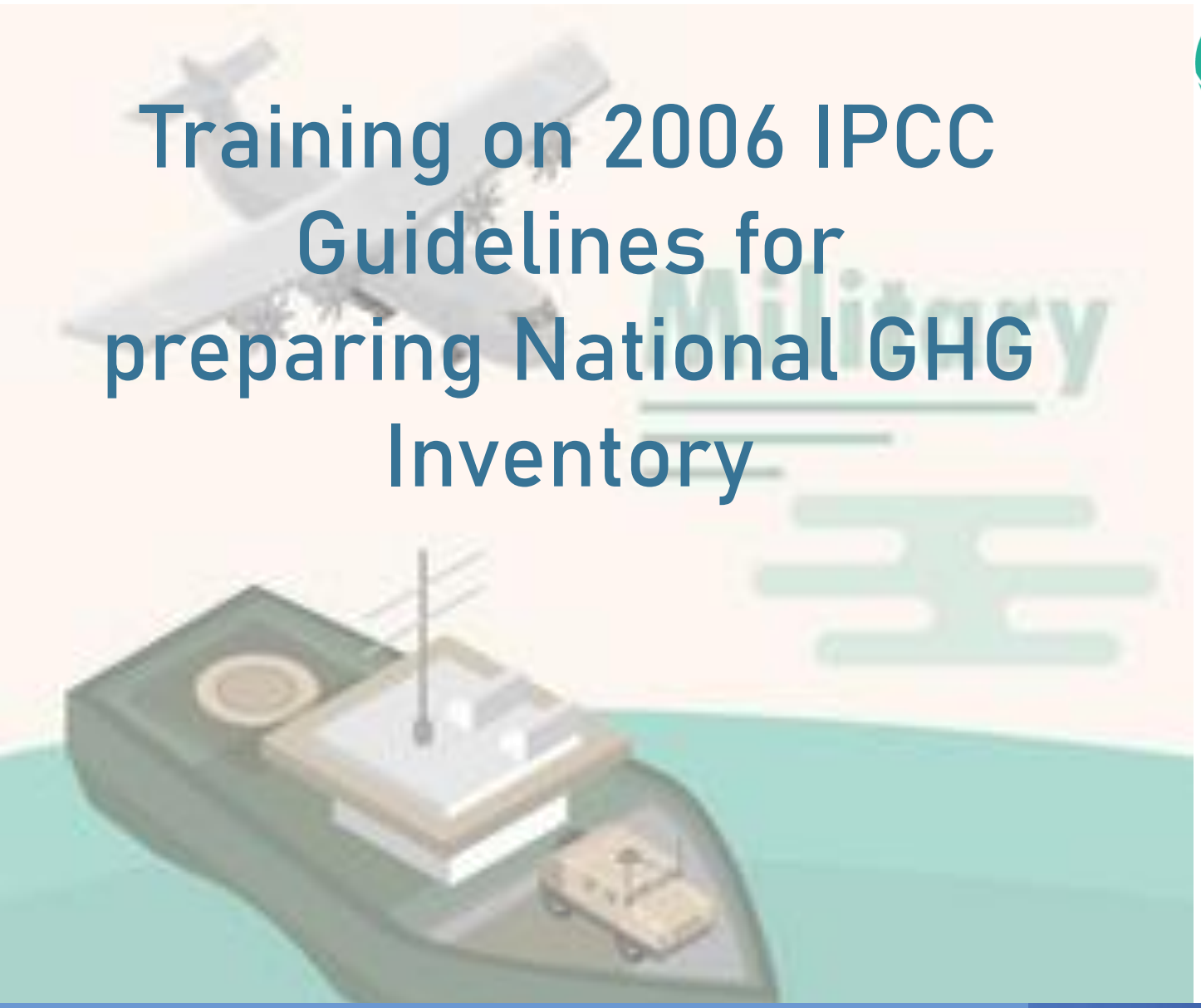
Training on 2006 IPCC Guidelines for preparing National GHG Inventory



GHG Inventory – Mobile combustion- Military

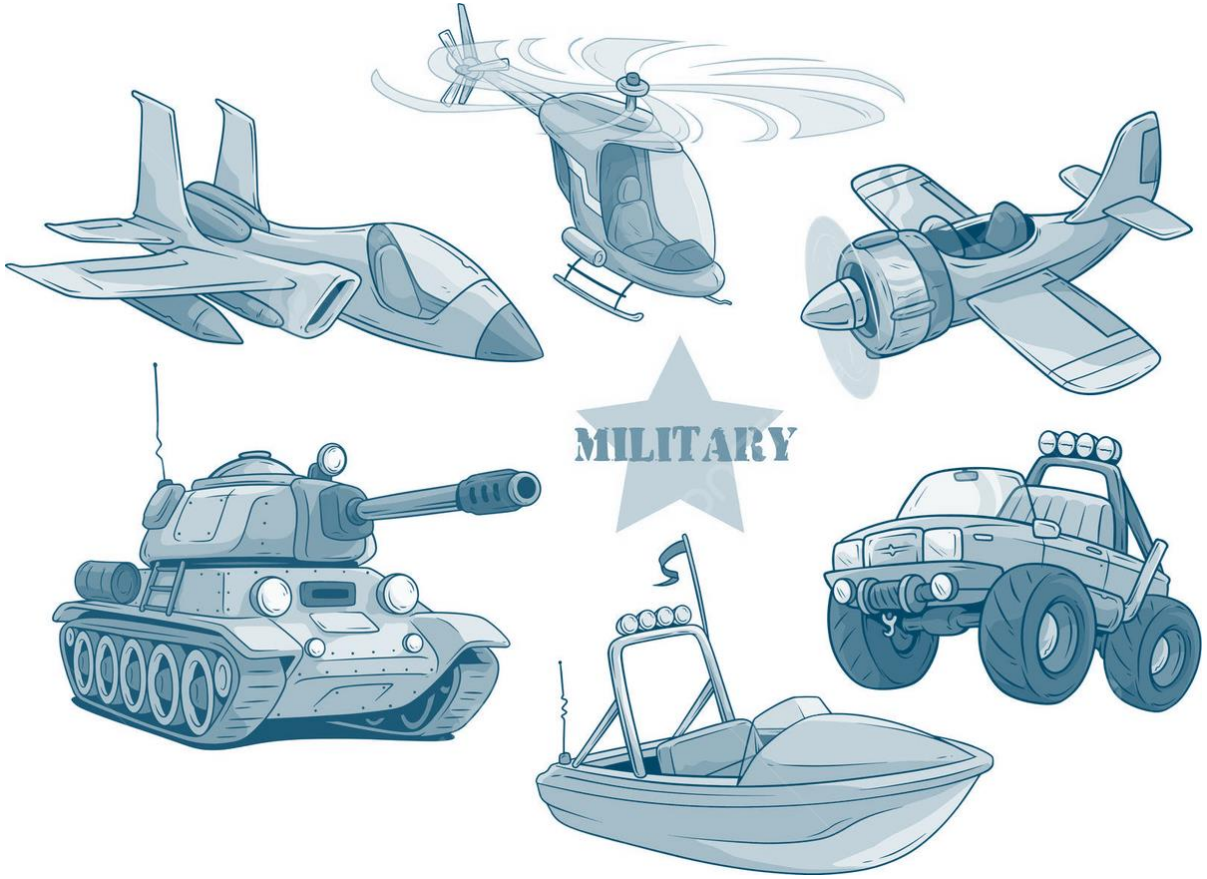
Present By:

Eng. H. M. Buddika Hemashantha

International MRV Transparency Advisor to CBIT-GSP

Organized by the Capacity Building Initiative for Transparency
Global Support Programme (CBIT-GSP)

MILITARY



- Sub-categories which can report military emissions

1.A.3.a.i – International Aviation (International bunkers)

1.A.5.b.i – Mobile (aviation component)

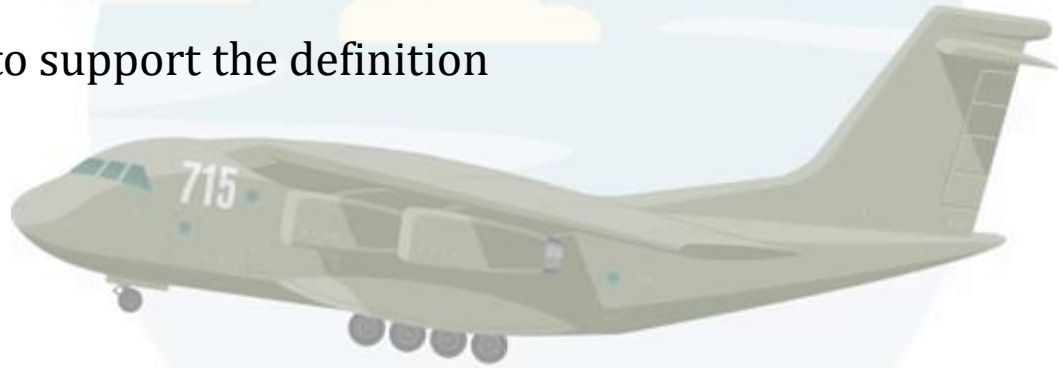
1.A.3.d.i – International water-borne navigation

1.A.5.b.ii – Mobile (water-borne component)

1.A.5.c – Multilateral operations

1.A.3.a.i – International Aviation (International bunkers)

- Includes emissions from international military aviation
- Considered as a distinct sub-category within the international military aviation
- Ensure that the same definitional criteria used for international aviation are applied to international military aviation emissions
- Ensure that data are available to support the definition

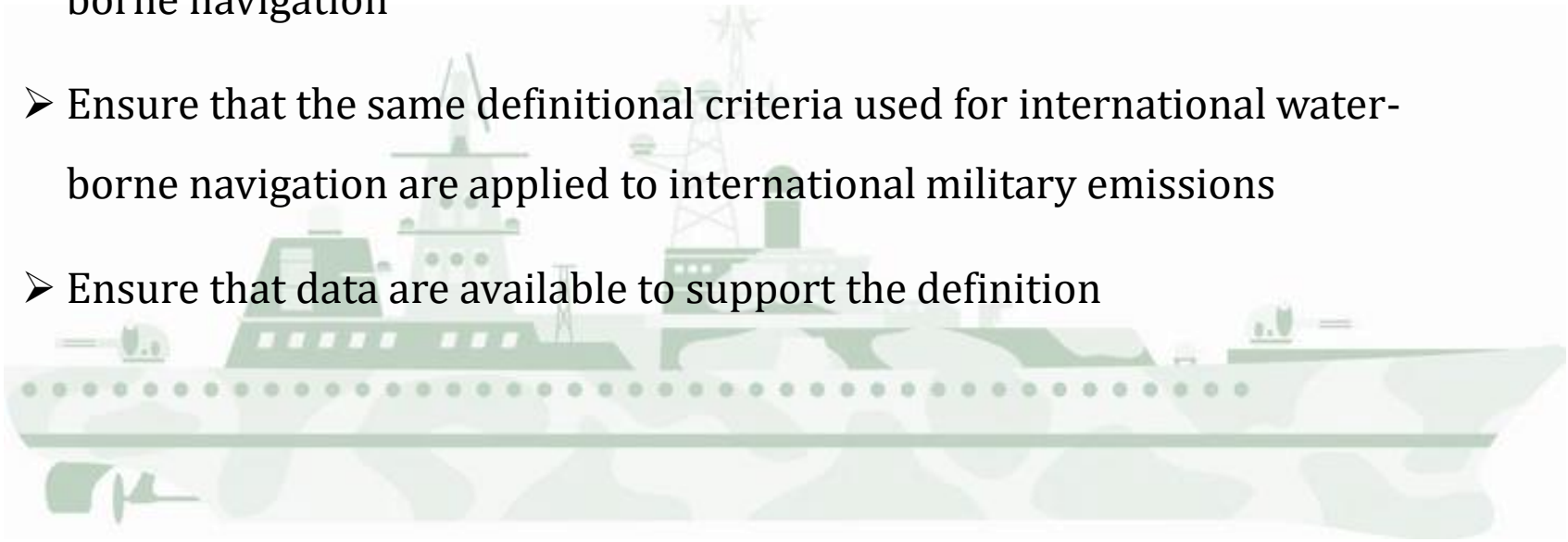


1.A.5.b.i – Mobile (aviation component)

- Domestic aviation exclude the military and it should be reported under 1.A.5.b.

1.A.3.d.i – International water-borne navigation

- Include emissions from international military water-borne navigation
- Considered as a distinct sub-category within the international water-borne navigation
- Ensure that the same definitional criteria used for international water-borne navigation are applied to international military emissions
- Ensure that data are available to support the definition

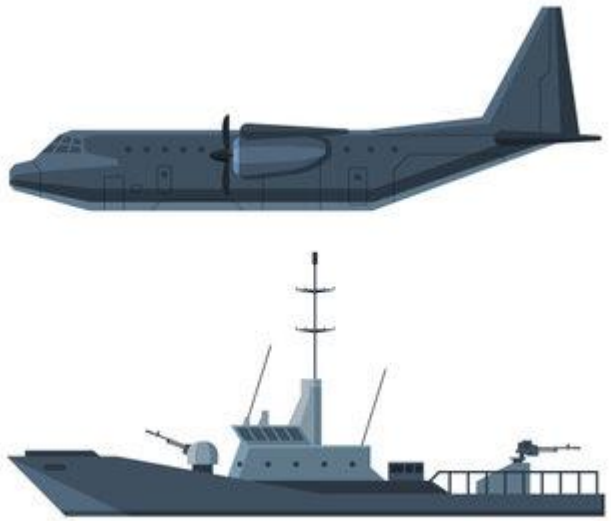


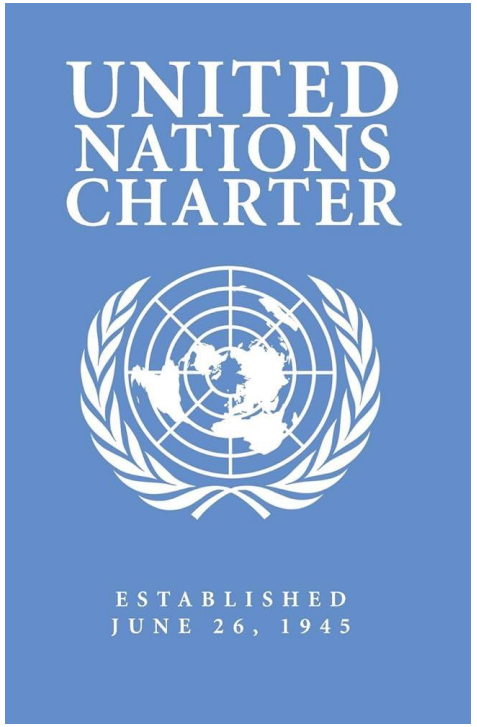
1.A.5.b.ii – Mobile (water-borne component)

- Domestic water-borne navigation exclude military, and it should be reported under here

1.A.5.c – Multilateral operations

- Includes emissions from fuel delivered to the military in the country and delivered to the military of other countries.
- Emissions from fuels used for aviation and water borne navigation in multilateral operations pursuant to the Charter of the United Nations





The 2006 IPCC Guidelines do not provide a distinct method for calculating military water-borne emissions

Calculations for military are done with aviation equation and water-borne navigation equation

- Water-borne navigation equation used to estimate emissions from military water-borne emissions

Tier 1	• Apply either default values or country-specific information

Water-borne navigation equation		
Emission = $\sum$ [Fuel Consumed $_{ab}$ * Emission Factor $_{ab}$]		
Parameter	Description	Unit
Emission	Emissions of CO_2, CH_4, N_2O	kg
a	Fuel type e (diesel, gasoline, LPG, bunker, etc.)	N/A
b	Water-borne navigation type (i.e., Ship or boat, and possibly engine type.) (Only at tier 2 is the fuel used differentiated by type of vessel so, b can be ignored at tier 1)	N/A

consult military experts to determine the most appropriate emission factors for the country's military water-borne navigation

Calculation example to find emissions from military water-borne navigation

Fuel type	Consumption (ktoe)	Emission factor (kg/TJ)			Conversion factor (TJ/ ktoe)
		CO_2	CH_4	N_2O	
Diesel	78.16	72800	6.5	2.1	41.87

*conversion factor is used in here because activity data was given in ktoe (kilo tonne of oil equivalents)

This is also an assumption for this activity

These EF are assumptions only for this example!

consult military experts to determine the most appropriate emission factors for the country's military water-borne navigation

Fuel type	Emissions = Fuel consumption * EF
	CO_2
Diesel	Fuel consumption = 78.16 ktoe * 41.87 TJ/ ktoe =3,272.5592 TJ E_{CO2} =3,272.5592 TJ * 72,800 kg/TJ = 238242309.8 kg or 238.25 Gg

Follow the same procedure to calculate CH_4 & N_2O emissions

- Aviation equation is used to estimate emissions from military aviation and military emissions comes under multilateral operations

Aviation equation
Emissions = Fuel Consumption * Emission Factor

- Default emission factors for civil aircraft should be used for military aviation unless better data are available
- Default fuel consumption factors for military aircraft are given in IPPC guideline >> Volume 2 >> Chapter 3

TABLE 3.6.7
FUEL CONSUMPTION FACTORS FOR MILITARY AIRCRAFT

Group	Sub- group	Representative type	Fuel flow(kg/hour)
Combat	Fast Jet – High Thrust	F16	3 283
	Fast Jet – Low Thrust	Tiger F-5E	2 100
Trainer	Jet trainers	Hawk	720
	Turboprop trainers	PC-7	120
Tanker/transport	Large tanker/ transport	C-130	2 225
	Small Transport	ATP	499
Other	MPAs Maritime Patrol	C-130	2 225

Sources: Tables 3.1 and 3.2 of Gardner *et. al* 1998 USEPA, 2005)

TABLE 3.6.8
FUEL CONSUMPTION PER FLIGHT HOUR FOR MILITARY AIRCRAFT

AIRCRAFT TYPE	Aircraft Description	FUEL USE (LITRES PER HOUR)
A-10A	Twin engine light bomber	2 331
B-1B	Four engine long-range strategic bomber. Used by USA only	13 959
B-52H	Eight engine long-range strategic bomber. Used by USA only.	12 833
C-12J	Twin turboprop light transport. Beech King Air variant.	398
C-130E	Four turboprop transport. Used by many countries.	2 956
C-141B	Four engine long-range transport. Used by USA only	7 849
C-5B	Four engine long-range heavy transport. Used by USA only	13 473
C-9C	Twin engine transport. Military variant of DC-9.	3 745
E-4B	Four engine transport. Military variant of Boeing 747.	17 339
F-15D	Twin engine fighter.	5 825
F-15E	Twin engine fighter-bomber	6 951
F-16C	Single engine fighter. Used by many countries.	3 252
KC-10A	Three engine tanker. Military variant of DC-10	10 002
KC-135E	Four engine tanker. Military variant of Boeing 707.	7 134
KC-135R	Four engine tanker with newer engines. Boeing 707 variant.	6 064
T-37B	Twin engine jet trainer.	694
T-38A	Twin engine jet trainer. Similar to F-5.	262

consult military experts to determine the most appropriate emission factors for the country's military aviation

Calculation example to find emissions from military aviation using tier 1

Aircraft type	Fuel use (kg/hour)	Fuel type	Airtime (hours)	IPCC default emission factor (kg/TJ)			Conversion factor (TJ/ Gg)
				CO_2	CH_4	N_2O	
C-130	2,225	Jet kerosene	50	71500	0.5	2	44.1

2006 IPCC default EF

TABLE 3.6.
CO_2 EMISSION FACTORS

Fuel	Default (kg/TJ)	Lower	Upper
Aviation Gasoline	70 000	67 500	73 000
Jet Kerosene	71 500	69 800	74 400

TABLE 3.6.5
NON-CO_2 EMISSION FACTORS

Fuel	CH_4 Default (Uncontrolled) Factors (in kg/TJ)	N_2O Default (Uncontrolled) Factors (in kg/TJ)
All fuels	0.5[a] (-57%/+100%)[b]	2 (-70%/+150%)[b]

Fuel type and airtime are assumptions for this example only.

TABLE 3.6.7
FUEL CONSUMPTION FACTORS FOR MILITARY AIRCRAFT

Group	Sub- group	Representative type	Fuel flow(kg/hour)
Combat	Fast Jet – High Thrust	F16	3 283
	Fast Jet – Low Thrust	Tiger F-5E	2 100
Trainer	Jet trainers	Hawk	720
	Turboprop trainers	PC-7	120
Tanker/transport	Large tanker/ transport	C-130	2 225
	Small Transport	ATP	499
Other	MPAs Maritime Patrol	C-130	2 225

Sources: Tables 3.1 and 3.2 of Gardner *et. al* 1998 USEPA, 2005)

This is from the IPCC guideline, used to obtain marked data in the table

As mentioned in the IPCC guideline, default EF used for civil aircrafts were used for this calculation also!

Fuel type	Emissions = Fuel Consumption * Emission Factor
	CO_2
Jet kerosene	Fuel consumption = 2,225 kg/hour * 50 hours = 111,250 kg In energy units (TJ) = 111,250 * 10^{-6} Gg * 44.1 TJ/Gg = 4.906125 TJ E_{CO2} = 4.906125 TJ * 71500 kg/TJ = 350787.94 kg or 0.45 Gg

Follow the same procedure to calculate CH_4 & N_2O emissions

Eng. H.M. Buddika Hemashantha

MRV Transparency Advisor to CBIT GSP

+44 7359 23 7074, +94 770 320 110

buddika@climatesi.com