Guidelines – Global Warming

Issued by: Inspection Department – Operations Section

1.0 General

Measurements of temperature taken by instruments all over the world, on land and at sea have revealed that during the 20th century the Earth's surface and lowest part of the atmosphere warmed up on an average by about 0.6°C. Fossil fuel burning for energy and transportation and deforestation for agriculture has resulted to an increased in the emission of greenhouse gases. Due to the increased in greenhouse gas emissions and concurrent increases in atmospheric greenhouse gas concentrations, global warming is now considered.

Internationally, the Intergovernmental Panel on Climate Change (IPCC), under the auspices of the United Nations (UN), World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP), is the most senior authoritative body providing scientific advice to global policy makers. The IPCC met in full session in 1990, 1995, 2001 and in 2007. They address issues such as the buildup of greenhouse gases, evidence, attribution and prediction of climate change, impacts of climate change and policy options.

2.0 Causes of Global Warming

Almost 100% of the observed temperature increased over the last 50 years has been due to the increase in the atmosphere of greenhouse gas concentrations like water vapor, carbon dioxide (CO_2), methane and ozone. Greenhouse gases are those gases that contribute to the greenhouse effect. These are the gases in the atmosphere that absorb and emit radiation within the thermal infrared range. The largest contributing source of greenhouse gas is the burning of fossil fuels leading to the emission of carbon dioxide.

2.1 Carbon Dioxide (CO_2)

Carbon dioxide exists in Earth's atmosphere currently at a globally averaged concentration of approximately 385 parts per million by volume. It is a greenhouse gas as it transmits visible light but absorbs strongly in the infrared and near-infrared. It is generated as a by-product of the combustion of fossil fuels or the burning of vegetable matter, among other chemical processes. Over very long time scales (thousand to millions of years), concentrations are influenced by emissions from volcanoes and other geothermal processes such as hot springs and geysers and by the dissolution of carbonates in crystal rocks.

2.2 Nitrogen Oxide (NO)

Nitrogen oxide commonly known as "laughing gas". It is the main naturally occurring regulator of stratospheric ozone. Considered over a 100 year period, it has 298 times more impact per unit

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weight than carbon dioxide. Thus, despite its low concentration, nitrous oxide is the fourth largest contributor to these greenhouse gases. It ranks behind carbon dioxide, methane, and water vapor, the latter of which comprises greater than 95% of all greenhouse gases. Control of nitrous oxide is part of efforts to curb greenhouse gas emissions.

2.3 Methane (CH_4)

It is a relatively potent greenhouse gas with a high global warming potential of 72 (averaged over 20 years) or 25 (averaged over 100 years). Methane in the atmosphere is eventually oxidized, producing carbon dioxide and water. As a result, methane in the atmosphere has a half life of seven years. Major source of methane is extraction from geological deposits known as natural gas field. It is associated with other hydrocarbon fuels. Apart from gas fields, an alternative method of obtaining methane is via biogas generated by the fermentation of organic matter including manure, wastewater sludge, municipal solid waste (including landfills), or any other biodegradable feedstock under anaerobic conditions. Methane in the Earth's atmosphere is an important greenhouse gas with a global warming potential of 25 over a 100-year period. This means that a methane emission will have 25 times the impact on temperature of a carbon dioxide emission of the same mass over the following 100 years. Methane has a large effect for a brief period (a net lifetime of 8.4 years in the atmosphere), whereas carbon dioxide has a small effect for a long period (over 100 years). Because of this difference in effect and time period, the global warming potential of methane over a 20 year time period is 72. The Earth's methane concentration has increased by about 150% since 1750, and it accounts for 20% of the total radiative forcing from all of the long-lived and globally mixed greenhouse gases. Usually, excess methane from landfills and other natural producers of methane are burned so CO_2 is released into the atmosphere instead of methane because methane is such a more effective greenhouse gas.

2.4 Chlorofluorocarbons (CFCs)

Chlorofluorocarbons belong to the haloalkanes family. Haloalkanes containing chlorine or bromine have been shown to have negative effects on the environment such as ozone depletion.

3.0 Effects of Global Warming

3.1 Effects on Weather

Increasing temperature is likely to lead increasing precipitation but the effects on storms are less clear. Extra tropical storms partly depend on the temperature gradient which is predicted to weaken in the northern hemisphere as the polar region warms more than the rest of the hemisphere.

a. Extreme Weather

Storm strength leading to extreme weather is increasing. Some studies have found that the increase in sea surface temperature may be offset by an increase in wind shear, leading to little or no change in hurricane activity.

b. Increased Evaporation

Over the course of the 20th century, evaporation rates have reduced worldwide. As the climate grows warmer and the cause of global dimming are reduced, evaporation will increase due to warmer oceans. Because the world is a closed system, this will cause heavier rainfall, with more erosion. This erosion can lead to desertification in tropical areas, especially in Africa. In other areas, increased rainfall lead to growth of forests in dry desert areas. The IPCC Third Annual Report says, "Global average water vapor concentration and precipitation are projected to increase during the 21st century. By the second half of the 21st century, it is likely that precipitation will have increased over northern mid- to high latitudes and Antarctica in winter. At low latitude, there are both regional increases and decreases over land areas. Larger year to year variations in precipitation are very likely over most areas where an increase in mean precipitation is projected.

c. Destabilization

In the northern hemisphere, the southern part of the Arctic region has experienced a temperature rise of 1°C to 3°C (1.8°F to 5.4°F) over the last 50 years. Canada, Alaska and Russia are experiencing initial melting of permafrost. This may disrupt ecosystems and by increasing bacterial activity in the soil lead to these areas becoming sources instead of carbon sinks. Hurricanes were though to be an entirely North Atlantic phenomenon. In late March 2004, the first Atlantic cyclone to form south of the equator hit Brazil with 40 m/s winds.

3.2 Glacier Retreat and Disappearance

Excluding the ice caps and ice sheets of the Arctic and Antarctic, the total surface area of glaciers worldwide has decreased by 50% since the end of the 19th century. Currently, glacier retreat rates and mass balance losses have been increasing in the Andes, Alps, Pyrenees, Himalayas, Rocky Mountains and North Cascades.

3.3 Oceans

The role of the oceans in global warming is a complex one. The oceans serve as a sink for carbon dioxide but increased levels of carbon dioxide have led to ocean acidification. Furthermore, as the ocean's temperature increases, it becomes less able to absorb excess carbon dioxide. Ongoing effects include rising sea levels due to thermal expansion and melting of glaciers and ice sheets, and warming of the ocean surface, leading to increased temperature stratification. Other possible effects include large-scale changes in ocean circulation.

a. Sea Level Rise

With increasing average global temperature, the water in the oceans expands in volume, and additional water enters them which had previously been locked up on land in glaciers.

b. Temperature Rise

From 1961 to 2003, the global ocean temperature has risen by 0.10°C from the surface to a depth of 700 m. There is variability both year-to-year and over longer time scales, with global ocean heat content observations showing high rates of warming for 1991 to 2003, but some cooling from 2003 to 2007.

c. Acidification

The world's oceans soak up much of the carbon dioxide produced by living organisms, either as dissolved gas, or in the skeletons of tiny marine creatures that fall to the bottom to become chalk or limestone. Oceans currently absorb about one ton of CO_2 per person per year. It is estimated that the oceans have absorbed around half of all CO_2 generated by human activities since 1800.

d. Shutdown of Thermohaline Circulation

There is some speculation that global warming could, via a shutdown or slowdown of the thermohaline circulation, trigger localized cooling in the North Atlantic and lead to cooling, or lesser warming, in that region. This would affect in particular areas like Scandinavia and Britain that are warmed by the North Atlantic drift. More significantly, it could lead to an oceanic anoxic event.

3.4 Abrupt and Irreversible Effects

Partial loss of ice sheets on polar land could imply meters of sea level rise, major changes in coastlines and inundation of low-lying areas, with greatest effects in river deltas and low-lying islands. Such changes are projected to occur over millennial time scales, but more rapid sea level rise on century time scales cannot be excluded.

3.5 Positive Feedback Effects

Methane Release from Melting Permafrost Peat Bogs – Western Siberia is the world's largest peat bog, a one million square kilometer region of permafrost peat bog that was formed 11,000 years ago at the end of the last ice age. The melting of its permafrost is likely to lead to the release, over decades, of large quantities of methane. As much as 70,000 million tons of methane, an extremely effective greenhouse gas, might be released over the next few decades, creating an additional source of greenhouse gas emissions. Similar melting has been observed in eastern Siberia.

a. Methane released from hydrates

Methane clathrate, also called methane hydrate, is a form of water ice that contains a large amount of methane within its crystal structure. Extremely large deposits of methane clathrate have been found under sediments on the ocean floors of Earth. The sudden release of large amounts of natural gas from methane clathrate deposits, in a runaway greenhouse effect, has been hypothesized as a cause of past and possibly future climate changes. The release of this

trapped methane is a potential major outcome of a rise in temperature; it is thought that this might increase the global temperature by an additional 5° in itself, as methane is much more powerful as a greenhouse gas than carbon dioxide. The theory also predicts this will greatly affect available oxygen content of the atmosphere.

b. Carbon Cycle Feedbacks

There have been predictions, and some evidence, that global warming might cause loss of carbon from terrestrial ecosystems, leading to an increase of atmospheric CO_2 levels. Several climate models indicate that global warming through the 21st century could be accelerated by the response of the terrestrial carbon cycle to such warming.

c. Forest Fires

The IPCC Fourth Assessment Report predicts that many mid-latitude regions, such as Mediterranean Europe, will experience decreased rainfall and an increased risk of drought, which in turn would allow forest fires to occur on larger scale, and more regularly. This releases more stored carbon into the atmosphere than the carbon cycle can naturally re-absorb, as well as reducing the overall forest area on the planet, creating a positive feedback loop. Part of that feedback loop is more rapid growth of replacement forests and a northward migration of forests as northern latitudes become more suitable climates for sustaining forests.

d. Retreat of Sea Ice

The sea absorbs heat from the sun, while the ice largely reflects the sun rays back to space. Thus, retreating sea ice will allow the sun to warm the now exposed sea water, contributing to further warming. The mechanism is the same as when a black car heats up faster in sunlight than a white car.

4.0 Stop Global Warming

Global warming is an urgent and serious problem. There are many easy solutions to reduce global warming and its impact. People should understand the problem and take measure accordingly to save the world.

a. People should reduce the usage of electrical appliances which emits green house gases. For e.g. the refrigerator releases chlorofluorocarbon (CFC) and the incandescent light lamp emits 300 pounds of carbon dioxide a year. This can be replaced by a compact fluorescent light bulb which saves much energy.

b. Follow RRR-Reduce, Reuse, Recycle. People should not dump waste products in the ground. Plant products, food waste, vegetable dump undergoes anaerobic decomposition i.e. they break down to produce methane, a green house gas instead of oxygen. Hence the product usage and wastage should be reduced or recycled for a healthy atmosphere.

c. Trees absorb a large amount of carbon dioxide. Many trees should be planted since they involve in photosynthesis, food preparation with the help of sunlight. During this process, trees absorb carbon dioxide and exhale oxygen. Also, existing forests should be saved and usage of plant byproducts shouldn't be wasted.

d. Usage of green power prevents 300 kg of carbon dioxide to be emitted into the atmosphere. The electricity obtained from the renewable resources like wind and water is called green power. The cost is also low in case of green power.

e. Insulation of the ceiling of a house and power saving is the important factor to reduce global warming. The electric appliances should be switched off instead to hold it in stand-by mode. This will save more power since stand-by mode consumes 40% of the energy.

f. People should use only energy efficient appliances. Thermostat should be used for air conditioners since it reduces the temperature automatically.

g. Consumption of organic food should be increased because organic soil absorb large amount of carbon dioxide. Buying local food reduces the consumption of fuel. Cows emits large amount of methane due to their vegetarian diet. Hence meat consumption should be reduced. Also tetra packs should be used instead of tinned food.

h. Periodic maintenance of the vehicles helps in efficient usage of fuel and reduces release of green house gases. Proper inflation of tires should be done and fuel wastage should be avoided.

i. Teach your neighbourhood and friends about the cause and impacts of global warming and methods to reduce it. Conservation of forests also forms a factor to reduce global warming.