INLET Program

User Guide

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# 1. MAIN Window

The INLET conceptual design program analyzes both the design and off-design performance of an external-compression inlet with a series of oblique shocks (from 1 to a maximum of 10) followed by a terminating normal shock. It is based on the equations developed in Chapter 10 of *Aircraft Engine Design, Second Edition.*

This program is designed to be user-friendly and multiple windows are used for program control and data input. INLET input data files may be saved on disk for later use (the file extension "INL" 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.

When the INLET program is run, the Main window is displayed. The top of the Main window is shown below.
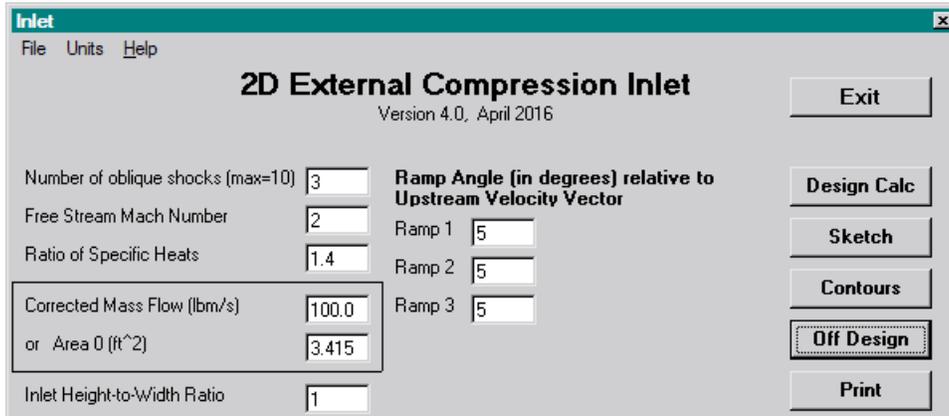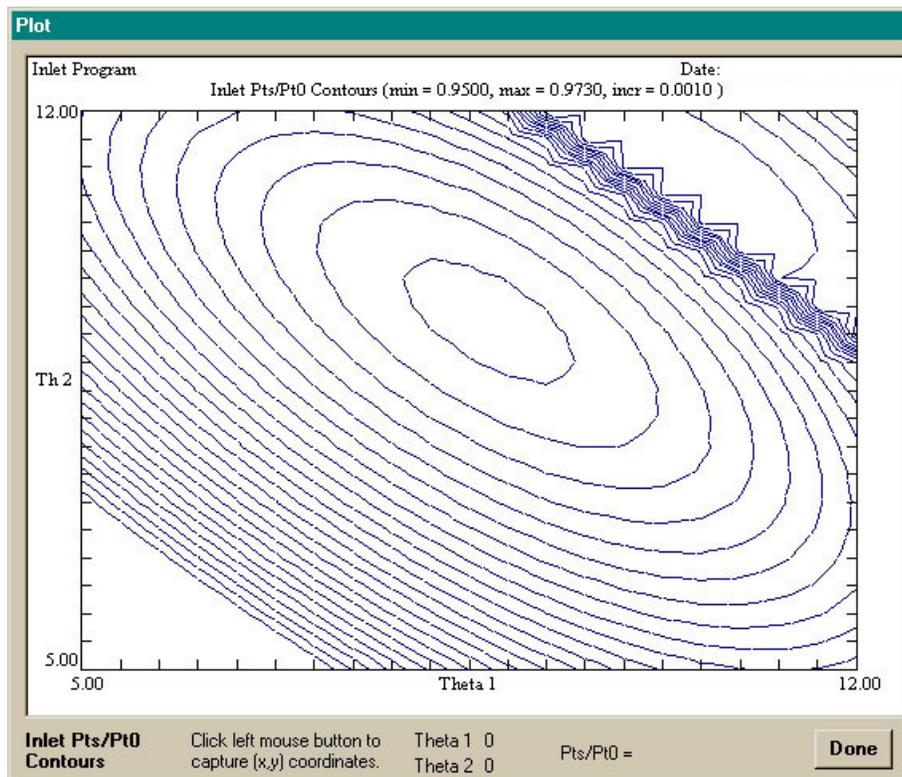

2. Total Pressure Contours

The variation of the inlet total pressure recovery (total pressure ratio of the shock system made up of oblique shocks plus a terminating normal shock) with design ramp angles can be determined and displayed for the user. This information can be used to select ramp angles that yield good design performance. The off-design performance can be determined using the Off Design portion of this program. Pressing the **Contour** button on the Main window displays the Contour Data window as shown below.

From the columns of variables on the left side of the window, the user selects the desired X and Y independent variables and their range of calculation. Pressing the **Calc Pt's** button causes the program to calculate the performance over the range of independent variables and display the minimum and maximum total pressure ratios. The user inputs the Contour Min, Contour Max, and Increment values before selecting the type of plot. Example data has been input (as shown in below) for the plots that follow.

3
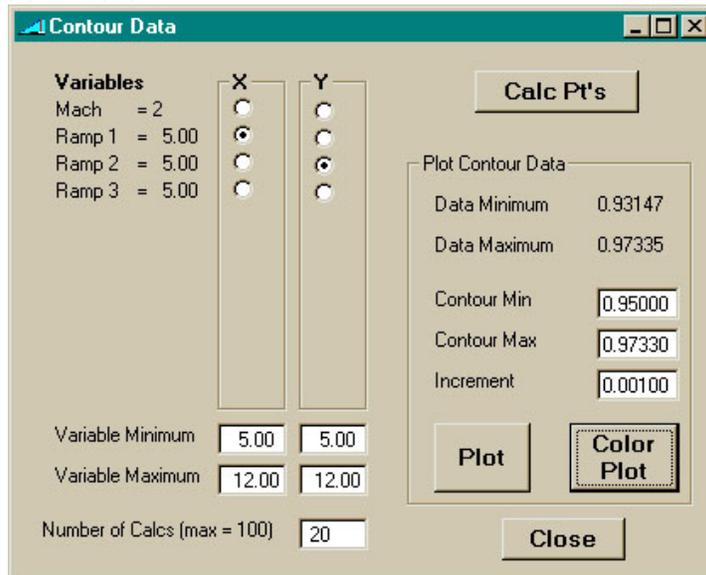
By pressing the **Plot** button, the black and white contour plot is generated and displayed in the Plot window as shown below. When the user moves the mouse across the plot, the arrows becomes a cross-hair. This feature allows the user to capture and display at the bottom of the screen the coordinates and total pressure value by pressing the left mouse button.

Plot

Inlet Program   Date:
Inlet Pts/Pt0 Contours (min = 0.9500, max = 0.9730, incr = 0.0010)

12.00

Th 2

5.00
  5.00   Theta 1   12.00

Inlet Pts/Pt0   Click left mouse button to   Theta 1 0
Contours   capture (x,y) coordinates.   Theta 2 0   Pts/Pt0 =   Done

By pressing the **Color Plot** button, Olectra Chart color contour plot is generated and displayed in the Plot window as shown below.

Contour Plot - Olectra Chart

Inlet Total Pressure Contours
Date:

Pts/Pt0

12
11
10
 9
 8
 7
 6
 5

  5 6 7 8 9 10 11 12
          Theta 1

Theta 2

0.9723 .. 0.9733
0.9713 .. 0.9723
0.9703 .. 0.9713
0.9692 .. 0.9703
0.9682 .. 0.9692
0.9672 .. 0.9682
0.9662 .. 0.9672
0.9652 .. 0.9662
0.9642 .. 0.9652
0.9632 .. 0.9642
0.9622 .. 0.9632
0.9611 .. 0.9622
0.9601 .. 0.9611
0.9591 .. 0.9601
0.9581 .. 0.9591
0.9571 .. 0.9581
0.9561 .. 0.9571
0.9551 .. 0.9561
0.9541 .. 0.9551
0.9530 .. 0.9541
0.9520 .. 0.9530
0.9510 .. 0.9520
0.9500 .. 0.9510

Print   Done

4
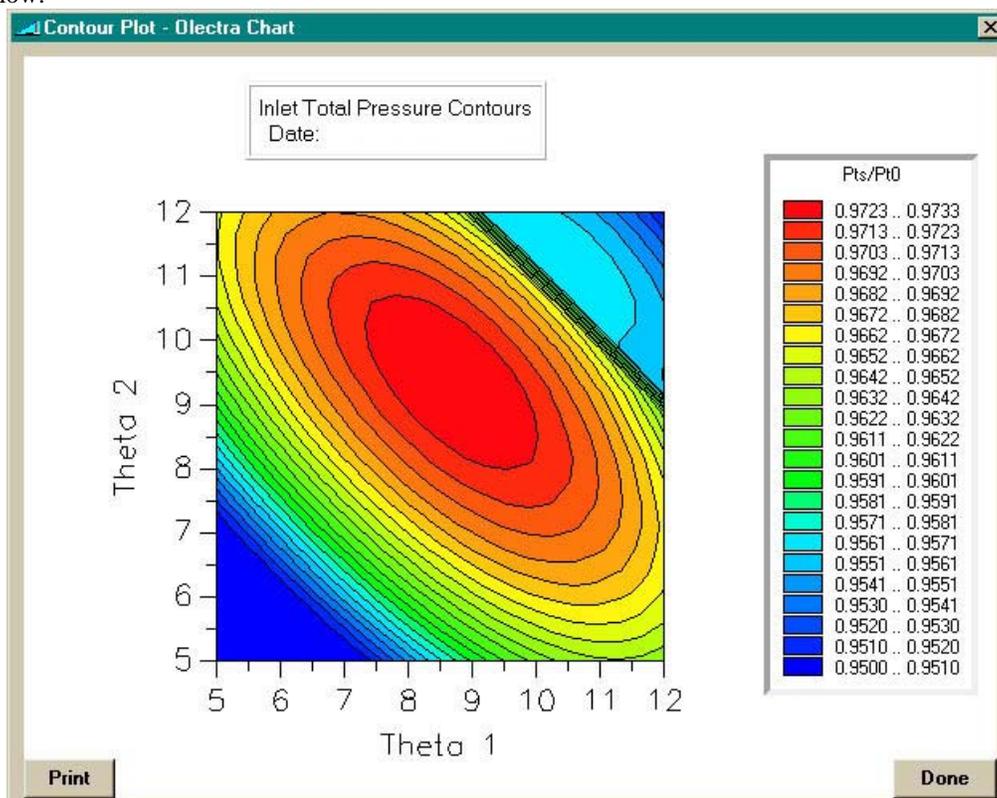
3. Design Calculations

     Pressing the **Design Calc** button displays the results in the bottom text window and the **Sketch**, **Off Design**, and **Print** buttons become visible. Shown below are the results for the default data.


```
File:
Results for Shock #1 - Oblique Shock
Mx    = 2.0000  My   = 1.8213  Theta  =  5.000  Beta  = 34.302
Py/Px = 1.3154  Ty/Tx = 1.0821  Pty/Ptx = 0.9979  Ay/Ax = 0.8684
Results for Shock #2 - Oblique Shock
Mx    = 1.8213  My   = 1.6487  Theta  =  5.000  Beta  = 37.946
Py/Px = 1.2966  Ty/Tx = 1.0776  Pty/Ptx = 0.9982  Ay/Ax = 0.8844
Results for Shock #3 - Oblique Shock
Mx    = 1.6487  My   = 1.4781  Theta  =  5.000  Beta  = 42.537
Py/Px = 1.2828  Ty/Tx = 1.0742  Pty/Ptx = 0.9984  Ay/Ax = 0.9012
Results for Terminal Shock  - Normal Shock
Mx    = 1.4781  My   = 0.7090  Theta  =  0.000  Beta  = 90.000
Py/Px = 2.3824  Ty/Tx = 1.3057  Pty/Ptx = 0.9366  Ay/Ax = 1.0000


Total Change Across Shocks:
M0    = 2.0000  Ms   = 0.7090  Theta  = 15.000
Ps/P0 = 5.2122  Ts/T0 = 1.6356  Pts/Pt0 = 0.9315  As/A0 = 0.6922
m corr =   100.0 lbm/sec          Area0  =   3.415 ft^2
```

4. SKETCH Window

After design calculations have been performed, pressing the **Sketch** button on the Main window opens the Sketch window and displays the shocks of the inlet at the design point as shown below. The ramps are shown in black, the oblique shocks are shown in blue, and the terminating normal shock is shown in red. The overall length to height ratio (*L/H*) of the inlet is given along with other data and results.

Sketch Pad

```
Height  = 22.18 in
Width   = 22.18 in
Length  = 32.51 in
As/A0   = 0.6922
M0      = 2.0000
Ms      = 0.7090
Pts/Pt0 = 0.931
Theta 1 =   5.00
Theta 2 =   5.00
Theta 3 =   5.00
```

Length

Height

Base

Tic Spacing = 6 in

Flip Sketch   Done
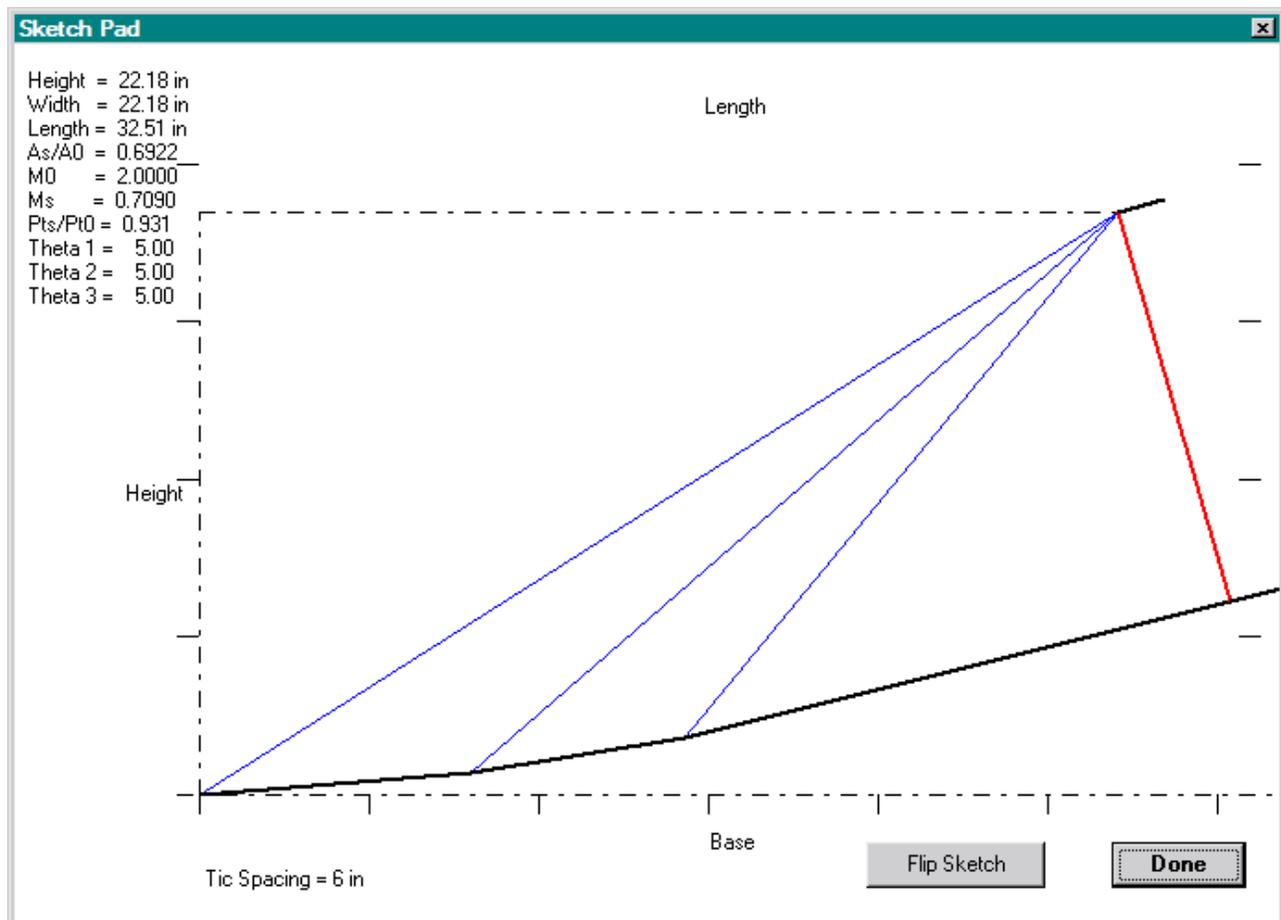
5. Off-Design Performance

Pressing the **Off Design** button on the Main window opens the Off Design Performance window (see below) for that design as shown below. The user can select from fixed ramps or variable ramps. Pressing the **Calculate** button for the fixed ramp input data gives the results displayed below.

```
⚑ Off Design Performance                                          ☒

┌─ Inlet Ramp ────────────────────────────────────┐    Number of    ┌─────────────┐
│  No. of Machs (max=20)          [    10]  ⦿ Fixed Ramp(s)  Calculation │  Calculate  │
│                                                   Mach No.    └─────────────┘
│  Minimum Mach Number            [  1.00]  ○ Variable Ramp(s)  (max=100)   ┌─────────────┐
│                                                               │    Print    │
│  Maximum Mach Number            [  2.00]              [25]     └─────────────┘
└──────────────────────────────────────────────────┘            ┌──────┐ ┌──────┐
                                                                 │ Plot │ │ Plot+│
                                                                 └──────┘ └──────┘
                                                                 ┌─────────────┐
                                                                 │    Done     │
                                                                 └─────────────┘

   M0      Ms       Pts/Pt0    As/A0     As/A1     A0/A1     Theta
 1.0000  1.000000  1.000000  1.000000  0.692182  0.692182   15.00
 1.0400  0.965700  0.999923  0.999772  0.692182  0.692339   15.00
 1.0800  0.931257  0.999431  0.999558  0.692182  0.692488   15.00
 1.1200  0.899988  0.998213  0.999366  0.692182  0.692621   15.00
 1.1600  0.871479  0.996052  0.999194  0.692182  0.692740   15.00
 1.2000  0.845387  0.992798  0.999039  0.692182  0.692847   15.00
 1.2400  0.955349  0.995744  0.964301  0.692182  0.717806   15.00
 1.2800  0.948617  0.997501  0.949607  0.692182  0.728914   15.00
 1.3200  0.901496  0.996434  0.941566  0.692182  0.735139   15.00
 1.3600  0.865577  0.993765  0.934935  0.692182  0.740353   15.00
 1.4000  0.835691  0.989624  0.929049  0.692182  0.745043   15.00
 1.4400  0.980644  0.995789  0.882804  0.692182  0.784071   15.00
 1.4800  0.918452  0.995563  0.868777  0.692182  0.796731   15.00
 1.5200  0.876995  0.993350  0.857530  0.692182  0.807180   15.00
 1.5600  0.844218  0.989524  0.847562  0.692182  0.816674   15.00
 1.6000  0.993836  0.993747  0.804908  0.692182  0.859951   15.00
 1.6400  0.928341  0.994288  0.787063  0.692182  0.879449   15.00
 1.6800  0.883453  0.992504  0.773157  0.692182  0.895267   15.00
 1.7200  0.849182  0.989071  0.760789  0.692182  0.909821   15.00
 1.7600  0.820882  0.984200  0.749398  0.692182  0.923650   15.00
 1.8000  0.796592  0.978033  0.738722  0.692182  0.936998   15.00
 1.8400  0.775249  0.970685  0.728610  0.692182  0.950002   15.00
 1.8800  0.756197  0.962260  0.718962  0.692182  0.962751   15.00
 1.9200  0.738997  0.952855  0.709707  0.692182  0.975306   15.00
 1.9600  0.723334  0.942562  0.700793  0.692182  0.987712   15.00
 2.0000  0.708971  0.931468  0.692180  0.692182  1.000000   15.00
```

Pressing the **Plot+** button generates the Olectra Chart plot of A_0/A_1 and P_{ts}/P_{t0} versus Mach number. The sudden increases in these two results with Mach number are due to the changes of a detached normal shock into oblique shock.

By pressing the **Plot** button, the black and white plot is generated and displayed in the Plot window. When the user moves the mouse across this plot, the arrow becomes a cross-hair. This feature allows the user to capture and display the plot coordinates at the bottom of the screen by pressing the left mouse button.

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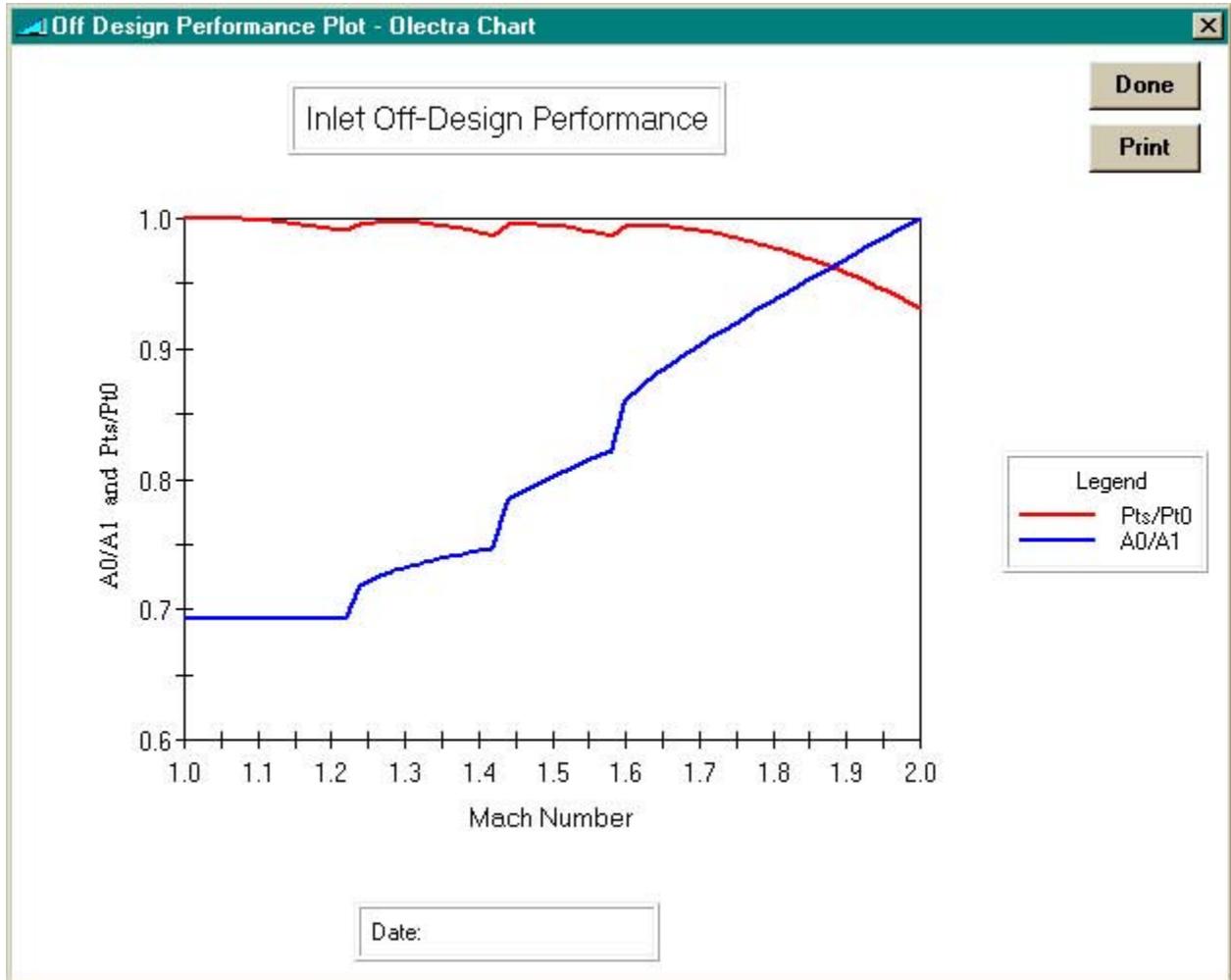
When **Variable Ramp(s)** radio button is selected in the Off Design Performance window, the **Schedule** button becomes visible as shown below.
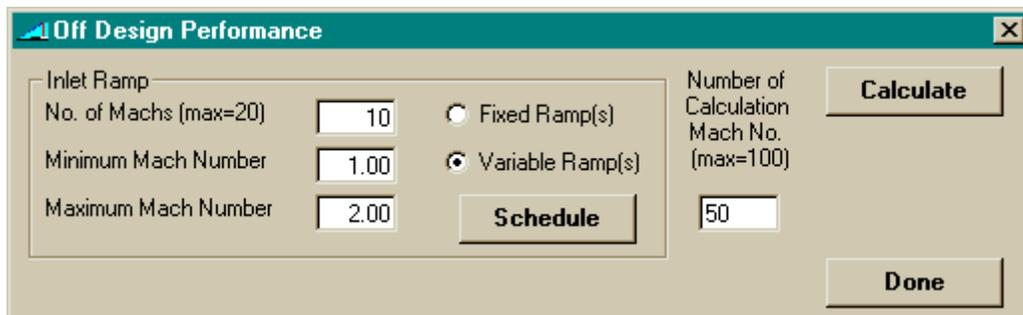
Pressing the **Schedule** button displays an editable ramp schedule that is used for the off-design performance. The number and range of Mach number are based on the user input in the Off Design Performance window.
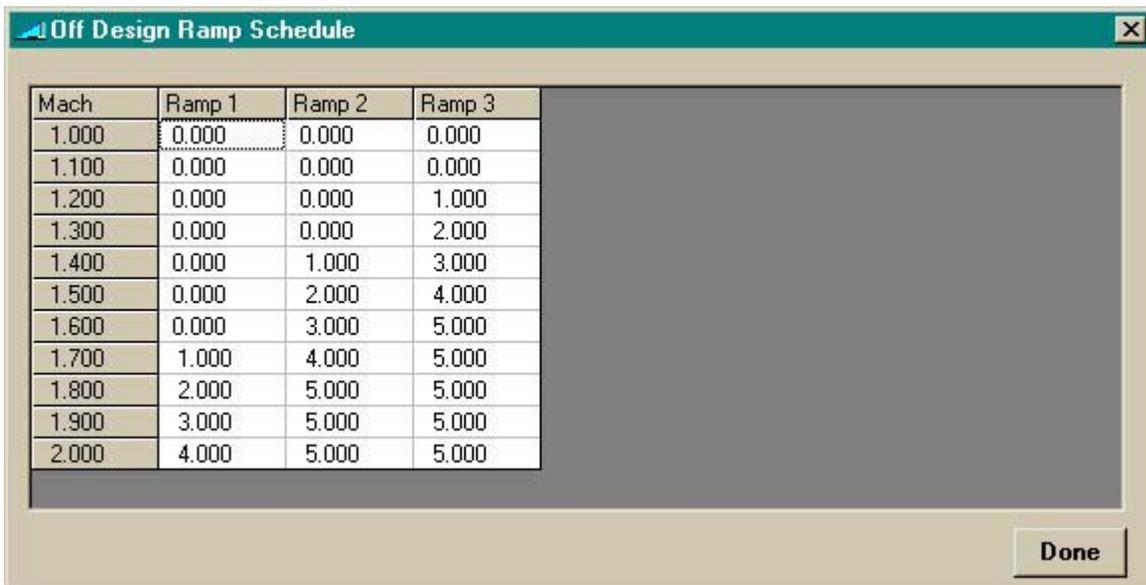
Pressing the **Calculate** button on the Off Design Performance window causes the program to determine the off-design performance of the inlet based on the variable ramp schedule. The results are displayed in the output window as shown below.

```
Off Design Performance                                                    ☒

┌Inlet Ramp─────────────────────────────┐  Number of      ┌─Calculate─┐
│ No. of Machs (max=20)      │  10 │  ○ Fixed Ramp(s)   Calculation
│                                           Mach No.
│ Minimum Mach Number        │ 1.00│  ◉ Variable Ramp(s) (max=100)      Print
│
│ Maximum Mach Number        │ 2.00│     Schedule       │ 50 │     Plot    Plot+
│
└───────────────────────────────────┘                            Done

File: C:\Program Files\AEDsys\Test.INL
  M0     Ms     Pts/Pt0   As/A0    As/A1    A0/A1    Theta
1.0000 1.000000 1.000000 1.000000 1.000000 1.000000  0.00
1.0200 0.980520 0.999990 1.000000 1.000000 1.000000  0.00
1.0400 0.962026 0.999923 1.000000 1.000000 1.000000  0.00
1.0600 0.944445 0.999751 1.000000 1.000000 1.000000  0.00
1.0800 0.927713 0.999431 1.000000 1.000000 1.000000  0.00
1.1000 0.911770 0.998928 1.000000 1.000000 1.000000  0.00
1.1200 0.896563 0.998213 1.000000 0.997606 0.997606  0.20
1.1400 0.882042 0.997261 1.000000 0.995200 0.995200  0.40
1.1600 0.868162 0.996052 1.000000 0.992782 0.992782  0.60
1.1800 0.854884 0.994569 1.000000 0.990351 0.990351  0.80
1.2000 0.842170 0.992798 1.000000 0.987909 0.987908  1.00
1.2200 0.829987 0.990731 1.000000 0.985454 0.985454  1.20
1.2400 0.818301 0.988359 1.000000 0.982988 0.982988  1.40
1.2600 0.807085 0.985677 1.000000 0.980509 0.980509  1.60
1.2800 0.796312 0.982682 1.000000 0.978019 0.978019  1.80
1.3000 0.785957 0.979374 1.000000 0.975516 0.975516  2.00
1.3200 0.775998 0.975752 1.000000 0.969262 0.969262  2.40
1.3400 0.766412 0.971819 1.000000 0.962961 0.962961  2.80
1.3600 0.757181 0.967579 1.000000 0.956614 0.956613  3.20
1.3800 0.748286 0.963035 1.000000 0.950220 0.950220  3.60
1.4000 0.739709 0.958194 1.000000 0.943781 0.943781  4.00
1.4200 0.731436 0.953063 1.000000 0.937296 0.937296  4.40
1.4400 0.723451 0.947648 1.000000 0.930767 0.930767  4.80
1.4600 0.715740 0.941958 1.000000 0.924193 0.924193  5.20
1.4800 0.708290 0.936001 1.000000 0.917574 0.917574  5.60
```

Pressing the **Plot+** button generates the Olectra Chart plot of A_0/A_1 and P_{ts}/P_{t0} versus Mach number. The sudden increases in these two results with Mach 1.6 are due to the change of a detached normal shock into oblique shock.

By pressing the **Plot** button, the black and white plot is generated and displayed in the Plot window. When the user moves the mouse across this plot, the arrow becomes a cross-hair. This feature allows the user to capture and display the plot coordinates at the bottom of the screen by pressing the left mouse button.