Flight efficiency metric calculation and annual review protocol

Flight efficiency metric (3Di) calculation

1.1 3DI is calculated as the mean of the 3Di scores for all flights taking place in UK airspace under NERL control within the relevant year of the control period. The metric will be calculated on a flight by flight basis and the mean published monthly. The annual average 3Di score will be used for the calculation of financial incentives.

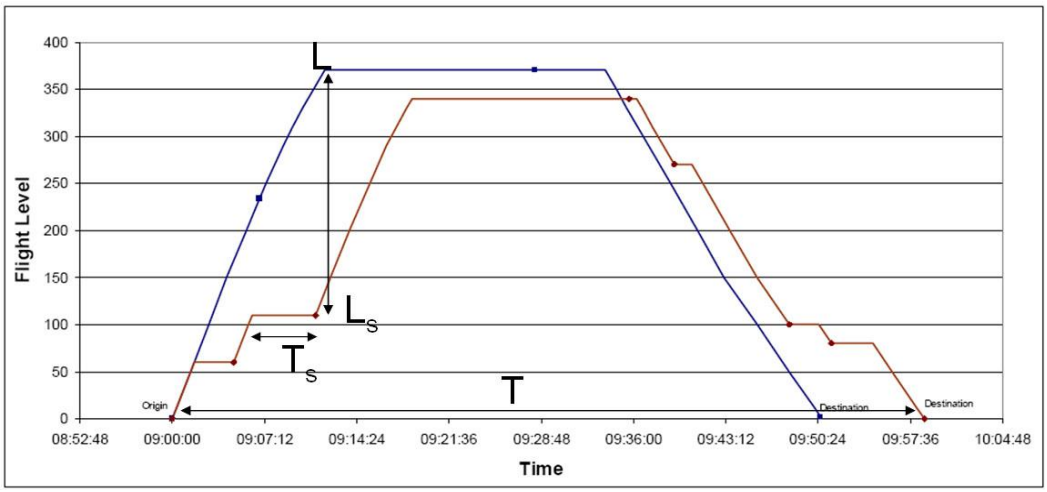
1.2 3Di score by flight is calculated as a combination of:

- Horizontal flight efficiency - defined as the difference between the UK portion of the overall optimal flight distance and the actual flight path flown within UK airspace. Horizontal flight efficiency is measured from the actual entry and exit point into and out of UKFIR, where the optimal flight distance is calculated using the same logic as the EUROCONTROL KEA algorithm.
- Vertical flight efficiency - defined as the difference in altitude between the reference (requested) flight level and the actual altitude of the period of level flight, alongside the time spent in level flight. Vertical inefficiency is split into flight phase (climb, cruise and descent) and the calculation for an individual flight phase is as follows:

1.3 Vertical Inefficiency = $$V = \sum_{s} \frac{T_s}{T}\left(\frac{L - L_s}{L}\right)$$

1.4 Where: V=Vertical Inefficiency, T=Total Flight Time (UKFIR), S=Step reference[1], Ts=Duration of Step, L=Reference Level, Ls=Level of Step, as illustrated on the next page.

1 A step being a period of the flight at constant level, each step having a corresponding duration and level.



1.5 Vertical and horizontal flight efficiency are combined using the following model form based on a multiple linear regression. This is a proxy estimate for the impact of the flight trajectory on fuel burn[2]:

$$\varphi = \beta_1 H + \beta_2 V_{CL} + \beta_3 V_{CR} + \beta_4 V_D$$

1.6 Where φ = 3D Inefficiency Score, β_1, β_2, β_3 and, β_4 are constants, VCL= Vertical Inefficiency of Climb, VCR= Vertical Inefficiency of Cruise, VD = Vertical Inefficiency of Descent, and H = KEA Horizontal Inefficiency

The 3Di Model

1.7 The coefficients of this model have been estimated using a sample of 145,865 flights from 2013, and tested on a further sample of 72,935 flights.

2 This estimated impact is calculated by comparing the fuel burn for the journey based on an optimal trajectory (continuous climb and descent to/from the reference flight level) to the fuel burn for the actual trajectory followed. These fuel burn estimates are generated by the NATS Kerosene Emissions Research Model (KERMIT) model which uses data on aircraft performance from the Eurocontrol BADA 3.11 database.

Table 1: Standard Metric Coefficients[3]

Parameter	Coefficient
Horizontal flight inefficiency (β 1)	✂
Climb vertical flight inefficiency(β 2)	✂
Cruise vertical flight inefficiency(β 3)	✂
Descent vertical flight inefficiency (β 4)	✂

Annual review protocol

1.8 The flight efficiency regression model and output will be reviewed each year. The annual review will test the continued appropriateness of the regression modelling coefficients that underpin the 3DI as described above.

1.9 The annual review will test the stability of the underlying model coefficients in February/March 2016 using calendar year data from 2015 and annually thereafter. The annual review will use a sample of the review year data chosen (using cluster sampling) to provide a sample reflective of the underlying population, with a target of 50,000 flights, and apply the same linear regression methodology used to derive new 3Di model coefficients.

1.10 The test model will be applied to the full calendar year data from the review year and the calculated mean 3Di score is compared to the actual mean 3Di score using the RP2 model (3DI) for the year.

1.11 If the difference between the mean 3Di score produced by the RP2 model and the test model is greater than or equal to 8% of the RP2 model score (3DI), then the 3DI bonus/penalty for the year would be cancelled. If the difference between the mean scores falls within the pre-specified threshold, then the bonus/penalty is applied.

1.12 The test will be verified by the CAA, and NERL should supply all data used to undertake the analysis (and any other relevant data requested) to the CAA by end of March in each year to allow the verification to be undertaken.

3 Coefficients redacted.

1.13 The data to be supplied to CAA will comprise:

- dataset to comprise of 50,000 sample flights representative of the population of all flights in the year;
- details of how the sample has been chosen using cluster sampling, including number of clusters identified, total number of days falling within each cluster, number of days sampled from each cluster and number of flights operated on the days sampled;
- the test model coefficients;
- the test model estimate of 3Di for the review year (X) based on the test model;
- the existing set of coefficients from the standard model;
- the existing estimate of 3Di for the review year (Y) based on the standard model coefficients; and
- for each flight - values for I, H, VCl, VCr & VD as used in the existing model.

1.14 The result of the annual review will be published by 30 April in the year following the review year to allow financial statements to reflect the outcome.

1.15 If the Annual Review test falls outside the accepted tolerance in a given year, then the test will be repeated in the following year as per the protocol set out above.

1.16 If the Annual Review test falls outside the accepted tolerance in two consecutive years, the CAA would expect the incentive to be withdrawn for the remainder of RP2. If however, the CAA and NERL are in agreement that the retention of the incentive is justified then it may remain in place until the following Annual Review. This justification would require sufficient analytical work, to be conducted and shared by NERL, to demonstrate:

- an understanding of the underlying causes of the variation in test results, and
- that continuing the model in its existing form would not lead to the generation of unwarranted bonuses/penalties in future years.