

ADS V4 User's Manual Part III Airfoil Dataset

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1. Introduction

1.1. The root node Airfoils

The Airfoil dataset is created from the root node Airfoils



Contextual Menu :	
Right click :	
New Airfoil	To create a new Airfoil dataset in the current session
Open Airfoil	To load an Airfoil dataset in the current session
Duplicate Airfoil	To duplicate an Airfoil dataset and load it in the current session

Several Airfoil datasets may be loaded in the same session



The airfoil datasets that will be loaded in the current session



1.2. To Create a new airfoil dataset in the current session

Commands :

Right click : New Airfoil

To create a new Airfoil in the current session

🛧 New Airfo	★ New Airfoil Config ×							
Series								
Section								
Accuracy :		Mach Number :		Reynolds N	umber :			
Step Angle	0.25	0	✓	200 000				
		0.1		400 000				
		0.2		600 000				
		0.3		800 000	~			
		0.4		1 000 000	✓			
				2 000 000	✓			
				4 000 000	✓			
				6 000 000	✓			
				8 000 000	✓			
				10 000 000				
					Ok			

- 1. Enter
 - a) The name of the Airfoil Series (NACA)
 - b) The name of the Airfoil Section (23012)
 - c) Define Airfoil Dataset conditions
 - a. Mach Number
 - b. Reynolds Number
- 2. Click on OK

The New Airfoil is displayed in the TreeView

Notes:

For NACA Airfoils, 4-Digits and 5-Digits, XFoil will automatically generate the coordinates of the airfoil and will compute the aerodynamics characteristics for all combination of the selected Mach Numbers and Reynolds Numbers.

For other Airfoil, the user will need to define the coordinates of the airfoil and then compute with XFoil the aerodynamics characteristics for all selected Mach Numbers and Reynolds Numbers.

XFoil (XFOIL V6.99) may be downloaded from http://web.mit.edu/drela/Public/web/xfoil/

The .exe file (xfoil.exe) must be copied in the folder ADS-Data/Airfoils/XFoil



1.2.1. To Create a new NACA 4/5 digits airfoil dataset

This is done in 3 steps

- **Step 1** Enter NACA to define the Series
- Step 2 Enter 4 or 5 digits to define the Section

🛧 New Airfo	★ New Airfoil Config ×						
Series					NACA		
Section					23013		
Accuracy :		Mach Number :		Reynolds N	umber :		
Step Angle	0.25	0	✓	200 000			
		0.1		400 000			
		0.2		600 000			
		0.3		800 000	✓		
		0.4		1 000 000	✓		
				2 000 000	✓		
				4 000 000	✓		
				6 000 000	✓		
				8 000 000	✓		
				10 000 000			
					Ok		

Step 3 Click on OK to launch XFoil and automatically generate the coordinates of the airfoil and to compute the aerodynamics characteristics for all combination of the selected Mach Numbers and Reynolds Numbers

At the end of the computation XFoil closes, the dataset is automatically saved and the TreeView is automatically updated





1.2.2. To Create a new airfoil dataset (not NACA 4/5 digits)

This is done in 13 steps

- **Step 1** Enter a Name to define the Series (Eppler)
- **Step 2** Enter a Name to define the Section (E169)

🛧 New Airfo	il Config	9			×
Series					Eppler
Section					E169
Accuracy :		Mach Nu	mber :	Reynolds Nu	umber :
Step Angle	0.25	0	\checkmark	200 000	
		0.1		400 000	
		0.2		600 000	
		0.3		800 000	\checkmark
		0.4		1 000 000	\checkmark
				2 000 000	\checkmark
				4 000 000	\checkmark
				6 000 000	\checkmark
				8 000 000	\checkmark
				10 000 000	
					Ok

The TreeView is automatically updated

Step 3Go to the web page UIUC Airfoil Coordinates Database.Most of the airfoils are available on this website





Step 4 Scroll the page to reach the desired file (e169.dat)

<u>F</u> ichier Éditio <u>n</u>	<u>A</u> ffichage <u>H</u> i	storique <u>M</u> arque-pages <u>O</u> utils Aid <u>e</u>	—		I	\times
🛃 UIUC Airfoil 🛛	Data Site	× +				
← → C ⁱ	ŵ	🛿 🖴 https://m-selig.ae.illinois.edu/ads/coord_database.html#E 🗏 🧐% 🛛 🗤 🖾 🕼	=	۹ (9	≡
	<u>A</u> . <u>B</u> . <u>C</u>	. D. E. F. G. H. I. J. K. L. M. N. O. P. Q. R. S. I. U. V. W. X. Y. Z. top	_			^
	e1098.dat e1200.dat e1210.dat e1211.dat e1212.dat e1212.dat e1212.dat e1214.dat e1230.dat e1230.dat e168.dat \ e169.dat \ e174.dat \ e176.dat \ e176.dat \ e176.dat \ e180.dat \ e184.dat \ e186.dat \ e186.dat \ e193.dat \\e193.dat \\e193.dat \	<pre>\Eppler E1098 general aviation airfoil \ e1098.gif\ \\ Eppler E1200 general aviation airfoil \ e1200.gif\ \\ Eppler E1210 general aviation airfoil \ e1210.gif\ \\ Eppler E1211 general aviation airfoil \ e1211.gif\ \\ Eppler E1212 general aviation airfoil \ e1212.gif\ \\ Eppler E1212 general aviation airfoil \ e1213.gif\ \\ Eppler E1213 general aviation airfoil \ e1213.gif\ \\ Eppler E1213 general aviation airfoil \ e1213.gif\ \\ Eppler E1213 general aviation airfoil \ e1213.gif\ \\ Eppler E1230 general aviation airfoil \ e1233.gif\ \\ Eppler E124 general aviation airfoil \ e123.gif\ \\ Eppler E124 general aviation airfoil \ e123.gif\ \\ Eppler E124 general aviation airfoil \ e123.gif\ \\ Eppler E1230 general aviation airfoil \ e123.gif\ \\ Eppler E124 general aviation airfoil \ e123.gif\ \\ Eppler E124 general aviation airfoil \ e124.gif\ \\ Eppler E124 general aviation airfoil \ e123.gif\ \\ Eppler E124 general aviation airfoil \ e124.gif\ \\ Eppler E124 low Reynolds number airfoil \ e124.gif\ \\ Eppler E174 low Reynolds number airfoil \ e124.gif\ \\ Eppler E178 low Reynolds number airfoil \ e127.gif\ \\ Eppler E180 low Reynolds number airfoil \ e132.gif\ \\ Eppler E181 low Reynolds number airfoil \ e132.gif\ \\ Eppler E182 low Reynolds number airfoil \ e182.gif\ \\ Eppler E184 low Reynolds number airfoil \ e184.gif\ \\ Eppler E184 low Reynolds number airfoil \ e184.gif\ \\ Eppler E184 low Reynolds number airfoil \ e132.gif\ \\ Eppler E184 low Reynolds number airfoil \ e133.gif\ \\ Eppler E184 low Reynolds number airfoil \ e193.gif\ \\ Eppler E193 low Reynolds number airfoil \ e193</pre>	ι.			
https://m-selig.ae	illinois.edu/ad	s/coord/e169.dat by Reynolds number airfoil \ e201.aif \ \		_		\checkmark



Step 5 Click on e169.dat to edit the file

E169 (14.	48)
1 00000	0 00000
0 99640	0.00022
0.99598	0.00115
0.96948	0.00290
0.90940	0.00230
0.94/3/	0.00314
0.91970	0.00771
0.88673	0.01081
0.84899	0.01458
0.80708	0.01904
0.76168	0.02416
0.71346	0.02985
0.66316	0.03596
0.61148	0.04231
0.55912	0.04866
0.50675	0.05477
0.45499	0.06036
0.40442	0.06516
0.35555	0.06889
0.30884	0.07127
0.26456	0.07202
0.22289	0.07110
0.18408	0.06858
0.14839	0.06450
0.11605	0.05896
0.08721	0.05212
0.06206	0.04427
0.04085	0.03567
0.02379	0.02657
0.01106	0.01729
0.00290	0.00819
0.00000	0.00000
0.00290	-0.00819
0.01106	-0.01729
0.02379	-0.02657
0.04085	-0.03567
0.06206	-0.04427
0.08721	-0.05212
0.11605	-0.05896
0.14839	-0.06450
0.18408	-0.06858
0.22289	-0.07110
0.26456	-0.07202
0 30884	-0.07127
0.35555	-0.06889
0 40442	-0.06516
0 45499	-0.06036
0.50675	-0.05477
0.55012	-0.04866
0.61149	-0.04000
0.66316	-0.03596
0.00310	-0.02985
0.71340	-0.02416
0.00100	-0 01904
0.84800	-0.01458
0.04039	-0.01081
0.00073	-0.00771
0.91970	-0.00514
0.94/3/	-0.00314
0.90940	-0.00115
0.90590	-0.00113
1 00000	0.00022
T.00000	0.00000



Step 6 Copy/Paste these values in Excel

- 1. On the web page, Ctrl+A + Ctrl+C
- 2. In Excel, Ctrl+V
- 3. In Excel, Remove the first line to keep the numbers only

	А	В	С
1	1.00000	0.00000	
2	0.99640	0.00022	
3	0.98598	0.00115	
4	0.96948	0.00290	
5	0.94737	0.00514	
6	0.91970	0.00771	
7	0.88673	0.01081	
8	0.84899	0.01458	
9	0.80708	0.01904	
10	0.76168	0.02416	
11	0.71346	0.02985	
12	0.66316	0.03596	
13	0.61148	0.04231	
14	0.55912	0.04866	
15	0.50675	0.05477	
16	0.45499	0.06036	
17	0.40442	0.06516	
18	0.35555	0.06889	
19	0.30884	0.07127	
20	0.26456	0.07202	

Step 7 In Excel, Convert the data, to split the selected column of text into multiple columns of numbers

- 1. Select the header of the first column (A)
- 2. On the top menu, select Data, then Text to Columns
- 3. In the Convert Text to Columns Wizard, select Delimited, then press Next.
- 4. Select the **Delimiters** for your data (= **Space**)
- 5. Select Finish.

	А	В	С	D
1		1	0	
2		0.9964	0.00022	
3		0.98598	0.00115	
4		0.96948	0.0029	
5		0.94737	0.00514	
6		0.9197	0.00771	
7		0.88673	0.01081	
8		0.84899	0.01458	
9		0.80708	0.01904	
10		0.76168	0.02416	
11		0.71346	0.02985	
12		0.66316	0.03596	
13		0.61148	0.04231	
14		0.55912	0.04866	
15		0.50675	0.05477	
16		0.45499	0.06036	
17		0.40442	0.06516	
18		0.35555	0.06889	
19		0.30884	0.07127	
20		0 26456	0 07202	



Step 8 In ADS, Load the Airfoil Coordinates table

🛧 ADS - Aircr	aft Design Software		
File Edit View T	Tools Window		
Tree view		Property display	• å ×
Airplanes Chip Engines Airfoils Displer-E16 Airfoil	59 Coordinates	Ż↓	
Aerody	List Geometric Characte	ristics	
Materials	🥭 Open Website: UIUC Air	foil Coordinates Database	
➡ Batteries O Tires	Load Table		
Fuels	Load Graph		
🛧 Airfoil Coordin	ates Eppler-E169		– 🗆 🗙
UPPER	R Surface (%)	LOWER Surface (%)	
1	Y 1	X Y	Sort by X Show Graph Compute

Step 9 In Excel, Select the data relative to the Upper Surface of the airfoil profile (positive values in column C), then **Ctrl+C**

	А	В	С	D
1		1	0	
2		0.9964	0.00022	
3		0.98598	0.00115	
4		0.96948	0.0029	
5		0.94737	0.00514	
6		0.9197	0.00771	
7		0.88673	0.01081	
8		0.84899	0.01458	
9		0.80708	0.01904	
10		0.76168	0.02416	
11		0.71346	0.02985	
12		0.66316	0.03596	
13		0.61148	0.04231	
14		0.55912	0.04866	
15		0.50675	0.05477	
16		0.45499	0.06036	
17		0.40442	0.06516	
18		0.35555	0.06889	
19		0.30884	0.07127	
20		0.26456	0.07202	
21		0.22289	0.0711	
22		0.18408	0.06858	
23		0.14839	0.0645	
24		0.11605	0.05896	
25		0.08721	0.05212	
26		0.06206	0.04427	
27		0.04085	0.03567	
28		0.02379	0.02657	
29		0.01106	0.01729	
30		0.0029	0.00819	
31		0	0	
32		0.0029	-0.00819	



Step 10 Paste these values in ADS

- 1. Select the first row (click on the Row Header (1))
- 2. Ctrl+V



Ai	Airfoil Coordinates Eppler-E169 — 🗆 🗙								
	UPPER Su	urface (%)		LC	WER Su	rface (%)			
	Х	Y			(Y			
1	1	0	\sim	1					
2	0.9964	0.00022	1				_		
3	0.98598	0.00115	1						
4	0.96948	0.0029							
5	0.94737	0.00514	1						
6	0.9197	0.00771							
7	0.88673	0.01081	1						
8	0.84899	0.01458							
9	0.80708	0.01904	1						
10	0.76168	0.02416							
11	0.71346	0.02985							
12	0.66316	0.03596							
13	0.61148	0.04231					г		_
14	0.55912	0.04866						Sort by	X
15	0.50675	0.05477					Γ	Show Gra	ph
16	0.45499	0.06036					L		
17	0.40442	0.06516	\sim					Comput	e



- **Step 11** Repeat Step 9 and Step 10 for the lower surface of the airfoil profile (negative values in Column C)
- **Step 12** Click on Show Graph to display the shape of the airfoil profile. The coordinates will be automatically sorted (increasing order)

Airf	oil Coordinate	s Eppler-E169					_	
UPPER Surface (%)					LOWER S	urface (%)		
	х	Y			x	Y		
1	1	0	$^{\sim}$	1	0	0	^	
2	0.9964	0.00022	1	2	0.0029	-0.00819		
3	0.98598	0.00115	1	3	0.01106	-0.01729		
4	0.96948	0.0029	1	4	0.02379	-0.02657		
5	0.94737	0.00514	1	5	0.04085	-0.03567		
6	0.9197	0.00771	1	6	0.06206	-0.04427		
7	0.88673	0.01081	1	7	0.08721	-0.05212		
8	0.84899	0.01458	1	8	0.11605	-0.05896		
9	0.80708	0.01904	1	9	0.14839	-0.0645		
10	0.76168	0.02416		10	0.18408	-0.06858		
11	0.71346	0.02985	1	11	0.22289	-0.0711	1	
12	0.66316	0.03596	1	12	0.26456	-0.07202	1	
13	0.61148	0.04231	1	13	0.30884	-0.07127		
14	0.55912	0.04866	1	14	0.35555	-0.06889	1	Sort by X
15	0.50675	0.05477	1	15	0.40442	-0.06516	1	Show Graph
16	0.45499	0.06036	1	16	0.45499	-0.06036	1	Sherr Graph
17	0.40442	0.06516		17	0.50675	-0.05477		Compute





Step 13 Click on Compute to launch XFoil and to automatically compute the aerodynamics characteristics for all combination of the selected Mach Numbers and Reynolds Numbers



At the end of the computation XFoil closes, the dataset is automatically saved and the TreeView is automatically updated



1.3. To Load an airfoil dataset in the current session

Commands :								
Right click :								
Open Airfoil	To load an Airfoil in the current session							

🛧 Open Airfoil		—		\times
Series	0007			^
NACA	0008			
NACA *	0009			
	0010			
	0011			
	0012			
	22112			
	23012			
	23015			
	23016			
	23019			\sim
Summary :				
			0	c –

- 1. Select
 - a) Series
 - to filter the list
- 2. Double click on the name of the Airfoil <u>or</u> click on the name then click on OK

The selected Airfoil is displayed in the TreeView



1.4. To duplicate an airfoil dataset and load it in the current session

Commands : Right click : Duplicate Airfoil To duplicate an Airfoil and load it in the current session

🛧 Open Airfoil		-		×
Series Boeing v	737a 737b 737c 737d			
Summary :				
			Ok	:

- 1. Select
 - a) Series
 - to filter the list
- 2. Double click on the name of the Airfoil <u>or</u> click on the name then click on OK

One copy of the selected Airfoil is displayed in the TreeView



2. Description

The structure of the airfoil dataset is well defined. The data are put together according to the subitem to which they belong.

4	<mark>∆</mark> Ai	irfoil	ls
	⊿ [1) N/	ASA-NLF(1)0416
			Airfoil Coordinates
	Þ	>	Aerodynamic Characteristics

Subitems:						
Airfoil Coordinates	Data relative to the geometric characteristics					
Aerodynamic Characteristics	Data relative to the aerodynamic characteristics					

2.1. NASA-NLF(1)0416

Root branch of the current dataset. The header is the concatenation of the Series Name and the Section.

Properties :							
General	Reference	NASA-NLF(1)0416					
	Series	NASA					
	Section	NLF(1)0416					
Fudge Factor	Ср(0)	Fudge Factor to apply on the Minimum Pressure Point on the Upper Surface of the Airfoil @low speed (used to compute the wave drag)					
Commands :							
Right click :							
Right click : Duplicate		To duplicate the current dataset					
Right click : Duplicate Remove		To duplicate the current dataset To remove the current dataset from the current session					
Right click : Duplicate Remove Save		To duplicate the current dataset To remove the current dataset from the current session To save the current dataset					



2.1.1. Airfoil Coordinates

Commands :						
Right click :						
List Geometric Characteristics	To list in the output window the geometric char- acteristics of the airfoil					
Open Website UIUC Airfoil Co- ordinates Database	To open the website UIUC Airfoil Coordinates Da- tabase					
Load Table	To load the Table with Airfoil Coordinates					
Load Graph	To load the Graph with Airfoil Coordinates					

Air	foil Coordinate	es NASA-NLF(1)	0416				-	- 🗆	\times
UPPER Surface (%)					LOWER	Surface (%)			
	х	Y			х	Y		Canthur	v
1	0	0	\sim	1	0	0	$^{\sim}$	Sort by	^
2	0.049	0.403		2	0.073	-0.439		Show Gra	ph
3	0.509	1.446		3	0.709	-1.154			
4	1.393	2.573	\sim	4	1.956	-1.883	\sim	Comput	e

Commands :	
Sort by X	To sort the coordinates by X-ascending
Show Graph	To load the Graph with Airfoil Coordinates
Compute	To Compute with XFoil the aerodynamic characteristics for different Mach Numbers and Reynolds Numbers



Notes:

The aerodynamic characteristics are computed with XFoil.

XFoil (XFOIL V6.99) may be downloaded from http://web.mit.edu/drela/Public/web/xfoil/

The .exe file (xfoil.exe) must be copied in the folder ADS-Data/Airfoils/XFoil



2.1.2. Aerodynamic Characteristics

Commands :							
Right click :							
Add New MN	To Add a new Dataset for a given Mach Number						
List Aerodynamic Characteristics	To list in the output window the aerodynamic characteristics of the airfoil for all Mach Numbers and all Reynolds Numbers						



2.1.2.1. MN

Data relative to one Mach Number

Properties :							
Mach Number	MN	Mach Number of the current Dataset					
Commands :							
Right click :							
Add New RN		To Add a new Dataset for a given Reynolds Number					
Remove MN		To remove the current dataset from the current session					
List Aerodynamic Characteristics		To list in the output window the aerodynamic characteristics of the airfoil for the given Mach Numbers and all Reynolds Numbers					
Load Graph		To load the Graph with Aerodynamic Characteristics for the given Mach Number					





2.1.2.1.1. **RN**

Data relative to one Reynolds Number

Dronortioc .
FIOPEILIES.

Reynolds Number	RN	Reynolds Number of the current Dataset
Aerodynamic Center	Position	Aerodynamic Center Location (% Chord)
Performance Curves	Has Curve Cd(Cl)	Specifies if it has Curve Cd(Cl)
	Has Curve Cd(i)	Specifies if it has Curve Cd(i)
	Has Curve Cl(i)	Specifies if it has Curve Cl(i)
	Has Curve Cl/Cd(i)	Specifies if it has Curve Cl/Cd(i)
	Has Curve Cm(i)	Specifies if it has Curve Cm(i)

Commands :

Right click :	
Remove RN	To remove the current dataset from the current session
List Aerodynamic Characteristics	To list in the output window the aerodynamic characteristics of the airfoil for the given Mach Numbers and the given Reyn- olds Numbers

2.1.2.1.1.1. Cl(i)

Commands :	
Right click :	
Load Table	To load the Table with Airfoil Aerodynamic Characteristics
Load Graph	To load the Graph with Airfoil Aerodynamic Characteristics

2.1.2.1.1.2. Cm(i)

Commands :	
Right click :	
Load Table	To load the Table with Airfoil Aerodynamic Characteristics
Load Graph	To load the Graph with Airfoil Aerodynamic Characteristics



2.1.2.1.1.3. Cd(Cl)

Commands :	
Right click :	
Load Table	To load the Table with Airfoil Aerodynamic Characteristics
Load Graph	To load the Graph with Airfoil Aerodynamic Characteristics

2.1.2.1.1.4. Cd(i)

Commands :	
Right click :	
Load Table	To load the Table with Airfoil Aerodynamic Characteristics
Load Graph	To load the Graph with Airfoil Aerodynamic Characteristics

2.1.2.1.1.5. Cl/Cd(i)

Commands :	
Right click :	
Load Table	To load the Table with Airfoil Aerodynamic Characteristics
Load Graph	To load the Graph with Airfoil Aerodynamic Characteristics