An Analysis of Using CFD in Conceptual Aircraft Design

By

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(ABSTRACT)

The evaluation of how Computational Fluid Dynamics (CFD) package may be incorporated into a conceptual design method is performed. The repeatability of the CFD solution as well as the accuracy of the calculated aerodynamic coefficients and pressure distributions was also evaluated on two different wing-body models. The overall run times of three different mesh densities was also evaluated to investigate if the mesh density could be reduced enough so that the computational stage of the CFD cycle may become affordable to use in the conceptual design stage. A farfield method was derived and used in this analysis to calculate the lift and drag coefficients. The CFD solutions were also compared with two methods currently used in conceptual design - the vortex lattice based program Vorview and ACSYNT. The unstructured Euler based CFD package FELISA was used in this study.

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Nomenclature

AR - Wing aspect ratio

ARA - Aircraft Research Association, Bedford, UK

c_p - Specific heat at constant pressure

C_i - Arbitrary constant *i*

C_{Di} - Induced drag coefficient

C_{Dw} - Wave (entropy) drag coefficient

C_D - Total drag coefficient

C_L - Lift coefficient

C_p - Coefficient of pressure

cvX - L2 residuals have decreased by X orders of magnitude

D - Distance mesh spacing becomes twice initial spacing in .bac file

D - Drag

D_i - Lift induced drag

D_w - Wave drag

DRA - Defense Research Agency, Bedford, UK

E - Internal energy

eta - Distance from fuselage centerline to a point divided by wing semi-span

EXP - Experimental Results

F_i - Arbitrary force in direction *i*

h - Enthalpy per unit mass

h_∞ - Freestream enthalpy

H - Stagnation enthalpy

K - Constant used to calculate lift induced drag

P - Pressure

P_∞ - Freestream pressure

q - Magnitude of velocity

R - Gas constant

s	- Entropy per unit mass
s_{∞}	- Freestream entropy
s_{cut}	- Entropy cutoff
s_{max}	- Maximum entropy in cutplane
T	- Temperature
T_{∞}	- Freestream temperature
u	- Velocity in x direction
U_{∞}	- Freestream Velocity
v	- Velocity in y direction
V	- Arbitrary velocity
w	- Velocity in z direction
x, y, z	- Cartesian coordinates
X_C	- Distance from source mesh spacing is held constant in .bac file
Γ_{α}	- Circulation around cell α
Γ_{cut}	- Induced drag cutoff
Γ_{max}	- Maximum circulation in cutplane
δ	– Kronecker delta
δ_1	– Initial mesh spacing in .bac file
ζ	- Vorticity
ρ	- Density
ψ	- Stream function
∇	- Vector differential operator

Chapter 1

Introduction

1.1 Background

Aircraft design begins with the conceptual phase, where possible designs are first imagined and evaluated from initial design requirements. In this phase, the designer has the greatest flexibility in determining the layout and configuration of the aircraft. After the conceptual phase, however, only minor changes to the aircraft configuration may occur. Therefore, it is important to have accurate drag and lift predictions early in the design phase when major configuration changes can occur [15]. The accuracy of these predictions must be balanced, however, with calculation speed. This is needed so many types of configurations can be compared and so size optimization on a selected configuration may occur.

Aerodynamics for conceptual designs is typically based on linear aerodynamic theory, supplemented with empirical data [15]. These methods work well for subsonic flows, where nonlinearities in the flow are negligible, but break down when the nonlinearities become important. For flows that are entirely supersonic there are nonlinear methods that work well for aerodynamic predictions [25]. However, for transonic flows these methods fail because the flow has both subsonic and supersonic areas [25]. The desire for more accurate lift and drag prediction for transonic flows - along with a more detailed analysis of the flow field for all flows types - have resulted in the increased use of computational fluid dynamics (CFD) early in the design stage.

1.2 Issues with CFD Usage in Conceptual Design

1.2.1 Overview

For most designers, the earliest use of CFD is in the preliminary design phase [15]. This can be contributed to the complexity of using CFD methods and the amount of time needed to generate the surface mesh on a CAD model, generate the computational mesh, and run the solution [17].

1.2.2 Surface Generation

Problems with the generating the surface mesh from a CAD geometry include the user having to fill any gaps or discontinuities in the surface and ensuring that the surfaces do not overlap [18]. Programs such as NASA's GridTool allow the user to import a CAD geometry and resolve these problems [19]. For conceptual design, these problems can be reduced by using a CAD package such as NASA's Rapid Aircraft Modeler. RAM was designed to quickly generate and export a conceptual aircraft model into an analysis package [22].

1.2.3 Mesh Generation

For CFD to be useful in conceptual design, the computational mesh must be built automatically. The generation of structured meshes, made of hexahedral blocks, requires extensive user interaction and skill to create an adequate grid [20]. This is because the user must guarantee the orthogonality of the mesh (for proper application of the boundary conditions) and ensure the mesh will capture the behavior of the flow [20]. These problems have led to the development of unstructured meshes - tetrahedral built from surface triangles - for CFD solutions [17].

Unstructured meshes are generated by defining the geometry and areas of interest in the flow field, and then the mesh is created algorithmically [10]. Although this method is not fully automated yet, it does result in quicker mesh generation of complex geometry which can be performed by non-expert users [13]. The main disadvantage to unstructured meshes is the increased time and memory needed for the flow solution [10], [11]. The increase in the flow solution time is overshadowed by the decrease in the mesh generation time - resulting in a faster overall cycle time - while computer memory is becoming less of an issue [10], [12].

1.2.4 Computational Speed

The most realistic flow solutions come from using the Navier-Stokes (NS) equations. The main drawback to using the NS equations are the longer run times for both the mesh generation and flow solution. These increases are partly due to the need to include a thin boundary layer above the surface which captures the viscous effects along the wall. These result in a higher number of points in the mesh - increasing the time it takes to generate the mesh and compute the flow solution.

The Euler equations - which neglect viscosity and heat generation and conduction - significantly reduce the computational time compared to the NS equations. This is because of the simpler flow physics and the absence of the boundary layer. Studies have shown that the Euler equations will have reasonable results for the lift and drag coefficients compared to both experimental and NS solutions for flows that do not experience strong shocks or large amounts of separation [11], [12], [23], [24].

Even using the Euler equations, however, the computational time is much too high for CFD to be used in conceptual design. One researcher found that it could take as long as 90 CPU hours for an unstructured Euler solution of a complete aircraft configuration to be run on a single SGI R10000 processor [12]. Advances in parallel computing and processor speed can reduce these run times, but at a cost of increasing the resources needed to compute the solution. The amount of time needed to generate an adequate solution must be reduced if many different aircraft types and flight conditions are going to be evaluated at a reasonable cost.

1.3 Purpose

The purpose of this work is to evaluate how an unstructured Euler CFD package may be incorporated into a conceptual design method. The repeatability of the CFD solution as well as the accuracy of the calculated aerodynamic coefficients and pressure distributions will be evaluated. The overall run times of three different mesh densities will also be evaluated. If the density of the mesh is reduced enough, the computational stage of the CFD cycle may become affordable to use in the conceptual design phase, but this must be balanced with the solution accuracy. The unstructured Euler based CFD package FELISA [9] was used in this study.

Chapter 2

Methodology

2.1 The FELISA System

FELISA is an unstructured CFD surface and volume mesh generator with a finite element method (FEM) Euler based flow solver. It was created for NASA by J. Perio of Imperial College, J. Peraire of M.I.T. and K. Morgan of University College of Swansea [9]. For this analysis version 2.0 Beta of FELISA was used on a Silicon Graphics Octane workstation running IRIX 6.5.13 with a 195 MHz R10000 processor and 640 MB of RAM.

This SGI Octane has a SPECfp95 rating (which is a measure of the speed the CPU can perform floating point operations) of 17.0. This would convert to an approximate SPECfp2000 rating of 140. It is predicted that the Apple G5 running a 1.6 GHz processor (available in the fall of 2002) will have a SPECfp2000 rating of around 1400. Therefore, the CPU run times given for the SGI in this analysis would be approximately 10 times faster if the analysis was run on the G5.

Starting from a file (.dat) which contains the surface points and surface intersection curves of a CAD model and a file (.bac) which contains the source distribution, the surface triangle mesh is generated by a two dimensional advancing front method. The volume tetrahedrals are then built from this surface mesh by using a three dimensional advancing front method. The flow solver uses a Galerkin FEM and explicit Runge-Kutta (RK) time stepping with added artificial viscosity to march in time to a steady state solution [9]. For this analysis a five step RK method was used with the artificial viscosity added to the first and second RK step.

The boundary condition of no normal velocity is imposed on the walls. Far field boundary conditions are imposed by applying an approximate Riemann problem solution in the direction normal to the far field boundary. The user must supply a file (.bco) with the boundary type of each surface. A control file (.nam) is also used to provide the different algorithmic constraints (CFL number, number of time steps, Mach number, angle of attack, etc.) [9].

2.2 Wing-Body Models

AGARD AR-303 was created to provide researchers with experimental wind tunnel test results to be used for CFD verification [27]. The models chosen for this study - selected from this reference - were the complete W4 wing-body model, studied by J. L. Fulker of DRA [8] (shown in Figure 1), and the M165 delta wing-body (without canard), studied by D. Stanniland of ARA (shown in Figure 2) [21]. Geometric information provided included the wing ordinates and body dimensions. Data was provided for given mach numbers and angles of attack and included the pressure coefficients at selected wing stations, the lift coefficient, and the drag coefficient. An end cap was placed on the M165 model to provide stability in the CFD solution.

Figure 1: W4 Wing-Body

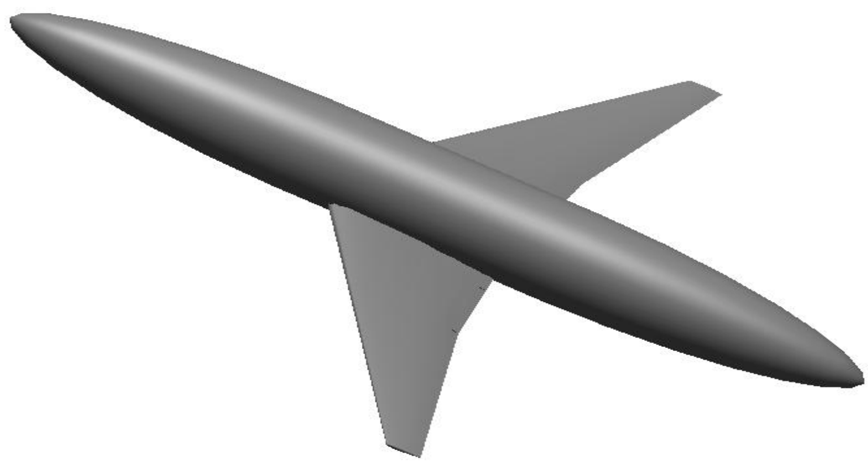
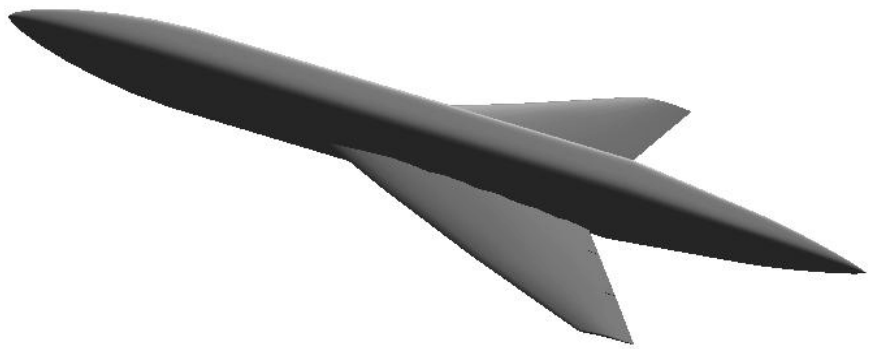


Figure 2: M165 Wing-Body



2.3 Geometry File (.dat) Creation

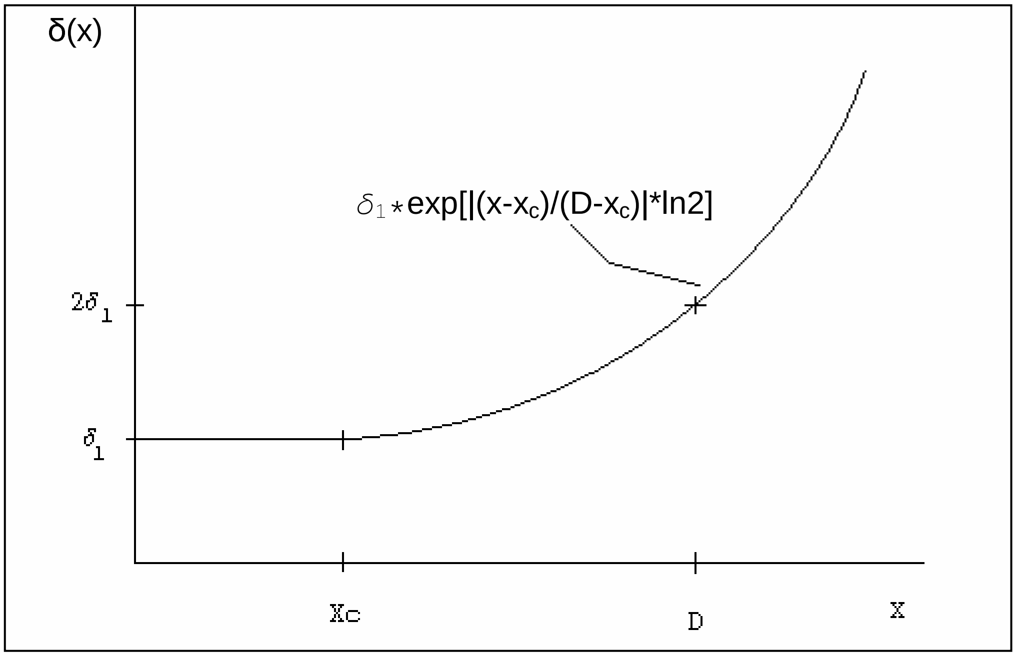
The geometry for each model was generated using NASA's Rapid Aircraft Modeler (RAM) [22]. RAM allows the user to parametrically input fuselage and wing dimensions (aspect ratio, taper ratio, span, etc.) as well as other wing information (wing ordinates, twist, sweep, dihedral, etc.). Once the geometry was created in RAM, it was converted into a FELISA format and the surface mesh was generated. (Note: A program named TOFEL, which is located in the FELISA bin directory, had to be used to extract the surface intersection curves from RAM's FELISA output file and convert this file to the .dat format.)

2.4 Source Distribution (.bac) Files

2.4.1 Source Description

Three types of sources are used to define the surface and volume mesh densities - the point source, the line source and the triangle source [9]. These sources are defined by their Cartesian coordinates, the initial mesh spacing (δ_1), the distance from the source the initial mesh spacing is held constant (x_c), and the distance from the source the mesh spacing becomes twice the initial mesh spacing (D). The mesh spacing is controlled by an exponential function for distances greater than x_c. When a triangle source is used, the spacing inside the triangle is held to δ_1 and is controlled by the exponential function outside the triangle. The remainder of the volume mesh is controlled by background spacing where only δ_1 is specified.

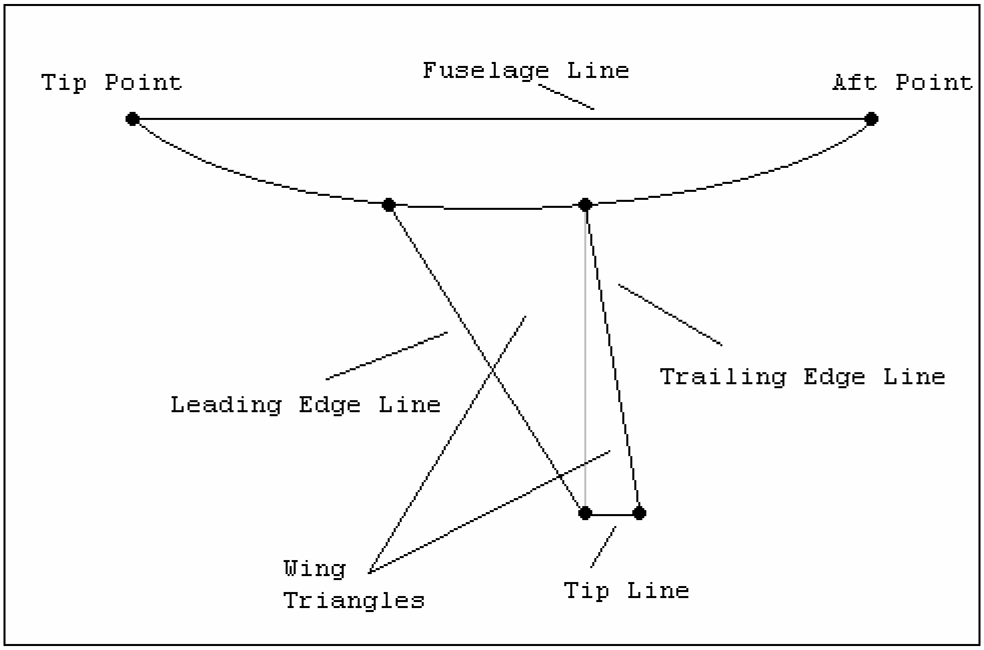
Figure 3: Source Spacing



2.4.2 Source Distributions for Wing-Bodies

The meshes used in this analysis were based on the example wing-body model (case) in the FELISA Users Manual [9]. The coarsest mesh used is similar to the example's mesh, the finer meshes have the initial spacing (δ_1) reduced by a factor of 1.2. The wing spacing is controlled by three line sources and at least two triangle sources. These line sources run along the leading edge, the trailing edge and the wing tip; the triangle sources are formed to make up the internal section of the wing. The mesh spacing on the fuselage is controlled by two points sources - nose and aft - and a line source running from nose to aft.

Figure 4: Wing-Body Sources



2.5 Procedure

Three mesh densities were evaluated on the two different wing-body models. Each mesh density was created and run three separate times for each model to ensure the repeatability of the solution. The lift and drag (initially by surface integration but a farfield method is also used), as well as the pressure coefficient at selected wing stations, were compared with the other mesh densities and the experimental values reported in AGARD AR-303. The wall time and the CPU time where recorded for the total CFD cycle - the surface mesh generation, the volume mesh generation and the flow solution. Also, the lift and drag were compared with the results from two different methods currently used in conceptual design - Vorview (a vortex lattice method) and ACSYNT. The parameters for the source spacing of the three mesh densities used in this analysis are shown in Tables 1 - 3.

Table 1: Mesh1 Parameters

	δ_1	X_c	D
Far Field	50% Fuse. Length	-	-
Fuse. Point	0.8% Fuse. Length	2.4% Fuse. Length	8% Fuse. Length
Fuse. Line	1.5% Fuse. Length	Fuse. Radius	4 * Fuse. Radius
Wing Line	3.0% Wing MAC	6% Wing MAC	24% Wing MAC
Wing Triangle	5.0% Wing MAC	10% Wing MAC	40% Wing MAC

Table 2: Mesh2 Parameters

	δ_1	X_c	D
Far Field	45% Fuse. Length	-	-
Fuse. Point	0.7% Fuse. Length	2.4% Fuse. Length	8% Fuse. Length
Fuse. Line	1.2% Fuse. Length	Fuse. Radius	4 * Fuse. Radius
Wing Line	2.5% Wing MAC	6% Wing MAC	24% Wing MAC
Wing Triangle	4.2% Wing MAC	10% Wing MAC	40% Wing MAC

Table 3: Mesh3 Parameters

	δ_1	X_c	D
Far Field	40% Fuse. Length	-	-
Fuse. Point	0.6% Fuse. Length	2.4% Fuse. Length	8% Fuse. Length
Fuse. Line	1.0% Fuse. Length	Fuse. Radius	4 * Fuse. Radius
Wing Line	2.0% Wing MAC	6% Wing MAC	24% Wing MAC
Wing Triangle	3.5% Wing MAC	10% Wing MAC	40% Wing MAC

Chapter 3

CFD Results

3.1 Introduction

The W4 and M165 wing-bodies were run three different times on three different meshes. The W4 wing-body was analyzed at a freestream Mach number of 0.78 and an angle of attack of 1.52º. The M165 wing-body was analyzed at a freestream Mach number of 0.90 and an angle of attack of 4.99 º. The results presented in this chapter are for the first run on each of the meshes. The two other runs produced the same values for the points, triangles and tetrahedral in the surface and volume meshes. CPU run times for the mesh generation were equal to the first run within three significant digits and within two significant digits for the flow solutions. The repeatability of the flow solution will be discussed in Chapter 6.

3.2 W4 Wing-Body

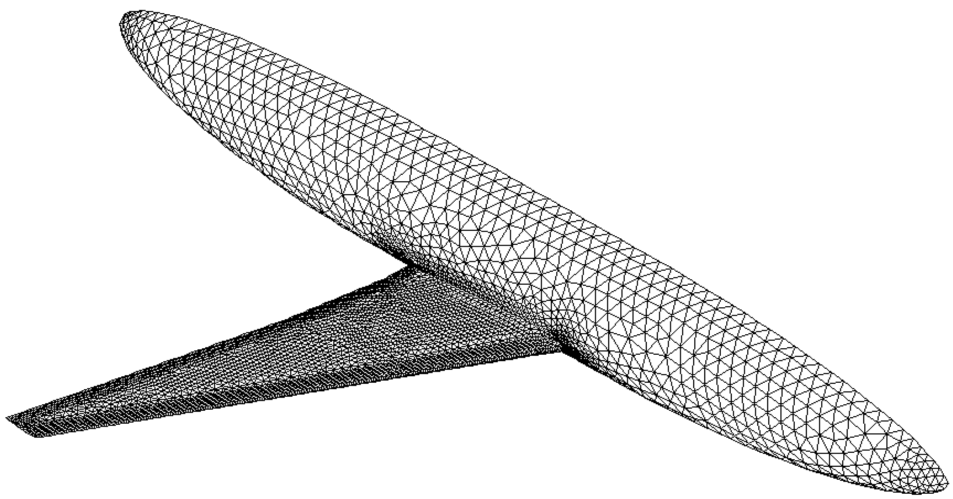
3.2.1 W4 - Mesh 1

Mesh1 - the coarsest mesh generated for the W4 wing-body - was based on the Case example in the FELISA Users Manual [9]. The parameters for the .bac file used to generate the mesh are listed in Table 4. The surface mesh contained 19,556 triangles made from 9780 surface points and took 11.5 CPU seconds (~14 Wall (actual clock time) seconds) to generate. The volume mesh contained 324,502 tetrahedral made form 61,025 points and took 787 CPU seconds (~14 Wall minutes) to generate. The resulting surface mesh is shown in Figure 5.

Table 4: Source Parameters - W4 Mesh1

	δ_1	X_1	D
Farfield	77.5	-	-
Fuse. Point	1.240	3.720	12.40
Fuse. Line	2.325	9.95	39.80
Wing Line	0.552	1.104	4.416
Wing Triangle	0.920	1.840	7.360

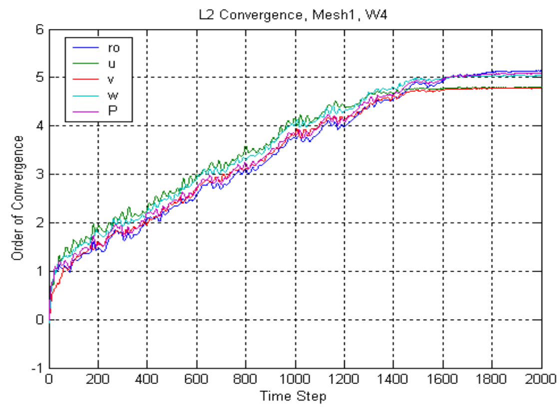
Figure 5: Surface Mesh - W4 Mesh1



The flow solution took 9.06 CPU second per Time Step (~10. Wall sec/TS) and converged around 1500 Time Steps, which took 226 CPU min. (~260 Wall min.). The convergence of the L2 residuals is shown in Figure 6. The Order of Convergence is defined by Equation 1. The resulting surface integrated lift and drag coefficients were 0.695 and -5.14E-3, respectively. The total run time (surface and volume mesh generation and flow solution) was 239 CPU min. (~4.5 Wall hr.).

$$\text{Order of Convergence} = -\log_{10}(\|R\|^{(i)} / \|R\|^{(1)}) \qquad (1)$$

Figure 6: L2 Residuals - W4 Mesh1



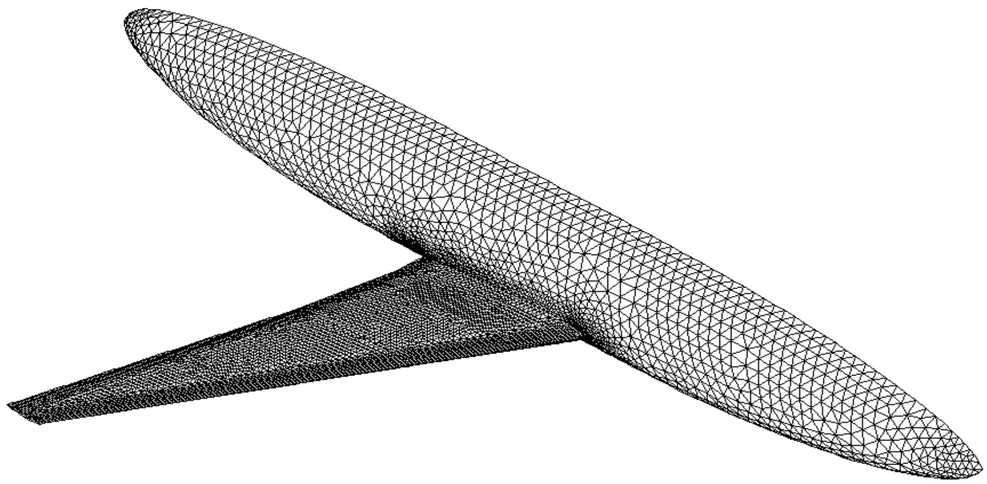
3.2.2 W4 - Mesh2

The parameters used to generate Mesh2 are shown in Table 5. The surface mesh contained 28,068 triangles made from 14,036 points and took 15.9 CPU seconds (~17 Wall sec.) to generate. The volume mesh contained 555,655 tetrahedrals made from 103,377 points and took 1420 CPU seconds (~25 Wall min.) to generate. The resulting surface mesh is shown in Figure 7.

Table 5: Source Parameters - W4 Mesh2

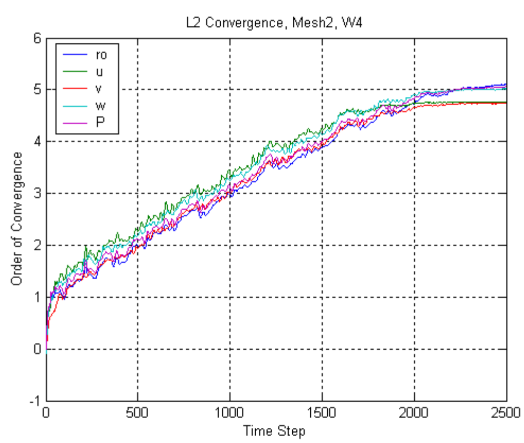
	δ_1	X_1	D
Farfield	69.75	-	-
Fuse. Point	1.085	3.720	12.40
Fuse. Line	1.860	9.95	39.80
Wing Line	0.460	1.104	4.416
Wing Triangle	0.773	1.840	7.360

Figure 7: Surface Mesh - W4 Mesh2



The flow solution took 15.4 CPU second per Time Step (~17. Wall sec/TS) and converged around 2000 Time Steps, which took 514 CPU min. (~570 Wall min.). The convergence of the L2 residuals is shown in Figure 8. The resulting surface integrated lift and drag coefficients were 0.714 and -1.93E-3, respectively. The total run time was 538 CPU min. (~10 Wall hr.).

Figure 8: L2 Residuals - W4 Mesh2



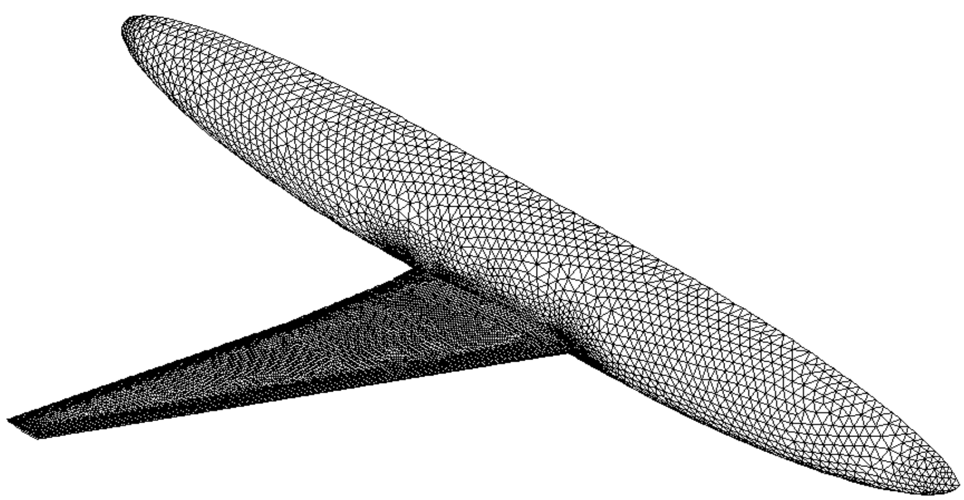
3.2.3 W4 - Mesh3

The parameters used to generate Mesh3 are shown in Table 6. The surface mesh contained 40,656 triangles made from 20,330 points and took 23.9 CPU seconds (~27 wall sec.) to generate. The volume mesh contained 970,254 tetrahedrals made from 178,606 points and took 2640 CPU seconds (~49 Wall min.) to generate. The resulting surface mesh is shown in Figure 9.

Table 6: Source Parameters - W4 Mesh3

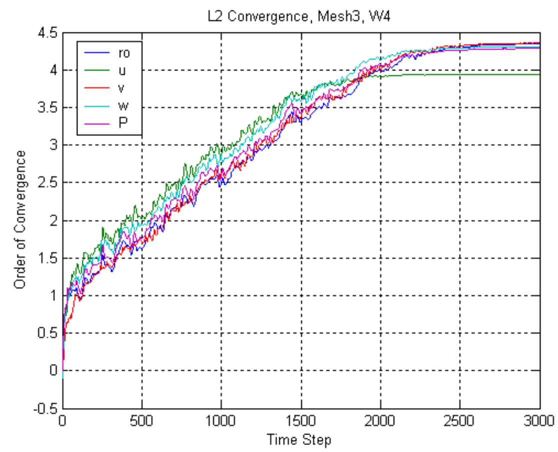
	δ_1	X_1	D
Farfield	62.0	-	-
Fuse. Point	0.930	3.720	12.40
Fuse. Line	1.550	9.95	39.80
Wing Line	0.368	1.104	4.416
Wing Triangle	0.644	1.840	7.360

Figure 9: Surface Mesh - W4 Mesh3



The flow solution took 28.0 CPU sec. per Time Step (~35. Wall sec/TS) and converged around 2500 Time Steps, which took 1170 CPU min. (~1500 Wall min.). The convergence of the L2 residuals is shown in Figure 10. The resulting surface integrated lift and drag coefficients were 0.727 and 8.46E-4, respectively. The total run time was 1210 CPU min. (~26 Wall hr.).

Figure 10: L2 Residuals - W4 Mesh3



3.3 M165 Wing-Body

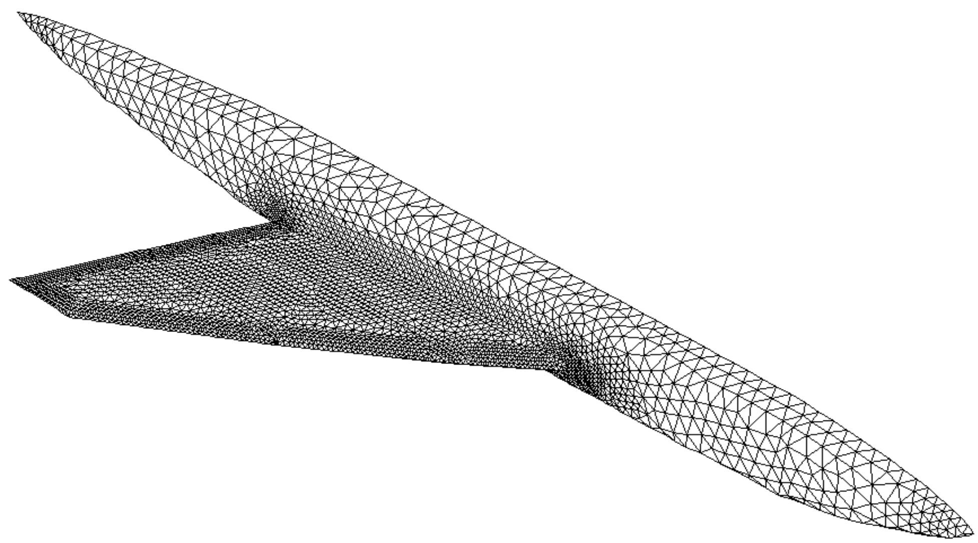
3.3.1 M165 - Mesh1

The parameters used to generate Mesh1 are shown in Table 7. For the Wing Lines and Wing Triangles one-half the MAC was used because of the delta wing. The Farfield and Fuselage parameters are based on the overall length of the model - model plus end cap. The surface mesh contained 14,844 triangles made from 7424 points and took 7.5 CPU seconds (~9 Wall sec.) to generate. The volume mesh contained 202,357 tetrahedrals made from 38,695 points and took 488 CPU seconds (~9 Wall min.) to generate. The resulting surface mesh is shown in Figure 11.

Table 7: Source Parameters - M165 Mesh1

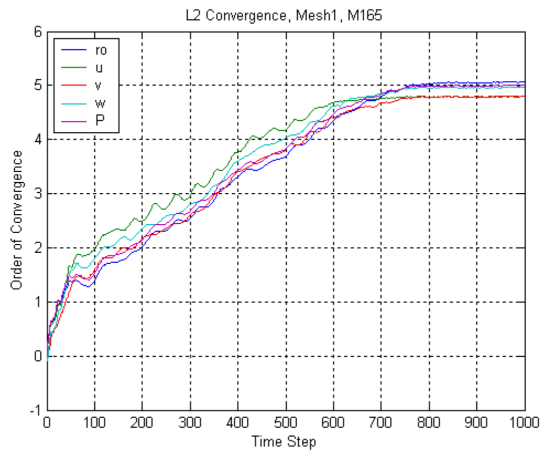
	δ_1	X_1	D
Farfield	100	-	-
Fuse. Point	1.60	4.80	16.0
Fuse. Line	3.00	7.67	30.7
Wing Line	0.725	1.45	5.80
Wing Triangle	1.208	2.42	9.67

Figure 11: Surface Mesh - M165 Mesh1



The flow solution took 5.44 CPU sec. per Time Step (~6.1 Wall sec/TS) and converged around 800 Time Steps, which took 72.6 CPU min. (~81 Wall min.). The convergence of the L2 residuals is shown in Figure 12. The resulting surface integrated lift and drag coefficients were 0.355 and -1.16E-2, respectively. The total run time was 81 CPU min. (~1.5 Wall hr.).

Figure 12: L2 Residuals - M165 Mesh1



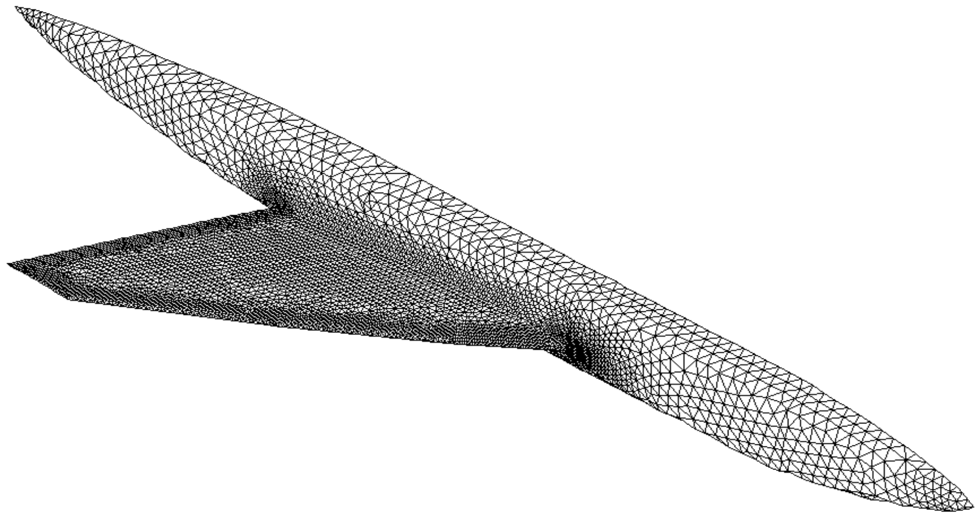
3.3.2 M165 - Mesh2

The parameters used to generate Mesh1 are shown in Table 8. The surface mesh contained 20,902 triangles made from 10,453 points and took 10.1 CPU seconds (~12 Wall sec.) to generate. The volume mesh contained 332,910 tetrahedrals made from 62,855 points and took 837 CPU seconds (~15 Wall min.) to generate. The resulting surface mesh is shown in Figure 13.

Table 8: Source Parameters - M165 Mesh2

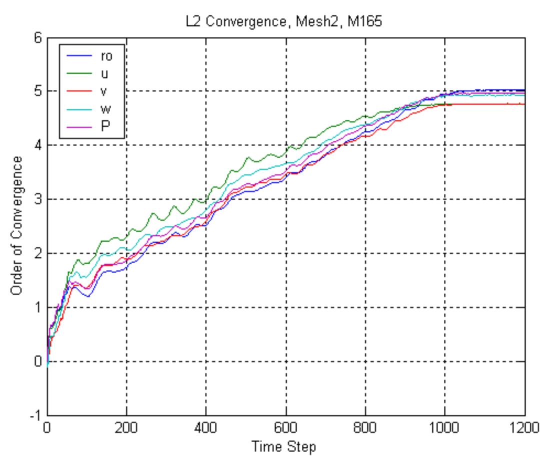
	δ_1	X_1	D
Farfield	90.0	-	-
Fuse. Point	1.40	4.80	16.0
Fuse. Line	2.40	7.67	30.7
Wing Line	0.604	1.45	5.80
Wing Triangle	1.015	2.42	9.67

Figure 13: Surface Mesh - M165 Mesh2



The flow solution took 9.45 CPU sec. per Time Step (~11 Wall sec/TS) and converged around 1000 Time Steps, which took 158 CPU min. (~180 Wall min.). The convergence of the L2 residuals is shown in Figure 14. The resulting surface integrated lift and drag coefficients were 0.362 and -1.14E-2, respectively. The total run time was 172 CPU min. (~3 Wall hr.).

Figure 14: L2 Residuals - M165 Mesh2



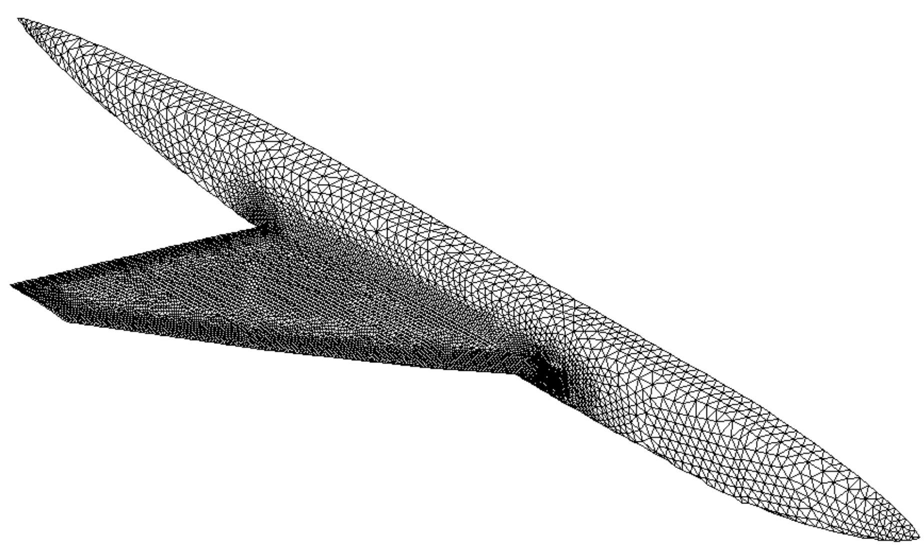
3.3.3 M165 - Mesh3

The parameters used to generate Mesh1 are shown in Table 9. The surface mesh contained 30,228 triangles made from 15,116 points and took 15.2 CPU seconds (~17 Wall sec.) to generate. The volume mesh contained 581,966 tetrahedrals made from 108,466 points and took 1560 CPU seconds (~28 Wall min.) to generate. The resulting surface mesh is shown in Figure 15.

Table 9: Source Parameters - M165 Mesh3

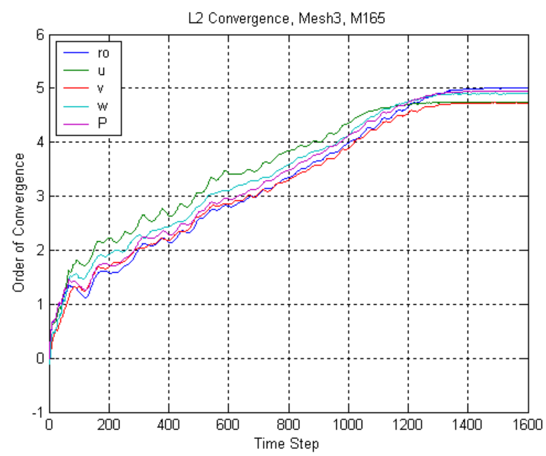
	δ_1	X_1	D
Farfield	80.0	-	-
Fuse. Point	1.20	4.80	16.0
Fuse. Line	2.00	7.67	30.7
Wing Line	0.483	1.45	5.80
Wing Triangle	0.846	2.42	9.67

Figure 15: Surface Mesh - M165 Mesh3



The flow solution took 17.2 CPU sec. per Time Step (~19 Wall sec/TS) and converged around 1400 Time Steps, which took 402 CPU min. (~450 Wall min.). The convergence of the L2 residuals is shown in Figure 16. The resulting surface integrated lift and drag coefficients were 0.366 and -1.10E-2, respectively. The total run time was 428 CPU min. (~8 Wall hr.).

Figure 16: L2 Residuals - M165 Mesh3



3.4 Summary

The average times to generate the meshes were 1.1E-3 CPU sec. per point for the surface mesh and 1.4E-2 sec. per point for the volume meshes. The lift coefficients calculated from the surface pressure integration technique varied within four percent for the W4 wing-body and within three percent for the M165 wing-body. All of the drag coefficients calculated from this technique were negative; therefore this method will not be suitable for drag prediction.

As the mesh density increased, the number of time steps needed for convergence also increased. Mesh1 for the M165 wing-body required the least number of time steps needed for convergence with 800 and Mesh3 for the W4 wing body required the most with 2500. This results in significantly longer run times for the denser meshes (81 CPU min. for M165 Mesh1 compared to 1210 CPU min. for W4 Mesh3) since not only does each time step require more CPU time, but they require more of them to converge. Therefore, reducing the number of points in the mesh will not only reduce the CPU time needed per time step, but also the number of time steps required for a converged solution.

Chapter 4

Far Field Drag Method

4.1 Introduction

The standard technique in evaluating the lift and drag coefficients from an Euler CFD solution is to integrated the pressure on the surface [1]. As seen in Chapter 3, this method does not work for calculating the drag coefficients (all but one drag value was negative). This error occurs because the aircraft surface is represented by triangles; therefore high grid resolution must be used in order to accurately represent curved surfaces [2]. Also, errors are introduced from the subtraction of two large forces in the flow direction. Therefore, the pressure distribution must be accurately known in order to determine the drag force [3]. These two problems suggest that in order for a surface integration technique to be accurate, a fine computational grid must be used, resulting in long run times. Another problem with surface integration technique is that they combine different drag components into one resultant drag coefficient. It is important, especially in conceptual design, to know how the drag is being produced so the aircraft can be efficiently designed [3].

These limitations of the surface integration technique have led researchers to look at other methods to evaluate the lift and drag coefficients generated by CFD. One method is the Wake Integration technique. In this method, the drag is computed from the physical phenomenon that causes drag forces [3]. This is done by evaluating the vortex and entropy produced on a plane perpendicular to the flow which lies downstream from the aircraft [2]. The vortices produced are results of the lift induced drag, and the entropy production is related to the wave drag [4]. Thus, this method will be used in this analysis since it is not as dependent on the grid resolution as surface integration, and it separates the drag components by the physical phenomena that create the drag.

4.2 DERIVATION OF EQUATIONS

4.2.1 Governing Equations

Assuming steady, inviscid, nonconducting flow with no body forces, radiation or heat generation, the governing equations can be written in the form

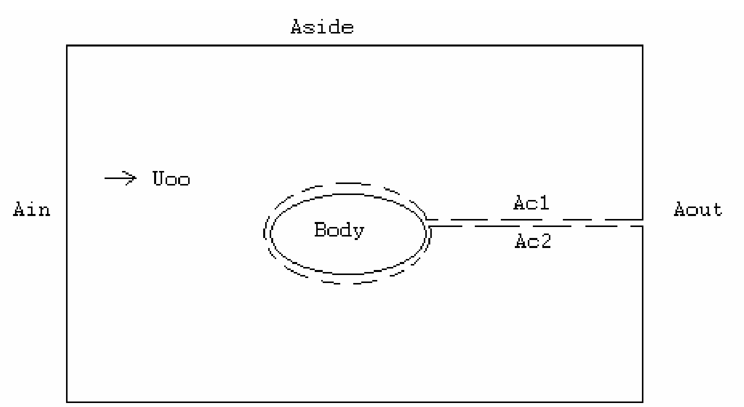
$$\int_{CS} G_i \cdot n_i dA = B_i \tag{2}$$

Where:

$$G_i = \begin{bmatrix} \rho V_j \\ \rho V_i V_j + P\delta_{ij} \\ [E+P]V_j \end{bmatrix} \quad , \quad B_i = \begin{bmatrix} 0 \\ \vec{F}_i \\ 0 \end{bmatrix} \quad , \quad \vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$$

For the system shown in Figure 17, it can be shown that the components on A_{c1} and A_{c2} will cancel each other and the integration over the body surface is zero for a non-porous surface.

Figure 17: Farfield Control Volume



The following assumptions are made to further simplify Equation 2:

- The inlet and outlet are perpendicular to the freestream
- The inlet and sides are far enough from the body so the effects of the body are negligible
- The inlet flow is uniform and equal to the freestream
- The inlet and outlet are of infinite radius

Now the governing equations (Eq 2) can be written as

$$\int_{Aout} [G_{i,in} - G_{i,out}] dA_{out} = B_{i,body} \tag{3}$$

-OR-

$$\int_{Aout} \begin{bmatrix} \rho_\infty U_\infty - \rho u \\ \rho_\infty U_\infty^2 + P_\infty - \rho u^2 - P \\ -\rho uv \\ -\rho uw \\ \rho_\infty U_\infty H_\infty - \rho uH \end{bmatrix} dA_{out} = \begin{bmatrix} 0 \\ F_{x,body} \\ F_{y,body} \\ F_{z,body} \\ 0 \end{bmatrix} \tag{4}$$

The Gibbs equations for a perfect gas, integrated with constant specific heats, may be written as

$$s - s_\infty = c_p \ln \frac{T}{T_\infty} - R \ln \frac{P}{P_\infty} \tag{5}$$

Using the Taylor Series for a natural log, and assuming small perturbations on the outlet so

$$T \approx T_\infty \quad , \quad P \approx P_\infty \quad , \text{ and } \quad u \approx U_\infty$$

And neglecting higher order terms, Eq 5 may be written as

$$s - s_\infty \approx \frac{c_p}{T_\infty}(T - T_\infty) + \frac{R}{P_\infty}(P_\infty - P) \tag{6}$$

For an ideal gas with constant specific heats, the energy equation and equation of state are represented by Equations 7 and 8.

$$h - h_\infty = c_p (T - T_\infty) \tag{7}$$

$$P = \rho RT \tag{8}$$

Using these relations, Equation 6 can be rewritten as

$$P_\infty - P \approx \rho_\infty T_\infty (s - s_\infty) - \rho_\infty (h - h_\infty) \tag{9}$$

Defining the stagnation enthalpy as

$$H \equiv h + \frac{1}{2} q^2 \tag{10}$$

Where

$$q^2 = \left| \vec{V} \cdot \vec{V} \right| = u^2 + v^2 + w^2 \qquad (11)$$

Equation 4 shows that for this flow there is no change in the stagnation enthalpy, therefore Equation 9 may be written as

$$P_\infty - P \approx \frac{P_\infty}{R}(s - s_\infty) - \frac{\rho_\infty}{2}(U_\infty^2 - u^2 - v^2 - w^2) \qquad (12)$$

Substituting Equation 12 into Equation 4, the drag can be found from the X component of the force

$$D \approx \int_{Aout} [(\rho_\infty U_\infty^2 - \rho u^2) + \frac{P_\infty}{R}(s - s_\infty) - \frac{\rho_\infty}{2}(U_\infty^2 - u^2 - v^2 - w^2)] dA_{out} \qquad (13)$$

Noting that only a shock will produce entropy for this flow and lift will cause vortex generation, Equation 13 can be separated into wave and lift induced drag components. Simplifying, again assuming small perturbations far downstream, the wave and induced drag can be found from Equations 14 and 15.

$$D_w \approx P_\infty \int_{Aout} \frac{\Delta s}{R} dA_{out} \qquad (14)$$

$$D_i \approx \frac{\rho_\infty}{2} \int_{Aout} (v^2 + w^2) dA_{out} \qquad (15)$$

Substituting the conservation of mass into the Z force component in Equation 4, the lift can be found from Equation 16.

$$F_y = -\rho_\infty U_\infty \int_{Aout} w dA_{out} \qquad (16)$$

4.2.2 Induced Drag

Assuming uniform density and velocity in the freestream direction on the outlet plane, a streamfunction and vorticity can be defined by Equations 17 and 18.

$$v = \frac{\partial \psi}{\partial z} \quad , \quad w = -\frac{\partial \psi}{\partial y} \qquad (17)$$

$$\zeta = \frac{\partial w}{\partial y} - \frac{\partial v}{\partial z} \qquad (18)$$

The streamfunction is further defined Poisson's Equation.

$$\nabla^2 \psi = -\zeta \tag{19}$$

Thus, following the method developed by Maskell [5], the induced drag can be found from Equation 20.

$$\begin{aligned}
D_i &\approx \frac{\rho_\infty}{2} \int_{Aout} \left[\left(\frac{\partial \psi}{\partial z} \right)^2 + \left(-\frac{\partial \psi}{\partial y} \right)^2 \right] dA_{out} \\
D_i &\approx \frac{\rho_\infty}{2} \int_{Aout} \left[\psi \frac{\partial^2 \psi}{\partial z^2} + \psi \frac{\partial^2 \psi}{\partial y^2} \right] dA_{out} \\
D_i &\approx \frac{\rho_\infty}{2} \int_{Aout} \psi \zeta dA_{out}
\end{aligned} \tag{20}$$

4.2.3 Lift

Using Stokes' theorem, Equation 16 may be written as Equation 21.

$$L \approx -\rho_\infty U_\infty \int_{Aout} y[\nabla(\vec{V})] \cdot \hat{i}\, dA_{out} = -\rho_\infty U_\infty \int_{Aout} y \left[\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z} \right] dA_{out} \tag{21}$$

Using the definition of vorticity, the lift can then be found from Equation 22.

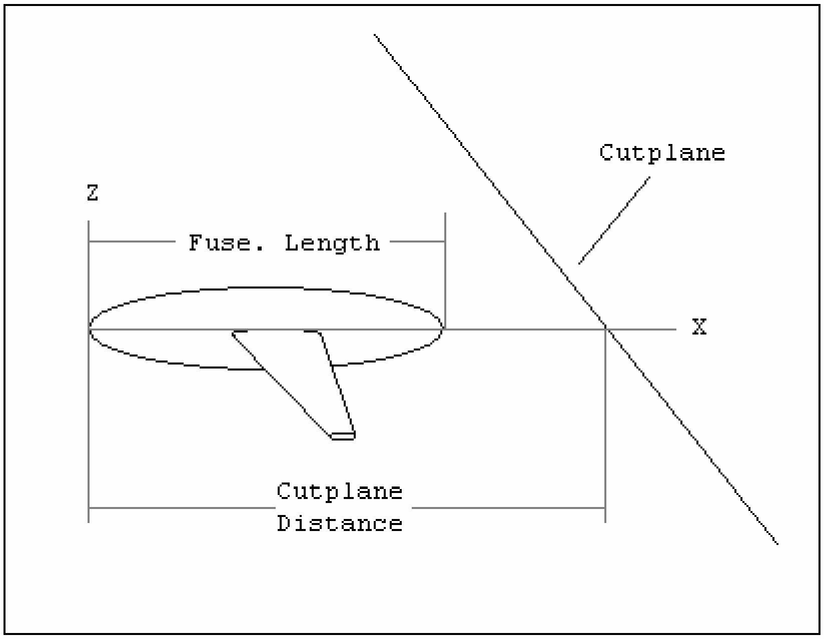
$$L \approx \rho_\infty U_\infty \int_{Aout} y \zeta dA_{out} \tag{22}$$

4.3 IMPLEMENTATION

4.3.1 Cut Plane

The data on the outlet plane was extracted by using FELISA's post processing program XPLT. Data included the velocities, pressure and density at those points and also how the points were connected into triangular elements. The cutplane is shown in Figure 18.

Figure 18: Cutplane



4.3.2 Wave Drag

To evaluate the wave drag, the change in entropy was calculated at each point, using Equation 6, on the plane. The change in entropy for a cell was evaluated as the average of the entropy change of the cell's nodes. Equation 14 was then calculated as the sum of the entropy change in the cells multiplied by the area of the cell.

4.3.3 Induced Drag

Following the method developed by Cummings et al. [6], the vorticity of a cell can be related to the circulation around the cell by Equation 23.

$$\Gamma_{cell} = \int_{cell} \zeta dA_{cell} = \oint_{cell} (vdy + wdz) \approx \sum_{cell} (\bar{v}\Delta y + \bar{w}\Delta z) \tag{23}$$

Imposing the boundary condition given by Equation 24, the streamfunction can be found by solving Equation 19 to get Equation 25.

$$\nabla \psi \to 0 \qquad as \qquad y^2 + z^2 \to \infty \tag{24}$$

$$\psi(y,z) = -\frac{1}{4\pi}\int \zeta(y_o, z_o)\ell n[(y-y_o)^2 + (z-z_o)^2]dA_o \qquad (25)$$

According to Cummings et al. [6], the streamfunction of at given point *j* in the outlet plane may be approximated by Equation 26, where β represents the cell index in the outlet plane and y_B and z_B are the coordinates of its centroid.

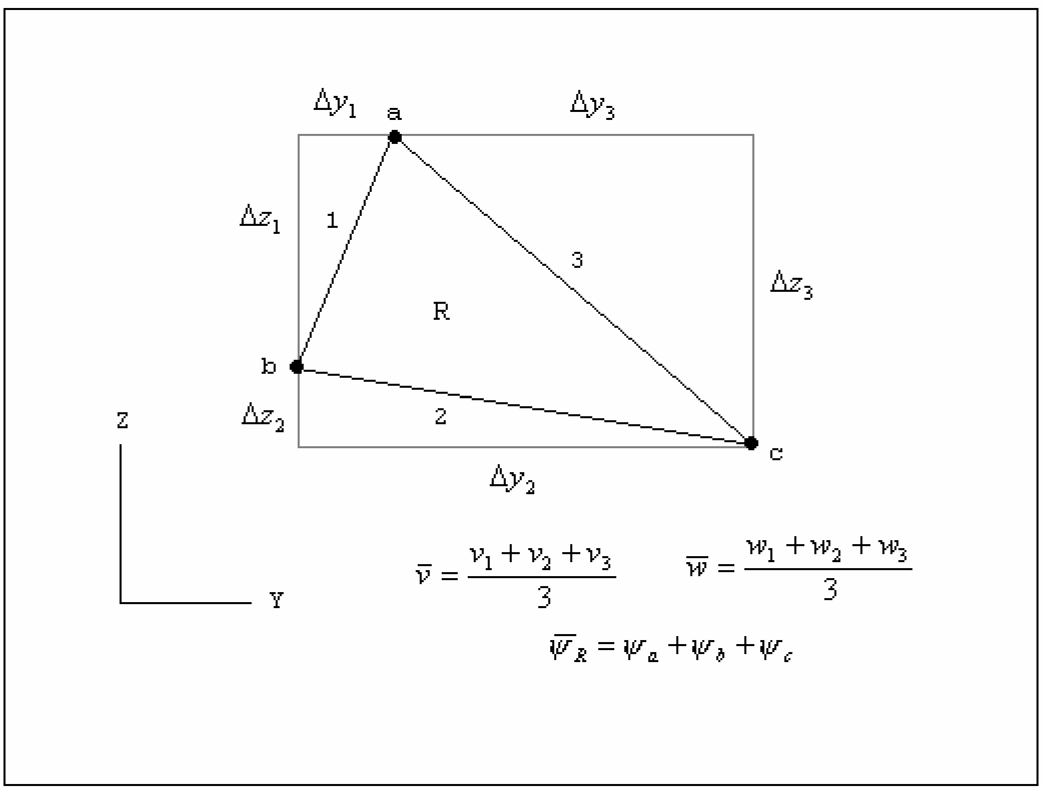
$$\psi_j = -\frac{1}{4\pi}\sum_{\beta}\Gamma_{\beta}\ell n[(y_j - y_{\beta})^2 + (z_j - z_{\beta})^2] \qquad (26)$$

Using these results the induced drag can be found from Equation 27, where α represents the cell index and $\overline{\psi}$ is the average streamfunction of the cell's nodes.

$$D_i \approx \frac{\rho_{\infty}}{2}\sum_{\alpha}\overline{\psi}_{\alpha}\Gamma_{\alpha} \qquad (27)$$

The triangular element R in the cutplane is shown in Figure 19.

Figure 19: Cell R in Cutplane



4.3.4 Lift

Similar to the induced drag development, the lift can be found by substituting Equation 23 into Equation 22 to yield Equation 28.

$$L \approx \rho_\infty U_\infty \sum_\alpha y_\alpha \Gamma_\alpha \tag{28}$$

4.3.5 Cut Off Parameters

Since the Euler equations are being solved numerically, there is some excess entropy production in the flow field [7]. This entropy may be small, but integrated over a large area, such as the outlet plane, significant error can occur in the wave drag calculation [4]. Also, since the equation to find the induced drag results in a nested summation, computational times can be large. Hunt et al. [4] suggest using cutoff parameters to both limit the amount of false entropy included in the wave drag calculation and to reduce the computation time of the induced drag calculation. For this implementation the wave drag cutoff (s_{cut}) is determined as a constant multiplied by the maximum entropy produced in the outlet plane (s_{max}). Likewise, the induced drag cutoff (Γ_{cut}) is determined as a constant multiplied by the maximum circulation in the outlet plane (Γ_{max}). This is shown in Equations 29 and 30.

$$s_{cut} = C_s s_{\max} \tag{29}$$

$$\Gamma_{cut} = C_\Gamma \left|\Gamma_{\max}\right| \tag{30}$$

Only cells that contain more entropy than the entropy cutoff are included in the wave drag calculation. Likewise, only the cells that contain more circulation than the induced drag cutoff are included in the induced drag calculation.

Chapter 5

Farfield Parameter Results

5.1 Entropy Drag Cutoff

The first parameter to be looked at for the farfield drag calculations is the cutoff level for the entropy (wave) drag. As mentioned in Chapter 4 this parameter is needed to reduce the effects of false entropy production in the entropy drag calculation. Three cutplane distances are used in this analysis; ten, twenty and thirty percent of the fuselage length away from the tail of the wing-body. The plots of the entropy drag for the first run of the two wing bodies are shown at these distances in Figures 20 - 25.

These graphs show that the entropy drag starts to level off for both wing-bodies around a cutoff of 0.04 for the 10% and 20% cutplane distances. The 30% cutplane distance does not level off for either wing-body and therefore will not be used. Figures 20 & 21 show that the entropy drag is fairly level for the W4 wing-body around a cutoff value of 0.05. Figures 23 & 24 show similar results for the M165 wing-body. The only departure from this is Mesh 1 on for the M165 20% cutplane (Figure 24), this is most likely due to the coarse mesh producing excessive amounts of entropy.

The cutoff level for the entropy drag is set to a value of 0.05. This values occurs in the flat regions of the curves for both wing-bodies and both cutplane distances for a majority of the mesh densities. The resulting entropy drag values at this cutoff level are reported in Tables 10 & 11.

Figure 20: Entropy Cutoff - W4 - 10% Cutplane

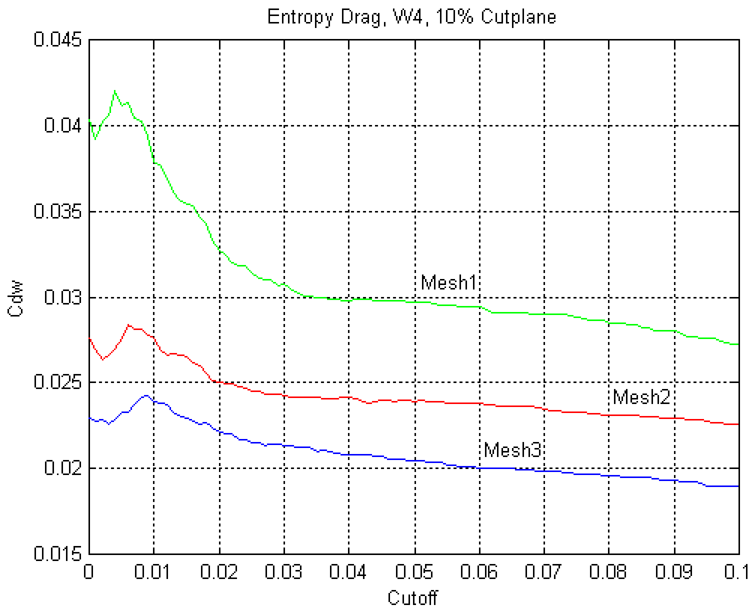


Figure 21: Entropy Cutoff - W4 - 20% Cutplane

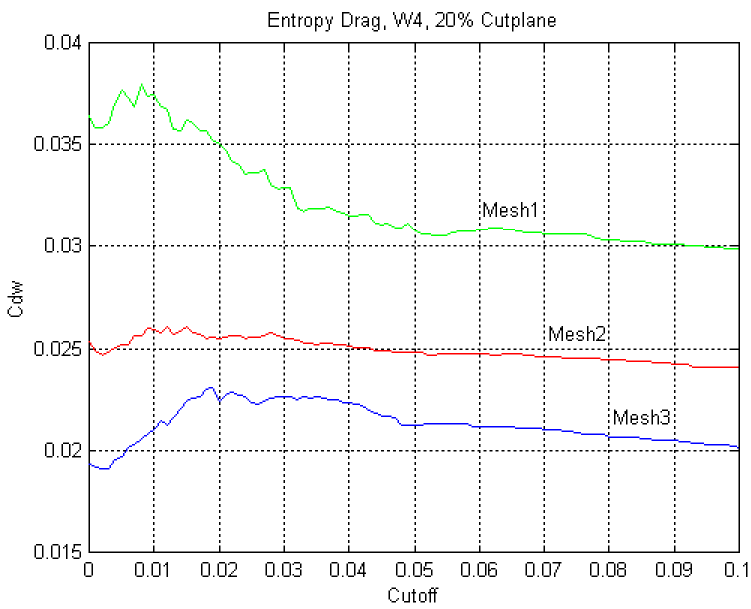


Figure 22: Entropy Cutoff - W4 - 30% Cutplane

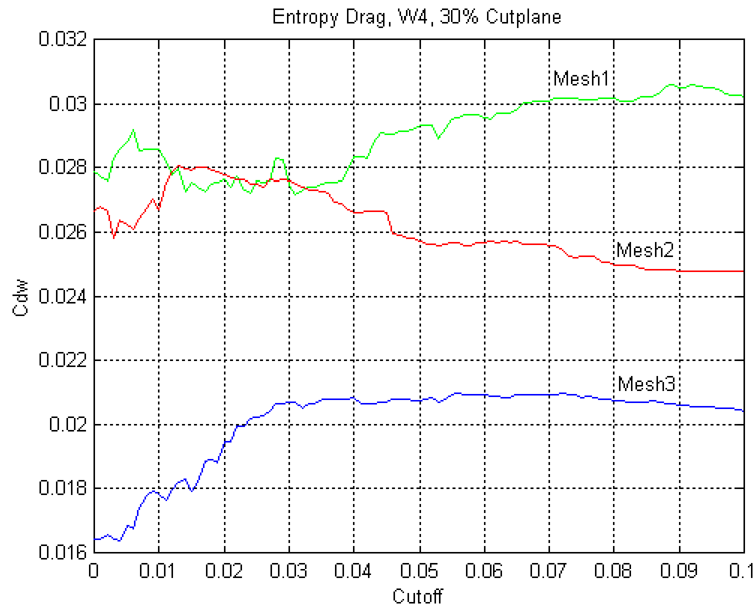


Figure 23: Entropy Cutoff - M165 - 10% Cutplane

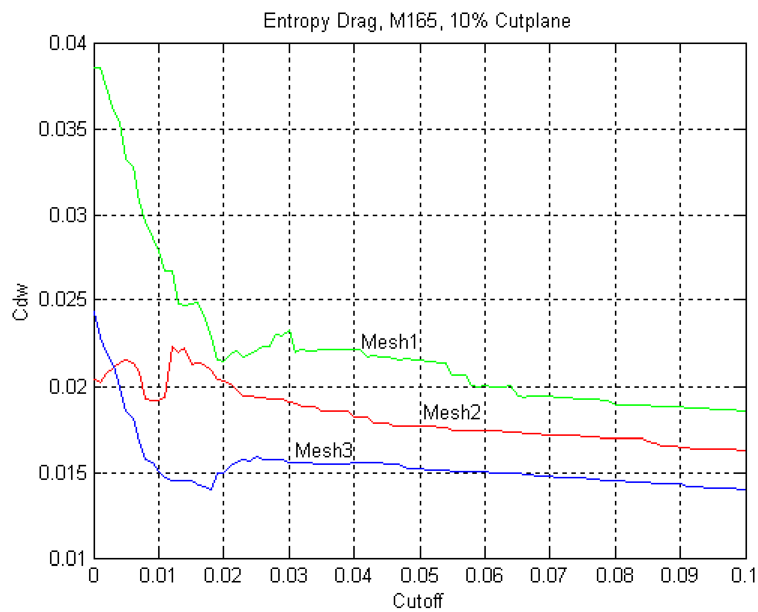


Figure 24: Entropy Cutoff - M165 - 20% Cutplane

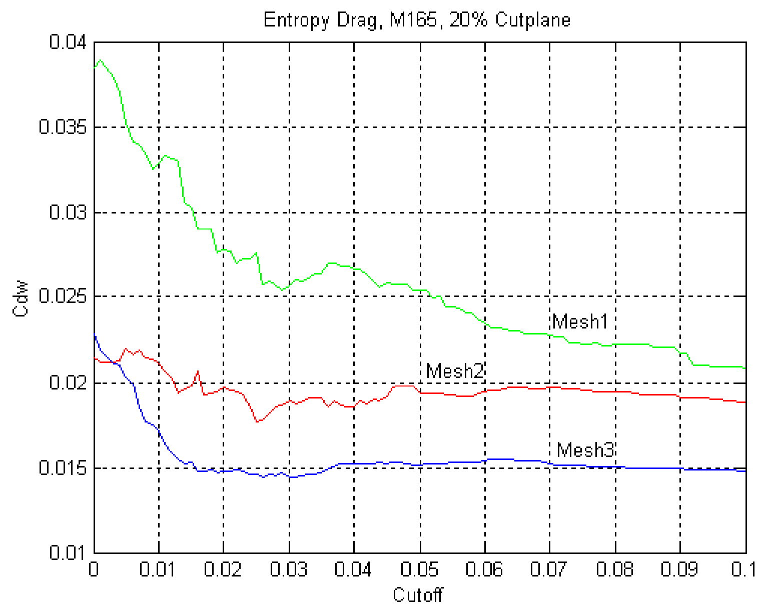


Figure 25: Entropy Cutoff - M165 - 30% Cutplane

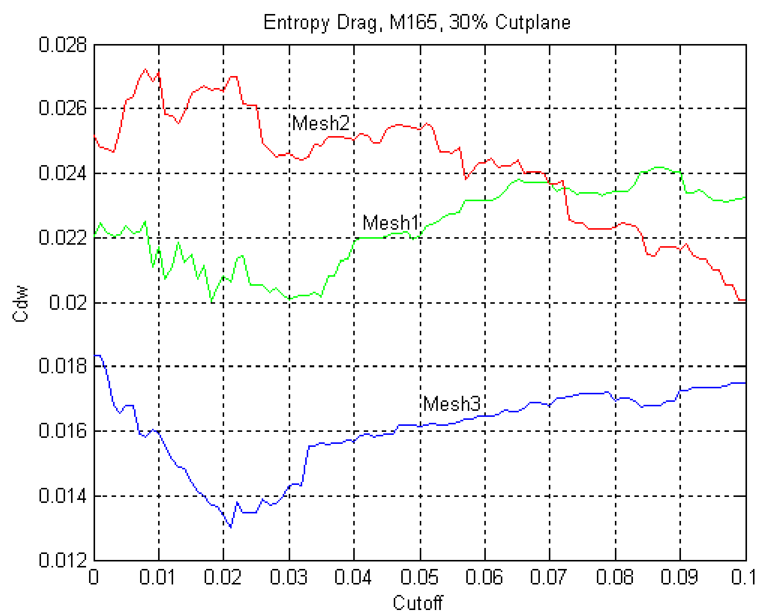


Table 10: Entropy Drag - W4

Mesh Number	*Entropy Drag* *10% Cutplane*	*Entropy Drag* *20% Cutplane*
Mesh1	0.02970	0.03075
Mesh2	0.02392	0.02481
Mesh3	0.02046	0.02126

Table 11: Entropy Drag - M165

Mesh Number	*Entropy Drag* *10% Cutplane*	*Entropy Drag* *20% Cutplane*
Mesh1	0.02154	0.02536
Mesh2	0.01766	0.01933
Mesh3	0.01518	0.01515

5.2 Induced Drag Cutoff

As stated in Chapter 4 a cutoff is needed to reduce the computational time in the induced drag calculation. Tables 12 - 17 show the values calculated for the induced drag and the percentage of points used in the calculation at the given cutoff value. These tables show that a small cutoff can significantly reduce the number of points used in the calculation while only having a minimal effect on the value of the induced drag. A cutoff value of 0.002 was chosen since this value used between 30% and 60% of the total number of points in the cutplane while only changing the value of the induced drag by less than a quarter of a percent.

This reduction of the points will decrease the computational time needed to calculate the induced drag since the equation to calculate the induced drag (Eq. 27) involves a nested loop. Therefore, the operational count would decrease by the square of the decrease in the number of points used in calculating the induced drag. This means that for the W4 wing-body, using only 33% of the total points in the cutplane would reduce the operation count by a factor of nine while only affecting the calculated drag by one quarter of a percent.

Table 12: Induced Drag - W4 Mesh1

Cutoff	***Points Used 10% Cutplane***	***Induced Drag 10% Cutplane***	***Points Used 20% Cutplane***	***Induced Drag 20% Cutplane***
0.000	100%	0.01680	100%	0.01648
0.001	46.25%	0.01680	67.48%	0.01647
0.002	34.90%	0.01677	55.25%	0.01647

Table 13: Induced Drag - W4 Mesh2

Cutoff	***Points Used 10% Cutplane***	***Induced Drag 10% Cutplane***	***Points Used 20% Cutplane***	***Induced Drag 20% Cutplane***
0.000	100%	0.01807	100%	0.01772
0.001	49.44%	0.01806	47.43%	0.01771
0.002	38.33%	0.01805	36.10%	0.01771

Table 14: Induced Drag - W4 Mesh3

Cutoff	***Points Used 10% Cutplane***	***Induced Drag 10% Cutplane***	***Points Used 20% Cutplane***	***Induced Drag 20% Cutplane***
0.000	100%	0.01901	100%	0.01874
0.001	39.80%	0.01901	40.85%	0.01872
0.002	30.56%	0.01900	30.24%	0.01869

Table 15: Induced Drag - M165 Mesh1

Cutoff	*Points Used 10% Cutplane*	*Induced Drag 10% Cutplane*	*Points Used 20% Cutplane*	*Induced Drag 20% Cutplane*
0.000	100%	0.01174	100%	0.01051
0.001	71.28%	0.01174	55.40%	0.01050
0.002	59.54%	0.01174	45.94%	0.01050

Table 16: Induced Drag - M165 Mesh2

Cutoff	*Points Used 10% Cutplane*	*Induced Drag 10% Cutplane*	*Points Used 20% Cutplane*	*Induced Drag 20% Cutplane*
0.000	100%	0.01236	100%	0.01162
0.001	63.50%	0.01236	63.59%	0.01162
0.002	51.67%	0.01235	54.86%	0.01162

Table 17: Induced Drag - M165 Mesh3

Cutoff	*Points Used 10% Cutplane*	*Induced Drag 10% Cutplane*	*Points Used 20% Cutplane*	*Induced Drag 20% Cutplane*
0.000	100%	0.01321	100%	0.01225
0.001	58.04%	0.01321	54.55%	0.01225
0.002	46.64%	0.01320	43.34%	0.01224

5.3 Cutplane Distance

Tables 10 & 11 show that the entropy drag will increase the farther behind the aircraft the cutplane is located. Likewise, the lift and the induced drag decreases the farther back the cutplane is located. This is caused by the circulation being damped out from the artificial viscosity, resulting in higher entropy drag and lower lift and induced drag but a consistent total drag (see References 2 & 10).

Tables 18 & 19 show, however, that there is an increase in the total drag coefficient as the cutplane is moved back. This is most likely caused from the mesh becoming coarser as the cutplane is moved back, which will decrease the accuracy of the lift and drag calculations. To reduce this effect the cutplane should be located close to the aircraft. However, at higher angles of attack the cutplane may intersect with a vertical stabilizer, therefore the cutplane needs to be far enough behind the aircraft to prevent this from occurring. Because of this latter requirement, the 20% cutplane will be used.

Table 18: Total Drag & Lift - W4

Mesh	***Total Drag*** ***10% Cutplane***	***Lift*** ***10% Cutplane***	***Total Drag*** ***20% Cutplane***	***Lift*** ***20% Cutplane***
Mesh1	0.04647	0.7123	0.04722	0.7048
Mesh2	0.04197	0.7151	0.04252	0.7173
Mesh3	0.03946	0.7348	0.03995	0.7316

Table 19: Total Drag & Lift - M165

Mesh	***Total Drag*** ***10% Cutplane***	***Lift*** ***10% Cutplane***	***Total Drag*** ***20% Cutplane***	***Lift*** ***20% Cutplane***
Mesh1	0.03328	0.3835	0.03586	0.4035
Mesh2	0.03001	0.3631	0.03095	0.3646
Mesh3	0.02838	0.3814	0.02739	0.3724

Chapter 6

Repeatability

6.1 Surface Pressures

Starting from only the four input files, the flow solution for each mesh density was computed three times in order to test the repeatability of the solution. The surface pressure distribution was plotted at a wing station about half the semi-span for both wing-bodies (53% for W4, 61% for M165) to evaluate if the pressure distributions were the same for each run. As Figures 26 - 31 show the pressure distributions were the same for all three runs at each mesh density for both wing-bodies.

Figure 26: Surface Pressure Repeatability - W4 Mesh1

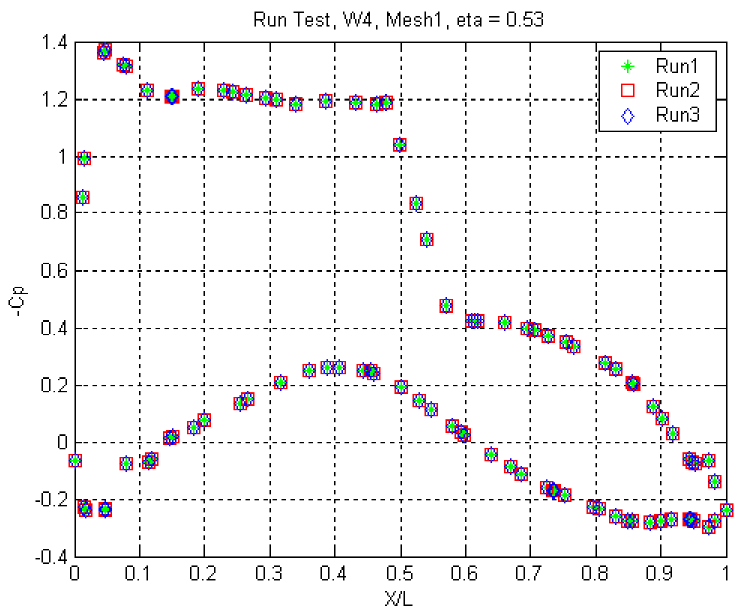


Figure 27: Surface Pressure Repeatability - W4 Mesh2

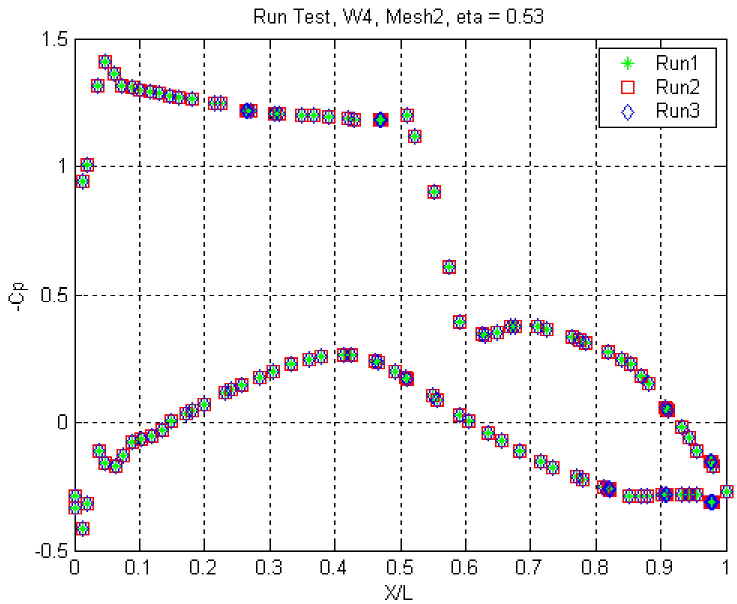


Figure 28: Surface Pressure Repeatability - W4 Mesh3

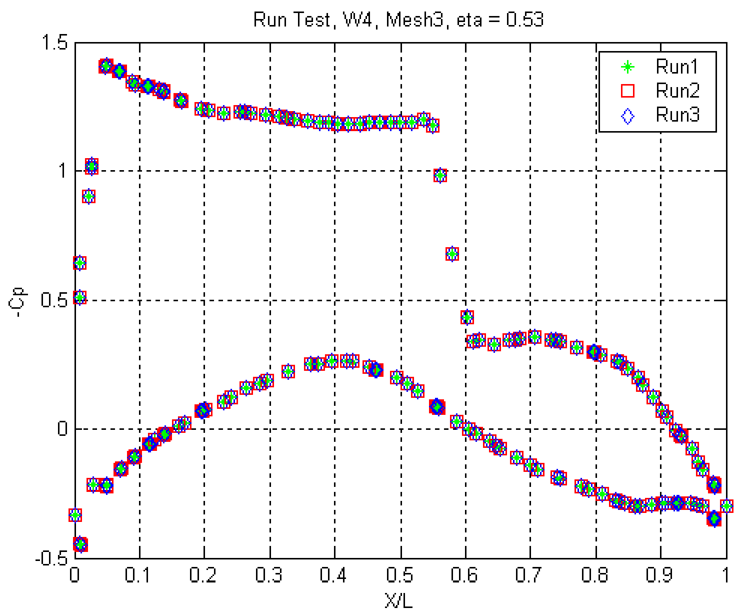


Figure 29: Surface Pressure Repeatability - M165 Mesh1

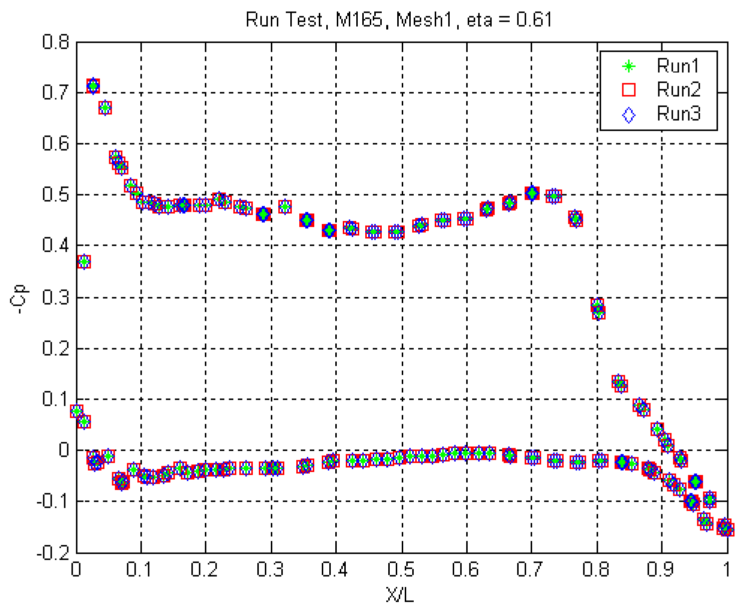


Figure 30: Surface Pressure Repeatability - M165 Mesh2

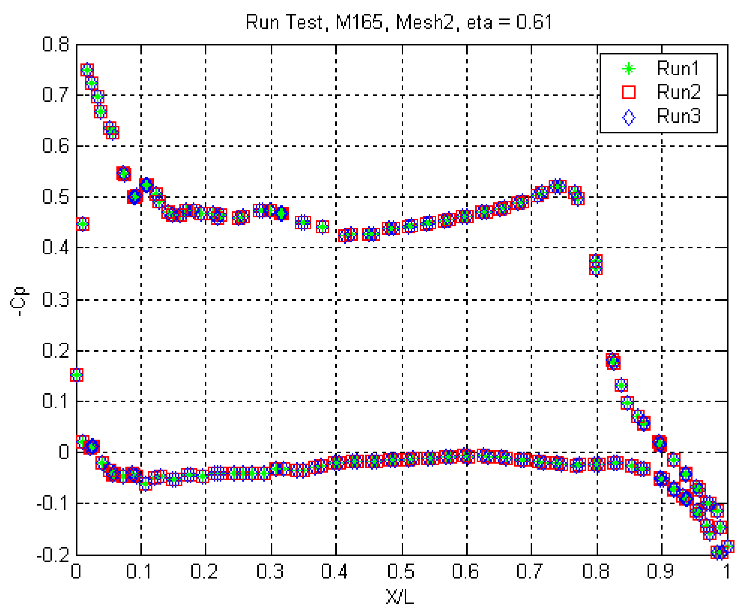
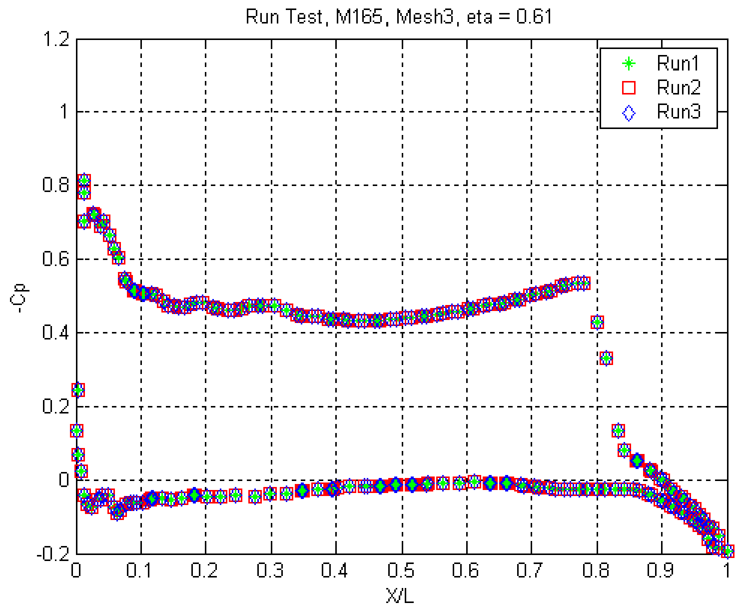


Figure 31: Surface Pressure Repeatability - M165 Mesh3



6.2 Lift & Drag

6.2.1 Surface Pressure Integration

The value for the lift coefficient calculated by surface pressure integration was also compared among the different runs. As Tables 20 & 21 show, the same results were obtained for each run at a given mesh density.

Table 20: Surface Integration Lift Repeatability - W4

	Run1	***Run2***	***Run3***
Mesh1	0.6952	0.6952	0.6952
Mesh2	0.7136	0.7136	0.7136
Mesh3	0.7266	0.7265	0.7265

Table 21: Surface Integration Lift Repeatability - M165

	Run1	***Run2***	***Run3***
Mesh1	0.3551	0.3551	0.3551
Mesh2	0.3616	0.3616	0.3616
Mesh3	0.3655	0.3655	0.3655

6.2.2 Farfield Lift & Drag

The lift and drag coefficients obtained from the farfield analysis were also compared for each run. The farfield parameters obtained in Chapter 5 (20% cutplane, 0.05 cutoff for the entropy drag and 0.002 cutoff for the induced drag) were used when calculating the values. As Tables 22 - 27 show, the same results were obtained for each run at each mesh density.

Table 22: Induced Drag Repeatability - W4

	Run1	***Run2***	***Run3***
Mesh1	0.01647	0.01647	0.01647
Mesh2	0.01771	0.01771	0.01771
Mesh3	0.01869	0.01869	0.01869

Table 23: Entropy Drag Repeatability - W4

	Run1	***Run2***	***Run3***
Mesh1	0.03075	0.03075	0.03075
Mesh2	0.02481	0.02480	0.02480
Mesh3	0.02126	0.02126	0.02126

Table 24: Farfield Lift Repeatability - W4

	Run1	***Run2***	***Run3***
Mesh1	0.7048	0.7049	0.7049
Mesh2	0.7173	0.7172	0.7172
Mesh3	0.7316	0.7316	0.7316

Table 25: Induced Drag Repeatability - M165

	Run1	***Run2***	***Run3***
Mesh1	0.01050	0.01050	0.01050
Mesh2	0.01162	0.01162	0.01162
Mesh3	0.01224	0.01224	0.01224

Table 26: Entropy Drag Repeatability - M165

	Run1	***Run2***	***Run3***
Mesh1	0.02536	0.02536	0.02536
Mesh2	0.01933	0.01933	0.01933
Mesh3	0.01515	0.01515	0.01515

Table 27: Farfield Lift Repeatability - M165

	Run1	***Run2***	***Run3***
Mesh1	0.4035	0.4035	0.4035
Mesh2	0.3646	0.3646	0.3646
Mesh3	0.3724	0.3724	0.3724

6.3 Summary

All of the runs produced the same values for the pressure distributions and the aerodynamic coefficients.

Chapter 7

Convergence

7.1 Surface Pressure Convergence

In order to evaluate the order of convergence needed to obtain an acceptable solution, the surface pressure distribution was plotted at different orders of convergence. The plots for the 53% wing station on the W4 wing-body and 61% wing station for the M165 wing-body are shown in Figures 32 - 37. As these figures show, the solution does not vary significantly after the L2 residual has decreased by three orders of magnitude.

Figure 32: Surface Pressure Convergence - W4 Mesh1

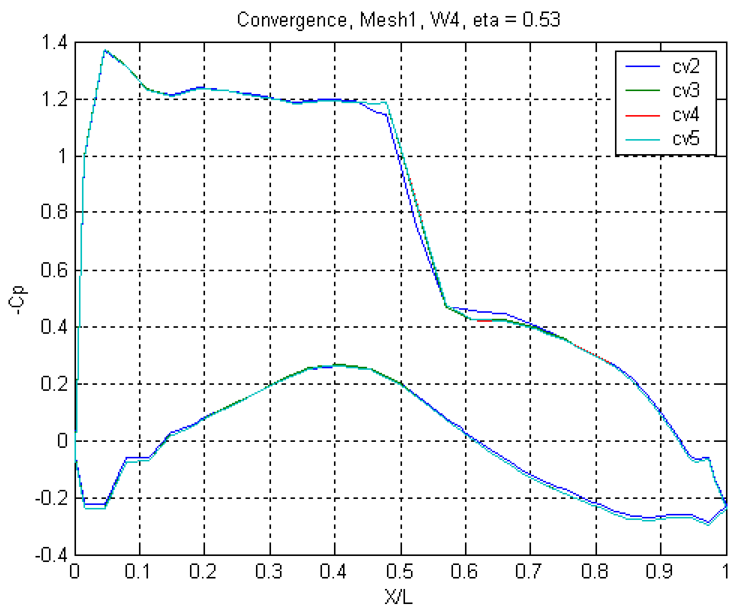


Figure 33: Surface Pressure Convergence - W4 Mesh2

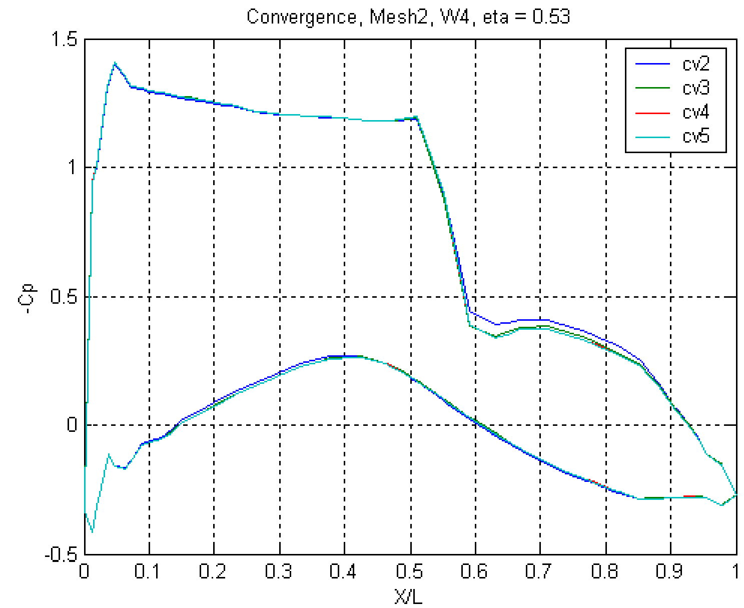


Figure 34: Surface Pressure Convergence - W4 Mesh3

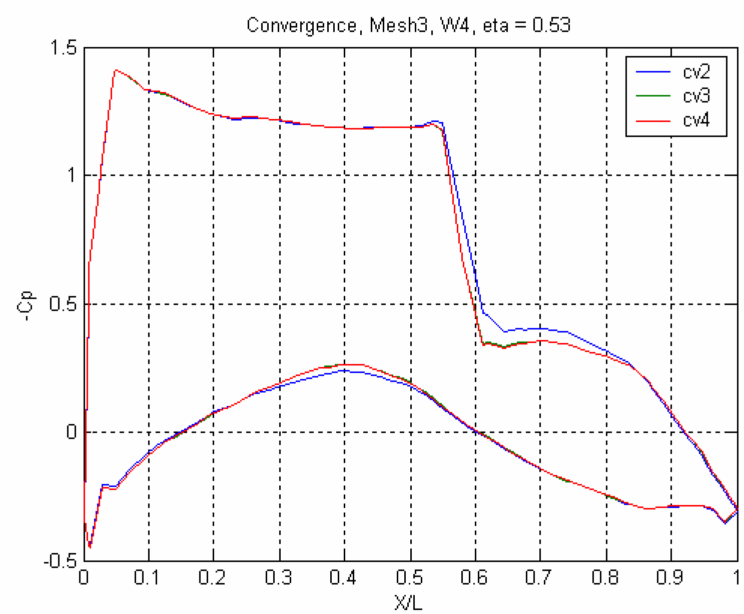


Figure 35: Surface Pressure Convergence - M165 Mesh1

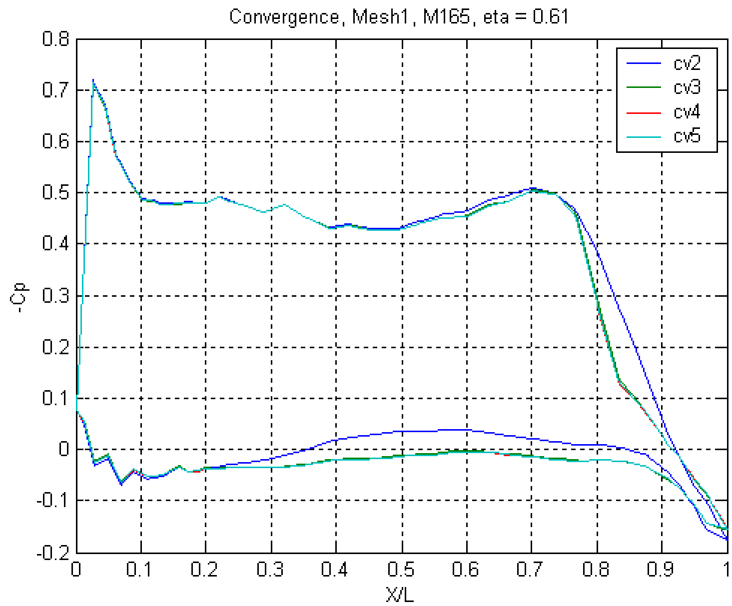


Figure 36: Surface Pressure Convergence - M165 Mesh2

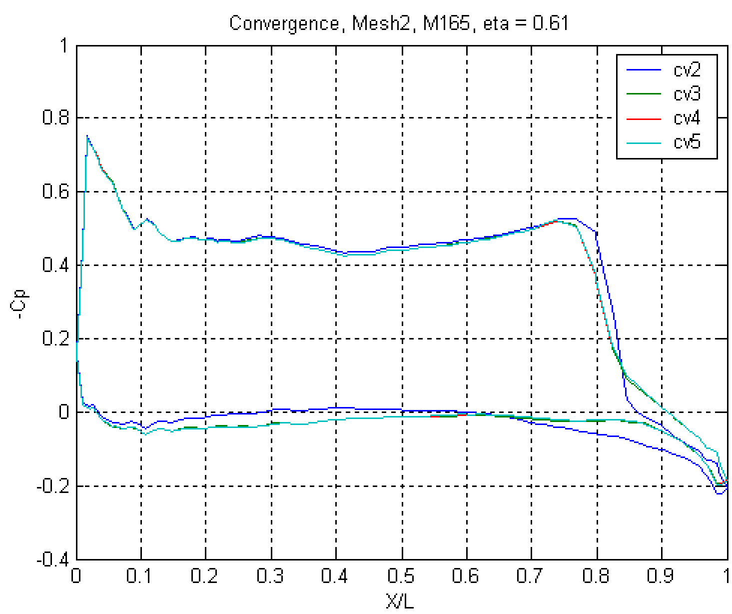
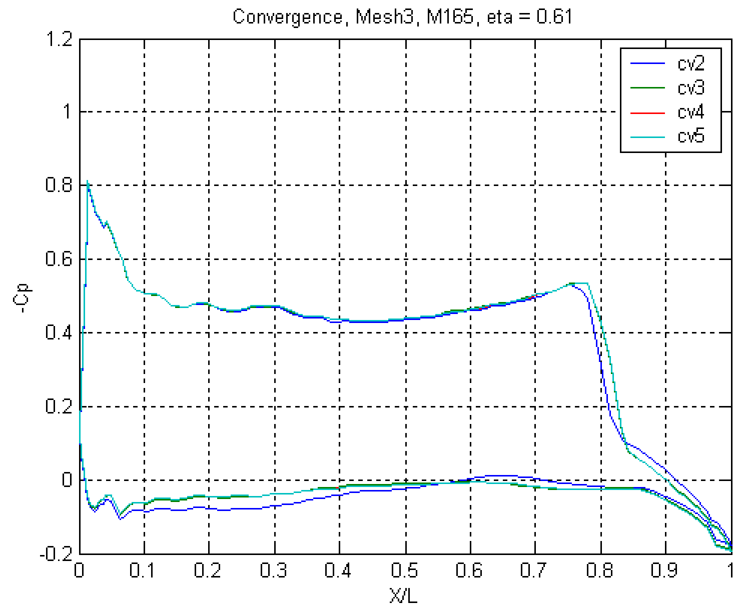


Figure 37: Surface Pressure Convergence - M165 Mesh3



7.2 Lift & Drag Convergence

The convergence of the aerodynamic coefficients was also evaluated. As shown by Tables 28 - 33, the aerodynamic coefficients only vary between the fully converged solution in the third significant digit for an order of convergence of three and in the fourth significant digit at an order of convergence of four. Therefore, the solution only needs to have the L2 residuals decrease by three orders of magnitude for the solution to be considered converged.

Table 28: Lift & Drag Convergence - W4 Mesh1

	Lift - Surf. Int.	*Lift - Farfield*	*Induced Drag*	*Wave Drag*
cv2	0.6905	0.6964	0.01622	0.03124
cv3	0.6942	0.7048	0.01649	0.03087
cv4	0.6952	0.7050	0.01647	0.03075
cv5	0.6952	0.7049	0.01647	0.03075

Table 29: Lift & Drag Convergence - W4 Mesh2

	Lift - Surf. Int.	*Lift - Farfield*	*Induced Drag*	*Wave Drag*
cv2	0.7232	0.7097	0.01716	0.02457
cv3	0.7130	0.7159	0.01766	0.02482
cv4	0.7135	0.7173	0.01772	0.02481
cv5	0.7136	0.7172	0.01771	0.02480

Table 30: Lift & Drag Convergence - W4 Mesh3

	Lift - Surf. Int.	*Lift - Farfield*	*Induced Drag*	*Wave Drag*
cv2	0.7398	0.7286	0.01833	0.02129
cv3	0.7272	0.7307	0.01863	0.02126
cv4	0.7265	0.7316	0.01869	0.02126

Table 31: Lift & Drag Convergence - M165 Mesh1

	Lift - Surf. Int.	*Lift - Farfield*	*Induced Drag*	*Wave Drag*
cv2	0.3462	0.3947	0.01006	0.02574
cv3	0.3549	0.4025	0.01043	0.02528
cv4	0.3552	0.4037	0.01050	0.02537
cv5	0.3551	0.4035	0.01050	0.02536

Table 32: Lift & Drag Convergence - M165 Mesh2

	Lift - Surf. Int.	*Lift - Farfield*	*Induced Drag*	*Wave Drag*
cv2	0.3585	0.3569	0.01093	0.01843
cv3	0.3621	0.3656	0.01167	0.01936
cv4	0.3616	0.3645	0.01162	0.01933
cv5	0.3616	0.3646	0.01162	0.01933

Table 33: Lift & Drag Convergence - M165 Mesh3

	Lift - Surf. Int.	*Lift - Farfield*	*Induced Drag*	*Wave Drag*
cv2	0.3681	0.3789	0.01277	0.01562
cv3	0.3652	0.3722	0.01224	0.01519
cv4	0.3654	0.3724	0.01224	0.01515
cv5	0.3655	0.3724	0.01224	0.01515

7.3 Summary

An order of convergence of at least three is needed for the surface pressures to become converged. The same result was found for the aerodynamic coefficients. After three orders of convergence the lift and drag coefficients vary by less than one half of a percent. Therefore, the flow solution may be stopped once the L2 residuals have decreased by three orders of magnitude.

Chapter 8

Mesh Density

8.1 W4 Wing-Body

8.1.1 Surface Pressure Distribution

The plots of the W4 wing-body pressure distribution (Figures 38 - 40) show that as the mesh density gets coarser, the shock wave becomes more diffused. This is caused from the shock discontinuity being stretched as the mesh points get farther apart. When compared to the experimental data, the coarser mesh (Mesh1) appears to match the shock better. Though the shock result between the coarse mesh and the experimental data is similar, the causes are different. The actual shock is being diffused by the viscous boundary layer, which is absent in the Euler solution.

There is some oscillation of the surface pressures at the leading and trailing edge of the wing in all of the meshes. This is most likely a result of the artificial viscosity being kept low in the flow solution to prevent excess entropy production which would increase the farfield wave drag calculation. When compared to the experimental data, the CFD solution does not match with the bottom of the wing's leading edge surface pressure. The denser meshes do a better job then the coarse mesh; however none of the meshes predict the high surface pressure spike. The W4 wing-body pressure coefficient is off by as much as 0.5; the M165 pressure coefficient, however, is only off by no more than 0.1. This is most likely a result of the curvature of the wing's leading edge being represented by flat triangles.

The remainder of the pressure distributions matches well with the other meshes and with the experimental data. There is a slight over prediction of the top surface pressure at the 28% wing station; this is attributed to the model used in the CFD analysis not matching exactly with the experimental model. This error is a result of only being able to define the wing cross section at four wing stations in RAM (root, tip, leading edge extension and trailing edge extension). The finer meshes (Mesh2 & Mesh3) do have slightly better agreement with the experimental data in these areas than does the coarse mesh (Mesh1).

Figure 38: Surface Pressure Comparison of Meshes - W4, eta = 28%

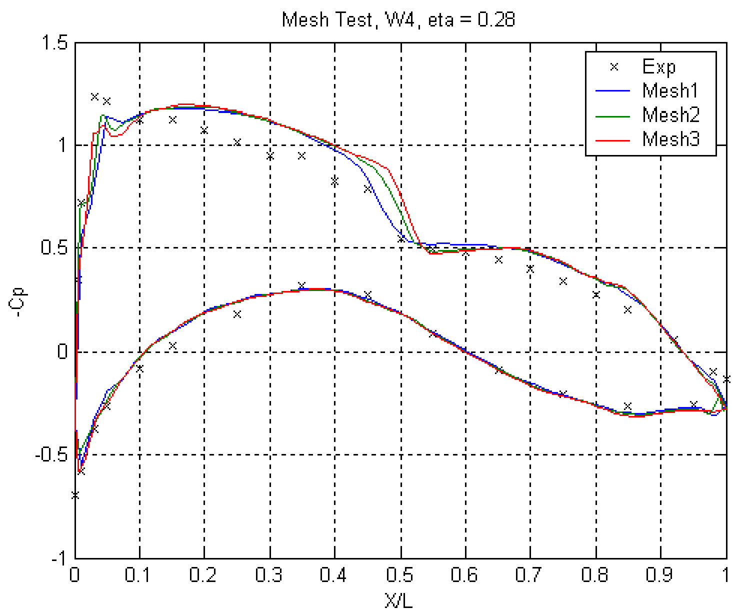


Figure 39: Surface Pressure Comparison of Meshes - W4, eta = 53%

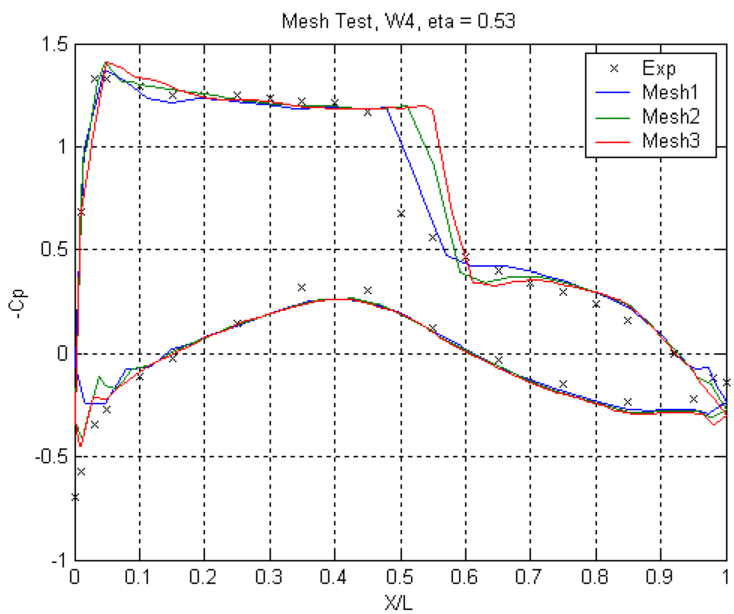
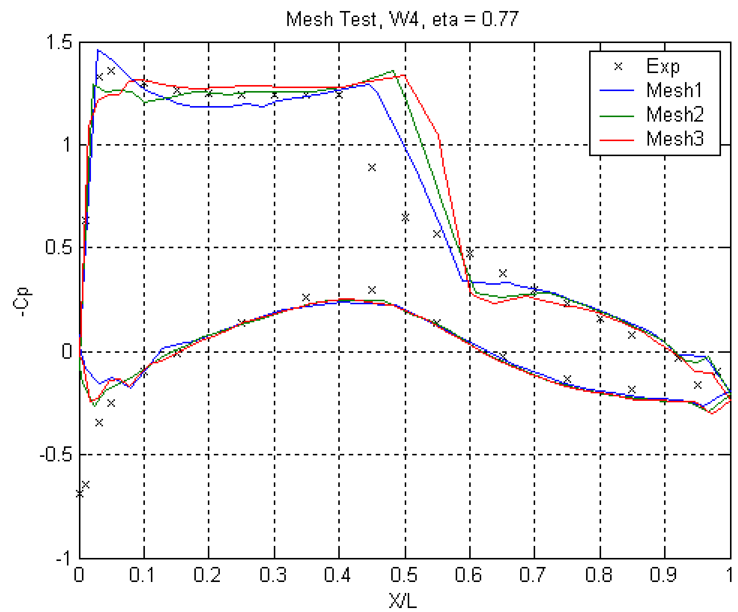


Figure 40: Surface Pressure Comparison of Meshes - W4, eta = 77%



8.1.2 Lift Coefficient Results

The results for W4 wing-body lift coefficient are shown in Table 34. The farfield and surface integration results agree fairly well for each mesh, the differences range from 0.5% to 1.4%. However, the CFD solution is off between 13% for the coarse mesh (Mesh1) to 17% for the finest mesh (Mesh3). Lift is caused from the difference in the surface pressure on the top and bottom of the wing. As shown in Figures 34 - 36, the CFD solutions have a sharper shock, which increases the area of this surface pressure difference. This results in a higher value for the lift coefficient for the Euler solution. The better agreement between the coarse mesh and the experimental solution is due to the shock being diffused more in the coarse mesh.

Table 34: Lift Comparison of Meshes - W4

Exp = 0.623	***Farfield***	***Surf. Int.***
Mesh1	0.7049	0.6952
Mesh2	0.7173	0.7136
Mesh3	0.7316	0.7265

8.1.3 Drag Coefficient Results

To estimate the induced drag for the experimental data Equation 31, which is commonly found in literature (e.g. Ref 29), is used. Drag results are shown in Table 35.

$$C_{Di} = C_L * C_L / (\pi * AR) \tag{31}$$

Table 35: Farfield Drag Comparison of Meshes - W4

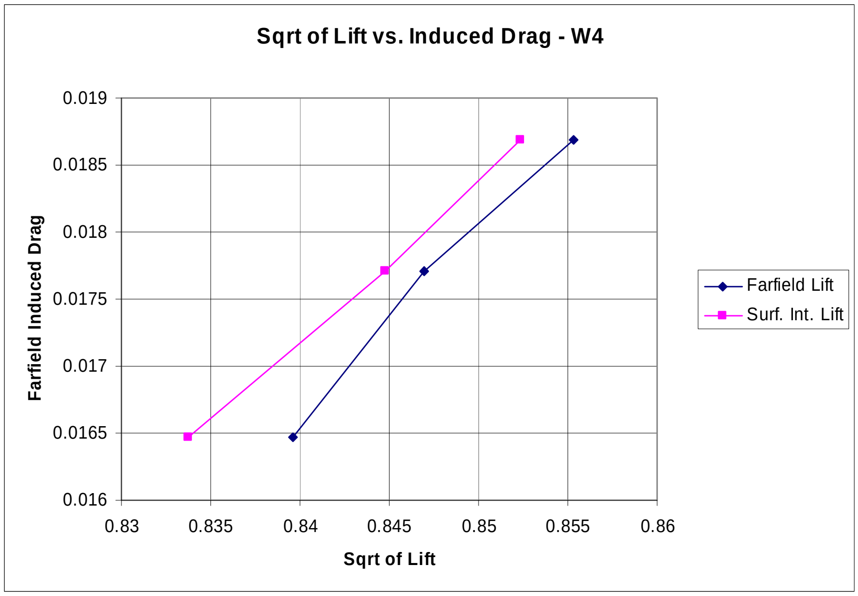
	Induced Drag	***Wave Drag***	***Total Drag***
Mesh1	0.01647	0.03075	0.04722
Mesh2	0.01771	0.02481	0.04252
Mesh3	0.01869	0.02126	0.03995
Exp	0.01544	0.02295	0.03840

The absence of the viscous boundary layer in the Euler equations should result in a smaller value of wave drag in the CFD solution. However, the numerical effects and the artificial viscosity of the Euler solution create false entropy, which increase the value of wave drag in the CFD solutions. Two areas where false entropy is produced are ahead of shocks and at areas of steep pressure gradients (i.e. leading edge of the wing) [7]. The result of this false entropy production is seen in Table 35 as higher values of wave drag.

Masson et al. [7] also state that coarser grids will increase the amount of entropy production. This is also seen in Table 35, the coarser mesh has the largest amount of wave drag which decreases as the mesh becomes finer.

Another cause for this larger value of drag is the higher amount of lift generated in the CFD solution - which results in a higher value for the induced drag. As shown in Figure 41, the increase in induced drag is fairly linear with respect to the square root of the lift. This is consistent with Equation 31.

Figure 41: Lift Verses Induced Drag - W4



8.1.4 Overall Results

Table 36 lists the overall results for the W4 wing-body. The solution time is the total time the CFD computation took - surface and volume mesh generation and flow solution - to obtain a solution that had the L2 residuals decrease by three orders of magnitude. The percentage difference between the CFD results and the experimental solution for the lift and drag coefficients are also listed for both the surface integration (S.I.) and farfield (F.F.) techniques.

Mesh1 had the fastest solution time, the best lift coefficient agreement and the worst total drag coefficient agreement. Mesh3 had the longest solution time, the worst lift coefficient agreement and the best drag coefficient agreement. Mesh2 was in the middle for each of these results. Overall the S.I. technique produced better results for the lift coefficient, but the drag coefficients were significantly under predicted. The F.F. technique produced better results for the drag coefficient and the lift coefficient was slightly higher than the S.I. value.

Table 36: Overall Results - W4

	CPU Solution Time - cv3	*S.I. Lift %Diff.*	*F.F. Lift %Diff.*	*S.I. Drag %Diff.*	*F.F. Drag %Diff.*
Mesh1	2:07 (2:20)	11.6%	13.1%	-113%	23.0%
Mesh2	4:41 (5:11)	14.5%	15.1%	-105%	10.7%
Mesh3	10:51 (12:06)	16.6%	17.4%	-97.8%	4.04%

8.2 M165 Wing-Body

8.2.1 Surface Pressure Distribution

Figures 42 - 44 show the surface pressure distribution on the M165 wing-body. The results are similar for the M165 wing-body as they were for the W4 wing-body when the three mesh densities are compared. However, there are more differences between the CFD solution and the experimental data. There is a strong shock present in the CFD solution; the experimental data has a shock that is fairly diffused. These differences are most likely due to separation and the shock interacting with the viscous boundary layer. As stated earlier in Chapter 1, the Euler equations agree well with the NS equations when there is no separation or strong shocks. These plots show how the Euler solution breaks down in these areas.

The same oscillation occurs in the M165 solution as occurred with the W4 solution at the leading and trailing edges. There is a small dip in the pressure distribution at the 86% wing station (Figure 44) on the top surface just behind the leading edge in the experimental data which does not occur in the CFD solution. This is probably caused by the flow separating and reattaching after the leading edge, which cannot be modeled with the Euler equations. The rest of the pressure distributions agree well with the experimental data for all meshes.

Figure 42: Surface Pressure Comparison of Meshes - M165, eta = 30%

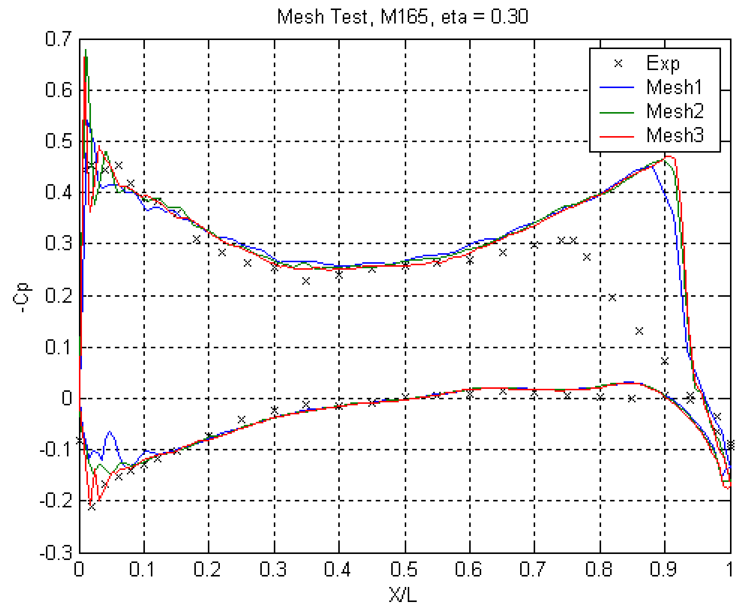


Figure 43: Surface Pressure Comparison of Meshes - M165, eta = 61%

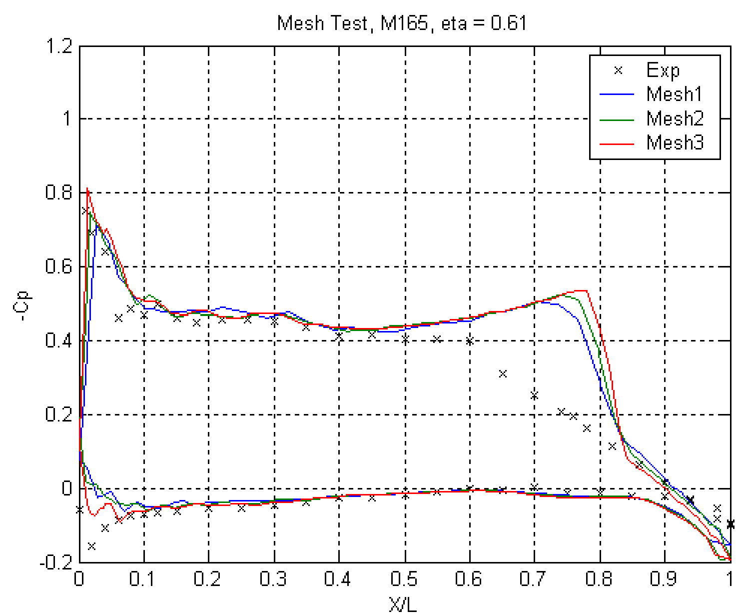
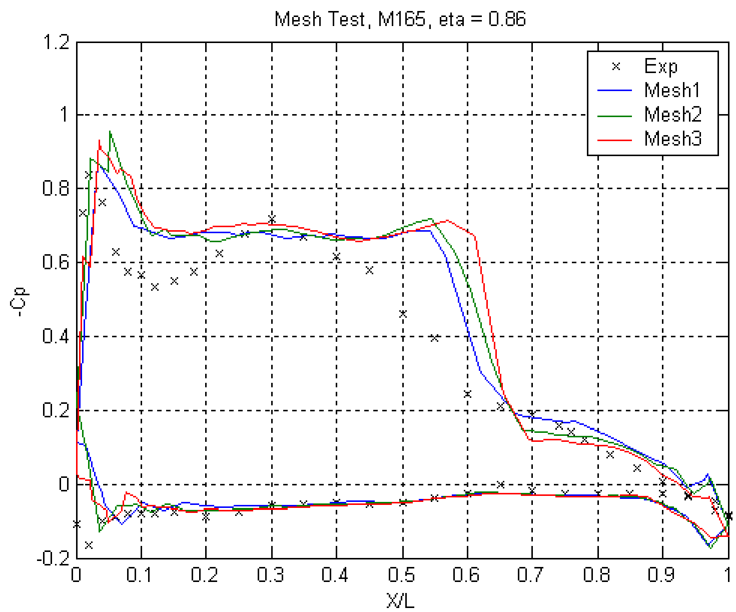


Figure 44: Surface Pressure Comparison of Meshes - M165, eta = 86%



8.2.2 Lift Coefficient Results

As with the W4 wing-body, the CFD solution for the M165 wing-body has a higher value for the lift coefficient. This is again attributed to the larger pressure difference on the wing in the Euler solution caused from the delayed shock. Also, the lift coefficient (except for the farfield lift of Mesh1) increases as the shock gets sharper - as it did in the W4 wing-body solution. The departure of the farfield lift for Mesh1 from this trend is most likely due to errors introduced from the vorticity being transported on the coarser mesh. The lift results are shown in Table 37.

Table 37: Lift Comparison of Meshes - M165

Exp = 0.3060	***Farfield***	***Surf. Int.***
Mesh1	0.4035	0.3551
Mesh2	0.3646	0.3616
Mesh3	0.3724	0.3655

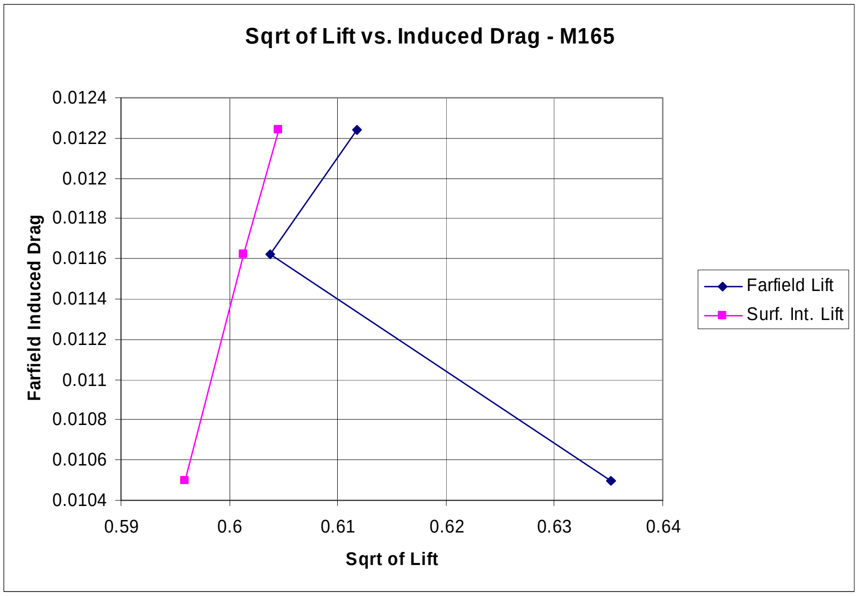
8.2.3 Drag Coefficient Results

The drag results for the M165 wing-body are similar to the results of the W4 wing-body. The induced drag is greater for the CFD solution - due to the higher values of lift created from the Euler solution - and the wave drag is high from the false entropy production. The wave drag also decreases as the mesh becomes finer. The drag results are shown in Table 38. Figure 45 shows the square root of lift and the induced drag vary linearly for the surface integrated lift; however, the error in the farfield lift for Mesh1 prevents any conclusion for the farfield lift plot.

Table 38: Farfield Drag Comparison of Meshes - M165

	Induced Drag	***Wave Drag***	***Total Drag***
Mesh1	0.01050	0.02536	0.03586
Mesh2	0.01162	0.01933	0.03095
Mesh3	0.01224	0.01515	0.02739
Exp	0.01296	0.01396	0.02692

Figure 45: Lift Verses Induced Drag - M165



8.2.4 Overall Results

Table 39 lists the overall results for the M165 wing-body. The results were similar to the W4 wing-body. Mesh1 had the fastest solution time, the best lift coefficient agreement (S.I.) and the worst total drag coefficient agreement. Mesh3 had the longest solution time, the worst lift coefficient agreement (S.I.) and the best drag coefficient agreement. Mesh2 was in the middle for each of these results. Again, the surface integration S.I. technique produced better results for the lift coefficient, but the drag coefficients were significantly under predicted. The F.F. technique produced better results for the drag coefficient and the lift coefficient was slightly higher than the S.I. value.

Table 39: Overall Results - M165

	CPU Solution Time - cv3	***S.I. Lift %Diff.***	***F.F. Lift %Diff.***	***S.I. Drag %Diff.***	***F.F. Drag %Diff.***
Mesh1	0:40 (1:06)	16.0%	31.9%	-143%	33.2%
Mesh2	1:25 (1:34)	18.2%	19.2%	-142%	15.0%
Mesh3	3:19 (3:49)	19.4%	21.7%	-141%	1.75%

Chapter 9

Comparison with Other Methods

9.1 Introduction

The two wing-bodies were analyzed using the vortex lattice based program Vorview (version 1.7.4) and the conceptual aircraft analysis code ACSYNT (version 2.0) [28], [29], [30]. These results were compared to those obtained from the CFD analysis to determine if the CFD analysis had any improvement over these codes. The vortex lattice method is based on the linearized Laplace equations, and therefore is much quicker to solve than an Euler based method. The main disadvantage to this method is that the flow is not being analyzed and therefore there is no information on the behavior of the flow - which was present in the Euler solution. ACSYNT uses empirical equations to build up the drag from the aircraft's components. Though this method does list the contributions from various drag sources (wave drag, interference drag, lift induced drag, etc.) the flow characteristics are still not known.

The Vorview solution was run on the same RAM geometries used in the CFD analysis. The analysis was run using cosine spacing of the vortices and 100% leading edge suction using the Polhamus analogy. The run times took approximately 15 seconds to complete on the same SGI machine used in the CFD analysis.

The input file for ACSYNT defines the geometry, weights and propulsion system of the aircraft. Also, user entered aerodynamic parameters are used in the minimum drag calculation - which includes the frictional, wave and interference drags. For this analysis, the aerodynamic parameters were left to their default values - except the wing type, which was set to the supercritical (transonic) wing - and all values which could be estimated from the geometric inputs were calculated by ACSYNT. A detailed aerodynamic analysis was done at the specified Mach number and angle of attack for each wing-body.

The geometry was set by defining the geometric parameters such as wing aspect ratio and taper ratio and the fuselage length and diameter. The geometry can be further manipulated through a graphical user interface. The runs took approximately 30 seconds on an IBM R5600 AIX machine.

9.2 Results

9.2.1 Overall Result Comparison

The results from the Vorview and ACSYNT analysis - along with the experimental and farfield CFD results - are given in Tables 40 and 41.

Table 40: Lift and Drag Method Comparisons - W4

	Lift	***Per. Diff.***	***Drag***	***Per. Diff.***
Vorview	0.544	-13%	0.0294	-23%
ACSYNT	0.263	-58%	0.0327	-15%
CFD Mesh1	0.705	13%	0.0472	23%
CFD Mesh2	0.717	15%	0.0425	11%
CFD Mesh3	0.732	17%	0.0399	3.9%
Exp	0.623	-	0.0384	-

Table 41: Lift and Drag Method Comparisons - M165

	Lift	***Per. Diff.***	***Drag***	***Per. Diff.***
Vorview	0.310	1.3%	0.0193	-28%
ACSYNT	0.269	-12%	0.0324	20%
CFD Mesh1	0.403	32%	0.0359	33%
CFD Mesh2	0.365	19%	0.0310	11%
CFD Mesh3	0.372	22%	0.0274	1.9%
Exp	0.306	-	0.0269	-

9.2.2 Vorview Results

Vorview under predicted the lift for the W4 Wing-Body by the same order of magnitude the CFD analysis over predicted the lift coefficient. The lift coefficient predicted by Vorview for the M165 Wing-Body was only off by one percent. The drag for both wing-bodies was under predicted by Vorview because of the lack of any viscous effects in the analysis. Though the Euler CFD results also do not include a viscous boundary layer, there is artificial viscosity present, which increases the drag. This artificial viscosity is not present in the vortex lattice method causing the drag coefficient to be lower in the Vorview analysis.

9.2.3 FRICTION

Since both the Euler and Lapalce equations neglect frictional effects, the program FRICTION was used to approximate these effects on the wing-bodies for the CFD and Vorview solutions. FRICTION uses the van Driest II model to calculate the turbulent skin friction form the Reynolds's number and the wetted surface area and the fineness ratio of the aircraft components [31]. FRICTION predicted the frictional drag coefficient to be 0.01377 for the W4 Wing-Body and 0.01070 for the M165 Wing-Body. The drag coefficients for combined drag predictions are given in Tables 42 and 43. As these tables show, the predicted drag coefficients are now all over predicted. The error in the Vorview result is less than 15%; however the error in the CFD solution is now considerable. This is because the artificial viscosity needed in the Euler solution is adding a nonphysical source of drag

Table 42: Drag Results with FRICTION - W4

	Initial	***FRICTION***	***TOTAL***	***Per. Diff. from EXP***
Vorview	0.0294	0.0138	0.0432	12%
CFD Mesh1	0.0472	0.0138	0.0610	59%
CFD Mesh2	0.0425	0.0138	0.0563	47%
CFD Mesh3	0.0399	0.0138	0.0537	40.%

Table 43: Drag Results with FRICTION - M165

	Initial	***FRICTION***	***TOTAL***	***Per. Diff. from EXP***
Vorview	0.0193	0.0107	0.0300	11%
CFD Mesh1	0.0359	0.0107	0.0466	73%
CFD Mesh2	0.0310	0.0107	0.0417	55%
CFD Mesh3	0.0274	0.0107	0.0381	42%

9.2.4 ACSYNT Results

The error in the lift coefficient for the W4 ACSYNT solution is most likely caused from this wing-body having a high amount of lift at zero angle of attack. Version 2.0 of ACSYNT accounts for the twist and camber in a wing by having the user input the lift coefficient at zero angle of attack at various mach numbers. Version 3.0, however, uses a vortex lattice method to account for twist and camber affects [28], [29]. Thomas Arledge's master's thesis (Ref 32) is an excellent source of information for understanding both ACSYNT's abilities and its limitations.

For this analysis it was assumed that nothing is known about the flight characteristics of the wing-body, therefore these parameters were not used. All other aerodynamic coefficients are off by less than 20%.

9.3 Discussion

ACSYNT is a useful tool for the sizing of an aircraft configuration if there is enough information known about the aircraft so the aerodynamic parameters can be set correctly. However, as shown with the W4 Wing-Body, if nothing is known about the aircraft in advance ACSYNT can have significant errors. Vorview performed well in predicting the lift and drag coefficients of the two wing-bodies when FRICTION was coupled with it. The CFD solutions, however, had considerable error when the frictional forces where added.

CFD would be most useful in analyzing and comparing set aircraft configurations with each other. This is because the details of the flow could be evaluated for the configuration and then the configuration could be modified using this knowledge. For example, areas of strong shocks would become apparent and the aircraft could then be modified to reduce their influence. A mesh based on the parameters of Mesh2 would work well for this type of analysis. This mesh would allow many different configurations to be looked at many different flight conditions while still maintaining a reasonable amount of accuracy.

Chapter 10

Conclusion

For conceptual design an unstructured Euler based CFD system appears to be the best method. Using an unstructured mesh will allow non-experts to quickly generate a mesh around complex aircraft geometry. Using the Euler equations resulted in quick results - mesh generation and flow solution - since there was no need for the boundary layer. The complexity of the system was also reduced since there was no need for a turbulence model.

It was found that all of the Euler CFD solutions were repeatable and the surface pressures of the CFD solution did produce similar trends compared to the experimental data. The deviations of the CFD surface pressures from the experimental data were primarily caused from the lack of the shock/boundary layer interaction in the Euler computations. This resulted in the CFD solution having a sharper, less diffuse pressure distribution at the shock.

It was also found that the surface integration technique did not produce acceptable results for the drag prediction. A farfield method was therefore derived to predict the aerodynamic coefficients. This method produced better results than the surface integration technique for the drag, but was sensitive to the artificial viscosity added (for stability) to the CFD solution. However, it must be noted that the farfield equations do not give any information on the pitching moment, which is needed in conceptual design.

Reducing the number of points in the mesh significantly reduced the time needed to run the entire CFD solution. The Mesh1 solutions for both wing-bodies were completed five times faster than the Mesh3 solutions. The main problem with using the coarser mesh was the larger amount of entropy drag that was produced. Therefore, Mesh3 should be used in order to obtain reasonable drag predictions. For lift prediction, however, it was found that the coarser meshes produced better results. This was attributed to the shock being diffuse by the mesh spacing in the CFD solution, which simulated the boundary layer diffusing the shock in the experimental results.

Chapter 11

Future Work

More work must be done before CFD can be used in the conceptual design stage. The export of a CAD model into the CFD program and the mesh generation must be done automatically. Also, the excess drag caused by the artificial viscosity must be filtered out if the farfield method is going to be used accurately with an Euler based CFD program.

The use of a multigrid method to speed up convergence rates should also be evaluated. In this method, the solution is advanced by alternating between a coarse and a fine mesh. The coarse mesh provides quicker convergence (as was seen in Chapter 3) while the fine mesh maintains the accuracy of the solution [10]. It is unknown how this method would effect the entropy drag calculation in the farfield method.

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Appendix A

Surface Pressure Data

W4 Mesh1 Eta = 0.28

X	Y	Z	Cp
6.89E+01	2.05E+01	-4.30E+00	3.55E-01
6.91E+01	2.05E+01	-4.59E+00	4.94E-01
6.90E+01	2.05E+01	-4.03E+00	-3.69E-01
9.35E+01	2.05E+01	-5.79E+00	3.06E-01
9.39E+01	2.05E+01	-5.81E+00	2.58E-01
9.35E+01	2.05E+01	-5.70E+00	1.58E-01
9.34E+01	2.05E+01	-5.78E+00	3.12E-01
9.33E+01	2.05E+01	-5.78E+00	3.06E-01
9.26E+01	2.05E+01	-5.75E+00	2.74E-01
9.30E+01	2.05E+01	-5.76E+00	2.76E-01
9.25E+01	2.05E+01	-5.74E+00	2.74E-01
9.22E+01	2.05E+01	-5.73E+00	2.76E-01
9.19E+01	2.05E+01	-5.72E+00	2.78E-01
7.01E+01	2.05E+01	-5.16E+00	1.95E-01
6.91E+01	2.05E+01	-4.66E+00	5.54E-01
6.96E+01	2.05E+01	-4.94E+00	3.48E-01
6.96E+01	2.05E+01	-4.95E+00	3.33E-01
7.00E+01	2.05E+01	-5.12E+00	2.21E-01
7.01E+01	2.05E+01	-5.16E+00	1.94E-01
7.07E+01	2.05E+01	-5.35E+00	1.43E-01
7.12E+01	2.05E+01	-5.50E+00	4.79E-02
7.07E+01	2.05E+01	-5.36E+00	1.40E-01
7.12E+01	2.05E+01	-5.51E+00	3.85E-02
9.17E+01	2.05E+01	-5.71E+00	2.82E-01
7.12E+01	2.05E+01	-5.51E+00	3.82E-02
7.17E+01	2.05E+01	-5.62E+00	-8.92E-03
9.14E+01	2.05E+01	-5.70E+00	2.91E-01
9.10E+01	2.05E+01	-5.69E+00	2.98E-01
7.21E+01	2.05E+01	-5.71E+00	-5.78E-02
7.28E+01	2.05E+01	-5.86E+00	-1.05E-01
9.06E+01	2.05E+01	-5.68E+00	3.03E-01
8.99E+01	2.05E+01	-5.69E+00	2.94E-01
8.97E+01	2.05E+01	-5.69E+00	2.93E-01
8.73E+01	2.05E+01	-5.82E+00	1.97E-01
8.51E+01	2.05E+01	-6.00E+00	7.67E-02
8.57E+01	2.05E+01	-5.95E+00	1.16E-01
7.50E+01	2.05E+01	-6.18E+00	-2.42E-01
7.41E+01	2.05E+01	-6.07E+00	-2.09E-01
8.49E+01	2.05E+01	-6.02E+00	6.02E-02
8.40E+01	2.05E+01	-6.11E+00	2.83E-03
8.63E+01	2.05E+01	-5.90E+00	1.50E-01
8.68E+01	2.05E+01	-5.85E+00	1.76E-01
8.65E+01	2.05E+01	-5.88E+00	1.59E-01
7.50E+01	2.05E+01	-6.18E+00	-2.42E-01
7.40E+01	2.05E+01	-6.05E+00	-1.99E-01
7.32E+01	2.05E+01	-5.93E+00	-1.35E-01
8.39E+01	2.05E+01	-6.11E+00	1.06E-03
8.75E+01	2.05E+01	-5.80E+00	2.05E-01
7.80E+01	2.05E+01	-6.37E+00	-3.04E-01
7.76E+01	2.05E+01	-6.36E+00	-3.03E-01
7.70E+01	2.05E+01	-6.34E+00	-2.90E-01
7.67E+01	2.05E+01	-6.32E+00	-2.85E-01
7.84E+01	2.05E+01	-6.38E+00	-3.03E-01
7.90E+01	2.05E+01	-6.38E+00	-2.95E-01
7.93E+01	2.05E+01	-6.38E+00	-2.91E-01
7.60E+01	2.05E+01	-6.27E+00	-2.75E-01
7.59E+01	2.05E+01	-6.26E+00	-2.73E-01
7.50E+01	2.05E+01	-6.18E+00	-2.43E-01

7.99E+01	2.05E+01	-6.37E+00	-2.63E-01
8.39E+01	2.05E+01	-6.11E+00	-2.99E-03
8.81E+01	2.05E+01	-5.77E+00	2.25E-01
8.87E+01	2.05E+01	-5.74E+00	2.48E-01
8.89E+01	2.05E+01	-5.72E+00	2.57E-01
8.95E+01	2.05E+01	-5.70E+00	2.82E-01
8.25E+01	2.05E+01	-6.22E+00	-1.02E-01
8.29E+01	2.05E+01	-6.19E+00	-6.82E-02
8.20E+01	2.05E+01	-6.27E+00	-1.48E-01
8.13E+01	2.05E+01	-6.31E+00	-1.92E-01
8.02E+01	2.05E+01	-6.36E+00	-2.51E-01
8.10E+01	2.05E+01	-6.33E+00	-2.12E-01
9.34E+01	2.05E+01	-5.69E+00	1.44E-01
9.34E+01	2.05E+01	-5.67E+00	1.35E-01
9.30E+01	2.05E+01	-5.57E+00	9.09E-02
6.91E+01	2.05E+01	-3.96E+00	-5.57E-01
6.95E+01	2.05E+01	-3.71E+00	-7.21E-01
7.01E+01	2.05E+01	-3.54E+00	-1.13E+00
6.95E+01	2.05E+01	-3.68E+00	-7.43E-01
7.01E+01	2.05E+01	-3.53E+00	-1.14E+00
7.07E+01	2.05E+01	-3.41E+00	-1.11E+00
7.07E+01	2.05E+01	-3.41E+00	-1.11E+00
7.08E+01	2.05E+01	-3.40E+00	-1.11E+00
9.26E+01	2.05E+01	-5.48E+00	5.03E-02
9.25E+01	2.05E+01	-5.44E+00	3.86E-02
9.24E+01	2.05E+01	-5.41E+00	1.48E-02
9.20E+01	2.05E+01	-5.31E+00	-4.34E-02
9.16E+01	2.05E+01	-5.21E+00	-1.06E-01
7.13E+01	2.05E+01	-3.33E+00	-1.14E+00
7.13E+01	2.05E+01	-3.32E+00	-1.14E+00
9.14E+01	2.05E+01	-5.17E+00	-1.26E-01
9.13E+01	2.05E+01	-5.15E+00	-1.36E-01
7.21E+01	2.05E+01	-3.26E+00	-1.18E+00
7.25E+01	2.05E+01	-3.24E+00	-1.18E+00
9.07E+01	2.05E+01	-4.99E+00	-2.28E-01
8.98E+01	2.05E+01	-4.82E+00	-3.00E-01
8.95E+01	2.05E+01	-4.76E+00	-3.23E-01
7.32E+01	2.05E+01	-3.21E+00	-1.18E+00
8.92E+01	2.05E+01	-4.70E+00	-3.37E-01
8.87E+01	2.05E+01	-4.60E+00	-3.61E-01
8.82E+01	2.05E+01	-4.52E+00	-3.88E-01
8.79E+01	2.05E+01	-4.46E+00	-4.09E-01
8.75E+01	2.05E+01	-4.40E+00	-4.31E-01
8.71E+01	2.05E+01	-4.34E+00	-4.52E-01
8.67E+01	2.05E+01	-4.28E+00	-4.67E-01
8.63E+01	2.05E+01	-4.22E+00	-4.86E-01
8.58E+01	2.05E+01	-4.15E+00	-4.94E-01
8.55E+01	2.05E+01	-4.10E+00	-5.00E-01
8.52E+01	2.05E+01	-4.06E+00	-5.04E-01
8.45E+01	2.05E+01	-3.98E+00	-5.14E-01
8.41E+01	2.05E+01	-3.92E+00	-5.18E-01
8.30E+01	2.05E+01	-3.79E+00	-5.23E-01
8.36E+01	2.05E+01	-3.86E+00	-5.20E-01
8.26E+01	2.05E+01	-3.76E+00	-5.20E-01
8.20E+01	2.05E+01	-3.69E+00	-5.25E-01
8.17E+01	2.05E+01	-3.66E+00	-5.31E-01
8.11E+01	2.05E+01	-3.60E+00	-6.05E-01
8.08E+01	2.05E+01	-3.57E+00	-6.81E-01
8.02E+01	2.05E+01	-3.52E+00	-8.21E-01
7.98E+01	2.05E+01	-3.49E+00	-8.87E-01
7.93E+01	2.05E+01	-3.44E+00	-9.45E-01
7.89E+01	2.05E+01	-3.41E+00	-9.73E-01
7.84E+01	2.05E+01	-3.37E+00	-1.01E+00
7.80E+01	2.05E+01	-3.35E+00	-1.03E+00
7.75E+01	2.05E+01	-3.32E+00	-1.06E+00
7.71E+01	2.05E+01	-3.29E+00	-1.09E+00
7.66E+01	2.05E+01	-3.27E+00	-1.11E+00
7.61E+01	2.05E+01	-3.25E+00	-1.12E+00
7.56E+01	2.05E+01	-3.23E+00	-1.14E+00
7.51E+01	2.05E+01	-3.21E+00	-1.15E+00
7.42E+01	2.05E+01	-3.20E+00	-1.17E+00

7.45E+01	2.05E+01	-3.21E+00	-1.16E+00
7.36E+01	2.05E+01	-3.21E+00	-1.17E+00

W4 Mesh1 eta = 0.53

X	Y	Z	Cp
7.88E+01	3.90E+01	-4.30E+00	6.39E-02
7.90E+01	3.90E+01	-4.58E+00	2.27E-01
7.90E+01	3.90E+01	-4.00E+00	-8.54E-01
9.60E+01	3.90E+01	-4.86E+00	2.75E-01
9.63E+01	3.90E+01	-4.86E+00	2.39E-01
9.60E+01	3.90E+01	-4.79E+00	1.41E-01
7.91E+01	3.90E+01	-4.63E+00	2.42E-01
7.96E+01	3.90E+01	-4.79E+00	2.41E-01
9.59E+01	3.90E+01	-4.86E+00	2.98E-01
9.55E+01	3.90E+01	-4.85E+00	2.76E-01
7.96E+01	3.90E+01	-4.80E+00	2.36E-01
9.54E+01	3.90E+01	-4.85E+00	2.71E-01
9.53E+01	3.90E+01	-4.85E+00	2.72E-01
8.02E+01	3.90E+01	-4.92E+00	7.56E-02
8.02E+01	3.90E+01	-4.92E+00	7.45E-02
8.08E+01	3.90E+01	-5.03E+00	7.13E-02
8.08E+01	3.90E+01	-5.03E+00	7.10E-02
9.49E+01	3.90E+01	-4.85E+00	2.71E-01
9.46E+01	3.90E+01	-4.86E+00	2.75E-01
9.43E+01	3.90E+01	-4.86E+00	2.80E-01
9.38E+01	3.90E+01	-4.87E+00	2.75E-01
8.09E+01	3.90E+01	-5.04E+00	5.96E-02
8.20E+01	3.90E+01	-5.21E+00	-5.01E-02
8.14E+01	3.90E+01	-5.13E+00	-1.88E-02
8.14E+01	3.90E+01	-5.13E+00	-1.49E-02
9.37E+01	3.90E+01	-4.88E+00	2.74E-01
9.34E+01	3.90E+01	-4.90E+00	2.59E-01
8.23E+01	3.90E+01	-5.25E+00	-7.59E-02
8.33E+01	3.90E+01	-5.35E+00	-1.35E-01
9.29E+01	3.90E+01	-4.93E+00	2.36E-01
9.20E+01	3.90E+01	-5.01E+00	1.85E-01
9.28E+01	3.90E+01	-4.94E+00	2.28E-01
9.00E+01	3.90E+01	-5.21E+00	4.68E-02
9.05E+01	3.90E+01	-5.15E+00	8.95E-02
9.08E+01	3.90E+01	-5.12E+00	1.14E-01
8.93E+01	3.90E+01	-5.28E+00	-2.13E-02
8.92E+01	3.90E+01	-5.29E+00	-3.26E-02
8.90E+01	3.90E+01	-5.31E+00	-5.33E-02
8.84E+01	3.90E+01	-5.37E+00	-1.11E-01
9.15E+01	3.90E+01	-5.05E+00	1.59E-01
8.81E+01	3.90E+01	-5.39E+00	-1.42E-01
9.17E+01	3.90E+01	-5.03E+00	1.69E-01
9.17E+01	3.90E+01	-5.03E+00	1.71E-01
8.76E+01	3.90E+01	-5.43E+00	-1.93E-01
8.68E+01	3.90E+01	-5.47E+00	-2.42E-01
8.68E+01	3.90E+01	-5.47E+00	-2.48E-01
8.66E+01	3.90E+01	-5.48E+00	-2.52E-01
8.59E+01	3.90E+01	-5.49E+00	-2.61E-01
8.56E+01	3.90E+01	-5.48E+00	-2.60E-01
8.51E+01	3.90E+01	-5.47E+00	-2.52E-01
8.44E+01	3.90E+01	-5.44E+00	-2.10E-01
8.43E+01	3.90E+01	-5.44E+00	-2.09E-01
8.43E+01	3.90E+01	-5.44E+00	-2.08E-01
8.35E+01	3.90E+01	-5.37E+00	-1.48E-01
7.91E+01	3.90E+01	-3.95E+00	-9.94E-01
7.96E+01	3.90E+01	-3.79E+00	-1.36E+00
9.59E+01	3.90E+01	-4.75E+00	6.77E-02
9.55E+01	3.90E+01	-4.66E+00	7.42E-02
7.96E+01	3.90E+01	-3.78E+00	-1.37E+00
8.01E+01	3.90E+01	-3.70E+00	-1.32E+00
9.54E+01	3.90E+01	-4.63E+00	7.07E-02
9.53E+01	3.90E+01	-4.62E+00	5.86E-02
8.02E+01	3.90E+01	-3.68E+00	-1.31E+00
8.02E+01	3.90E+01	-3.68E+00	-1.31E+00
8.08E+01	3.90E+01	-3.61E+00	-1.23E+00

9.49E+01	3.90E+01	-4.51E+00	-3.06E-02
9.46E+01	3.90E+01	-4.44E+00	-8.36E-02
9.44E+01	3.90E+01	-4.38E+00	-1.25E-01
9.39E+01	3.90E+01	-4.27E+00	-2.04E-01
8.08E+01	3.90E+01	-3.61E+00	-1.23E+00
8.14E+01	3.90E+01	-3.55E+00	-1.21E+00
8.14E+01	3.90E+01	-3.55E+00	-1.21E+00
9.38E+01	3.90E+01	-4.26E+00	-2.10E-01
9.33E+01	3.90E+01	-4.18E+00	-2.55E-01
8.30E+01	3.90E+01	-3.48E+00	-1.22E+00
8.21E+01	3.90E+01	-3.51E+00	-1.23E+00
8.28E+01	3.90E+01	-3.49E+00	-1.23E+00
9.31E+01	3.90E+01	-4.13E+00	-2.79E-01
9.22E+01	3.90E+01	-4.01E+00	-3.33E-01
9.12E+01	3.90E+01	-3.87E+00	-3.95E-01
9.10E+01	3.90E+01	-3.85E+00	-4.00E-01
9.04E+01	3.90E+01	-3.78E+00	-4.19E-01
9.15E+01	3.90E+01	-3.91E+00	-3.73E-01
9.20E+01	3.90E+01	-3.98E+00	-3.49E-01
8.96E+01	3.90E+01	-3.71E+00	-4.21E-01
8.95E+01	3.90E+01	-3.70E+00	-4.24E-01
8.96E+01	3.90E+01	-3.70E+00	-4.22E-01
8.88E+01	3.90E+01	-3.64E+00	-4.75E-01
8.83E+01	3.90E+01	-3.60E+00	-7.06E-01
8.80E+01	3.90E+01	-3.58E+00	-8.36E-01
8.75E+01	3.90E+01	-3.56E+00	-1.04E+00
8.72E+01	3.90E+01	-3.54E+00	-1.19E+00
8.69E+01	3.90E+01	-3.53E+00	-1.18E+00
8.64E+01	3.90E+01	-3.50E+00	-1.19E+00
8.56E+01	3.90E+01	-3.48E+00	-1.19E+00
8.56E+01	3.90E+01	-3.48E+00	-1.19E+00
8.56E+01	3.90E+01	-3.48E+00	-1.19E+00
8.48E+01	3.90E+01	-3.47E+00	-1.18E+00
8.42E+01	3.90E+01	-3.46E+00	-1.20E+00
8.39E+01	3.90E+01	-3.46E+00	-1.20E+00
8.34E+01	3.90E+01	-3.47E+00	-1.21E+00

W4 Mesh1 eta = 0.77

X	Y	Z	Cp
8.83E+01	5.66E+01	-4.30E+00	-1.87E-02
8.84E+01	5.66E+01	-4.40E+00	8.29E-02
8.84E+01	5.66E+01	-4.20E+00	-5.27E-01
9.98E+01	5.66E+01	-4.47E+00	2.08E-01
9.99E+01	5.66E+01	-4.47E+00	1.90E-01
9.98E+01	5.66E+01	-4.44E+00	1.47E-01
8.86E+01	5.66E+01	-4.57E+00	1.54E-01
8.89E+01	5.66E+01	-4.63E+00	1.25E-01
9.95E+01	5.66E+01	-4.48E+00	2.65E-01
9.91E+01	5.66E+01	-4.49E+00	2.43E-01
8.92E+01	5.66E+01	-4.70E+00	1.79E-01
8.95E+01	5.66E+01	-4.74E+00	8.98E-02
9.86E+01	5.66E+01	-4.51E+00	2.28E-01
9.90E+01	5.66E+01	-4.50E+00	2.35E-01
8.98E+01	5.66E+01	-4.79E+00	-1.37E-02
9.01E+01	5.66E+01	-4.83E+00	-3.11E-02
9.04E+01	5.66E+01	-4.86E+00	-4.81E-02
9.85E+01	5.66E+01	-4.52E+00	2.26E-01
9.83E+01	5.66E+01	-4.53E+00	2.18E-01
9.06E+01	5.66E+01	-4.89E+00	-7.94E-02
9.80E+01	5.66E+01	-4.55E+00	2.06E-01
9.78E+01	5.66E+01	-4.56E+00	2.00E-01
9.74E+01	5.66E+01	-4.59E+00	1.86E-01
9.70E+01	5.66E+01	-4.64E+00	1.52E-01
9.68E+01	5.66E+01	-4.65E+00	1.41E-01
9.10E+01	5.66E+01	-4.93E+00	-1.14E-01
9.11E+01	5.66E+01	-4.94E+00	-1.26E-01
9.66E+01	5.66E+01	-4.68E+00	1.15E-01
9.20E+01	5.66E+01	-4.99E+00	-2.02E-01
9.20E+01	5.66E+01	-4.99E+00	-2.02E-01
9.20E+01	5.66E+01	-4.99E+00	-2.02E-01

9.60E+01	5.66E+01	-4.74E+00	5.80E-02
9.57E+01	5.66E+01	-4.79E+00	9.60E-03
9.33E+01	5.66E+01	-4.99E+00	-2.30E-01
9.30E+01	5.66E+01	-5.01E+00	-2.39E-01
9.44E+01	5.66E+01	-4.92E+00	-1.58E-01
9.40E+01	5.66E+01	-4.97E+00	-2.24E-01
9.51E+01	5.66E+01	-4.85E+00	-6.17E-02
8.86E+01	5.66E+01	-4.01E+00	-1.46E+00
8.89E+01	5.66E+01	-3.95E+00	-1.41E+00
9.95E+01	5.66E+01	-4.37E+00	2.08E-02
9.91E+01	5.66E+01	-4.29E+00	1.74E-02
8.92E+01	5.66E+01	-3.88E+00	-1.33E+00
8.95E+01	5.66E+01	-3.84E+00	-1.26E+00
9.90E+01	5.66E+01	-4.27E+00	1.68E-02
9.90E+01	5.66E+01	-4.26E+00	3.46E-03
8.98E+01	5.66E+01	-3.80E+00	-1.24E+00
9.01E+01	5.66E+01	-3.77E+00	-1.20E+00
9.04E+01	5.66E+01	-3.75E+00	-1.18E+00
9.85E+01	5.66E+01	-4.18E+00	-9.60E-02
9.80E+01	5.66E+01	-4.09E+00	-1.50E-01
9.06E+01	5.66E+01	-3.73E+00	-1.18E+00
9.80E+01	5.66E+01	-4.08E+00	-1.52E-01
9.80E+01	5.66E+01	-4.08E+00	-1.55E-01
9.16E+01	5.66E+01	-3.69E+00	-1.18E+00
9.10E+01	5.66E+01	-3.71E+00	-1.18E+00
9.13E+01	5.66E+01	-3.70E+00	-1.19E+00
9.74E+01	5.66E+01	-4.00E+00	-2.19E-01
9.71E+01	5.66E+01	-3.96E+00	-2.45E-01
9.18E+01	5.66E+01	-3.68E+00	-1.21E+00
9.26E+01	5.66E+01	-3.68E+00	-1.24E+00
9.68E+01	5.66E+01	-3.91E+00	-2.80E-01
9.61E+01	5.66E+01	-3.84E+00	-3.21E-01
9.60E+01	5.66E+01	-3.83E+00	-3.31E-01
9.57E+01	5.66E+01	-3.81E+00	-3.30E-01
9.35E+01	5.66E+01	-3.69E+00	-1.29E+00
9.51E+01	5.66E+01	-3.77E+00	-3.44E-01
9.48E+01	5.66E+01	-3.75E+00	-5.97E-01
9.43E+01	5.66E+01	-3.72E+00	-9.09E-01
9.36E+01	5.66E+01	-3.69E+00	-1.25E+00
9.27E+01	5.66E+01	-3.68E+00	-1.25E+00
9.31E+01	5.66E+01	-3.68E+00	-1.27E+00

W4 Mesh2 eta = 0.28

X Y	Z Cp		
6.89E+01	2.05E+01	-4.30E+00	3.54E-01
6.89E+01	2.05E+01	-4.42E+00	4.10E-01
6.89E+01	2.05E+01	-4.16E+00	-1.01E-01
9.33E+01	2.05E+01	-5.78E+00	2.98E-01
9.38E+01	2.05E+01	-5.80E+00	2.85E-01
9.39E+01	2.05E+01	-5.81E+00	2.74E-01
9.37E+01	2.05E+01	-5.74E+00	2.11E-01
6.91E+01	2.05E+01	-4.60E+00	4.90E-01
6.91E+01	2.05E+01	-4.65E+00	4.69E-01
6.94E+01	2.05E+01	-4.86E+00	4.05E-01
6.96E+01	2.05E+01	-4.94E+00	3.62E-01
6.98E+01	2.05E+01	-5.05E+00	3.06E-01
7.00E+01	2.05E+01	-5.13E+00	2.60E-01
7.02E+01	2.05E+01	-5.21E+00	2.01E-01
7.05E+01	2.05E+01	-5.30E+00	1.54E-01
9.32E+01	2.05E+01	-5.77E+00	3.01E-01
9.33E+01	2.05E+01	-5.77E+00	2.99E-01
9.28E+01	2.05E+01	-5.75E+00	2.80E-01
9.27E+01	2.05E+01	-5.75E+00	2.80E-01
9.23E+01	2.05E+01	-5.73E+00	2.77E-01
9.23E+01	2.05E+01	-5.73E+00	2.78E-01
7.07E+01	2.05E+01	-5.36E+00	1.29E-01
7.10E+01	2.05E+01	-5.46E+00	7.57E-02
9.18E+01	2.05E+01	-5.71E+00	2.86E-01
9.18E+01	2.05E+01	-5.71E+00	2.87E-01
9.17E+01	2.05E+01	-5.71E+00	2.89E-01

7.12E+01	2.05E+01	-5.51E+00	4.04E-02
7.17E+01	2.05E+01	-5.62E+00	-8.06E-03
7.29E+01	2.05E+01	-5.87E+00	-1.20E-01
7.19E+01	2.05E+01	-5.67E+00	-3.28E-02
7.24E+01	2.05E+01	-5.79E+00	-8.09E-02
7.20E+01	2.05E+01	-5.69E+00	-4.14E-02
9.06E+01	2.05E+01	-5.68E+00	3.09E-01
9.12E+01	2.05E+01	-5.69E+00	3.01E-01
9.11E+01	2.05E+01	-5.69E+00	3.03E-01
9.01E+01	2.05E+01	-5.69E+00	3.04E-01
8.97E+01	2.05E+01	-5.69E+00	2.98E-01
8.91E+01	2.05E+01	-5.71E+00	2.70E-01
8.90E+01	2.05E+01	-5.72E+00	2.64E-01
8.85E+01	2.05E+01	-5.75E+00	2.44E-01
8.83E+01	2.05E+01	-5.76E+00	2.35E-01
8.82E+01	2.05E+01	-5.76E+00	2.33E-01
7.37E+01	2.05E+01	-6.00E+00	-1.71E-01
7.30E+01	2.05E+01	-5.89E+00	-1.27E-01
7.39E+01	2.05E+01	-6.03E+00	-1.87E-01
7.44E+01	2.05E+01	-6.11E+00	-2.14E-01
8.76E+01	2.05E+01	-5.80E+00	2.14E-01
8.73E+01	2.05E+01	-5.82E+00	2.04E-01
7.47E+01	2.05E+01	-6.14E+00	-2.21E-01
7.52E+01	2.05E+01	-6.19E+00	-2.40E-01
8.68E+01	2.05E+01	-5.85E+00	1.84E-01
8.64E+01	2.05E+01	-5.89E+00	1.61E-01
8.61E+01	2.05E+01	-5.91E+00	1.47E-01
8.54E+01	2.05E+01	-5.97E+00	1.05E-01
7.54E+01	2.05E+01	-6.22E+00	-2.56E-01
8.53E+01	2.05E+01	-5.98E+00	9.65E-02
8.43E+01	2.05E+01	-6.07E+00	3.23E-02
7.74E+01	2.05E+01	-6.36E+00	-2.96E-01
7.78E+01	2.05E+01	-6.37E+00	-3.01E-01
7.70E+01	2.05E+01	-6.34E+00	-2.89E-01
7.67E+01	2.05E+01	-6.32E+00	-2.82E-01
7.62E+01	2.05E+01	-6.29E+00	-2.74E-01
7.82E+01	2.05E+01	-6.38E+00	-3.00E-01
7.87E+01	2.05E+01	-6.39E+00	-2.99E-01
7.59E+01	2.05E+01	-6.26E+00	-2.67E-01
7.89E+01	2.05E+01	-6.39E+00	-2.94E-01
7.95E+01	2.05E+01	-6.38E+00	-2.79E-01
8.03E+01	2.05E+01	-6.36E+00	-2.37E-01
7.97E+01	2.05E+01	-6.38E+00	-2.70E-01
8.04E+01	2.05E+01	-6.36E+00	-2.30E-01
8.11E+01	2.05E+01	-6.33E+00	-1.98E-01
8.11E+01	2.05E+01	-6.32E+00	-1.94E-01
8.19E+01	2.05E+01	-6.28E+00	-1.58E-01
8.19E+01	2.05E+01	-6.27E+00	-1.55E-01
8.24E+01	2.05E+01	-6.24E+00	-1.13E-01
8.26E+01	2.05E+01	-6.22E+00	-8.65E-02
8.27E+01	2.05E+01	-6.22E+00	-8.51E-02
8.34E+01	2.05E+01	-6.15E+00	-3.18E-02
8.35E+01	2.05E+01	-6.15E+00	-2.74E-02
8.43E+01	2.05E+01	-6.07E+00	2.97E-02
8.43E+01	2.05E+01	-6.07E+00	3.09E-02
6.91E+01	2.05E+01	-3.99E+00	-6.73E-01
6.91E+01	2.05E+01	-3.95E+00	-7.16E-01
6.94E+01	2.05E+01	-3.73E+00	-7.32E-01
6.95E+01	2.05E+01	-3.70E+00	-7.94E-01
6.98E+01	2.05E+01	-3.60E+00	-1.14E+00
7.00E+01	2.05E+01	-3.57E+00	-1.15E+00
7.03E+01	2.05E+01	-3.49E+00	-1.08E+00
7.04E+01	2.05E+01	-3.46E+00	-1.07E+00
9.31E+01	2.05E+01	-5.60E+00	1.31E-01
9.32E+01	2.05E+01	-5.62E+00	1.35E-01
9.27E+01	2.05E+01	-5.50E+00	6.78E-02
9.27E+01	2.05E+01	-5.49E+00	6.15E-02
9.35E+01	2.05E+01	-5.71E+00	1.74E-01
9.23E+01	2.05E+01	-5.38E+00	5.41E-03
9.22E+01	2.05E+01	-5.36E+00	-8.56E-03
9.18E+01	2.05E+01	-5.27E+00	-5.95E-02

7.08E+01	2.05E+01	-3.40E+00	-1.11E+00
7.09E+01	2.05E+01	-3.38E+00	-1.12E+00
9.17E+01	2.05E+01	-5.24E+00	-7.87E-02
9.16E+01	2.05E+01	-5.22E+00	-9.03E-02
7.13E+01	2.05E+01	-3.33E+00	-1.14E+00
7.14E+01	2.05E+01	-3.32E+00	-1.14E+00
7.17E+01	2.05E+01	-3.29E+00	-1.16E+00
9.11E+01	2.05E+01	-5.10E+00	-1.67E-01
9.09E+01	2.05E+01	-5.04E+00	-2.01E-01
7.20E+01	2.05E+01	-3.27E+00	-1.18E+00
7.24E+01	2.05E+01	-3.24E+00	-1.17E+00
9.02E+01	2.05E+01	-4.89E+00	-2.88E-01
9.01E+01	2.05E+01	-4.86E+00	-3.02E-01
8.94E+01	2.05E+01	-4.74E+00	-3.20E-01
8.93E+01	2.05E+01	-4.72E+00	-3.23E-01
8.86E+01	2.05E+01	-4.59E+00	-3.67E-01
8.86E+01	2.05E+01	-4.59E+00	-3.68E-01
8.84E+01	2.05E+01	-4.56E+00	-3.76E-01
8.78E+01	2.05E+01	-4.46E+00	-4.08E-01
8.78E+01	2.05E+01	-4.45E+00	-4.11E-01
8.71E+01	2.05E+01	-4.34E+00	-4.58E-01
8.70E+01	2.05E+01	-4.32E+00	-4.61E-01
8.64E+01	2.05E+01	-4.23E+00	-4.83E-01
8.62E+01	2.05E+01	-4.21E+00	-4.86E-01
8.56E+01	2.05E+01	-4.12E+00	-5.00E-01
8.54E+01	2.05E+01	-4.10E+00	-4.99E-01
8.49E+01	2.05E+01	-4.02E+00	-4.97E-01
8.46E+01	2.05E+01	-3.99E+00	-4.96E-01
8.41E+01	2.05E+01	-3.93E+00	-4.96E-01
8.38E+01	2.05E+01	-3.90E+00	-4.94E-01
8.34E+01	2.05E+01	-3.84E+00	-4.90E-01
8.30E+01	2.05E+01	-3.80E+00	-4.86E-01
8.26E+01	2.05E+01	-3.76E+00	-4.84E-01
8.22E+01	2.05E+01	-3.72E+00	-5.02E-01
8.19E+01	2.05E+01	-3.68E+00	-5.32E-01
8.14E+01	2.05E+01	-3.64E+00	-6.52E-01
8.11E+01	2.05E+01	-3.60E+00	-7.42E-01
8.06E+01	2.05E+01	-3.56E+00	-8.49E-01
8.04E+01	2.05E+01	-3.54E+00	-8.91E-01
7.98E+01	2.05E+01	-3.49E+00	-9.37E-01
7.71E+01	2.05E+01	-3.29E+00	-1.08E+00
7.71E+01	2.05E+01	-3.29E+00	-1.08E+00
7.64E+01	2.05E+01	-3.26E+00	-1.11E+00
7.71E+01	2.05E+01	-3.29E+00	-1.08E+00
7.61E+01	2.05E+01	-3.25E+00	-1.12E+00
7.78E+01	2.05E+01	-3.33E+00	-1.05E+00
7.80E+01	2.05E+01	-3.35E+00	-1.04E+00
7.57E+01	2.05E+01	-3.23E+00	-1.14E+00
7.43E+01	2.05E+01	-3.20E+00	-1.18E+00
7.47E+01	2.05E+01	-3.21E+00	-1.17E+00
7.50E+01	2.05E+01	-3.21E+00	-1.16E+00
7.51E+01	2.05E+01	-3.21E+00	-1.16E+00
7.41E+01	2.05E+01	-3.20E+00	-1.18E+00
7.36E+01	2.05E+01	-3.20E+00	-1.18E+00
7.32E+01	2.05E+01	-3.21E+00	-1.18E+00
7.29E+01	2.05E+01	-3.22E+00	-1.18E+00
7.96E+01	2.05E+01	-3.47E+00	-9.53E-01
7.90E+01	2.05E+01	-3.42E+00	-9.93E-01
7.85E+01	2.05E+01	-3.39E+00	-1.02E+00

W4 Mesh2 eta = 0.53

X	Y	Z	Cp
7.88E+01	3.90E+01	-4.30E+00	3.33E-01
7.88E+01	3.90E+01	-4.31E+00	3.32E-01
7.88E+01	3.90E+01	-4.29E+00	2.84E-01
9.63E+01	3.90E+01	-4.86E+00	2.71E-01
9.60E+01	3.90E+01	-4.86E+00	3.08E-01
9.60E+01	3.90E+01	-4.78E+00	1.71E-01
7.90E+01	3.90E+01	-4.58E+00	4.16E-01
7.91E+01	3.90E+01	-4.63E+00	3.16E-01

9.59E+01	3.90E+01	-4.86E+00	3.13E-01
9.59E+01	3.90E+01	-4.86E+00	3.11E-01
9.55E+01	3.90E+01	-4.85E+00	2.81E-01
9.53E+01	3.90E+01	-4.85E+00	2.79E-01
7.94E+01	3.90E+01	-4.75E+00	1.12E-01
7.96E+01	3.90E+01	-4.79E+00	1.59E-01
7.99E+01	3.90E+01	-4.86E+00	1.70E-01
8.01E+01	3.90E+01	-4.90E+00	1.31E-01
9.51E+01	3.90E+01	-4.85E+00	2.78E-01
9.47E+01	3.90E+01	-4.86E+00	2.81E-01
8.04E+01	3.90E+01	-4.96E+00	7.74E-02
8.06E+01	3.90E+01	-5.00E+00	6.54E-02
9.47E+01	3.90E+01	-4.86E+00	2.81E-01
9.46E+01	3.90E+01	-4.86E+00	2.82E-01
8.09E+01	3.90E+01	-5.05E+00	5.27E-02
8.11E+01	3.90E+01	-5.09E+00	2.65E-02
9.42E+01	3.90E+01	-4.86E+00	2.85E-01
9.41E+01	3.90E+01	-4.87E+00	2.85E-01
8.14E+01	3.90E+01	-5.13E+00	-5.42E-03
8.18E+01	3.90E+01	-5.19E+00	-3.43E-02
9.37E+01	3.90E+01	-4.88E+00	2.86E-01
9.32E+01	3.90E+01	-4.91E+00	2.61E-01
9.32E+01	3.90E+01	-4.91E+00	2.60E-01
8.20E+01	3.90E+01	-5.21E+00	-4.73E-02
8.23E+01	3.90E+01	-5.25E+00	-7.31E-02
9.32E+01	3.90E+01	-4.91E+00	2.59E-01
9.31E+01	3.90E+01	-4.92E+00	2.53E-01
8.28E+01	3.90E+01	-5.31E+00	-1.15E-01
9.25E+01	3.90E+01	-4.96E+00	2.19E-01
8.33E+01	3.90E+01	-5.35E+00	-1.44E-01
8.30E+01	3.90E+01	-5.33E+00	-1.27E-01
9.23E+01	3.90E+01	-4.98E+00	2.11E-01
9.17E+01	3.90E+01	-5.03E+00	1.76E-01
9.13E+01	3.90E+01	-5.07E+00	1.54E-01
9.08E+01	3.90E+01	-5.12E+00	1.12E-01
8.38E+01	3.90E+01	-5.40E+00	-1.75E-01
8.46E+01	3.90E+01	-5.45E+00	-2.26E-01
8.41E+01	3.90E+01	-5.42E+00	-1.97E-01
8.51E+01	3.90E+01	-5.47E+00	-2.46E-01
8.54E+01	3.90E+01	-5.48E+00	-2.59E-01
8.62E+01	3.90E+01	-5.48E+00	-2.66E-01
8.61E+01	3.90E+01	-5.48E+00	-2.64E-01
8.69E+01	3.90E+01	-5.47E+00	-2.40E-01
8.74E+01	3.90E+01	-5.44E+00	-2.00E-01
8.70E+01	3.90E+01	-5.46E+00	-2.37E-01
8.77E+01	3.90E+01	-5.42E+00	-1.76E-01
8.77E+01	3.90E+01	-5.42E+00	-1.72E-01
8.84E+01	3.90E+01	-5.37E+00	-1.04E-01
8.86E+01	3.90E+01	-5.35E+00	-8.90E-02
8.92E+01	3.90E+01	-5.30E+00	-2.87E-02
8.94E+01	3.90E+01	-5.27E+00	-7.16E-03
8.99E+01	3.90E+01	-5.22E+00	3.91E-02
9.03E+01	3.90E+01	-5.18E+00	7.10E-02
7.90E+01	3.90E+01	-4.00E+00	-9.44E-01
7.91E+01	3.90E+01	-3.95E+00	-1.01E+00
9.59E+01	3.90E+01	-4.76E+00	1.50E-01
9.59E+01	3.90E+01	-4.76E+00	1.51E-01
9.56E+01	3.90E+01	-4.67E+00	1.13E-01
9.53E+01	3.90E+01	-4.61E+00	5.97E-02
7.94E+01	3.90E+01	-3.83E+00	-1.32E+00
7.96E+01	3.90E+01	-3.79E+00	-1.41E+00
7.99E+01	3.90E+01	-3.73E+00	-1.36E+00
8.01E+01	3.90E+01	-3.70E+00	-1.32E+00
9.52E+01	3.90E+01	-4.57E+00	1.77E-02
9.48E+01	3.90E+01	-4.47E+00	-4.84E-02
8.03E+01	3.90E+01	-3.66E+00	-1.31E+00
8.06E+01	3.90E+01	-3.63E+00	-1.30E+00
9.47E+01	3.90E+01	-4.47E+00	-5.51E-02
9.47E+01	3.90E+01	-4.46E+00	-5.88E-02
8.08E+01	3.90E+01	-3.60E+00	-1.29E+00
8.11E+01	3.90E+01	-3.58E+00	-1.28E+00

9.43E+01	3.90E+01	-4.36E+00	-1.51E-01
9.41E+01	3.90E+01	-4.32E+00	-1.84E-01
8.14E+01	3.90E+01	-3.56E+00	-1.28E+00
8.16E+01	3.90E+01	-3.54E+00	-1.27E+00
9.38E+01	3.90E+01	-4.26E+00	-2.29E-01
9.35E+01	3.90E+01	-4.21E+00	-2.47E-01
8.20E+01	3.90E+01	-3.52E+00	-1.26E+00
8.26E+01	3.90E+01	-3.49E+00	-1.25E+00
9.32E+01	3.90E+01	-4.15E+00	-2.76E-01
9.26E+01	3.90E+01	-4.06E+00	-3.12E-01
8.27E+01	3.90E+01	-3.49E+00	-1.24E+00
8.34E+01	3.90E+01	-3.47E+00	-1.22E+00
9.24E+01	3.90E+01	-4.03E+00	-3.23E-01
9.22E+01	3.90E+01	-4.00E+00	-3.34E-01
8.35E+01	3.90E+01	-3.47E+00	-1.22E+00
8.36E+01	3.90E+01	-3.47E+00	-1.22E+00
9.15E+01	3.90E+01	-3.91E+00	-3.63E-01
8.42E+01	3.90E+01	-3.46E+00	-1.21E+00
8.49E+01	3.90E+01	-3.47E+00	-1.20E+00
8.43E+01	3.90E+01	-3.46E+00	-1.21E+00
8.63E+01	3.90E+01	-3.50E+00	-1.18E+00
8.70E+01	3.90E+01	-3.53E+00	-1.18E+00
8.70E+01	3.90E+01	-3.53E+00	-1.18E+00
8.71E+01	3.90E+01	-3.53E+00	-1.18E+00
8.77E+01	3.90E+01	-3.57E+00	-1.20E+00
8.80E+01	3.90E+01	-3.58E+00	-1.12E+00
8.61E+01	3.90E+01	-3.50E+00	-1.19E+00
8.56E+01	3.90E+01	-3.48E+00	-1.19E+00
8.52E+01	3.90E+01	-3.47E+00	-1.20E+00
8.84E+01	3.90E+01	-3.61E+00	-9.03E-01
8.89E+01	3.90E+01	-3.64E+00	-6.06E-01
8.92E+01	3.90E+01	-3.67E+00	-3.95E-01
9.05E+01	3.90E+01	-3.80E+00	-3.72E-01
8.98E+01	3.90E+01	-3.72E+00	-3.46E-01
8.99E+01	3.90E+01	-3.73E+00	-3.38E-01
9.02E+01	3.90E+01	-3.76E+00	-3.53E-01
9.06E+01	3.90E+01	-3.81E+00	-3.73E-01
9.12E+01	3.90E+01	-3.87E+00	-3.73E-01

W4 Mesh2 eta = 0.77

X	Y	Z	Cp
8.83E+01	5.66E+01	-4.30E+00	7.77E-02
8.84E+01	5.66E+01	-4.37E+00	1.57E-01
8.84E+01	5.66E+01	-4.22E+00	-3.24E-01
9.99E+01	5.66E+01	-4.47E+00	2.10E-01
9.99E+01	5.66E+01	-4.47E+00	2.12E-01
9.99E+01	5.66E+01	-4.47E+00	2.06E-01
8.88E+01	5.66E+01	-4.60E+00	1.93E-01
8.86E+01	5.66E+01	-4.55E+00	2.64E-01
9.96E+01	5.66E+01	-4.48E+00	2.97E-01
9.94E+01	5.66E+01	-4.49E+00	2.66E-01
9.91E+01	5.66E+01	-4.49E+00	2.42E-01
9.87E+01	5.66E+01	-4.51E+00	2.42E-01
9.87E+01	5.66E+01	-4.51E+00	2.42E-01
9.86E+01	5.66E+01	-4.51E+00	2.40E-01
8.90E+01	5.66E+01	-4.66E+00	1.52E-01
8.93E+01	5.66E+01	-4.70E+00	1.16E-01
8.95E+01	5.66E+01	-4.74E+00	8.01E-02
8.97E+01	5.66E+01	-4.78E+00	3.40E-02
8.99E+01	5.66E+01	-4.81E+00	2.63E-03
9.02E+01	5.66E+01	-4.85E+00	-3.07E-02
9.83E+01	5.66E+01	-4.53E+00	2.27E-01
9.81E+01	5.66E+01	-4.54E+00	2.22E-01
9.05E+01	5.66E+01	-4.87E+00	-6.11E-02
9.07E+01	5.66E+01	-4.90E+00	-8.62E-02
9.78E+01	5.66E+01	-4.56E+00	2.12E-01
9.74E+01	5.66E+01	-4.60E+00	1.92E-01
9.11E+01	5.66E+01	-4.93E+00	-1.13E-01
9.12E+01	5.66E+01	-4.94E+00	-1.29E-01
9.16E+01	5.66E+01	-4.97E+00	-1.56E-01

9.67E+01	5.66E+01	-4.67E+00	1.42E-01
9.74E+01	5.66E+01	-4.60E+00	1.89E-01
9.67E+01	5.66E+01	-4.67E+00	1.42E-01
9.26E+01	5.66E+01	-5.00E+00	-2.36E-01
9.20E+01	5.66E+01	-4.99E+00	-1.96E-01
9.67E+01	5.66E+01	-4.67E+00	1.42E-01
9.67E+01	5.66E+01	-4.67E+00	1.42E-01
9.45E+01	5.66E+01	-4.92E+00	-1.52E-01
9.50E+01	5.66E+01	-4.87E+00	-9.32E-02
9.54E+01	5.66E+01	-4.83E+00	-1.80E-02
9.57E+01	5.66E+01	-4.78E+00	2.97E-02
9.42E+01	5.66E+01	-4.95E+00	-1.82E-01
9.37E+01	5.66E+01	-4.98E+00	-2.45E-01
9.34E+01	5.66E+01	-4.99E+00	-2.49E-01
9.28E+01	5.66E+01	-5.01E+00	-2.47E-01
8.88E+01	5.66E+01	-3.98E+00	-1.25E+00
8.85E+01	5.66E+01	-4.03E+00	-1.29E+00
9.94E+01	5.66E+01	-4.35E+00	5.55E-02
9.96E+01	5.66E+01	-4.39E+00	2.33E-02
9.92E+01	5.66E+01	-4.30E+00	4.63E-02
9.88E+01	5.66E+01	-4.22E+00	-4.67E-02
9.87E+01	5.66E+01	-4.22E+00	-5.01E-02
9.87E+01	5.66E+01	-4.21E+00	-5.44E-02
8.90E+01	5.66E+01	-3.91E+00	-1.26E+00
8.93E+01	5.66E+01	-3.87E+00	-1.26E+00
8.95E+01	5.66E+01	-3.84E+00	-1.20E+00
8.97E+01	5.66E+01	-3.81E+00	-1.22E+00
8.99E+01	5.66E+01	-3.79E+00	-1.23E+00
9.02E+01	5.66E+01	-3.76E+00	-1.25E+00
9.83E+01	5.66E+01	-4.14E+00	-1.04E-01
9.81E+01	5.66E+01	-4.10E+00	-1.30E-01
9.04E+01	5.66E+01	-3.74E+00	-1.26E+00
9.08E+01	5.66E+01	-3.72E+00	-1.25E+00
9.79E+01	5.66E+01	-4.06E+00	-1.63E-01
9.74E+01	5.66E+01	-3.99E+00	-2.20E-01
9.10E+01	5.66E+01	-3.71E+00	-1.24E+00
9.14E+01	5.66E+01	-3.70E+00	-1.26E+00
9.73E+01	5.66E+01	-3.98E+00	-2.22E-01
9.73E+01	5.66E+01	-3.98E+00	-2.24E-01
9.16E+01	5.66E+01	-3.69E+00	-1.26E+00
9.17E+01	5.66E+01	-3.69E+00	-1.26E+00
9.67E+01	5.66E+01	-3.90E+00	-2.86E-01
9.63E+01	5.66E+01	-3.86E+00	-2.74E-01
9.32E+01	5.66E+01	-3.68E+00	-1.28E+00
9.33E+01	5.66E+01	-3.69E+00	-1.30E+00
9.25E+01	5.66E+01	-3.68E+00	-1.26E+00
9.24E+01	5.66E+01	-3.68E+00	-1.25E+00
9.39E+01	5.66E+01	-3.70E+00	-1.35E+00
9.42E+01	5.66E+01	-3.71E+00	-1.20E+00
9.46E+01	5.66E+01	-3.74E+00	-8.40E-01
9.50E+01	5.66E+01	-3.76E+00	-5.58E-01
9.54E+01	5.66E+01	-3.78E+00	-2.83E-01
9.59E+01	5.66E+01	-3.82E+00	-2.63E-01

W4 Mesh3 eta = 0.28

X Y	Z	Cp	
6.89E+01	2.05E+01	-4.30E+00	3.27E-01
6.90E+01	2.05E+01	-4.54E+00	5.79E-01
6.90E+01	2.05E+01	-4.05E+00	-3.58E-01
9.39E+01	2.05E+01	-5.81E+00	2.81E-01
9.39E+01	2.05E+01	-5.81E+00	2.82E-01
9.39E+01	2.05E+01	-5.80E+00	2.77E-01
6.90E+01	2.05E+01	-4.55E+00	5.83E-01
6.90E+01	2.05E+01	-4.57E+00	5.77E-01
6.93E+01	2.05E+01	-4.79E+00	5.15E-01
6.93E+01	2.05E+01	-4.83E+00	4.80E-01
6.96E+01	2.05E+01	-4.96E+00	3.51E-01
6.97E+01	2.05E+01	-5.00E+00	3.27E-01
6.99E+01	2.05E+01	-5.10E+00	2.83E-01
7.01E+01	2.05E+01	-5.15E+00	2.54E-01

7.03E+01	2.05E+01	-5.23E+00	2.12E-01
7.04E+01	2.05E+01	-5.28E+00	1.82E-01
9.33E+01	2.05E+01	-5.78E+00	2.89E-01
9.33E+01	2.05E+01	-5.78E+00	2.92E-01
9.25E+01	2.05E+01	-5.74E+00	2.85E-01
9.25E+01	2.05E+01	-5.74E+00	2.85E-01
9.29E+01	2.05E+01	-5.76E+00	2.85E-01
9.29E+01	2.05E+01	-5.76E+00	2.84E-01
9.25E+01	2.05E+01	-5.74E+00	2.85E-01
9.21E+01	2.05E+01	-5.72E+00	2.85E-01
7.07E+01	2.05E+01	-5.35E+00	1.34E-01
7.08E+01	2.05E+01	-5.39E+00	1.11E-01
9.21E+01	2.05E+01	-5.72E+00	2.85E-01
9.21E+01	2.05E+01	-5.72E+00	2.85E-01
9.17E+01	2.05E+01	-5.71E+00	2.92E-01
9.17E+01	2.05E+01	-5.71E+00	2.92E-01
7.11E+01	2.05E+01	-5.48E+00	6.21E-02
7.12E+01	2.05E+01	-5.49E+00	5.30E-02
9.13E+01	2.05E+01	-5.70E+00	3.02E-01
9.12E+01	2.05E+01	-5.69E+00	3.04E-01
7.16E+01	2.05E+01	-5.62E+00	-1.19E-02
7.17E+01	2.05E+01	-5.63E+00	-1.85E-02
7.18E+01	2.05E+01	-5.65E+00	-2.54E-02
9.10E+01	2.05E+01	-5.69E+00	3.09E-01
9.06E+01	2.05E+01	-5.68E+00	3.14E-01
9.03E+01	2.05E+01	-5.68E+00	3.16E-01
7.43E+01	2.05E+01	-6.09E+00	-2.06E-01
7.54E+01	2.05E+01	-6.22E+00	-2.53E-01
7.57E+01	2.05E+01	-6.25E+00	-2.60E-01
7.50E+01	2.05E+01	-6.18E+00	-2.36E-01
7.44E+01	2.05E+01	-6.11E+00	-2.13E-01
7.49E+01	2.05E+01	-6.16E+00	-2.32E-01
7.60E+01	2.05E+01	-6.27E+00	-2.70E-01
7.42E+01	2.05E+01	-6.09E+00	-2.03E-01
7.65E+01	2.05E+01	-6.30E+00	-2.78E-01
7.37E+01	2.05E+01	-6.01E+00	-1.79E-01
7.35E+01	2.05E+01	-5.98E+00	-1.67E-01
8.99E+01	2.05E+01	-5.69E+00	3.10E-01
8.97E+01	2.05E+01	-5.69E+00	3.01E-01
8.90E+01	2.05E+01	-5.72E+00	2.71E-01
8.92E+01	2.05E+01	-5.71E+00	2.81E-01
7.31E+01	2.05E+01	-5.92E+00	-1.42E-01
7.27E+01	2.05E+01	-5.85E+00	-1.08E-01
7.66E+01	2.05E+01	-6.32E+00	-2.80E-01
7.72E+01	2.05E+01	-6.35E+00	-2.93E-01
7.72E+01	2.05E+01	-6.35E+00	-2.93E-01
7.72E+01	2.05E+01	-6.35E+00	-2.93E-01
7.78E+01	2.05E+01	-6.37E+00	-3.01E-01
7.79E+01	2.05E+01	-6.37E+00	-3.02E-01
7.84E+01	2.05E+01	-6.38E+00	-3.03E-01
7.86E+01	2.05E+01	-6.38E+00	-2.99E-01
7.94E+01	2.05E+01	-6.38E+00	-2.80E-01
7.90E+01	2.05E+01	-6.39E+00	-2.93E-01
7.25E+01	2.05E+01	-5.80E+00	-8.86E-02
8.86E+01	2.05E+01	-5.74E+00	2.53E-01
8.84E+01	2.05E+01	-5.75E+00	2.46E-01
8.80E+01	2.05E+01	-5.77E+00	2.31E-01
8.77E+01	2.05E+01	-5.79E+00	2.23E-01
8.73E+01	2.05E+01	-5.81E+00	2.10E-01
8.07E+01	2.05E+01	-6.34E+00	-2.19E-01
7.96E+01	2.05E+01	-6.38E+00	-2.67E-01
8.03E+01	2.05E+01	-6.36E+00	-2.33E-01
8.01E+01	2.05E+01	-6.37E+00	-2.43E-01
8.02E+01	2.05E+01	-6.36E+00	-2.38E-01
8.10E+01	2.05E+01	-6.33E+00	-2.03E-01
8.13E+01	2.05E+01	-6.31E+00	-1.87E-01
8.17E+01	2.05E+01	-6.28E+00	-1.57E-01
8.19E+01	2.05E+01	-6.28E+00	-1.48E-01
8.20E+01	2.05E+01	-6.27E+00	-1.42E-01
8.24E+01	2.05E+01	-6.23E+00	-9.93E-02
8.29E+01	2.05E+01	-6.20E+00	-6.50E-02

8.30E+01	2.05E+01	-6.19E+00	-5.72E-02
8.31E+01	2.05E+01	-6.18E+00	-4.72E-02
8.36E+01	2.05E+01	-6.14E+00	-1.83E-02
8.38E+01	2.05E+01	-6.12E+00	-5.25E-04
8.41E+01	2.05E+01	-6.09E+00	1.83E-02
8.45E+01	2.05E+01	-6.05E+00	4.65E-02
8.48E+01	2.05E+01	-6.03E+00	6.24E-02
8.47E+01	2.05E+01	-6.04E+00	5.62E-02
8.57E+01	2.05E+01	-5.94E+00	1.27E-01
8.52E+01	2.05E+01	-5.99E+00	9.48E-02
8.58E+01	2.05E+01	-5.94E+00	1.32E-01
8.64E+01	2.05E+01	-5.88E+00	1.67E-01
8.59E+01	2.05E+01	-5.93E+00	1.37E-01
8.71E+01	2.05E+01	-5.83E+00	1.99E-01
8.67E+01	2.05E+01	-5.86E+00	1.83E-01
6.90E+01	2.05E+01	-4.04E+00	-3.62E-01
6.90E+01	2.05E+01	-4.04E+00	-3.69E-01
6.93E+01	2.05E+01	-3.81E+00	-6.42E-01
6.93E+01	2.05E+01	-3.78E+00	-7.24E-01
6.96E+01	2.05E+01	-3.67E+00	-1.06E+00
6.97E+01	2.05E+01	-3.64E+00	-1.06E+00
6.99E+01	2.05E+01	-3.57E+00	-1.10E+00
7.00E+01	2.05E+01	-3.55E+00	-1.09E+00
7.03E+01	2.05E+01	-3.49E+00	-1.04E+00
7.04E+01	2.05E+01	-3.46E+00	-1.04E+00
9.33E+01	2.05E+01	-5.65E+00	1.64E-01
9.34E+01	2.05E+01	-5.66E+00	1.67E-01
9.30E+01	2.05E+01	-5.56E+00	1.14E-01
9.29E+01	2.05E+01	-5.55E+00	1.03E-01
9.26E+01	2.05E+01	-5.47E+00	5.42E-02
9.26E+01	2.05E+01	-5.46E+00	4.67E-02
9.22E+01	2.05E+01	-5.37E+00	-1.28E-03
7.07E+01	2.05E+01	-3.41E+00	-1.05E+00
7.08E+01	2.05E+01	-3.39E+00	-1.07E+00
9.22E+01	2.05E+01	-5.36E+00	-9.49E-03
9.18E+01	2.05E+01	-5.27E+00	-5.62E-02
9.18E+01	2.05E+01	-5.25E+00	-6.73E-02
9.17E+01	2.05E+01	-5.23E+00	-7.99E-02
7.11E+01	2.05E+01	-3.35E+00	-1.11E+00
7.12E+01	2.05E+01	-3.34E+00	-1.12E+00
9.12E+01	2.05E+01	-5.11E+00	-1.63E-01
7.16E+01	2.05E+01	-3.30E+00	-1.16E+00
7.19E+01	2.05E+01	-3.27E+00	-1.17E+00
9.11E+01	2.05E+01	-5.09E+00	-1.75E-01
9.06E+01	2.05E+01	-4.98E+00	-2.48E-01
9.06E+01	2.05E+01	-4.98E+00	-2.50E-01
7.31E+01	2.05E+01	-3.21E+00	-1.20E+00
9.01E+01	2.05E+01	-4.87E+00	-3.06E-01
7.26E+01	2.05E+01	-3.23E+00	-1.19E+00
7.25E+01	2.05E+01	-3.23E+00	-1.18E+00
7.25E+01	2.05E+01	-3.23E+00	-1.18E+00
9.00E+01	2.05E+01	-4.85E+00	-3.13E-01
7.32E+01	2.05E+01	-3.21E+00	-1.20E+00
7.37E+01	2.05E+01	-3.20E+00	-1.19E+00
8.94E+01	2.05E+01	-4.74E+00	-3.32E-01
7.39E+01	2.05E+01	-3.20E+00	-1.19E+00
7.43E+01	2.05E+01	-3.20E+00	-1.18E+00
7.45E+01	2.05E+01	-3.20E+00	-1.17E+00
7.52E+01	2.05E+01	-3.22E+00	-1.16E+00
7.50E+01	2.05E+01	-3.21E+00	-1.17E+00
7.59E+01	2.05E+01	-3.24E+00	-1.14E+00
7.56E+01	2.05E+01	-3.23E+00	-1.15E+00
7.66E+01	2.05E+01	-3.27E+00	-1.11E+00
7.62E+01	2.05E+01	-3.25E+00	-1.13E+00
7.68E+01	2.05E+01	-3.28E+00	-1.10E+00
7.73E+01	2.05E+01	-3.30E+00	-1.08E+00
7.74E+01	2.05E+01	-3.31E+00	-1.07E+00
7.79E+01	2.05E+01	-3.34E+00	-1.04E+00
7.80E+01	2.05E+01	-3.35E+00	-1.04E+00
7.86E+01	2.05E+01	-3.39E+00	-1.01E+00
8.93E+01	2.05E+01	-4.72E+00	-3.37E-01

8.88E+01	2.05E+01	-4.62E+00	-3.61E-01
8.87E+01	2.05E+01	-4.60E+00	-3.65E-01
8.81E+01	2.05E+01	-4.49E+00	-4.01E-01
8.80E+01	2.05E+01	-4.49E+00	-4.02E-01
8.80E+01	2.05E+01	-4.48E+00	-4.06E-01
8.74E+01	2.05E+01	-4.39E+00	-4.41E-01
8.73E+01	2.05E+01	-4.37E+00	-4.46E-01
8.72E+01	2.05E+01	-4.35E+00	-4.53E-01
8.68E+01	2.05E+01	-4.29E+00	-4.73E-01
8.64E+01	2.05E+01	-4.24E+00	-4.86E-01
8.62E+01	2.05E+01	-4.20E+00	-4.94E-01
8.57E+01	2.05E+01	-4.14E+00	-4.99E-01
8.56E+01	2.05E+01	-4.11E+00	-5.01E-01
8.51E+01	2.05E+01	-4.05E+00	-4.98E-01
8.48E+01	2.05E+01	-4.02E+00	-4.97E-01
8.44E+01	2.05E+01	-3.97E+00	-4.92E-01
8.42E+01	2.05E+01	-3.93E+00	-4.89E-01
8.38E+01	2.05E+01	-3.89E+00	-4.85E-01
8.35E+01	2.05E+01	-3.85E+00	-4.82E-01
8.32E+01	2.05E+01	-3.82E+00	-4.82E-01
8.28E+01	2.05E+01	-3.78E+00	-4.75E-01
8.25E+01	2.05E+01	-3.75E+00	-4.72E-01
8.22E+01	2.05E+01	-3.71E+00	-5.06E-01
8.19E+01	2.05E+01	-3.68E+00	-6.01E-01
8.15E+01	2.05E+01	-3.65E+00	-7.11E-01
8.13E+01	2.05E+01	-3.62E+00	-8.00E-01
8.09E+01	2.05E+01	-3.58E+00	-8.79E-01
8.06E+01	2.05E+01	-3.56E+00	-9.02E-01
8.02E+01	2.05E+01	-3.52E+00	-9.26E-01
8.00E+01	2.05E+01	-3.50E+00	-9.38E-01
7.96E+01	2.05E+01	-3.46E+00	-9.58E-01
7.93E+01	2.05E+01	-3.45E+00	-9.72E-01
7.87E+01	2.05E+01	-3.40E+00	-1.01E+00
7.87E+01	2.05E+01	-3.39E+00	-1.01E+00

W4 Mesh3 eta = 0.53

X Y	Z	Cp	
7.88E+01	3.90E+01	-4.30E+00	3.32E-01
7.89E+01	3.90E+01	-4.50E+00	4.45E-01
7.89E+01	3.90E+01	-4.08E+00	-5.09E-01
9.60E+01	3.90E+01	-4.86E+00	3.47E-01
9.63E+01	3.90E+01	-4.86E+00	2.99E-01
9.60E+01	3.90E+01	-4.79E+00	2.23E-01
9.60E+01	3.90E+01	-4.86E+00	3.48E-01
9.60E+01	3.90E+01	-4.86E+00	3.44E-01
9.57E+01	3.90E+01	-4.86E+00	2.98E-01
9.56E+01	3.90E+01	-4.86E+00	2.93E-01
7.90E+01	3.90E+01	-4.54E+00	4.48E-01
7.93E+01	3.90E+01	-4.71E+00	2.16E-01
7.93E+01	3.90E+01	-4.71E+00	2.16E-01
7.93E+01	3.90E+01	-4.71E+00	2.16E-01
7.96E+01	3.90E+01	-4.80E+00	2.21E-01
7.97E+01	3.90E+01	-4.81E+00	2.16E-01
8.00E+01	3.90E+01	-4.88E+00	1.57E-01
8.00E+01	3.90E+01	-4.89E+00	1.53E-01
8.04E+01	3.90E+01	-4.96E+00	1.10E-01
8.04E+01	3.90E+01	-4.97E+00	1.05E-01
9.54E+01	3.90E+01	-4.85E+00	2.85E-01
9.51E+01	3.90E+01	-4.85E+00	2.85E-01
9.50E+01	3.90E+01	-4.85E+00	2.85E-01
9.49E+01	3.90E+01	-4.85E+00	2.86E-01
9.47E+01	3.90E+01	-4.86E+00	2.87E-01
9.46E+01	3.90E+01	-4.86E+00	2.88E-01
8.12E+01	3.90E+01	-5.10E+00	2.57E-02
8.10E+01	3.90E+01	-5.06E+00	4.31E-02
8.08E+01	3.90E+01	-5.03E+00	5.97E-02
8.08E+01	3.90E+01	-5.04E+00	5.62E-02
9.43E+01	3.90E+01	-4.86E+00	2.93E-01
9.40E+01	3.90E+01	-4.87E+00	2.96E-01
8.12E+01	3.90E+01	-5.11E+00	2.06E-02

8.16E+01	3.90E+01	-5.16E+00	-1.03E-02
9.39E+01	3.90E+01	-4.87E+00	2.98E-01
9.36E+01	3.90E+01	-4.88E+00	2.87E-01
8.22E+01	3.90E+01	-5.24E+00	-6.99E-02
8.22E+01	3.90E+01	-5.24E+00	-6.71E-02
8.17E+01	3.90E+01	-5.18E+00	-2.10E-02
9.34E+01	3.90E+01	-4.89E+00	2.81E-01
9.34E+01	3.90E+01	-4.90E+00	2.76E-01
9.30E+01	3.90E+01	-4.92E+00	2.54E-01
9.26E+01	3.90E+01	-4.95E+00	2.34E-01
9.24E+01	3.90E+01	-4.96E+00	2.23E-01
9.19E+01	3.90E+01	-5.01E+00	1.95E-01
9.19E+01	3.90E+01	-5.02E+00	1.93E-01
9.18E+01	3.90E+01	-5.02E+00	1.90E-01
9.13E+01	3.90E+01	-5.07E+00	1.57E-01
9.11E+01	3.90E+01	-5.09E+00	1.39E-01
9.07E+01	3.90E+01	-5.13E+00	1.12E-01
8.91E+01	3.90E+01	-5.30E+00	-3.06E-02
8.77E+01	3.90E+01	-5.42E+00	-1.75E-01
8.80E+01	3.90E+01	-5.40E+00	-1.49E-01
8.74E+01	3.90E+01	-5.44E+00	-2.00E-01
8.69E+01	3.90E+01	-5.47E+00	-2.27E-01
8.86E+01	3.90E+01	-5.35E+00	-8.07E-02
8.86E+01	3.90E+01	-5.35E+00	-8.61E-02
8.85E+01	3.90E+01	-5.36E+00	-8.96E-02
9.02E+01	3.90E+01	-5.18E+00	7.33E-02
9.01E+01	3.90E+01	-5.19E+00	6.53E-02
9.00E+01	3.90E+01	-5.21E+00	4.92E-02
8.96E+01	3.90E+01	-5.25E+00	1.51E-02
8.94E+01	3.90E+01	-5.27E+00	-1.16E-03
8.69E+01	3.90E+01	-5.47E+00	-2.30E-01
8.67E+01	3.90E+01	-5.47E+00	-2.38E-01
8.63E+01	3.90E+01	-5.48E+00	-2.60E-01
8.61E+01	3.90E+01	-5.48E+00	-2.61E-01
8.53E+01	3.90E+01	-5.48E+00	-2.54E-01
8.57E+01	3.90E+01	-5.49E+00	-2.64E-01
8.28E+01	3.90E+01	-5.31E+00	-1.07E-01
8.30E+01	3.90E+01	-5.33E+00	-1.23E-01
8.34E+01	3.90E+01	-5.37E+00	-1.55E-01
8.23E+01	3.90E+01	-5.25E+00	-7.52E-02
8.38E+01	3.90E+01	-5.40E+00	-1.74E-01
8.40E+01	3.90E+01	-5.41E+00	-1.86E-01
8.46E+01	3.90E+01	-5.45E+00	-2.21E-01
8.46E+01	3.90E+01	-5.45E+00	-2.20E-01
8.46E+01	3.90E+01	-5.45E+00	-2.21E-01
8.51E+01	3.90E+01	-5.48E+00	-2.49E-01
9.60E+01	3.90E+01	-4.78E+00	2.18E-01
9.60E+01	3.90E+01	-4.77E+00	2.12E-01
9.57E+01	3.90E+01	-4.71E+00	1.56E-01
9.56E+01	3.90E+01	-4.68E+00	1.27E-01
7.89E+01	3.90E+01	-4.05E+00	-6.45E-01
7.92E+01	3.90E+01	-3.92E+00	-9.02E-01
7.93E+01	3.90E+01	-3.87E+00	-1.01E+00
7.93E+01	3.90E+01	-3.87E+00	-1.02E+00
7.96E+01	3.90E+01	-3.78E+00	-1.41E+00
7.97E+01	3.90E+01	-3.78E+00	-1.41E+00
8.00E+01	3.90E+01	-3.71E+00	-1.39E+00
8.00E+01	3.90E+01	-3.71E+00	-1.38E+00
8.04E+01	3.90E+01	-3.66E+00	-1.34E+00
8.04E+01	3.90E+01	-3.65E+00	-1.34E+00
9.54E+01	3.90E+01	-4.63E+00	7.89E-02
9.51E+01	3.90E+01	-4.56E+00	3.01E-02
9.51E+01	3.90E+01	-4.55E+00	2.28E-02
9.50E+01	3.90E+01	-4.53E+00	3.67E-03
9.47E+01	3.90E+01	-4.47E+00	-4.69E-02
9.46E+01	3.90E+01	-4.44E+00	-7.20E-02
8.12E+01	3.90E+01	-3.57E+00	-1.31E+00
8.11E+01	3.90E+01	-3.58E+00	-1.31E+00
8.08E+01	3.90E+01	-3.61E+00	-1.33E+00
8.08E+01	3.90E+01	-3.61E+00	-1.33E+00
9.44E+01	3.90E+01	-4.38E+00	-1.21E-01

9.41E+01	3.90E+01	-4.32E+00	-1.71E-01
8.12E+01	3.90E+01	-3.57E+00	-1.31E+00
8.16E+01	3.90E+01	-3.54E+00	-1.27E+00
9.40E+01	3.90E+01	-4.29E+00	-1.97E-01
9.37E+01	3.90E+01	-4.24E+00	-2.35E-01
8.17E+01	3.90E+01	-3.53E+00	-1.27E+00
8.22E+01	3.90E+01	-3.51E+00	-1.24E+00
9.35E+01	3.90E+01	-4.20E+00	-2.59E-01
9.30E+01	3.90E+01	-4.12E+00	-2.87E-01
9.34E+01	3.90E+01	-4.19E+00	-2.65E-01
9.23E+01	3.90E+01	-4.02E+00	-3.17E-01
9.12E+01	3.90E+01	-3.87E+00	-3.55E-01
8.67E+01	3.90E+01	-3.52E+00	-1.18E+00
8.70E+01	3.90E+01	-3.53E+00	-1.18E+00
8.76E+01	3.90E+01	-3.56E+00	-1.19E+00
8.73E+01	3.90E+01	-3.54E+00	-1.19E+00
8.79E+01	3.90E+01	-3.58E+00	-1.19E+00
8.65E+01	3.90E+01	-3.51E+00	-1.18E+00
8.62E+01	3.90E+01	-3.50E+00	-1.18E+00
8.59E+01	3.90E+01	-3.49E+00	-1.18E+00
8.56E+01	3.90E+01	-3.48E+00	-1.18E+00
8.82E+01	3.90E+01	-3.60E+00	-1.20E+00
8.86E+01	3.90E+01	-3.63E+00	-9.82E-01
8.84E+01	3.90E+01	-3.61E+00	-1.17E+00
8.90E+01	3.90E+01	-3.65E+00	-6.79E-01
8.93E+01	3.90E+01	-3.68E+00	-4.35E-01
8.97E+01	3.90E+01	-3.72E+00	-3.44E-01
8.95E+01	3.90E+01	-3.70E+00	-3.41E-01
9.01E+01	3.90E+01	-3.75E+00	-3.28E-01
9.05E+01	3.90E+01	-3.79E+00	-3.44E-01
9.06E+01	3.90E+01	-3.81E+00	-3.46E-01
9.08E+01	3.90E+01	-3.82E+00	-3.48E-01
9.16E+01	3.90E+01	-3.92E+00	-3.46E-01
9.17E+01	3.90E+01	-3.94E+00	-3.42E-01
9.18E+01	3.90E+01	-3.95E+00	-3.38E-01
9.28E+01	3.90E+01	-4.08E+00	-2.98E-01
8.54E+01	3.90E+01	-3.48E+00	-1.19E+00
8.51E+01	3.90E+01	-3.47E+00	-1.19E+00
8.47E+01	3.90E+01	-3.46E+00	-1.20E+00
8.45E+01	3.90E+01	-3.46E+00	-1.20E+00
8.43E+01	3.90E+01	-3.46E+00	-1.21E+00
8.39E+01	3.90E+01	-3.46E+00	-1.22E+00
8.35E+01	3.90E+01	-3.47E+00	-1.22E+00
8.34E+01	3.90E+01	-3.47E+00	-1.23E+00
8.32E+01	3.90E+01	-3.47E+00	-1.23E+00
8.24E+01	3.90E+01	-3.50E+00	-1.24E+00
8.28E+01	3.90E+01	-3.48E+00	-1.22E+00
9.28E+01	3.90E+01	-4.09E+00	-2.96E-01

W4 Mesh3 eta = 0.77

X Y	Z	Cp	
8.83E+01	5.66E+01	-4.30E+00	2.15E-02
8.84E+01	5.66E+01	-4.37E+00	4.44E-02
8.83E+01	5.66E+01	-4.23E+00	-3.31E-01
9.99E+01	5.66E+01	-4.47E+00	2.40E-01
9.97E+01	5.66E+01	-4.48E+00	2.92E-01
9.97E+01	5.66E+01	-4.42E+00	1.34E-01
9.96E+01	5.66E+01	-4.48E+00	3.05E-01
9.96E+01	5.66E+01	-4.48E+00	3.00E-01
9.93E+01	5.66E+01	-4.49E+00	2.45E-01
9.91E+01	5.66E+01	-4.49E+00	2.46E-01
9.90E+01	5.66E+01	-4.50E+00	2.44E-01
9.87E+01	5.66E+01	-4.51E+00	2.38E-01
8.88E+01	5.66E+01	-4.62E+00	1.41E-01
8.86E+01	5.66E+01	-4.56E+00	2.30E-01
8.90E+01	5.66E+01	-4.66E+00	1.31E-01
8.92E+01	5.66E+01	-4.69E+00	1.68E-01
8.85E+01	5.66E+01	-4.51E+00	2.42E-01
8.94E+01	5.66E+01	-4.73E+00	1.04E-01
8.96E+01	5.66E+01	-4.76E+00	6.01E-02

8.98E+01	5.66E+01	-4.79E+00	4.44E-02
8.99E+01	5.66E+01	-4.81E+00	2.12E-02
9.01E+01	5.66E+01	-4.84E+00	-7.71E-03
9.86E+01	5.66E+01	-4.51E+00	2.38E-01
9.86E+01	5.66E+01	-4.51E+00	2.38E-01
9.83E+01	5.66E+01	-4.53E+00	2.36E-01
9.81E+01	5.66E+01	-4.54E+00	2.26E-01
9.04E+01	5.66E+01	-4.86E+00	-3.45E-02
9.79E+01	5.66E+01	-4.55E+00	2.16E-01
9.76E+01	5.66E+01	-4.58E+00	2.02E-01
9.05E+01	5.66E+01	-4.88E+00	-5.37E-02
9.08E+01	5.66E+01	-4.91E+00	-8.07E-02
9.09E+01	5.66E+01	-4.91E+00	-9.05E-02
9.75E+01	5.66E+01	-4.59E+00	1.96E-01
9.71E+01	5.66E+01	-4.63E+00	1.74E-01
9.13E+01	5.66E+01	-4.95E+00	-1.41E-01
9.13E+01	5.66E+01	-4.95E+00	-1.44E-01
9.70E+01	5.66E+01	-4.63E+00	1.69E-01
9.18E+01	5.66E+01	-4.98E+00	-1.83E-01
9.19E+01	5.66E+01	-4.99E+00	-1.87E-01
9.23E+01	5.66E+01	-5.00E+00	-2.19E-01
9.24E+01	5.66E+01	-5.01E+00	-2.29E-01
9.25E+01	5.66E+01	-5.01E+00	-2.31E-01
9.30E+01	5.66E+01	-5.01E+00	-2.56E-01
9.31E+01	5.66E+01	-5.01E+00	-2.57E-01
9.36E+01	5.66E+01	-4.98E+00	-2.34E-01
9.56E+01	5.66E+01	-4.79E+00	2.15E-02
9.57E+01	5.66E+01	-4.78E+00	3.52E-02
9.39E+01	5.66E+01	-4.97E+00	-2.21E-01
9.43E+01	5.66E+01	-4.94E+00	-1.73E-01
9.45E+01	5.66E+01	-4.92E+00	-1.57E-01
9.49E+01	5.66E+01	-4.88E+00	-8.89E-02
9.51E+01	5.66E+01	-4.85E+00	-5.30E-02
9.64E+01	5.66E+01	-4.70E+00	1.15E-01
9.64E+01	5.66E+01	-4.70E+00	1.15E-01
9.64E+01	5.66E+01	-4.70E+00	1.16E-01
9.96E+01	5.66E+01	-4.40E+00	1.02E-01
9.96E+01	5.66E+01	-4.40E+00	1.07E-01
9.93E+01	5.66E+01	-4.34E+00	9.39E-02
9.91E+01	5.66E+01	-4.30E+00	4.70E-02
9.90E+01	5.66E+01	-4.27E+00	1.45E-02
9.87E+01	5.66E+01	-4.21E+00	-3.32E-02
8.95E+01	5.66E+01	-3.83E+00	-1.30E+00
8.98E+01	5.66E+01	-3.80E+00	-1.30E+00
8.94E+01	5.66E+01	-3.85E+00	-1.31E+00
8.92E+01	5.66E+01	-3.88E+00	-1.31E+00
8.90E+01	5.66E+01	-3.92E+00	-1.24E+00
8.88E+01	5.66E+01	-3.96E+00	-1.24E+00
8.99E+01	5.66E+01	-3.79E+00	-1.29E+00
8.86E+01	5.66E+01	-4.02E+00	-1.21E+00
8.85E+01	5.66E+01	-4.07E+00	-1.09E+00
9.02E+01	5.66E+01	-3.77E+00	-1.28E+00
9.87E+01	5.66E+01	-4.20E+00	-3.42E-02
9.87E+01	5.66E+01	-4.20E+00	-3.70E-02
9.83E+01	5.66E+01	-4.14E+00	-9.77E-02
9.82E+01	5.66E+01	-4.11E+00	-1.16E-01
9.03E+01	5.66E+01	-3.75E+00	-1.27E+00
9.05E+01	5.66E+01	-3.74E+00	-1.27E+00
9.80E+01	5.66E+01	-4.08E+00	-1.43E-01
9.77E+01	5.66E+01	-4.03E+00	-1.74E-01
9.07E+01	5.66E+01	-3.72E+00	-1.28E+00
9.09E+01	5.66E+01	-3.72E+00	-1.27E+00
9.76E+01	5.66E+01	-4.02E+00	-1.85E-01
9.74E+01	5.66E+01	-3.99E+00	-2.00E-01
9.13E+01	5.66E+01	-3.70E+00	-1.28E+00
9.14E+01	5.66E+01	-3.70E+00	-1.28E+00
9.15E+01	5.66E+01	-3.69E+00	-1.28E+00
9.71E+01	5.66E+01	-3.95E+00	-2.15E-01
9.70E+01	5.66E+01	-3.94E+00	-2.18E-01
9.23E+01	5.66E+01	-3.68E+00	-1.28E+00
9.20E+01	5.66E+01	-3.68E+00	-1.28E+00

9.30E+01	5.66E+01	-3.68E+00	-1.28E+00
9.26E+01	5.66E+01	-3.68E+00	-1.28E+00
9.33E+01	5.66E+01	-3.69E+00	-1.30E+00
9.35E+01	5.66E+01	-3.69E+00	-1.30E+00
9.40E+01	5.66E+01	-3.71E+00	-1.33E+00
9.41E+01	5.66E+01	-3.71E+00	-1.34E+00
9.47E+01	5.66E+01	-3.74E+00	-1.06E+00
9.47E+01	5.66E+01	-3.74E+00	-1.05E+00
9.48E+01	5.66E+01	-3.75E+00	-9.12E-01
9.57E+01	5.66E+01	-3.81E+00	-2.34E-01
9.63E+01	5.66E+01	-3.86E+00	-2.65E-01
9.54E+01	5.66E+01	-3.78E+00	-2.71E-01
9.64E+01	5.66E+01	-3.87E+00	-2.61E-01
9.65E+01	5.66E+01	-3.88E+00	-2.57E-01
9.53E+01	5.66E+01	-3.77E+00	-2.89E-01

M165 Mesh1 eta = 0.30

X	Y	Z	Cp
1.40E+02	1.44E+01	-4.76E+00	1.37E-01
1.40E+02	1.44E+01	-4.75E+00	1.36E-01
1.40E+02	1.44E+01	-4.72E+00	1.04E-01
8.71E+01	1.44E+01	-4.11E+00	1.86E-03
8.72E+01	1.44E+01	-4.18E+00	2.97E-02
8.74E+01	1.44E+01	-4.28E+00	6.01E-02
8.72E+01	1.44E+01	-4.02E+00	-1.16E-01
8.77E+01	1.44E+01	-3.71E+00	-5.27E-01
8.77E+01	1.44E+01	-4.43E+00	9.41E-02
8.77E+01	1.44E+01	-3.70E+00	-5.37E-01
1.40E+02	1.44E+01	-4.78E+00	1.52E-01
1.39E+02	1.44E+01	-4.80E+00	1.22E-01
8.79E+01	1.44E+01	-4.53E+00	1.17E-01
8.83E+01	1.44E+01	-4.61E+00	1.03E-01
8.87E+01	1.44E+01	-4.67E+00	1.10E-01
8.89E+01	1.44E+01	-4.73E+00	1.22E-01
8.92E+01	1.44E+01	-4.77E+00	8.35E-02
8.96E+01	1.44E+01	-4.80E+00	6.39E-02
8.99E+01	1.44E+01	-4.82E+00	7.65E-02
1.39E+02	1.44E+01	-4.81E+00	9.69E-02
1.38E+02	1.44E+01	-4.83E+00	7.30E-02
1.38E+02	1.44E+01	-4.84E+00	6.69E-02
1.38E+02	1.44E+01	-4.87E+00	4.71E-02
1.38E+02	1.44E+01	-4.87E+00	4.67E-02
1.37E+02	1.44E+01	-4.88E+00	4.43E-02
9.03E+01	1.44E+01	-4.84E+00	1.08E-01
1.37E+02	1.44E+01	-4.91E+00	2.43E-02
1.37E+02	1.44E+01	-4.92E+00	2.14E-02
9.07E+01	1.44E+01	-4.86E+00	1.30E-01
9.10E+01	1.44E+01	-4.87E+00	1.33E-01
9.12E+01	1.44E+01	-4.88E+00	1.33E-01
9.17E+01	1.44E+01	-4.91E+00	1.25E-01
9.22E+01	1.44E+01	-4.93E+00	1.11E-01
1.36E+02	1.44E+01	-4.96E+00	3.36E-03
1.35E+02	1.44E+01	-5.00E+00	-1.14E-02
9.25E+01	1.44E+01	-4.94E+00	1.02E-01
9.36E+01	1.44E+01	-4.98E+00	1.08E-01
9.47E+01	1.44E+01	-5.02E+00	1.03E-01
9.47E+01	1.44E+01	-5.02E+00	1.03E-01
9.38E+01	1.44E+01	-4.99E+00	1.08E-01
9.36E+01	1.44E+01	-4.98E+00	1.08E-01
9.57E+01	1.44E+01	-5.06E+00	9.51E-02
9.59E+01	1.44E+01	-5.07E+00	9.32E-02
9.59E+01	1.44E+01	-5.07E+00	9.32E-02
9.71E+01	1.44E+01	-5.12E+00	8.40E-02
9.79E+01	1.44E+01	-5.15E+00	7.60E-02
1.34E+02	1.44E+01	-5.01E+00	-1.46E-02
1.34E+02	1.44E+01	-5.04E+00	-2.37E-02
1.09E+02	1.44E+01	-5.41E+00	1.22E-02
1.10E+02	1.44E+01	-5.42E+00	1.02E-02
1.10E+02	1.44E+01	-5.42E+00	9.76E-03
1.11E+02	1.44E+01	-5.42E+00	7.95E-03

1.09E+02	1.44E+01	-5.41E+00	1.36E-02
1.08E+02	1.44E+01	-5.40E+00	1.72E-02
1.07E+02	1.44E+01	-5.39E+00	2.03E-02
1.07E+02	1.44E+01	-5.40E+00	1.92E-02
1.06E+02	1.44E+01	-5.38E+00	2.17E-02
1.05E+02	1.44E+01	-5.37E+00	2.50E-02
1.05E+02	1.44E+01	-5.36E+00	2.71E-02
1.04E+02	1.44E+01	-5.35E+00	3.16E-02
1.04E+02	1.44E+01	-5.34E+00	3.19E-02
1.03E+02	1.44E+01	-5.32E+00	3.69E-02
1.03E+02	1.44E+01	-5.31E+00	4.02E-02
1.02E+02	1.44E+01	-5.29E+00	4.71E-02
1.01E+02	1.44E+01	-5.24E+00	5.53E-02
1.01E+02	1.44E+01	-5.27E+00	5.02E-02
1.11E+02	1.44E+01	-5.42E+00	6.58E-03
9.93E+01	1.44E+01	-5.20E+00	6.47E-02
1.00E+02	1.44E+01	-5.23E+00	5.93E-02
9.88E+01	1.44E+01	-5.18E+00	6.83E-02
1.30E+02	1.44E+01	-5.16E+00	-2.35E-02
1.30E+02	1.44E+01	-5.15E+00	-2.46E-02
1.31E+02	1.44E+01	-5.13E+00	-2.74E-02
1.29E+02	1.44E+01	-5.18E+00	-2.10E-02
1.28E+02	1.44E+01	-5.19E+00	-1.93E-02
1.29E+02	1.44E+01	-5.19E+00	-1.96E-02
1.31E+02	1.44E+01	-5.11E+00	-2.88E-02
1.32E+02	1.44E+01	-5.10E+00	-3.05E-02
1.26E+02	1.44E+01	-5.24E+00	-1.73E-02
1.26E+02	1.44E+01	-5.26E+00	-1.70E-02
1.25E+02	1.44E+01	-5.26E+00	-1.69E-02
1.27E+02	1.44E+01	-5.23E+00	-1.76E-02
1.27E+02	1.44E+01	-5.21E+00	-1.73E-02
1.25E+02	1.44E+01	-5.28E+00	-1.78E-02
1.33E+02	1.44E+01	-5.07E+00	-2.97E-02
1.33E+02	1.44E+01	-5.06E+00	-2.96E-02
1.24E+02	1.44E+01	-5.29E+00	-1.85E-02
1.24E+02	1.44E+01	-5.29E+00	-1.85E-02
1.23E+02	1.44E+01	-5.32E+00	-1.97E-02
1.23E+02	1.44E+01	-5.31E+00	-1.90E-02
1.21E+02	1.44E+01	-5.35E+00	-2.02E-02
1.22E+02	1.44E+01	-5.34E+00	-1.99E-02
1.21E+02	1.44E+01	-5.35E+00	-2.04E-02
1.20E+02	1.44E+01	-5.36E+00	-2.07E-02
1.20E+02	1.44E+01	-5.37E+00	-2.04E-02
1.20E+02	1.44E+01	-5.37E+00	-2.07E-02
1.18E+02	1.44E+01	-5.39E+00	-1.56E-02
1.19E+02	1.44E+01	-5.38E+00	-1.77E-02
1.18E+02	1.44E+01	-5.39E+00	-1.26E-02
1.17E+02	1.44E+01	-5.40E+00	-9.85E-03
1.17E+02	1.44E+01	-5.40E+00	-9.41E-03
1.16E+02	1.44E+01	-5.40E+00	-7.14E-03
1.15E+02	1.44E+01	-5.41E+00	-3.60E-03
1.16E+02	1.44E+01	-5.41E+00	-4.34E-03
1.14E+02	1.44E+01	-5.41E+00	2.10E-04
1.14E+02	1.44E+01	-5.41E+00	1.78E-03
1.13E+02	1.44E+01	-5.41E+00	3.31E-03
1.13E+02	1.44E+01	-5.42E+00	4.12E-03
1.12E+02	1.44E+01	-5.42E+00	4.33E-03
1.40E+02	1.44E+01	-4.68E+00	6.18E-02
1.39E+02	1.44E+01	-4.64E+00	5.02E-02
8.77E+01	1.44E+01	-3.70E+00	-5.40E-01
8.83E+01	1.44E+01	-3.44E+00	-4.93E-01
8.86E+01	1.44E+01	-3.35E+00	-4.26E-01
8.90E+01	1.44E+01	-3.27E+00	-4.10E-01
8.96E+01	1.44E+01	-3.14E+00	-4.16E-01
8.96E+01	1.44E+01	-3.14E+00	-4.16E-01
8.96E+01	1.44E+01	-3.14E+00	-4.16E-01
9.25E+01	1.44E+01	-2.81E+00	-3.68E-01
9.03E+01	1.44E+01	-3.04E+00	-4.16E-01
9.07E+01	1.44E+01	-2.98E+00	-4.07E-01
9.09E+01	1.44E+01	-2.96E+00	-4.00E-01
1.39E+02	1.44E+01	-4.61E+00	4.22E-02

1.38E+02	1.44E+01	-4.55E+00	7.30E-03
1.38E+02	1.44E+01	-4.54E+00	-1.65E-04
1.38E+02	1.44E+01	-4.47E+00	-4.19E-02
1.38E+02	1.44E+01	-4.47E+00	-4.61E-02
1.38E+02	1.44E+01	-4.46E+00	-4.66E-02
9.16E+01	1.44E+01	-2.87E+00	-3.99E-01
9.18E+01	1.44E+01	-2.86E+00	-3.94E-01
9.17E+01	1.44E+01	-2.87E+00	-3.98E-01
1.36E+02	1.44E+01	-4.27E+00	-3.56E-01
1.36E+02	1.44E+01	-4.28E+00	-3.33E-01
1.37E+02	1.44E+01	-4.39E+00	-9.30E-02
9.26E+01	1.44E+01	-2.79E+00	-3.66E-01
9.33E+01	1.44E+01	-2.75E+00	-3.72E-01
9.36E+01	1.44E+01	-2.73E+00	-3.72E-01
9.42E+01	1.44E+01	-2.71E+00	-3.62E-01
9.46E+01	1.44E+01	-2.68E+00	-3.64E-01
9.51E+01	1.44E+01	-2.66E+00	-3.60E-01
1.36E+02	1.44E+01	-4.27E+00	-3.61E-01
1.36E+02	1.44E+01	-4.27E+00	-3.62E-01
9.56E+01	1.44E+01	-2.64E+00	-3.49E-01
9.63E+01	1.44E+01	-2.63E+00	-3.43E-01
9.68E+01	1.44E+01	-2.62E+00	-3.35E-01
9.73E+01	1.44E+01	-2.61E+00	-3.27E-01
9.83E+01	1.44E+01	-2.60E+00	-3.13E-01
9.88E+01	1.44E+01	-2.59E+00	-3.13E-01
9.96E+01	1.44E+01	-2.59E+00	-3.10E-01
1.00E+02	1.44E+01	-2.59E+00	-3.01E-01
1.01E+02	1.44E+01	-2.59E+00	-2.95E-01
1.02E+02	1.44E+01	-2.59E+00	-2.89E-01
1.02E+02	1.44E+01	-2.60E+00	-2.87E-01
1.02E+02	1.44E+01	-2.60E+00	-2.81E-01
1.04E+02	1.44E+01	-2.62E+00	-2.66E-01
1.04E+02	1.44E+01	-2.61E+00	-2.64E-01
1.05E+02	1.44E+01	-2.64E+00	-2.66E-01
1.05E+02	1.44E+01	-2.63E+00	-2.66E-01
1.06E+02	1.44E+01	-2.66E+00	-2.67E-01
1.06E+02	1.44E+01	-2.65E+00	-2.66E-01
1.09E+02	1.44E+01	-2.71E+00	-2.57E-01
1.08E+02	1.44E+01	-2.70E+00	-2.57E-01
1.07E+02	1.44E+01	-2.67E+00	-2.61E-01
1.07E+02	1.44E+01	-2.68E+00	-2.60E-01
1.10E+02	1.44E+01	-2.73E+00	-2.59E-01
1.10E+02	1.44E+01	-2.73E+00	-2.58E-01
1.11E+02	1.44E+01	-2.76E+00	-2.63E-01
1.11E+02	1.44E+01	-2.75E+00	-2.62E-01
1.12E+02	1.44E+01	-2.80E+00	-2.61E-01
1.12E+02	1.44E+01	-2.79E+00	-2.62E-01
1.14E+02	1.44E+01	-2.83E+00	-2.66E-01
1.13E+02	1.44E+01	-2.82E+00	-2.63E-01
1.15E+02	1.44E+01	-2.87E+00	-2.74E-01
1.14E+02	1.44E+01	-2.86E+00	-2.72E-01
1.16E+02	1.44E+01	-2.92E+00	-2.76E-01
1.16E+02	1.44E+01	-2.90E+00	-2.76E-01
1.17E+02	1.44E+01	-2.96E+00	-2.81E-01
1.17E+02	1.44E+01	-2.95E+00	-2.80E-01
1.18E+02	1.44E+01	-3.02E+00	-2.89E-01
1.18E+02	1.44E+01	-3.00E+00	-2.85E-01
1.20E+02	1.44E+01	-3.07E+00	-3.04E-01
1.19E+02	1.44E+01	-3.05E+00	-3.02E-01
1.22E+02	1.44E+01	-3.20E+00	-3.18E-01
1.22E+02	1.44E+01	-3.17E+00	-3.11E-01
1.21E+02	1.44E+01	-3.13E+00	-3.11E-01
1.20E+02	1.44E+01	-3.11E+00	-3.10E-01
1.23E+02	1.44E+01	-3.26E+00	-3.34E-01
1.23E+02	1.44E+01	-3.24E+00	-3.30E-01
1.27E+02	1.44E+01	-3.50E+00	-3.70E-01
1.26E+02	1.44E+01	-3.47E+00	-3.63E-01
1.26E+02	1.44E+01	-3.42E+00	-3.55E-01
1.25E+02	1.44E+01	-3.39E+00	-3.52E-01
1.28E+02	1.44E+01	-3.56E+00	-3.78E-01
1.28E+02	1.44E+01	-3.59E+00	-3.80E-01

1.29E+02	1.44E+01	-3.65E+00	-3.85E-01
1.29E+02	1.44E+01	-3.69E+00	-3.90E-01
1.30E+02	1.44E+01	-3.75E+00	-4.03E-01
1.30E+02	1.44E+01	-3.78E+00	-4.10E-01
1.31E+02	1.44E+01	-3.85E+00	-4.20E-01
1.32E+02	1.44E+01	-3.89E+00	-4.27E-01
1.32E+02	1.44E+01	-3.96E+00	-4.41E-01
1.33E+02	1.44E+01	-3.99E+00	-4.44E-01
1.34E+02	1.44E+01	-4.08E+00	-4.49E-01
1.34E+02	1.44E+01	-4.11E+00	-4.50E-01
1.24E+02	1.44E+01	-3.34E+00	-3.40E-01
1.24E+02	1.44E+01	-3.31E+00	-3.38E-01

M165 Mesh1 eta = 0.61

X Y	Z Cp		
1.11E+02	2.93E+01	-5.16E+00	-7.57E-02
1.11E+02	2.93E+01	-5.34E+00	-5.44E-02
1.11E+02	2.93E+01	-4.87E+00	-3.69E-01
1.45E+02	2.93E+01	-4.33E+00	9.47E-02
1.46E+02	2.93E+01	-4.43E+00	1.53E-01
1.46E+02	2.93E+01	-4.42E+00	1.54E-01
1.46E+02	2.93E+01	-4.41E+00	1.45E-01
1.45E+02	2.93E+01	-4.34E+00	9.80E-02
1.44E+02	2.93E+01	-4.54E+00	9.96E-02
1.44E+02	2.93E+01	-4.53E+00	1.04E-01
1.45E+02	2.93E+01	-4.50E+00	1.34E-01
1.45E+02	2.93E+01	-4.49E+00	1.42E-01
1.44E+02	2.93E+01	-4.54E+00	9.91E-02
1.44E+02	2.93E+01	-4.57E+00	7.57E-02
1.43E+02	2.93E+01	-4.59E+00	6.70E-02
1.43E+02	2.93E+01	-4.61E+00	5.93E-02
1.42E+02	2.93E+01	-4.65E+00	4.25E-02
1.13E+02	2.93E+01	-5.51E+00	1.13E-02
1.12E+02	2.93E+01	-5.49E+00	1.43E-02
1.12E+02	2.93E+01	-5.50E+00	2.63E-02
1.12E+02	2.93E+01	-5.50E+00	2.30E-02
1.13E+02	2.93E+01	-5.51E+00	5.65E-02
1.13E+02	2.93E+01	-5.51E+00	6.03E-02
1.13E+02	2.93E+01	-5.51E+00	6.36E-02
1.14E+02	2.93E+01	-5.49E+00	3.91E-02
1.42E+02	2.93E+01	-4.66E+00	3.68E-02
1.15E+02	2.93E+01	-5.48E+00	4.97E-02
1.15E+02	2.93E+01	-5.47E+00	5.25E-02
1.15E+02	2.93E+01	-5.46E+00	5.27E-02
1.42E+02	2.93E+01	-4.67E+00	3.39E-02
1.41E+02	2.93E+01	-4.71E+00	2.71E-02
1.16E+02	2.93E+01	-5.44E+00	4.91E-02
1.16E+02	2.93E+01	-5.43E+00	4.33E-02
1.17E+02	2.93E+01	-5.41E+00	3.38E-02
1.17E+02	2.93E+01	-5.39E+00	4.30E-02
1.18E+02	2.93E+01	-5.37E+00	4.21E-02
1.18E+02	2.93E+01	-5.36E+00	3.67E-02
1.18E+02	2.93E+01	-5.34E+00	3.75E-02
1.19E+02	2.93E+01	-5.32E+00	3.56E-02
1.19E+02	2.93E+01	-5.33E+00	3.65E-02
1.20E+02	2.93E+01	-5.30E+00	3.60E-02
1.21E+02	2.93E+01	-5.28E+00	3.48E-02
1.41E+02	2.93E+01	-4.73E+00	2.34E-02
1.22E+02	2.93E+01	-5.27E+00	3.46E-02
1.23E+02	2.93E+01	-5.25E+00	3.09E-02
1.22E+02	2.93E+01	-5.27E+00	3.44E-02
1.41E+02	2.93E+01	-4.73E+00	2.34E-02
1.39E+02	2.93E+01	-4.78E+00	1.99E-02
1.39E+02	2.93E+01	-4.78E+00	2.00E-02
1.38E+02	2.93E+01	-4.82E+00	2.28E-02
1.38E+02	2.93E+01	-4.83E+00	2.24E-02
1.37E+02	2.93E+01	-4.87E+00	1.97E-02
1.37E+02	2.93E+01	-4.87E+00	1.90E-02
1.36E+02	2.93E+01	-4.91E+00	1.50E-02

1.34E+02	2.93E+01	-4.96E+00	9.99E-03
1.36E+02	2.93E+01	-4.92E+00	1.45E-02
1.34E+02	2.93E+01	-4.96E+00	9.88E-03
1.34E+02	2.93E+01	-4.96E+00	9.75E-03
1.23E+02	2.93E+01	-5.24E+00	2.99E-02
1.25E+02	2.93E+01	-5.22E+00	2.20E-02
1.25E+02	2.93E+01	-5.22E+00	2.01E-02
1.26E+02	2.93E+01	-5.20E+00	2.00E-02
1.27E+02	2.93E+01	-5.17E+00	1.78E-02
1.28E+02	2.93E+01	-5.15E+00	1.61E-02
1.26E+02	2.93E+01	-5.18E+00	1.95E-02
1.28E+02	2.93E+01	-5.14E+00	1.38E-02
1.29E+02	2.93E+01	-5.12E+00	1.19E-02
1.30E+02	2.93E+01	-5.11E+00	1.15E-02
1.30E+02	2.93E+01	-5.09E+00	1.02E-02
1.31E+02	2.93E+01	-5.08E+00	8.36E-03
1.31E+02	2.93E+01	-5.06E+00	5.95E-03
1.32E+02	2.93E+01	-5.04E+00	5.24E-03
1.33E+02	2.93E+01	-5.02E+00	5.38E-03
1.33E+02	2.93E+01	-5.00E+00	6.59E-03
1.12E+02	2.93E+01	-4.57E+00	-7.14E-01
1.12E+02	2.93E+01	-4.57E+00	-7.15E-01
1.12E+02	2.93E+01	-4.56E+00	-7.11E-01
1.12E+02	2.93E+01	-4.41E+00	-6.69E-01
1.13E+02	2.93E+01	-4.29E+00	-5.72E-01
1.13E+02	2.93E+01	-4.27E+00	-5.63E-01
1.13E+02	2.93E+01	-4.24E+00	-5.53E-01
1.14E+02	2.93E+01	-4.16E+00	-5.18E-01
1.14E+02	2.93E+01	-4.10E+00	-5.02E-01
1.15E+02	2.93E+01	-4.01E+00	-4.85E-01
1.14E+02	2.93E+01	-4.05E+00	-4.86E-01
1.15E+02	2.93E+01	-3.96E+00	-4.83E-01
1.45E+02	2.93E+01	-4.33E+00	9.38E-02
1.45E+02	2.93E+01	-4.26E+00	6.19E-02
1.44E+02	2.93E+01	-4.25E+00	5.97E-02
1.44E+02	2.93E+01	-4.19E+00	2.04E-02
1.44E+02	2.93E+01	-4.18E+00	1.51E-02
1.43E+02	2.93E+01	-4.12E+00	-8.36E-03
1.15E+02	2.93E+01	-3.93E+00	-4.78E-01
1.17E+02	2.93E+01	-3.78E+00	-4.79E-01
1.43E+02	2.93E+01	-4.11E+00	-1.95E-02
1.42E+02	2.93E+01	-4.07E+00	-4.00E-02
1.16E+02	2.93E+01	-3.87E+00	-4.77E-01
1.16E+02	2.93E+01	-3.80E+00	-4.79E-01
1.17E+02	2.93E+01	-3.77E+00	-4.81E-01
1.18E+02	2.93E+01	-3.70E+00	-4.78E-01
1.18E+02	2.93E+01	-3.67E+00	-4.79E-01
1.19E+02	2.93E+01	-3.62E+00	-4.90E-01
1.42E+02	2.93E+01	-4.01E+00	-7.81E-02
1.19E+02	2.93E+01	-3.59E+00	-4.87E-01
1.20E+02	2.93E+01	-3.54E+00	-4.76E-01
1.41E+02	2.93E+01	-3.99E+00	-8.82E-02
1.20E+02	2.93E+01	-3.52E+00	-4.74E-01
1.40E+02	2.93E+01	-3.91E+00	-1.25E-01
1.40E+02	2.93E+01	-3.90E+00	-1.36E-01
1.21E+02	2.93E+01	-3.48E+00	-4.63E-01
1.21E+02	2.93E+01	-3.47E+00	-4.63E-01
1.22E+02	2.93E+01	-3.44E+00	-4.77E-01
1.22E+02	2.93E+01	-3.44E+00	-4.77E-01
1.23E+02	2.93E+01	-3.42E+00	-4.50E-01
1.39E+02	2.93E+01	-3.82E+00	-2.69E-01
1.39E+02	2.93E+01	-3.81E+00	-2.85E-01
1.23E+02	2.93E+01	-3.42E+00	-4.50E-01
1.25E+02	2.93E+01	-3.41E+00	-4.32E-01
1.25E+02	2.93E+01	-3.41E+00	-4.30E-01
1.26E+02	2.93E+01	-3.41E+00	-4.35E-01
1.26E+02	2.93E+01	-3.40E+00	-4.34E-01
1.27E+02	2.93E+01	-3.40E+00	-4.27E-01
1.38E+02	2.93E+01	-3.74E+00	-4.51E-01
1.38E+02	2.93E+01	-3.73E+00	-4.58E-01

1.37E+02	2.93E+01	-3.67E+00	-4.97E-01
1.37E+02	2.93E+01	-3.66E+00	-4.97E-01
1.36E+02	2.93E+01	-3.61E+00	-5.04E-01
1.36E+02	2.93E+01	-3.60E+00	-5.02E-01
1.34E+02	2.93E+01	-3.55E+00	-4.84E-01
1.34E+02	2.93E+01	-3.55E+00	-4.82E-01
1.33E+02	2.93E+01	-3.51E+00	-4.75E-01
1.33E+02	2.93E+01	-3.51E+00	-4.72E-01
1.32E+02	2.93E+01	-3.48E+00	-4.55E-01
1.32E+02	2.93E+01	-3.47E+00	-4.54E-01
1.31E+02	2.93E+01	-3.45E+00	-4.51E-01
1.31E+02	2.93E+01	-3.45E+00	-4.50E-01
1.30E+02	2.93E+01	-3.43E+00	-4.40E-01
1.29E+02	2.93E+01	-3.43E+00	-4.40E-01
1.27E+02	2.93E+01	-3.40E+00	-4.26E-01
1.28E+02	2.93E+01	-3.41E+00	-4.26E-01
1.28E+02	2.93E+01	-3.41E+00	-4.27E-01

M165 mesh1 eta = 0.86

X	Y	Z	Cp
1.30E+02	4.13E+01	-5.07E+00	-1.15E-01
1.31E+02	4.13E+01	-5.21E+00	-1.27E-03
1.30E+02	4.13E+01	-5.13E+00	-1.03E-01
1.30E+02	4.13E+01	-4.88E+00	-4.20E-01
1.31E+02	4.13E+01	-5.23E+00	2.43E-02
1.51E+02	4.13E+01	-4.33E+00	1.11E-01
1.51E+02	4.13E+01	-4.34E+00	1.13E-01
1.51E+02	4.13E+01	-4.33E+00	1.06E-01
1.31E+02	4.13E+01	-5.25E+00	5.81E-02
1.32E+02	4.13E+01	-5.22E+00	1.09E-01
1.32E+02	4.13E+01	-5.18E+00	5.58E-02
1.32E+02	4.13E+01	-5.18E+00	5.09E-02
1.50E+02	4.13E+01	-4.37E+00	1.65E-01
1.50E+02	4.13E+01	-4.38E+00	1.55E-01
1.32E+02	4.13E+01	-5.18E+00	5.37E-02
1.33E+02	4.13E+01	-5.13E+00	7.02E-02
1.50E+02	4.13E+01	-4.40E+00	8.68E-02
1.49E+02	4.13E+01	-4.42E+00	7.60E-02
1.49E+02	4.13E+01	-4.44E+00	5.86E-02
1.49E+02	4.13E+01	-4.46E+00	4.83E-02
1.34E+02	4.13E+01	-5.08E+00	4.93E-02
1.34E+02	4.13E+01	-5.08E+00	4.93E-02
1.34E+02	4.13E+01	-5.08E+00	4.93E-02
1.34E+02	4.13E+01	-5.03E+00	5.90E-02
1.36E+02	4.13E+01	-4.90E+00	5.88E-02
1.35E+02	4.13E+01	-4.94E+00	5.97E-02
1.35E+02	4.13E+01	-4.98E+00	6.19E-02
1.35E+02	4.13E+01	-4.98E+00	6.19E-02
1.35E+02	4.13E+01	-4.98E+00	6.19E-02
1.36E+02	4.13E+01	-4.90E+00	5.79E-02
1.48E+02	4.13E+01	-4.48E+00	3.79E-02
1.48E+02	4.13E+01	-4.49E+00	3.79E-02
1.47E+02	4.13E+01	-4.50E+00	3.44E-02
1.47E+02	4.13E+01	-4.51E+00	3.45E-02
1.36E+02	4.13E+01	-4.89E+00	5.84E-02
1.37E+02	4.13E+01	-4.85E+00	5.80E-02
1.47E+02	4.13E+01	-4.53E+00	3.20E-02
1.46E+02	4.13E+01	-4.54E+00	3.21E-02
1.38E+02	4.13E+01	-4.81E+00	5.46E-02
1.38E+02	4.13E+01	-4.80E+00	5.27E-02
1.38E+02	4.13E+01	-4.79E+00	5.23E-02
1.39E+02	4.13E+01	-4.75E+00	4.77E-02
1.40E+02	4.13E+01	-4.72E+00	5.06E-02
1.40E+02	4.13E+01	-4.71E+00	4.99E-02
1.40E+02	4.13E+01	-4.71E+00	5.03E-02
1.41E+02	4.13E+01	-4.68E+00	4.10E-02
1.42E+02	4.13E+01	-4.66E+00	3.34E-02
1.42E+02	4.13E+01	-4.65E+00	2.98E-02
1.43E+02	4.13E+01	-4.64E+00	2.66E-02
1.43E+02	4.13E+01	-4.62E+00	2.64E-02

1.44E+02	4.13E+01	-4.61E+00	2.66E-02
1.44E+02	4.13E+01	-4.59E+00	2.71E-02
1.45E+02	4.13E+01	-4.57E+00	3.00E-02
1.46E+02	4.13E+01	-4.56E+00	3.20E-02
1.31E+02	4.13E+01	-4.63E+00	-8.69E-01
1.31E+02	4.13E+01	-4.62E+00	-8.66E-01
1.31E+02	4.13E+01	-4.60E+00	-8.53E-01
1.31E+02	4.13E+01	-4.47E+00	-7.81E-01
1.50E+02	4.13E+01	-4.26E+00	-2.54E-02
1.50E+02	4.13E+01	-4.25E+00	-1.25E-02
1.32E+02	4.13E+01	-4.38E+00	-6.99E-01
1.32E+02	4.13E+01	-4.29E+00	-6.84E-01
1.32E+02	4.13E+01	-4.34E+00	-6.93E-01
1.33E+02	4.13E+01	-4.23E+00	-6.72E-01
1.34E+02	4.13E+01	-4.05E+00	-6.83E-01
1.50E+02	4.13E+01	-4.19E+00	8.43E-03
1.49E+02	4.13E+01	-4.17E+00	-1.55E-02
1.33E+02	4.13E+01	-4.18E+00	-6.67E-01
1.33E+02	4.13E+01	-4.13E+00	-6.70E-01
1.34E+02	4.13E+01	-4.08E+00	-6.76E-01
1.49E+02	4.13E+01	-4.12E+00	-5.63E-02
1.49E+02	4.13E+01	-4.08E+00	-6.63E-02
1.35E+02	4.13E+01	-3.91E+00	-6.75E-01
1.34E+02	4.13E+01	-4.01E+00	-6.83E-01
1.35E+02	4.13E+01	-3.97E+00	-6.84E-01
1.35E+02	4.13E+01	-3.94E+00	-6.81E-01
1.48E+02	4.13E+01	-4.04E+00	-8.28E-02
1.48E+02	4.13E+01	-3.99E+00	-1.10E-01
1.36E+02	4.13E+01	-3.87E+00	-6.81E-01
1.36E+02	4.13E+01	-3.85E+00	-6.82E-01
1.36E+02	4.13E+01	-3.84E+00	-6.80E-01
1.37E+02	4.13E+01	-3.80E+00	-6.69E-01
1.37E+02	4.13E+01	-3.78E+00	-6.68E-01
1.47E+02	4.13E+01	-3.97E+00	-1.20E-01
1.47E+02	4.13E+01	-3.94E+00	-1.36E-01
1.38E+02	4.13E+01	-3.74E+00	-6.74E-01
1.38E+02	4.13E+01	-3.72E+00	-6.72E-01
1.38E+02	4.13E+01	-3.72E+00	-6.77E-01
1.39E+02	4.13E+01	-3.70E+00	-6.70E-01
1.40E+02	4.13E+01	-3.68E+00	-6.65E-01
1.46E+02	4.13E+01	-3.89E+00	-1.60E-01
1.46E+02	4.13E+01	-3.86E+00	-1.65E-01
1.45E+02	4.13E+01	-3.78E+00	-1.85E-01
1.46E+02	4.13E+01	-3.87E+00	-1.69E-01
1.41E+02	4.13E+01	-3.68E+00	-6.85E-01
1.41E+02	4.13E+01	-3.68E+00	-6.88E-01
1.42E+02	4.13E+01	-3.69E+00	-6.21E-01
1.43E+02	4.13E+01	-3.71E+00	-3.79E-01
1.40E+02	4.13E+01	-3.67E+00	-6.67E-01
1.43E+02	4.13E+01	-3.72E+00	-3.03E-01
1.44E+02	4.13E+01	-3.76E+00	-1.90E-01
1.44E+02	4.13E+01	-3.76E+00	-1.86E-01

M165 Mesh2 eta = 0.30

X	Y	Z	Cp
1.40E+02	1.44E+01	-4.75E+00	1.60E-01
1.40E+02	1.44E+01	-4.69E+00	1.08E-01
1.40E+02	1.44E+01	-4.77E+00	1.60E-01
8.71E+01	1.44E+01	-4.11E+00	1.16E-02
8.76E+01	1.44E+01	-4.42E+00	9.46E-02
8.73E+01	1.44E+01	-4.24E+00	5.84E-02
8.73E+01	1.44E+01	-3.95E+00	-2.51E-01
8.77E+01	1.44E+01	-4.45E+00	1.05E-01
8.78E+01	1.44E+01	-4.48E+00	1.16E-01
8.82E+01	1.44E+01	-4.60E+00	1.48E-01
8.87E+01	1.44E+01	-4.72E+00	1.30E-01
8.88E+01	1.44E+01	-4.73E+00	1.27E-01
8.88E+01	1.44E+01	-4.73E+00	1.29E-01
8.93E+01	1.44E+01	-4.77E+00	1.41E-01
8.98E+01	1.44E+01	-4.81E+00	1.48E-01

1.39E+02	1.44E+01	-4.80E+00	1.09E-01
1.39E+02	1.44E+01	-4.81E+00	1.02E-01
1.39E+02	1.44E+01	-4.83E+00	8.60E-02
1.38E+02	1.44E+01	-4.84E+00	7.60E-02
1.40E+02	1.44E+01	-4.78E+00	1.57E-01
1.40E+02	1.44E+01	-4.78E+00	1.60E-01
1.38E+02	1.44E+01	-4.85E+00	6.37E-02
1.38E+02	1.44E+01	-4.87E+00	5.21E-02
8.99E+01	1.44E+01	-4.81E+00	1.44E-01
1.37E+02	1.44E+01	-4.88E+00	4.47E-02
1.37E+02	1.44E+01	-4.91E+00	3.09E-02
9.00E+01	1.44E+01	-4.82E+00	1.40E-01
9.04E+01	1.44E+01	-4.84E+00	1.26E-01
9.08E+01	1.44E+01	-4.86E+00	1.25E-01
9.10E+01	1.44E+01	-4.87E+00	1.30E-01
1.37E+02	1.44E+01	-4.91E+00	2.73E-02
1.36E+02	1.44E+01	-4.94E+00	1.39E-02
9.13E+01	1.44E+01	-4.89E+00	1.30E-01
9.16E+01	1.44E+01	-4.90E+00	1.30E-01
9.22E+01	1.44E+01	-4.93E+00	1.26E-01
9.25E+01	1.44E+01	-4.94E+00	1.22E-01
1.36E+02	1.44E+01	-4.96E+00	6.40E-03
1.35E+02	1.44E+01	-4.98E+00	-4.07E-03
9.26E+01	1.44E+01	-4.95E+00	1.21E-01
9.33E+01	1.44E+01	-4.97E+00	1.13E-01
9.36E+01	1.44E+01	-4.98E+00	1.09E-01
9.41E+01	1.44E+01	-5.00E+00	1.08E-01
9.45E+01	1.44E+01	-5.02E+00	1.06E-01
9.50E+01	1.44E+01	-5.04E+00	1.03E-01
9.55E+01	1.44E+01	-5.05E+00	1.01E-01
9.60E+01	1.44E+01	-5.07E+00	9.62E-02
9.65E+01	1.44E+01	-5.09E+00	9.07E-02
9.71E+01	1.44E+01	-5.12E+00	8.32E-02
9.75E+01	1.44E+01	-5.13E+00	8.01E-02
9.79E+01	1.44E+01	-5.15E+00	7.48E-02
1.00E+02	1.44E+01	-5.24E+00	5.73E-02
1.01E+02	1.44E+01	-5.27E+00	5.07E-02
1.00E+02	1.44E+01	-5.23E+00	5.80E-02
9.95E+01	1.44E+01	-5.21E+00	6.50E-02
9.92E+01	1.44E+01	-5.20E+00	6.93E-02
9.85E+01	1.44E+01	-5.17E+00	7.21E-02
1.01E+02	1.44E+01	-5.27E+00	4.98E-02
1.02E+02	1.44E+01	-5.30E+00	4.14E-02
1.03E+02	1.44E+01	-5.33E+00	3.74E-02
1.02E+02	1.44E+01	-5.31E+00	4.04E-02
1.03E+02	1.44E+01	-5.33E+00	3.66E-02
1.04E+02	1.44E+01	-5.35E+00	3.04E-02
1.04E+02	1.44E+01	-5.35E+00	3.00E-02
1.05E+02	1.44E+01	-5.37E+00	2.64E-02
1.05E+02	1.44E+01	-5.37E+00	2.61E-02
1.06E+02	1.44E+01	-5.39E+00	2.43E-02
1.06E+02	1.44E+01	-5.39E+00	2.37E-02
1.07E+02	1.44E+01	-5.40E+00	1.89E-02
1.07E+02	1.44E+01	-5.40E+00	1.87E-02
1.08E+02	1.44E+01	-5.41E+00	1.47E-02
1.09E+02	1.44E+01	-5.41E+00	1.40E-02
1.08E+02	1.44E+01	-5.41E+00	1.46E-02
1.10E+02	1.44E+01	-5.42E+00	1.00E-02
1.24E+02	1.44E+01	-5.28E+00	-1.73E-02
1.24E+02	1.44E+01	-5.30E+00	-1.78E-02
1.24E+02	1.44E+01	-5.29E+00	-1.74E-02
1.21E+02	1.44E+01	-5.36E+00	-2.06E-02
1.23E+02	1.44E+01	-5.32E+00	-1.91E-02
1.23E+02	1.44E+01	-5.31E+00	-1.82E-02
1.21E+02	1.44E+01	-5.36E+00	-2.07E-02
1.20E+02	1.44E+01	-5.37E+00	-1.98E-02
1.21E+02	1.44E+01	-5.35E+00	-2.07E-02
1.22E+02	1.44E+01	-5.34E+00	-2.07E-02
1.22E+02	1.44E+01	-5.34E+00	-2.07E-02
1.19E+02	1.44E+01	-5.38E+00	-1.92E-02

1.19E+02	1.44E+01	-5.38E+00	-1.79E-02
1.18E+02	1.44E+01	-5.39E+00	-1.52E-02
1.18E+02	1.44E+01	-5.39E+00	-1.40E-02
1.17E+02	1.44E+01	-5.40E+00	-9.81E-03
1.17E+02	1.44E+01	-5.40E+00	-1.13E-02
1.17E+02	1.44E+01	-5.40E+00	-1.10E-02
1.16E+02	1.44E+01	-5.40E+00	-6.84E-03
1.16E+02	1.44E+01	-5.40E+00	-5.87E-03
1.15E+02	1.44E+01	-5.41E+00	-3.12E-03
1.15E+02	1.44E+01	-5.41E+00	-1.86E-03
1.14E+02	1.44E+01	-5.41E+00	-1.63E-04
1.14E+02	1.44E+01	-5.41E+00	2.73E-03
1.13E+02	1.44E+01	-5.41E+00	2.89E-03
1.13E+02	1.44E+01	-5.42E+00	4.09E-03
1.12E+02	1.44E+01	-5.42E+00	4.27E-03
1.12E+02	1.44E+01	-5.42E+00	4.51E-03
1.12E+02	1.44E+01	-5.42E+00	7.96E-03
1.11E+02	1.44E+01	-5.42E+00	8.40E-03
1.11E+02	1.44E+01	-5.42E+00	9.36E-03
1.10E+02	1.44E+01	-5.42E+00	8.92E-03
1.25E+02	1.44E+01	-5.27E+00	-1.66E-02
1.25E+02	1.44E+01	-5.26E+00	-1.65E-02
1.25E+02	1.44E+01	-5.26E+00	-1.65E-02
1.26E+02	1.44E+01	-5.24E+00	-1.73E-02
1.27E+02	1.44E+01	-5.23E+00	-1.73E-02
1.27E+02	1.44E+01	-5.22E+00	-1.70E-02
1.28E+02	1.44E+01	-5.21E+00	-1.70E-02
1.28E+02	1.44E+01	-5.20E+00	-1.83E-02
1.29E+02	1.44E+01	-5.18E+00	-2.07E-02
1.29E+02	1.44E+01	-5.18E+00	-2.10E-02
1.30E+02	1.44E+01	-5.16E+00	-2.29E-02
1.30E+02	1.44E+01	-5.15E+00	-2.48E-02
1.30E+02	1.44E+01	-5.15E+00	-2.53E-02
1.31E+02	1.44E+01	-5.13E+00	-2.80E-02
1.31E+02	1.44E+01	-5.12E+00	-2.93E-02
1.32E+02	1.44E+01	-5.10E+00	-2.94E-02
1.32E+02	1.44E+01	-5.08E+00	-3.01E-02
1.33E+02	1.44E+01	-5.07E+00	-2.93E-02
1.34E+02	1.44E+01	-5.04E+00	-2.29E-02
1.34E+02	1.44E+01	-5.04E+00	-2.25E-02
1.34E+02	1.44E+01	-5.03E+00	-2.10E-02
1.35E+02	1.44E+01	-5.00E+00	-1.19E-02
8.76E+01	1.44E+01	-3.76E+00	-6.77E-01
8.77E+01	1.44E+01	-3.69E+00	-6.53E-01
8.81E+01	1.44E+01	-3.54E+00	-5.00E-01
8.82E+01	1.44E+01	-3.46E+00	-4.02E-01
8.83E+01	1.44E+01	-3.42E+00	-3.77E-01
8.88E+01	1.44E+01	-3.32E+00	-4.14E-01
8.92E+01	1.44E+01	-3.22E+00	-4.80E-01
8.95E+01	1.44E+01	-3.17E+00	-4.66E-01
8.93E+01	1.44E+01	-3.20E+00	-4.79E-01
8.98E+01	1.44E+01	-3.11E+00	-4.36E-01
9.07E+01	1.44E+01	-2.99E+00	-4.05E-01
9.01E+01	1.44E+01	-3.07E+00	-4.08E-01
9.03E+01	1.44E+01	-3.03E+00	-4.01E-01
9.09E+01	1.44E+01	-2.96E+00	-4.11E-01
9.20E+01	1.44E+01	-2.84E+00	-3.94E-01
9.19E+01	1.44E+01	-2.86E+00	-3.96E-01
9.10E+01	1.44E+01	-2.94E+00	-4.08E-01
9.14E+01	1.44E+01	-2.90E+00	-4.05E-01
1.39E+02	1.44E+01	-4.65E+00	7.92E-02
1.39E+02	1.44E+01	-4.62E+00	6.86E-02
1.39E+02	1.44E+01	-4.58E+00	4.30E-02
1.38E+02	1.44E+01	-4.55E+00	1.60E-02
1.38E+02	1.44E+01	-4.52E+00	-9.18E-03
1.37E+02	1.44E+01	-4.45E+00	-1.99E-02
1.37E+02	1.44E+01	-4.45E+00	-2.11E-02
1.37E+02	1.44E+01	-4.42E+00	-9.60E-02
1.37E+02	1.44E+01	-4.44E+00	-2.24E-02
9.22E+01	1.44E+01	-2.83E+00	-3.92E-01

1.37E+02	1.44E+01	-4.36E+00	-2.29E-01
9.28E+01	1.44E+01	-2.78E+00	-3.82E-01
1.37E+02	1.44E+01	-4.36E+00	-2.45E-01
1.36E+02	1.44E+01	-4.29E+00	-4.29E-01
9.33E+01	1.44E+01	-2.75E+00	-3.89E-01
9.37E+01	1.44E+01	-2.73E+00	-3.88E-01
9.43E+01	1.44E+01	-2.69E+00	-3.70E-01
9.45E+01	1.44E+01	-2.69E+00	-3.71E-01
1.36E+02	1.44E+01	-4.27E+00	-4.48E-01
9.52E+01	1.44E+01	-2.66E+00	-3.71E-01
9.54E+01	1.44E+01	-2.65E+00	-3.67E-01
9.77E+01	1.44E+01	-2.60E+00	-3.26E-01
1.35E+02	1.44E+01	-4.19E+00	-4.63E-01
9.63E+01	1.44E+01	-2.63E+00	-3.41E-01
9.77E+01	1.44E+01	-2.60E+00	-3.26E-01
9.92E+01	1.44E+01	-2.59E+00	-3.00E-01
1.35E+02	1.44E+01	-4.16E+00	-4.61E-01
9.93E+01	1.44E+01	-2.59E+00	-2.99E-01
9.76E+01	1.44E+01	-2.60E+00	-3.27E-01
1.34E+02	1.44E+01	-4.09E+00	-4.56E-01
1.01E+02	1.44E+01	-2.59E+00	-2.87E-01
1.00E+02	1.44E+01	-2.59E+00	-2.94E-01
9.93E+01	1.44E+01	-2.59E+00	-2.99E-01
9.65E+01	1.44E+01	-2.62E+00	-3.36E-01
1.02E+02	1.44E+01	-2.60E+00	-2.75E-01
1.01E+02	1.44E+01	-2.59E+00	-2.82E-01
1.15E+02	1.44E+01	-2.86E+00	-2.69E-01
1.14E+02	1.44E+01	-2.84E+00	-2.66E-01
1.16E+02	1.44E+01	-2.90E+00	-2.71E-01
1.15E+02	1.44E+01	-2.87E+00	-2.70E-01
1.17E+02	1.44E+01	-2.94E+00	-2.73E-01
1.16E+02	1.44E+01	-2.91E+00	-2.72E-01
1.17E+02	1.44E+01	-2.95E+00	-2.73E-01
1.18E+02	1.44E+01	-2.98E+00	-2.78E-01
1.11E+02	1.44E+01	-2.77E+00	-2.55E-01
1.11E+02	1.44E+01	-2.75E+00	-2.55E-01
1.12E+02	1.44E+01	-2.80E+00	-2.60E-01
1.12E+02	1.44E+01	-2.78E+00	-2.56E-01
1.13E+02	1.44E+01	-2.83E+00	-2.65E-01
1.13E+02	1.44E+01	-2.81E+00	-2.61E-01
1.07E+02	1.44E+01	-2.68E+00	-2.53E-01
1.07E+02	1.44E+01	-2.66E+00	-2.53E-01
1.10E+02	1.44E+01	-2.75E+00	-2.54E-01
1.10E+02	1.44E+01	-2.73E+00	-2.57E-01
1.09E+02	1.44E+01	-2.72E+00	-2.58E-01
1.09E+02	1.44E+01	-2.70E+00	-2.52E-01
1.06E+02	1.44E+01	-2.66E+00	-2.52E-01
1.06E+02	1.44E+01	-2.64E+00	-2.62E-01
1.08E+02	1.44E+01	-2.70E+00	-2.53E-01
1.08E+02	1.44E+01	-2.68E+00	-2.53E-01
1.04E+02	1.44E+01	-2.62E+00	-2.57E-01
1.04E+02	1.44E+01	-2.61E+00	-2.63E-01
1.03E+02	1.44E+01	-2.61E+00	-2.63E-01
1.03E+02	1.44E+01	-2.60E+00	-2.73E-01
1.05E+02	1.44E+01	-2.64E+00	-2.62E-01
1.05E+02	1.44E+01	-2.63E+00	-2.56E-01
1.18E+02	1.44E+01	-2.99E+00	-2.80E-01
1.19E+02	1.44E+01	-3.02E+00	-2.86E-01
1.19E+02	1.44E+01	-3.03E+00	-2.88E-01
1.33E+02	1.44E+01	-4.03E+00	-4.47E-01
1.20E+02	1.44E+01	-3.07E+00	-2.93E-01
1.20E+02	1.44E+01	-3.08E+00	-2.96E-01
1.21E+02	1.44E+01	-3.13E+00	-3.03E-01
1.21E+02	1.44E+01	-3.12E+00	-3.01E-01
1.22E+02	1.44E+01	-3.18E+00	-3.13E-01
1.22E+02	1.44E+01	-3.19E+00	-3.15E-01
1.23E+02	1.44E+01	-3.23E+00	-3.21E-01
1.23E+02	1.44E+01	-3.24E+00	-3.22E-01
1.24E+02	1.44E+01	-3.29E+00	-3.34E-01
1.24E+02	1.44E+01	-3.31E+00	-3.37E-01
1.25E+02	1.44E+01	-3.35E+00	-3.45E-01

1.25E+02	1.44E+01	-3.37E+00	-3.48E-01
1.26E+02	1.44E+01	-3.42E+00	-3.59E-01
1.26E+02	1.44E+01	-3.44E+00	-3.62E-01
1.27E+02	1.44E+01	-3.49E+00	-3.70E-01
1.27E+02	1.44E+01	-3.51E+00	-3.73E-01
1.28E+02	1.44E+01	-3.57E+00	-3.78E-01
1.28E+02	1.44E+01	-3.59E+00	-3.79E-01
1.29E+02	1.44E+01	-3.65E+00	-3.88E-01
1.29E+02	1.44E+01	-3.66E+00	-3.90E-01
1.30E+02	1.44E+01	-3.73E+00	-3.97E-01
1.30E+02	1.44E+01	-3.75E+00	-3.99E-01
1.31E+02	1.44E+01	-3.81E+00	-4.07E-01
1.31E+02	1.44E+01	-3.83E+00	-4.09E-01
1.32E+02	1.44E+01	-3.90E+00	-4.24E-01
1.32E+02	1.44E+01	-3.92E+00	-4.27E-01
1.33E+02	1.44E+01	-3.99E+00	-4.39E-01

M165 Mesh2 eta = 0.61

X	Y	Z	Cp
1.11E+02	2.93E+01	-5.16E+00	-1.53E-01
1.11E+02	2.93E+01	-5.31E+00	-1.99E-02
1.11E+02	2.93E+01	-4.88E+00	-4.47E-01
1.46E+02	2.93E+01	-4.44E+00	1.95E-01
1.46E+02	2.93E+01	-4.42E+00	1.85E-01
1.46E+02	2.93E+01	-4.39E+00	1.47E-01
1.45E+02	2.93E+01	-4.48E+00	1.57E-01
1.46E+02	2.93E+01	-4.46E+00	1.96E-01
1.45E+02	2.93E+01	-4.51E+00	1.19E-01
1.45E+02	2.93E+01	-4.49E+00	1.43E-01
1.45E+02	2.93E+01	-4.52E+00	1.13E-01
1.44E+02	2.93E+01	-4.55E+00	9.12E-02
1.44E+02	2.93E+01	-4.55E+00	9.05E-02
1.44E+02	2.93E+01	-4.57E+00	8.41E-02
1.43E+02	2.93E+01	-4.59E+00	7.15E-02
1.43E+02	2.93E+01	-4.59E+00	7.05E-02
1.43E+02	2.93E+01	-4.63E+00	5.38E-02
1.43E+02	2.93E+01	-4.63E+00	5.11E-02
1.12E+02	2.93E+01	-5.50E+00	2.14E-02
1.12E+02	2.93E+01	-5.46E+00	-8.19E-03
1.12E+02	2.93E+01	-5.47E+00	-1.09E-02
1.12E+02	2.93E+01	-5.47E+00	-1.12E-02
1.13E+02	2.93E+01	-5.52E+00	3.48E-02
1.13E+02	2.93E+01	-5.51E+00	3.94E-02
1.13E+02	2.93E+01	-5.52E+00	4.23E-02
1.13E+02	2.93E+01	-5.51E+00	4.70E-02
1.14E+02	2.93E+01	-5.50E+00	4.19E-02
1.14E+02	2.93E+01	-5.49E+00	4.38E-02
1.14E+02	2.93E+01	-5.49E+00	4.55E-02
1.43E+02	2.93E+01	-4.63E+00	5.09E-02
1.43E+02	2.93E+01	-4.63E+00	4.99E-02
1.15E+02	2.93E+01	-5.47E+00	6.21E-02
1.15E+02	2.93E+01	-5.46E+00	4.88E-02
1.15E+02	2.93E+01	-5.44E+00	4.61E-02
1.16E+02	2.93E+01	-5.42E+00	5.28E-02
1.16E+02	2.93E+01	-5.41E+00	5.17E-02
1.17E+02	2.93E+01	-5.39E+00	4.44E-02
1.17E+02	2.93E+01	-5.39E+00	4.42E-02
1.42E+02	2.93E+01	-4.68E+00	3.17E-02
1.41E+02	2.93E+01	-4.71E+00	2.74E-02
1.42E+02	2.93E+01	-4.69E+00	3.09E-02
1.18E+02	2.93E+01	-5.36E+00	4.66E-02
1.18E+02	2.93E+01	-5.34E+00	4.13E-02
1.19E+02	2.93E+01	-5.33E+00	4.01E-02
1.19E+02	2.93E+01	-5.34E+00	4.02E-02
1.19E+02	2.93E+01	-5.31E+00	4.11E-02
1.20E+02	2.93E+01	-5.31E+00	4.07E-02
1.21E+02	2.93E+01	-5.28E+00	3.95E-02
1.20E+02	2.93E+01	-5.29E+00	4.17E-02
1.24E+02	2.93E+01	-5.23E+00	2.65E-02

1.24E+02	2.93E+01	-5.23E+00	2.93E-02
1.23E+02	2.93E+01	-5.24E+00	3.49E-02
1.23E+02	2.93E+01	-5.25E+00	3.52E-02
1.22E+02	2.93E+01	-5.26E+00	3.09E-02
1.22E+02	2.93E+01	-5.27E+00	3.21E-02
1.25E+02	2.93E+01	-5.21E+00	2.03E-02
1.25E+02	2.93E+01	-5.22E+00	2.06E-02
1.26E+02	2.93E+01	-5.19E+00	1.77E-02
1.26E+02	2.93E+01	-5.20E+00	1.84E-02
1.27E+02	2.93E+01	-5.17E+00	1.63E-02
1.27E+02	2.93E+01	-5.17E+00	1.62E-02
1.28E+02	2.93E+01	-5.14E+00	1.30E-02
1.28E+02	2.93E+01	-5.15E+00	1.36E-02
1.29E+02	2.93E+01	-5.12E+00	1.26E-02
1.29E+02	2.93E+01	-5.12E+00	1.31E-02
1.30E+02	2.93E+01	-5.09E+00	1.08E-02
1.30E+02	2.93E+01	-5.10E+00	1.14E-02
1.31E+02	2.93E+01	-5.07E+00	8.43E-03
1.31E+02	2.93E+01	-5.07E+00	8.85E-03
1.33E+02	2.93E+01	-5.00E+00	7.06E-03
1.33E+02	2.93E+01	-5.01E+00	6.69E-03
1.32E+02	2.93E+01	-5.04E+00	7.07E-03
1.32E+02	2.93E+01	-5.04E+00	6.98E-03
1.34E+02	2.93E+01	-4.97E+00	1.03E-02
1.34E+02	2.93E+01	-4.98E+00	9.09E-03
1.35E+02	2.93E+01	-4.93E+00	1.46E-02
1.35E+02	2.93E+01	-4.94E+00	1.34E-02
1.36E+02	2.93E+01	-4.89E+00	1.88E-02
1.36E+02	2.93E+01	-4.90E+00	1.83E-02
1.40E+02	2.93E+01	-4.75E+00	2.08E-02
1.40E+02	2.93E+01	-4.74E+00	2.06E-02
1.39E+02	2.93E+01	-4.78E+00	2.34E-02
1.39E+02	2.93E+01	-4.79E+00	2.32E-02
1.38E+02	2.93E+01	-4.83E+00	2.47E-02
1.38E+02	2.93E+01	-4.82E+00	2.43E-02
1.37E+02	2.93E+01	-4.86E+00	2.22E-02
1.37E+02	2.93E+01	-4.86E+00	2.16E-02
1.45E+02	2.93E+01	-4.34E+00	9.84E-02
1.46E+02	2.93E+01	-4.37E+00	1.13E-01
1.13E+02	2.93E+01	-4.23E+00	-5.46E-01
1.13E+02	2.93E+01	-4.21E+00	-5.45E-01
1.15E+02	2.93E+01	-4.03E+00	-5.22E-01
1.13E+02	2.93E+01	-4.32E+00	-6.27E-01
1.13E+02	2.93E+01	-4.35E+00	-6.35E-01
1.14E+02	2.93E+01	-4.10E+00	-5.02E-01
1.14E+02	2.93E+01	-4.12E+00	-5.00E-01
1.14E+02	2.93E+01	-4.12E+00	-4.99E-01
1.15E+02	2.93E+01	-4.02E+00	-5.24E-01
1.15E+02	2.93E+01	-3.95E+00	-5.07E-01
1.12E+02	2.93E+01	-4.46E+00	-6.68E-01
1.45E+02	2.93E+01	-4.28E+00	7.19E-02
1.45E+02	2.93E+01	-4.32E+00	9.78E-02
1.45E+02	2.93E+01	-4.27E+00	6.60E-02
1.44E+02	2.93E+01	-4.21E+00	4.23E-02
1.44E+02	2.93E+01	-4.21E+00	4.23E-02
1.44E+02	2.93E+01	-4.21E+00	4.14E-02
1.12E+02	2.93E+01	-4.50E+00	-6.97E-01
1.12E+02	2.93E+01	-4.65E+00	-7.22E-01
1.11E+02	2.93E+01	-4.71E+00	-7.48E-01
1.15E+02	2.93E+01	-3.92E+00	-4.91E-01
1.16E+02	2.93E+01	-3.87E+00	-4.70E-01
1.43E+02	2.93E+01	-4.15E+00	1.51E-02
1.43E+02	2.93E+01	-4.15E+00	1.32E-02
1.16E+02	2.93E+01	-3.84E+00	-4.65E-01
1.17E+02	2.93E+01	-3.80E+00	-4.66E-01
1.17E+02	2.93E+01	-3.76E+00	-4.73E-01
1.17E+02	2.93E+01	-3.72E+00	-4.74E-01
1.43E+02	2.93E+01	-4.09E+00	-1.63E-02
1.43E+02	2.93E+01	-4.09E+00	-1.65E-02
1.43E+02	2.93E+01	-4.08E+00	-2.11E-02
1.42E+02	2.93E+01	-4.01E+00	-5.56E-02

1.18E+02	2.93E+01	-3.69E+00	-4.68E-01
1.18E+02	2.93E+01	-3.64E+00	-4.69E-01
1.19E+02	2.93E+01	-3.62E+00	-4.61E-01
1.41E+02	2.93E+01	-3.98E+00	-7.10E-02
1.42E+02	2.93E+01	-4.01E+00	-5.77E-02
1.19E+02	2.93E+01	-3.60E+00	-4.66E-01
1.20E+02	2.93E+01	-3.54E+00	-4.60E-01
1.20E+02	2.93E+01	-3.53E+00	-4.64E-01
1.21E+02	2.93E+01	-3.49E+00	-4.75E-01
1.21E+02	2.93E+01	-3.48E+00	-4.75E-01
1.23E+02	2.93E+01	-3.42E+00	-4.52E-01
1.21E+02	2.93E+01	-3.46E+00	-4.73E-01
1.23E+02	2.93E+01	-3.42E+00	-4.52E-01
1.22E+02	2.93E+01	-3.45E+00	-4.69E-01
1.22E+02	2.93E+01	-3.45E+00	-4.69E-01
1.23E+02	2.93E+01	-3.42E+00	-4.52E-01
1.41E+02	2.93E+01	-3.93E+00	-9.74E-02
1.40E+02	2.93E+01	-3.87E+00	-1.82E-01
1.39E+02	2.93E+01	-3.81E+00	-3.61E-01
1.39E+02	2.93E+01	-3.81E+00	-3.75E-01
1.38E+02	2.93E+01	-3.74E+00	-4.98E-01
1.28E+02	2.93E+01	-3.41E+00	-4.40E-01
1.28E+02	2.93E+01	-3.41E+00	-4.40E-01
1.29E+02	2.93E+01	-3.42E+00	-4.44E-01
1.29E+02	2.93E+01	-3.42E+00	-4.42E-01
1.30E+02	2.93E+01	-3.43E+00	-4.49E-01
1.30E+02	2.93E+01	-3.43E+00	-4.49E-01
1.31E+02	2.93E+01	-3.45E+00	-4.56E-01
1.31E+02	2.93E+01	-3.45E+00	-4.52E-01
1.41E+02	2.93E+01	-3.91E+00	-1.32E-01
1.40E+02	2.93E+01	-3.88E+00	-1.75E-01
1.38E+02	2.93E+01	-3.73E+00	-5.09E-01
1.37E+02	2.93E+01	-3.68E+00	-5.21E-01
1.37E+02	2.93E+01	-3.67E+00	-5.21E-01
1.36E+02	2.93E+01	-3.63E+00	-5.09E-01
1.36E+02	2.93E+01	-3.62E+00	-5.04E-01
1.35E+02	2.93E+01	-3.58E+00	-4.92E-01
1.35E+02	2.93E+01	-3.57E+00	-4.89E-01
1.34E+02	2.93E+01	-3.54E+00	-4.81E-01
1.34E+02	2.93E+01	-3.53E+00	-4.78E-01
1.33E+02	2.93E+01	-3.51E+00	-4.72E-01
1.33E+02	2.93E+01	-3.50E+00	-4.70E-01
1.32E+02	2.93E+01	-3.48E+00	-4.61E-01
1.32E+02	2.93E+01	-3.47E+00	-4.62E-01
1.27E+02	2.93E+01	-3.41E+00	-4.27E-01
1.27E+02	2.93E+01	-3.40E+00	-4.28E-01
1.26E+02	2.93E+01	-3.41E+00	-4.25E-01
1.26E+02	2.93E+01	-3.41E+00	-4.27E-01
1.24E+02	2.93E+01	-3.41E+00	-4.43E-01
1.24E+02	2.93E+01	-3.41E+00	-4.42E-01
1.23E+02	2.93E+01	-3.42E+00	-4.50E-01

M165 Mesh2 eta = 0.86

X	Y	Z	Cp
1.30E+02	4.13E+01	-5.07E+00	-2.15E-01
1.30E+02	4.13E+01	-5.16E+00	-7.95E-02
1.30E+02	4.13E+01	-4.78E+00	-7.63E-01
1.31E+02	4.13E+01	-4.73E+00	-8.84E-01
1.31E+02	4.13E+01	-4.59E+00	-8.48E-01
1.51E+02	4.13E+01	-4.33E+00	1.11E-01
1.51E+02	4.13E+01	-4.34E+00	1.13E-01
1.51E+02	4.13E+01	-4.33E+00	1.05E-01
1.50E+02	4.13E+01	-4.36E+00	1.72E-01
1.50E+02	4.13E+01	-4.37E+00	1.60E-01
1.50E+02	4.13E+01	-4.39E+00	1.09E-01
1.50E+02	4.13E+01	-4.40E+00	9.60E-02
1.49E+02	4.13E+01	-4.42E+00	6.89E-02
1.49E+02	4.13E+01	-4.44E+00	5.83E-02
1.49E+02	4.13E+01	-4.45E+00	4.82E-02

1.32E+02	4.13E+01	-5.16E+00	7.35E-02
1.34E+02	4.13E+01	-5.08E+00	7.11E-02
1.31E+02	4.13E+01	-5.23E+00	5.85E-02
1.32E+02	4.13E+01	-5.19E+00	5.73E-02
1.32E+02	4.13E+01	-5.20E+00	5.43E-02
1.32E+02	4.13E+01	-5.21E+00	5.88E-02
1.31E+02	4.13E+01	-5.25E+00	1.25E-01
1.31E+02	4.13E+01	-5.26E+00	1.20E-01
1.31E+02	4.13E+01	-5.26E+00	1.27E-01
1.33E+02	4.13E+01	-5.13E+00	5.76E-02
1.33E+02	4.13E+01	-5.12E+00	5.41E-02
1.33E+02	4.13E+01	-5.11E+00	5.84E-02
1.35E+02	4.13E+01	-5.00E+00	7.29E-02
1.48E+02	4.13E+01	-4.47E+00	3.70E-02
1.34E+02	4.13E+01	-5.02E+00	7.19E-02
1.34E+02	4.13E+01	-5.05E+00	7.29E-02
1.34E+02	4.13E+01	-5.04E+00	7.19E-02
1.48E+02	4.13E+01	-4.48E+00	3.24E-02
1.48E+02	4.13E+01	-4.50E+00	3.22E-02
1.36E+02	4.13E+01	-4.93E+00	6.79E-02
1.35E+02	4.13E+01	-4.95E+00	6.90E-02
1.35E+02	4.13E+01	-4.97E+00	7.02E-02
1.35E+02	4.13E+01	-4.96E+00	6.81E-02
1.47E+02	4.13E+01	-4.50E+00	3.10E-02
1.47E+02	4.13E+01	-4.51E+00	3.40E-02
1.46E+02	4.13E+01	-4.53E+00	3.49E-02
1.36E+02	4.13E+01	-4.89E+00	6.05E-02
1.36E+02	4.13E+01	-4.90E+00	6.13E-02
1.36E+02	4.13E+01	-4.89E+00	6.03E-02
1.37E+02	4.13E+01	-4.86E+00	6.43E-02
1.37E+02	4.13E+01	-4.84E+00	6.05E-02
1.45E+02	4.13E+01	-4.56E+00	3.02E-02
1.46E+02	4.13E+01	-4.54E+00	3.53E-02
1.38E+02	4.13E+01	-4.81E+00	5.42E-02
1.39E+02	4.13E+01	-4.78E+00	5.49E-02
1.39E+02	4.13E+01	-4.76E+00	5.31E-02
1.40E+02	4.13E+01	-4.73E+00	5.00E-02
1.40E+02	4.13E+01	-4.72E+00	5.02E-02
1.41E+02	4.13E+01	-4.69E+00	4.68E-02
1.41E+02	4.13E+01	-4.69E+00	4.60E-02
1.42E+02	4.13E+01	-4.66E+00	3.54E-02
1.42E+02	4.13E+01	-4.66E+00	3.46E-02
1.43E+02	4.13E+01	-4.63E+00	2.19E-02
1.43E+02	4.13E+01	-4.63E+00	2.18E-02
1.44E+02	4.13E+01	-4.60E+00	2.55E-02
1.44E+02	4.13E+01	-4.60E+00	2.62E-02
1.45E+02	4.13E+01	-4.57E+00	3.00E-02
1.50E+02	4.13E+01	-4.28E+00	-1.59E-02
1.50E+02	4.13E+01	-4.27E+00	-4.15E-03
1.50E+02	4.13E+01	-4.22E+00	2.71E-02
1.50E+02	4.13E+01	-4.19E+00	9.68E-03
1.49E+02	4.13E+01	-4.15E+00	-4.00E-02
1.49E+02	4.13E+01	-4.12E+00	-4.83E-02
1.34E+02	4.13E+01	-4.00E+00	-6.59E-01
1.35E+02	4.13E+01	-3.97E+00	-6.58E-01
1.34E+02	4.13E+01	-4.05E+00	-6.73E-01
1.34E+02	4.13E+01	-4.08E+00	-6.76E-01
1.33E+02	4.13E+01	-4.17E+00	-6.73E-01
1.33E+02	4.13E+01	-4.12E+00	-6.74E-01
1.33E+02	4.13E+01	-4.21E+00	-6.89E-01
1.33E+02	4.13E+01	-4.27E+00	-6.74E-01
1.32E+02	4.13E+01	-4.31E+00	-7.00E-01
1.32E+02	4.13E+01	-4.39E+00	-7.84E-01
1.32E+02	4.13E+01	-4.43E+00	-8.16E-01
1.31E+02	4.13E+01	-4.54E+00	-9.56E-01
1.49E+02	4.13E+01	-4.09E+00	-5.01E-02
1.48E+02	4.13E+01	-4.05E+00	-7.72E-02
1.48E+02	4.13E+01	-4.03E+00	-8.97E-02
1.48E+02	4.13E+01	-3.98E+00	-1.06E-01
1.35E+02	4.13E+01	-3.92E+00	-6.68E-01
1.35E+02	4.13E+01	-3.90E+00	-6.74E-01

1.36E+02	4.13E+01	-3.85E+00	-6.83E-01
1.37E+02	4.13E+01	-3.79E+00	-6.92E-01
1.47E+02	4.13E+01	-3.97E+00	-1.11E-01
1.47E+02	4.13E+01	-3.92E+00	-1.27E-01
1.37E+02	4.13E+01	-3.79E+00	-6.92E-01
1.37E+02	4.13E+01	-3.78E+00	-6.91E-01
1.37E+02	4.13E+01	-3.77E+00	-6.83E-01
1.47E+02	4.13E+01	-3.91E+00	-1.30E-01
1.46E+02	4.13E+01	-3.88E+00	-1.30E-01
1.40E+02	4.13E+01	-3.68E+00	-6.75E-01
1.39E+02	4.13E+01	-3.68E+00	-6.61E-01
1.45E+02	4.13E+01	-3.81E+00	-1.43E-01
1.46E+02	4.13E+01	-3.83E+00	-1.36E-01
1.40E+02	4.13E+01	-3.67E+00	-6.89E-01
1.41E+02	4.13E+01	-3.68E+00	-7.10E-01
1.44E+02	4.13E+01	-3.77E+00	-1.47E-01
1.42E+02	4.13E+01	-3.68E+00	-7.18E-01
1.42E+02	4.13E+01	-3.70E+00	-6.26E-01
1.39E+02	4.13E+01	-3.69E+00	-6.68E-01
1.38E+02	4.13E+01	-3.71E+00	-6.63E-01
1.38E+02	4.13E+01	-3.72E+00	-6.65E-01
1.44E+02	4.13E+01	-3.75E+00	-2.15E-01
1.43E+02	4.13E+01	-3.73E+00	-3.35E-01
1.43E+02	4.13E+01	-3.71E+00	-5.25E-01

M165 Mesh3 eta = 0.30

X Y	Z Cp		
1.40E+02	1.44E+01	-4.75E+00	1.69E-01
1.40E+02	1.44E+01	-4.76E+00	1.75E-01
1.40E+02	1.44E+01	-4.72E+00	1.40E-01
8.71E+01	1.44E+01	-4.11E+00	5.09E-03
8.72E+01	1.44E+01	-4.19E+00	4.27E-02
8.74E+01	1.44E+01	-4.30E+00	6.51E-02
8.72E+01	1.44E+01	-4.02E+00	-1.72E-01
8.75E+01	1.44E+01	-4.37E+00	9.18E-02
8.83E+01	1.44E+01	-4.66E+00	1.38E-01
8.76E+01	1.44E+01	-4.41E+00	1.27E-01
8.79E+01	1.44E+01	-4.52E+00	2.09E-01
8.83E+01	1.44E+01	-4.64E+00	1.42E-01
8.84E+01	1.44E+01	-4.67E+00	1.42E-01
8.88E+01	1.44E+01	-4.72E+00	1.99E-01
8.91E+01	1.44E+01	-4.76E+00	1.78E-01
1.39E+02	1.44E+01	-4.80E+00	1.21E-01
1.39E+02	1.44E+01	-4.81E+00	1.08E-01
1.39E+02	1.44E+01	-4.79E+00	1.26E-01
1.40E+02	1.44E+01	-4.77E+00	1.69E-01
1.39E+02	1.44E+01	-4.82E+00	1.01E-01
1.38E+02	1.44E+01	-4.83E+00	8.09E-02
1.38E+02	1.44E+01	-4.84E+00	7.78E-02
8.92E+01	1.44E+01	-4.77E+00	1.74E-01
1.38E+02	1.44E+01	-4.86E+00	6.50E-02
1.38E+02	1.44E+01	-4.86E+00	6.16E-02
1.37E+02	1.44E+01	-4.88E+00	4.87E-02
8.93E+01	1.44E+01	-4.78E+00	1.67E-01
8.96E+01	1.44E+01	-4.80E+00	1.46E-01
8.99E+01	1.44E+01	-4.82E+00	1.44E-01
1.37E+02	1.44E+01	-4.89E+00	4.64E-02
9.01E+01	1.44E+01	-4.83E+00	1.46E-01
9.03E+01	1.44E+01	-4.84E+00	1.41E-01
9.05E+01	1.44E+01	-4.85E+00	1.38E-01
9.07E+01	1.44E+01	-4.86E+00	1.39E-01
9.10E+01	1.44E+01	-4.87E+00	1.36E-01
1.37E+02	1.44E+01	-4.91E+00	3.44E-02
9.13E+01	1.44E+01	-4.89E+00	1.38E-01
9.15E+01	1.44E+01	-4.90E+00	1.34E-01
9.17E+01	1.44E+01	-4.90E+00	1.31E-01
9.20E+01	1.44E+01	-4.92E+00	1.25E-01
1.36E+02	1.44E+01	-4.93E+00	2.02E-02
1.36E+02	1.44E+01	-4.95E+00	1.21E-02
9.23E+01	1.44E+01	-4.93E+00	1.20E-01

1.37E+02	1.44E+01	-4.91E+00	3.00E-02
9.30E+01	1.44E+01	-4.96E+00	1.16E-01
9.27E+01	1.44E+01	-4.95E+00	1.18E-01
9.33E+01	1.44E+01	-4.97E+00	1.12E-01
9.37E+01	1.44E+01	-4.99E+00	1.09E-01
9.40E+01	1.44E+01	-5.00E+00	1.08E-01
9.45E+01	1.44E+01	-5.02E+00	1.06E-01
9.48E+01	1.44E+01	-5.03E+00	1.06E-01
9.54E+01	1.44E+01	-5.05E+00	9.64E-02
1.35E+02	1.44E+01	-4.96E+00	6.97E-03
1.35E+02	1.44E+01	-4.99E+00	-3.02E-03
1.35E+02	1.44E+01	-5.00E+00	-7.59E-03
1.34E+02	1.44E+01	-5.02E+00	-1.60E-02
1.34E+02	1.44E+01	-5.03E+00	-1.81E-02
1.33E+02	1.44E+01	-5.06E+00	-2.62E-02
9.75E+01	1.44E+01	-5.13E+00	8.15E-02
9.79E+01	1.44E+01	-5.15E+00	8.02E-02
9.71E+01	1.44E+01	-5.12E+00	8.35E-02
9.66E+01	1.44E+01	-5.10E+00	8.63E-02
1.32E+02	1.44E+01	-5.09E+00	-2.98E-02
1.32E+02	1.44E+01	-5.09E+00	-2.97E-02
1.32E+02	1.44E+01	-5.11E+00	-2.86E-02
1.31E+02	1.44E+01	-5.12E+00	-2.82E-02
1.31E+02	1.44E+01	-5.14E+00	-2.55E-02
1.30E+02	1.44E+01	-5.14E+00	-2.47E-02
9.63E+01	1.44E+01	-5.09E+00	9.01E-02
9.57E+01	1.44E+01	-5.06E+00	9.46E-02
9.84E+01	1.44E+01	-5.17E+00	7.55E-02
1.26E+02	1.44E+01	-5.24E+00	-1.55E-02
1.26E+02	1.44E+01	-5.24E+00	-1.54E-02
1.26E+02	1.44E+01	-5.26E+00	-1.63E-02
1.25E+02	1.44E+01	-5.26E+00	-1.60E-02
1.25E+02	1.44E+01	-5.28E+00	-1.65E-02
1.25E+02	1.44E+01	-5.28E+00	-1.70E-02
1.27E+02	1.44E+01	-5.22E+00	-1.64E-02
1.27E+02	1.44E+01	-5.22E+00	-1.69E-02
1.28E+02	1.44E+01	-5.20E+00	-1.70E-02
1.28E+02	1.44E+01	-5.20E+00	-1.76E-02
1.24E+02	1.44E+01	-5.30E+00	-1.75E-02
1.24E+02	1.44E+01	-5.30E+00	-1.74E-02
1.23E+02	1.44E+01	-5.31E+00	-1.75E-02
1.23E+02	1.44E+01	-5.32E+00	-1.77E-02
1.22E+02	1.44E+01	-5.34E+00	-1.89E-02
1.22E+02	1.44E+01	-5.33E+00	-1.85E-02
1.21E+02	1.44E+01	-5.35E+00	-1.99E-02
1.21E+02	1.44E+01	-5.35E+00	-2.01E-02
1.21E+02	1.44E+01	-5.36E+00	-1.99E-02
1.20E+02	1.44E+01	-5.37E+00	-1.98E-02
1.20E+02	1.44E+01	-5.37E+00	-1.87E-02
1.19E+02	1.44E+01	-5.38E+00	-1.86E-02
1.19E+02	1.44E+01	-5.38E+00	-1.70E-02
1.19E+02	1.44E+01	-5.39E+00	-1.60E-02
1.18E+02	1.44E+01	-5.39E+00	-1.37E-02
1.18E+02	1.44E+01	-5.39E+00	-1.26E-02
1.17E+02	1.44E+01	-5.40E+00	-1.08E-02
1.17E+02	1.44E+01	-5.40E+00	-9.62E-03
9.87E+01	1.44E+01	-5.18E+00	7.20E-02
1.16E+02	1.44E+01	-5.40E+00	-7.00E-03
1.16E+02	1.44E+01	-5.40E+00	-6.08E-03
1.15E+02	1.44E+01	-5.41E+00	-3.93E-03
1.15E+02	1.44E+01	-5.41E+00	-2.33E-03
1.15E+02	1.44E+01	-5.41E+00	3.55E-04
1.29E+02	1.44E+01	-5.18E+00	-1.86E-02
1.14E+02	1.44E+01	-5.41E+00	1.17E-03
1.14E+02	1.44E+01	-5.41E+00	2.37E-03
1.14E+02	1.44E+01	-5.41E+00	3.52E-03
1.13E+02	1.44E+01	-5.42E+00	5.01E-03
1.13E+02	1.44E+01	-5.42E+00	5.49E-03
1.12E+02	1.44E+01	-5.42E+00	7.11E-03
1.12E+02	1.44E+01	-5.42E+00	7.54E-03
1.11E+02	1.44E+01	-5.42E+00	8.20E-03

1.11E+02	1.44E+01	-5.42E+00	8.85E-03
1.10E+02	1.44E+01	-5.42E+00	1.03E-02
1.10E+02	1.44E+01	-5.42E+00	1.04E-02
1.29E+02	1.44E+01	-5.18E+00	-1.96E-02
1.10E+02	1.44E+01	-5.42E+00	1.12E-02
1.09E+02	1.44E+01	-5.41E+00	1.19E-02
1.09E+02	1.44E+01	-5.41E+00	1.42E-02
1.08E+02	1.44E+01	-5.41E+00	1.52E-02
1.08E+02	1.44E+01	-5.40E+00	1.70E-02
1.08E+02	1.44E+01	-5.40E+00	1.77E-02
1.07E+02	1.44E+01	-5.40E+00	2.04E-02
1.07E+02	1.44E+01	-5.39E+00	2.16E-02
1.06E+02	1.44E+01	-5.38E+00	2.37E-02
1.06E+02	1.44E+01	-5.38E+00	2.45E-02
1.05E+02	1.44E+01	-5.37E+00	2.71E-02
1.05E+02	1.44E+01	-5.37E+00	2.82E-02
1.04E+02	1.44E+01	-5.36E+00	3.08E-02
1.04E+02	1.44E+01	-5.35E+00	3.16E-02
1.04E+02	1.44E+01	-5.34E+00	3.52E-02
1.03E+02	1.44E+01	-5.33E+00	3.65E-02
1.03E+02	1.44E+01	-5.32E+00	3.96E-02
1.03E+02	1.44E+01	-5.31E+00	4.11E-02
1.02E+02	1.44E+01	-5.29E+00	4.62E-02
1.02E+02	1.44E+01	-5.28E+00	4.75E-02
1.01E+02	1.44E+01	-5.27E+00	5.21E-02
1.01E+02	1.44E+01	-5.26E+00	5.50E-02
1.00E+02	1.44E+01	-5.24E+00	5.99E-02
1.00E+02	1.44E+01	-5.23E+00	6.11E-02
9.94E+01	1.44E+01	-5.21E+00	6.67E-02
9.92E+01	1.44E+01	-5.20E+00	6.97E-02
1.30E+02	1.44E+01	-5.16E+00	-2.15E-02
1.33E+02	1.44E+01	-5.06E+00	-2.67E-02
1.33E+02	1.44E+01	-5.07E+00	-2.82E-02
1.30E+02	1.44E+01	-5.15E+00	-2.36E-02
8.75E+01	1.44E+01	-3.82E+00	-6.65E-01
8.77E+01	1.44E+01	-3.72E+00	-5.78E-01
8.75E+01	1.44E+01	-3.79E+00	-6.56E-01
8.79E+01	1.44E+01	-3.59E+00	-3.88E-01
8.80E+01	1.44E+01	-3.53E+00	-3.64E-01
8.83E+01	1.44E+01	-3.43E+00	-4.20E-01
8.87E+01	1.44E+01	-3.32E+00	-4.91E-01
8.87E+01	1.44E+01	-3.31E+00	-4.86E-01
8.88E+01	1.44E+01	-3.29E+00	-4.83E-01
8.92E+01	1.44E+01	-3.22E+00	-4.67E-01
8.94E+01	1.44E+01	-3.18E+00	-4.63E-01
8.96E+01	1.44E+01	-3.15E+00	-4.57E-01
8.99E+01	1.44E+01	-3.10E+00	-4.43E-01
9.00E+01	1.44E+01	-3.08E+00	-4.35E-01
9.01E+01	1.44E+01	-3.06E+00	-4.28E-01
1.39E+02	1.44E+01	-4.60E+00	5.42E-02
1.39E+02	1.44E+01	-4.64E+00	9.05E-02
1.39E+02	1.44E+01	-4.65E+00	9.99E-02
1.40E+02	1.44E+01	-4.69E+00	1.10E-01
1.39E+02	1.44E+01	-4.59E+00	4.60E-02
1.38E+02	1.44E+01	-4.55E+00	2.48E-02
1.38E+02	1.44E+01	-4.54E+00	1.68E-02
9.05E+01	1.44E+01	-3.01E+00	-4.12E-01
9.08E+01	1.44E+01	-2.96E+00	-4.12E-01
9.20E+01	1.44E+01	-2.84E+00	-3.95E-01
1.38E+02	1.44E+01	-4.50E+00	-1.32E-02
1.38E+02	1.44E+01	-4.49E+00	-1.62E-02
9.10E+01	1.44E+01	-2.94E+00	-4.10E-01
1.37E+02	1.44E+01	-4.45E+00	-3.47E-02
9.17E+01	1.44E+01	-2.87E+00	-4.01E-01
9.15E+01	1.44E+01	-2.89E+00	-4.05E-01
9.15E+01	1.44E+01	-2.88E+00	-4.03E-01
9.22E+01	1.44E+01	-2.83E+00	-3.93E-01
9.25E+01	1.44E+01	-2.80E+00	-3.94E-01
9.28E+01	1.44E+01	-2.78E+00	-3.91E-01
9.31E+01	1.44E+01	-2.76E+00	-3.88E-01
1.37E+02	1.44E+01	-4.42E+00	-8.64E-02

1.37E+02	1.44E+01	-4.40E+00	-1.37E-01
1.36E+02	1.44E+01	-4.36E+00	-3.19E-01
9.36E+01	1.44E+01	-2.73E+00	-3.81E-01
1.36E+02	1.44E+01	-4.34E+00	-3.73E-01
1.36E+02	1.44E+01	-4.29E+00	-4.65E-01
9.38E+01	1.44E+01	-2.72E+00	-3.79E-01
9.44E+01	1.44E+01	-2.69E+00	-3.64E-01
9.43E+01	1.44E+01	-2.69E+00	-3.67E-01
9.51E+01	1.44E+01	-2.66E+00	-3.50E-01
9.51E+01	1.44E+01	-2.66E+00	-3.50E-01
1.36E+02	1.44E+01	-4.28E+00	-4.68E-01
1.35E+02	1.44E+01	-4.22E+00	-4.69E-01
9.58E+01	1.44E+01	-2.64E+00	-3.50E-01
9.58E+01	1.44E+01	-2.64E+00	-3.49E-01
1.35E+02	1.44E+01	-4.21E+00	-4.69E-01
1.35E+02	1.44E+01	-4.18E+00	-4.63E-01
9.74E+01	1.44E+01	-2.61E+00	-3.26E-01
9.66E+01	1.44E+01	-2.62E+00	-3.41E-01
9.69E+01	1.44E+01	-2.61E+00	-3.37E-01
9.76E+01	1.44E+01	-2.60E+00	-3.24E-01
9.83E+01	1.44E+01	-2.59E+00	-3.13E-01
9.85E+01	1.44E+01	-2.59E+00	-3.10E-01
9.92E+01	1.44E+01	-2.59E+00	-3.00E-01
9.94E+01	1.44E+01	-2.59E+00	-2.98E-01
1.00E+02	1.44E+01	-2.59E+00	-2.94E-01
1.34E+02	1.44E+01	-4.13E+00	-4.55E-01
1.34E+02	1.44E+01	-4.12E+00	-4.53E-01
1.33E+02	1.44E+01	-4.04E+00	-4.45E-01
1.33E+02	1.44E+01	-4.02E+00	-4.43E-01
1.33E+02	1.44E+01	-3.99E+00	-4.39E-01
1.00E+02	1.44E+01	-2.59E+00	-2.93E-01
1.01E+02	1.44E+01	-2.59E+00	-2.85E-01
1.01E+02	1.44E+01	-2.59E+00	-2.83E-01
1.04E+02	1.44E+01	-2.62E+00	-2.56E-01
1.03E+02	1.44E+01	-2.61E+00	-2.55E-01
1.03E+02	1.44E+01	-2.60E+00	-2.61E-01
1.03E+02	1.44E+01	-2.60E+00	-2.64E-01
1.02E+02	1.44E+01	-2.59E+00	-2.75E-01
1.02E+02	1.44E+01	-2.60E+00	-2.73E-01
1.02E+02	1.44E+01	-2.59E+00	-2.73E-01
1.04E+02	1.44E+01	-2.62E+00	-2.55E-01
1.05E+02	1.44E+01	-2.63E+00	-2.52E-01
1.05E+02	1.44E+01	-2.63E+00	-2.51E-01
1.06E+02	1.44E+01	-2.65E+00	-2.51E-01
1.06E+02	1.44E+01	-2.65E+00	-2.51E-01
1.07E+02	1.44E+01	-2.66E+00	-2.53E-01
1.07E+02	1.44E+01	-2.66E+00	-2.53E-01
1.07E+02	1.44E+01	-2.67E+00	-2.50E-01
1.08E+02	1.44E+01	-2.68E+00	-2.48E-01
1.07E+02	1.44E+01	-2.68E+00	-2.47E-01
1.08E+02	1.44E+01	-2.70E+00	-2.53E-01
1.08E+02	1.44E+01	-2.70E+00	-2.52E-01
1.09E+02	1.44E+01	-2.71E+00	-2.51E-01
1.09E+02	1.44E+01	-2.72E+00	-2.53E-01
1.10E+02	1.44E+01	-2.74E+00	-2.55E-01
1.10E+02	1.44E+01	-2.75E+00	-2.56E-01
1.20E+02	1.44E+01	-3.11E+00	-2.96E-01
1.21E+02	1.44E+01	-3.12E+00	-2.99E-01
1.19E+02	1.44E+01	-3.03E+00	-2.77E-01
1.19E+02	1.44E+01	-3.04E+00	-2.80E-01
1.18E+02	1.44E+01	-2.99E+00	-2.75E-01
1.18E+02	1.44E+01	-3.00E+00	-2.76E-01
1.17E+02	1.44E+01	-2.97E+00	-2.71E-01
1.17E+02	1.44E+01	-2.96E+00	-2.65E-01
1.15E+02	1.44E+01	-2.89E+00	-2.60E-01
1.16E+02	1.44E+01	-2.90E+00	-2.62E-01
1.14E+02	1.44E+01	-2.86E+00	-2.59E-01
1.15E+02	1.44E+01	-2.87E+00	-2.59E-01
1.14E+02	1.44E+01	-2.84E+00	-2.58E-01
1.14E+02	1.44E+01	-2.83E+00	-2.58E-01
1.20E+02	1.44E+01	-3.08E+00	-2.92E-01

1.20E+02	1.44E+01	-3.07E+00	-2.90E-01
1.16E+02	1.44E+01	-2.92E+00	-2.65E-01
1.16E+02	1.44E+01	-2.93E+00	-2.63E-01
1.13E+02	1.44E+01	-2.82E+00	-2.57E-01
1.13E+02	1.44E+01	-2.81E+00	-2.56E-01
1.12E+02	1.44E+01	-2.79E+00	-2.56E-01
1.12E+02	1.44E+01	-2.78E+00	-2.56E-01
1.11E+02	1.44E+01	-2.77E+00	-2.56E-01
1.11E+02	1.44E+01	-2.76E+00	-2.57E-01
1.21E+02	1.44E+01	-3.15E+00	-3.06E-01
1.21E+02	1.44E+01	-3.17E+00	-3.08E-01
1.22E+02	1.44E+01	-3.21E+00	-3.19E-01
1.22E+02	1.44E+01	-3.20E+00	-3.16E-01
1.23E+02	1.44E+01	-3.25E+00	-3.22E-01
1.23E+02	1.44E+01	-3.26E+00	-3.25E-01
1.24E+02	1.44E+01	-3.31E+00	-3.34E-01
1.24E+02	1.44E+01	-3.30E+00	-3.31E-01
1.25E+02	1.44E+01	-3.35E+00	-3.40E-01
1.25E+02	1.44E+01	-3.37E+00	-3.43E-01
1.26E+02	1.44E+01	-3.42E+00	-3.54E-01
1.25E+02	1.44E+01	-3.41E+00	-3.52E-01
1.26E+02	1.44E+01	-3.46E+00	-3.60E-01
1.27E+02	1.44E+01	-3.48E+00	-3.62E-01
1.27E+02	1.44E+01	-3.55E+00	-3.72E-01
1.27E+02	1.44E+01	-3.53E+00	-3.70E-01
1.28E+02	1.44E+01	-3.59E+00	-3.78E-01
1.28E+02	1.44E+01	-3.61E+00	-3.81E-01
1.29E+02	1.44E+01	-3.68E+00	-3.91E-01
1.29E+02	1.44E+01	-3.66E+00	-3.88E-01
1.30E+02	1.44E+01	-3.72E+00	-3.96E-01
1.30E+02	1.44E+01	-3.75E+00	-3.99E-01
1.31E+02	1.44E+01	-3.79E+00	-4.07E-01
1.31E+02	1.44E+01	-3.82E+00	-4.11E-01
1.31E+02	1.44E+01	-3.87E+00	-4.22E-01
1.32E+02	1.44E+01	-3.89E+00	-4.26E-01
1.32E+02	1.44E+01	-3.94E+00	-4.33E-01

M165 mesh3 eta = 0.61

X	Y	Z	Cp
1.11E+02	2.93E+01	-5.16E+00	-1.35E-01
1.11E+02	2.93E+01	-5.21E+00	-6.95E-02
1.11E+02	2.93E+01	-5.29E+00	-2.47E-02
1.11E+02	2.93E+01	-5.06E+00	-2.44E-01
1.11E+02	2.93E+01	-4.82E+00	-7.02E-01
1.11E+02	2.93E+01	-5.37E+00	4.21E-02
1.11E+02	2.93E+01	-4.78E+00	-7.81E-01
1.46E+02	2.93E+01	-4.45E+00	1.86E-01
1.46E+02	2.93E+01	-4.42E+00	1.93E-01
1.46E+02	2.93E+01	-4.38E+00	1.55E-01
1.45E+02	2.93E+01	-4.50E+00	1.31E-01
1.45E+02	2.93E+01	-4.48E+00	1.61E-01
1.45E+02	2.93E+01	-4.51E+00	1.24E-01
1.44E+02	2.93E+01	-4.53E+00	1.12E-01
1.45E+02	2.93E+01	-4.47E+00	1.82E-01
1.44E+02	2.93E+01	-4.54E+00	1.04E-01
1.44E+02	2.93E+01	-4.56E+00	9.24E-02
1.44E+02	2.93E+01	-4.57E+00	8.58E-02
1.11E+02	2.93E+01	-5.42E+00	6.71E-02
1.12E+02	2.93E+01	-5.46E+00	7.52E-02
1.12E+02	2.93E+01	-5.49E+00	5.60E-02
1.12E+02	2.93E+01	-5.51E+00	5.29E-02
1.12E+02	2.93E+01	-5.52E+00	4.21E-02
1.13E+02	2.93E+01	-5.51E+00	7.34E-02
1.13E+02	2.93E+01	-5.52E+00	4.15E-02
1.13E+02	2.93E+01	-5.51E+00	9.06E-02
1.43E+02	2.93E+01	-4.59E+00	7.48E-02
1.14E+02	2.93E+01	-5.49E+00	6.12E-02
1.14E+02	2.93E+01	-5.50E+00	6.11E-02
1.13E+02	2.93E+01	-5.51E+00	8.49E-02
1.14E+02	2.93E+01	-5.50E+00	6.85E-02

1.43E+02	2.93E+01	-4.60E+00	7.03E-02
1.14E+02	2.93E+01	-5.49E+00	6.16E-02
1.43E+02	2.93E+01	-4.62E+00	5.95E-02
1.15E+02	2.93E+01	-5.46E+00	5.21E-02
1.15E+02	2.93E+01	-5.47E+00	5.55E-02
1.14E+02	2.93E+01	-5.48E+00	6.33E-02
1.15E+02	2.93E+01	-5.46E+00	5.15E-02
1.16E+02	2.93E+01	-5.42E+00	5.41E-02
1.16E+02	2.93E+01	-5.44E+00	5.18E-02
1.43E+02	2.93E+01	-4.63E+00	5.60E-02
1.16E+02	2.93E+01	-5.42E+00	5.42E-02
1.17E+02	2.93E+01	-5.40E+00	5.13E-02
1.17E+02	2.93E+01	-5.40E+00	5.14E-02
1.17E+02	2.93E+01	-5.38E+00	4.37E-02
1.42E+02	2.93E+01	-4.66E+00	4.29E-02
1.17E+02	2.93E+01	-5.38E+00	4.36E-02
1.18E+02	2.93E+01	-5.35E+00	4.57E-02
1.42E+02	2.93E+01	-4.67E+00	3.95E-02
1.41E+02	2.93E+01	-4.69E+00	2.93E-02
1.18E+02	2.93E+01	-5.35E+00	4.58E-02
1.18E+02	2.93E+01	-5.35E+00	4.58E-02
1.19E+02	2.93E+01	-5.34E+00	4.79E-02
1.20E+02	2.93E+01	-5.31E+00	4.36E-02
1.41E+02	2.93E+01	-4.71E+00	2.73E-02
1.20E+02	2.93E+01	-5.31E+00	4.36E-02
1.20E+02	2.93E+01	-5.31E+00	4.36E-02
1.21E+02	2.93E+01	-5.29E+00	4.48E-02
1.21E+02	2.93E+01	-5.29E+00	4.48E-02
1.21E+02	2.93E+01	-5.27E+00	3.92E-02
1.21E+02	2.93E+01	-5.27E+00	3.92E-02
1.22E+02	2.93E+01	-5.26E+00	3.78E-02
1.22E+02	2.93E+01	-5.26E+00	3.73E-02
1.41E+02	2.93E+01	-4.73E+00	2.44E-02
1.40E+02	2.93E+01	-4.75E+00	2.50E-02
1.40E+02	2.93E+01	-4.77E+00	2.50E-02
1.23E+02	2.93E+01	-5.25E+00	3.17E-02
1.24E+02	2.93E+01	-5.23E+00	2.51E-02
1.23E+02	2.93E+01	-5.24E+00	3.11E-02
1.26E+02	2.93E+01	-5.20E+00	1.72E-02
1.24E+02	2.93E+01	-5.23E+00	2.49E-02
1.25E+02	2.93E+01	-5.22E+00	2.41E-02
1.25E+02	2.93E+01	-5.21E+00	2.23E-02
1.25E+02	2.93E+01	-5.22E+00	2.40E-02
1.25E+02	2.93E+01	-5.22E+00	2.40E-02
1.26E+02	2.93E+01	-5.20E+00	1.72E-02
1.27E+02	2.93E+01	-5.18E+00	1.81E-02
1.27E+02	2.93E+01	-5.18E+00	1.81E-02
1.27E+02	2.93E+01	-5.18E+00	1.79E-02
1.30E+02	2.93E+01	-5.10E+00	1.17E-02
1.30E+02	2.93E+01	-5.10E+00	1.16E-02
1.29E+02	2.93E+01	-5.12E+00	1.34E-02
1.29E+02	2.93E+01	-5.12E+00	1.36E-02
1.28E+02	2.93E+01	-5.14E+00	1.51E-02
1.28E+02	2.93E+01	-5.14E+00	1.51E-02
1.31E+02	2.93E+01	-5.08E+00	1.01E-02
1.27E+02	2.93E+01	-5.16E+00	1.70E-02
1.31E+02	2.93E+01	-5.08E+00	1.00E-02
1.27E+02	2.93E+01	-5.16E+00	1.71E-02
1.32E+02	2.93E+01	-5.05E+00	8.34E-03
1.32E+02	2.93E+01	-5.05E+00	8.35E-03
1.33E+02	2.93E+01	-5.03E+00	7.07E-03
1.33E+02	2.93E+01	-5.03E+00	7.06E-03
1.33E+02	2.93E+01	-5.00E+00	7.83E-03
1.33E+02	2.93E+01	-5.00E+00	7.85E-03
1.34E+02	2.93E+01	-4.97E+00	1.05E-02
1.34E+02	2.93E+01	-4.97E+00	1.08E-02
1.37E+02	2.93E+01	-4.88E+00	2.36E-02
1.37E+02	2.93E+01	-4.87E+00	2.54E-02
1.37E+02	2.93E+01	-4.85E+00	2.56E-02
1.38E+02	2.93E+01	-4.84E+00	2.64E-02
1.36E+02	2.93E+01	-4.90E+00	2.05E-02

1.36E+02	2.93E+01	-4.91E+00	1.91E-02
1.35E+02	2.93E+01	-4.93E+00	1.61E-02
1.35E+02	2.93E+01	-4.94E+00	1.54E-02
1.38E+02	2.93E+01	-4.82E+00	2.62E-02
1.39E+02	2.93E+01	-4.81E+00	2.60E-02
1.39E+02	2.93E+01	-4.79E+00	2.54E-02
1.13E+02	2.93E+01	-4.31E+00	-6.27E-01
1.13E+02	2.93E+01	-4.27E+00	-6.05E-01
1.12E+02	2.93E+01	-4.42E+00	-7.01E-01
1.13E+02	2.93E+01	-4.36E+00	-6.65E-01
1.12E+02	2.93E+01	-4.47E+00	-6.91E-01
1.12E+02	2.93E+01	-4.55E+00	-7.18E-01
1.12E+02	2.93E+01	-4.59E+00	-7.25E-01
1.13E+02	2.93E+01	-4.21E+00	-5.46E-01
1.14E+02	2.93E+01	-4.19E+00	-5.40E-01
1.15E+02	2.93E+01	-4.05E+00	-5.07E-01
1.45E+02	2.93E+01	-4.30E+00	1.08E-01
1.45E+02	2.93E+01	-4.33E+00	1.30E-01
1.45E+02	2.93E+01	-4.35E+00	1.34E-01
1.45E+02	2.93E+01	-4.28E+00	9.51E-02
1.44E+02	2.93E+01	-4.25E+00	7.97E-02
1.44E+02	2.93E+01	-4.24E+00	7.10E-02
1.14E+02	2.93E+01	-4.11E+00	-5.14E-01
1.14E+02	2.93E+01	-4.12E+00	-5.15E-01
1.14E+02	2.93E+01	-4.12E+00	-5.15E-01
1.15E+02	2.93E+01	-4.03E+00	-5.08E-01
1.15E+02	2.93E+01	-3.98E+00	-5.05E-01
1.11E+02	2.93E+01	-4.76E+00	-8.12E-01
1.44E+02	2.93E+01	-4.20E+00	5.56E-02
1.44E+02	2.93E+01	-4.19E+00	4.82E-02
1.15E+02	2.93E+01	-3.95E+00	-5.03E-01
1.16E+02	2.93E+01	-3.90E+00	-4.86E-01
1.43E+02	2.93E+01	-4.15E+00	3.35E-02
1.16E+02	2.93E+01	-3.87E+00	-4.75E-01
1.16E+02	2.93E+01	-3.84E+00	-4.73E-01
1.43E+02	2.93E+01	-4.14E+00	2.63E-02
1.16E+02	2.93E+01	-3.80E+00	-4.71E-01
1.17E+02	2.93E+01	-3.78E+00	-4.71E-01
1.43E+02	2.93E+01	-4.10E+00	3.40E-03
1.17E+02	2.93E+01	-3.74E+00	-4.78E-01
1.17E+02	2.93E+01	-3.71E+00	-4.82E-01
1.18E+02	2.93E+01	-3.68E+00	-4.80E-01
1.18E+02	2.93E+01	-3.64E+00	-4.70E-01
1.43E+02	2.93E+01	-4.09E+00	-1.21E-03
1.42E+02	2.93E+01	-4.04E+00	-2.16E-02
1.42E+02	2.93E+01	-4.03E+00	-2.68E-02
1.41E+02	2.93E+01	-3.98E+00	-5.00E-02
1.19E+02	2.93E+01	-3.58E+00	-4.60E-01
1.19E+02	2.93E+01	-3.61E+00	-4.65E-01
1.19E+02	2.93E+01	-3.56E+00	-4.61E-01
1.20E+02	2.93E+01	-3.54E+00	-4.66E-01
1.20E+02	2.93E+01	-3.51E+00	-4.72E-01
1.21E+02	2.93E+01	-3.49E+00	-4.73E-01
1.41E+02	2.93E+01	-3.97E+00	-5.22E-02
1.41E+02	2.93E+01	-3.92E+00	-7.91E-02
1.22E+02	2.93E+01	-3.46E+00	-4.75E-01
1.21E+02	2.93E+01	-3.48E+00	-4.72E-01
1.22E+02	2.93E+01	-3.45E+00	-4.75E-01
1.22E+02	2.93E+01	-3.44E+00	-4.59E-01
1.23E+02	2.93E+01	-3.43E+00	-4.49E-01
1.40E+02	2.93E+01	-3.90E+00	-1.34E-01
1.40E+02	2.93E+01	-3.85E+00	-3.31E-01
1.25E+02	2.93E+01	-3.41E+00	-4.35E-01
1.24E+02	2.93E+01	-3.41E+00	-4.45E-01
1.30E+02	2.93E+01	-3.43E+00	-4.45E-01
1.29E+02	2.93E+01	-3.42E+00	-4.41E-01
1.28E+02	2.93E+01	-3.41E+00	-4.35E-01
1.27E+02	2.93E+01	-3.41E+00	-4.33E-01
1.26E+02	2.93E+01	-3.40E+00	-4.31E-01
1.26E+02	2.93E+01	-3.41E+00	-4.32E-01
1.25E+02	2.93E+01	-3.41E+00	-4.37E-01

1.25E+02	2.93E+01	-3.41E+00	-4.35E-01
1.29E+02	2.93E+01	-3.42E+00	-4.39E-01
1.28E+02	2.93E+01	-3.41E+00	-4.36E-01
1.30E+02	2.93E+01	-3.43E+00	-4.46E-01
1.30E+02	2.93E+01	-3.44E+00	-4.49E-01
1.27E+02	2.93E+01	-3.41E+00	-4.34E-01
1.27E+02	2.93E+01	-3.40E+00	-4.33E-01
1.39E+02	2.93E+01	-3.81E+00	-4.30E-01
1.31E+02	2.93E+01	-3.45E+00	-4.54E-01
1.31E+02	2.93E+01	-3.46E+00	-4.58E-01
1.24E+02	2.93E+01	-3.42E+00	-4.46E-01
1.23E+02	2.93E+01	-3.42E+00	-4.45E-01
1.32E+02	2.93E+01	-3.46E+00	-4.59E-01
1.32E+02	2.93E+01	-3.48E+00	-4.65E-01
1.32E+02	2.93E+01	-3.49E+00	-4.67E-01
1.33E+02	2.93E+01	-3.50E+00	-4.71E-01
1.33E+02	2.93E+01	-3.51E+00	-4.76E-01
1.34E+02	2.93E+01	-3.53E+00	-4.78E-01
1.34E+02	2.93E+01	-3.54E+00	-4.80E-01
1.35E+02	2.93E+01	-3.56E+00	-4.89E-01
1.35E+02	2.93E+01	-3.58E+00	-4.92E-01
1.36E+02	2.93E+01	-3.60E+00	-5.00E-01
1.36E+02	2.93E+01	-3.61E+00	-5.04E-01
1.36E+02	2.93E+01	-3.64E+00	-5.10E-01
1.37E+02	2.93E+01	-3.66E+00	-5.14E-01
1.37E+02	2.93E+01	-3.69E+00	-5.26E-01
1.38E+02	2.93E+01	-3.70E+00	-5.32E-01
1.38E+02	2.93E+01	-3.74E+00	-5.34E-01
1.38E+02	2.93E+01	-3.76E+00	-5.35E-01

M165 Mesh3 eta = 0.86

X	Y	Z	Cp
1.30E+02	4.13E+01	-5.07E+00	-3.46E-02
1.30E+02	4.13E+01	-5.07E+00	-2.52E-02
1.30E+02	4.13E+01	-5.07E+00	-2.65E-02
1.30E+02	4.13E+01	-5.10E+00	-1.29E-02
1.30E+02	4.13E+01	-5.05E+00	-7.85E-02
1.30E+02	4.13E+01	-5.22E+00	-9.71E-03
1.31E+02	4.13E+01	-4.83E+00	-5.87E-01
1.30E+02	4.13E+01	-4.90E+00	-6.15E-01
1.31E+02	4.13E+01	-5.22E+00	7.17E-02
1.31E+02	4.13E+01	-5.23E+00	4.27E-02
1.51E+02	4.13E+01	-4.34E+00	1.40E-01
1.51E+02	4.13E+01	-4.33E+00	1.41E-01
1.51E+02	4.13E+01	-4.32E+00	1.22E-01
1.33E+02	4.13E+01	-5.10E+00	6.66E-02
1.33E+02	4.13E+01	-5.09E+00	7.11E-02
1.34E+02	4.13E+01	-5.06E+00	7.39E-02
1.34E+02	4.13E+01	-5.05E+00	7.67E-02
1.33E+02	4.13E+01	-5.14E+00	6.34E-02
1.33E+02	4.13E+01	-5.12E+00	6.24E-02
1.32E+02	4.13E+01	-5.16E+00	5.71E-02
1.32E+02	4.13E+01	-5.18E+00	6.40E-02
1.32E+02	4.13E+01	-5.19E+00	4.00E-02
1.32E+02	4.13E+01	-5.22E+00	2.03E-02
1.32E+02	4.13E+01	-5.22E+00	7.09E-02
1.31E+02	4.13E+01	-5.25E+00	1.04E-01
1.48E+02	4.13E+01	-4.47E+00	3.57E-02
1.49E+02	4.13E+01	-4.42E+00	8.29E-02
1.49E+02	4.13E+01	-4.42E+00	8.16E-02
1.50E+02	4.13E+01	-4.39E+00	1.03E-01
1.50E+02	4.13E+01	-4.39E+00	1.05E-01
1.50E+02	4.13E+01	-4.37E+00	1.42E-01
1.50E+02	4.13E+01	-4.36E+00	1.44E-01
1.49E+02	4.13E+01	-4.44E+00	6.13E-02
1.49E+02	4.13E+01	-4.46E+00	4.43E-02
1.49E+02	4.13E+01	-4.44E+00	6.05E-02
1.48E+02	4.13E+01	-4.47E+00	3.52E-02
1.48E+02	4.13E+01	-4.49E+00	3.14E-02
1.34E+02	4.13E+01	-5.02E+00	6.80E-02

1.34E+02	4.13E+01	-5.01E+00	6.67E-02
1.35E+02	4.13E+01	-4.98E+00	7.15E-02
1.35E+02	4.13E+01	-4.98E+00	7.06E-02
1.48E+02	4.13E+01	-4.49E+00	3.00E-02
1.35E+02	4.13E+01	-4.95E+00	6.97E-02
1.36E+02	4.13E+01	-4.94E+00	6.97E-02
1.47E+02	4.13E+01	-4.51E+00	3.27E-02
1.36E+02	4.13E+01	-4.88E+00	6.50E-02
1.36E+02	4.13E+01	-4.91E+00	6.58E-02
1.47E+02	4.13E+01	-4.51E+00	3.27E-02
1.37E+02	4.13E+01	-4.87E+00	6.50E-02
1.37E+02	4.13E+01	-4.85E+00	6.39E-02
1.47E+02	4.13E+01	-4.51E+00	3.26E-02
1.47E+02	4.13E+01	-4.53E+00	3.31E-02
1.37E+02	4.13E+01	-4.84E+00	6.41E-02
1.37E+02	4.13E+01	-4.83E+00	6.23E-02
1.38E+02	4.13E+01	-4.82E+00	5.88E-02
1.46E+02	4.13E+01	-4.53E+00	3.33E-02
1.46E+02	4.13E+01	-4.55E+00	3.46E-02
1.38E+02	4.13E+01	-4.79E+00	5.85E-02
1.38E+02	4.13E+01	-4.79E+00	5.90E-02
1.40E+02	4.13E+01	-4.70E+00	5.21E-02
1.40E+02	4.13E+01	-4.72E+00	5.27E-02
1.39E+02	4.13E+01	-4.76E+00	5.58E-02
1.39E+02	4.13E+01	-4.75E+00	5.61E-02
1.41E+02	4.13E+01	-4.69E+00	5.11E-02
1.41E+02	4.13E+01	-4.68E+00	4.17E-02
1.46E+02	4.13E+01	-4.55E+00	3.45E-02
1.42E+02	4.13E+01	-4.65E+00	3.43E-02
1.42E+02	4.13E+01	-4.67E+00	4.03E-02
1.45E+02	4.13E+01	-4.57E+00	3.13E-02
1.44E+02	4.13E+01	-4.59E+00	2.81E-02
1.43E+02	4.13E+01	-4.62E+00	2.72E-02
1.42E+02	4.13E+01	-4.65E+00	3.25E-02
1.44E+02	4.13E+01	-4.59E+00	2.76E-02
1.44E+02	4.13E+01	-4.61E+00	2.70E-02
1.43E+02	4.13E+01	-4.62E+00	2.68E-02
1.33E+02	4.13E+01	-4.26E+00	-6.95E-01
1.33E+02	4.13E+01	-4.24E+00	-6.93E-01
1.34E+02	4.13E+01	-4.11E+00	-6.85E-01
1.34E+02	4.13E+01	-4.09E+00	-6.79E-01
1.34E+02	4.13E+01	-4.05E+00	-6.80E-01
1.32E+02	4.13E+01	-4.31E+00	-7.31E-01
1.32E+02	4.13E+01	-4.36E+00	-7.76E-01
1.32E+02	4.13E+01	-4.40E+00	-8.32E-01
1.31E+02	4.13E+01	-4.47E+00	-8.55E-01
1.31E+02	4.13E+01	-4.49E+00	-8.41E-01
1.31E+02	4.13E+01	-4.55E+00	-8.88E-01
1.31E+02	4.13E+01	-4.61E+00	-9.09E-01
1.31E+02	4.13E+01	-4.62E+00	-9.30E-01
1.33E+02	4.13E+01	-4.17E+00	-6.86E-01
1.33E+02	4.13E+01	-4.17E+00	-6.86E-01
1.33E+02	4.13E+01	-4.17E+00	-6.86E-01
1.49E+02	4.13E+01	-4.16E+00	-2.99E-03
1.49E+02	4.13E+01	-4.16E+00	-3.92E-03
1.48E+02	4.13E+01	-4.06E+00	-6.22E-02
1.49E+02	4.13E+01	-4.11E+00	-2.42E-02
1.49E+02	4.13E+01	-4.11E+00	-2.46E-02
1.49E+02	4.13E+01	-4.10E+00	-2.97E-02
1.50E+02	4.13E+01	-4.21E+00	3.25E-02
1.50E+02	4.13E+01	-4.21E+00	3.37E-02
1.50E+02	4.13E+01	-4.27E+00	3.65E-02
1.50E+02	4.13E+01	-4.27E+00	3.58E-02
1.34E+02	4.13E+01	-4.01E+00	-6.89E-01
1.34E+02	4.13E+01	-3.99E+00	-6.99E-01
1.35E+02	4.13E+01	-3.88E+00	-7.05E-01
1.48E+02	4.13E+01	-4.05E+00	-6.42E-02
1.48E+02	4.13E+01	-4.01E+00	-8.25E-02
1.35E+02	4.13E+01	-3.93E+00	-7.00E-01
1.35E+02	4.13E+01	-3.93E+00	-6.99E-01
1.35E+02	4.13E+01	-3.93E+00	-6.99E-01

1.36E+02	4.13E+01	-3.87E+00	-7.04E-01
1.48E+02	4.13E+01	-4.00E+00	-8.80E-02
1.36E+02	4.13E+01	-3.83E+00	-7.06E-01
1.47E+02	4.13E+01	-3.96E+00	-9.93E-02
1.47E+02	4.13E+01	-3.95E+00	-1.03E-01
1.36E+02	4.13E+01	-3.81E+00	-7.04E-01
1.36E+02	4.13E+01	-3.80E+00	-7.03E-01
1.36E+02	4.13E+01	-3.81E+00	-7.04E-01
1.47E+02	4.13E+01	-3.94E+00	-1.04E-01
1.46E+02	4.13E+01	-3.89E+00	-1.09E-01
1.37E+02	4.13E+01	-3.76E+00	-6.99E-01
1.38E+02	4.13E+01	-3.73E+00	-6.87E-01
1.38E+02	4.13E+01	-3.73E+00	-6.83E-01
1.38E+02	4.13E+01	-3.73E+00	-6.86E-01
1.38E+02	4.13E+01	-3.71E+00	-6.69E-01
1.46E+02	4.13E+01	-3.88E+00	-1.10E-01
1.46E+02	4.13E+01	-3.83E+00	-1.20E-01
1.39E+02	4.13E+01	-3.70E+00	-6.66E-01
1.41E+02	4.13E+01	-3.67E+00	-6.87E-01
1.39E+02	4.13E+01	-3.69E+00	-6.59E-01
1.45E+02	4.13E+01	-3.83E+00	-1.21E-01
1.45E+02	4.13E+01	-3.79E+00	-1.16E-01
1.43E+02	4.13E+01	-3.71E+00	-6.75E-01
1.40E+02	4.13E+01	-3.68E+00	-6.65E-01
1.41E+02	4.13E+01	-3.67E+00	-6.85E-01
1.40E+02	4.13E+01	-3.67E+00	-6.72E-01
1.45E+02	4.13E+01	-3.78E+00	-1.20E-01
1.41E+02	4.13E+01	-3.67E+00	-6.92E-01
1.43E+02	4.13E+01	-3.71E+00	-6.71E-01
1.42E+02	4.13E+01	-3.69E+00	-7.13E-01
1.43E+02	4.13E+01	-3.71E+00	-6.75E-01
1.44E+02	4.13E+01	-3.74E+00	-2.43E-01
1.44E+02	4.13E+01	-3.74E+00	-2.46E-01
1.44E+02	4.13E+01	-3.73E+00	-3.76E-01

Appendix B

FELISA .bac & .nam Files

W4 Files

W4.nam - Control File

```
 &control
   restart  = .false.,
   nsmth    = 0,
   smofc    = 0.00,
   diss     = 0.5,
   cfl      = 3.0,
   relax    = 1.0,
   alpha(1) = 1.523,
   beta(1)  = 0.00,
   mach(1)  = 0.779,
   ntime    = 3000,
   nstou    = 20,
   nstage   = 5,
   ndis(1)  = .true.,
   ndis(2)  = .true.,
   bulkvis  = .false.,
   nlimit   = 2,
   aref     = 1341,
 &end
```

```
  FELISA Background Mesh ---- Model: W4 Mesh1
  8   6   2   8   6
  1   -100000.000000   -100000.000000   100000.000000
   1.00    .00    .00      77.5
    .00   1.00    .00      77.5
    .00    .00   1.00      77.5
  2   100000.000000   -100000.000000   100000.000000
   1.00    .00    .00      77.5
    .00   1.00    .00      77.5
    .00    .00   1.00      77.5
  3   -100000.000000   100000.000000   100000.000000
   1.00    .00    .00      77.5
    .00   1.00    .00      77.5
    .00    .00   1.00      77.5
  4   100000.000000   100000.000000   100000.000000
   1.00    .00    .00      77.5
    .00   1.00    .00      77.5
    .00    .00   1.00      77.5
  5   -100000.000000   -100000.000000   -100000.000000
   1.00    .00    .00      77.5
    .00   1.00    .00      77.5
    .00    .00   1.00      77.5
  6   100000.000000   -100000.000000   -100000.000000
   1.00    .00    .00      77.5
    .00   1.00    .00      77.5
    .00    .00   1.00      77.5
  7   -100000.000000   100000.000000   -100000.000000
   1.00    .00    .00      77.5
    .00   1.00    .00      77.5
    .00    .00   1.00      77.5
```

```
 8   100000.000000   100000.000000   -100000.000000
  1.00    .00    .00      77.5
   .00   1.00    .00      77.5
   .00    .00   1.00      77.5
    1     7     5     8     4
    2     7     5     4     1
    3     7     1     4     3
    4     5     6     8     2
    5     5     2     8     4
    6     5     2     4     1
 === Point Sources ===
Fuselage - Fuse Nose
   0.0000    0.0000    0.0000    1.240    3.720    12.40
Fuselage - Fuse Tail
   154.70    0.0000    0.0000    1.240    3.720    12.40
 === Line Sources ===
Fuselage - Fuse Line
   0.0000    0.0000    0.0000    2.325    9.95    39.80
   154.70    0.0000    0.0000    2.325    9.95    39.80
Multi_Wing_Comp: Trailing Edge Line 1
   92.660    0.0000    -5.8264    0.552    1.104    4.416
   94.501    30.102    -5.4167    0.552    1.104    4.416
Multi_Wing_Comp: Trailing Edge Line 2
   94.501    30.102    -5.4177    0.552    1.104    4.416
   98.294    48.595    -4.5997    0.552    1.104    4.416
Multi_Wing_Comp: Trailing Edge Line 3
   98.294    48.595    -4.5997    0.552    1.104    4.416
   103.35    73.240    -4.4172    0.552    1.104    4.416
Multi_Wing_Comp: Leading Edge Line 1
   57.810    0.0000    -4.3000    0.552    1.104    4.416
   74.018    30.102    -4.3000    0.552    1.104    4.416
Multi_Wing_Comp: Leading Edge Line 2
   74.018    30.102    -4.3000    0.552    1.104    4.416
   83.975    48.595    -4.3000    0.552    1.104    4.416
Multi_Wing_Comp: Leading Edge Line 3
   83.976    48.595    -4.3000    0.552    1.104    4.416
   97.246    73.240    -4.3000    0.552    1.104    4.416
Multi_Wing_Comp: Tip
   97.246    73.240    -4.3000    0.552    1.104    4.416
   103.35    73.240    -4.4172    0.552    1.104    4.416
 === Triangle Sources ===
Multi_Wing_Comp: Trailing Edge Tri 1
   92.660    0.0000    -5.8264    0.920    1.840    7.360
   94.501    30.102    -5.4167    0.920    1.840    7.360
   57.810    0.0000    -4.3000    0.920    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 2
   94.501    30.102    -5.4167    0.920    1.840    7.360
   98.294    48.595    -4.5997    0.920    1.840    7.360
   74.018    30.102    -4.3000    0.920    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 3
   98.294    48.595    -4.5997    0.920    1.840    7.360
   103.35    73.240    -4.4172    0.920    1.840    7.360
   83.976    48.595    -4.3000    0.920    1.840    7.360
Multi_Wing_Comp: Leading Edge Tri 1
   57.810    0.0000    -4.3000    0.920    1.840    7.360
   74.018    30.102    -4.3000    0.920    1.840    7.360
   94.501    30.102    -5.4167    0.920    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 2
   74.018    30.102    -4.3000    0.920    1.840    7.360
   83.976    48.595    -4.3000    0.920    1.840    7.360
   98.294    48.595    -4.5997    0.920    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 3
```

```
  83.976    48.595    -4.3000    0.920    1.840    7.360
  97.246    73.240    -4.3000    0.920    1.840    7.360
  103.35    73.240    -4.4171    0.920    1.840    7.360

FELISA Background Mesh ---- Model: W4 Mesh2
 8   6   2   8   6
 1   -100000.000000   -100000.000000   100000.000000
  1.00    .00    .00      77.5
   .00   1.00    .00      77.5
   .00    .00   1.00      77.5
 2   100000.000000   -100000.000000   100000.000000
  1.00    .00    .00      77.5
   .00   1.00    .00      77.5
   .00    .00   1.00      77.5
 3   -100000.000000   100000.000000   100000.000000
  1.00    .00    .00      77.5
   .00   1.00    .00      77.5
   .00    .00   1.00      77.5
 4   100000.000000   100000.000000   100000.000000
  1.00    .00    .00      77.5
   .00   1.00    .00      77.5
   .00    .00   1.00      77.5
 5   -100000.000000   -100000.000000   -100000.000000
  1.00    .00    .00      77.5
   .00   1.00    .00      77.5
   .00    .00   1.00      77.5
 6   100000.000000   -100000.000000   -100000.000000
  1.00    .00    .00      77.5
   .00   1.00    .00      77.5
   .00    .00   1.00      77.5
 7   -100000.000000   100000.000000   -100000.000000
  1.00    .00    .00      77.5
   .00   1.00    .00      77.5
   .00    .00   1.00      77.5
 8   100000.000000   100000.000000   -100000.000000
  1.00    .00    .00      77.5
   .00   1.00    .00      77.5
   .00    .00   1.00      77.5
    1     7     5     8     4
    2     7     5     4     1
    3     7     1     4     3
    4     5     6     8     2
    5     5     2     8     4
    6     5     2     4     1
 === Point Sources ===
Fuselage - Fuse Nose
   0.0000    0.0000    0.0000    1.240    3.720    12.40
Fuselage - Fuse Tail
   154.70    0.0000    0.0000    1.240    3.720    12.40
 === Line Sources ===
Fuselage - Fuse Line
   0.0000    0.0000    0.0000    2.325    9.95    39.80
   154.70    0.0000    0.0000    2.325    9.95    39.80
Multi_Wing_Comp: Trailing Edge Line 1
   92.660    0.0000    -5.8264    0.552    1.104    4.416
   94.501    30.102    -5.4167    0.552    1.104    4.416
Multi_Wing_Comp: Trailing Edge Line 2
   94.501    30.102    -5.4177    0.552    1.104    4.416
   98.294    48.595    -4.5997    0.552    1.104    4.416
Multi_Wing_Comp: Trailing Edge Line 3
   98.294    48.595    -4.5997    0.552    1.104    4.416
   103.35    73.240    -4.4172    0.552    1.104    4.416
```

```
Multi_Wing_Comp: Leading Edge Line 1
  57.810    0.0000    -4.3000    0.552    1.104    4.416
  74.018    30.102    -4.3000    0.552    1.104    4.416
Multi_Wing_Comp: Leading Edge Line 2
  74.018    30.102    -4.3000    0.552    1.104    4.416
  83.975    48.595    -4.3000    0.552    1.104    4.416
Multi_Wing_Comp: Leading Edge Line 3
  83.976    48.595    -4.3000    0.552    1.104    4.416
  97.246    73.240    -4.3000    0.552    1.104    4.416
Multi_Wing_Comp: Tip
  97.246    73.240    -4.3000    0.552    1.104    4.416
  103.35    73.240    -4.4172    0.552    1.104    4.416
 === Triangle Sources ===
Multi_Wing_Comp: Trailing Edge Tri 1
  92.660    0.0000    -5.8264    0.920    1.840    7.360
  94.501    30.102    -5.4167    0.920    1.840    7.360
  57.810    0.0000    -4.3000    0.920    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 2
  94.501    30.102    -5.4167    0.920    1.840    7.360
  98.294    48.595    -4.5997    0.920    1.840    7.360
  74.018    30.102    -4.3000    0.920    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 3
  98.294    48.595    -4.5997    0.920    1.840    7.360
  103.35    73.240    -4.4172    0.920    1.840    7.360
  83.976    48.595    -4.3000    0.920    1.840    7.360
Multi_Wing_Comp: Leading Edge Tri 1
  57.810    0.0000    -4.3000    0.920    1.840    7.360
  74.018    30.102    -4.3000    0.920    1.840    7.360
  94.501    30.102    -5.4167    0.920    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 2
  74.018    30.102    -4.3000    0.920    1.840    7.360
  83.976    48.595    -4.3000    0.920    1.840    7.360
  98.294    48.595    -4.5997    0.920    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 3
  83.976    48.595    -4.3000    0.920    1.840    7.360
  97.246    73.240    -4.3000    0.920    1.840    7.360
  103.35    73.240    -4.4171    0.920    1.840    7.360
```

```
  FELISA Background Mesh ---- Model: W4 Mesh3
 8   6   2   8   6
 1   -100000.000000   -100000.000000   100000.000000
  1.00    .00    .00      62.0
   .00   1.00    .00      62.0
   .00    .00   1.00      62.0
 2   100000.000000   -100000.000000   100000.000000
  1.00    .00    .00      62.0
   .00   1.00    .00      62.0
   .00    .00   1.00      62.0
 3   -100000.000000   100000.000000   100000.000000
  1.00    .00    .00      62.0
   .00   1.00    .00      62.0
   .00    .00   1.00      62.0
 4   100000.000000   100000.000000   100000.000000
  1.00    .00    .00      62.0
   .00   1.00    .00      62.0
   .00    .00   1.00      62.0
 5   -100000.000000   -100000.000000   -100000.000000
  1.00    .00    .00      62.0
   .00   1.00    .00      62.0
   .00    .00   1.00      62.0
 6   100000.000000   -100000.000000   -100000.000000
```

```
  1.00    .00    .00      62.0
   .00   1.00    .00      62.0
   .00    .00   1.00      62.0
 7   -100000.000000   100000.000000   -100000.000000
  1.00    .00    .00      62.0
   .00   1.00    .00      62.0
   .00    .00   1.00      62.0
 8   100000.000000   100000.000000   -100000.000000
  1.00    .00    .00      62.0
   .00   1.00    .00      62.0
   .00    .00   1.00      62.0
    1     7     5     8     4
    2     7     5     4     1
    3     7     1     4     3
    4     5     6     8     2
    5     5     2     8     4
    6     5     2     4     1
 === Point Sources ===
Fuselage - Fuse Nose
   0.0000    0.0000    0.0000     0.930    3.720    12.40
Fuselage - Fuse Tail
   154.70    0.0000    0.0000     0.930    3.720    12.40
 === Line Sources ===
Fuselage - Fuse Line
   0.0000    0.0000    0.0000     1.550    9.950    39.80
   154.70    0.0000    0.0000     1.550    9.950    39.80
Multi_Wing_Comp: Trailing Edge Line 1
   92.660    0.0000    -5.8264    0.368    1.104    4.416
   94.501    30.102    -5.4167    0.368    1.104    4.416
Multi_Wing_Comp: Trailing Edge Line 2
   94.501    30.102    -5.4177    0.368    1.104    4.416
   98.294    48.595    -4.5997    0.368    1.104    4.416
Multi_Wing_Comp: Trailing Edge Line 3
   98.294    48.595    -4.5997    0.368    1.104    4.416
   103.35    73.240    -4.4172    0.368    1.104    4.416
Multi_Wing_Comp: Leading Edge Line 1
   57.810    0.0000    -4.3000    0.368    1.104    4.416
   74.018    30.102    -4.3000    0.368    1.104    4.416
Multi_Wing_Comp: Leading Edge Line 2
   74.018    30.102    -4.3000    0.368    1.104    4.416
   83.975    48.595    -4.3000    0.368    1.104    4.416
Multi_Wing_Comp: Leading Edge Line 3
   83.976    48.595    -4.3000    0.368    1.104    4.416
   97.246    73.240    -4.3000    0.368    1.104    4.416
Multi_Wing_Comp: Tip
   97.246    73.240    -4.3000    0.368    1.104    4.416
   103.35    73.240    -4.4172    0.368    1.104    4.416
 === Triangle Sources ===
Multi_Wing_Comp: Trailing Edge Tri 1
   92.660    0.0000    -5.8264    0.644    1.840    7.360
   94.501    30.102    -5.4167    0.644    1.840    7.360
   57.810    0.0000    -4.3000    0.644    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 2
   94.501    30.102    -5.4167    0.644    1.840    7.360
   98.294    48.595    -4.5997    0.644    1.840    7.360
   74.018    30.102    -4.3000    0.644    1.840    7.360
Multi_Wing_Comp: Trailing Edge Tri 3
   98.294    48.595    -4.5997    0.644    1.840    7.360
   103.35    73.240    -4.4172    0.644    1.840    7.360
   83.976    48.595    -4.3000    0.644    1.840    7.360
Multi_Wing_Comp: Leading Edge Tri 1
   57.810    0.0000    -4.3000    0.644    1.840    7.360
```

```
   74.018    30.102    -4.3000    0.644    1.840    7.360
   94.501    30.102    -5.4167    0.644    1.840    7.360
 Multi_Wing_Comp: Trailing Edge Tri 2
   74.018    30.102    -4.3000    0.644    1.840    7.360
   83.976    48.595    -4.3000    0.644    1.840    7.360
   98.294    48.595    -4.5997    0.644    1.840    7.360
 Multi_Wing_Comp: Trailing Edge Tri 3
   83.976    48.595    -4.3000    0.644    1.840    7.360
   97.246    73.240    -4.3000    0.644    1.840    7.360
   103.35    73.240    -4.4171    0.644    1.840    7.360
```

M165 Files

M165.nam - Control File

```
&control
   restart  = .false.,
   nsmth    = 0,
   smofc    = 0.00,
   diss     = 0.5,
   cfl      = 3.0,
   relax    = 1.0,
   alpha(1) = 4.99,
   beta(1)  = 0.00,
   mach(1)  = 0.901,
   ntime    = 3000,
   nstou    = 20,
   nstage   = 5,
   ndis(1)  = .true.,
   ndis(2)  = .true.,
   bulkvis  = .false.,
   nlimit   = 2,
   aref     = 2001,
 &end
```

```
*  FELISA Background Mesh ---- Model: M165 Mesh1
  8   6   2   4   2
  1   -100000.000000   -100000.000000   100000.000000
   1.00    .00    .00      100.0
    .00   1.00    .00      100.0
    .00    .00   1.00      100.0
  2   100000.000000   -100000.000000   100000.000000
   1.00    .00    .00      100.0
    .00   1.00    .00      100.0
    .00    .00   1.00      100.0
  3   -100000.000000   100000.000000   100000.000000
   1.00    .00    .00      100.0
    .00   1.00    .00      100.0
    .00    .00   1.00      100.0
  4   100000.000000   100000.000000   100000.000000
   1.00    .00    .00      100.0
    .00   1.00    .00      100.0
    .00    .00   1.00      100.0
  5   -100000.000000   -100000.000000   -100000.000000
   1.00    .00    .00      100.0
    .00   1.00    .00      100.0
    .00    .00   1.00      100.0
  6   100000.000000   -100000.000000   -100000.000000
   1.00    .00    .00      100.0
    .00   1.00    .00      100.0
    .00    .00   1.00      100.0
  7   -100000.000000   100000.000000   -100000.000000
```

```
 1.00    .00    .00      100.0
  .00   1.00    .00      100.0
  .00    .00   1.00      100.0
 8   100000.000000   100000.000000   -100000.000000
 1.00    .00    .00      100.0
  .00   1.00    .00      100.0
  .00    .00   1.00      100.0
   1     7     5     8     4
   2     7     5     4     1
   3     7     1     4     3
   4     5     6     8     2
   5     5     2     8     4
   6     5     2     4     1
 === Point Sources ===
Nose
  0.000   0.000    0.000     1.60    4.80    16.0
Tail
  200.0   0.000    0.000     1.60    4.80    16.0
 === Line Sources ===
Fuselage - Center Line
  0.000    0.000    0.000    3.00    7.67    30.7
  200.0    0.000    0.000    3.00    7.67    30.7
Wing - Leading Edge
  64.03    0.000   -1.972    0.725    1.45    5.80
  140.8    47.97   -4.570    0.725    1.45    5.80
Wing - Trailing Edge
  134.5    0.000   -4.570    0.725    1.45    5.80
  153.7    47.97   -4.570    0.725    1.45    5.80
Wing - Tip Chord
  140.8    47.97   -4.570    0.725    1.45    5.80
  153.7    47.97   -4.570    0.725    1.45    5.80
 === Triangle Sources ===
Wing - Triangle 1
  64.03    0.000   -1.972    1.208    2.42    9.67
  140.8    47.97   -4.570    1.208    2.42    9.67
  153.7    47.97   -4.570    1.208    2.42    9.67
Wing - Triangle 2
  64.03    0.000   -1.972    1.208    2.42    9.67
  153.7    47.97   -4.570    1.208    2.42    9.67
  134.5    0.000   -4.570    1.208    2.42    9.67

*  FELISA Background Mesh ---- Model: M165 Mesh2
 8   6   2   4   2
 1   -100000.000000   -100000.000000   100000.000000
 1.00    .00    .00      90.0
  .00   1.00    .00      90.0
  .00    .00   1.00      90.0
 2   100000.000000   -100000.000000   100000.000000
 1.00    .00    .00      90.0
  .00   1.00    .00      90.0
  .00    .00   1.00      90.0
 3   -100000.000000   100000.000000   100000.000000
 1.00    .00    .00      90.0
  .00   1.00    .00      90.0
  .00    .00   1.00      90.0
 4   100000.000000   100000.000000   100000.000000
 1.00    .00    .00      90.0
  .00   1.00    .00      90.0
  .00    .00   1.00      90.0
 5   -100000.000000   -100000.000000   -100000.000000
 1.00    .00    .00      90.0
  .00   1.00    .00      90.0
```

```
  .00    .00   1.00      90.0
 6   100000.000000   -100000.000000   -100000.000000
 1.00    .00    .00      90.0
  .00   1.00    .00      90.0
  .00    .00   1.00      90.0
 7   -100000.000000   100000.000000   -100000.000000
 1.00    .00    .00      90.0
  .00   1.00    .00      90.0
  .00    .00   1.00      90.0
 8   100000.000000   100000.000000   -100000.000000
 1.00    .00    .00      90.0
  .00   1.00    .00      90.0
  .00    .00   1.00      90.0
   1     7     5     8     4
   2     7     5     4     1
   3     7     1     4     3
   4     5     6     8     2
   5     5     2     8     4
   6     5     2     4     1
 === Point Sources ===
Nose
  0.000   0.000    0.000     1.40    4.80    16.0
Tail
  200.0   0.000    0.000     1.40    4.80    16.0
 === Line Sources ===
Fuselage - Center Line
  0.000    0.000    0.000    2.40    7.67    30.7
  200.0    0.000    0.000    2.40    7.67    30.7
Wing - Leading Edge
  64.03    0.000   -1.972    0.604    1.45    5.80
  140.8    47.97   -4.570    0.604    1.45    5.80
Wing - Trailing Edge
  134.5    0.000   -4.570    0.604    1.45    5.80
  153.7    47.97   -4.570    0.604    1.45    5.80
Wing - Tip Chord
  140.8    47.97   -4.570    0.604    1.45    5.80
  153.7    47.97   -4.570    0.604    1.45    5.80
 === Triangle Sources ===
Wing - Triangle 1
  64.03    0.000   -1.972    1.015    2.42    9.67
  140.8    47.97   -4.570    1.015    2.42    9.67
  153.7    47.97   -4.570    1.015    2.42    9.67
Wing - Triangle 2
  64.03    0.000   -1.972    1.015    2.42    9.67
  153.7    47.97   -4.570    1.015    2.42    9.67
  134.5    0.000   -4.570    1.015    2.42    9.67

 *  FELISA Background Mesh ---- Model: M165 Mesh3
 8   6   2   4   2
 1   -100000.000000   -100000.000000   100000.000000
 1.00    .00    .00      80.0
  .00   1.00    .00      80.0
  .00    .00   1.00      80.0
 2   100000.000000   -100000.000000   100000.000000
 1.00    .00    .00      80.0
  .00   1.00    .00      80.0
  .00    .00   1.00      80.0
 3   -100000.000000   100000.000000   100000.000000
 1.00    .00    .00      80.0
  .00   1.00    .00      80.0
  .00    .00   1.00      80.0
 4   100000.000000   100000.000000   100000.000000
```

```
 1.00    .00    .00      80.0
  .00   1.00    .00      80.0
  .00    .00   1.00      80.0
 5   -100000.000000   -100000.000000   -100000.000000
 1.00    .00    .00      80.0
  .00   1.00    .00      80.0
  .00    .00   1.00      80.0
 6   100000.000000   -100000.000000   -100000.000000
 1.00    .00    .00      80.0
  .00   1.00    .00      80.0
  .00    .00   1.00      80.0
 7   -100000.000000   100000.000000   -100000.000000
 1.00    .00    .00      80.0
  .00   1.00    .00      80.0
  .00    .00   1.00      80.0
 8   100000.000000   100000.000000   -100000.000000
 1.00    .00    .00      80.0
  .00   1.00    .00      80.0
  .00    .00   1.00      80.0
   1     7     5     8     4
   2     7     5     4     1
   3     7     1     4     3
   4     5     6     8     2
   5     5     2     8     4
   6     5     2     4     1
 === Point Sources ===
Nose
   0.000   0.000    0.000     1.20    4.80    16.0
Tail
   200.0   0.000    0.000     1.20    4.80    16.0
 === Line Sources ===
Fuselage - Center Line
   0.000    0.000    0.000    2.00    7.67    30.7
   200.0    0.000    0.000    2.00    7.67    30.7
Wing - Leading Edge
   64.03    0.000   -1.972    0.483    1.45    5.80
   140.8    47.97   -4.570    0.483    1.45    5.80
Wing - Trailing Edge
   134.5    0.000   -4.570    0.483    1.45    5.80
   153.7    47.97   -4.570    0.483    1.45    5.80
Wing - Tip Chord
   140.8    47.97   -4.570    0.483    1.45    5.80
   153.7    47.97   -4.570    0.483    1.45    5.80
 === Triangle Sources ===
Wing - Triangle 1
   64.03    0.000   -1.972    0.846    2.42    9.67
   140.8    47.97   -4.570    0.846    2.42    9.67
   153.7    47.97   -4.570    0.846    2.42    9.67
Wing - Triangle 2
   64.03    0.000   -1.972    0.846    2.42    9.67
   153.7    47.97   -4.570    0.846    2.42    9.67
   134.5    0.000   -4.570    0.846    2.42    9.67
```

Appendix C

Vorview Output

```
************************************************
*****                                  *****
***** VORLAX/VORVIEW - SUMMARY OUTPUT FILE *****
*****                                  *****
************************************************

 FILE NAME: W4

*** SOLUTION INPUT PARAMETERS ***
 LAX     =        0    EQUAL CHORDWISE VORTICE SPACING
 HAG     =    0.000    HEIGHT ABOVE GROUND
 ITRMAX  =      500    MAX NUMBER OF ITERATIONS
 NPAN    =       68    NUMBER OF MAJOR PANELS
 NAP     =       20    NUMBER OF CAMBER POINTS
 TOTPAN  =      476    NUMBER OF SUB-PANELS
 SPC     =   -1.000    LEADING EDGE SUCTION MULT (SPC < 0.0 - POLHAMUS ANALOGY)

*** GEOMETRY PARAMETERS ***
 SREF    = 2682.000    REF WING AREA
 AR      =    8.000    REF WING ASPECT RATIO
 TAPER   =    0.200    REF WING TAPER RATIO
 WSPAN   =  146.480    REF WING SPAN
 CBAR    =   21.069    PITCHING MOMENT REF LENGTH
 XBAR    =    0.000    X VALUE OF MOMENT REF POINT
 ZBAR    =    0.000    Z VALUE OF MOMENT REF POINT

*** FLIGHT CONDITION PARAMETERS ***
 LATRAL  =        0    SYMETRIC FLIGHT/CONFIG
 PSI     =    0.000    SIDESLIP ANGLE (DEGREES)
 PITCHQ  =    0.000    PITCH RATE (DEGS/SEC)
 ROLLQ   =    0.000    ROLL RATE (DEGS/SEC)
 YAWQ    =    0.000    YAW RATE (DEGS/SEC)
 NMACH   =        1    NUMBER OF MACH NOS
 MACH NO =    0.779
 NALPHA  =        1    NUMBER OF ATTACK ANGLES
 ALPHA   =    1.523

*** RESULTS ***
 CLTOT  - TOTAL LIFT COEFFICIENT
 CDTOT  - TOTAL PRESSURE DRAG COEFFICIENT
 CYTOT  - TOTAL LATERAL FORCE COEFFICIENT
 CMTOT  - TOTAL PITCHING MOMENT COEFFICIENT
 CRMTOT - TOTAL ROLLING MOMENT COEFFICIENT
 CYMTOT - TOTAL YAWING MOMENT COEFFICIENT
 E      - OSWALDS EFFICIENCY FACTOR
 ITER   - NUMBER OF ITERATIONS TO CONVERGENCE

MACH NO  =  0.779
```

ALPHA	CLTOT	CDTOT	CLTRF	CDTRF	CYTOT	CMTOT
CRMTOT	CYMTOT	CD/CL^2	E	(CD/CL^2)_TRF	E_TRF	ITER
1.52	0.54447	0.02944	0.53221	0.02697	0.00003	-2.12406
0.00023	0.00001	0.09930	0.40069	0.09522	0.41786	39

```
***********************************************
*****                    *****
***** VORLAX/VORVIEW - SUMMARY OUTPUT FILE *****
*****                    *****
***********************************************

 FILE NAME: M165

*** SOLUTION INPUT PARAMETERS ***
 LAX     =        0    EQUAL CHORDWISE VORTICE SPACING
 HAG     =    0.000    HEIGHT ABOVE GROUND
 ITRMAX  =      500    MAX NUMBER OF ITERATIONS
 NPAN    =       56    NUMBER OF MAJOR PANELS
 NAP     =       20    NUMBER OF CAMBER POINTS
 TOTPAN  =      448    NUMBER OF SUB-PANELS
 SPC     =   -1.000    LEADING EDGE SUCTION MULT (SPC < 0.0 - POLHAMUS ANALOGY)

*** GEOMETRY PARAMETERS ***
 SREF    = 4002.000    REF WING AREA
 AR      =    2.300    REF WING ASPECT RATIO
 TAPER   =    0.183    REF WING TAPER RATIO
 WSPAN   =   95.940    REF WING SPAN
 CBAR    =   48.337    PITCHING MOMENT REF LENGTH
 XBAR    =    0.000    X VALUE OF MOMENT REF POINT
 ZBAR    =    0.000    Z VALUE OF MOMENT REF POINT

*** FLIGHT CONDITION PARAMETERS ***
 LATRAL  =        0    SYMETRIC FLIGHT/CONFIG
 PSI     =    0.000    SIDESLIP ANGLE (DEGREES)
 PITCHQ  =    0.000    PITCH RATE (DEGS/SEC)
 ROLLQ   =    0.000    ROLL RATE (DEGS/SEC)
 YAWQ    =    0.000    YAW RATE (DEGS/SEC)
 NMACH   =        1    NUMBER OF MACH NOS
 MACH NO =    0.900
 NALPHA  =        1    NUMBER OF ATTACK ANGLES
 ALPHA   =    4.990

*** RESULTS ***
 CLTOT  - TOTAL LIFT COEFFICIENT
 CDTOT  - TOTAL PRESSURE DRAG COEFFICIENT
 CYTOT  - TOTAL LATERAL FORCE COEFFICIENT
 CMTOT  - TOTAL PITCHING MOMENT COEFFICIENT
 CRMTOT - TOTAL ROLLING MOMENT COEFFICIENT
 CYMTOT - TOTAL YAWING MOMENT COEFFICIENT
 E      - OSWALDS EFFICIENCY FACTOR
 ITER   - NUMBER OF ITERATIONS TO CONVERGENCE

MACH NO =   0.900
```

ALPHA	CLTOT	CDTOT	CLTRF	CDTRF	CYTOT	CMTOT
CRMTOT	CYMTOT	CD/CL^2	E	(CD/CL^2)_TRF	E_TRF	ITER
4.99	0.30956	0.01930	0.29319	0.02549	0.00001	-0.72072
0.00007	0.00001	0.20137	0.68729	0.29657	0.46665	56

Appendix D

ACSYNT Files

W4 Files

```
$ DATA BLOCK A
**** AGARD W4 WING-BODY MISSION ******
$ DATA BLOCK B
      1       0       0       0       0       0       0
$ DATA BLOCK V
END
TRANSPORT
   5    2    1  570  570    1    0    0    0    0    7    0
   0.0001      0.80 850000.00      0.00      0.00      0.00
   1    2    3    4    6
   1    3
   3
***** W4 WING-BODY GEOMETRY *****
 $WING
  AR       =     8.000,   AREA     =     2.887,   DIHED     =     0.000,
  SWEEP    =      28.3,   TAPER    =     0.200,   TCROOT    =     0.160,
  TCTIP    =     0.114,   XWING    =     0.423,   ZROOT     =    -0.432,
  TWISTW   =       0.0,   KSWEEP   =         0,
  $END
 $STRAKE
  XLAFT    =     0.611,   YSAFT    =     0.441,   IFLEX     =         1,
  $END
 $FUS
  BDMAX    =     0.653,   BODL     =     5.076,   FRAB      =     1.250,
  FRATIO   =       0.0,   FRN      =      1.25,
  $END
 $CREW
  NCREW    =         1,
  $END
 $FUEL
  DEN      =      50.0,   WFUEL    =     100.0,
  $END
 $ENGINE
  N        =         1,
  $END
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
 $TRDATA
  CRMACH   =      0.85, DESLF    =      2.50, FRFURE   =     0.050,
  RANGE    =     100.0, TIMTO1   =     0.000, TIMTO2   =      5.00,
  ULTLF    =     3.750, WFEXT    =     0.000, WFTRAP   =      50.0,
  WFUEL    =    1000.0, IPLOT    =         1, IPSIZE   =        -3,
  MMPROP   =         1, NCODE    =         0, LENVEL   =.FALSE.,
  $END
      2   0.0E+00
      MACH NO.   ALTITUDE     HORIZONTAL    NO.  VIND
PHASE   START END  START  END    DIST  TIME    TURN  'G'S  WKFUEL M IP IX W B A P
------- ---- ----  ----- -----  ------ -----  ---- -----  ------ - -- -- - - - -
CLIMB   0.50 0.00      0 30000     0.0   0.0   0.0   0.0  1.0000 0  2 -1 0 0 0 0
CRUISE  0.78 0.78     -1 30000    -1.0   0.0   0.0   0.0  1.0000 0  4  0 0 0 0 0
**** W4 ****
 $ACHAR
```

```
  ALMAX    =    20.000,   AMC      =    35.000,   AJCAN    =        0,
  ALELJ    =        4,   INORM    =        1,   ISMNDR   =        0,
  ISUPCR   =        0,   ITRAP    =        0,   IXCD     =        1,
  ELLIPC   =F        ,   ELLIPW   =F        ,
  $END
 $AMULT
  CSF      =    0.000,   ESSF     =    0.000,
  $END
 $ATRIM
  $END
 $ADET
  IALF     =        0,   IALP     =        2,   ICOD     =        1,
  IPLOT    =        1,   NALF     =       10,   NMDTL    =        1,
  ALIN(1)  =    1.523,   ALIN(2)  =    3.000,   ALIN(3)  =    3.500,
  ALIN(4)  =    3.600,   ALIN(5)  =    3.700,   ALIN(6)  =    3.800,
  ALIN(7)  =    3.900,   ALIN(8)  =    4.000,   ALIN(9)  =    4.100,
  ALIN(10) =    4.200,   ALTV     =      0.0,   SMN      =    0.778,
  ISTRS    =        0,   ITB      =        0,   ITS      =        0,
  $END
 $ADRAG
  ICDO     =        0,
  $END
 $ATAKE
  $END
 $APRINT
  $END
****** ENGINE ANALYSIS **************
6
 $LEWIS
  DIA1     =    0.150, TWOAB    =    100.0, TWTO     =    100.0,
  $END
 $AFTBD
 $END
TRANSPORT
W4 Wing-Body
 $OPTS
  WGTO     =    200.0, AFMACH   =    0.900,
  $END
 $FIXW
  $END
```

Detailed Aerodynamics Output

Mach = .78
Altitude = 0.

Parasite Drag

Friction	.0215
Body	.0115
Wing	.0094
Strakes	.0005
H. Tail	.0000
V. Tail	.0000
Canard	.0000
Interference	.0062
Wave	.0009
External	.0000
Tanks	.0000
Bombs	.0000
Stores	.0000
Extra	.0000

Induced Drag

Alpha	Cl	Cd	L/D	Cm	e	Cdtrim	Deltrim	Zone
1.5	.263	.0327	8.0	.000	.66	.0025	1.7	2
3.0	.516	.0453	11.4	.000	.63	.0106	3.7	2
3.5	.602	.0516	11.7	.000	.63	.0148	4.4	2
3.6	.619	.0530	11.7	.000	.62	.0157	4.5	2
3.7	.636	.0544	11.7	.000	.62	.0167	4.7	2
3.8	.653	.0559	11.7	.000	.62	.0177	4.8	2
3.9	.670	.0574	11.7	.000	.62	.0187	5.0	2
4.0	.687	.0590	11.7	.000	.62	.0198	5.1	2
4.1	.704	.0606	11.6	.000	.62	.0209	5.3	2
4.2	.721	.0622	11.6	.000	.61	.0220	5.4	2

Slope Factors

Cl/Alpha (per radian) 9.8001

Cdl/Cl^2 .0648

Alpha Transition Zone 2-3 13.748

Camber	.0000	Programmed Flap Setting		0.
Cdmin	.0286	Flap Type	Single	0. sq. ft

M165 Files

```
$ DATA BLOCK A
**** AGARD M165 WING-BODY ******
$ DATA BLOCK B
       1        0        0        0        0        0        0
$ DATA BLOCK V
END
TRANSPORT
   5    2    1  570  570    1    0    0    0    0    7    0
   0.0001      0.80 850000.00      0.00      0.00      0.00
   1    2    3    4    6
   1    3
   3
***** M165 WING-BODY GEOMETRY *****
 $WING
  AR       =    2.300,   AREA     =    4.308,   DIHED    =    0.000,
  SWEEP    =     58.0,   TAPER    =    0.183,   TCROOT   =   0.0514,
  TCTIP    =   0.0522,   XWING    =    0.480,   ZROOT    =   -0.596,
  TWISTW   =    -5.45,   KSWEEP   =        0,
  $END
 $FUS
  BDMAX    =    0.503,   BODL     =    5.584,   FRAB     =    1.250,
  FRATIO   =      0.0,   FRN      =     1.25,
  $END
 $CREW
  NCREW    =        1,
  $END
 $FUEL
  DEN      =     50.0,   WFUEL    =    100.0,
  $END
 $ENGINE
  N        =        1,
  $END
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
 $TRDATA
  CRMACH   =     0.95, DESLF    =     2.50, FRFURE   =    0.050,
  RANGE    =    100.0, TIMTO1   =    0.000, TIMTO2   =     5.00,
  ULTLF    =    3.750, WFEXT    =    0.000, WFTRAP   =     50.0,
  WFUEL    =    100.0, IPLOT    =        1, IPSIZE   =       -3,
  MMPROP   =        1, NCODE    =        0, LENVEL   =.FALSE.,
  $END
       2   0.0E+00
       MACH NO.   ALTITUDE     HORIZONTAL     NO.  VIND
PHASE   START END  START  END    DIST  TIME    TURN  'G'S  WKFUEL M IP IX W B A P
------- ---- ----  ----- -----  ------ -----  ---- -----  ------ - -- -- - - - -
CLIMB   0.50 0.00      0 30000     0.0   0.0   0.0   0.0  1.0000 0  2 -1 0 0 0 0
CRUISE  0.90 0.90     -1 30000    -1.0   0.0   0.0   0.0  1.0000 0  4  0 0 0 0 0
**** M165 WING-BODY ****
 $ACHAR
  ALMAX    =   30.000,   AMC      =   35.000,   AJCAN    =        0,
  ALELJ    =        4,   INORM    =        1,   ISMNDR   =        0,
  ISUPCR   =        0,   ITRAP    =        1,   IXCD     =        1,
  ELLIPC   =F        ,   ELLIPW   =F        ,
  $END
 $AMULT
  CSF      =    0.000,   ESSF     =    0.000,
```

```
  $END
 $ATRIM
  $END
 $ADET
  IALF     =        0,   IALP      =        2,   ICOD      =        1,
  IPLOT    =        1,   NALF      =       10,   NMDTL     =        1,
  ALIN(1)  =     4.99,   ALIN(2)  =    4.000,   ALIN(3)  =    4.500,
  ALIN(4)  =    5.000,   ALIN(5)  =    5.500,   ALIN(6)  =    6.000,
  ALIN(7)  =    6.500,   ALIN(8)  =    7.000,   ALIN(9)  =    7.500,
  ALIN(10) =    8.000,   ALTV     =      0.0,   SMN      =    0.901,
  ISTRS    =        0,   ITB      =        0,   ITS      =        0,
  $END
 $ADRAG
  ICDO     =        0,
  $END
 $ATAKE
  $END
 $APRINT
  $END
****** ENGINE THRUST SET **************
6
 $LEWIS
  DIA1     =    0.150, TWOAB    =    100.0, TWTO     =    100.0,
  $END
 $AFTBD
 $END
TRANSPORT
M165 Wing-Body
 $OPTS
  WGTO     =    200.0, AFMACH   =    0.950,
  $END
 $FIXW
  $END
```

```
 Detailed Aerodynamics Output

 Mach     =     .90
 Altitude =      0.

 Parasite Drag        Induced Drag
 Friction      .0126    Alpha    Cl      Cd    L/D     Cm     e   Cdtrim  Deltrim  Zone
  Body         .0062      5.0   .269   .0324   8.3   .000   .58   .0010      .9     2
  Wing         .0064      4.0   .216   .0260   8.3   .000   .59   .0006      .6     2
  Strakes      .0000      4.5   .243   .0290   8.4   .000   .59   .0008      .7     2
  H. Tail      .0000      5.0   .269   .0324   8.3   .000   .58   .0010      .9     2
  V. Tail      .0000      5.5   .296   .0362   8.2   .000   .57   .0012     1.0     2
  Canard       .0000      6.0   .322   .0404   8.0   .000   .57   .0015     1.1     2
 Interference  .0025      6.5   .348   .0449   7.7   .000   .56   .0018     1.2     2
 Wave          .0000      7.0   .373   .0498   7.5   .000   .56   .0021     1.3     2
 External      .0000      7.5   .399   .0551   7.2   .000   .55   .0024     1.4     2
  Tanks        .0000      8.0   .424   .0614   6.9   .000   .54   .0028     2.3     2
  Bombs        .0000                 Slope Factors
  Stores       .0000                 Cl/Alpha (per radian)       2.9557
  Extra        .0000                 Cdl/Cl^2                     .2573
                             Alpha Transition Zone 2-3      8.420
 Camber        .0000                 Programmed Flap Setting          0.
 ____________________
 Cdmin         .0151                 Flap Type      Single          1. sq. ft
```

Appendix E

FRICTION Files

```
 CASE TITLE:     W4 - Wing Body

 SREF =  2682.00000  MODEL SCALE =  1.000  NO. OF COMPONENTS = 2
 input mode =  1  (mode=0: input M,h;  mode=1: input M, Re/L)

COMPONENT TITLE    SWET (FT2)  REFL(FT)   TC  ICODE FRM FCTR FTRANS
FUSELAGE          7915.0000  154.700   0.129   1   1.0845   0.0000
WING              4642.0000   18.400   0.115   0   1.2157   0.0000

   TOTAL SWET =   12557.0000

 REYNOLDS NO./FT =0.278E+06   XME =  0.779

   COMPONENT       RN       CF     CF*SWET   CF*SWET*FF   CDCOMP
FUSELAGE        0.430E+08  0.00224 17.69400    19.18959   0.00715
WING            0.512E+07  0.00315 14.60043    17.75040   0.00662
                       SUM =32.29442    36.93999   0.01377

FRICTION DRAG: CDF = 0.01204          FORM DRAG: CDFORM = 0.00173

 SUMMARY

  J   XME      RE/FT       CDF     CDFORM   CDF+CDFORM
  1   0.779   0.278E+06   0.01204   0.00173   0.01377

 END OF CASE


 CASE TITLE:     M165 - Wing Body

 SREF =     0.40020  MODEL SCALE =  1.000  NO. OF COMPONENTS = 2
 input mode =  1  (mode=0: input M,h;  mode=1: input M, Re/L)

COMPONENT TITLE    SWET (FT2)  REFL(FT)   TC  ICODE FRM FCTR FTRANS
FUSELAGE             0.8914    2.000   0.077   1   1.0350   0.0000
WING                 0.6103    0.483   0.051   0   1.0921   0.0000

   TOTAL SWET =       1.5017

 REYNOLDS NO./FT =0.114E+08   XME =  0.900

   COMPONENT       RN       CF     CF*SWET   CF*SWET*FF   CDCOMP
FUSELAGE        0.228E+08  0.00243  0.00216     0.00224   0.00560
WING            0.550E+07  0.00307  0.00187     0.00204   0.00511
                       SUM = 0.00404     0.00428   0.01070

FRICTION DRAG: CDF = 0.01008          FORM DRAG: CDFORM = 0.00062

 SUMMARY

  J   XME      RE/FT       CDF     CDFORM   CDF+CDFORM
  1   0.900   0.114E+08   0.01008   0.00062   0.01070

  END OF CASE
```

Appendix F

Farfield Drag Code (MATLAB)

%Program to Calculate Drag from FELISA cutplane - V1.0

```
clear
fname = 'W4A3R2.mac'   % File Name
mach = 0.779;  % Freestream Mach Number
alpha = 1.523;  % Angle of Attack (deg)
Area = 1341;  % Refrence (wing) Area
AR = 7.965;  % Wing Aspect Ratio
gamma = 1.4;  % specific heat ratio

Pinf = 1/(mach*mach*gamma);  % Freestream Pressure

% Read in file xxx.mac
fname = fopen(fname,'r');
npoint = fscanf(fname,'%d',1); %number of points
nelem = fscanf(fname,'%d',1); %number of elements

% Read x,y,z of points
for i = 1:npoint
   A(i) = fscanf(fname,'%d',1);
   x(i) = fscanf(fname,'%e',1);
   y(i) = fscanf(fname,'%e',1);
   z(i) = fscanf(fname,'%e',1);
end
z = z/cos(alpha*pi/180);

% Read points in elements
for i = 1:nelem
   A(i) = fscanf(fname,'%d',1);
   pt1(i) = fscanf(fname,'%d',1);
   pt2(i) = fscanf(fname,'%d',1);
   pt3(i) = fscanf(fname,'%d',1);
end

% Read Unknowns
for i = 1:npoint
   A(i) = fscanf(fname,'%d',1);
   ro(i) = fscanf(fname,'%e',1);
   u(i) = fscanf(fname,'%e',1);
   v(i) = fscanf(fname,'%e',1);
   w(i) = fscanf(fname,'%e',1);
   P(i) = fscanf(fname,'%e',1);
end
w = w.*cos(alpha*pi/180) - u.*sin(alpha*pi/180);
fclose(fname);

%Calculate entropy drag
[Cdw,Ae] = wave(npoint,nelem,P,ro,pt1,pt2,pt3,y,z,Pinf,Area,gamma,mach);

%Calculate Vortex Drag
[Cdv,Cl] = vortex(v,w,pt1,pt2,pt3,y,z,Area,AR,Ae,npoint,nelem);

%Total Drag
Cd = Cdv + Cdw
Cl
```

% Induced Drag & Lift Function

```
function [Cdv,Cl] = vortex(v,w,pt1,pt2,pt3,y,z,Area,AR,Ae,npoint,nelem)
n = nelem;
i = 1:n;
Circ(i) = 0;
Circmx = 0;
Ymax = 0;
for i = 1:n
  j = pt1(i);
  k = pt2(i);
  l = pt3(i);
  Circ(i) = 0.5*(v(j) + v(k))*(y(k) - y(j)) + 0.5*(w(j) + w(k))*(z(k) - z(j));  % Circulation around Cell
  Circ(i) = Circ(i) + 0.5*(v(k) + v(l))*(y(l) - y(k)) + 0.5*(w(k) + w(l))*(z(l) - z(k));
  Circ(i) = Circ(i) + 0.5*(v(l) + v(j))*(y(j) - y(l)) + 0.5*(w(l) + w(j))*(z(j) - z(l));
  Y(i) = 1/3*(y(j) + y(k) + y(l)); % Centroids of Cell
  Z(i) = 1/3*(z(j) + z(k) + z(l));
  norm(i) = (Y(i) - y(j))*(z(k) - z(j)) - (Z(i) - z(j))*(y(k) - y(j));
  if norm(i) > 0
    Circ(i) = -1*Circ(i);
  end
  if abs(Circ(i)) > Circmx
    Circmx = abs(Circ(i));
    Ymax = Y(i);
  end
end
Ymax
cut1 = 5*Circmx;
Dv = 0; % Vortex drag
for i = 1:n
  if abs(Circ(i)) > cut1
    j = pt1(i);
    k = pt2(i);
    l = pt3(i);

    stream1 = Circ(1:n)*(log((y(j) - Y(1:n)).^2 + (z(j) - Z(1:n)).^2) - log((y(j) + Y(1:n)).^2 + (z(j) + Z(1:n)).^2));
    stream2 = Circ(1:n)*(log((y(k) - Y(1:n)).^2 + (z(k) - Z(1:n)).^2) - log((y(k) + Y(1:n)).^2 + (z(k) + Z(1:n)).^2));
    stream3 = Circ(1:n)*(log((y(l) - Y(1:n)).^2 + (z(l) - Z(1:n)).^2) - log((y(l) + Y(1:n)).^2 + (z(l) + Z(1:n)).^2));

    PSI = -1/(12*pi)*(stream1 + stream2 + stream3);  % Stream funct at centroid (1/2 body)
    Dv = Dv + 1/2*Circ(i)*PSI;
  end
end

Cdv = 2*Dv/Area

cut2 = 0.005*Circmx*Ymax;
L = 0; % Lift
for i = 1:n
 if abs(Circ(i)*Y(i)) > cut2
   L = L + Y(i)*Circ(i);
 endif
end

Cl = 2*L/Area;
```

%Wave Drag Function

```
function [Cdw,Ae] = wave(npoint,nelem,P,ro,pt1,pt2,pt3,y,z,Pinf,Area,gamma,mach)

% Calculate the entropy
for i = 1:npoint
   if ro(i) == 0
      S(i) = 0;
   else
      S(i) = 1/(gamma-1)*(log(P(i)/Pinf) + gamma*log(1/ro(i)));
   end
end

%Calculate Entropy at each cell
i = 1:npoint;
Smax = max(S(i));
Cut = 0.15*Smax;

Dw = 0;
for i = 1:nelem
   j = pt1(i);
   k = pt2(i);
   l = pt3(i);
   vx = (y(k)-y(j))*(z(l)-z(j)) - (y(l)-y(j))*(z(k)-z(j));
   Se(i) = 1/3*(S(j) + S(k) + S(l));
   Ae(i) = 0.5*abs(vx);
   if Se(i) > Cut
      Dw = Dw + Se(i)*Ae(i);
   end
end

Cdw = 2*Pinf*Dw/Area
```

Appendix G

Farfield Drag Code (Fortran77)

```
c *** DRAG PROGRAM for FELISA2.0B
c *** Jan 14,2002
c *** Calculate Farfield Lift and Drag Values

      program lift

      parameter(mxpoi =2000000)
      parameter(mxele =9000000)
      parameter(mxpla = 100000)

      integer x2(3,mxele)

      real    un(5,mxpoi), x5(mxpoi), x1(3,mxpoi), x4(5,mxpoi)
      real    co(3,mxpoi), lm(4,mxele), norm(mxpla), YZ(2,mxpla)
      real    circ(mxpla), S(mxpla), stream(3,mxpla), Ae(mxpla)
      real    mach, Cd, Cdw, Cdv, Cl
      real    cut1, cut2, xbb, xss, xcp, Yb, Zb

      character*80 filenam,textread,fname

      logical   debug,low,restart,bulkvis,ndis(5)

      common /iou/ inp2, inp4, inp5
      common /dat/ aref,dref,xref,yref,zref
      common /inf/ mach,gamma,roinf,uinf,pinf
      common /plane1/ ne, np, nbf
      common /plane2/ anx, any, anz, x0, y0, z0

      namelist /control/  einf,  roinf,  uinf, epslm, nstage,     cfl,
     &                   diss2,  diss1, relax, alpha,   beta, restart,
     &                 bulkvis, nlimit,  ndis, nsmth,  smofc,      lg,
     &                   nite0,  nite1, nite2, ncycl,  ncyci,   nstou,
     &                     low,  debug, meshc, meshf,   disx,     xc1,
     &                     xc2,    xc3,   xc4, ntann,   ntime,   diss,
     &                    aref,   dref,  xref,  yref,   zref,
     &                    mach,  gamma

c *** open files.

      inp2  = 2
      inp4  = 4
      inp5  = 5

c *** prints header

      write(*,1000)

c *** problem name
```

```
      ierr = 0
  300 continue
      if(ierr.eq.1) write(*,'(/,a)') '  Could not open '//fname
      ierr = 1
      write(*,'(//)')
      filenam = textread(' DRAG > *** Enter problem name: ')
      l = namlen(filenam)

c *** unknowns

      fname = filenam(1:l)//'.unk'
      open(inp2,file=fname,err=300,status='old',form='unformatted')
      rewind(inp2)

c *** reads the unknowns

      read(inp2) npunk
      if (npunk.gt.mxpoi) call error1('main','mxpoi',npunk)
      call inpunk(inp2,npunk,un)

c *** X distance for cutplane

      write(*,
     &  '((/," DRAG > *** Input X distance for cutplane ... "),$)')
      read(*,*) xcp

c *** SemiSpan

      write(*,
     &  '((/," DRAG > *** Input Box Size (zero for all)... "),$)')
      read(*,*) xbb

c *** Cutoff for Wave Drag

      write(*,
     &  '((/," DRAG > *** Input Wave Drag Cutoff ... "),$)')
      read(*,*) cut1

c *** Cutoff for Induced Drag and Lift

      write(*,
     &  '((/," DRAG > *** Input Vortex Cutoff ... "),$)')
      read(*,*) cut2

c *** namelist

      fname = filenam(1:l)//'.nam'
      open(inp4,file=fname,err=300,status='old',form='formatted')
      rewind(inp4)

c *** volume mesh

      fname = filenam(1:l)//'.plt'
      open(inp5,file=fname,err=300,status='old',form='unformatted')
      rewind(inp5)
```

```
      aref   = 1.0
      dref   = 1.0
      xref   = 0.0
      yref   = 0.0
      zref   = 0.0

      einf   = 0.0
      roinf  = 0.0
      uinf   = 0.0
      epslm  = 0.05
      nstage = 5
      cfl    = 2.8
      diss2  = 0.1
      diss1  = 0.3
      diss   = 0.0
      relax  = 0.1
      mach   = -1.0
      gamma  = 1.4
      alpha  = 0.0
      beta   = 0.0
      restart = .false.
      bulkvis = .false.
      nlimit  = 1
      nsmth = 2
      smofc = 0.25
      ndis(1) = .true.
      ndis(2) = .false.
      ndis(3) = .false.
      ndis(4) = .false.
      ndis(5) = .false.
      lg    = 1
      nite0 = 1
      nite1 = 1
      nite2 = 1
      ntime = 1000
      ncycl = 1000
      ncyci = 1000
      nstou = 5
      low   = .false.
      debug = .false.
      meshc = 1
      meshf = 1
      disx  = 6.0
      xc1   = -1.2
      xc2   = -0.2
      xc3   = 0.014
      xc4   = 0.0714
      ntann = 1
      nrs   = 0

      read(inp4,control)

c *** Need freestream Mach number

      if (mach .lt. 0.0) then
         write(*,'(/," DRAG-err > *** FREESTREAM")')
```

```
          write(*,'(
      & " Value of freestream Mach number or gamma incorrect")')
          write(*,'(/," Cannot continue; Stopping")')
          stop
       endif

       pinf = 1.0/(gamma*mach**2)

c *** Cut Plane Normals

       anx = COS(alpha*3.1416/180)
       any = 0.0
       anz = SIN(alpha*3.1416/180)
       x0  = xcp
       y0  = 0.0
       z0  = 0.0

c *** read the volume mesh

       read(inp5) ne, np, nbf
       call inplt(inp5, co, lm)

c *** find intesection of mesh and cutplane

        write(*,'(/," DRAG > *** Running ... ",/)')

        call cntcut(co, lm, np2, ne2, x5)

        if ( np2 .eq. 0 ) then
           write(*,'(a,i5)')
      &    '  ERROR -> NO INTERSECTION FOUND FOR CUT'
        endif

        call cutvol(co, lm, un, np1, ne1,
      &              x1, x2, x4, x5)

        write(*,'(/,"     Num El...",1x,i6)') ne1

c *** Bounding Box Limit

        do ip=1,np1
           x1(3,ip) = x1(3,ip)/COS(alpha*3.1416/180)
           x4(4,ip) = x4(4,ip)*COS(alpha*3.1416/180)
      &              - x4(2,ip)*SIN(alpha*3.1416/180)
        enddo

        if(xbb .ne. 0) then
          n = 0
          do ie = 1,ne1
            j = x2(1,ie)
            k = x2(2,ie)
            l = x2(3,ie)
            Yb = max(abs(x1(2,j)),abs(x1(2,k)),
      &             abs(x1(2,l)))
            Zb = max(abs(x1(3,j)),abs(x1(3,k)),
      &             abs(x1(3,l)))
            if(Yb .le. xbb .and. Zb .le. xbb) then
```

```
            n = n + 1
            x2(1,n) = j
            x2(2,n) = k
            x2(3,n) = l
         endif
      enddo
      ne1 = n
    endif
    write(*,'(/," Num El Box...",1x,i6)') ne1

c *** Calculate entropy and vortex drag

      call entropy(np1,ne1,x1,x2,x4,pinf,gamma,cut1,S,Cdw,Ae)
      Cdw = 2*Cdw/aref

      call vortex(ne1,x1,x2,x4,cut2,Ae,circ,norm,stream,YZ,Cl,Cdv)
      Cdv = 2*Cdv/aref
      Cd = Cdw + Cdv
      Cl = 2*Cl/aref

      write(*,'(/,"        Cdw...",1x,1p,e15.7)') Cdw
      write(*,'(/,"        Cdv...",1x,1p,e15.7)') Cdv
      write(*,'(/,"        Cd....",1x,1p,e15.7)') Cd
      write(*,'(/,"        Cl....",1x,1p,e15.7)') Cl
      write(*,'(/)')

 1000 format(2(/),
     &         '    ******************************************',/,
     &         '    ***                                    ***',/,
     &         '    ***  *        F E L I S A          *  ***',/,
     &         '    ***  *         s o l v e           *  ***',/,
     &         '    ***                                    ***',/,
     &         '    ***                                    ***',/,
     &         '    ***    *        D R A G          *    ***',/,
     &         '    ***                                    ***',/,
     &         '    ***     COMPUTES FARFIELD LIFT & DRAG    ***',/,
     &         '    ***                                    ***',/,
     &         '    ******************************************',/,
     &         '    ***                                    ***',/,
     &         '    ***            Version 0.2             ***',/,
     &         '    ***            Jan 10, 2002            ***',/,
     &         '    ***                                    ***',/,
     &         '    ******************************************',///)

      stop
      end

c*--------------------------------------------------------------------*
c     input unknowns from the .unk file                                *
c*--------------------------------------------------------------------*

      subroutine inpunk(inp,npoin,unkno)

      dimension unkno(5,*)

c *** reads the unknowns.
```

```
      read(inp) ((unkno(j,i),i=1,npoin),j=1,5)
      close(inp)

      return
      end

c*----------------------------------------------------------------------------*
c     input volume mesh from the .plt file                                   *
c*----------------------------------------------------------------------------*

      subroutine inplt(inp,cor,pts)

      dimension cor(3,*), pts(4,*)
      common /plane1/ ne, np, nbf

c *** reads the vol. mesh

      read(inp) ((pts(j,i),i=1,ne),j=1,4)
      read(inp) ((cor(j,i),i=1,np),j=1,3)
      close(inp)

      return
      end

c*----------------------------------------------------------------------------*
c*    [namlen] determines the length of a character string                   *
c*----------------------------------------------------------------------------*

      integer function namlen(filenam)
      character*80 filenam

      namlen = 0
      do 100 i = 80,1,-1
      if (filenam(i:i).eq.' ') goto 100
      namlen = i
      goto 200
  100 continue
  200 continue

      return
      end

c*----------------------------------------------------------------------------*
c*    [textread] outputs a prompt and reads a character string               *
c*----------------------------------------------------------------------------*

      character*80 function textread( prompt)
      character*(*) prompt

      write(*,'(/,a,$)') prompt
      read(*,'(a)') textread

      return
      end

c*----------------------------------------------------------------------------*
c*    [error1] prints messages related to arrays out-of-bounds checking      *
```

```
c*----------------------------------------------------------------------------*

      subroutine error1(t1,t2,in)
      character*(*) t1,t2
      character*80 w1,w2
      w1 = ' DRAG > *** subprogram '//t1
      w2 = '       increase the dimension '//t2//' to more than: '
      write(*,'(a,/,a,i7)') w1,w2,in
      STOP
      end

c*----------------------------------------------------------------------------*
c*                                                                            *
c*    [cntcut] obtains the number of points, elements and                     *
c*             boundary sides in the cut of a 3D mesh                         *
c*             with a plane                                                   *
c*                                                                            *
c*----------------------------------------------------------------------------*
      subroutine cntcut(xc, lm, np1, ne1, dis)

      parameter (EPS = 1.e-03)
      real       xc(3,*)
      integer    lm(4,*)
      real       dis(*)

      common /plane1/ ne, np, nbf
      common /plane2/ anx, any, anz, x0, y0, z0

c *** Moves slightly the points on the plane

      do ip = 1,np
        dis(ip) = anx*( xc(1,ip)-x0 )+
     &            any*( xc(2,ip)-y0 )+
     &            anz*( xc(3,ip)-z0 )
        if( abs(dis(ip)) .lt. EPS ) then
          dis(ip) = sign(1.,dis(ip))*EPS
        else
          dis(ip) = sign(1.,dis(ip))*999.
        endif
      enddo

c *** Calculates the new number of points, elements and
c     boundary sides

      np1 = 0
      ne1 = 0

      do ie = 1,ne
        kp = 4
        if( dis(lm(1,ie)) .lt. 0. ) kp = kp-1
        if( dis(lm(2,ie)) .lt. 0. ) kp = kp-1
        if( dis(lm(3,ie)) .lt. 0. ) kp = kp-1
        if( dis(lm(4,ie)) .lt. 0. ) kp = kp-1
        if( kp .eq. 1 .or. kp .eq. 3 ) then
          ne1 = ne1+1
          np1 = np1+3
        else if( kp .eq. 2 ) then
```

```
          ne1 = ne1+2
          np1 = np1+4
        endif
      enddo

      return
      end

c*----------------------------------------------------------------------*
c*                                                                      *
c*    [cutvol] performes the intersection between a plane               *
c*             and a volume mesh and its boundary                       *
c*                                                                      *
c*----------------------------------------------------------------------*
      subroutine cutvol( xc,  lm, un,
     &                 np1, ne1, xc1, lm1, un1, dis)

      parameter (EPS = 1.e-03)

      real       xc(3,*),  un(5,*)
      integer    lm(4,*), lm1(3,*)
      real      xc1(3,*), un1(5,*), dis(*)
      integer   npos(4), nneg(4)


      common /plane1/ ne, np, nbf
      common /plane2/ anx, any, anz, x0, y0, z0

      np1 = 0
      ne1 = 0

c *** Cut of the Volume Mesh

      do ie = 1,ne
        kp = 0
        kn = 0
        do in = 1,4
         ip = lm(in,ie)
         if( dis(ip) .gt. 0.0) then
           kp = kp+1
           npos(kp) = ip
         else
           kn = kn+1
           nneg(kn) = ip
         endif
        enddo
        if( kp .ne. 4 .and. kn .ne. 4 ) then
          nol = np1
          do ikp = 1,kp
            ipos = npos(ikp)
            if( abs(dis(ipos)) .lt. 99. ) then
              xp1 = xc(1,ipos)+dis(ipos)*anx
              xp2 = xc(2,ipos)+dis(ipos)*any
              xp3 = xc(3,ipos)+dis(ipos)*anz
            else
              xp1 = xc(1,ipos)
              xp2 = xc(2,ipos)
```

```
          xp3 = xc(3,ipos)
        endif
        do ikn = 1,kn
          np1 = np1+1
          ineg = nneg(ikn)
          if( abs(dis(ineg)) .lt. 99. ) then
            xn1 = xc(1,ineg)+dis(ineg)*anx
            xn2 = xc(2,ineg)+dis(ineg)*any
            xn3 = xc(3,ineg)+dis(ineg)*anz
          else
            xn1 = xc(1,ineg)
            xn2 = xc(2,ineg)
            xn3 = xc(3,ineg)
          endif
          call slice(xp1, xp2, xp3, xn1, xn2, xn3,
&                    xc1(1,np1), xc1(2,np1), xc1(3,np1), f)

            un1(1,np1) = (1.-f)*un(1,ipos)+f*un(1,ineg)
            un1(2,np1) = (1.-f)*un(2,ipos)+f*un(2,ineg)
            un1(3,np1) = (1.-f)*un(3,ipos)+f*un(3,ineg)
            un1(4,np1) = (1.-f)*un(4,ipos)+f*un(4,ineg)
            un1(5,np1) = (1.-f)*un(5,ipos)+f*un(5,ineg)

        enddo
      enddo
      n1         = nol+1
      n2         = nol+2
      n3         = nol+3
      n4         = nol+4
      ne1        = ne1+1
      lm1(1,ne1) = n1
      lm1(2,ne1) = n2
      lm1(3,ne1) = n3
      if( kp .eq. 2 ) then
        ne1        = ne1+1
        lm1(1,ne1) = n1
        lm1(2,ne1) = n3
        lm1(3,ne1) = n4
        x12 = xc1(1,n1)-xc1(1,n2)
        y12 = xc1(2,n1)-xc1(2,n2)
        z12 = xc1(3,n1)-xc1(3,n2)
        x32 = xc1(1,n3)-xc1(1,n2)
        y32 = xc1(2,n3)-xc1(2,n2)
        z32 = xc1(3,n3)-xc1(3,n2)
        x42 = xc1(1,n4)-xc1(1,n2)
        y42 = xc1(2,n4)-xc1(2,n2)
        z42 = xc1(3,n4)-xc1(3,n2)
        d1 = anx*(y12*z32-z12*y32)-
&            any*(x12*z32-z12*x32)+
&            anz*(x12*y32-y12*x32)
        d4 = anx*(y42*z32-z42*y32)-
&            any*(x42*z32-z42*x32)+
&            anz*(x42*y32-y42*x32)
        if( d1*d4 .le. 0.0 ) lm1(1,ne1) = n2
      endif
    endif
  enddo
```

```
      return
      end

c*---------------------------------------------------------------------------*
c*                                                                           *
c*    [slice] calculates the intersection (x,y,z) between                    *
c*            a side defined by (x1,y1,z1) and (x2,y2,z2)                    *
c*            and a plane defined by a point (x0,y0,z0)                      *
c*            and the normal to the plane (anx,any,anz).                     *
c*            It also returns the interpolation factor a1.                   *
c*                                                                           *
c*---------------------------------------------------------------------------*
      subroutine slice(x1, y1, z1, x2, y2, z2, x,  y,  z, a1)

      parameter ( EPS = 1.e-06 )

      common /plane2/ anx, any, anz, x0, y0, z0

      x21 = x2-x1
      y21 = y2-y1
      z21 = z2-z1
      x10 = x1-x0
      y10 = y1-y0
      z10 = z1-z0
      a2  = x21*anx+y21*any+z21*anz
      a1  = x10*anx+y10*any+z10*anz
      a1  = -a1/a2
      x   = x1+a1*x21
      y   = y1+a1*y21
      z   = z1+a1*z21

      return
      end

c*---------------------------------------------------------------------------*
c*                                                                           *
c*    [entropy] calculates the drag caused from entropy production           *
c*                                                                           *
c*---------------------------------------------------------------------------*
      subroutine entropy(np1,ne1,x1,x2,x4,pinf,gamma,cut1,S,Dw,Ae)

      real       x1(3,*),  x4(5,*), S(*), Dw, Ae(*)
      integer    x2(3,*)

      Smax = 0
      do ip=1,np1
         S(ip) = 1.0/(gamma-1.0)*(LOG(x4(5,ip)/pinf)
     &            + gamma*LOG(1/x4(1,ip)))
         if(S(ip) .gt. Smax) Smax = S(ip)
      enddo

      Cutw = cut1*Smax
      Dw = 0
      n = 0
      do ie=1,ne1
         j = x2(1,ie)
```

```
         k = x2(2,ie)
         l = x2(3,ie)
         Se = (1.0/3.0)*(S(j) + S(k) + S(l))
         Ae(ie) = 0.5*ABS((x1(2,k)-x1(2,j))*(x1(3,l)-x1(3,j))
     &        - (x1(2,l)-x1(2,j))*(x1(3,k)-x1(3,j)))
         if(ABS(Se) .gt. Cutw) then
            Dw = Dw + pinf*Se*Ae(ie)
            n = n + 1
         endif
      enddo
      write(*,'(/," Num El Cdw...",1x,i6)') n

      return
      end

c*-----------------------------------------------------------------------------*
c*                                                                             *
c*    [vortex] calculates the lift and drag caused from vortex production      *
c*                                                                             *
c*-----------------------------------------------------------------------------*
      subroutine vortex(ne1,x1,x2,x4,cut2,Ae,circ,norm,stream,YZ,lif,Dv)

      real       x1(3,*),  x4(5,*), Ae(*), lif, Dv
      integer    x2(3,*)
      real       circ(*), YZ(2,*), norm(*), stream(3,*)

c *** Calculate Ciculation around cell

      circmx = 0
      do ie=1,ne1
         j = x2(1,ie)
         k = x2(2,ie)
         l = x2(3,ie)
         circ(ie) = 0.5*((x4(3,j)+x4(3,k))*(x1(2,k)-x1(2,j))
     &                + (x4(4,j)+x4(4,k))*(x1(3,k)-x1(3,j))
     &                + (x4(3,k)+x4(3,l))*(x1(2,l)-x1(2,k))
     &                + (x4(4,k)+x4(4,l))*(x1(3,l)-x1(3,k))
     &                + (x4(3,l)+x4(3,j))*(x1(2,j)-x1(2,l))
     &                + (x4(4,l)+x4(4,j))*(x1(3,j)-x1(3,l)))
         YZ(1,ie) = 1.0/3.0*(x1(2,j)+x1(2,k)+x1(2,l))
         YZ(2,ie) = 1.0/3.0*(x1(3,j)+x1(3,k)+x1(3,l))
         norm(ie) = (YZ(1,ie)-x1(2,j))*(x1(3,k)-x1(3,j))
     &            - (YZ(2,ie)-x1(3,j))*(x1(2,k)-x1(2,j))

         if(norm(ie) .gt. 0.0) circ(ie) = -1.0*circ(ie)
         if(abs(circ(ie)) .gt. circmx) circmx = abs(circ(ie))

         stream(1,ie) = 0
         stream(2,ie) = 0
         stream(3,ie) = 0
      enddo

c *** Calculate Vortex Drag

      Cutv = cut2*circmx
      Dv = 0
      lif = 0
```

```
      n = 0
      do ie=1,ne1
      if(abs(circ(ie)) .gt. Cutv) then
         j = x2(1,ie)
         k = x2(2,ie)
         l = x2(3,ie)
         do ip=1,ne1

            stream(1,ie) = stream(1,ie) + circ(ip)*
     &                         (LOG((x1(2,j)-YZ(1,ip))**2
     &                            + (x1(3,j)-YZ(2,ip))**2)
     &                       -  LOG((x1(2,j)+YZ(1,ip))**2
     &                            + (x1(3,j)+YZ(2,ip))**2))
            stream(2,ie) = stream(2,ie) + circ(ip)*
     &                         (LOG((x1(2,k)-YZ(1,ip))**2
     &                            + (x1(3,k)-YZ(2,ip))**2)
     &                       -  LOG((x1(2,k)+YZ(1,ip))**2
     &                            + (x1(3,k)+YZ(2,ip))**2))
            stream(3,ie) = stream(3,ie) + circ(ip)*
     &                         (LOG((x1(2,l)-YZ(1,ip))**2
     &                            + (x1(3,l)-YZ(2,ip))**2)
     &                       -  LOG((x1(2,l)+YZ(1,ip))**2
     &                            + (x1(3,l)+YZ(2,ip))**2))
         enddo

         Dv = Dv + 0.5*circ(ie)*(-1.0/(37.699)*
     &      (stream(1,ie) + stream(2,ie) + stream(3,ie)))

         lif = lif + YZ(1,ie)*circ(ie)
         n = n + 1
      endif
      enddo

      write(*,'(/," Num El Vor...",1x,i6)') n
      return
      end

c*--------------------------------------------------------------------------------*
c***END_OF_FILE***
c*--------------------------------------------------------------------------------*
```

VITA

Daniel J. McCormick graduated with a B.S. in Mechanical Engineering from the University of Florida in May of 1999. After a year of working as an Aerospace Engineer at the Naval Aviation Depot in Jacksonville, FL he attended Virginia Tech to pursue a Masters degree in Mechanical Engineering, which he obtained in June of 2002. He currently works at Sandis National Laboratories in Albuquerque, NM.