**Your assignment is to input the following information from your airliner model and any applicable historical parameters into the Excel spreadsheet ITERATION2.XLS, which is available on Canvas.**

**Each group will submit this Microsoft Word file and the ITERATION2.XLS file via Canvas. All areas highlighted in yellow should have answers provided.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Aircraft Wing** | | **Horizontal Tail** | | **Vertical Tail** | | **Fuselage** | |
| **nz** | **3.5** | **nz** | **3.5** | **nz** | **3.5** | **nz** | **3.5** |
| **WTO** | **181,200 lbs** | **WTO** | **181,200 lbs** | **WTO** | **181,200 lbs** | **WTO** | **181,200 lbs** |
| **S** | **1370. ft2** | **SHT** | **497.3 ft2** | **SVT** | **285.8 ft2** | **Sfuse** | **4,393.2 ft2** |
| **A** | **10.13** | **AHT** | **4.47** | **AVT** | **2.31** | **Lfuse** | **129.5 ft** |
| **t/c** | **0.13** | **bHT** | **47.12 ft** | **t/c** | **0.13** | **(L/D)fuse** | **10.50** |
| **l** | **0.21** | **Fw** | **9.1 ft** | **HHT/HVT** | **0** | **Kdoor** | **1.12** |
| **Lc/4** | **25.00 deg** | **LHT c/4** | **31.02 deg** | **LVT c/4** | **22.85 deg** | **Klg** | **1.12** |
| **Sf** | **822.0 ft2** | **lHT** | **54.0 ft** | **lVT** | **52.4 ft** | **Kws** | **0.3733** |
|  | | **Ky** | **16.2 ft** | **Kz** | **52.5 ft** |  | |
|  | | | | | | | |
| **Main LG** | | **Nose LG** | | **Propulsion** | | **Equipment** | |
| **nz** | **3.5** | **nz** | **3.5** | **Weng** | **6,130 lbs** | **WTO** | **30,804 lbs** |
| **WLND** | **6,623 lbs** | **WLND** | **6,623 lbs** |  | |  | |
| **LMLG** | **3.7 ft** | **LNLG** | **3.7 ft** |  | |  | |
| **Nmw** | **4 wheels** | **Nnw** | **2 wheels** |  | |  | |
| **Nmss** | **2 struts** |  | |  | |  | |

**1. Use the data from the airliner fact sheet and the data from the previous spreadsheets to fill in this table with all of the parameter values (with units!) to calculate the following aircraft component weights utilizing the Statistical Group Weights Method and the Approximate Group Weights Method:**

**It’s important to account for all of the engines on the airliner!!**

**Weng = (weight per engine) x (number of engines)**

**2. Input all of Part 1’s values into the ITERATION2.XLS spreadsheet to calculate all of the aircraft component weights and fill out the data table below.**

**OW % = aircraft’s component weight / resulting Operating Weight \* 100 (expressed as XX.YY%)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Statistical Group Weights Method** | | **Approximate Group Weights Method** | | |
| **Aircraft Component** | **Weight (lb)** | **OW %** | **Factor** | **Weight (lb)** | **OW %** |
| **Wing** | 15,384 | 20.39% | 10 \* S | 13,700 | 15.83% |
| **+ Horizontal Tail** | 1,811 | 2.40% | 5.5 \* SHT | 2,735 | 3.16% |
| **+ Vertical Tail** | 1,289 | 1.71% | 5.5 \* SVT | 1,572 | 1.82% |
| **+ Fuselage** | 17,832 | 23.63% | 5 \* Sfuse | 21,961 | 25.38% |
| **+ Main LG** | 260 | 0.34% | 0.85\*0.043\*WTO | 6,623 | 7.65% |
| **+ Nose LG** | 110 | 0.15% | 0.15\*0.043\*WTO | 1,169 | 1.35% |
| **+ Propulsion** | 7,969 | 10.56% | 1.3 \* Weng | 7,969 | 9.21% |
| **+ Equipment** | 30,804 | 40.82% | 0.17 \* WTO | 30,804 | 35.60% |
| **= Operating Weight** | 75,459 | 100.00% |  | 86,533 | 100.00% |

**Airliner data sheet Operating Weight Empty (lb):** 99,360 lbs

**How do the two weight estimation methods compare to the Operating Weight Empty value provided by the airliner data sheet? Can you think of any reasons why they would be different for your airliner?**  
 Both methods estimated the operating weight to be at least 10,000 lbs lighter than the weight from the Max-8’s data sheet. This difference could be attributed to a few factors. First, there is a large disparity between the statistical and approximate method landing gear weights, the statistical method seems to be more accurate since it takes into account each component of the gear. I expect that there may be hydraulic systems and other parts that were not included within the equipment systems weight or the landing gear/fuselage weights. Additionally, the seats, cabin details, instruments, safety features, and other internal components of the plane that are not accounted for specifically within our calculation that likely has a larger contribution than the equations assume.

**3. The ITERATION2.XLS spreadsheet has most of the necessary data to calculate the wetted areas for the major aircraft components. Enter that data into the table below. Refer to your airliner’s data sheet for the engine diameter and engine length values.**

|  |  |  |
| --- | --- | --- |
| **Aircraft Component** | **Wetted Area (ft2)** | **Wetted Area %** |
| **Wing** | 2,394.2 | 25.26% |
| **+ Horizontal Tail** | 1,016.5 | 10.72% |
| **+ Vertical Tail** | 584.2 | 6.16% |
| **+ Fuselage** | 4,392.2 | 46.34% |
| **+ Propulsion** | 1,091.1 | 11.51% |
| **= Total Wetted Area** | 9,478.2 | 100.00% |

**Compare these two values of Swet/Sref:** **Initial Swet/Sref from WINGLOAD = 6.30**

**Divide Total Wetted Area by Sref = 6.92**

**(from the table above)**

**How well do these two Swet/Sref values compare? What are a couple of reasons why they would be different?**

Since Sref is the same for both methods, the larger Swet/Sref from the ITERATION2 spreadsheet implies that it has a larger wetted area. The main reasons this could be the case are the use of trapezoidal wing approximations, the fuselage shape, and some of the approximation equations for wetted areas of the horizontal and vertical tails. When producing trapezoidal wing approximations, the difference in shape from the original likely left more of the wing shape exposed (not inside the fuselage) which would increase the approximated wetted area. Additionally, the vertical and horizontal tail wetted areas are calculated using statical methods which may have overestimated the values. Lastly, when we generated the fuselage shape from the Excel spreadsheet, it had a different shape than the real fuselage from the side view and appeared slightly larger, contributing to a higher Swet.

**4. The ITERATION2.XLS spreadsheet also has all of the necessary data to calculate the Zero-Lift Drag Coefficient for each major aircraft component. Enter that data below:**

|  |  |  |
| --- | --- | --- |
| **Aircraft Component** | **Zero-Lift Drag Coefficient (CD0)** | **CD0 %** |
| **Wing** | 0.0071 | 32.13% |
| **+ Horizontal Tail** | 0.0032 | 14.48% |
| **+ Vertical Tail** | 0.0018 | 8.14% |
| **+ Fuselage** | 0.0100 | 45.25% |
| **= Total CD0** | 0.0221 | 100.00% |

**Compare these two values for CD0:** **Initial CD0 from WINGLOAD: 0.0189**

**Total CD0 from Table: 0.0221**

**How well do these two CD0 values compare? Why could they be different?**

Our calculated CDO is relatively close to the value calculated in WINGLOAD. The value that resulted from WINGLOAD is the product of the Cfe and the ratio of Swet and Sref, this is only an approximation for CD0 since Cfe is chosen based on the type of aircraft. It is not surprising that the values differ due to the vast difference in method of calculation. Our value from the table calculations seems more reliable since it is comprised of the contributions of drag from each major component of the aircraft. Analyzing the percent of CD0 allows us to see that our values are logical, with the fuselage and wing comprising the largest contributions to CD0 while the horizontal and vertical tails combined is still only 2/3 of the wing’s CD0. Lastly, the WINGLOAD CD0 was calculated with an Swet/Sref of 6.30, which is lower than our calculated value. When using the 6.92 that we calculated instead, we find CD0 to be 0.0208, which is much closer to our result from the table above.

**Calculate K (use e = 0.80) and enter your new Parabolic Drag Polar equation below ( CD = CD0 + K CL2 )**

**CD = 0.0221 + 0.0393 CL2**

**Provide a brief description of how each student on this project team contributed to completing this homework assignment:**

Nathan Long – A majority of values in the ITERATION2 spreadsheet and Swet/Sref difference explaination.

Brice Martinelli – Completed a large portion of the word document and aided in clarification of drag polar calculations.

**HOMEWORK CHECKLIST**

**Submit this Word document on Canvas by 11:59 p.m. on the due date. Include the following:**

**- Filled-out tables and answers to the questions in this Word document**

**- Completed ITERATION2.XLS spreadsheet**