MODULATION CHARGES – ANNEX EMISSION SCORE (P)

A/ GENERAL

1) The final emission score (P) is calculated based on the ICAO database on aircraft engine emissions.

   From this database, data on number of engines, NO_x values, HC values and fuel flow values (to calculate CO^2) can be retrieved based on the UID numbers (unique identification) provided by the airport.

   https://www.easa.europa.eu/domains/environment/icao-aircraft-engine-emissions-databank

   In case no UID number is available and/or for unregulated engines, a final emission score equal to 0 will be applied.

2) The applied methodology is based on the ERLIG (Emissions Related Landing Charges Investigation Group) formula for the NO_x and HC calculations on the one hand, and on the Eurocontrol formula for the CO^2 calculations on the other hand.

3) The specific emission value of each aircraft is taken into account up to the third decimal.

B/ CALCULATION METHODOLOGY

The calculation consists of the following steps:

1. NO_x & HC

1.1 NO_x :

The absolute amount of NO_x within the LTO cycle is calculated by using the ICAO databank for all LTO-modes of the individual engine.

$$NO_{x,aircraft} = E \times \sum \{(60 \times time \times fuelflow \times NO_x\text{-index}) / 1000\} \text{ (in kg } NO_x)$$

where: - E : number of engines fitted to the aircraft
- ∑ : sum of the 4 LTO-modes (NO_x take-off + NO_x climbout + NO_x approach + NO_x taxi/idle)
  - NO_x take-off: (60 x 0.7 x fuelflow T/O (kg/sec) x NO_x T/O-index) / 1000
  - NO_x climbout: (60 x 2.2 x fuelflow C/O (kg/sec) x NO_x C/O-index) / 1000
  - NO_x approach: (60 x 4.0 x fuelflow App (kg/sec) x NO_x App-index) / 1000
  - NO_x taxi/idle: (60 x 26.0 x fuelflow Taxi (kg/sec) x NO_x Taxi-index) / 1000
- Time: time in mode according to the table below
- Fuelflow: fuel flow per mode (in kg/sec)
- NO_x -index: measured NOx-emission index per mode (in g/kg fuel)

Mode	Time in minutes	Ref. ICAO dbase Fuel Flow	Ref. ICAO dbase NOx
Take off	0.7	Column BZ	Column AQ
Climb out	2.2	Column CA	Column AR
Approach	4.0	Column CB	Column AS
Taxi	26.0	Column CC	Column AT

The sum of the 4 LTO-modes also corresponds to the NO_x LTO Total Mass (expressed in g-value), to be found in column BH of the ICAO database Annex 16, Volume 2 on aircraft engine emissions, and consequently to be divided by 1000 to reach the required kg-value.

1.2 HC

Unburnt hydrocarbons (HC) represent the total mass of carbon monoxide emitted per engine during an LTO cycle and is used to determine a compensation factor (A).

The characteristic HC Dp/Foo values for each engine can be found in column AA of the ICAO database Annex 16, Volume 2 on aircraft engine emissions.

when HC ≤ 19,6 g/kN	Column AA ICAO database	A = 1
when HC > 19,6 g/kN	Column AA ICAO database	A = HC / 19,6 g/kN (with a max value of 4)

1.3 NO_x & HC emission value (per aircraft)

NO_x & HC emission value = A x $NO_{x,aircraft}$

1.4 NO_x & HC emission score (per aircraft)

NO_x & HC emission score = 100 - (100 x (NO_x & HC emission value - $NO_{x,min}$) / ($NO_{x,max}$ - $NO_{x,min}$)

This is a formula to determine an emission score between 0 and 100 (based on the emission value of a specific aircraft type in comparison to other aircraft types in the dataset).

→ $NO_{x,min}$ refers to the lowest NO_x & HC emission value of aircraft operating at Brussels Airport in 2022 (2.104)
→ $NO_{x,max}$ refers to the highest NO_x & HC emission value of aircraft operating at Brussels Airport in 2022 (68.228)

In case the NO_x & HC emission values for an aircraft exceed the current min/max bands, the score shall be limited to 100 (max) and 0 (min).

NO_x & HC emission score = 100 - (100 x (NO_x & HC emission value – 2.104) / 66.124)

2. CO^2

2.1 CO^2 emission value (per aircraft)

CO^2 emission value = F x 3.15 x E

where: - E: number of engines
- F: the fuel flow per LTO cycle for each engine (to be found in column CD of the ICAO database)
- 3.15 value: is the emitted CO2 amount for each kg fuel burnt per aircraft (always same value)

2.2 CO^2 emission score (per aircraft)

CO^2 emission score = 100 - (100 x (CO^2 value - CO^2_{min}) / (CO^2_{max}- CO^2_{min}))

This is a formula to determine a CO^2 emission score between 0 and 100 (based on the CO^2 emission value of a specific aircraft type in comparison to other aircraft types in the dataset).

→ CO^2_{min} refers to the lowest CO^2 emission value of aircraft operating at Brussels Airport in 2022 (447.300)
→ CO^2_{max} refers to the highest CO^2 emission value of aircraft operating at Brussels Airport in 2022 (11176.200)

In case the CO^2emission values for an aircraft exceed the current min/max bands, the score shall be limited to 100 (max) and 0 (min).

CO^2 emission score = 100 - (100 x (CO^2 emission value – 447.300) / 10728.900)

3. FINAL EMISSION SCORE (PER AIRCRAFT)

Final emission score (P) = (NO_x & HC emission score + CO^2 emission score) / 2

→

Final emission score	Emission factor (Pi)
≥ 90	0.95
> 10, < 90	1
≤ 10	1.05