9. Airfoils

9.1 Introduction

The Airfoils menu is used to display or introduce the characteristics of an airfoil, namely:

- its geometric characteristics
- its aerodynamic characteristics

The data can be downloaded from the PCA2000 website or introduced by the user via the PCA2000 interface.

After that, in the PCA2000 analysis and design modules, mentioning the name of the airfoil only will lead to the knowledge of all its geometric and aerodynamic characteristics.

🐓 Airfoil (NACA 66(3))-218)	_ 🗆 🗙
	General Geometric data Aerodynamic data Graph	
	PCA2000	
	Reference :	
	NACA 66(3)-218	
	Series : Development group :	
	NACA 💌 NASA	•
	Airfoil with flap :	
	Ubtained from wind tunnel measurement :	
	General information :	
	Hinge axis location (% chord)	
	Aerodynamic center location 26,0 (% chord)	
	Notes :	
		~
	Close	Save

Figure 9.1 : Generalities



9.2 Table of content

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9.3 Airfoils

9.3.1 Description

To access the Airfoils module, **click** on **[Analysis]** then **[Airfoils]** of the menu bar of the main window. You can also reach it directly by clicking on \mathbb{N} of the vertical toolbar.



Figure 9.2 : Airfoils

You can press on the **F1** key at any time to reach the contextual help



To navigate within the controls of a window, use the **tab key**.

9.3.2 Visualizing the characteristics of a given airfoil

When you open the **Airfoils** menu, all the references related to data files of airfoils stored in the folder **Airfoils** of **PCA2000-Data** are automatically downloaded in the application.

To visualize the characteristics of a given airfoil, **click** on the airfoil's reference that appears in the drop-down list under **References**. All the tabs of the Airfoils window are now accessible.

9.3.2.1 Generalities

The first tab contains the general information related to the selected airfoil.

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	Close	Save

Figure 9.3 : Generalities



9.3.2.2 Geometric data

The second tab contains the geometric information related to the selected airfoil, namely the coordinates of the lower surface and the upper surface.

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100 A	Ge Ge	ometrical data (% chord) :			
		XU	YU	XL	YL	
	1	0,000	0,000	0,000	0,000	
Base Contractor	2	0,382	1,449	0,618	-1,349	
	3	0,617	1,778	0,883	-1,638	
	4	1,096	2,319	1,404	-2,105	
	5	2,319	3,285	2,681	-2,913	
States 12	6	4,796	4,673	5,204	-4,041	
	7	7,288	5,728	7,712	-4,880	
	8	9,788	6,581	10,212	-5,547	
	9	14,801	7,895	15,199	-6,549	
	10	19,822	8,842	20,178	-7,250	
Res /	11	24,850	9,494	25,150	-7,704	
	12	29,880	9,884	30,120	-7,940	
	13	34,911	10,030	35,089	-7,970	
	14	39,943	9,916	40,057	-7,774	
	15	44,973	9,577	45,027	-7,387	-
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Figure 9.4 : Geometric data



9.3.2.3 Aerodynamic data

The third tab contains the aerodynamic information of the selected data set. Each data set corresponds to the combination of a Reynolds number and a trailing edge flap angle position (if the profile is equipped with one).

In order to visualize in a graphic the information contained in a table, **click** directly on the [**Graphic**] tab or **click** on the button placed in the upper left corner in the table.

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	3	-0,8	0,11	-7,2	-0,0399	-0,69	0,01472	
	4	4,0	0,56	-3,3	-0,0456	-0,52	0,01149	
	5	6,0	0,68	-0,7	-0,0494	-0,37	0,00943	
13. 19	6	10,0	1,10	1,3	-0,0555	-0,30	0,00882	
	7	14,8	1,26	2,5	-0,0604	-0,27	0,00847	
1	8	16,6	1,33	3,6	-0,0564	-0,24	0,00779	
1000	9	18,2	1,34	4,5	-0,0466	-0,18	0,00570	
	10	19,6	1,23	6,1	-0,0389	-0,18	0,00505	
1 34	11	20,4	1,08	7,7	-0,0385	-0,17	0,00463	
	12			9,1	-0,0396	-0,14	0,00461	
	13			10,5	-0,0371	-0,13	0,00461	
	14			12,1	-0,0286	-0,02	0,00453	
	15			13,4	-0,0216	0,13	0,00454	-1
	10			14.4	0.0070	0.00	0.00450	<u> </u>
							Close	Save

Figure 9.5 : Aerodynamic data

By default, the graphic displayed corresponds to the lift coefficient curve of the selected data set.



Figure 9.6 : Graphic visualization



To select another data set:

- 1. Open the drawer control by placing the mouse pointer on it
- 2. Choose the information that you wish to visualize.

To visualize the aerodynamic data:

- 1. Select one or several data set that you wish to see displayed (maximum 5 at a time),
- 2. **Choose** the information that you wish to visualize:

cl(i)	Evolution of the lift coefficient in relation with the incidence angle
cm(i)	Evolution of the moment coefficient measured at the aerodynamic center posi- tion in relation with the incidence angle
cmh(i)	Evolution of the moment coefficient measured at the control surface axis posi- tion (if the profile is equipped with one) in relation with the incidence angle
cd(cl)	Evolution of the drag coefficient in relation with the lift coefficient

3. The display is done automatically.



Figure 9.7 : Visualization of the aerodynamic data

The drawer control closes automatically once you move the mouse pointer away.

-**X**-

%

Once you move the mouse pointer over the graphic, the coordinates of the pointer's position are displayed in the two areas located at the bottom of the graphic.



The graphic legend can be moved around thanks to the mouse (left button) by clicking on it and by keeping the button pressed until the desired place is reached.

:

Use the **arrows** $\leftarrow \rightarrow \uparrow \checkmark$ of the keyboard to move the mouse pointer precisely around.



Figure 9.8 : Visualization of the aerodynamic data

In order to visualize other information:

- 1. Open the drawer control,
- 2. Choose the information that you wish to display
- 3. Close the box.



Visualizing the geometric data of the profile:

- 1. **Open** the drawer control,
- 2. Click on the button,
- 3. **Close** the drawer control.

-**X**-

Once you move the mouse pointer away, the drawer control closes automatically.

:

The graphic legend can be moved around thanks to the mouse (left button) by clicking on it and by keeping the button pressed until the desired place is reached.

-**X**

Use the **arrows** $\leftarrow \rightarrow \uparrow \checkmark$ of the keyboard to move the mouse pointer precisely around.







9.3.3 Inserting the characteristics of a new airfoil

In order to introduce the characteristics of a new airfoil in the database,

1. **Click** on [**File**] then [**New**] of the menu bar of the main window.

The Airfoils module is reset.

- 2. **Insert** the name of the new airfoil
- 3. Click on Next>.



Figure 9.10 : Definition of the airfoil reference



9.3.3.1 Definition of the general information

Introduce the general information related to the new airfoil

🐓 Airfoil (New Airfo	il)	_ 🗆 🗙
J- Airfoil (New Airfo	iii) General Geometric data Aerodynamic data Graph PCA2000 Reference : Image: Series : Development group : NACA Image: Series : Development group : Image: Series : NACA Image: Series : Development group : Image: Series : Image: Airfoil with flap : Image: Series : Development : General information : Image: Series : Image: Series : Hinge axis location Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : Image: Series : <th></th>	
	Close	Save

Figure 9.11 : Generalities

9.3.3.2 Definition of the geometric characteristics.

Insert its geometric characteristic.

🐓 Airfoil (New Airfo	il)					_ 🗆 🗙
	General	Geometric data	Aerodynamic dat	ta Graph		
	F PCA20	00	•			
	<u> </u>	Geometrical dat	a (% chord) :			
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	3					
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	13					
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				Clo	ise	Save

Figure 9.12 : Geometric information



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Click with the mouse left button on the column title or on the line number to select the whole column or the whole line.

Click with the mouse right button, once it is located on the table, to activate the functions **[Cut]**, **[Copy]**, **[Paste]**.

Use these 2 functionalities to fill in the table of values copied from other PCA2000 tables or spreadsheets such as Excel for example. If you proceed in that way, you will considerably speed up the introduction of data and avoid transcription errors.

9.3.3.3 <u>Definition of the aerodynamic characteristics</u>

In order to add a new data set:

1. Click on Create New .

The area located right at the bottom of the control button is now accessible.



Figure 9.13 : Creation of a new data set

- 2. Select the Reynolds number that corresponds to the new data set and,
- 3. **Select** the trailing edge flap angle position if the airfoil is equipped with one. As a reminder, this characteristic is determined under the tab **Generalities**
- 4. Click on Select .



🐓 Airfoil (New Airfo	oil)				
	General	Geometric d	ata Aero	dynamic data	Graph
Constantine of the	PCA20	00			
	<u></u> _	Re: 300000	10 - Flap a	ngle : 0 *	Data Set
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Sector Constant	13				
	14				
	15				Cancel Select
	101				
					Close Save

The new data set (empty) is displayed in the drop-down list.

Figure 9.14 : Selection of the new data file

5. **Fill in** the table, cell by cell or use the [**copy**] [**paste**] functions taking information from other PCA2000 tables or spreadsheets such as Excel for example.

🐓 Airfoil (New Airfoil)								
G	eneral	Geome	tric data	Aerody	namic data	Graph	1	
L L L L L L L L L L L L L L L L L L L	PCA20	100						
	~	Re : 300	00000 -	Flap an	gle : 0 *			\bigcirc
		i	cl	i	cm	r cl	cd	
	1	-12,3	-0,91					
	2	-8,4	-0,60					
	3	-0,8	0,11					
	4	4,0	0,56					
	5	6,0	0,68					
	6	10,0	1,10					
	7	14,8	1,26					
	8	16,6	1,33					
	9	18,2	1,34					
	10	19,6	1,23					
	11	20,4	1,08					
	12							
All and All	13							
	14							
	15							
							Close	Save

Figure 9.15 : Definition of the new data set

9.3.4 Save the data file of a new profile

In order to save the information related to the new profile in a file, **click** on [**File**] then [**Save as**] of the menu bar of the main window. You can also do it by clicking on **Ii** in the toolbar.

The dialogue box [Save] is displayed on the screen.



The name of the profile will be NameOfTheProfile.arf

The file will be saved automatically in a specific folder according to its series:

- NACA : PCA2000-Data\Airfoils\NACA\NameOfTheProfile
- Eppler : PCA2000-Data\Airfoils\Eppler\NameOfTheProfile
- Wortmann : PCA2000-Data\Airfoils\Wortmann\NameOfTheProfile

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Figure 9.16 : Save the data file