Concorde Performance Limited TOW (PLTOW)

(a guide for using Take-Off Data tables and applying corrections)

I thought I would put something together to try and explain how the Take-Off Data tables in Parts 1 & 2 of the Concorde Performance Manuals work, and how the various references to different weights factor in when determining our final Take-Off figures.

The Concorde Performance Manual Part 1 is where most of this information comes from and you will see whenever the team produce new route files, we will include the **PLTOW** data from Part 1 or Part 2 of the Performance Manual if it is available. Not all airfields will have data for take-off, and this is where the Generalised Take-Off Data calculations will come in but that is not within the scope of this document as it is too complicated to explain here.

Part 1 covers:

Take-Off Data from Major Airfields, (EGLL, KJFK, TBPB, CYYZ & KIAD)
Take-Off Data from Main Alternates,
Take-Off Data from Alternates & Charter Destinations.

Part 1 is available in the **Home > Downloads > BAVirtual > DocStore > OM B** section of the BAV Website or via the following link Performance Manual Part 1.

Part 2 covers: Take-Off Data from Minor Airfields.

At the time of writing this is not available in pdf format to the best of my knowledge. Part 1 comes in at just over 560 pages and Part 2 is even thicker. I have original printed versions of both parts and will always ensure where possible that if **PLTOW** data for a new route is available from Part 2, I will scan and include the relevant pages, but the thought of scanning the entire Part 2 is something I do not want to contemplate.

Let us now look at the various weights you are likely to see when flight planning if you are going to determine your own take-off figures:

All weights referred to in this guide will be in metric tonnes unless otherwise stated.

These definitions come from:

Part 1 of the **Performance Manual Section 1.1.11. MAXIMUM TAKE-OFF WEIGHTS**

A. Performance Limited TOW (PLTOW)

The weight extracted from the Take-Off data page for the actual outside air temperature (OAT) and forecast wind component, corrected for pressure altitude, centre of gravity and DDM items is the Performance Limited TOW.

B. Maximum Authorised TOW (MATOW)

Maximum Authorised TOW is **185,070kg**. Notional weights in excess of this figure are tabulated when available to enable the highest possible weights to be used prior to applying significant negative corrections such as some DDM items.

N.B. The FAA Environmental Impact Statement and Noise Rule requires all Concorde operations from any U.S airfield to be restricted to a MATOW of 182,250kg.

C. Runway Maximum Authorised Take-Off Weight (RMATOW)

RMATOW is the maximum take-off weight authorised on any particular runway under the provisions of the "Procedure To Authorise The Use Of Runways" detailed in section 1.1.27 of this manual.

Note: *It appears that my hard copy of the manual is dated later than the copy available in the downloads section and **C**. above is not included in the online version, and the Section reference is therefore irrelevant for the online version. There are however **NO** weight restrictions on **LHR, JFK** or **BGI** runways. Any restrictions would be shown on the relevant Take-Off Data pages where appropriate.*

D. Regulated Take-Off Weight (RTOW)

RTOW is the lowest of the **MATOW,** the **PLTOW** and the **RMATOW**. It should be borne in mind that Regulated Landing Weight may limit **RTOW** on short sectors.

Other weights you will see mentioned are:

Actual Take-Off Weight (ATOW) this is the planned weight of the aircraft at Take-Off and can only be altered by adding or removing passengers, cargo or fuel.

ATOW less than PLTOW this is where, after we have carried out all our corrections to the **PLTOW,** our **ATOW** is still less than the **PLTOW** and we must apply additional corrections.

Before we can start our calculations, we need some pieces of information: the relevant weather at **Heathrow is 270° at 08kts, temperature is 19°C with a pressure of 1025,** this is what we will use for our departure planning.

Thankfully here the wind is blowing straight down the runway and so we do not have to worry about crosswind calculations to determine the exact headwind component.

Our **ATOW** for this flight has been calculated to be **184·10**.

To start our calculations, we are going to deal with the **PLTOW** and for that we need the relevant table from the Performance Manual. For our flight we are going to assume we are doing a Heathrow to Barbados run and as we are going to be near to our maximum weights for this flight.

OAT °C	10kt TAIL	Inc /kt	5kt TAIL	Inc /kt	STILL AIR	Inc /kt	10kt HEAD	Inc /kt	20kt HEAD	Inc /kt
39	163.1 155/177	0.8	167.2 160/183	0.8	171.3 166/189	0.3	173.9 170/192	0.3	176.5 173/196	0.3
36	165.1 154/178	0.8	169.2 160/183	0.8	173.4 166/189	0.3	176.0 169/193	0.3	178.6 173/197	0.3
33	166.9 154/178	0.8	171.1 160/184	0.8	175.3 165/190	0.3	178.0 169/194	0.3	180.6 173/198	0.3
30	168.8 154/179	0.8	173.0 159/185	0.9	177.3 165/191	0.3	180.0 169/195	0.3	182.7 173/199	0.3
27	170.6 154/180	0.8	174.8 159/186	0.9	179.2 165/192	0.3	181.9 169/196	0.3	184.6 172/199	0.3
24	172.3 154/181	0.9	176.7 159/187	0.9	181.0 165/193	0.3	183.8 169/196	0.3	186.6 172/200	0.3
21	174.0 154/181	0.9	178.4 159/187	0.9	182.8 165/193	0.3	185.7 169/197	0.3	188.5 172/201	0.3
18	175.7 154/182	0.9	180.1 159/188	0.9	184.6 165/194	0.3	187.5 169/198	0.3	190.3 172/202	0.3
15	177.3 154/183	0.9	181.7 159/188	0.9	186.3 165/194	0.3	189.2 169/198	0.3	192.0 172/202	0.3

PLTOW is obtained by looking at the relevant Take-Off Data for our departure airport and runway. To the left we have an extract of the data for 27L at EGLL which we will use for these calculations.

As you can see, I have highlighted 2 boxes in red and 2 in blue.

Our headwind is 08kts, so it is going to be somewhere between the **STILL AIR** column and the **10kt HEAD** column, we always need to take the result from the **least favourable** entry.

In this case the **STILL AIR** column gives us a lower **PLTOW** value (the figure in the top left of each box is the **PLTOW**).

So, we know we are going to be working from the boxes that are coloured red as they give the worst weights for the given wind.

Now we need to decide between the 21°C figures or the 18°C figure as our current outside air temperature lies between both at 19°C. Again, we go for the worst figure, 21°C is 182·8 and for 18°C it is 184·6.

Therefore 182·8 is the worst figure, now we know what our base figures are that we are going to be working with:

182·8 is the **PLTOW** before any corrections to it have been made.
0·3 is the **wind correction** factor (top right figure of each box).
165 is our $\mathbf{V_1}$ figure (bottom left-hand figure of each box).
193 is our $\mathbf{V_R}$ figure (bottom right-hand figure of each box).

Now we can start on the corrections for our flight.

Before we start, you will see that in many cases we are not going to fall neatly into a box where the temperature and wind components are exactly right for our flight.

It is entirely permissible to extrapolate data from the Take-Off Data tables if you are working within the data provided.

It must be noted that not all the tables are the same, one table may show data for a 20kt tailwind, the other only a 10kt tailwind. You cannot assume because one runway has a 20kt tailwind limit the other one would too.

*The **ONLY** time you can extrapolate **OUTSIDE** of the tables is for the **MAXIMUM** temperature shown and you can only do that for a **MAXIMUM** of **3°C,** however, the penalties for going above are a **1,000kg per °C** reduction in the **PLTOW**, so there will be a big performance hit.*

For our example we are midway between 18°C and 21°C, to extrapolate our data the calculation will be – the highest figure in our range which is 184·6 minus the lower figure in our range, 182·8.

This gives us 1·8 as there is 3°C between the upper and lower levels, we will divide this by 3 to give us the change per °C = (184·6 - 182·8) / 3 = **0·6**.

As you can see the 18°C figure is 184·6 and the 21°C figure is 182·8 so we need to **ADD 0·6** for each degree lower we are going to get to our particular air temperature:

21°C = 182·8
20°C = 183·4
19°C = 184·0
18°C = 184·6

For our temperature of 19°C our temperature corrected PLTOW is 184·0.

Now we can address the wind component correction we have 8 kts on the nose and the wind correction factor is 0·3 / kt, therefore 0·3 * 8 = **2·4.**

The new PLTOW corrected for temperature and wind is now 184·0 + 2·4 = 186·4.

*The wind component factor will vary, even for the same temperature or the same wind condition. It may even show 0 or be missing altogether, especially on the highest **HEAD** wind values as you will not be applying a wind correction over the top of the highest value as you would be exceeding the table data which is not permissible.*

*It must be noted that if (for example) you had an 18kt headwind and were using the **10kt HEAD** & **20kt HEAD** columns and the **10kt HEAD** column gives the worst **PLTOW** you would only apply 8kts of wind component correction because 10kts has already been used for that column.*

The next correction to be made is for **Pressure Altitude,** the chart we need for this is this one:

CORRECTION TO MAXIMUM TAKE-OFF WEIGHT (1000kg)

QNH mb	0	1	2	3	4	5	6	7	8	9	
1040	3.9	4.0	4.2	4.3	4.4	4.6	4.7	4.9	5.0	5.2	
1030	2.4	2.6	2.7	2.9	3.0	3.1	3.3	3.4	3.6	3.7	ADD
1020	1.0	1.1	1.3	1.4	1.6	1.7	1.9	2.0	2.1	2.3	
1010	-0.6	-0.4	-0.2	0.0	0.1	0.3	0.4	0.6	0.7	0.9	
1000	-2.5	-2.3	-2.1	-1.9	-1.7	-1.5	-1.3	-1.2	-1.0	-0.8	
990	-4.3	-4.1	-3.9	-3.7	-3.5	-3.4	-3.2	-3.0	-2.8	-2.6	SUBTRACT
980	-6.1	-5.9	-5.8	-5.6	-5.4	-5.2	-5.0	-4.8	-4.6	-4.4	
970	-8.0	-7.8	-7.6	-7.4	-7.2	-7.0	-6.9	-6.7	-6.5	-6.3	

For pressures above **1013** it is an **addition** and for pressures below **1013** it is a **subtraction**.

We have a pressure of **1025** so ours will be an addition of **1·7** to our previously acquired figures.

Our previous **PLTOW** corrected for temperature and wind was **186·4**, now we can add an additional **1·7** to this figure to give us **188·1.**

The next calculation that needs to be made is for **C of G**, this gets a little more interesting as there are several variants that could come into play, dependent upon our Take-Off weight.

First off, we know that for a Heathrow – Barbados run we are going to be close to maximum weights and with an extremely high fuel load resulting in a **54% Co**.

The following calculation **ONLY** needs to be carried out for **54% Co. departures** and the chart we need for that is:

MAXIMUM TAKE-OFF WEIGHT CORRECTIONS - TONNES FOR TAKE-OFF AT 54% Co.

MTOW (1000kg)	0	2	4	6	8
	INCREMENT – TONNES				
180	.90	.91	.92	.93	.94
170	.85	.86	.87	.88	.89

Our previous **PLTOW** corrected for temperature, wind & pressure altitude gave us **188·1.**

Looking at the chart to the left we can see that for **188** the **INCREMENT** is **0·94**, so we can add this to our last figure of **188·1** to give us **189·04.**

This is our FINAL PLTOW figure.

However, this is Concorde and life isn't going to be that easy, we know that our **ACTUAL TOW (ATOW) is 184·10.**

The manual goes on to tell us this:

If the actual TOW is less than the value obtained in b. (b. is our FINAL PLTOW figure of 189·04) *The difference between the PLTOW before the increment was applied and the actual TOW must be used to determine the "actual TOW less than PLTOW" Take-Off speed and Θ_2 corrections.*

We know that our actual **TOW is 184·10** and as this figure is **LESS** than the **PLTOW** we previously obtained which was **188·10.** To obtain our **ATOW less than PLTOW** figure we need to subtract **188·10** from **184·10**, this gives us a figure of **4·0.**

The above ONLY affects the V_1, V_R, V_2 & Θ_2 figures, keep a note of it as it will be needed later.

The only other adjustment we would need to make is due to allowable Despatch Deviations, these are detailed in Section 1.8 of Part 1 of the Performance Manual but are not included in this guide for the sake of simplicity; but cover all the allowed deficiencies where despatch is still authorised, in the world of flight simulation all our departures are likely to be with a perfectly serviceable aircraft.

Our final figures are therefore:

PLTOW – 189·04
ATOW less than PLTOW – 4·0
MATOW – 185·07
RMATOW – There are no published restrictions for 27L at EGLL
RTOW – 185·07 as it is always the lowest value out of PLTOW, MATOW and RMATOW.

So, what does this tell us? If we weighed 189·04 tonnes, we could theoretically take-off from 27L at the given wind, temperature, pressure, and fuel loading. However, we know that Concorde when operating from the UK had a **MATOW** of 185·07 (in the USA & Canada it was restricted to 182·25 tonnes) and that our flight has an **ATOW** of 184·10, therefore it is perfectly capable of departing from 27L as it is **0·97** tonnes under the **MATOW** of **185·07**.

Back to our flight from Heathrow to Barbados. When we initially extracted the data from the **PLTOW** table we had the following figures:

BRITISH AIRWAYS **CONCORDE** TAKE-OFF DATA — **LONDON HEATHROW**

A/D Elev **80ft** — **FULL LENGTH** RWY **27L**

CLG NIL — **RVR/VIS** 150m — **SLOPE** 0.02%DN

TOR 3658m (12001ft) — **ED** 3658m (12001ft) — **TOD(U)** 3304m (10840ft)

OAT °C	10kt TAIL	Inc /kt	5kt TAIL	Inc /kt	STILL AIR	Inc /kt	10kt HEAD	Inc /kt	20kt HEAD	Inc /kt	30kt HEAD
39	163.1 155/177	0.8	167.2 160/183	0.8	171.3 166/189	0.3	173.9 170/192	0.3	176.5 173/196	0.3	179.1 177/199
36	165.1 154/178	0.8	169.2 160/183	0.8	173.4 166/189	0.3	176.0 169/193	0.3	178.6 173/197	0.3	181.2 177/200
33	166.9 154/178	0.8	171.1 160/184	0.8	175.3 165/190	0.3	178.0 169/194	0.3	180.6 173/198	0.3	183.3 177/201
30	168.8 154/179	0.8	173.0 159/185	0.9	177.3 165/191	0.3	180.0 169/195	0.3	182.7 173/199	0.3	185.4 176/202
27	170.6 154/180	0.8	174.8 159/186	0.9	179.2 165/192	0.3	181.9 169/196	0.3	184.6 172/199	0.3	187.4 176/203
24	172.3 154/181	0.9	176.7 159/187	0.9	181.0 165/193	0.3	183.8 169/196	0.3	186.6 172/200	0.3	189.4 176/204
21	174.0 154/181	0.9	178.4 159/187	0.9	182.8 165/193	0.3	185.7 169/197	0.3	188.5 172/201	0.3	191.3 176/205
18	175.7 154/182	0.9	180.1 159/188	0.9	184.6 165/194	0.3	187.5 169/198	0.3	190.3 172/202	0.3	193.1 176/205
15	177.3 154/183	0.9	181.7 159/188	0.9	186.3 165/194	0.3	189.2 169/198	0.3	192.0 172/202	0.3	194.9 176/206
12	178.6 154/183	0.9	183.1 160/189	0.9	187.6 165/195	0.3	190.6 169/199	0.3	193.4 173/203	0.2	195.0 176/206
9	179.2 155/184	0.9	183.7 160/190	0.9	188.3 166/196	0.3	191.2 170/200	0.3	194.0 174/204	0.1	195.0 176/206
6	179.8 155/185	0.9	184.3 161/191	0.9	188.9 167/197	0.3	191.7 170/201	0.3	194.6 174/205	0.0	195.0 177/207
3	180.4 156/186	0.9	184.9 162/192	0.9	189.4 167/198	0.3	192.3 171/202	0.3	195.0 175/205	0.0	195.0 177/208
0	180.9 157/187	0.9	185.4 162/193	0.9	189.9 168/199	0.3	192.8 172/202	0.2	195.0 176/206	0.0	195.0 178/208
-3	181.4 157/188	0.9	185.9 163/194	0.9	190.4 169/200	0.3	193.2 173/203	0.2	195.0 176/206	0.0	195.0 179/208
V2= θ2=	VR+ 21 13.5		VR+ 21 13.5		VR+ 21 13.0		VR+ 21 13.0		VR+ 21 12.5		VR+ 21 12.5

1. **V1 WET SPEED:** V1 WET is V1 DRY minus 15kt.

2. **Noise Abatement Procedures:** See pages LHR/10, LHR/11, LHR/12 and LHR/13.

V_1 – 165 kts

V_R – 193 kts

Down at the bottom of the column with the red boxes drawn (which is where we acquired our **PLTOW** figures from) we can see that

$V_2 = V_R + 21$

And

$\Theta_2 = 13{\cdot}0$

And if it were a wet departure, we would be subtracting 15 kts from our V_1 speed.

Assuming today it is dry we need to adjust our V_1, V_R, V_2 and Θ_2 figures due to our **ATOW less than PLTOW** figures.

If we had a departure at 53·5% Co. then there would be no Centre of Gravity adjustments to be made, if we were departing below 140,000kg and the C.G. limit is 53% Co then we would need to make some adjustments. I will detail those at the end of this document.

To do the calculation for a 54% Co departure, we need another chart:

ATOW LESS THAN PLTOW

Speed and Screen Pitch Attitude corrections for Take-Off at less than PLTOW -

WEIGHT DIFFERENCE FROM PLTOW TONNES	V_{1D} or V_{1W} CORRECTION KT SUBTRACT	V_R CORRECTION KT SUBTRACT	Θ_2 CORRECTION DEGREES ADD
2	2	1	0.0
4	3	1	0.5
6	5	2	0.5
8	6	2	0.5
10	7	2	0.5

This is the table where our **ATOW less than PLTOW** figure of **4·0** comes into play as we now need to get our final take off speeds and Θ_2 figures.

As you can see from the table our figure of **4·0** means we have to **SUBTRACT 3 kts** from our V_1 figure **1 kt** from our V_R figure and **ADD 0·5** to our Θ_2 figure.

But what about correction to V_2? For that we need another chart:

ATOW LESS THAN PLTOW (cont)

V_2 Screen Speed corrections for actual Take-Off weights less than PLTOW -

PLTOW V_2(KT)	SUBTRACT V_2 CORRECTION (KT) ACTUAL T.O.W. (1000 KG)														
	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180 & ABOVE
232	37	35	33	30	28	25	23	20	17	15	12	9	7	4	0
230	35	33	31	28	26	23	21	18	15	13	10	7	5	2	0
228	33	31	29	26	24	21	19	16	13	11	8	5	3	0	
226	31	29	27	24	22	19	17	14	11	9	6	3	1	0	
224	29	27	25	22	20	17	15	12	9	7	4	1	0		
222	27	25	23	20	18	15	13	10	7	5	2	0	0		
220	25	23	21	18	16	13	11	8	5	3	0	0			
218	23	21	19	16	14	11	9	6	3	1	0				
216	21	19	17	14	12	9	7	4	1	0					
214	19	17	15	12	10	7	5	2	0	0					

This chart deals purely with corrections to V_2 and as you know, our original PLTOW V_2 figure was **214.**

Following this figure across to our actual take-off weight of **184·10** you can see that no alteration needs to be made to our published V_2 figure.

Finally, we can now come up with our final corrected take off figures for Heathrow 27L and our flight to Barbados given the **ATOW** we were supplied with and the corrections we have had to make to the original published figures:

V_1 – 165 kts minus 3 kts = **162 kts**
V_R – 193 kts minus 1 kt = **192 kts**
V_2 – 214 kts and no correction = **214 kts**
Θ_2 – 13·0 degrees plus 0·5 degrees = **13·5°**

One final thing to remember, our **MINIMUM ALLOWED V_1** is **132 kts, V_R** is **139 kts** and our **MAXIMUM allowed Θ_2** is **18°** so our final figures can never be outside of these values.

Earlier I mentioned that there were also corrections to be made for 53% Co., this is what the Performance Manual says on the subject:

For Take-Off at weights below **140,000kg** the aft C.G. limit is 53% Co to avoid spurious M/CG warnings.

In this situation, the following procedure should be followed: -

a. Obtain PLTOW and Take-Off speeds as normal.
b. Reduce the PLTOW by the penalty shown below. Limit actual TOW to this value or MATOW, whichever is lower.

c. If the actual TOW is less than the value obtained in b. the difference between the PLTOW **before** the reduction was applied and the actual TOW must be used to determine the "actual TOW less than PLTOW" Take-Off speed and Θ_2 corrections.

MAXIMUM TAKE-OFF WEIGHT CORRECTIONS - TONNES FOR TAKE-OFF AT 53% Co TOCG.

MTOW (1000kg) TONNES	0	2	4	6	8
	DECREMENT – TONNES				
180	3.6	3.6	3.7	3.7	3.8
170	3.4	3.4	3.5	3.5	3.6
160	3.2	3.2	3.3	3.3	3.4
150	3.0	3.0	3.1	3.1	3.2
140	2.8	2.8	2.9	2.9	3.0
130	2.6	2.6	2.7	2.7	2.8
120	2.4	2.4	2.5	2.5	2.6
110	2.3	2.2	2.3	2.3	2.4

I should of course add a disclaimer here and say that all the above is my interpretation of the actual Performance Manuals, and that I do not have first-hand knowledge of how the data was applied but this document is a result of many hours of reading.

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Appendices

PLTOW Correction Reference	Table Used	Printed Table Location
Pressure Altitude	Correction to Maximum Take-Off Weight	Performance Manual Part 1 Section 1.3.3
Centre of Gravity Correction	Correction for 54% Co.	Performance Manual Part 1 Section 1.3.4
ATOW less than PLTOW	V_1, V_R and Θ_2 corrections	Performance Manual Part 1 Section 1.3.5
ATOW less than PLTOW	V_2 corrections	Performance Manual Part 1 Section 1.3.6
Centre of Gravity Correction	Correction for 53% Co.	Performance Manual Part 1 Section 1.3.4