Proposal to the 46th Session of the Marine Environmental Protection Committee (MEPC 46) titled "Prevention of Air Pollution from Ships: A Preliminary Study on Estimation of GHG Emissions other than CO2 from Ocean-Going Vessels" (April, 2001)

PREVENTION OF AIR POLLUTION FROM SHIPS

Preliminary Study on estimation of GHG emissions other than CO 2 from ocean-going vessels

1 Efforts to reduce the GHG emissions from ocean-going vessels

In relation to the emission of Greenhouse Gases from ocean-going vessels, United Nations Framework Convention on Climate Change (UNFCCC) has requested the International Maritime Organization (IMO) to organize a quantitative investigation into the emissions and study on the available options for reduction. Japan has previously introduced some of the results of the Ship & Ocean Foundation's (SOF) research into the CO_2 emissions from ocean-going ships, which was presented at MEPC 44 and MEPC 45. While continuing its research into CO_2 emissions, SOF has also made a preliminary estimation of the emission of GHGs other than CO_2. This information paper introduces the results of this study.

2 Breakdown of Each GHG Emission

UNFCCC defines GHGs as CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. However, PFCs and SF_6 will not be dealt with in this document. PFCs are contained in extinguishers, however the leakage from such apparatus is predicted to be minimal in comparison to HFCs. The use of SF6 is mainly in the cleansing of electrical equipment and its presence on ships is also considered insignificant.

2.1CH 4

The emission of CH4 from ships mainly results from the engines combustion and from the loading and unloading of crude oil.

- **CH4 emissions from the engine combustion of ocean-going ships**

The CH_4 emission of $41*10^3$t/year shown in MEPC 45/8 was employed in this study.

- **CH4 emissions from the transportation of crude oil**

  The emission of CH_4 that accompanies the transportation of crude oil can be broken into four main categories; emissions during loading, emissions during unloading, emissions during navigation under loaded condition and emissions during ballast navigation.
  From an investigation of statistical documents and the SOF's ship field study, the following assumptions were made and the emission of CH_4 from crude oil tankers was estimated.
  It was assumed that the emission of inert gas containing CH_4 from the cargo holds of tankers during loading and unloading was approximately 1.8 times and 0.2 times respectively of the total volume of crude oil loaded.
  The leakage of inert gas containing CH_4 under loaded navigation and ballast navigation was assumed to be 5% and 3% per week respectively of the transported volume of crude oil.
  The methane gas density was taken from the vapor composition of the particular crude oil, which differs according to production origin. The average period of transportation was taken to be five weeks.

  Given the above assumptions, the results of the estimation of CH4 emissions are shown in Table 1.

Table 1: Methane Gas Emissions from Crude Oil Tankers -1996-
(unit: 103 t t/year)

Loading	Unloading	Loaded Navigation	Ballast Navigation	Total
121	10	10	2	143

The total emissions of CH_4 from ship engines and the transportation of crude oil is estimated as $41*10^3+143*10^3 = 184*10^3$t/year, which gives a CO_2 equivalent value of $3.9*10^6$t/year.

2.2N2O

The emission coefficient established by UNFCCC was employed (0.08g/kg-fuel). Using this coefficient, the total N_2O emissions are estimated as $11.4*10^3$t/year, which gives a CO_2 equivalent value of $3.5*10^3$t/year.
However, N_2O is mainly emitted when there is a change in load on the vessels engine. Due to this, the application of this emission coefficient to the total navigational time may have lead to an overestimation of the emissions.

Furthermore, the results of the SOF's ship field study also suggest that there will be a need to consider the revision of this coefficient.

2.3HFCs

For 20ft reefer containers, it is understood that 3 to 4 times of the amount of the initial injection of 30kg of refrigerant have escaped into the atmosphere between the initial injection of refrigerant to container and the container's scrapping. HFCs emissions are estimated as approximately 2.8-5.2*10^3t/year from the volume of HFCs emitted from a single container during its life span (20 years) and the total number of reefer containers in 1996. This gives a CO_2 equivalent value of 4.7-8.9*10^6t/year

2.4Summary

A summary of the estimations is shown in Table 2. For ocean-going vessels, the total emission of other GHGs is estimated to be approximately 3-4 percentages of that of CO_2

Table 2: Breakdown of GHG Emissions from Ocean-Going Vessels (1996)

	CO_2	CH_4	N_2O	HFCs (R134a)
Global Warming Potential	1	21	310	1,700
Total Emission from Vessels (10^3t/year)	437×10^3	184	11.4	2.8 ~ 5.2
CO_2 Equivalent (10^6t/year)	437	3.9	3.5	4.7 ~ 8.9
Emission Ratio to CO_2 (percentage)	-	0.9	0.8	1.1 ~ 2.0

Conclusion

The total emission rate of the other GHGs when compared to the total emissions of CO_2 is only approximately 3-4 %.

In regard to the reduction of CH_4, there are many examples of measures that can be taken to collect and combust CH_4 in the inert gases emitted when crude oil is loaded or unloaded.

Regarding to the reduction of N_2O, through the use of denitrification devices, actual examples show that the decomposition of N_2O would be possible. Furthermore, the reduction of HFCs would be possible through the improvement of refrigerant replacement and handling.

When compared to CO_2 reduction, the methods to reduce other Greenhouse gases are

relatively simple to implement and therefore should be further investigated as an option to reduce the emissions of GHGs.