

# Lift and Drag of Airfoil NACA 23012 in Small Subsonic Wind Tunnel

AE 245

Laboratory Session #?

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## Abstract

The purpose of experiment is to yada yada yada. (Procedure) A solid aluminum airfoil NACA XXXX is placed in yada yada yada. (Main results) From the experiment, the Stall Angle of Attack and Zero Lift Drag Coefficient are found to be yada yada yada. (Results predictable?) Compare to the published NACA findings, the experiment's results are yada yada yada. (Results fulfill or fall short of purpose?) The results show that yada yada yada. (What can be made of these results?) By knowing the Stall Angle of Attack and the Zero Lift Drag Coefficient, the design of the airfoil could be yada yada yada.

# Preface

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### ***List of Symbols***

<b>Symbol</b>	<b>Name</b>	<b>Units</b>
L	Lift	Pounds (lbs.)
$\rho$	Density	slugs/ft <sup>3</sup>
<i>(list the rest)...</i>		

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<i>(list the rest)...</i>		

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<i>(list the rest)...</i>		

## Introduction

Wind tunnel testing has provided concrete experimental data to help verify and complement theoretically derived data about airfoil, wing, entire aircraft or any of its components. In this particular laboratory session, a NACA XXXX airfoil is placed in the small subsonic wind tunnel. The tunnel will be run at a constant speed while the angle of attack will be changed from  $X^\circ$  to  $Y^\circ$ .

(What was investigated?) The full-scale wind tunnel data of NACA XXXX was yada yada yada (fill in the rest of the history you can find from all sources including the internet). (Reason for investigation) Since its' 1934 published date, the data yada yada yada. And to verify the accuracy of the small subsonic wind tunnel data acquisition system, comparing the old data to the new experiment results will yada yada yada. (Possible application the results have) Appropriate modifications can be yada yada yada.

## Theoretical Considerations

(Identify the variables) For this experiment, only two forces that are acting on the airfoil will be investigated. They are lift and drag. (Define the variables) To find lift and drag, the following equations are used:

$$L = \text{XXXXXXX lbs.} \quad (\text{Ref. Y}) \quad (\text{Eq. Z})$$

$$D = \text{XXXXXXX lbs.} \quad (\text{Ref. Y}) \quad (\text{Eq. Z})$$

(you need to assign numbers to Y and Z)

(How they are related) The density in both the equations above can be calculated by using the Perfect Gas Law. The Perfect Gas Law equation states that:

(insert equation and reference here)

The pressure and temperature values are yada yada yada.

(What makes them significant?) From the laboratory handout, the velocity in the test section is given as:

(insert equation and reference here)

The alcohol level reading is found by reading yada yada yada. To figure out the  $\Delta p$  in the above equation, the test speed alcohol level at the test section should subtract yada yada yada.

## Apparatus and Procedures

(Show that sound procedures are followed so that achieved results would not be in doubt. What are the standard or special apparatus used?) To conduct this experiment, the small subsonic wind tunnel is used. The wind tunnel as seen in Figure 1 below is 540 inches long and has a test section of 21 (height) by 30 inches (width). The wind tunnel has a 3-blade fan powered by a constant rpm (revolutions per minute) electric motor.

(include a figure of the wind tunnel here)

Figure 1: The University of Kansas Aerospace Engineering Department Small Subsonic Wind Tunnel in the basement of Learned Hall.

The test subject – NACA XXXX airfoil – is mounted in the center of the test section. The airfoil measures at *yada yada yada* and it is supported by a stand and pitch control rod. A dial under the test section floor allows the airfoil angle of attack to be changed.

Next to the wind tunnel, there is a voltmeter-amplifier and manometer board filled with blue-dyed alcohol. The voltmeter-amplifier is connected to the pyramidal balance that is located under the test section floor. The balance measures three degree of freedom that detects lift, drag and pitching moment. As for the manometer board, two tubes of alcohol is linked to the inlet static pressure and test section static pressure ports respectively. The two tubes can monitor the differences of the static pressure to approximately indicate the test section velocity.

(What setups are used? List the steps and order the experiment is carried out. How each step is performed) (You copy the handout's Procedure but please remember to reference it.)

## Presentation of Results

(Include sufficient data to honestly illustrate the results. That means all necessary graphs and tables of results. Present all the significant data and only the significant data.)

- Tables should be labeled with Roman numerals and complete descriptive title placed at the top
- Graphs, labeled with Arabic numerals, should have meaningful descriptive title placed at the bottom
- Graph titles should never repeat what the plot axes are
- The graph should use from 50% to 90% of the length and width of the printed page

## Discussion of Results

Discuss the significance of the results comparing to the purpose of the investigation, previous investigations or with predictions based on theory. Make sure you constantly refer to the necessary graph/table when you discuss certain aspect of the data.

Do the results confirm, contradict, or modify the first expectation? In what ways are the results limited?

What further tests are needed? What procedures should be repeated before the results are accepted? What reasons are there to trust the results? How accurate are the results?

What relationships are there among the results from different procedures? What reasons are there for believing that these relationships are significant?

## **Conclusion and Recommendations**

Present the most important conclusions reached based on the interpretation of the test data in a numbered list

Provide at least one conclusion even if the results are unsatisfactory, inconsistent or no results are obtained. List recommendations for future investigations or actions

## References

List in numerical order all published works used in carrying out the investigation and in writing of the report. Make sure you list only references you used in this report. Any extra references or not mentioned in the report will result in deduction of points.

E.g. (do not use these as they are)

1. Brown, Charles, "Why Snoopy is not the Red Baron", Peanuts Publications, Lawrence, KS, 1919, page 110-130.
2. Web link [http://users.acsol.net/~nmasters/External\\_airfoil\\_flaps.htm](http://users.acsol.net/~nmasters/External_airfoil_flaps.htm), External airfoil flaps.

## **Appendix A: Raw Data**

Put raw data, mathematical derivation, typical or special computations, figure, tables, and graphs that supplement the report in the Appendix

## **Appendix B: Hand Calculations**

Hand calculations of a set of data that has been processed should be shown in the appendix