Basic 3x4 Wind Tunnel User Reference

Tunnel Limits and Accuracy:
- Lift: 50 lbs ±4% fs
- Drag: 25 lbs ±1.2% fs
- Pitching Moment: 8 ft-lbs ±3% fs
- Angle of Attack (AOA): +22º to -14º ±0.1º
- Dynamic Pressure: 25 psf ±0.05% fs

Tunnel Sign Convention:
- Red arrows indicate positive direction for each component

Tunnel Basic Information:
- 2.9 x 4.2 ft test section
- 7.5 ft long
- 11.66 ft² Test section area

Mount Hole Pattern:

Advice for Designing and Mounting a Model:
- Most models are mounted upside down in the tunnel.
- You may not be able to utilize the entire AOA sweep depending on model length.
- The required method for mounting models is using blind nuts and machine screws. Blind nuts and various lengths of machine screws may be available in the wind tunnel.
- If a customer’s model fails in the tunnel the customer will be barred from the wind tunnel pending formal review of the incident by Dr. Miller.

Using the Data Acquisition Wizard:
- The computer installed in the console is used to acquire data
- Log onto the user account and open Excel
- In the upper left corner click “Start Wizard”
  1. Agree to the disclaimer and then fill out all experimental information, then click “Next”
  2. The next screen allows you to choose what type of test you want to do
     a. Static Tare: The model is mounted and q = 0 (keep the garage door closed) & data taken for planned AOA range.
     b. Dynamic Tare: The model is not mounted and tunnel is running at desired q & data taken for planned AOA range.
     c. Run: The model is mounted and tunnel is running at desired q & for planned AOA range.
  3. Select the test type you want, and then follow the instructions.
  4. The program will then calculate the WOZ (wind off zeros).
  5. Once WOZ has been calculated you can click start to see the forces.
  6. Use the pitch increase switch to increase the speed to your desired q.
7. Then you may perform your AOA sweep collecting data at every AOA.
8. When you are done return to AOA = 0, then click stop, then done.
9. You can collect more data, or quit.
10. When you quit you can save the excel sheet, the program also saves a text file with all the data.
11. Don’t forget to leave with your data from the computer using a flash drive.

Reducing Data; a Refresher:

To get usable information from your wind tunnel test you must reduce the balance data, for each AOA, by removing the static tares \((L'', D'', M'')\), converting to balance coefficients \((C_L'', C_D'', C_M'')\), and removing the dynamic tares \((C_L', C_D', C_M')\). Then the loads will also need to be transferred to the model reference center \((C_L, C_D, C_M)\).

1. Subtract the static tare from the run data:
\[
L'' = L_{RUN} - L_{ST}, \quad D'' = D_{RUN} - D_{ST}, \quad M'' = M_{RUN} - M_{ST}
\]

2. Reduce the forces to coefficients:
\[
C_L'' = \frac{L''}{q_{run} \times S_{ref}}, \quad C_D'' = \frac{D''}{q_{run} \times S_{ref}}, \quad C_M'' = \frac{M''}{q_{run} \times S_{ref} \times c_{ref}}
\]

3. You must also reduce the dynamic tare data to coefficient form, make sure to use the \(q\) that was collected with the dynamic tare.

4. Then subtract the dynamic tare:
\[
L' = L'' - C_L_{L,DT}, \quad D' = D'' - C_D_{D,DT}, \quad M' = M'' - C_M_{M,DT}
\]

5. That is all you need to do for lift and drag, however you must now transfer the moments to your reference location.

6. To transfer the loads is simple:
\[
C_L = C_L', \quad C_D = C_D'
\]

7. The moment transfer equation used will vary depending on what quadrant the model reference center is located in as shown below.

8. The equations, for example, in four locations are:

\[
\begin{align*}
\text{Zone 1: } & \quad C_M = C_M' - x_{ref} C_L' - y_{ref} C_D' \\
\text{Zone 2: } & \quad C_M = C_M' - x_{ref} C_L' + y_{ref} C_D' \\
\text{Zone 3: } & \quad C_M = C_M' + x_{ref} C_L' + y_{ref} C_D' \\
\text{Zone 4: } & \quad C_M = C_M' + x_{ref} C_L' - y_{ref} C_D'
\end{align*}
\]

Some tips for moment transfer:

- Keep in mind that your \(x_{ref}\) and \(y_{ref}\) will vary with every angle of attack.
- The quadrant that your model reference center is in may change during the AOA sweep, so double check the quadrant for every AOA.
- Don’t forget to include the \(x\) and \(y\) offsets on the mount plate.
- Make sure your \(x_{ref}\) and \(y_{ref}\) units are consistent.