the nodal agency for licensing for import/export of HFCs is implementing the licensing system for HFCs, based on the recommendations of the Ozone Cell, MoEFCC. Data reporting for HFCscommenced from 2022 along with other ODS as per provisions of Article 7 of the Montreal Protocol.

The following are the sectors and sub-sectors where HFCs are used:

(i) Air-conditioning Manufacturing including room AC, light commercial, VRF systems and chillers;

(ii) Refrigeration Manufacturing including commercial refrigeration (cooling cabinets, freezers including vaccine coolers and freezers, water coolers, cold rooms, fishing vessels);

(iii) Process chillers (including food processing equipment);

(iv) Mobile Airconditioning including buses, trains, etc.;

(v) Foam Manufacturing;

(vi) Firefighting manufacturing;

(vii) Industrial Aerosols including cosmetics;

(viii) Meter Dose Inhalers.

The development of the national strategy for HFC phase-down comprises the following:

(i) Outreach and awareness raising;

(ii) Development of a National Strategy including policy framework for the implementation of the Kigali Amendment;

(iii) Establishing a framework for implementing licensing, quota system, and reporting obligations related to HFCs.

Of the above three activities, activity (i) and (ii), i.e., outreach and awareness and development of National strategy including policy framework for implementation of the Kigali Amendment are going on in parallel. The third activity, namely establishing a legislative framework including quota system and amendment to the Ozone Depleting Substances (Regulation and Control) Rules to align with phase-down of HFCs can be commenced once the draft strategy for HFC phase-down is ready.

As part of the awareness and outreach component, 34 workshops comprising 18 workshops through physical mode and 16 workshops through virtual mode are being conducted across the country. These workshops are being organised in close cooperation with the concerned line ministries and departments comprising DPIIT, DCPC, MSDE, MSME, Ministry of Power including BEE and EESL, DST, CSIR, DRDO, CPCB, State Pollution Control Boards and the concerned industry associations concerned with the Montreal Protocol implementation. Till date, 23 awareness-cum-sensitization workshops have been completed. Sectoral HFC data is also being collected through these workshops. The details of the workshops conducted are as follows:

Place	Date
Delhi	22-Nov-2022
Ludhiana	1-Dec-2022
Chennai	15-Dec-2022
Guwahati	24-Dec-2022
Chandigarh	7-Jan-2023
Delhi	13-Jan-2023
Hyderabad	17-Jan-2023
Bengaluru	23-Jan-2023
Kolkata	27-Jan-2023
Lucknow	31-Jan-2023
Kochi	3-Feb-2023
Pune	7-Feb-2023
Vizag	18-Feb-2023
Indore	21-Feb-2023
Mumbai	24-Feb-2023
Ahmedabad	3-Apr-2023
Vadodara	4-Jun-2023

Details of Virtual workshops

Date
13-Dec-2022
10-Jan-2023
10-Feb-2023
10-Mar-2023
20-Mar-2023
12-Apr-2023

The development of strategy and policy framework comprises prioritizing the sectors and sub-sectors for HFC phase-down. The prioritization will be based on the consumption pattern of HFCs in various sectors and sub-sectors, availability of low GWP alternatives, capacities of the industry to adapt the low GWP alternative technologies considering their availability, technical feasibility, economic viability and safety related issues and keeping in view of the compliance obligations of the country.

The National Strategy for HFC phase-down will be developed by 2023 and the regulatory framework including framework for implementing licensing, quota system will be developed by 2024.

Other Initiatives

India Cooling Action Plan (ICAP)

Cooling is an essential part for economic growth and development in Article 5 countries. The RAC sector is a major consumer of electricity. The direct and indirect emissions of the RAC Sector relate to use of refrigerants and energy consumed by the equipment. It is a widely known fact that about 90% of the total emissions from RAC equipment is because of energy consumption. The Kigali Amendment to the Montreal Protocol, for the first time, has recognized linkages between maintaining and/or improving energy efficiency of the RAC equipment with refrigerant transition under the Montreal Protocol.

Keeping in view that energy efficiency is a major driver for technology choice under the Kigali Amendment and considering the need for an integrated view to be taken with respect to cooling for maximization of climate benefits under the Kigali amendment, the Government of India has initiated the development of ICAP, which provides a long-term perspective and guidance with respect to cooling needs. The proposed plan would integrate issues of energy efficiency, refrigerant transitions, technology choices, reduction of cooling load, focus on servicing sector, and having an innovation ecosystem for development low GWP technologies.

The ICAP aims to provide a 20-year perspective plan (2018-2038) and policy recommendations, to address the cooling requirement across sectors while providing for ways and means to provide thermal comfort and access to sustainable cooling to all, involving multi-stakeholders to synergize actions for addressing cooling demand across all areas: technology, manufacturing, energy efficiency and the environment, while reemphasizing the principles enshrined in the CP of India for phase out of ODS, i.e., to have minimum economic dislocation and obsolescence cost and maximize indigenous production to twin environment and economic gains.

Given the cross-cutting nature of cooling demand, the ICAP implementation proposes active collaboration among the relevant ministries as well as the private sector entities.

Dr Harsh Vardhan, then Minister for Environment, Forest and Climate Change released the ICAP on 8 March 2019.

India is the first country in world to develop a Cooling Action Plan, which aims to reduce both direct and indirect emissions.

The five broad goals thatemerged from the interventions proposal in the ICAP by 2037-2038 are:

(i) Reduction of cooling demand by 20% to 25%;

(ii) Reduction of cooling energy requirements by 25% to 40%;

(iii) Reduction of refrigerant demand by 25 to 30%;

(iv) Recognition of cooling as a thrust area for research for low GWP solution under national science and technology programme to support development of technological solution;

(v) Unified training and certification system for Service Technicians.

The ICAP has been appreciated internationally as an important policy initiative which has the potential to provide socio-economic and environmental benefits related to reduced refrigerant use, climate change mitigation and Sustainable Development Goals (SDGs). Many countries are now involved in development of cooling action plans keeping in view the significant environmental benefits and the fulfilment of SDGs.

The United Nations Secretary General in his message on World Ozone Day 2019 has highlighted the need for all countries to develop national cooling action plans. This step taken by India has led to a global recognition of this important policy initiative which can help in climate action and achievement of sustainable development goals.

The ICAP recommends synergies with ongoing government programmes and schemes such as Housing for All, the Smart Cities Mission, Doubling Farmers Income and Skill India Mission, in order to maximize socio-economic co-benefits. The following benefits would accrue to the society over and above the environmental benefits by the implementation of ICAP: (i) thermal comfort for all; (ii) sustainable cooling; (iii) improved cold chain infrastructure using low GWP technologies would facilitate better storage of produce and reduce transportation costs. lead towards: doubling farmers income; (v) skilled and certified RAC technicians would have better livelihoods, (vi) environment protection; (vii) Make in India and; (viii) robust R&D on alternative cooling technologies.

Implementation of recommendations of IICAP:

To operationalize the recommendations of ICAP, the following six thematic working groups have been constituted under the Steering Committee:

1) Space Cooling in Buildings;
2) Cold-chain and Refrigeration;
3) RAC Servicing Sector;
4) Refrigerant Demand and Indigenous Production and R&D to support development technologies;
5) Transport Air-conditioning.

Implementation of the recommendations of the ICAP

The action points for the thematic areas “Space cooling in buildings”, “Cold Chain”,” Servicing Sector” and “Refrigerant demand and indigenous Production and R&D” have been finalized and are under implementation by the concerned nodal ministries/departments/agencies.

Space cooling covers both passive and active cooling strategies, optimization of cooling loads, encompassing natural and mechanical ventilation in building design, thermal comfort standards specifying pre-setting of temperatures for air-conditioning equipment in commercial built spaces and promoting use of energy efficient refrigerant based appliances including not in-kind technologies.

The Cold Chain sector comprising cold storages or refrigerated warehouses, pack houses, reefer transport and ripening chambers–is poised for a significant growth in the coming years. The development of uninterrupted cold chain infrastructure will be a major driver in supporting the government's priority areas of reducing food loss, ensuring food security and doubling farmers income.

The Servicing sector comprises use of good servicing practices by service technicians to reduce refrigerant leakage and minimize emissions. Unified training and certification for RAC service technicians have potential to provide significant environment and livelihood benefit to service technicians, besides inculcating confidence amongst consumers.

Indigenous Production and R&D aims towards indigenous development and encouraging domestic manufacturing of next generation low GWP refrigerants, cooling appliances along with safety standards for wider adoption of such refrigerants during the phase-down of HFCs under the Kigali Amendment, synergising with ICAP goals.

Indigenous capacity development including research on low global warming (GWP) chemicals.

Towards effectively utilising the diverse expertise and facilities available in various R&D and academic institutions of higher learning for result based outcomes, there needs to be a concerted and coordinated mechanism between various stakeholders, with deep expertise in refrigeration and air conditioning research. As such, a robust enabling platform is a key need in fostering meaningful collaborations and linkages and supporting the R&D efforts. The expertise of R&D institution synergized with industry efforts can help in achieving sustainable cooling through indigenous efforts as well technology.

In order to promote indigenous manufacturing of low global warming potential chemicals and development of a robust R&D ecosystem the MoEFCC has collaborated with 8 Indian Institutes of Technology (Roorkee, Hyderabad, Kanpur, Patna, Banaras, Madras and Tirupati) to promote research and development of low GWP chemicals, including blends thereof, to be used as alternatives to substances controlled under the Montreal Protocol in line with industry requirements through engagement of research scholars. This would help in creating awareness for development and adoption on indigenous low GWP alternative technologies which could be deployed during the HFC phase-down besides promoting "Make in India" initiative of the Government.

The MoEFCC has also organised a workshop on 4 August 2023 at Delhi on "Indigenous capacity development including research on GWP chemicals to be used as alternatives to HFCs. The objective of the workshop was to develop a Road ap along with an action plan for indigenous development, which encourages domestic manufacturing of next generation low GWP refrigerants, cooling appliances along with safety standards and upgradation of skill of the existing manpower for wider adoption of such refrigerants during the phase down of HFCs under the Kigali Amendment. The deliberations from the workshop resulted in specific recommendations towards achieving the said objectives, categorised as short term (up to 3 years), medium term (3-5 years) and long term (above 5 years).

Participation in Montreal Protocol meetings

Representatives from the MoEFCC participated in the following meetings of the Montreal Protocol:

- 34th Meeting of the Parties (MOP) to the Montreal Protocol held from 31 October to 4 November 2022 at Montreal, Canada.
- 45th meeting of the Open-Ended Working Group of Parties to the Montreal Protocol held from 3-7 July 2023 at Bangkok, Thailand

- 91st and 92nd meetings of the Ex-Com of the MLF for implementation of the Montreal Protocol.

Significant outcomes of the MOP 34 include the following:

a) Finalization of Terms of Reference (TOR) for the study on the 2024–2026 replenishment of the MLF for the Implementation of the Montreal Protocol;

b) Decision on continued provision of information on energy efficient and low global warming potential technologies with emphasis on coordinated investment in energy efficiency and refrigerant transition, associating all concerned stakeholders;

c) Strengthening the effective implementation and enforcement of the Montreal Protocol including those relating to HFC-23 by product emissions, CTC, QPS uses of methyl bromide;

d) Strengthening the TEAP and its Technical Options Committees of the Montreal Protocol;

e) India has been elected as a coopted member with China as member to represent the Ex-Com for the year 2023.

Significant discussions of the OEWG 45 include the following:

a) Report of the Replenishment Task Force (RTF) TEAP on funding levels for the replenishment for the triennium 2024–2026;

b) Report of Energy efficiency Task Force of the TEAP on assessing energy efficiency gains in implementation of MLF projects and information on benefits of combined energy efficiency and HFC phase-down and how funding modalities for energy efficiency can be handled in the context of returns to the consumers;

c) Issues relating to implementation and enforcement of the Montreal Protocol including those relating to combatting illegal trade, HFC-23 by product emissions, CTC, QPS uses of methyl bromide.

The OEWG, being a subsidiary body to the MOP, deals with specific issues and recommends actions to MOP. The OEWG also considers all issues prior to forwarding its recommendations to the MOP. The MOP makes the final decision on any matter referred to it by the OEWG. Accordingly, the above issues will be further deliberated at the 35th MOP scheduled to be held at Nairobi from 23-27 October 2023.

Significant outcomes of the meetings of the Ex-Com of the MLF

91st meeting of the Ex-Com held from 5-9 December 2022:

a) HPMP Stage-III for India was approved to be implemented from 2023 to 2030 for the complete phase-out of HCFCs for controlled applications as per the accelerated phase out schedule of the Montreal Protocol;

b) The fourth tranche for HPMP Stage-II was approved;

c) Funding for all Institutional strengthening projects (ISP) and renewals at a level 38% higher than existing amount, with a minimum level of ISP funding of US$ 60,000 per year. The duration of ISP renewal implementation phases from the current two years to three years along with the revised format of terminal reports and requests for extension of IS funding and the corresponding performance indicators were also approved;

d) Funding window of US$ 20 million, subject to further augmentation for Pilot projects to maintain and/or enhance energy efficiency of replacement technologies and equipment in the context of HFC phase-down was approved;

e) Criteria for a funding window for an inventory of banks of used or unwanted controlled substances and a plan for the collection, transport and disposal of such substances was approved.

92nd meeting of the Ex-Com held from 28 May to 2 June 2023:

a) Funding requests for preparation of four projects to demonstrate HFC phase-down under the Kigali Amendment were approved;

b) Decision was taken on the contribution of HCFC phase-out and HFC phase-down towards sustainable cooling through which the MLF Secretariat would develop a paper for consideration by the Ex-Com of the MLF;

c) Operational framework to further elaborate on institutional aspects and projects and activities that could be undertaken by the MLF for maintaining and/or enhancing the energy efficiency of replacement technologies was discussed after which a decision was taken that the MLF Secretariat would develop a paper on for consideration by the Ex-Com on activities and associated costs relating to energy efficiency to be undertaken while under taking HFC phase-down along with funding options.

Discussion on cost guidelines for financing HFC phase-down in Article-5 countries continued at both 91St and 92nd meetings of the ExCom.

Awareness Generation

The Ozone Cell, MoEF&CC, the National Ozone Unit has undertaken comprehensive public awareness campaign to ensure that the industries and public at large are aware about the ill effects of ozone depletion, and undertake necessary ODS phase-out activities and support the policies to protect the ozone layer.

Material has been made available on the Ozone Cell website for awareness generation among the public. Instructional training videos for RAC service technicians in six different languages, viz., English, Hindi, Bengali, Kannada, Tamil and Gujarati have also been made available. Separately, as part of awareness generation and information dissemination activities the Ozone Cell has set up YouTube channel, Facebook and Twitter pages.

World Ozone Day

The United Nations General Assembly in 1995 adopted a resolution which proclaims 16 September as World Ozone Day, to commemorate the signing of the Montreal Protocol on Substances that Deplete the Ozone Layer. The Montreal Protocol came into force in 1987 and since then, 16 September of every year is celebrated as the World Ozone Day by the Parties to the Montreal Protocol.

India has been celebrating World Ozone Day on 16 September since 1995.

World Ozone Day 2022

The theme of World Ozone Day 2022 was "Montreal Protocol@35: global cooperation protecting life on earth". The MoEFCC celebrated the the 28th World on 16 September 2022 at Auditorium, Yashwantrao Chavan Pratishthan, Mumbai, in collaboration with the Department of Environment and Climate Change, Government of Maharashtra. Hon'ble Union Minister for Environment, Forest and Climate Change and Labour and Employment was the Chief Guest. Hon'ble Chief Minister of Maharashtra, Shri Eknath Shinde, Hon'ble Union Minister of State for Environment, Forest and Climate Change, Shri Ashwini Kumar Choubey were the Guests of honour.

Release of Awareness Materials

a) **Release of winning entries of National-level Poster and slogan competitions for school children.**

   To create awareness among the students to protect the Ozone Layer, competitions in the categories of Poster and Slogan Writing were organized for school children across the country. In all 4,270 entries were received for the poster competition and 1,161 entries for the slogan category respectively through a web portal developed for the purpose. The winning entries were finalized by a panel of judges.

b) **24th edition of "The Montreal Protocol: India's Success Story**" highlighting India's achievements in the Montreal Protocol Implementation in phasing out of ODS till date.

Release of Publications

a) **Action Plan for implementation of the recommendations of the India Cooling Action Plan (ICAP) for Cold Chain.** The action plan has been finalized after mapping of the recommendations given in the ICAP with the on-going government programmes/schemes and the proposed actions by different agencies after extensive discussions with all the concerned stakeholders including line ministries/ departments;

b) **Study Report on "Passive & Low Energy Cooling Strategies for Achieving Thermal Comfort in India's Upcoming Affordable Housing".** The study aims to provide best practices for architects, building professionals and end-users to adopt energy-efficient strategies for constructing buildings and will help a long way in promoting passive cooling measures in building construction leading to thermal comfort;

c) **Study Report on "Reduction in GHG emissions through ODS phase-out under the Montreal Protocol implementation in India"**. The Study projects the reduction of GHG emissions due to phase-out of ODS in the country through the implementation of the Montreal Protocol;

d) **Study report on "Sensitizing building construction community on passive cooling design, non-ODS, low GWP and energy efficient technologies".** The Study aims to provide a guide for architects, building professionals and others associated with the construction industry to adopt passive design strategies for constructing buildings, to improve thermal comfort to the users;

e) **Quarterly newsletter "newsTRAC" for RAC service technicians** to disseminate information on new developments and initiatives in the RAC service sector to the service technicians, besides promoting awareness on good service practices as well as new alternative refrigerants entering the market and their effective handling;

f) **Short video film on India Cooling Action Plan;**

g) **Animation video message on energy efficient cooling by "Prakriti".**

Website

The website of the Ozone Cell along with five project related websites were integrated into a single website and migrated to the National Informatics Centre (NIC) server. The website http://ozonecell.nic.in is updated regularly.

MIS System for ODS phase-out activities

A comprehensive Management Information System (MIS) system for all activities relating to ODS phase-out including the regulatory framework under the ODS Rules, project implementation and monitoring has been developed. The MIS system was launched on the occasion of the World Ozone Day 2018 and in under implementation.

The MIS is fully operationalized and simplified provisions have been introduced for compliance by enterprises. These include registration and reporting for ODS as producer, user, importer, exporter and seller as per the various provisions of the ODS (Regulation and Control) Rules 2000 and its amendments. Provision for submission of quarterly and annual returns on ODS online by the enterprises has also been made in the MIS.

Activities related to the implementation of ODS Rules, 2000 and its amendments and Montreal Protocol

Activities related to the implementation of ODS Rules, 2000 and its amendments were carried out inter alia including registration, Regulation of export/ import, issuance of production quota, monitoring and reporting.

The statutory reporting under the Montreal Protocol under Article 7 has been completed and the CPPR submitted to the Secretariat of the MLF for the implementation of the Montreal Protocol.

Monitoring System in India

A detailed monitoring mechanism has been established by the Ozone Cell, MoEF&CC 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 as follows:

The MoEF&CC has constituted a Standing Committee on Monitoring under the Chairmanship of Chairman, CPCB with members from concerned Departments, Industry Associations and the Ozone Cell, MoEF&CC. The Committee reviews the data collected and analysed by the Ozone Cell, MoEF&CC from ODS producers, DGFT, DGCIS, etc., on production, imports, exports and user industry in the country. The production, import and export data is collated in the Article 7 format of the Montreal Protocol for submission to the Ozone Secretariat. The Standing Committee on Monitoring is an advisory body to the ESC. The Article 7 data thus vetted by the Standing Committee on Monitoring is submitted to the ESC for its approval and then it is submitted to the Ozone Secretariat.

The Ozone Cell has been convening regular meetings with representatives of the World Bank, UNDP, UNEP, UNIDO and Bilateral Agencies 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, MoEF&CC is holding periodic meetings with industries to monitor their implementation progress for ODS phase-out.

Awards and Recognitions

The Ozone Cell of India has been conferred with several awards/ appreciations/ recognitions for successful implementation of the Montreal Protocol and its ODS phase-out activities.

Other activities

- Recommendations were issued to enterprises for import and export of ODSs and ODS based equipment for getting license from the DGFT.
- Data on production, consumption, export and import of ODS is being collected from various sources, collated and submitted to the Secretariat for the Vienna Convention and the Montreal Protocol (The Ozone Secretariat) and the CPPR to the Secretariat of the MLF for the implementation of the Montreal Protocol by the end of September each year as per the Article 7 of the Montreal Protocol.

Key to Success

India attributes its success in achieving rapid progress of ODS phase out on 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 planning and implementation levels;
- Sending clear messages from the Government to various stakeholders by notifying appropriate regulations and policies;
- Awareness raising activities for key target groups;
- Increasing the capacity of the Ozone Cell by its active involvement in the Regional.

Network of ODS officers and other international fora:

- To create awareness among the stakeholders producing and consuming HCFCs;
- Monitoring of production and consumption sectors for complete phase-out of ODS;
- Mechanism for more involvement of state-level organizations in ODS phase-out activities.

3 INDIA'S ACHIEVEMENTS TO DATE OF THE MONTREAL PROTOCOL REGIME

Achievements

Contribution and achievements of India for the protection of the stratospheric ozone and implementation of the Montreal Protocol are multi-fold. The industries that were producing and consuming ODS were motivated by creating extensive awareness about the ill-effects of the ozone layer depletion in the early stage of the Montreal Protocol. Simultaneously, activities related to the Montreal Protocol were initiated as early as in 1989 by establishing a task force for evaluating the use of ODS and estimating sector wise consumption of ODS.

India not only developed and put in place policies/ regulations for phase-out of ODS as per the Montreal Protocol Schedule within the country, but also played a visionary role since the inception of the Montreal Protocol including in the key policy negotiations on behalf of the developing nations.

India debated extensively to make industrialized countries to realize their historic responsibility for production, consumption and emissions of ODS, that has caused the stratospheric ozone hole. Subsequently, India played a vital role for setting up the financial mechanism of the Montreal Protocol the MLF as early as 1990 to provide technical and financial assistance to the developing countries. Today, the financial mechanism has proved to be the key element in making the Montreal Protocol a successful Environmental Treaty.

India became a Party to the Vienna Convention for the Protection of the Ozone Layer on 18 March 1991 and the Montreal Protocol on Substances that Deplete the Ozone Layer on 19 June 1992 and since then, made outstanding contributions for the protection of ozone layer.

Comprehensive Ozone Depleting Substances (ODSs) (Regulation and Control) Rules, 2000 were developed and put in place under the Environment (Protection) Act 1986, which were utmost important for the successful implementation of ODS phase-out in a vast country like India. These rules set the deadlines for phasing-out of various ODSs. The unique feature of these Rules was banning the use of CFCs and halons in manufacturing of new equipment as early as from 1 January 2003. This not only helped achieve the early phase-out of CFCs and halons in the country, but also reduced the inventory of ODS-based equipment which resulted in reduction of servicing requirements.

Another significant achievement was phase-out of production and consumption of virgin halons as early as 2002, being high-Ozone Depleting Potential (ODP) chemicals.

India accelerated the phase-out of production and consumption of CFCs with effect from 1 August 2008, 17 months ahead of the Montreal Protocol schedule except use of pharmaceutical grade CFCs in manufacturing of Metered Dose Inhalers (MDIs) for asthma, COPD and other respiratory ailments within the country and other Article 5 Parties.

The phase-out of ODS in MSMEs, which were widely scattered were handled using an innovative approach, realizing that MSMEs have relatively a large share in Indian economy. Several sector-wise umbrella projects were formulated in a number of sectors, viz., Aerosol sector, Foam Manufacturing, Refrigeration Manufacturing, to cater to the needs of MSMEs. These enterprises were provided need-based appropriate equipment for converting their operations from ODS to non-ODS technologies. Safety issues in using flammable propellants like Hydrocarbon Aerosol Propellant (HAP) by small aerosol fillers were addressed adequately.

The phase-out of use of CFCs in Refrigeration and Air Conditioning (RAC) Servicing sector was an extremely challenging task because it involved the informal sector that comprissed a large number of very tiny enterprises. These enterprises were located throughout the country, including in small towns and rural areas. National CFC Consumption Phase-out Plan (NCCoPP) and its forerunning projects (Indo- Swiss-German Project "Ecological Refrigeration (ECOFRIG) and Human and Institutional Development in Ecological Refrigeration (HIDECOR) not only addressed this sector in a very effective manner by training more than 20,000 servicing technicians but also provided equipment support to a large number of enterprises. This was one of the significant achievements addressing the informal sector in the country.

Another challenging task was to phase-out the production and Consumption of CTC, especially in the Consumption sector which involved a large number of MSMEs and tiny enterprises using CTC as solvent. This sector was successfully addressed through an umbrella project and was provided technical assistance to replace CTC used in garment manufacturing as well as metal cleaning.

India successfully phased-out the production and consumption of CFCs, CTC, methyl choloroform and halons for controlled use as of 1 January 2010.

Another critical challenge was to phase out the use of pharmaceutical grade CFCs in manufacturing of MDIs. The "National Strategy for Transition to Non-CFC MDIs and Plan for Phase-out of CFCs in the Manufacture of Pharmaceutical MDIs" was implemented by the UNDP as lead implementing agency, in association with UNEP and the Government of Italy in close cooperation of MDI manufacturers under the guidance of Ozone Cell, MoEF&CC. The MDI manufacturers have done a commendable work and converted all the CFC-based formulations of MDIs to CFC-free and placed in the market as early as in 2011 with the due approval of Central Drug Standard Control Organization, Ministry of Health & Family Welfare (MoHFW). India sought pharmaceutical grade CFCs through EUN only for 2010 and withdrew the nominations for 2011 in consultation with MDI manufacturers. Accordingly, India informed the 22nd MOP to the Montreal Protocol that India would not seek any CFCs for manufacturing of MDIs through Essential Use Nomination (EUN) for 2011 and beyond. The 22nd MOP congratulated India for its outstanding contribution and achievement in this area.

The implementation of the National Strategy for Transition to non-CFC MDIs and Plan for Phase-out of CFCs in Manufacturing of Pharmaceutical MDIs has resulted successful phase-out of pharmaceutical grade CFCs in manufacturing of MDIs as of December 2012, 11 months prior to the schedule approved by the Ex-Com of the MLF. India was one of the first countries to switch over from CFC to non-ODS in MDI manufacturing.

Recognizing the importance and challenges in implementation of the accelerated phase-out of HCFCs as per the decision of the 19th MOP held in September 2007, India initiated activities as early as 2008 and developed and launched the Roadmap for phase-out of HCFCs in India in October, 2009 describing the long-term vision and action plan. Since then, a number of activities have been carried out.

India's HCFC Phase-out Management Plan (HPMP) Stage-I was approved by Ex-Com in its 66th meeting held in April 2012 for the period 2012- 2015 to meet the 2013 and 2015 phase-out targets of HCFCs.

India successfully met the 2013 target of freeze of HCFC production and consumption and 10% phase-out targets of HCFCs in 2015, as per the accelerated phase-out schedule of the Montreal Protocol.

Through the HPMP Stage-I, a total of 341.77 ODP tonne of HCFCs have been phased out, of which 310.53 OPD tonne is of HCFC-141b in the Foam Manufacturing sector and 31.24 ODP tonne is for HCFC-22 in the RAC Servicing sector, in accordance with the agreement between the Government of India and the Ex-Com of the MLF. The net direct emission reductions are thus 3,071,260.5 CO2 eq. tonne.

HPMP Stage-II

The 77th meeting of the Ex-com held from 28 November to 2 December 2016 approved the HPMP Stage-II for India. Under HPMP-II, India has secured US$ 48.3 million from the MLF including implementing agencies support cost for phasing out 8,190 Metric Tonnes (MT) or 769.49 ODP tonne of HCFC consumption between 2017 to 2023, in order to meet the compliance targets under Montreal Protocol for 2020.

India has voluntarily followed a low carbon development path in HPMP Stage-II, while phasing out HCFCs by adopting non-ODS, low GWP and energy-efficient technologies in its HPMP, which is unlike growth paths taken by many countries in the developed world. The HPMP has been developed in a manner that industrial obsolescence and adverse economic impacts to the industry are minimized and the compliance targets of the Montreal Protocol are achieved.

India's HPMP has may unique initiatives both in the choice of conversion technologies adopted and in having a specific component on sector-based policy development for phase out of HCFCs. The cross sectoral nature of HCFC phase- out activities has been recognized. Enabling Activities for policy development in energy efficiency, green procurement, standard development for new HCFC alternatives, cold chain development, building sector are being undertaken. Studies have been awarded in each of these areas. The study reports are under finalisation.

Successful implementation of the HPMP Stage-II in India will result in a sustainable phase-out of 769.49 ODP tons of HCFCs. Due to the relatively high GWP of HCFCs, their phase-out will result in reduced direct Green House Gas (GHG) emissions. The net contribution towards reduction of direct Carbon Di-Oxide (CO2) emissions are 4,262,100 MT CO2 Eq. per year from 2020 and 7, 697, 600 MT CO2 Eq. per year from 2023.

The HPMP-II also provides for promotion of energy efficiency, development building codes integrating HCFC phase out issues, cold chain development with non-HCFC alternatives and development of standards for new non-ODS and low GWP alternatives, while transitioning away from HCFCs.

Noting that MSMEs face specific challenges in terms of financing, technical resources and management bottlenecks when changing to non-ODS and low GWP alternatives, special dispensations have been made to MSMEs in the foam sector through additional funding of 40% over and above the cost-effective threshold. Also, fixed funding allocated for extremely tiny enterprises below benchmark consumption threshold transitioning low GWP alternatives blowing agents in order to allow proper delivery of technical assistance.

In the RAC Servicing Sector 17000 technicians have been trained. Under the enabling activities, studies have been commissioned on Space cooling requirement/demand and the opportunities for the application of non-ODS and low GWP alternatives; Application of non-ODS and low GWP alternatives in Cold Chain Sector in India; Develop framework for bulk procurement of air-conditioners to promote energy efficient and climate friendly cooling equipment through study of existing technical specifications for RAC products and recommend specifications for non-ODS and low GWP equipment for including public procurement process and develop a database of service enterprises/ technicians in the states.

In a significant first, amongst the Article 5 parties (developing countries) under the Montreal Protocol, India has been able to achieve the complete phase out of HCFC-141b in the foam manufacturing sector, as part of implementation of HPMP Stage-II. HCFC-141b is one of the most potent chemicals involved in stratospheric ozone depletion after the CFCs.

The ODSs (Regulation and Control) Rules, 2000 have been amended to align with the accelerated phase-out of HCFCs. The ODSs (Regulation and Control) Amendment Rules, 2014 were published on 4th April, 2014 in the Gazette of India.

Notification amending the ODSs (Regulation and Control) Rules, 2000, was published in the Gazette of India on 31 December, 2019, inter alia prohibiting the issuance of import license for HCFC-141b from 1st January, 2020. With this notification, prohibiting the import of HCFC-141b, the country has been made free of HCFC-141b. Simultaneously, the use of HCFC-141b by foam manufacturing industry has also closed as on 1st January 2020 under the ODSs (Regulation and Control) Amendment Rules, 2014.

Achievement of 1.1.2020 reduction target for HCFCs

In line with the accelerated phase out schedule of the Montreal Protocol for HCFCs to achieve 35% reduction target the production and consumption of HCFCs, India successfully achieved the reduction of consumption and production of HCFCs by 44% from the baseline. Independent verification by UNDP, the lead implementing agency for HPMP confirmed the same.

HPMP Stage-III

Stage-III of the HPMP will be last of the HPMPs, to be implemented during the period 2023-2030. As per the Ozone Depleting Substances (Regulation and Control) Rules, as amended in 2014, the use of HCFCs in all manufacturing sectors should be completed by 31.12.2024. The activities in the RAC servicing sector would continue beyond 31.12.2024 and will go on till 2030.

HPMP Stage III for India was approved in the 91st meeting of the Ex-Com of the MLF to phase out 10678.87 MT or 579.99 ODP tonne of HCFCs consumption from the starting point, contributing to India's compliance with the 2025 and 2030 control targets HCFCs under the Montreal Protocol.

HPMP Stage-III will be the last of the HPMPs for India, for assisting the country in achieving compliance with the Montreal Protocol 2025 and 2030 control targets as per the accelerated phase out schedule of the Montral Protocol

Implementation of HPMP-Stage-III will result in net direct CO_2-equivalent emission reductions of 19,239,929 tonnes CO2-eq. from 2030 onwards.

Hydrofluorocarbons (HFC) - 23 incineration

India has taken a lead and issued an order for incinerating the HFC-23, a by-product of HCFC-22 refrigerant production, voluntarily by the producers of HCFC-22. HFC-23, a potent GHG, with GWP of 14800, is produced as a by-product of HCFC-22 manufacturing, and if vented out in environment, is a threat to the environment. India announced this step voluntarily without a commitment of financial support from the MLF, which shows the determination and commitment of the country on climate issues.

Kigali Amendment to the Montreal Protocol

The Kigali Amendment to the Montreal Protocol was decided by the Parties to the Montreal Protocol at its 28th meeting held in October 2016 at Kigali, Rwanda for phase down of Hydrofluorocarbons (HFCs) which have high global warming potential ranging from 12 to 14,000.

As per the agreed phase-down of HFCs under the Kigali Amendment, India will have to complete its phase down the production and consumption of HFCs in 4 steps from 2032 onwards with reduction of 10% from the baseline of production and consumption in 2032, 20% in 2037, 30% in 2042 and 85% in 2047 respectively. The baseline constitutes the average of production and consumption of HFCs for the period 2024-2026 and the freeze applicable for India is 2028.

Ratification of the Kigali Amendment by India

In September 2021, the Government of India has ratified the Kigali Amendment after approval by the Union Cabinet. It has also been decided that a National Strategy for the implementation of phase-down of HFCs, in consultation of Industry and other stake holders, will be developed by 2023.

The Kigali Amendment came into force for India on 26 December 2021. Thereafter, framework for licensing system and reporting obligations has been put in place and data reporting for HFCs has commenced from 2022 along with other Ozone Depleting Substances as per provisions of Article 7 of the Montreal Protocol.

National Strategy for HFC phase down

The development of the national strategy for HFC phase down comprises the following:

(i) Outreach and awareness raising.

(ii) Development of a national Strategy including policy framework for the implementation of the Kigali Amendment.

(iii) Establishing a framework for implementing licensing, quota system, and reporting obligations related to HFCs.

As part of the awareness and outreach component, 34 workshops comprising 18 workshops through physical mode and 16 workshops through virtual mode are being conducted across the country. These workshops are being organised in close cooperation with the concerned line Ministries and departments and the concerned industry associations concerned with the Montreal Protocol implementation.

The development of strategy and policy framework comprises prioritizing the sectors and sub-sectors for HFC phase down and will be developed by 2023. Thee regulatory framework including framework for implementing licensing, quota system will be developed by 2024.

India Cooling Action Plan (ICAP)

Recognizing the cross cutting use of RAC technologies in various sectors and close linkage of energy efficiency with refrigerant transitions while phasing down HFCs, it has been decided to develop a ICAP. This plan would inter-alia integrate the phase out of ODSs/phase down of HFCs while maximizing energy efficiency of air-conditioning equipment's.

The ICAP shall provide a perspective plan 20-year perspective plan (2018-2038) and policy recommendations, to address the cooling requirement across sectors while providing for ways and means to provide thermal comfort and access to sustainable cooling to all, involving multi-stakeholders to synergize actions for addressing cooling demand across all areas: technology, manufacturing, energy efficiency and the environment, while reemphasizing the principles enshrined in the Country Programme of India for phase out of ODS i.e. to have minimum economic dislocation and obsolescence cost and maximize indigenous production to twin environment and economic gains.

Given the cross-cutting nature of cooling demand, the ICAP implementation proposes active collaboration among the relevant ministries as well as the private sector entities.

India is the first country in world to develop a Cooling Action Plan, which addresses cooling requirement across sectors and lists out actions which can help reduce the cooling demand. On 8th March, 2019, the then Minister of Environment, Forests & Climate Change (Hon'ble MEF&CC) released the ICAP. The ICAP aims to reduce both direct and indirect emissions. The thrust of the ICAP is to look for synergies in actions for securing both environmental and socio- economic benefits. The overarching goal of ICAP is to provide sustainable cooling and thermal comfort for all while securing environmental and socio-economic benefits for the society.

Launch of ICAP by the then MEF&CC on 8th March, 2019 at New Delhi, India

The India Cooling Action sets the following goals:

(i) reduce cooling demand across sectors by 20% to 25% by 2037-38,

(ii) reduce refrigerant demand by 25% to 30% by 2037-38,

(iii) Reduce cooling energy requirements by 25% to 40% by 2037-38,

(iv) recognize "cooling and related areas" as a thrust area of research under national S&T Programme,

(v) training and certification of 100,000 servicing sector technicians by 2022-23, synergizing with Skill India Mission. These actions will have significant climate benefits.

The following benefits would accrue to the society over and above the environmental benefits:

(i) Thermal comfort for all - provision for cooling for Economically Weaker Section (EWS) and Lower Income Group (LIG) housing,

(ii) Sustainable cooling - low GHG emissions related to cooling,

(iii) Doubling Farmers Income - better cold chain infrastructure - better value of produce to farmers, less wastage of produce,

(iv) Skilled workforce for better livelihoods and environmental protection,

(v) Make in India - domestic manufacturing of air-conditioning and related cooling equipment's,

(vi) Robust Research & Development (R&D) on alternative cooling technologies - to provide push to innovation in cooling sector.

The ICAP has been appreciated internationally as an important policy initiative which has the potential to provide socio-economic and environmental benefits related to reduced refrigerant use, climate change mitigation and SDGs. The concept of development of National Cooling Action Plans which have an integrated long term view of cooling requirement across sectors has been recognized globally.

The United Nations Secretary General in his message on World Ozone day 2019 has highlighted the need for all countries to develop national cooling action plans. This step taken by India has led to a global recognition of this important policy initiative which can help in climate action and achievement of sustainable development goals.

Action points relating to implementation of recommendations of ICAP for the thematic areas Space Cooling in building sector cold chain, Servicing Sector and Indigenous production and R&D have been finalized after consultation with all the concerned Ministries/Departments/ Agencies. The action points were also circulated to the concerned Ministries/Departments/Agencies for implementation.

ICAP may accessed at https://ozonecell.nic.in/wp-content/uploads/2019/03/INDIA-COOLING-ACTION-PLAN-e-circulation-version080319.pdf

Training and Certification of RAC Service technicians under Skill India Mission

Upskilling air-conditioner service technicians under PMKVY

A Memorandum of Understanding (MoU) was signed between the Ministries of Environment, Forest and Climate Change and Skill Development and Entrepreneurship on 2nd August, 2018. The two Ministries have agreed to jointly undertake upskilling and certification of 100,000 RAC service technicians on good servicing practices and knowledge of alternative refrigerants to ozone-depleting chemicals. The project will be funded under the Skill India Mission - PMKVY.

Competency Enhancement of System Houses and MSMEs in foam manufacturing sector

A Memorandum of Agreement (MoA) has been signed between the Central Institute of Plastics Engineering & Technology (CIPET), Department of Chemicals & Petro-chemicals (DCPC), Ministry of Chemicals & Fertilizers, Govt. of India and the Project Management Unit (PMU), Ozone Cell, MoEF&CC, Government of India to develop Competency Enhancement framework and facilities for System Houses and foam manufacturing enterprises especially MSMEs.

CIPET is a premier institute in the country in the area of plastic engineering and technology and has emerged as a global institution renowned for its research & development in the niche areas of Polymer Science & Technology (PST) and high-quality Education & Skill development in the field of plastics. With the MoA, CIPET and Ozone Cell have agreed to undertake Competency Enhancement of System Houses and MSMEs in the foam manufacturing sector for ensuring smooth and sustainable phase out of HCFC-141b.

A Technical Assistance facility has been established at Laboratory for Advanced Research in Polymeric Materials (LARPM) CIPET, Bhubaneshwar for providing training and testing facilities to System Houses and foam manufacturing enterprises covered under HPMP as part of MoA signed between CIPET, DCPC and Ozone Cell, MoEF&CC. In this regard, a meeting and visit to LARPM, CIPET was made on 31st January, 2019 at LARPM, CIPET, Bhubaneswar.

The technical assistance facility at CIPET would assist in. (i) customizing trials, (ii) evaluation, testing, (iii) modification/validation of non-HCFC formulations for applications, and (iv) technical resources and training center.

CIPET has been continuously assisting enterprises for stabilizing alternative technologies. The assisted enterprises have been able to move toward adoption of alternatives at commercial scale.

Indigenous capacity development including research on low global warming (GWP) chemicals

In order to promote indigenous manufacturing of low global warming potential chemicals and development of a robust R&D ecosystem the MoEFCC has collaborated with 8 Indian Institutes of Technology (Roorkee, Hyderabad, Kanpur, Patna, Banaras, Madras and Tirupati) to promote research and development of low global warming potential chemicals, including blends thereof, to be used as alternatives to substances controlled under the Montreal Protocol in line with industry requirements through engagement of research scholars. This would help in creating awareness for development and adoption on indigenous low global warming potential alternative technologies which could be deployed during the HFC phase down besides promoting "Make in India" initiative of the Government.

The MoEFCC has also organised a workshop on "Indigenous capacity development including research on GWP chemicals to be used as alternatives to HFCs on 4th August 2023 at Delhi. The objective of the workshop was to develop a Roadmap along with an action plan for indigenous development, which encourages domestic manufacturing of next generation low GWP refrigerants, cooling appliances along with safety standards and upgradation of skill of the existing manpower for wider adoption of such refrigerants during the phase down of HFCs under the Kigali Amendment. The deliberations from the workshop resulted in specific recommendations towards achieving the said objectives, categorised as short term (up to 3 years), medium term (3-5 years) and long term (above 5 years).

Negotiations in Montreal Protocol Meetings

India has been pro-actively participating in the negotiations in the Montreal Protocol meetings on behalf of the developing countries, both at the Meeting of the Parties (MOP) and the Executive Committee (Ex-Com) of the Multilateral Fund (MLF).

The key issues of negotiation of the MOP include energy efficiency including financing of energy efficiency under the framework of the Montreal Protocol, replenishment of the multilateral fund and issues relating to implementation and enforcement of the Montreal Protocol including those relating to combatting illegal trade, HFC-23 by product emissions, CTC, QPS uses of Methyl Bromide.

The key issues of negotiation at the Ex-Com meetings include approval of funding window for Pilot projects to maintain and/or enhance energy efficiency of replacement technologies and equipment in the context of HFC phase-down, enhanced funding for institutional strengthening projects, criteria for funding window for an inventory of banks of used or unwanted controlled substances and a plan for the collection, transport and disposal of such substances and contribution of HCFC phase out and HFC phase down towards sustainable cooling through which the MLF Secretariat will develop a paper for consideration by the Ex-Com of the MLF.

Website and MIS

The website of the Ozone Cell along with five project related websites were integrated into a single website and migrated to the National Informatics Centre (NIC) server. The website http://ozonecell.nic.in is updated regularly

The comprehensive Management Information System (MIS) system for all activities relating to ODS phase-out including regulatory framework under the ODS (Regulation and Control) Rules 2000 and its amendments is fully operationalized and simplified provisions have been introduced for compliance by enterprises with respect to registration and reporting of ODS including submission of online quarterly and annual returns

Awards and Appreciations received

The Ozone Cell of India has been conferred with several awards/appreciations/recognitions for successful implementation of the Montreal Protocol and its ODS phase-out activities.

4 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 ODS such as CFC, CTC, HCFC, halon, methyl chloroform and methyl bromide can contribute to ozone layer depletion.

Actions that an individual can take to protect the ozone layer:

Be an ozone-friendly consumer

Buy products (aerosol spray cans, refrigerators, air-conditioners, MDIs, fire extinguishers, etc.) that are labelled "ozone friendly" or "CFC free". The product labels should indicate that they do not contain ODS such as CFC or halon. 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. All 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. Start refrigerant recovery and recycling programme in your area.

Be an ozone-friendly office worker

Help your company in identifying which of the existing equipments (e.g., water coolers, air-conditioners, cleaning solvents, fire extinguishers etc.) are based on ODS. Develop a plan replacing them with cost-effective non-ODS based equipments/eproducts. Become an environmental leader within your office.

Be an ozone-friendly company

Replace ODS used in your premises and in your manufacturing processes. Contact your NOU to see if you are eligible for financial and technical assistance from the MLF. If the products manufactured in your company are based on ODS, plan and implement conversion of production line to non-ODSs technologies that do not destroy 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 ODS on ozone layer, health 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, neighbours and friends about the need to protect the ozone layer and help them get involved. Work with NGOs to help the community. Start information campaigns and technical assistance projects to phase out ODS 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. Also learn about your national strategy and policies to implement the Montreal Protocol and ODS phase-out program in your country. Get in touch with your country's NOU and learn how you can get involved on an individual level.

Website: http://ozonecell.nic.in

5 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 km (6-10 miles)). The remaining ozone (about 90%) resides in the stratosphere between the top of the troposphere and about 50 km (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 an oxygen molecule (O2) being broken apart by UV radiation from the sun. In the lower atmosphere (troposphere), ozone is formed by a different set of chemical reactions that involve naturally occurring gases and those from pollution sources.

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

Ozone in the stratosphere absorbs a large part of the sun's biologically harmful UV radiation. Stratospheric ozone is considered "good" ozone because of this beneficial role. In contrast, ozone formed at earth's surface in excess of natural amounts is considered "bad" ozone because it is harmful to humans, plants, and animals. Natural ozone near the surface and in the lower atmosphere plays an important beneficial role in chemically removing pollutants from the atmosphere.

Q.4. How is total ozone distributed over the globe?

The distribution of total ozone over the earth varies with location on timescales that range from daily to seasonal. The variations are caused by large-scale movements of stratospheric air and the chemical production and destruction of ozone. Total ozone is generally lowest at the equator and highest in the polar regions.

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 on balloons, aircraft, and satellites. Some instruments measure ozone locally by continuously drawing air samples into a small detection chamber. Other instruments measure ozone remotely over long distances by using ozone's unique optical absorption or emission properties.

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, at Earth's surface, of gases containing chlorine and bromine. Most of these gases accumulate in the lower atmosphere because they are unreactive and do not dissolve readily in rain or snow. Natural air motions transport these accumulated gases to the stratosphere, where they are converted to more reactive gases. Some of these 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 emission of ODS to the atmosphere. The ODS are manufactured halogen source gases that are controlled worldwide by the Montreal Protocol. These gases bring chlorine and bromine atoms to the stratosphere, where they destroy ozone in chemical reactions. Important examples are the CFCs, once used in almost all refrigeration and air-conditioning systems, and the halons, which were used in fire extinguishers. Current ODS abundances in the atmosphere are known directly from air sample measurements.

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

Emissions from human activities and natural processes represent a large source of chlorine- and bromine containing gases that enter the stratosphere. When exposed to ultraviolet radiation from the sun, these halogen source gases are converted to more reactive gases containing chlorine and bromine. Some reactive gases act as chemical reservoirs that convert to form the most reactive gases, namely chlorine monoxide (ClO) and bromine monoxide (BrO). The most reactive gases participate in catalytic reactions that efficiently destroy ozone. Most volcanoes emit some reactive halogen gases that readily dissolve in water 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 thousands of ozone molecules before it leaves the stratosphere. In this way, a small amount of reactive chlorine or bromine has a large impact on the ozone layer. A special situation develops in the polar regions in the late winter/early spring season where large enhancements in the abundance of the most reactive gas, chlorine monoxide, leads to severe ozone depletion.

Q.10. Why has an "ozone hole" appeared over Antarctica when ODS are present throughout the stratosphere?

The ODS 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" occurs because of the special atmospheric and chemical conditions that exist there and nowhere else on the globe. The very low winter temperatures in the Antarctic stratosphere cause polar stratospheric clouds (PSCs) to form. Special reactions that occur on PSCs, combined with 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 reported in the mid-1980s. Antarctic ozone depletion is seasonal, occurring primarily in late winter and early spring (August-November). Peak depletion occurs in early October when ozone is often completely destroyed over a range of altitudes, thereby reducing total ozone by as much as two-thirds at some locations. This severe depletion creates the “ozone hole” apparent in images of Antarctic total ozone made using satellite observations. In most years the maximum area of the ozone hole far 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 most years in the late winter/early spring period (January-March). However, the maximum depletion is 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?

Depletion of the global ozone layer began gradually in the 1980s and reached a maximum of about 5% in the early 1990s. The depletion has lessened since then and now is about 3.5% averaged over the globe. The average depletion exceeds the natural year-to year variations of global total ozone. The ozone loss is very small near the equator and increases with latitude toward the poles. The larger polar depletion is attributed to the late winter/early spring ozone destruction that occurs there each year.

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 three decades. If large volcanic eruptions occur in the coming decades, ozone depletion will increase for several years afterwards.

Q.15. Are there controls on the production of ODS?

Yes, the production and consumption of ODSs are controlled under a 1987 international agreement known as the “Montreal Protocol on Substances that Deplete the Ozone Layer” and by its subsequent Amendments and Adjustments. The Protocol, now ratified by all 197 United Nations members, establishes legally binding controls on national production and consumption of ODSs. Production and consumption of all principal ODSs by developed and developing nations will be almost completely phased out before the middle of the twenty-first century.

Q.16. Has the Montreal Protocol been successful in reducing ODS in the atmosphere?

Yes, as a result of the Montreal Protocol, the overall abundance of ODSs in the atmosphere has been decreasing for about a decade. If the nations of the world continue to comply with the provisions of the Montreal Protocol, the decrease will continue throughout the twenty-first century. Those gases that are still increasing in the atmosphere, such as halon-1301 and HCFC-22, will begin to decrease in the coming decades if compliance with the Protocol continues. Only after mid-century will the effective abundance of ODS fall to values that were present before the Antarctic ozone hole was observed in the early 1980s.

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

Yes, UV radiation at earth's surface increases as the amount of overhead total ozone decreases, because ozone absorbs UV radiation from the sun. Measurements by ground-based instruments and estimates made using satellite data provide evidence that surface ultraviolet radiation has increased in large geographic regions in response to ozone depletion.

Q.18. Is depletion of the ozone layer the principal cause of climate change?

No, ozone depletion itself is not the principal cause of climate change. Changes in ozone and climate are directly linked because ozone absorbs solar radiation and is also a greenhouse gas. Stratospheric ozone depletion and increases in global tropospheric ozone that have occurred in recent decades have opposing contributions to climate change. The ozone-depletion contribution, while leading to surface cooling, is small compared with the contribution from all other GHG increases, which leads to surface warming. The total forcing from these other GHG is the principal cause of observed and projected climate change. Ozone depletion and climate change are indirectly linked because both ODS and their substitutes are the GHG.

Q.19. Have reductions of ODS under the Montreal Protocol also protected Earth's climate?

Yes. All ODS are also GHG that contribute to climate forcing when they accumulate in the atmosphere.

Montreal Protocol controls have led to a substantial reduction in the emissions of ODS over the last two decades. These reductions have provided the added benefit of reducing the human contribution to climate change while protecting the ozone layer. Without Montreal Protocol controls, the climate forcing contribution from annual ODS emissions could now be 10-fold larger than its present value, which would be a significant fraction of the climate forcing from current CO emissions.

Q.20. How is ozone expected to change in the coming decades?

Substantial recovery of the ozone layer from the effects of ODSs is expected near the middle of the twenty-first century, assuming global compliance with the Montreal Protocol. Recovery will occur as ODSs and reactive halogen gases in the stratosphere decrease in the coming decades. In addition to responding to ODSs, future ozone amounts will increasingly be influenced by expected changes in climate. The resulting changes in stratospheric ozone will depend strongly on the geographic region. During the long recovery period, large volcanic eruptions could temporarily reduce global ozone amounts for several years.

SYNTHESIS OF THE 2022 ASSESSMENT REPORTS OF THE SCIENTIFIC ASSESSMENT PANEL, THE ENVIRONMENTAL EFFECTS ASSESSMENT PANEL AND THE TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL

Introduction

1. The Scientific Assessment Panel, the Environmental Effects Assessment Panel and the Technology and Economic Assessment Panel are charged with providing periodic assessments within their areas of expertise to the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer. This report provides a high-level synthesis of the 2022 assessment reports of the three panels. The scientific and technological issues associated with the Montreal Protocol, along with the climate and environmental benefits of the Protocol, are highlighted herein and discussed in detail in the individual assessment reports of these panels:

    Scientific Assessment Panel

    Environmental Effects Assessment Panel

    Technology and Economic Assessment Panel

2. This report provides updated information highlighting the success of the Montreal Protocol in limiting the growth in the atmospheric abundances of ozone-depleting substances (ODS) and hydrofluorocarbons (HFC), thereby reducing stratospheric ozone depletion, avoiding additional contributions to climate change and protecting the environment. The indications that those actions are leading to ozone recovery are increasingly clear, especially for ozone in the upper stratosphere and over the Antarctic region. With the implementation of the 2016 Kigali Amendment to the Montreal Protocol to phase-down HFC, a significant amount of future climate warming will be avoided, adding to that avoided due to the decline in ODS production and consumption under the Protocol.
3. Significant impacts on human health, and the environment caused by stratospheric ozone depletion and the resulting increases in UV radiation have been avoided because of the Montreal Protocol. Since full recovery of the ozone layer will take several decades, long-term monitoring of ODS, HFC, ozone and UV radiation continues to be essential.

Key findings

I. Actions taken under the Montreal Protocol have continued to decrease atmospheric abundances of controlled ozone-depleting substances and advance the recovery of the stratospheric ozone layer.

4. The atmospheric abundances of both total tropospheric chlorine and total tropospheric bromine from long-lived ODS have declined since the 2018 Assessment. The observed rates of decline in tropospheric chlorine and

tropospheric bromine in substances controlled under the Montreal Protocol were 15.4 ± 4.1 ppt Cl yr^{-1} and 0.18 ± 0.05 ppt Br yr^{-1} respectively, close to the Baseline scenario from the 2018 Assessment. Tropospheric chlorine from very short-lived gases, whose sources are mainly anthropogenic and which are not controlled under the Montreal Protocol, increased by 2.1 ± 0.6 ppt Cl yr^{-1}.

5. Progress on ODS phase-out continues to be made in every residential, commercial, industrial, agricultural, medical, and military sector, with the production and consumption of ODS having been phased out from many applications worldwide.
   - The phase-out of the consumption and production of hydrochlorofluorocarbon (HCFC)-22 is essentially complete in non-Article 5 parties and is progressing in Article 5 parties.
   - Significant progress has been made to phase out the use of HCFC in foams. There are alternative foam blowing agents (FBAs) in use commercially today in nearly every foam application.
   - Phase-out of controlled uses of methyl bromide (MB) is virtually complete, but significant quarantine and pre-shipment (QPS) uses remain, as these are currently exempted from Montreal Protocol controls. Alternatives have nevertheless been identified, and are in use in some countries, for a good proportion of these uses.
   - The phase-out of controlled substances in sterilization uses is considered complete. Technically and economically feasible alternatives are commercially available for all aerosol uses, although not all alternatives are suitable across all applications in all locations.
   - Alternative low GWP refrigerants are available for all refrigeration, air-conditioning and heat pump (RACHP) applications, which account for the majority of all HCFC and HFC emissions. These alternatives are being widely applied in some applications and regions, but accessibility is still a major hindrance for the widescale adoption of lower GWP refrigerants and progress towards goals of the Kigali Amendment phase-down schedules.
6. Evidence for ozone recovery, consistent with these declines in ODS abundances, has strengthened.
   - Total column ozone (TCO) in the Antarctic continues to recover, notwithstanding substantial interannual variability in the size, strength, and longevity of the ozone hole, which is driven by interannual variability in meteorology.
   - Outside of the Antarctic region (from 90°N to 60°S), the limited evidence of TCO recovery since 1996 has low confidence.
   - TCO is expected to return to 1980 values around 2066 in the Antarctic, around 2045 in the Arctic, and around 2040 for the near-global average (60°N–60°S).
7. Trends in stratospheric ozone vary with altitude as well as geographic region.
   - Outside of the polar regions, observations and models are in agreement that ozone in the upper stratosphere continues to recover.
   - In contrast, ozone in the lower stratosphere has not yet shown signs of recovery.
   - Models simulate a small recovery in mid-latitude lower-stratospheric ozone in both hemispheres that is not seen in observations. Reconciling this discrepancy is key to ensuring a full understanding of ozone recovery.
8. As yet, there is no published evidence that lockdowns associated with the COVID-19 epidemic impacted the trends in atmospheric abundances of ODSs or their replacements or that they have impacted stratospheric ozone. Supply shortages of low-GWP alternatives in

some sectors are understood to have started in 2020 due to COVID-19 related supply chain and logistics issues, raw material shortages, manufacturing issues, and severe weather, at the same time as increasing global demand. While these supply issues are less severe now, these will need careful monitoring as extended shortages in supply could delay transition away from HFCs across the various sectors of use.

II. The Montreal Protocol contributes to environmental sustainability and human health and well-being, in line with many Sustainable Development Goals

9. The Montreal Protocol continues to contribute to the implementation of many of the United Nations SDGs by protecting the stratospheric ozone layer and contributing to the mitigation of climate change. These SDGs address the areas related to climate change, air and water quality, biodiversity and ecosystems, sustainable production and consumption, food security, contaminants and materials, and human health. Thus, the Montreal Protocol has wide-ranging significance for sustainability by protecting human health and maintaining healthy, diverse ecosystems on land and in the water.

10. Surface levels of solar ultraviolet-B radiation (UV-B) would have increased world-wide without the Montreal Protocol, and these changes would have been the greatest in polar regions (e.g., the Antarctic mid-summer UV index would have increased from 3 to 33 between 1975 and 2065). Further, a modelling study with an extreme scenario estimated that the impact of large increases in UV-B radiation on terrestrial vegetation in a world without the Montreal Protocol would have drastically reduced the photosynthetic uptake of carbon dioxide by plants. This reduction in carbon sequestration would have, in turn, increased atmospheric carbon dioxide levels, resulting in an additional rise of global mean surface temperature of 0.5-1.0ºC by 2100.

11. By safeguarding the earth from extreme UV-B radiation, the Montreal Protocol is playing a key role in protecting human health. One modelling study compared the Montreal Protocol, as amended and adjusted, with the extreme scenario of unregulated ODS emissions increasing at a rate of 3% per year throughout the twenty-first century. This analysis estimated that 11 million cases of melanoma, 432 million cases of basal cell and squamous cell carcinoma (keratinocyte cancers), and 63 million cases of cataracts (the leading cause of blindness globally) were avoided for people born in the United States between 1890-2100 because of the Montreal Protocol. Approximately half of these cases are avoided because of the amendments and adjustments made to the original 1987 Montreal Protocol. The Montreal Protocol has also made it possible to continue to receive the beneficial health effects (e.g., vitamin D production and improved immune system function) of moderate exposure to sunlight through spending time outdoors.

12. Solar UV radiation causes photodegradation of plastics, which ultimately results in fragmentation and the formation of micro- and nanoplastics (particles less than 5 mm and 0.1 ìm in diameter, respectively). The implementation of the Montreal Protocol has likely prevented increases in the generation of microplastics in the environment, although the amount of this reduction and its biological consequences remain uncertain.

III. The significant decreases in projected HFC emissions from the provisions of the Kigali Amendment will substantially protect future climate.

13. The HFC are increasingly used as ODS alternatives in refrigeration and air conditioning, in the aerosols and foam sectors, and as fire suppression agents. While they do

not contain ozone-depleting chlorine or bromine, they are greenhouse gases. The Kigali Amendment, which was adopted in 2016 and came into force in 2019, sets schedules for the phase-down of the global production and consumption of specific HFCs. Although radiative forcing from HFCs is currently small, the Kigali Amendment is designed to avoid unchecked growth in emissions and the associated warming that would have arisen from the projected increases in demand in coming decades.

14. The atmospheric abundances of most currently measured HFC continue to increase, as was projected in the baseline scenario of the 2018 Assessment. Global emissions of HFC, which originate from both Article 5 and non-Article 5 parties, increased by 18 per cent between 2016 and 2020 in carbon dioxide (CO_2)-equivalent units.

15. Current projected HFC emissions are lower than those projected in the 2018 Assessment. The 2020–2050 cumulative emissions in the 2022 updated Kigali Amendment scenario are 14–18 Pg CO_2-eq lower than in the corresponding scenario in the previous Assessment. The new scenario follows national controls on the consumption and production of HFC in non-Article 5 countries, reflects lower reported consumption in China, is based on updated historical information on the use of HFCs in non-Article 5 countries, uses observed mixing ratios through 2020 as a constraint, and includes assumptions about reduced use of HFC for commercial and industrial refrigeration. The new scenario also assumes that all countries adhere to the provisions of the Kigali Amendment.

16. Annual average surface warming from HFC is expected to be 0.04°C in 2100 under the updated 2022 Kigali Amendment scenario, compared to 0.3–0.5°C without control measures. A more rapid phase-down of HFC than that required by the Amendment would further limit climate change from HFC.

17. The global HFC-23 emissions of 17.2 ± 0.8 kt yr^{-1} in 2019 derived from atmospheric observations are substantially higher than the emissions of 2.2 kt yr^{-1} in that year derived from activity-based estimates. These activity-based estimates are derived from UNFCCC emission reports, information on production and emissions abatement submitted under the Montreal Protocol, and the estimated effect of national regulations. The atmospheric HFC-23 levels are inconsistent with the substantial rise in emissions abatement reported to the UNFCCC.

18. The HFC-23 emissions are expected to grow in the coming decades. The HFC-23 is released as a by-product of HCFC-22 production and other processes. These other processes include production of HFC-32, the manufacture of TFE/HFP from HCFC-22 feedstock, the production processes of other fluorocarbons (e.g., for HFC-125, HFC-134a, HFC-143a), and some steps of HFO production.

19. The planned HFC phase-down under the Kigali Amendment, as well as regional regulations, are driving industry towards low-GWP HFC alternatives and innovative applications, especially with respect to refrigeration, air conditioning and foams. However, the range of new, lower GWP products creates challenges in finding the best solution for each application, taking into consideration factors such as flammability, toxicity, availability, cost, accessibility, operating conditions, and other properties.

20. Trifluoroacetic acid (TFA), is a breakdown product in the atmosphere of some HFCs, HCFCs, HFOs and HCFOs and fluoroketones (FKs). The TFA formed in the atmosphere is rapidly deposited in precipitation and, on reaching the surface (soil or water), it forms salts with alkali metals (e.g., sodium, potassium, calcium). The TFA salts are unreactive and have long environmental lifetimes but are easily excreted by animals and therefore do not bioaccumulate in the food

chain. Like other mineral salts, TFA salts accumulate in oceans and salt-lakes. The formation of TFA in the atmosphere is expected to increase in the coming decades due to increased use of HFO and HCFO. While TFA continues to be found in the environment, including in remote regions, concentrations are so low that it is currently judged very unlikely to have adverse toxicological consequences for humans and ecosystems. Continued monitoring and assessment are nevertheless advised due to uncertainties in the localized deposition of TFA and its potential effects on some untested marine organisms.

IV. Improvements in energy efficiency during the HFC phase-down have the potential to accelerate and further increase the climate benefits from the Kigali Amendment

21. There is a rapidly increasing global demand for refrigeration and air conditioning. Improved energy efficiency in new refrigeration, air conditioning and heat pump (RACHP) equipment synchronously with HFC phase-down could serve to moderate energy use, potentially doubling the climate benefit from the HFC phase-down. This could make a cost-effective and near-term contribution to the path to net zero GHG emissions. Early conversion to efficient RACHP equipment containing low GWP alternatives can reduce energy costs and avoid the build-up of high GWP HFC refrigerant banks.

22. Technology developments are proceeding at pace, and RACHP equipment using low and medium GWP refrigerants with increased energy efficiency is available in all sectors, but not necessarily accessible in all countries.

V. Successful actions by the Parties have reversed the upward trend of unexpected emissions observed between 2013 and 2017

23. While the 2018 Scientific Assessment found that global CFC-11 emissions unexpectedly increased in the 2013-2017 period, the 2022 Scientific Assessment concluded that global CFC-11 emissions declined after 2018. The initial CFC-11 emissions increase led to a number of scientific investigations and policy responses. Consequently, CFC-11 emissions decreased to 45 ± 10 Gg in both 2019 and 2020. This decrease suggests the elimination of most of the unexpected emissions occurring in the years after 2012.

24. A large fraction of the unexpected CFC-11 emissions originated from eastern China. This finding is based on available regional observations from several east Asia sites. The decline of CFC-11 emissions from eastern China since 2018 explains 60 ± 30% of the observed global emission decrease. While the global network of surface observation stations provides estimates of total CFC-11 emissions, the network is too geographically sparse to fully assess regional emissions.

25. Emissions from the CFC-11 banks alone could not explain the 2013-2017 unexpected increase, indicating unreported CFC-11 production and use in this period. This production was most likely used for closed-cell foams. Unreported production may also have occurred earlier, in the 2007 to 2012 period.

26. Regional observations suggest some CFC-12 emissions may have been associated with the unreported CFC-11 production. Uncertainties in emissions from banks and gaps in the observing network are too large to determine whether all unexpected CFC-12 emissions have ceased.

VI. Carbon tetrachloride abundances continue to decline at a slower rate than expected based on previous trends

27. Carbon tetrachloride (CCl_4) atmospheric abundances continued to decrease, but at slower rates than expected based on previous trends. Global CCl_4 emission estimates based on atmospheric observations averaged 44 ± 15 Gg yr^{-1} in both 2016 and 2020.

28. Regional CCl4 emissions from eastern China over the period 2013–2019 show year-to-year variability likely related to CFC-11 production. Emissions increased after 2013, reaching 11.3 ± 1.9 Gg yr^{-1} in 2016, and decreased to 6.3 ± 1.1 Gg yr^{-1} in 2019.

29. Production of CCl_4 has increased in recent years due mainly to growing demand for feedstock use for production of HFCs, HFOs/HCFOs, and perchloroethylene. Increasing CCl_4 production is likely to continue because of the increasing demand for HFO/HCFOs. Most emissions arise from CCl_4 production, handling, supply chain, and usages. Additional CCl_4 emissions likely arise from non-chloromethane production, such as the vinyl chain production process, which is identified as a new potential source of CCl_4 emissions.

VII. The atmospheric abundances of a number of minor ozone-depleting substances have been increasing; cumulatively, those substances may eventually have an impact on stratospheric ozone

30. Global abundances of the minor species CFC-13, CFC-112a, CFC-113a, CFC-114a, and CFC-115 increased from 16.0 ± 0.3 ppt in 2016 to a total of 17.2 ± 0.3 ppt Cl in 2020. Atmospheric observations confirm that eastern Asia is a substantial source region. These findings likely indicate an increase or stabilization of the emissions of these relatively low abundance compounds. Some of these unexplained emissions are likely occurring as leaks of feedstocks or by-products, and the remainder is not understood. These species have a minor impact on stratospheric chlorine loading and stratospheric ozone depletion.

31. The production and usage of short-lived chlorinated solvents are not controlled by the Montreal Protocol, and some are used in large amounts. Their impact on stratospheric ozone, and their ozone depletion potentials (ODPs), vary depending on the season and location of emissions. Emissions of these substances could grow in the future even as emissions from long-lived ODSs decline. Important examples of short-lived chemicals that are used as feedstocks are $CHCl_3$ (chloroform), CH_2Cl_2 (dichloromethane or DCM), $CHCl{=}CCl_2$ (trichloroethene or TCE), and $CCl_2{=}CCl_2$ (perchloroethene or PCE). Sustained increases in anthropogenic chlorinated very short-lived substance (VSLS) emissions, as seen for CH_2Cl_2 over the last two decades, would lead to more stratospheric ozone depletion in the future.

32. Dichloromethane (CH_2Cl_2, or DCM) (180-day lifetime) is the main component of VSLS chlorine. Its atmospheric abundance continued to increase between 2016 and 2020 with a slightly lower growth rate than prior to 2016. This increase primarily results from a growth in CH_2Cl_2 emissions in Asia. Given market trends in chemical production and DCM usage, global DCM production and atmospheric concentrations are currently not expected to increase significantly in the next few decades. The DCM is used mainly as a solvent (such as in pharmaceutical manufacturing, paint stripping, adhesives) and as a foam-blowing agent, and is also used as feedstock for HFC-32 production. In recent years, there has been a decrease in solvent use in some regions (e.g., EU and US) and a substantial increase in others (e.g., in South and East Asia). The DCM feedstock use for HFC-32 production is increasing globally. Future global trends are difficult to predict. With the toxicity profile of DCM, general solvent uses are being increasingly regulated. Nevertheless, there is currently increasing global capacity to produce DCM to supply solvent and feedstock uses.

33. The estimated input of chlorine from VSLSs to the stratosphere in 2020 increased by about 10 ppt since the last Assessment and amounts to 130 ± 30 ppt, contributing about 4% of the total chlorine input. Brominated VSLSs, with mainly natural sources, contribute 5 ± 2 ppt to

stratospheric bromine and show no long-term changes.

34. New evidence suggests that VSLS iodine, mostly from natural sources, is transported to the stratosphere, contributing 0.3–0.9 ppt iodine in particulate or gas-phase form. No observational trend estimates exist.

VIII. Production, by-production, feedstock use and intermediates

35. Since 2002, total reported ODS production has increased by a small amount, with increased production for feedstock uses offsetting the decrease in production for controlled emissive uses. The overall increase in ODS feedstock uses through the last decade has been mostly due to the increase in HCFC feedstock uses, particularly HCFC-22, while uptake of HFOs is driving a more recent increase in carbon tetrachloride feedstock use.

36. Emissions during chemical manufacturing results from products, co-products, by-products, feedstock, or intermediates.
    - By-production of controlled substances in production processes occurs through over- or under-reaction enroute to the intended product, the presence of impurities undergoing reactions, and unintended side reactions.
    - Intermediates are the chemical building blocks that raw materials pass through when being chemically transformed into products. Emission rates are much lower for intermediates than for the final product.

37. Several production processes generate HFC-23 by-production and emissions, including during the production of HCFC-22 and HFC-32. Production processes of other fluorocarbons can also result in HFC-23 by-production, although at lower rates. (See also Section III above.)

38. HCFC-22 is mainly used as feedstock to produce tetrafluoroethylene (TFE) and hexafluoropropylene (HFP), which are used in fluoropolymer production. The manufacture of TFE/HFP from HCFC-22 feedstock generates by-production and emissions of HFC-23 and PFC-c-318 (c-C4F8), and both have a very high GWP. These combined emissions as CO2 equivalent, without consideration of their possible abatement, are larger than the estimated emissions of HFC-23 from HCFC-22 production.

39. The current combined GWP-weighted emissions of CFCs plus HCFCs are comparable to those of HFCs. Reductions in future emissions of CFCs and HCFCs would require addressing emissions from banks and from production, by-production, and feedstock use. Global emissions of long-lived HFC-23, largely a by-product of HCFC-22 production, are likely to grow unless abatement increases or feedstock use of HCFC-22 decreases.

IX. While halon atmospheric abundances are declining slowly, there remains a demand for halon-1301 which may not be met in the future without new production

40. Tropospheric bromine from halons has decreased from a peak of 8.5 ± 0.1 ppt in 2006 to 7.3 ± 0.1 ppt in 2020. Halon-1211, halon-2402, and halon-1202 abundances continued to decline between 2016 and 2020. The rate of change of halon-1301 remained indistinguishable from zero. In 2020, it was the most abundant halon in the atmosphere.

41. Halon-1301emissions appear to be higher than anticipated from a fixed bank of fire suppression uses suggesting other source(s) of emissions such as from its feedstock production and use. Conversely, these higher emissions could be due to a higher rate of emissions from the halon-1301 bank than anticipated. If this is the case, the bank of halon-1301 could be significantly less than that required to fill ongoing needs.

42. Demand for halons for fire-fighting uses persists and will ultimately exceed the supply from available banks without the

implementation of alternatives. There are continuing long-term uses of halon (e.g., in oil and gas facilities, nuclear facilities and military installations) and growing demand from civil aviation for halon-1301 owing to the lack of replacements for engine and cargo compartment fire-fighting applications in new aircraft. The current, estimated run-out timeframe of between 2030 and 2049, when halon-1301 would be no longer available, means that the civil aviation industry (and others) must look to their own stockpiles of halon-1301 to avoid grounding aircraft because of a lack of appropriate fire protection. New designs in the military sector may only be able to use halon-1301 or high-GWP HFCs to meet stringent design/life-safety requirements.

43. The HFC phase-down regulations in non-Article 5 parties are having a bigger impact on the cost and availability of HFC fire suppressants than initially anticipated owing to their high GWP and the availability of a low-GWP fluoroketone suitable for some applications. As the supply of newly produced HFCs for fire protection decreases in response to phase-down regulations, HFC recycling will become even more important to fulfill demand.

X. Quantifying ODS and HFC banks and the time-course of their continued emissions is important in determining the pace of ozone layer recovery and potential impacts on climate.

44. Monitoring the banks of controlled substances and assessing their accumulation in equipment and products is important due to the potential impact of their uncontrolled emissions on ozone depletion and climate. A bank is defined as the total amount of controlled substances contained in existing equipment, stockpiles, foams, and other products not yet released to the atmosphere. This includes the "reachable" bank, also referred to as "active" bank, which includes those controlled substances contained in equipment or products in use and thus potentially reachable or accessible for management upon entering the waste stream at its end-of-life (EOL). In contrast, the "non-reachable" or "inactive" bank denotes substances that have been landfilled or illegally dumped along with the equipment or product.

45. Effective management of active ODS and HFC banks aims to minimize the global impacts associated with the release of ODS and HFC by minimizing emissions, and by supporting HFC phase-down through recovering HFC for recycling, reclamation and reuse. Environmentally sound destruction of surplus or contaminated ODS and HFC at EOL is encouraged by the Montreal Protocol because it avoids unnecessary emissions and protects the stratospheric ozone layer and/or the climate. ODS and HFC banks in A5 parties, particularly in the refrigeration and air conditioning and foams sectors, are growing rapidly and will dominate global bank volumes by the early 2030s, resulting from declining banks in non-Article 5 parties and the rapid uptake of HFC-containing equipment in Article 5 parties. For the refrigeration and air conditioning and foams sectors, a combined estimated total of 6,000 ktonnes of ODSs and HFCs are contained in the active bank in 2022, equaling 16 GtCO_2 equivalent.

XI. Atmospheric concentrations of methyl bromide have not declined since 2016

46. Methyl bromide (CH_3Br) average global atmospheric abundances have varied annually between 6.5 ppt and 6.9 ppt during 2016–2020 with no clear overall trend. Northern Hemisphere abundances are approximately 0.8 ppt higher than in the Southern Hemisphere. Phase-out of controlled, non-exempted (i.e., non-QPS) uses of methyl bromide is reported to be virtually complete. Parties report that more than 99.8% of the

baseline consumption of 66,428 tonnes for these controlled applications has been phased out by 1 January 2023. This means that methyl bromide is currently used almost exclusively for QPS applications, with consumption remaining generally stable at 10,000 tonnes per year and concentrated in about 17 consuming countries.

47. Economically and technically feasible alternatives are available for QPS and could replace about 40% of current uses. Recapture and/or recycling methyl bromide could avoid about 70% of methyl bromide emissions arising from QPS use; however, this technology is costly and there is little incentive to adopt it. Reduction in emissions for all remaining uses of methyl bromide for QPS, together with identification and stopping any unreported uses, are considered important factors to returning concentrations in the atmosphere to natural levels. Owing to the relatively short lifetime of methyl bromide in the atmosphere (0.7 years), adoption of any suitable alternatives and in some cases adoption of recapture/destruction would have an immediate benefit in reducing its atmospheric concentration.

XII. The timing and extent of the recovery of stratospheric ozone depends on future concentrations of both ozone-depleting substances and greenhouse gases

48. Model simulations show that the future recovery of the ozone layer outside of the polar regions will be governed mostly by GHGs, assuming continued adherence to the Montreal Protocol. The wide range of possible future levels of CO_2, CH_4, and N_2O is an important limitation to providing accurate future projections of ozone globally and for the ozone hole, as well as in other geographic regions. Total column ozone returns to 1980 values sooner for scenarios that assume larger emissions of GHG (higher climate forcing) than scenarios with smaller GHG emissions (lower climate forcing).

49. For 60°S–60°N, simulations show that total ozone recovers to the 1980 level more rapidly under a higher climate forcing scenario because large future increases in both CO_2 and CH_4 tend to increase ozone. Under a low climate forcing scenario, the models project that ozone over 60°S–60°N may not reach the 1980 level by the end of this century. In this low climate forcing simulation, future declines in total ozone driven by rising N_2O outweigh the small future ozone increases caused by CO_2 and CH_4. For a medium climate forcing scenario, total ozone over 60°S–60°N is projected to return to the 1980 level around year 2040.

50. In addition to changes in ODS and GHG concentrations, projections of future ozone levels also depend on other factors that influence atmospheric chemistry and composition.

- Future commercial supersonic or hypersonic aircraft fleets could cause stratospheric ozone depletion through their emissions of substantial amounts of water vapor and nitrogen oxides (NO_x) into the stratosphere.
- Rocket launches presently have a small effect on total stratospheric ozone (much less than 0.1%). However, rocket systems using new propellants (e.g., hydrogen and methane) and increased launch frequencies could exert a substantial influence in the future. In addition, the demise of space hardware on re-entry through the atmosphere may have implications for stratospheric chemistry and composition that would lead to effects on ozone.
- Changes in stratospheric aerosol and water vapor from explosive volcanic eruptions would lead to increased ozone depletion and changes in stratospheric circulation. Ozone will become less sensitive to volcanic injections as ODS concentrations decline in coming decades.

- The intentional injection of sulfate aerosols into the stratosphere is being studied as a possible option for reducing climate warming and associated impacts. Model simulations show that injections have the potential to produce changes in ozone from chemical and dynamical processes, with the magnitude and sign of these changes depending strongly on the injection scenario and the state of climate change from anthropogenic activities.

XIII. Stratospheric ozone depletion and climate change are linked.

51. As reported in previous Assessments, ODSs are powerful greenhouse gases that lead to surface warming. Ozone itself is also a greenhouse gas and its changes impact climate. Increases in CO2 and decreases in ozone both tend to cool the stratosphere (while future increases in ozone have a warming tendency); cooling of the stratosphere away from polar regions slows the rate of ozone destruction, leading to higher ozone concentrations in the stratosphere.
52. The estimated rate of long-term cooling in the global middle and upper stratosphere (0.6 K $decade^{-1}$) based on observations is similar to previous Assessments. The long-term trends are primarily driven by increasing CO_2 and stratospheric ozone. In the future, increasing GHGs and the effects of ozone recovery would have opposing effects on stratospheric temperature and circulation.
53. New evidence suggests that ozone recovery has caused changes in the observed trends of the southern hemisphere atmospheric circulation between the ozone depletion and recovery periods. Model simulations support the attribution of these changes to ozone recovery. These results provide evidence that southern hemisphere circulation trends have responded to the recovery of Antarctic ozone due to the Montreal Protocol.
54. While there are no detectable surface impacts of long-term Arctic ozone changes, new evidence shows that for individual years low springtime Arctic ozone can amplify existing stratospheric circulation anomalies and their influence on tropospheric circulation and surface climate.
55. New evidence confirms that ozone depletion is unlikely to have driven the observed high-latitude sea-surface temperature cooling and changes in Antarctic sea ice since 1979.

XIV. Compliance with Protocol provisions ensures the protection of stratospheric ozone and climate.

56. Full compliance with the Montreal Protocol provisions contributes to ozone recovery and climate protection (as noted above).
    - Total column ozone (TCO) returns to 1980 values around 2066 in the Antarctic, around 2045 in the Arctic, and around 2040 for the near-global average.
    - In 2020, the Montreal Protocol has led to the avoidance of 0.17 ± 0.06°C global surface warming and 0.45 ± 0.23°C of Arctic surface warming. Projections show that by mid-century the Protocol will likely avoid 0.79 ± 0.24°C compared to a scenario with uncontrolled ODS emissions.
    - The Kigali Amendment avoids 0.3–0.5°C of warming by 2100.
57. Successful collaboration of experts across the Assessment Panels on science and technology has led to coordinated research and analyses to provide answers on sources of unexpected emissions of CFC-11 that occurred from 2013 to 2017. This issue highlights the need for vigilance to sustain compliance to guarantee the recovery of the ozone layer and maximize the speed of recovery.
58. Additional options for action to hasten the recovery of the ozone layer and protect the climate include the elimination of the remaining ODSs and their emissions, such as emissions from feedstock uses, by-product

emissions, methyl bromide from QPS applications, VSLSs, and banks of controlled substances. These would individually lead to small-to-modest ozone benefits; collectively, they would advance ozone recovery by a maximum of 16 years.

XV. Scientific, technical, and environmental policy considerations.

59. If ODS feedstock emissions as currently estimated were to be eliminated in future years, the return of mid-latitude equivalent effective stratospheric chlorine (EESC) to 1980 abundances could be advanced by almost 4 years, largely due to reductions in CCl_4, and simultaneously reduce total climate forcing from ODSs. Better understanding and monitoring of emissions of controlled substances from production, by-production, and feedstock use, is important given the contribution to overall global emissions.

60. In 2021, nearly all reported methyl bromide production was for QPS purposes, which is an uncontrolled use under the Montreal Protocol. Alternatives to methyl bromide are available, as are recapture technologies, that would lead to a reduction in emissions. Eliminating future emissions of methyl bromide from QPS applications currently allowed by the Montreal Protocol would accelerate the return of mid-latitude EESC to 1980 abundances by two years (as noted in previous Assessments).

61. Emissions of anthropogenic very short-lived chlorine substances, dominated by dichloromethane (DCM), continue to grow and contribute to ozone depletion. If DCM emissions continue at their current level, they would deplete approximately 1 DU of annually averaged global TCO. Elimination of these emissions would rapidly reverse this depletion.

62. Anthropogenic N_2O emissions are now the largest of the uncontrolled ODS emissions, as other larger emission sources (CFC-11, CFC-12 and CFC-113) have been phased out. A 3% reduction in anthropogenic N_2O emissions, averaged over 2023–2070, would lead to an increase in annually averaged global TCO of about 0.5 DU over the same period, and a decrease of about 0.04 Wm^{-2} in radiative forcing, averaged over 2023–2100.

63. With increasing ODS and HFC banks in Article 5 parties, particularly in the refrigeration and air conditioning and foams sectors, quantities potentially available for recovery and management are expected to increase in Article 5 parties. The refrigeration, air conditioning and heat pump (RACHP) sector dominates HFC consumption, and it is estimated to be responsible for around 95% and 80% of the consumption in Article 5 parties and globally, respectively. Timely efforts to establish and finance EOL management capacity to prevent HFC emissions could have a significant impact, given the predicted size and growth of these banks in larger Article 5 parties. Addressing the barriers to the transboundary movement of EOL ODSs and HFCs will be important in supporting preferential recovery/recycling and environmentally sound destruction of EOL ODSs and HFCs, thereby minimizing their emissions.

64. Under the Kigali Amendment, parties are progressing with national regulations to phase-down HFCs, which is spurring market demand for lower-GWP alternatives and higher efficiency equipment. Even so, the range of new, lower-GWP alternatives creates challenges in finding the best solution for each application, considering factors such as flammability, toxicity, availability, cost, accessibility, and the equipment and system operating conditions.

    - Ultralow-, low-, and/or medium-GWP alternative refrigerants are available for all RACHP applications and are being widely applied in some RACHP applications and regions. Accessibility is still a major hindrance for the widescale adoption.

- Most ultralow-, low-, and medium-GWP refrigerants have different flammability classes (lower flammability, flammable, and higher flammability). As such, the RACHP sector continues to update the relevant safety standards to enable their use (e.g., increased allowable flammable refrigerant charge limits for self-contained commercial refrigeration, air-to-air air conditioning, and heating-only heat pump applications).
- Addressing active banks containing high-GWP and energy-inefficient RAC equipment can further contribute to reducing energy demand and the servicing tail of unwanted high GWP refrigerants.
- Supply shortages of low-GWP alternatives in some sectors have eased with new production capacity of HFO and HCFO alternatives, but these shortages have delayed transitions away from HFCs across the various sectors of use. Future sufficiency of supply to meet growing demand due to the HFC phase-down will need to be monitored to avoid future disruptions.
- In most Article 5 parties, but especially in low- and very low-volume consuming countries, the majority of ODS and HFC refrigerants are used for servicing, so ensuring support for proper training and servicing would reduce direct emissions of ODS and HFC refrigerants and reduce the loss in energy efficiency in RACHP equipment over the lifetime of the equipment.
- In specific foam applications some challenges remain, particularly for smaller enterprises in some Article 5 parties due to the availability, safety, and cost of some lower-GWP alternatives as well as product performance requirements.
- While global consumption of HFCs for electronics manufacturing and magnesium production is relatively small, it is increasing for electronics manufacturing, and the alternatives to HFCs currently include other fluorinated gases, many of which have higher GWPs.
- Transition away from high-GWP HFC-pressurized metered dose inhalers (pMDIs) is a major undertaking with serious potential public health risks unless it is carefully managed.

65. Atmospheric monitoring station networks provide observations of global surface concentrations of long-lived ODS and HFC resulting from anthropogenic emissions. However, gaps in regional atmospheric monitoring limit the scientific community's ability to identify and quantify emissions of controlled substances from many source regions.
66. Several space-borne instruments providing vertically resolved, global measurements of ozone-related atmospheric constituents (e.g., reactive chlorine, water vapour, and long-lived transport tracers) are due to be retired within a few years. Without replacement of these instruments, the ability to monitor and explain changes in the stratospheric ozone layer in the future will be impeded.
67. The impact on the ozone layer of stratospheric aerosol injection (SAI), which has been proposed as a possible option to offset global warming, has been assessed following the terms of reference for the 2022 Scientific Assessment Panel report. Important potential consequences, such as deepening of the Antarctic ozone hole and delay in ozone recovery, were identified. Many knowledge gaps and uncertainties prevent a more robust evaluation at this time.
68. Heightened concerns about the twenty-first century ozone layer include impacts of:
    - further increases in nitrous oxide (N_2O), methane (CH_4), and CO_2 concentrations;

- rapidly expanding ODS and HFC feedstock use and emissions;
- continued and even increased use of methyl bromide for QPS use;
- climate change on total column ozone in the tropics;
- extraordinary wildfires and volcanic eruptions;
- and the increased frequency of civilian rocket launches and the emissions of a proposed new fleet of supersonic commercial aircraft.

69. While our knowledge of the effects of UV radiation is improving, there remain many challenges in adequately assessing the interactive effects of future changes in surface solar UV radiation and climate on human health, food security, ecosystem health and biodiversity. These challenges are in part due to uncertainty of how the effects of gradual climate change and periodic extreme climate events will alter UV irradiation at the Earth's surface and subsequently affect species' adaptation and ecosystem structure and function in a rapidly evolving environment. There is thus a clear need to include solar UV radiation with other climate change factors in experimental and modelling studies of human health and aquatic and terrestrial ecosystems to enable a more robust assessment of the environmental effects from changes in UV radiation under different future global climate scenarios.

Release of "The Montreal Protocol: India's Success Story" on the occasion of 28th World Ozone Day function held on 16th September, 2022 at Mumbai, India.

Release of "Poster" on the occasion of 28th World Ozone Day function held on 16th September, 2022 at Mumbai, India.

Shri Bhupender Yadav, Hon'ble Minister for Environment, Forest and Climate Change, Government of India and Shri Ashwini Kumar Choubey, Hon'ble Minister of State for Environment, Forest & Climate Change, Government of India visiting "Winning Entries (Poster & Slogan)" on the occasion of 28th World Ozone Day function held on 16th September, 2022 at Mumbai, India.

Shri Bhupender Yadav, Hon'ble Minister for Environment, Forest and Climate Change, Government of India addressing the participants, on the occasion of 28th World Ozone Day in the presence of Shri Eknath Shinde, Hon'ble Chief Minister, Government of Maharashtra, function held on 16th September, 2022 at Mumbai, India.

Shri Ashwini Kumar Choubey, Hon'ble Minister of State for Environment, Forest & Climate Change, Government of India addressing the participants, on the occasion of 28th World Ozone Day function held on 16th September, 2022 at Mumbai, India.

School Students attending the 28th World Ozone Day function held on 16th September, 2022 at Mumbai, India.

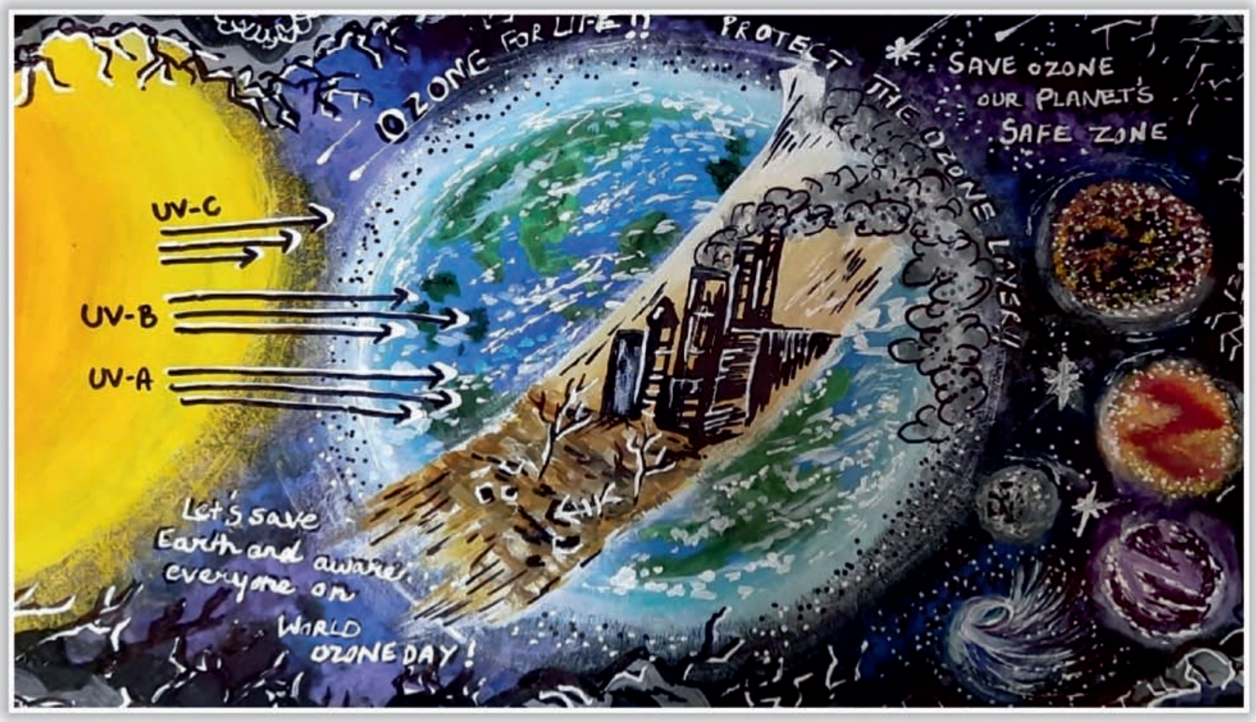
Ms Leena Nandan, Secretary Ministry of Environment, Forest & Climate Change, Government of India addressing the participants during the "Workshop on Indigenous capacity development including research on low global warming (GWP) chemicals" held on 4th August, 2023 at New Delhi, India.

Participants attending the "Workshop on Indigenous capacity development including research on low global warming (GWP) chemicals" held on 4th August, 2023 at New Delhi, India.

Ms Rajasree Ray, Economic Advisor Ministry of Environment, Forest & Climate Change, Government of India addressing the participants during the "Stakeholders awareness cum consultation workshop for development of national strategy for phase down of Hydrofluorocarbons (HFCs)" held on 22nd November, 2022 at New Delhi, India.

National level online Poster making competition First Prize winning entry of Moturi Sathwik, Sri Chaitanya Techno School, Aryapuram, opp. Fire Station, Rajamahendra Varam, East Godavari, Andhra Pradesh, organized on the occasion of 29th World Ozone Day, 2023.

National level online Poster making competition Second Prize winning entry of Devika Dev, Sacred Heart Public School (SHPS), S H Mount P. O., Kottayam, Kerala, organized on the occasion of 29th World Ozone Day, 2023.



National level online Poster making competition Third Prize winning entry of Pranshi Sharma, DAV Public School Sector - 14, Gurugram , Haryana, organized on the occasion of 29th World Ozone Day, 2023.

National level online Poster making competition Consolation Prize winning entry of Kashvi Prasad Gupta, St. Cecilia's Public School, F - Block, Vikas Puri, New Delhi, organized on the occasion of 29th World Ozone Day, 2023.

National level online Poster making competition Consolation Prize winning entry of Vineypal Singh, Government Multipurpose Senior Secondary School (M.P.S.S.), Passi Road, Patiala, Punjab, organized on the occasion of 29th World Ozone Day, 2023.

National level online Poster making competition Consolation Prize winning entry of Nayonika Jena, DAV Public School, Unit - 8, BBSR, Nayapalli, Bhubaneswar, Odisha, organized on the occasion of 29th World Ozone Day, 2023.

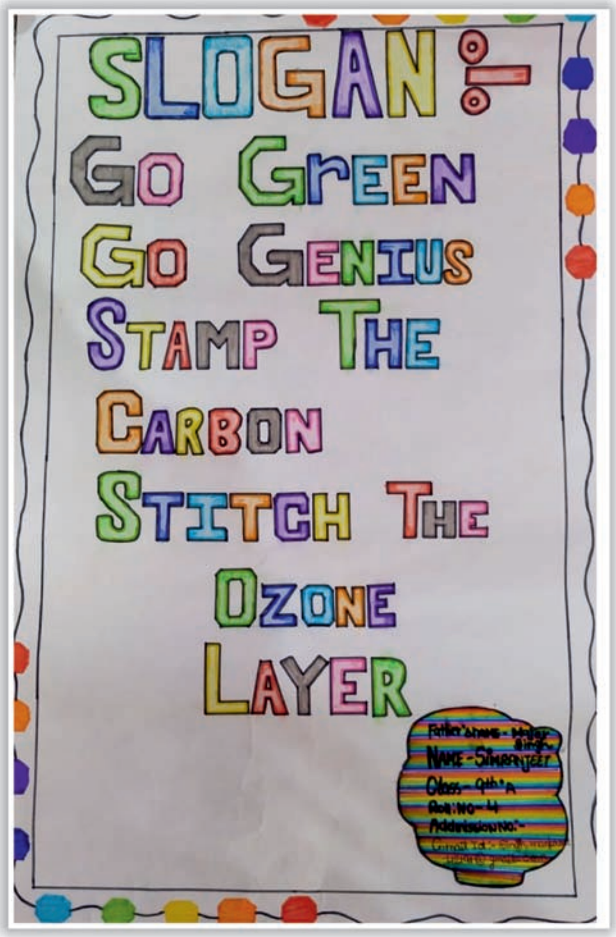
National level online Slogan writing competition First Prize winning entry of Devanshi, Darbari Lal D.A.V. Model School, ND - Block, Pitampura, Delhi, organized on the occasion of 29th World Ozone Day, 2023.

National level online Slogan writing competition Second Prize winning entry of M. Reshma, Kendriya Vidyalaya No. II, AFS, Hindon, Ghaziabad, Uttar Pradesh, organized on the occasion of 29th World Ozone Day, 2023.

Let's walk, bike or take a hike, to beat the heat and not accept defeat from the climate fight.

National level online Slogan writing competition Third Prize winning entry of Amaira Kapoor, Tagore International School, Paschimi Marg, Vasant Vihar, New Delhi, organized on the occasion of 29th World Ozone Day, 2023.

National level online Slogan writing competition Consolation Prize winning entry of Ekamjeet Singh, GMS Gatana Kalan (Mansa), V.P.O. Jatanakalan, The. Sardul garh, Distt. Mansa, Punjab, organized on the occasion of 29th World Ozone Day, 2023.



National level online Slogan writing competition Consolation Prize winning entry of Simranjeet Kaur, Govt. High School Rogla, V.P.O. - Rogla, Teh. - Sunam, Distt. - Sangrur, Punjab, organized on the occasion of 29th World Ozone Day, 2023.

National level online Slogan writing competition Consolation Prize winning entry of V. Harshitha, Coimbatore Public School, Off. Thudiyalur - Saravanampatti Road, Chinnamettupalyam, Saravanampatti (P.O.), Coimbatore, Tamil Nadu, organized on the occasion of 29th World Ozone Day, 2023.

National level online Slogan writing competition Consolation Prize winning entry of R. Vinusri, Jayaseelan Matric Higher Secondary School, Muthuppandipatti, Nakkalappatti (PO), Usilampatti, Madurai, Tamil Nadu, organized on the occasion of 29th World Ozone Day, 2023.

National level online Slogan writing competition Consolation Prize winning entry of Bhakti Gauns, Auxilium High School, Caranzalem, Goa, organized on the occasion of 29th World Ozone Day, 2023.

Slogan Writing Competition

1ST PRIZE

Devanshi

Darbari Lal D.A.V.
Model School
ND – Block, Pitampura, Delhi

2ND PRIZE

M. Reshma

Kendriya Vidyalaya No. II,
AFS, Hindon, Ghaziabad,
Uttar Pradesh

3RD PRIZE

Amaira Kapoor

Tagore International School,
Paschimi Marg,
Vasant Vihar, New Delhi

Let's walk, bike or take a hike, to beat the heat and not accept defeat from the climate fight.

SEPTEMBER 2023

WHOM TO CONTACT TO LEARN MORE ABOUT OZONE

Ozone Cell

Ministry of Environment, Forest and Climate Change
Government of India
1st Floor, 9 Institutional Area, Lodhi Road, New Delhi-110003
Tel.: 011-2464 2176
Website: http://ozonecell.nic.in