where:

$M_{ship,t}$ and $W_{ship,t}$ represents the total mass of CO_2 emitted from and the total transport work undertaken by a ship of this type in a given calendar year, as stipulated in the *Guidelines on operational carbon intensity indicators and the calculation methods (G1)*.

4 The reduction factors for the required annual operational CII of ship types

4.1 In accordance with regulation 28 of MARPOL Annex VI, the required annual operational CII for a ship is calculated as follows:

$$\text{Required annual operational } CII = (1 - Z/100) \times CII_R$$

where CII_R is the reference value in year 2019 as defined in the *Guidelines on the reference lines for use with operational carbon intensity indicators (G2)*, Z is a general reference to the reduction factors for the required annual operational CII of ship types from year 2023 to 2030, as specified in table 1.

Table 1: Reduction factor (Z%) for the CII relative to the 2019 reference line

Year	Reduction factor relative to 2019
2023	5%*
2024	7%
2025	9%
2026	11%
2027	- **
2028	- **
2029	- **
2030	- **

Note:

* Z factors of 1%, 2% and 3% are set for the years of 2020 to 2022, similar as business as usual until entry into force of the measure.

** Z factors for the years of 2027 to 2030 to be further strengthened and developed taking into account the review of the short-term measure.

5 Background information on rational ranges of reduction factors of ship types in year 2030

5.1 In the *Initial IMO Strategy on Reduction of GHG Emissions from Ships* (Resolution MEPC.304(72)), the levels of ambition on carbon intensity of international shipping have been set taking year 2008 as reference. The carbon intensity of international shipping in year 2008, as well as the improvement through 2012 to 2018, has been estimated in the *Fourth IMO GHG Study 2020*. However, since the scope and data collection methods applied in the *Fourth IMO GHG Study 2020* were inconsistent with those under IMO DCS, the results derived from the two sources cannot be compared directly.

5.2 To ensure the comparability of the attained carbon intensity of international shipping through year 2023 to 2030 with the reference line, the following methods are applied to calculate the equivalent carbon intensity target in year 2030 ($eR_{shipping,2030}$), taking year 2019 as reference, i.e. how much additional improvement is needed by 2030 from the 2019 performance level.

5.3 The achieved carbon intensity reduction of international shipping in year 2019 relative to year 2008 ($R_{shipping,2019}$) can be estimated as the sum of the achieved carbon intensity reduction of international shipping in year 2018 relative to year 2008 ($R_{shipping,2018}$) as given by the *Fourth IMO GHG Study 2020* and the estimated average annual improvement during 2012 and 2018 ($\overline{r}_{shipping}$), as follows:

$$R_{shipping,2019} = R_{shipping,2018} + \overline{r}_{shipping} \quad (5)$$

5.4 The following provides the calculations using demand-based measurement and supply-based measurement.

5.4.1 Demand-based measurement of 2030 target

As estimated by the *Fourth IMO GHG Study 2020*, the attained CII of international shipping (on aggregated demand-based metric) has reduced by **31.8%** ($R_{shipping,2018}=31.8\%$) compared to 2008, with an estimated average annual improvement at **1.5** percentage points ($\overline{r}_{shipping}=1.5\%$). In accordance with Eq.(5), the carbon intensity reduction achieved in year 2019 is estimated as **33.3%** ($R_{shipping,2019}=33.3\%$).

5.4.2 Supply-based measurement of 2030 target

As estimated by the *Fourth IMO GHG Study 2020*, the attained CII of international shipping (on aggregated supply-based metric) has reduced by **22.0%** ($R_{shipping,2018}=22.0\%$) compared to 2008, with an estimated average annual improvement at **1.6** percentage points ($\overline{r}_{shipping}=1.6\%$). In accordance with Eq.(5), the carbon intensity reduction achieved in year 2019 relative to 2008 is estimated as **23.6%** ($R_{shipping,2019}=23.6\%$).

5.5 Given the achieved carbon intensity reduction of international shipping in year 2019 relative to year 2008, the carbon intensity reduction target of international shipping in year 2030 can be converted to the equivalent target ($eR_{shipping,2030}$) relative to year 2019, as follows:

$$eR_{shipping,2030} = \frac{40\% - R_{shipping,2019}}{1 - R_{shipping,2019}} \quad (6)$$

5.5.1 Demand-based measurement of 2030 target

In accordance with Eq.(6), the equivalent reduction factor of international shipping in year 2030 relative to year 2019 ($eR_{shipping,2030}$) would be at least **10.0%** measured in aggregated demand-based CII metric, i.e. at least additional **10.0%** improvement from the 2019 level is needed by 2030.

5.5.2 Supply-based measurement of 2030 target

In accordance with Eq.(6), the equivalent reduction factor of international shipping in 2030 relative to year 2019 ($eR_{shipping,2030}$) would be at least **21.5%**, measured in aggregated supply-based CII metric, i.e. at least additional **21.5%** improvement from the 2019 level is needed by 2030.

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