# COMPR Program

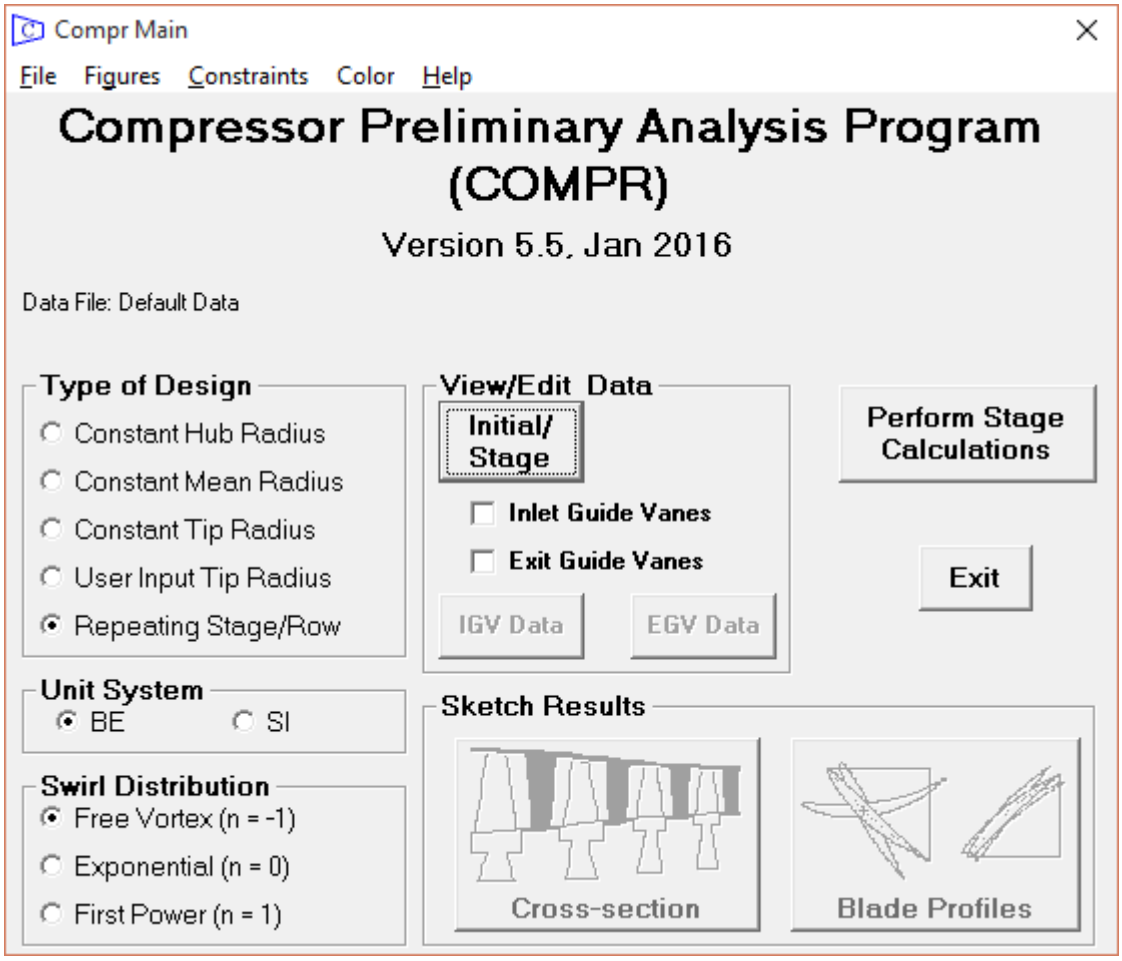
# User Guide

**January 2016**

Table of Contents

# 1. MAIN Window

When the COMPR program is run, the default input data is loaded from within the program and the Main window is displayed as shown below.




The compressor mean-line design program COMPR is based on the equations developed in *Elements of Gas Turbine Propulsion* and *Aircraft Engine Design, Second Edition.* It can analyze the following five different types of mean-line design:

1. Constant hub radius.
2. Constant mean radius.
3. Constant tip radius.
4. User input tip radius.
5. Repeating stage/repeating row.

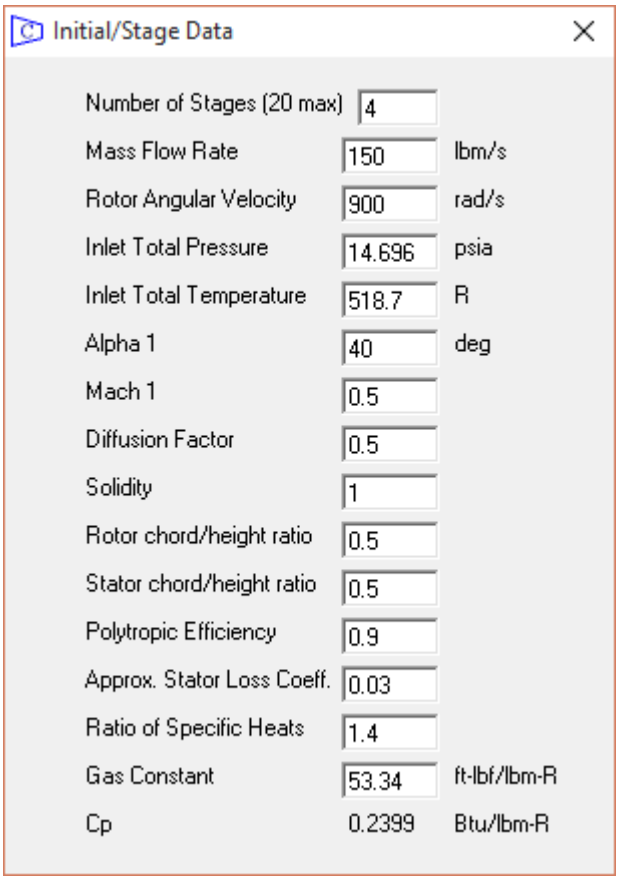
Each of these designs can be analyzed using the user-selected unit system (English or SI) and swirl velocity distribution (three choices: free vortex, exponential, and first power).

This program is designed to be user-friendly and multiple windows are used for program control and data input. COMPR input data files may be saved on disk for later use (the file extension “cmp” is used for these files). Also, saved input data files may be read from disk for current use. Program output is directed to an output window and may be sent to a printer.

It is recommended that a multi-stage compressor design begin with the Repeating Stage/Row type of design. Starting from the results of this design, each stage can be custom designed using the User Input Tip Radius or another type of design.

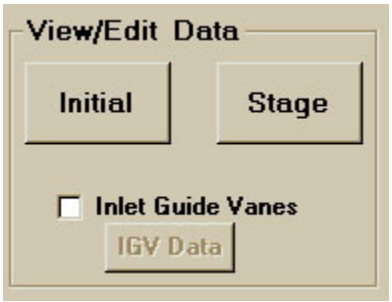
## 2. VIEW/EDIT DATA Windows

For the **Repeating Stage/Row** design, pressing the **Initial/Stage** button on the Main window opens the Initial/Stage Data window for that design as shown below.

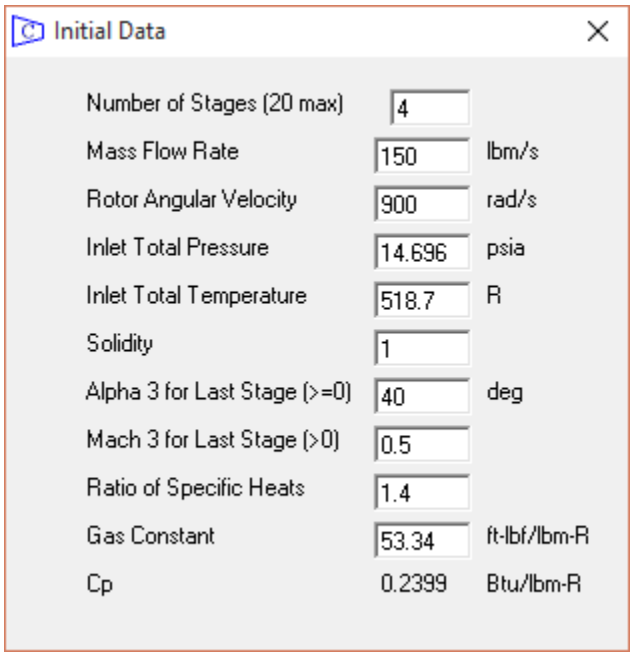



The approximate stator loss coefficient ($\phi_s = \Delta P_t / \{\rho V_2^2 / [2 g_c]\}$) allocates the stage total pressure loss (calculated using the polytropic efficiency) between the stator and rotor.

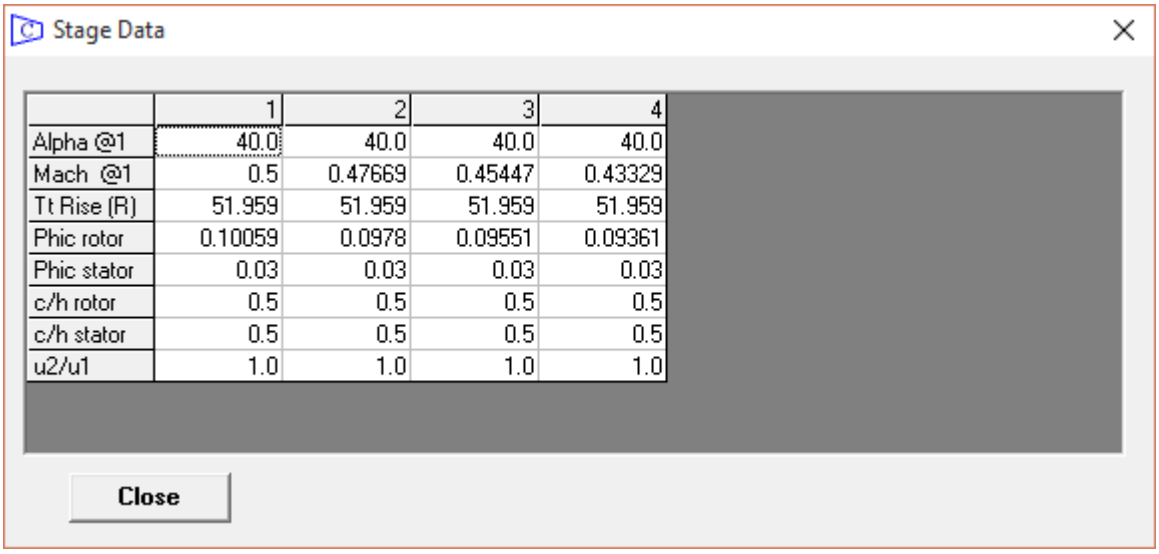
For the other four designs, two buttons for data entry are displayed on the Main window: **Initial** button and **Stage** button (see below).



When the **Initial** data button is pressed, the following Initial Data window is displayed:

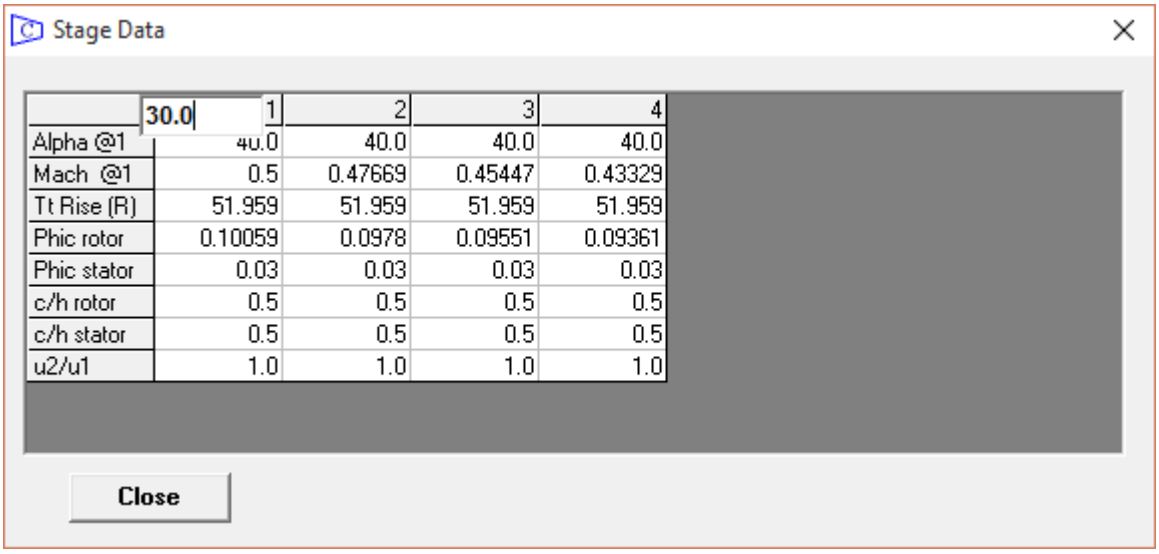



When the **Stage** data button is pressed, the following data window is displayed:

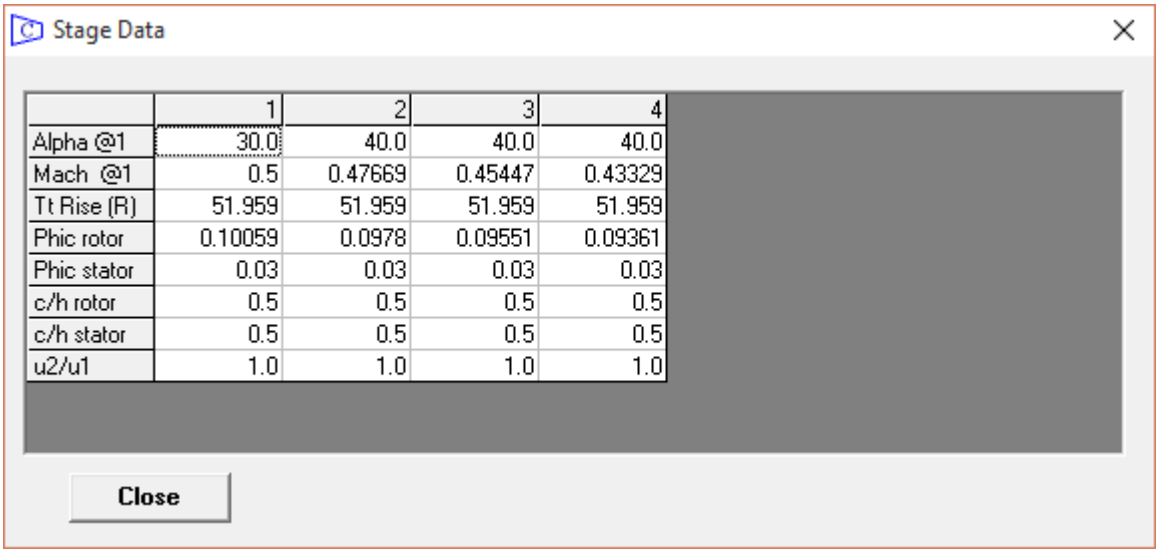



| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Alpha @1 | 40.0 | 40.0 | 40.0 | 40.0 |
| Mach @1 | 0.5 | 0.47669 | 0.45447 | 0.43329 |
| Tt Rise (R) | 51.959 | 51.959 | 51.959 | 51.959 |
| Phic rotor | 0.10059 | 0.0978 | 0.09551 | 0.09361 |
| Phic stator | 0.03 | 0.03 | 0.03 | 0.03 |
| c/h rotor | 0.5 | 0.5 | 0.5 | 0.5 |
| c/h stator | 0.5 | 0.5 | 0.5 | 0.5 |
| u2/u1 | 1.0 | 1.0 | 1.0 | 1.0 |

Data is edited in this window by moving to the desired data cell, double-click on the cell to open an edit window as shown below.

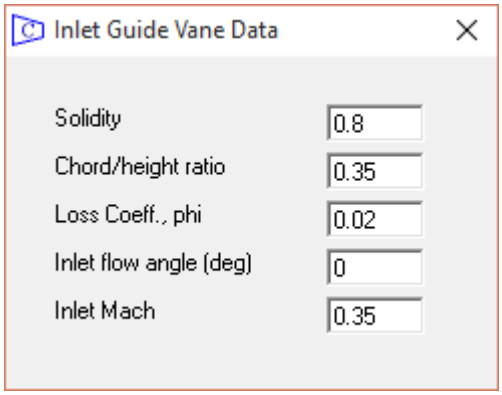



Make the changes and then press either the Enter key or Tab key and the updated window is displayed as shown below.



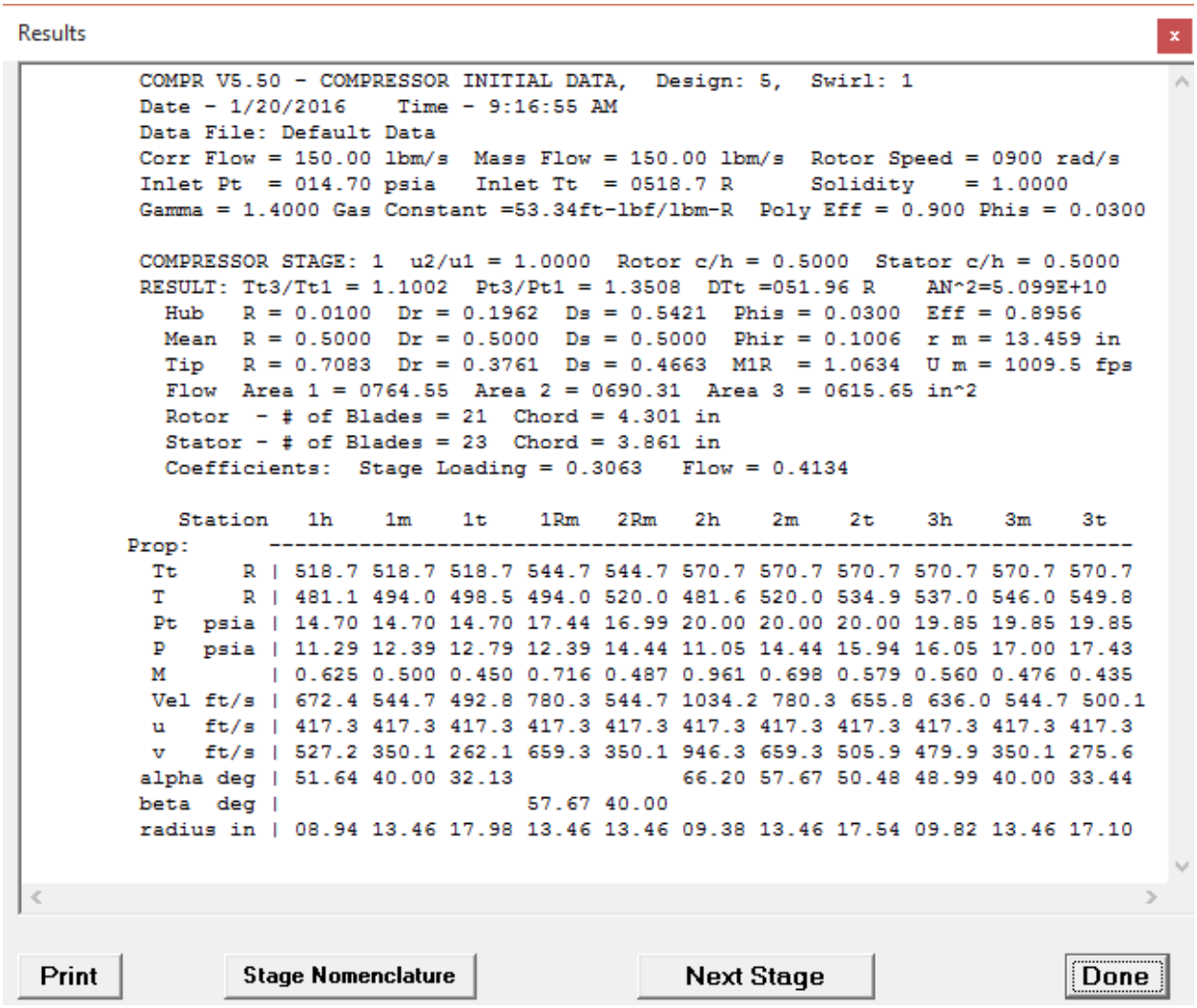

If the Inlet Guide Vane **IGV** check box is marked on the Main window, the **IGV** button becomes active. Pressing the **IGV** button opens the Inlet Guide Vane Data window shown here.

If the Exit Guide Vane EGV check box is marked on the Main window, the **EGV** button becomes active. Pressing the **FGV** button opens the Exit Guide Vane Data window which is similar to that of the IGV.



# 3. RESULTS Window – Perform Calculations

Pressing the **Perform Calculations** button on the Main window causes the Results window to be opened and the input data and results displayed for the first stage (or IGV) as shown below for the first of a four-stage repeating stage/row design using the default data.




If the computer has a default printer, the **Print** button is visible and the user can use it to have the results printed. The **Next Stage** button is active for advancement to the next stage calculations.

The fourth stage results of the four-stage design is shown below.

Results

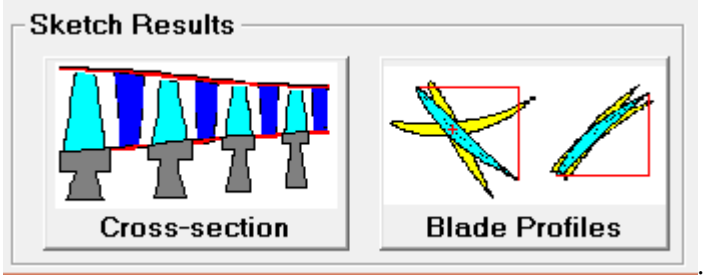
```
COMPR V5.50 - COMPRESSOR INITIAL DATA,  Design: 5,  Swirl: 1
Date - 1/20/2016    Time - 9:17:19 AM
Data File: Default Data
Corr Flow = 150.00 lbm/s  Mass Flow = 150.00 lbm/s  Rotor Speed = 0900 rad/s
Inlet Pt  = 014.70 psia   Inlet Tt  = 0518.7 R      Solidity    = 1.0000
Gamma = 1.4000 Gas Constant =53.34ft-lbf/lbm-R  Poly Eff = 0.900 Phis = 0.0300

COMPRESSOR STAGE: 4  u2/u1 = 1.0000  Rotor c/h = 0.5000  Stator c/h = 0.5000
RESULT: Tt3/Tt1 = 1.0770  Pt3/Pt1 = 1.2633  DTt =051.96 R    AN^2=2.884E+10
  Hub   R = 0.2760  Dr = 0.5182  Ds = 0.5202  Phis = 0.0300  Eff = 0.8966
  Mean  R = 0.5000  Dr = 0.5000  Ds = 0.5000  Phir = 0.0936  r m = 13.459 in
  Tip   R = 0.6368  Dr = 0.4157  Ds = 0.4818  M1R  = 0.7931  U m = 1009.5 fps
  Flow  Area 1 = 0422.26  Area 2 = 0390.51  Area 3 = 0357.56 in^2
  Rotor  - # of Blades = 36  Chord = 2.403 in
  Stator - # of Blades = 39  Chord = 2.211 in
  Coefficients:  Stage Loading = 0.3063   Flow = 0.4134

    Station   1h     1m     1t     1Rm    2Rm    2h     2m     2t     3h     3m     3t
Prop:       ------------------------------------------------------------------------
  Tt      R | 674.6 674.6 674.6 700.6 700.6 726.5 726.5 726.5 726.5 726.5 726.5
  T       R | 644.7 649.9 652.8 649.9 675.9 659.3 675.9 685.7 697.7 701.8 704.4
  Pt   psia | 33.63 33.63 33.63 38.38 37.63 42.74 42.74 42.74 42.48 42.48 42.48
  P    psia | 28.70 29.51 29.98 29.51 33.18 30.43 33.18 34.90 36.86 37.64 38.12
  M         | 0.481 0.436 0.408 0.624 0.427 0.714 0.612 0.546 0.455 0.419 0.396
  Vel ft/s  | 599.1 544.7 511.2 780.3 544.7 898.6 780.3 700.6 588.8 544.7 515.5
  u   ft/s  | 417.3 417.3 417.3 417.3 417.3 417.3 417.3 417.3 417.3 417.3 417.3
  v   ft/s  | 429.9 350.1 295.4 659.3 350.1 795.8 659.3 562.8 415.4 350.1 302.6
 alpha deg  | 45.85 40.00 35.29              62.33 57.67 53.44 44.87 40.00 35.95
 beta  deg  |                       57.67 40.00
 radius in  | 10.96 13.46 15.96 13.46 13.46 11.15 13.46 15.77 11.35 13.46 15.57
```

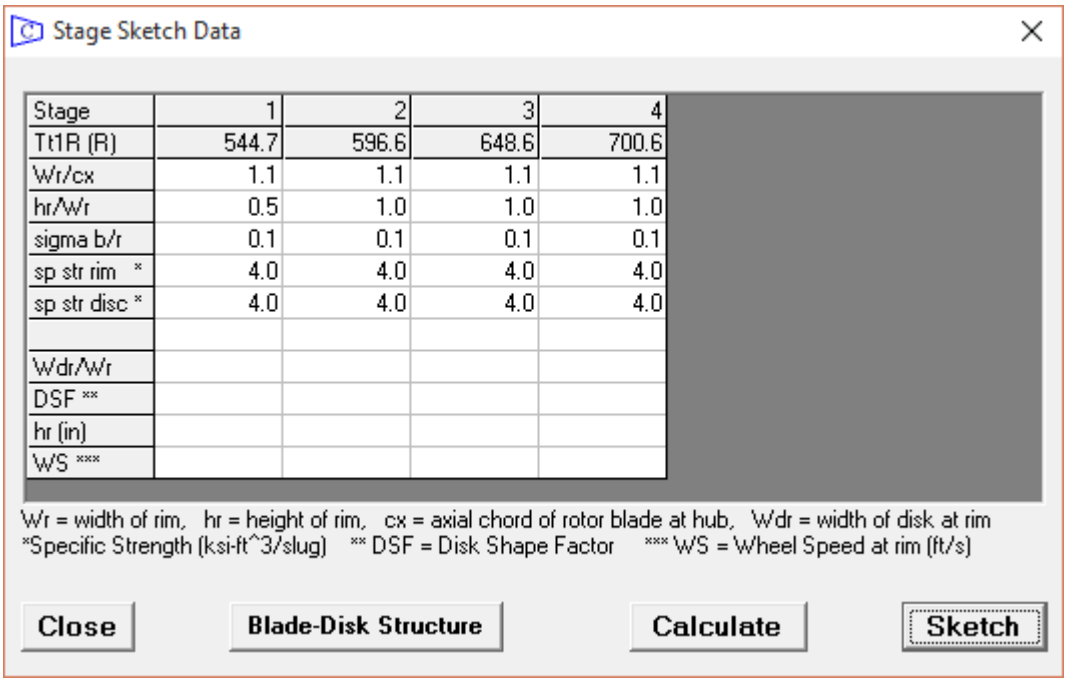
Print | Stage Nomenclature | Next Stage | Done

Pressing the Done button displays the Main window with both Sketch Results buttons active as shown below.

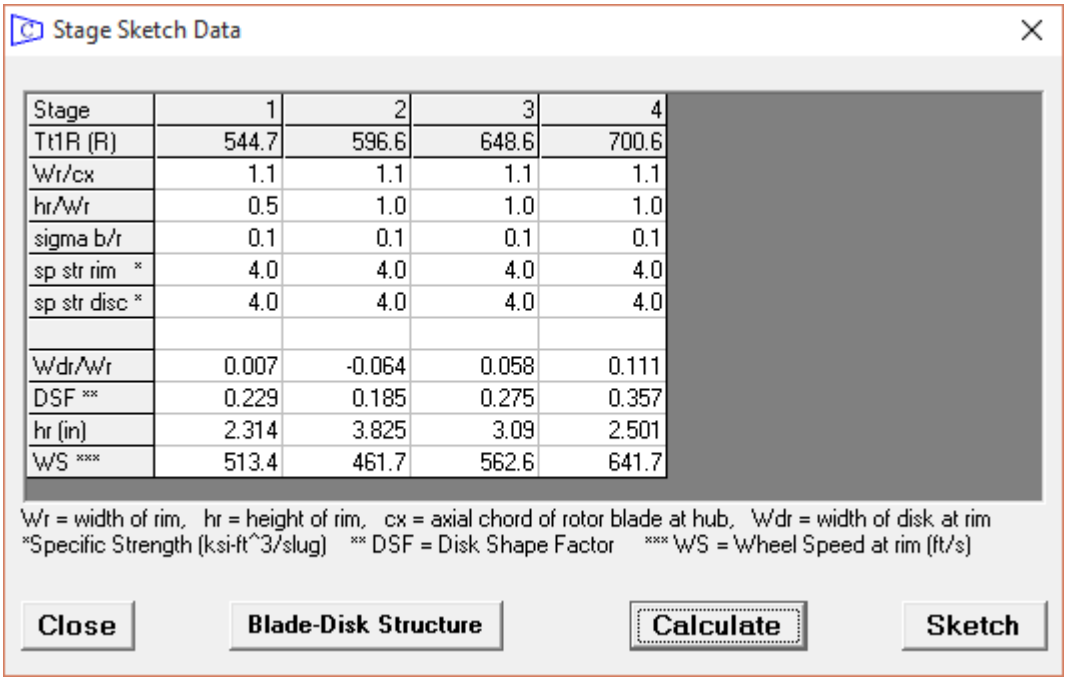


# 4. SKETCH RESULTS Window

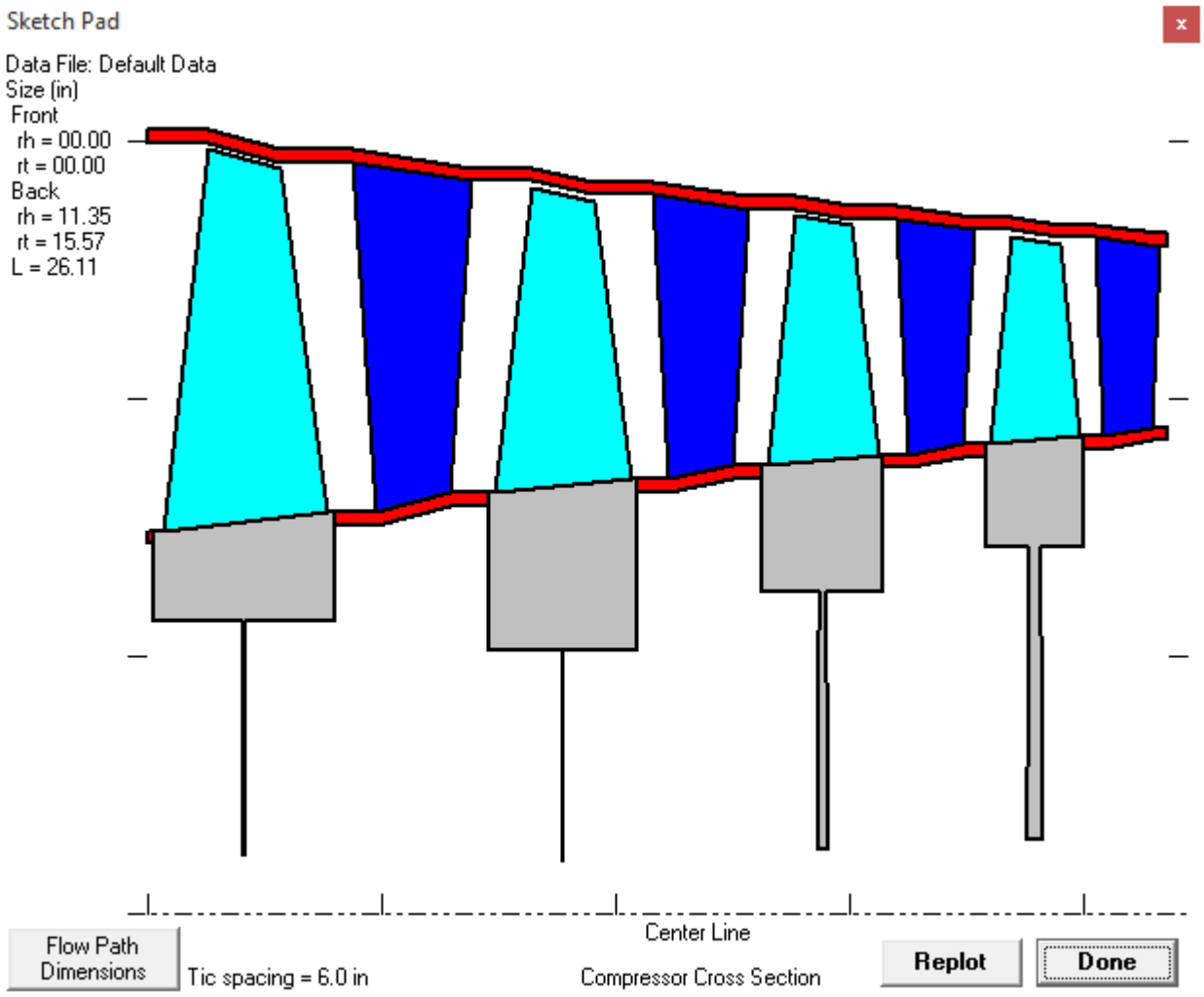
Pressing the **Cross-section** button on the Main window causes the Stage Sketch Data window to be opened and the input data displayed as shown below.



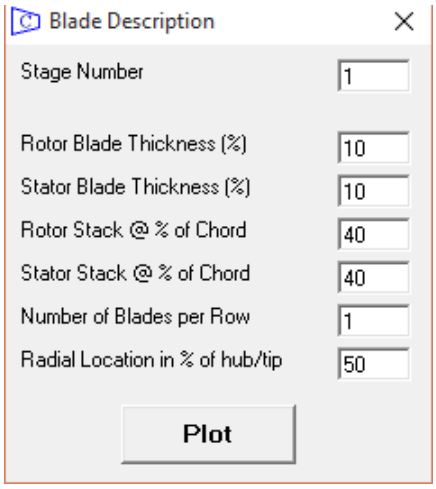

Pressing the **Calculate** button on the Stage Sketch Data window displays the results on an updated window as shown below. If the **Sketch** button is selected before the **Calculate** button, the results are calculated but not displayed



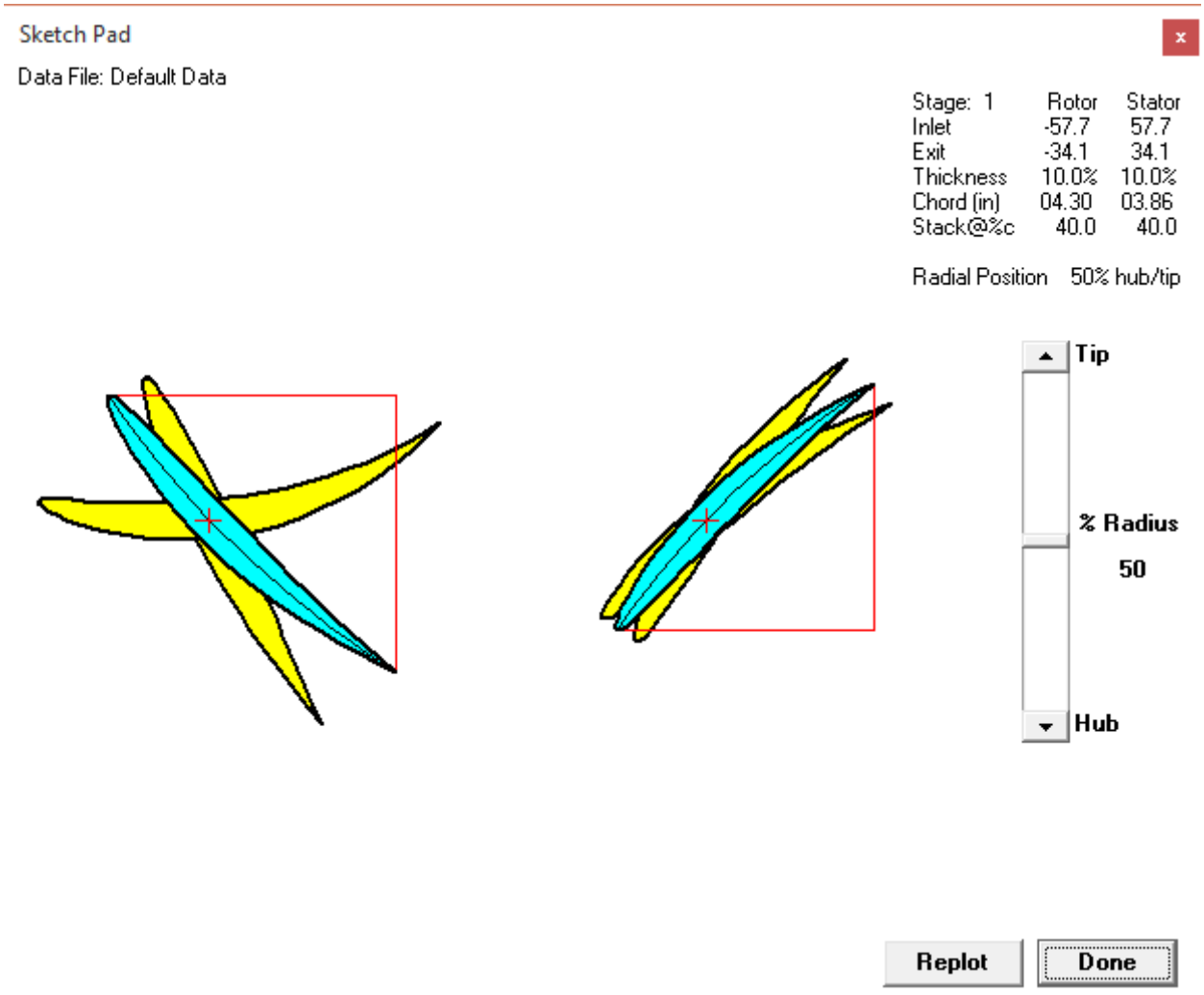
Pressing the **Sketch** button displays the Sketch Pad window with a cross-sectional sketch of the multi-stage axial flow compressor.



Pressing the **Blade Profiles** button on the Main window causes the Blade Description window to be opened and the input data displayed as shown below.




Pressing the **Plot** button for the data above displays the Sketch Pad window with a sketch of the blade shape. The hub and tip blade profiles are shown in yellow and the profile at the radius of interest is shown in light blue. The rotor airfoil is shown on the left and the stator airfoil is shown on the right.



Pressing the **Plot** button for previous data with three blades per row displays the Sketch Pad window as shown below.