# Aeroservoelastic and Flight Dynamics Analysis using Computational Fluid Dynamics

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### SUMMARY

This document in large part is based on the Masters Thesis of Cole Stephens. The document encompasses a variety of technical and practical issues involved when using the STARS codes for Aeroservoelastic analysis of vehicles. The document covers in great detail a number of technical issues and step-by-step details involved in the simulation of a system where aerodynamics, structures and controls are tightly coupled. Comparisons are made to a benchmark experimental program conducted at NASA Langley.

One of the significant advantages of the methodology detailed is that as a result of the technique used to accelerate the CFD-based simulation, a systems model is produced which is very useful for developing the control law strategy, and subsequent high-speed simulations.

In summary, the document details the following areas:

- Literature review of previous methods used for analysis
- > A discussion and comparison of methods used for modeling surface deformations
- > Details of the surface transpiration concept
- Summary of the appropriate STARS modules used
- Implementation of the benchmark test case including detailed discussion and sensitivity studies in the following areas:
  - Mode Shape calculation and definition
  - CFD geometry specification
  - Boundary condition specifications
  - > Effects of dissipation parameters on the unsteady CFD solution
  - Steady-State solution convergence criteria
  - ➢ Uncertainty estimation
  - Time-step issues
  - Modal and system identification issues
  - Control law development
- Results including:
  - Steady State
  - Steady state with control surface deflections
  - Comparisons between actual deflection, simulated deflection using transpiration, and experimental results.
  - > Aeroelastic results and comparisons with experiment
  - Aeroservoelastic results illustrating control law development and flutter suppression.

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## NOMENCLATURE

CFD	Computational Fluid Dynamics
ASE	Aeroservoelasticity
CG	Center of Gravity
EA	Elastic Axis
α	Angle of Attack (°)
δ	Flap Deflection Angle (°)
М	Mach Number
а	Speed of Sound (in/s)
q	Dynamic Pressure (psi, psf))
$\mathbf{q}_{\mathbf{f}}$	Dynamic Pressure at Flutter (psi, psf)
ρ	Air Density (slinch/in <sup>3</sup> )
γ	Ratio of Specific Heats (1.4 Air, 1.148 R-12)
v	Fluid Velocity (in/s)
ω	Structural Natural Frequency (rad/s, Hz)
φ	Structural Mode Shape
ω <sub>h</sub>	Plunge Frequency (rad/s, Hz)
ωα	Pitch Frequency (rad/s, Hz)
ωδ	Control Surface Frequency (rad/s, Hz)
K <sub>h</sub>	Plunge Stiffness (in lb)

$K_{\alpha}$	Pitch Stiffness (in·lb/rad)
m	Mass (slinch)
Iα	Pitch Mass Moment of Inertia (slinch in <sup>2</sup> )
$I_{\delta}$	Control Surface Mass Moment of Inertia (slinch in <sup>2</sup> )
X <sub>cg</sub>	Location of CG Relative to EA, Positive Aft (in)
$S_{h,\alpha}$	Plunge-Pitch Coupling (slinch in)
$S_{h,\delta}$	Plunge-Control Surface Coupling (slinch in)
$S_{\alpha,\delta}$	Pitch-Control Surface Coupling (slinch in <sup>2</sup> )

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### CHAPTER 1

#### INTRODUCTION

### 1.1 Background

An efficient method of predicting the aeroservoelastic characteristics of modern high-speed aircraft is crucial to aircraft design and flight testing. It is therefore essential that the flight envelope be well defined prior to flight test operations. Without accurate insight into an aircraft's aeroelastic tendencies, flight testing becomes a serious threat both for the aircraft and its pilot.

Aeroelastic solutions are characterized by two main disciplines: structural dynamics and computational fluid dynamics. Aeroservoelastic solutions include the additional complexities introduced by forced control surface deflections during the simulation. The structural dynamics portion of the code predicts a structures natural response, or mode shapes. Any arbitrary deflection can therefore be described as a superposition of a number of these natural mode shapes [Dowell, 1995]. Given an arbitrary applied load, an aerodynamic load for example, the structural dynamics and resulting deformations can be determined. The CFD solver uses the resulting displacements and velocities that arise from the elastic structure and deflecting control surfaces, and calculates new aerodynamic loads.

In the case of an aerodynamic body, these deflections have a great impact on the flow field surrounding the body. Changes in this flow impact the lift, drag, and moment experienced. This variation in loading is accompanied by a corresponding change in structural deflections, which cause aerodynamic changes, which cause structural deformations, and the cycle is repeated until one of two possibilities occur. One possibility is that the changing aerodynamic loads and structural vibrations will peacefully coexist and not result in a structural instability. The other possibility is that the loads and deflections will coalesce and produce an unstable fluid-structure interaction, also known as aerodynamic flutter. It is this flutter phenomenon that poses the greatest threat to aircraft traveling at speeds ranging from high subsonic to hypersonic. Allowed to progress, flutter has the definite possibility of causing structural failure, and has the distinct probability of seriously injuring its pilot.

As described above, in the absence of forced control inputs, the classical aeroelastic system simply reacts to the unsteady aerodynamics. In general, however, aeroservoelastic systems have control surfaces such as ailerons and flaps that complicate an aeroelastic analysis. Deflecting an aileron, for example, not only produces the differential lift required to roll an aircraft, but also alters the twist of the wing itself. This twist causes an effective increase or decrease, depending on how the aileron is deflected, in the effective angle of attack seen by the entire wing. As a result, the effectiveness of a deflected control surface decreases with increasing Mach number until the resulting change in angle of attack exactly counteracts the increase or decrease in lift produced by the aileron such that the aircraft does not roll. This aeroservoelastic phenomenon is known as control surface reversal. In the case of flutter, control surfaces can serve as a

the case of flutter, control surfaces can serve as a means by which to actively control aeroelastic response, falling under the category of active flutter suppression.

Application of these solution techniques in an operational environment means that the time it takes to complete a complete aeroelastic or aeroservoelastic simulation be kept to a minimum without sacrificing solution accuracy. The structural solver requires far less time, by several orders of magnitude, than does the CFD solution. Emphasis should be given, therefore, to those means which improve the speed and efficiency of the CFD solution.

1.2 Problem Definition

For current research, the STARS computer programs developed at NASA Dryden Flight Research Center have been the primary means of a full ASE prediction [Gupta, 1997]. STARS is an highly integrated, finite-element based code for multidisciplinary analysis of flight vehicles including static and structural dynamics, computational fluid dynamics, heat transfer, and aeroservoelasticity capability.

Mentioned earlier, it is the CFD portion of the total simulation that requires the vast majority of the solution time. Within each time step, structural deflections are determined due to the predicted aerodynamic loads. Compared to the solution time required by the CFD module, determination of the structural dynamics is essentially instantaneous. This means that at each intermittent time step, it is the structural dynamics solver that ends up *waiting* for the aerodynamic loads from the CFD portion of the code. This computational time is substantially increased if the solution must be paused at each time step to deform the mesh based on a structural change due to modified aerodynamic loads. Further difficulty is encountered if the mesh must be deformed in such a way as to

account for discontinuous motions such as leading and trailing edge control surface deflections. Accounting for these control surface deflections in a CFD grid presents particular difficulty due the very close proximity of the control surface and adjacent wing surfaces. In most cases, control surface deflections result in the exposure of surfaces not previously seen by the CFD solver. These overlapping surfaces prove to be a significant hindrance to flow computation.

## 1.3 Research Objective

In practical transonic and supersonic aeroservoelastic applications, thin, lightweight wings and control surfaces lend themselves to the susceptibility of flutter. Along with continuing improvements in computational speed, there are more sophisticated solution algorithms that take advantage of the additional speed and memory capabilities. These advances in solution techniques continue to push the limits of even the most powerful computers. In order to more fully appreciate advances in the state-of-the-art, ASE simulations must incorporate means which reduce the amount of computational effort required to produce an accurate prediction. With the computational overhead involved with time-dependent deforming meshes, it is necessary to cultivate an efficient means by which continuous surface deformations as well as control surface deflections are accounted for in the ASE simulation as a means of actively controlling the response of a system.

### **CHAPTER 2**

#### LITERATURE REVIEW

Regardless of the solution methodology used, a full ASE simulation requires a means of coping with the structural dynamics and the determination of the natural mode shapes, the unsteady aerodynamics, control inputs, and a means of incorporating these structural and control surface deformations onto the CFD grid. Certainly, there will be other differences within each simulation method, but at a minimum, the above items will be common to virtually all ASE solutions.

## 2.1 Structural Dynamics

For the types of problems that are commonly encountered, the structural dynamics portion of the solution is already much faster than the aerodynamics. The determination of the structural mode shapes are generally determined one of two ways. First, the mode shapes, pitch and plunge for example, could be known prior to the ASE simulation and specified throughout the solution. A more general ASE simulation uses some sort of structural dynamics solver, finite elements etc, to determine the structural characteristics of the system. This type of solver computes arbitrary structural displacements based on the aerodynamic loads. However, no matter how one chooses to solve for the structural dynamics of the system, a significant amount of forethought must be given as to how these structural deformations are related to a corresponding CFD grid. This point is discussed in more detail later. STARS incorporates the finite element method to solve for the structural response of the system.

## 2.2 Unsteady Aerodynamics Solver

The next issue is still the subject of a great many research papers. The question of exactly how to model the unsteady aerodynamics is very often subject to computational availability, time, and personal preference. Possibilities include, but are not limited to, transonic small disturbance (TSD), and full potential equations (FPE), and more recently Euler and Navier-Stokes equations. Historically, TSD and the full potential method were most commonly used due to their compatibility with the computers of the time. With advances in computer speed and memory, higher equation models such as the Euler and Navier-Stokes have become more tractable.

## 2.2.1 Transonic Small Disturbance & Full Potential Equations

For three dimensional configurations, the transonic small disturbance equations have been a popular choice for aeroelastic analysis and flutter prediction. The transonic speed range is of primary interest because the flutter dynamic pressure is typically lower there [Cunningham, Batina, & Bennett, 1988]. For the computational capability of the day, the TSD and FPE equations were a popular choice because of their relatively low computational cost and ease of implementation. Migration to more sophisticated models is due mainly to the fact that these equations are not adequate in the presence of strong shocks [Ruo & Sankar, 1987].

### 2.2.2 Euler and Navier-Stokes Equations

Advances in computational speed and memory have allowed the practical implementation of Euler and Navier-Stokes solution algorithms to complex two and three dimensional problems. These equations allow for the analysis of a wider variety of problems at broader Mach number range than can be done with TSD or FPE equations. The Navier-Stokes equations, with an adequate choice of turbulence model, are limited only by the assumption that the fluid is a continuum. Take the viscous terms out of the Navier-Stokes equations, and the Euler equations are obtained. For sufficiently high Reynolds numbers, the inviscid flow assumption makes good physical sense, as is shown by the following equation:

$$\operatorname{Re}_{L} = \frac{\rho U L}{\mu} = \frac{\rho U^{2}}{\mu U/L}$$
(2-1)

The above equation expresses the Reynolds number as a ratio of the inertial forces to viscous forces. It is apparent, therefore, that as the Reynolds number increases, inertial forces become more dominant than the viscous terms. The dominance of the inertial terms in high-speed flows, such as those encountered during flutter, show that the inviscid flow assumption made in the Euler equations are a valid means of aerodynamic prediction. As one would expect, the Euler solutions are more limited in solutions where there are significant boundary layer effects, boundary-layer/shock-interactions, and regions of separated flow.

Substantial work has demonstrated the effectiveness of the Euler solution for problems of practical interest. Free from the burden of determining a turbulence model and constructing a mesh capable of resolving the boundary layer, an Euler solution is an

extremely attractive alternative to a code using the Navier-Stokes equations. Introduced in section 1.2, STARS makes use of the Euler equations on an unstructured mesh for its CFD prediction.

## 2.3 Modeling Surface Deformations

As with the choice of flow solvers, there are several popular methods of applying a resulting surface deflection to a CFD grid. Many mesh deformation techniques use a body-fitted mesh which generally requires that the mesh move rigidly or shear as the body deforms. These assumptions consequently limit the ASE analysis to rigid-body or small amplitude motions [Batina, 1989]. Again, not an exhaustive collection of methods, but a presentation of a few practical grid deformation techniques follows in the next few sections.

## 2.3.1 Body-Fitted Coordinate Systems

One popular method of accounting for structural deformations in the CFD mesh is the use of a body-fitted coordinate system. With this coordinate system, the wing surface becomes a coordinate surface. This method involves a coordinate map from this physical space to computational space [Malone, Sankar, & Sotomayer, 1984]. The relationship between the physical and computational coordinate system can be visualized by *unwrapping* the physical grid about a line, or axis, which lies within the wing surface. Then, in the computational grid, the wing surface, as well as any assumed wake shape, becomes a coordinate surface [Malone & Sankar, 1985]. Figure 2-1 shows the body fitted coordinate system in the physical coordinate system. Note that key points are labeled with letters. Figure 2-2 shows the transformed physical coordinate system in the computational coordinate system.



Figure 2-1: Physical Coordinate System



Figure 2-2: Computational Coordinate System

The above figures were obtained from a paper on the unsteady modeling of a fighter wing in transonic flow [Malone, Sankar, & Sotomayer, 1984].

Resulting surface deformations must be related from physical to computational space through a series of matrix transformations. These matrix transformations must be calculated and implemented at each time step in an ASE solution. Although implementation presents relatively few problems, the computational expense of these transformations can be significant on complicated three-dimensional geometries. Additionally, this author has not seen this method implemented on a case involving a discontinuous surface deflection such as those due to flaps or ailerons. As was discussed earlier, the use of these meshes often require the assumption of small-amplitude, rigid-body deformations.

#### 2.3.2 Dynamic Meshes

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Possibly the most intuitive of methods is the concept of a moving mesh. It simply makes sense that one could deform the mesh in accordance to that predicted by a structural dynamics solver. Work done by Batina has demonstrated the effectiveness of such a method using an unstructured finite-difference mesh with an Euler solver [Batina, 1989].

Though the concept is simple, implementation comes at a price. What this type of mesh boils down to is a large network of nodes connected by a series of springs whose stiffness is inversely proportional to the length of its edge. At each time step, specified boundary nodes are displaced by an amount corresponding to that of the aeroelastic response of the body. The displacement of the rest of the computational domain is therefore solved iteratively using static equilibrium equations in the x and y directions.

This results in x and y displacements for each of the interior nodes inside the computational domain. This iterative procedure is accomplished by a predictor-corrector method that first predicts the displacements due to linear extrapolation and corrects these displacements with several Jacobi iterations of the static equilibrium equations.

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Given in Figure 2-3, Figure 2-4, and Figure 2-5 are the original reference grid, the deformed grid at maximum  $\alpha$  and the deformed grid at minimum  $\alpha$ , respectively, for a wing oscillating about its quarter chord.



Figure 2-3: Reference Grid for Deforming Mesh Algorithm

Mentioned previously, the grid points on the outer boundary are fixed and the grid points on the airfoil are fixed relative to the airfoil. From a maximum pitch oscillation of  $15^{\circ}$  to a minimum pitch angle of -15°, the mesh smoothly transitions from one state to another using the procedure described above.



Figure 2-4: Maximum Pitch Angle ( $\alpha$ =15°) Using a Deforming Mesh Algorithm



Figure 2-5: Minimum Pitch Angle ( $\alpha$ =-15°) Using a Deforming Mesh Algorithm

The above figures were taken from a paper by J. T. Batina [Batina, 1989].

As one can imagine, the use of this type of mesh results in elements that have been deformed from their original shape. These deformations lead to volumetric changes within each element inside the computational domain. It is therefore necessary to add a geometric conservation law to account for the changing cell areas at each time step. As will be discussed later, deforming meshes also encounter difficulty in areas of surface discontinuities.

Recently, an improved spring analogy was presented as an alternative to the method proposed by Batina [Farhat, Degand, Koobus, and Lesoinne, 1998]. In addition to the linear springs between nodes, torsional springs at each node were also included to further deal with the difficulties involved with volumetric changes during mesh deformation. Results were presented for a wing with a full-length flap. Although related to the problem of discontinuous surface deformations, the full-length flap is more amiable to this type of problem since moving surfaces never separate from one another. Common to any dynamic mesh algorithm, substantial computational effort was involved with deforming the mesh at each time-step. An estimate was made that the computational overhead involved in the implementation of this dynamic mesh accounted for roughly 20% of the CPU time involved in a complete solution.

#### 2.3.3 Re-Meshing

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Perhaps the most versatile option is the re-meshing approach. Using this method, the entire computational domain is re-meshed at each time-step to account for structural deformations and velocities. This method does not involve a complicated meshdeforming algorithm, it simply re-defines the surface geometry and generates a new

computational mesh. Of course, with current hardware, the re-meshing approach is still by far the most computationally expensive.

The problem with discontinuous surface deformations still exists with this method. Even though the grid is re-defined at each step and there is no mesh-shearing to speak of, the varying intersection points at the interface of the wing and control surface must still be calculated in order to model the geometry exactly. This calculation involves specific knowledge about the geometry and would be difficult to implement in a general-purpose CFD code. Often, when a mesh is re-generated to account for control surface deflections, additional surfaces are required to fill structural voids resulting from the displacement. In an unsteady ASE simulation where the solution involves both wing and control surface deflections, maintaining these varying intersection points would be complicated at best and would most likely involve a substantial amount of user intervention. This point is further illustrated in section 2.4.2.

### 2.3.4 Surface Transpiration

Though both the body fitted coordinate system and the dynamic mesh algorithms have demonstrated their efficacy for solving aeroelastic problems, both require a substantial amount of computational effort in between mesh deformations. As was seen with the body fitted coordinate system, the resulting deformed grid must be mapped to a computational system at each intermediate time-step. Even more so with the dynamic mesh algorithms, consequential structural deformations result in a modification of the entire computational domain.

In an environment where speed, without sacrificed accuracy, is of primary concern, surface transpiration has shown itself as a viable tool to the aeroelastician. The

concept of surface transpiration is simple. With known structural displacements and velocities, a simple modification to the nodal boundary conditions on the existing CFD grid is capable of altering the displacements and velocities used in the flow solver.

With this method, no modifications are made to the existing CFD grid except for a slight boundary condition modification to nodes on a deformable surface. As was encountered with the previously discussed methods of grid modification, there are no other complications associated with the transpiration method. With the transpiration method there is no mapping from one coordinate system to another, no relative nodal displacements, no elemental volume changes, no changes to the computational domain, no need to iteratively solve for new nodal boundary conditions, etc. Stated again, the only changes necessary are to nodal boundary conditions on deformable surfaces. Unlike previous methods, deformations are accounted for only on those surfaces that require it.

What exactly is this change in *existing boundary conditions*? Generally it is quite simply a change in the flow tangency boundary condition on an element. To attain the no-flow normal to the surface boundary condition, the flow solver computes a surface normal for each surface element. Observe Figure 2-6 below.



Figure 2-6: Slight Surface Element Rotation

This figure shows an arbitrary surface element undergoing a *slight* change in orientation. It is important to keep the word *slight* in mind because it stands to reason that any approximate method will loose effectiveness for *large* deformations. The figure shows a single structural element with surface normal  $\hat{n}_1$  being modified so its new surface normal is  $\hat{n}_2$ . Transpiration therefore assumes that there is no significant stretching or volumetric change within the element so that the area of each element remains constant. For a typical wing undergoing small amplitude structural deformations and control surface deflections, this is a very reasonable assumption.

Assuming that a normal has an x, y, and z component, a change in orientation is accomplished by changing the velocity boundary condition on the affected nodes. This change in boundary condition comes in the form of an additional fluid velocity outside of the existing surface elements. This additional velocity effects the way the unsteady flow solver resolves the flow tangency boundary condition, see Figure 2-7 below:



Figure 2-7: Illustration of the Transpiration Concept

In the above figure,  $V_{Original}$  is the original tangential fluid velocity with normal,  $\hat{n}_{Original}$ . Through an aeroelastic or control surface deformation, for example, the it is desired that the surface be deformed in such a way that it now has normal,  $\hat{n}_{New}$ . For the steady and unsteady cases, the flow tangency boundary condition is represented by equation (2-2) and (2-3), respectively.

$$V \cdot \hat{n} = 0 \tag{2-2}$$

$$V \cdot \hat{n} = V_{h} \cdot \hat{n} \tag{2-3}$$

Equation (2-2) simply states that the velocity normal to the body must be zero Only slightly more complicated, equation (2-3) states that the fluid velocity normal to the surface must be equal to the velocity of the body normal to itself. In other words, no flow can move through a solid surface. It is necessary to point out that the  $V_b$  mentioned here is not the same as  $V_{Transpiration}$  shown in Figure 2-7.

In summary, each surface element that is to undergo a change in orientation acts as a source sheet. The strength of the source is determined by the extent of the simulated deflection. Now, expand this procedure to an entire surface discretized into a large number of elements. With a known surface deformation, perhaps from a finite element solver e.g., it is desired that a surface be distorted from its original position. Within reasonable limits, this arbitrary surface deformation can be simulated with an appropriate change in the direction of the surface normal on each element making up the surface. Since the flow solver is concerned with maintaining the flow tangency boundary condition at each CFD node, the solution obtained on the simulated deformation should closely approximate that of the actual deformation.

## 2.4 Transpiration Concept

Of the three methods of incorporating mesh modifications into the ASE solution described in the previous section, the transpiration method shows the greatest potential for accounting for mesh deformations with the least computational overhead. Its simplicity is its greatest asset. Although the dynamics solver must still *wait* for the CFD solver to predict the new aerodynamic loads, transferring the predicted deformations to the CFD mesh is extremely fast. Since only the surfaces affected by the deflection are affected, the rest of the computational domain remains *untouched* for the duration of the

ASE simulation. Surface normals on walls, far-fields, and interior element surfaces are also not modified. Appreciable time savings are realized due to the fact that a modification to only those normals on the surface of a wing or fuselage, for example, must be modified.

## 2.4.1 Origins of Transpiration

Transpiration can trace its origins back to the late 1950's in a paper entitled *On Displacement Thickness* which describes the "method of equivalent sources" for modeling the influence of the boundary layer on the inviscid flow outside them [Lighthill, 1958]. Rather than thickening an actual airfoil, the boundary layer effect could be accounted for by an equivalent surface distribution of sources. This is done by specifying the necessary inflow or outflow boundary conditions on the original surface and solving for the inviscid flow. As was described in Section 2.3.4, this method requires no modification to the existing grid.

Simplicity, speed, and accuracy are the transpiration concepts greatest advantages. As has been developed, the use of the transpiration boundary condition can be implemented on an existing CFD grid with a minimal amount of computational effort. The time it takes to simulate a deformed mesh is minimized due to the fact that no actual grid deformation takes place, the computational volume is not modified, and only those surfaces that require a boundary condition modification are affected. It's accuracy has been effectively demonstrated over time through work done by Fisher, 1996, Raj & Harris, 1993, Bharadvaj, 1990.

## 2.4.2 Application to Current Research

Past research has demonstrated the effectiveness of the transpiration method when applied to aeroelastic problems [Fisher and Arena, 1996]. For a variety of problems covering a wide range of Mach numbers, the transpiration method proved to be a viable tool in the prediction of aeroelastic responses. Here two specific examples are covered in more detail. The first is a  $2 \times 1$  plate case, the second is the AGARD wing.

The 2×1 plate consists of a flexible plate surrounded by a rigid support, see Figure 2-8 below. To evaluate the usefulness of the transpiration method on this case, the CFD mesh was deformed through a superposition of the first six natural modes, see Figure 2-9.



Figure 2-8: 2×1 Plate CFD Mesh



Figure 2-9: Actual 2×1 Plate Deformation

The transpiration method was used to simulate the actual deflection seen in the figure above. For this case, at Mach 0.95, relatively large surface deformations at this transonic Mach number produce strong discontinuities on the pressures along the plate.



Figure 2-10: Steady Pressure Contours on the Deformed 2×1 Plate at Mach 0.95

As can be seen in Figure 2-10, the transpiration method does an excellent job of modeling the flow dynamics on the surface of the plate. In the figure above, three lengthwise pressure *cuts* show the pressure distribution along each cut. In each section, agreement between actual and simulated deflections are very good.

Another example of the application of the transpiration method is with the AGARD 445.6 wing. This standard aeroelastic test case serves as a good reference for application of the transpiration method to simulate surface deformations on a lifting surface. Figure 2-11 shows two views of the AGARD wing. The leftmost figure shows the undeformed mesh that will be used to simulate the figure on the right which is

actually deformed. This case serves to demonstrate the effectiveness of the transpiration boundary condition when applied to relatively large surface deflection. As one can tell from the figure, there are significant deformations resulting from both bending and torsional modes.



Figure 2-11: AGARD 445.6 Wing, Undeflected and Deflected CFD Meshes

As was done with the  $2 \times 1$  Plate case, comparison is made between the simulated and actually deformed mesh by means of chordwise pressure cuts at several points along the span of the wing. For a Mach number of 0.678, we get Figure 2-12, below.



Figure 2-12: Steady Pressure Contours for the AGARD Wing at Mach 0.678

For three chordwise pressure *cuts* through different spanwise locations along the wing we once again see excellent agreement between the simulated and actual surface deformation.

What was lacking from the above two examples was a moving control surface. Relatively smooth mesh deformations, as typically occur in aeroelastic problems, are much more simple to deal with than are discontinuous surface deformations. For the scope of the current research, the appealing characteristic about the transpiration method is, oddly enough, the fact that the mesh does not move. Deflected control surfaces provide several inherent difficulties for CFD solvers. When attempting to model a control surface displacement, there are several factors that affect a CFD codes ability to handle these difficult surface transitions. First is the very close proximity of control surface edges to adjacent parts of the airframe. Especially when using an Euler solver, these very narrow gaps present significant computational difficulties. The flow through these gaps, along surfaces which are parallel to the flow direction, will result in very high flow gradients and will effectively *wash* out other, more significant, flow physics.

The second difficulty arises from the fact that even if one assumes that there is no gap, the varying size of the face along the wing-flap intersection would be terribly difficult to account for, even in a dynamic mesh. Figure 2-13 below helps illustrate this problem.



Figure 2-13: Variable Wing-Flap Intersection Example

Notice the area in the circled region in the above figure. For any change in flap angle, the intersecting surfaces and the points of intersection change. Also observe that as the flap changes position, the size and shape of the newly exposed surface changes. These surfaces, specifically the lines defining the surfaces, must be modified with each different flap angle. The addition of these surfaces is necessary do keep the solution domain closed. For the case of a wing with a finite-span flap, for example, deflection of the flap requires the definition of 4 new surfaces with each new deflection. In either a dynamic mesh or re-meshing algorithm, for example, this variation in surface definition would be difficult to account for.

Related to the second problem, is again the difficulty encountered in the immediate vicinity of the flap during a control surface deflection. With the flap in its stowed position, there is essentially a smooth, continuous surface over the entire wing. Assume that this flap, or control surface in general, is deployed several degrees. One must consider what happens to the grid in the vicinity of the flap. With a dynamic grid, the mesh must stretch to account for this displacement. The problem encountered with this mesh deformation is the amount of *mesh shearing* that must be endured for the flap to deflect.

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Shown in Figure 2-15 is an example of this mesh shearing. For a simple wing with a flap lying within the span of the wing, a flap deflection similar to that of Figure 2-13 would produce surface discontinuities in the surrounding area of the flap. Figure 2-14 shows the desired 10° flap deflection. The next figure, Figure 2-15, shows how a mesh deforming algorithm might deform the existing mesh.


Figure 2-14: Desired Flap Deflection

Mesh shearing has the consequence of degrading the flow solution quality. Notice that in the region of the flap, mesh shearing results in the elongation of elements surrounding the wing-flap intersection. Due to this shearing effect, there now exists poor grid resolution around an area with high flow gradients, an area actually in need of grid enhancement.



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Figure 2-15: Mesh-Shearing Example



Figure 2-16: Equivalent Mesh for Transpiration

Using the concept of surface transpiration, there is no mesh deformation necessary, hence no mesh to shear. Figure 2-16 shows the only mesh needed for the application of a reasonably arbitrary flap deflection. With the above mesh, any arbitrary flap deflection can be accounted for by simply rotating the elemental normals on the flap by the desired flap deflection angle. Once again, one can see the speed at which this method may be applied.

#### 2.5 Benchmark Models Program

The Structures Division of NASA Langley Research Center (LaRC) initiated the Benchmark Models Program (BMP) to obtain experimental data for the validation of unsteady CFD codes. A variety of models were tested in the NASA Langley Transonic Dynamics Tunnel (TDT) [Scott, Hoadley, Wieseman, & Durham, 1997]. In the BMP program, two specific models are of interest. Each model has a rectangular planform with a NACA 0012 cross-section, 16 inch chord, and 32 inch span. The first model was simply a rigid rectangular wing fitted with pressure transducers over the surface of the wing. The second model is referred to as the BACT, standing for Benchmark Active Controls Technology. Though different models, each shares identical model dimensions, and instrumentation. The only practical difference between the two models is the presence of three control surfaces. These three control surfaces, two of which can be seen in Figure 2-17, are a trailing edge control surface, and upper and lower spoilers.



Figure 2-17: BACT Wing Model Dimensions

The control surfaces are centered along the models 60% span (19.2 in), and has a length equal to 30% (9.6 in) of the wing's span. The trailing edge control surface has a width of 25% (4 in) model chord while the spoilers have a width of 15% (2.4 in) model chord.

The first model, the NACA 0012 wing, was tested in air and provided a large experimental database. This database included steady pressure measurements, unsteady pressure measurements during flutter, and flutter boundaries over a wide Mach number range. Tested in R-12, the BACT model's primary purpose was to provide additional data for the purposes of evaluating a CFD code's effectiveness in modeling the control surfaces illustrated above.

Both models were mounted inside the TDT on a device known as the Pitch and Plunge Apparatus (PAPA) [Farmer, 1982]. Shown below in Figure 2-18, the BACT model is seen mounted to the flexible PAPA mount system.



Figure 2-18: BACT Model on Flexible PAPA Mount

This mount system is simple and possesses dynamic properties that are easily obtained by analytical means. It is important to note that the PAPA mount shown above is slightly different than that described in the paper by Farmer, but these differences are primarily cosmetic.

The mount basically consists of a model mounted to a "Chevron" bracket. Seen on the Chevron mount are adjustable masses that allow adjustments to the models center of gravity location. This Chevron mount is connected to a turn table by four steel rods and a rectangular *drag strut*. The mount is designed such that it allows only two degrees of freedom: rigid body pitch and plunge. The turntable allows an arbitrary choice in angle of attack. The Chevron mount, rods, drag strut, and turntable are *hidden* behind a large splitter plate such that only the model is seen in the tunnel test section. For steady pressure tests, this mount can be *rigidified* by replacing the Chevron mount, rods, and drag strut by a large diameter (~6 in) rod.

With the quality and amount of experimental data available, these models serve as the primary experimental benchmark to which all computational results obtained from the current research are compared. Efforts presented within this paper illustrate the implementation of the transpiration method within the STARS computer codes on: steady pressure measurements, steady control surface deflections, conventional flutter, and control inputs for purposes of flutter suppression.

#### **CHAPTER 3**

#### METHODOLOGY & PROCEDURE

The primary research tools for the current effort are the STARS codes developed at NASA Dryden Flight Research Center [Gupta, 1997]. The current version of STARS is the result of the evolution of the original STARS (<u>STructural Analysis RoutineS</u>) computer code into an highly-integrated multidisciplinary tool for the analysis of a wide variety of 2D and 3D structures. This evolution involves the addition of several *modules* to the original STARS code. Each individual module, general by design, is integrated into an effective tool for the prediction of complicated aeroelastic and aeroservoelastic problems. These modules include: structures, heat transfer, linear aerodynamics, CFD, controls engineering, and others.

#### 3.1 STARS Modules

The scope of the current research is primarily involved with two of the modules within the STARS computer programs. For a general ASE simulation, the user is typically concerned with the structural dynamics of the system and the steady and unsteady aerodynamic characteristics. The modules used for the current effort are the structures and CFD modules, which are in turn integrated into the full ASE simulation.

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#### 3.1.1 SOLIDS Module

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The SOLIDS module has a large solution bandwidth, but for problems pertinent to current research, we are concerned with the determination of the free and forced response. The free response comes from the solution of the following equation:

$$[M]{\dot{u}} + [K]{u} = 0 \tag{3-1}$$

where [M] and [K] are the inertial and stiffness matrices, respectively. Generally, once a *solids* model is generated, STARS solves the above equation for the natural frequencies ( $\omega$ ) and mode shapes ( $\phi$ ). If, however, the natural frequencies and structural mode shapes are known *a priori*, one can bypass this solution and manually create the generalized mass and stiffness values.

#### 3.1.2 CFD Module

The STARS flow solver is an Euler-based code that applies finite-element CFD on an unstructured grid. The implementation of an unstructured grid is a significant feature of the STARS computer codes. For the general three-dimensional case, the computational mesh consists of an assemblage of tetrahedra. These tetrahedra are oriented to form to the geometry being considered, thus making possible the treatment of complicated shapes.

The unstructured grid shape is assembled using the advancing front technique. This procedure consists of dividing a boundary into a finite number of points (nodes) such that the external surface is sufficiently represented. Adapted from a figure by Peiró, Peraire, and Morgan, Figure 3-1 shows how these triangles, or tetrahedra in three dimensions, are arranged beginning at these outer nodes [Peiró, Peraire, and Morgan,

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1993]. Additional tetrahedra are added in such a manner that the surface *front* collapses upon itself until the entire domain is filled with tetrahedra.



Figure 3-1: Stages of Advancing Front Technique

The CFD module, in general, consists of four major parts:

- SURFACE: Generates the two-dimensional front
- VOLUME: Generates the three-dimensional computational domain
- SETBND: Defines the boundary conditions in the domain

• EULER: Steady or unsteady Euler flow solver

Each one of the above steps, as one would surmise, need to be done in that particular order.

The user is able to specify certain parameters pertaining to the density of the CFD surface and volumetric mesh. For regions such as leading and trailing edges of wings, for example, the user may wish to define regions of higher mesh density, while maintaining low mesh density in the far-field. STARS also has the capability of adaptive re-meshing. Once a flow solution is obtained, the user has the option of letting STARS automatically adjust the existing computational grid such that regions of high gradients receive a more dense arrangement of elements.

## 3.1.3 Aeroelastic and Aeroservoelastic Solver

In general, the equations of motion for the coupled, time-marched ASE solution involves the solution of (3-2), which is a matrix equation of motion for an arbitrary structure in generalized coordinates.

$$[M]{\dot{u}} + [C]{\dot{u}} + [K]{u} = f(t)$$
(3-2)

In the above equation: [M] = generalized mass matrix

- [C] = generalized damping matrix
- [K] = generalized stiffness matrix
- {u} = generalized displacement vector

f(t) = generalized aerodynamic force vector

The general procedure, therefore, for solving aeroelastic and aeroservoelastic problems is as follows. A steady CFD solution serves as the initial conditions for the structural dynamics solver. A perturbation about this steady CFD flow will cause a change in the structural displacement and velocity boundary conditions. These changes in displacement and velocity boundary conditions serve as boundary conditions for the next time-step in the CFD solution. Resulting forces and moments are then fed into the structural dynamics solver which in turn computes new displacement and velocity boundary conditions for the CFD flow solver. This process continues until the complete time-history is obtained. The above procedure can be visualized graphically through Figure 3-2 below.



Figure 3-2: Block Diagram of Time-Marching Approach

## 3.2 Implementation of the BACT Model into STARS

As was mentioned in Chapter 2, the primary test cases for this effort are a NACA 0012 wing tested in air and the BACT wing tested in R-12. Both in the Benchmark Models Program and geometrically similar, models were tested under similar Mach numbers and dynamic pressures in the Langley Transonic Dynamics Tunnel at NASA

Langley Research Center. The main difference, other than the fluid medium, is the fact that the BACT wing has the capability of modeling control surface deflections, whereas the NACA 0012 wing is simply a rigid, rectangular wing with no control surfaces.

The next few sections discuss in more detail, the incorporation of both these models into STARS. Since, for all practical purposes, the two wings are exactly the same except for the trailing edge control surface, the solids and CFD models used in STARS will be the same..

## 3.2.1 BACT SOLIDS Model Development

Described in this section is an overview of the various steps taken to construct a finite element solids mesh to represent the BACT wing. A solids model that included the PAPA mount described in Chapter 2 was not developed due to the simple mode shapes and frequencies exhibited by the BACT-PAPA system. Since the model was constrained to only plunge and pitch, the mode shapes and natural frequencies were available from experimental data. Additionally, modeling the mount would have required a significant amount of parameter *fine-tuning* in order to assure the natural frequencies and mode shapes coincided with experimental results.

Even though the structural dynamics of the entire system were already known, a structural mesh of the wing and flap itself is still needed. Mode shapes defined with this model are in turn interpolated a CFD mesh. For too course a grid, it is possible that one may introduce errors in the interpolation from one grid to another. For this reason, care was given to provide a tighter mesh in the region of the trailing edge control surface.

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<sup>-</sup> D Case: N/A olids Case: bact

Figure 3-3: Finite Element Solids Mesh for BACT Wing

Figure 3-3 shows the resulting finite element structural mesh used in STARS. Over the majority of the wing, a relatively coarse mesh is used due to the fact that only rigid body pitch and plunge motions are encountered due to the PAPA mount. An obvious exception to the otherwise coarse mesh is the *tight* mesh in the region of the trailing edge control surface. To minimize any possible error in the interpolation from the solids mesh to the CFD mesh this region was meshed much more densely than the rest of the wing.

The majority of the solids mesh construction took place within the solids preprocessor within STARS. PREPROCS is simply a tool that guides the user through the creation of the mesh, assignment of structural properties, etc. It also formats and writes the corresponding data file containing solution parameters, nodal properties and locations, element properties and connectivity, structural properties, materials etc. The *thick* lines running from leading to trailing edge along the edge of the trailing edge control surface and along the beginning of the flap actually correspond to small elements that had to be added manually. It was discovered that in the interpolation from the solids mesh to the CFD mesh exaggerated corresponding displacements of the flap due to the large elements adjacent to the flap. Due to the way STARS implements the interpolation, control surface deflections were seen out to locations corresponding to one half the size of the larger elements. This was the first time this problem had been encountered within STARS. Before, when modeling continuous structural deformations, this sort of problem never surfaced. To alleviate this problem, smaller elements had to be added around the entire perimeter of the flap. Deflections still get interpolated out to one half of the elements width, but the elements are sized such that these errors are negligible.

In the PREPROCS routine discussed above, elements are assigned material types and associated constants, nodes are constrained, etc. These constants, however, are not used in this particular case for reasons discussed previously. The input data file created by PREPROCS is given in Appendix A-1. Since the structural mass, damping, and stiffness characteristics are obtained experimentally, STARS allows the manual input of this data. This point is covered in more detail a little later.

## 3.2.1.1 Structural Mode Shape Definition

In general, once one has developed the STARS solids mesh, the solution can be set up to run the un-damped, free vibration analysis to determine a user defined number of structural natural frequencies and mode shapes. For the case of the BACT, the two structural mode shapes are well defined, as is the control mode, and it is a relatively straightforward procedure to define ones own structural mode shapes. Discussed in the next few paragraphs is a general set of steps used in the creation of the two structural mode shapes and the control mode.

First, the necessary parameters in the solids file are set to solve for the first three natural mode shapes. Run the undamped, free vibration analysis to obtain a properly formatted *out.2* file. Although the data in the file will be replaced, STARS requires proper formatting for later modules so the file serves as a formatting tool only.

Now that an *out.2* file has been created, although filled with irrelevant data, the user defined mode shapes need to be developed and replace the data currently in the *out.2* file. To keep the problem as general as possible, a series of EXCEL workbooks are set up to contain each of the calculated mode shapes. Even though the mode shapes are known, the magnitude of the modal displacements is still arbitrary. Mode 1 is simply a rigid body plunge motion. For this mode, the spreadsheet contained a large matrix of data containing information on the nodal displacement due to a generalized displacement of 1 inch. Table 3-1 shows how the data was arranged in the spreadsheet. A similar format was used with the other two modes.

Table 3-1: Spreadsheet Layout for Manual Input of a Structural Mode

	Original Location			New Location			Nodal Displacement		
Node	X	Y	Z	X'	Y'	Z'	ΔΧ	$\frac{1}{\Delta Y}$	ΔZ

Each row in the above table contained data for every node in the solids file. The simplest case was rigid body plunge. In this case, one inch was added to each original z coordinate.

Slightly more complicated was the determination of the rigid body pitch motion. The magnitude of the rotation, so long as the rotation was a pure rotation about the models mid-chord (8 inches), was arbitrary. The modal displacement vector, however, is sensitive to this magnitude. It makes more sense to explain this point with an example. Consider the choice between a rigid body rotation ( $\phi_2$ ) of 1° or 10°. Two figures below illustrate how STARS interprets the mode shapes it creates, or the user defines.



Figure 3-4: Rigid Body Pitch Mode Definition Example

Shown in Figure 3-4 is the original structural position (dashed) and the rotated position. Remembering from Table 3-1 that nodal displacements were specified such that only the original and final position are known. STARS therefore interprets the entire structural rotation as the *straight-line* displacement from the initial position to the final position. Figure 3-4 shows only the positive displacement. For an oscillatory motion, however, both positive *and* negative displacements would be encountered Figure 3-5 shows what happens for a displacement opposite that of the defined rotational mode shape.



Figure 3-5: Structural Deformation Opposite Original Definition

As the structure rotates from its original position (dashed) to its specified deflection (dotted & grayed), each node follows a particular vector defined by the final displacement. As the structure rotates from this position, back through the original position, and to the position shown in Figure 3-5, it follows the path defined as shown by the vectors. One can immediately see that this structure must compress and stretch as it cycles through its motion.

We can now see the effect of the magnitude of the specified rotational mode shape. It makes sense then that if the rotation amount is *small* that any compression and stretching can be kept to a minimum. Keep in mind also that actual displacements may be larger than those originally specified, resulting in further contraction and expansion. It is apparent that a compromise is needed. Structural distortion during rotation was minimized by specifying small, 1°, rotational mode shapes, and neglecting any slight changes in the longitudinal direction, i.e. as the object rotates, only vertical motion is realized, translational motion is neglected. This effect is illustrated below in Figure 3-6.



Figure 3-6: Implemented Rotational Mode Shape for STARS

The above figure is shown at an exaggerated displacement to highlight the method used. In actuality, the 1° rotation produces translational changes on the order of 0.001 inches. Additionally, neglecting this small translation allows for a more general rotation angle. For small angles, those around 8° or so, translation due to rotation can still be considered insignificant.

Finally, specification of the control mode followed much the same procedure as did the rotational rigid body mode. The difference being the fact that the control surface rotated about the <sup>3</sup>/<sub>4</sub> chord point (12 inches) as opposed to the mid-chord. Again, modal displacement vectors were specified at each node, but only the nodes on the flap had non-zero values. The same stretching/compression problems were encountered with the flap. It was critical that the flap be modeled as accurately as possible so that any slight deflection would be correctly interpolated to the CFD grid, hence the dense mesh in Figure 3-3. The translational effects due to flap deflections were more significant than those due to the entire wing pitching because of the relative sizes of the flap and wing. As was done with the rigid body rotation, a 1° generalized displacement was used to specify the motion of the flap. The EXCEL workbooks showing the nodal displacement data are given in Appendix A-2 through A-4.

With all of the little details discussed in the previous paragraphs, it is easy to loose sight of what has actually been taking place. Up to this point a solids mesh has been generated, STARS has performed an undamped, free-vibration analysis on this mesh and has generated an out.2 file (for formatting purposes only). The next step is to replace the data in the file with the natural frequencies and mode shapes that were developed a few paragraphs back. The data in the out.2 file must be arranged in an exact format due to a formatted read inside STARS. Inside this file, displacement and rotation data are given for each structural node number. Displacements for each node are broken up into x, y, and z translations and x, y, and z rotations. As opposed to entering all the data manually, a quick FORTRAN program (Appendix A-5) was written that read in the data from Appendices A-2 and A-4, sorted it into the proper form and output the data into an external file. Data from this new file is in turn manually pasted into the proper location inside the out.2 file. There is quite a bit of manual overhead when one chooses to define frequencies and mode shapes that is not involved when STARS computes them. However, time savings are realized during the latter parts of the solution when simple changes in mass, damping, stiffness, CG locations, etc. require the modification of a single parameter and not the re-definition of the basic structural mode.

Throughout this section, there has been a reference to the CFD mesh. Before discussing further structural requirements for the full ASE simulation, the development of the CFD mesh must be considered.

#### 3.2.2 BACT CFD Model Development

The development of the CFD mesh consists of several key elements. First, the model geometry must be constructed and entered such a way that STARS can read it.

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Next, the CFD mesh must be set such that the grid is sufficiently dense, or coarse, in the appropriate areas. Finally, once the CFD boundary conditions are completely specified and the solution parameters are set, the stage is set for a steady-state CFD solution.

# 3.2.2.1 BACT Geometry Specification in STARS

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> The first step in defining the CFD mesh in STARS is the specification of the lines and surfaces that will make up both the model geometry and computational domain. Described in the next few paragraphs is the development of two CFD meshes. The first mesh is the is used to investigate the application of the transpiration method for a variety of cases including steady and unsteady aeroelastic cases, steady control surface deflections, and finally control surface deformations as a means of flutter suppression. The second CFD mesh is used to compare an actual control surface deflection to one that has been modeled using the transpiration boundary condition.

> Shown below in Figure 3-7 are the important labels defining the lines and surfaces of the entire computational domain.



Figure 3-7: CFD Computational Volume Specification

In the above figure, the circles indicate the definition and specified direction of a line. Parallelograms indicate the existence of a surface. In both cases, dashed lines represent lines or surfaces that would be hidden in order to facilitate the visualization of the 3-D geometry. Next, a similar procedure is employed in Figure 3-8 for defining lines and surfaces on the wing itself.



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Figure 3-8: Wing Geometry Specification

To specify the chordwise points that define the NACA 0012 airfoil cross section, such as lines 13 and 14, 161 cosine spaced points outline the curve of the airfoil. Cosine spacing simply allows finer specification along the leading and trailing edges with reduced spacing over the surface of the airfoil where there is the least curvature. Admittedly, there is an excessively large number of points defining these curves, but any effort to minimize any sort of modeling error was utilized. Surface 15 corresponds to the wing tip. A rounded surface for the wing tip was included to match that of the experimental BACT model. This rounded tip is simply a surface of revolution which is defined by <sup>1</sup>/<sub>2</sub> of the airfoil section.



Figure 3-9: Close-Up of Deflected Flap Geometry Definition

Figure 3-9 demonstrates the additional lines and surfaces needed to define the wing geometry for a deflected control surface. For clarity, only lines and surfaces that were modified or added were included in this figure.

Addition of the control surface causes several difficulties due to the changing intersection points between the control surface and the wing. With any slight change in the deflection angle, intersection points must be recalculated and the STARS data file modified. This manual re-meshing concept is, as one would expect, time consuming. The time it takes to go from one deflection angle to another is on the order of 2 to 3 hours. That is just the time it takes to modify the wing geometry. Changes also must be made to the file that contains information about grid density and element source location

since surfaces are being displaced from their original positions. Additional time must also be spent regenerating the tetrahedral mesh throughout the entire computational domain. This process itself, can take a couple more hours. All in all, the time it takes to go from one deflection angle to another can take on the order of 5 or 6 hours to completely redefine the geometry and regenerate the computational volume. The complete data file is given in Appendix B-1.

The procedure described above serves as a very good basis for the use of the transpiration method to model these types of discontinuous deflections. In an environment where it is desired to obtain results for a number of control surface deflections, one could easily make the simple modification to the scaling factor that describes the control surface deflection angle. For example, a 0° deflection is equivalent to saying "Zero times the generalized displacement of 1°." Similarly, for a 10° deflection, it equivalent to saying, "Ten times the generalized displacement of 1°." It is important to note here that a positive control surface deflection angle corresponds to a downward deflection of the flap.

As in the SOLIDS definition, a series of EXCEL workbooks was set up in order to facilitate the assembly of the data file STARS uses to create the surface front. The spread sheet is set up in such a way as to automatically re-define each surface and line definition for any symmetric 4-digit NACA series airfoil cross-section. Due to the number of reference points defining the airfoil cross-section, the data file is nearly 6000 lines long. One can immediately appreciate the use of the automatic file generator for such a large number of points. For the case of the actual control surface deflection, however, the data file generation cannot be done automatically. With each deflection

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angle, the intersection points discussed earlier change, so one must go through and compute the intersection points and redefine lines 24, 26, 33, 34, 36, 37, 39 and 40.

#### 3.2.2.2 BACT Grid Specification in STARS

To this point we now have only the lines and surfaces that define the CFD geometry. Next, we need to specify the location and density of the tetrahedral elements that will define each surface and the internal volume. STARS allows one to specify point, line, or triangular sources. These sources can be thought of as sources of tetrahedral elements. Based on the specifications, tetrahedral elements will originate from the point, line, or triangle at a specified density and taper off toward larger elements based on another specification. For the BACT wing, line sources were placed along the leading and trailing edges of the wing, the upper and lower surface locations that correspond to the beginning of the control surface, and along the wing tip. An arrangement of triangular sources lie under the surfaces of the wing and control surface.

Arriving at an optimal grid density is an iterative process. One simply begins with a grid that *seems* right and iterates based on the mesh observed. With this file specified, STARS is able to assemble the mesh for each surface which can then be viewed to get a visual sense of the grid density. The resulting mesh for the BACT wing can be seen in Figure 3-10. This figure contains four different views of the surface mesh. The mesh is dense where one would expect high flow gradients, and less dense where there the flow gradients are not as sharp. Of course, it makes sense to have a more dense grid at the leading and trailing edges, at the wing tip and over the control surface region but the grid density over the upper surface of the wing seems overly dense at first glance. This is explained by the simple fact that the BACT wing was tested at transonic Mach numbers. At a Mach number greater than Mach 0.77, transonic shocks begin to appear on the surface of the wing. As the flap rotates up and down, these shocks also translate across the surface of the wing. During flutter, as the wing pitches and plunges, the location of the shock changes once again. In a full aeroservoelastic simulation where the wing experiences each of the cases mentioned above, the location of the transonic shock can manifest itself at almost any chordwise location. Also, for this relatively low aspect ratio wing, one would expect the three-dimensional effects to be significant.



Figure 3-10: Views Showing Tetrahedral Surface Mesh on the BACT Wing

Therefore, in order to accurately capture the full three-dimensionality of the flow and the location of the transonic shocks, the grid density over the entire surface of the wing must

be kept sufficiently dense. The file containing the specifications on the location and density of the tetrahedral sources is given in Appendix B-2.

What has been constructed thus far are the wing and flow domain lines and surfaces and the surface discretization for each surface. What is lacking now are the three dimensional tetrahedra that will constitute the rest of the computational domain. What we were able to see in Figure 3-10 was the grid density on the wing and wall. Common sense dictates that the more tetrahedra one has in the flow domain, the longer the solution will take to converge. There is, therefore, a tradeoff between a sufficiently dense grid and solution time. The authors of the mesh generation code recommend Equation (3-3) as an approximation of the number of mesh points as a function of the number of surface points [Peiró, Peraire, and Morgan, 1993].

$$N'_p = C \left( N^s_p \right)^n \tag{3-3}$$

Where  $N'_{p}$  = Number of Mesh Nodes

C = Empirical Constant (1.62)

 $N_p^s$  = Number of Surface Nodes

n = Empirical Constant (1.15)

Table 3-2 shows a the number of surface nodes and a comparison between the number of mesh nodes resulting from running the volume generator for the BACT model, and the suggested value from (3-3). Additionally, the number of tetrahedra in the computational domain is 342,469.

Table 3-2: Actual and Suggested Number of Mesh Nodes for STARS Volume

	BACT Model	Suggested by Eq. (3-3)
Surface Nodes	8814	NĂ
Mesh Nodes	63902	55778

The 63,902 mesh nodes compares reasonably well with the 55,778 nodes predicted by Equation (3-3).

# 3.2.2.3 BACT Boundary Condition Specification in STARS

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From 3.1.2 we see that the next step is to run the SETBND routine to define the boundary conditions for lines and surfaces. This routine uses the file, found in Appendix B-3, to specifify walls, far-fields, symmetry planes, singularity lines, etc. STARS uses this data to assign the proper CFD boundary conditions on the nodes adjacent to the specified elements. For the BACT wing, the back wall and all of the wing surfaces are defined as *walls*. The remaining surfaces are defined with *far-field* boundary conditions. Lines along the trailing edge are defined as singularity elements. A singularity line simply defines a region in the CFD model which does not have a well defined normal, such as the trailing edge of the wing, where the upper and lower surfaces end at a sharp point, there is no way to specify a single normal. Ignoring singularities can result in abnormally high flow gradients that tend to *wash-out* the true flow physics.

The last thing that needs to be done is to specify constants that the flow solver will use throughout the solution. This is done using two files. The first is the *CONU* file. This file specifies the number of time-steps to run, the number of *inner-loops* to run at each time step and a host of other parameters. This file is given in Appendix B-4 so only those parameters that are of key interest to running a steady solution for the BACT case are discussed.

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# 3.2.2.4 Effect of the Dissipation Parameters in STARS

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Making use of the inviscid flow assumption can be problematic in the transonic flow regime. Here, transonic shocks on the surface of a wing tend to be weak. With an Euler solver, these shocks tend to be predicted later and more sharply than shown with experimental data. STARS allows the variation of a few control parameters that introduce dissipation into the numerical solution. Changing the values of diss(1) and diss(2) in the file *BACT.CONU*, given in Appendix B-4, had a very significant impact on the pressure distribution prediction. From their default value of 1, the constants were eventually modified to their current value of 3.5. Figure 3-11 shows the predicted pressure contours, with and without modified dissipation constants, compared to those obtained through experiment.



Figure 3-11: Effect of Dissipation Constants on C<sub>p</sub> in STARS CFD Solution

As the figure illustrates, the predicted transonic shock without dissipation is predicted aft of the actual shock and is more sharp in nature. Including dissipation allows for very good agreement between experiment the STARS prediction.

Determination of the best value of the dissipation constants was an iterative process. For the range of Mach numbers at which the BACT wing was tested, the highest value of dissipation that did not cause the solution to go unstable was ~3.5. Dissipation was not noted to improve the solution convergence time, which is discussed in more detail next.

#### 3.2.2.5 Steady-State Solution Convergence Criteria

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As the steady solution starts out from a given free-stream Mach number, the resulting flow-field about the geometry evolves through time. As the solution progresses STARS outputs residual values. These *residuals* are an indication of how much a flow parameter, such as density and velocity have changed since the beginning of the solution. Typically, once the residuals "become small enough", the solution is said to have converged. What was discovered with the BACT wing, however, is that the residuals were not necessarily the best indicators of convergence. The item that ended up being the most convenient indicator of solution convergence was the maximum Mach number. The judgment of when the residuals were *low enough* was too subjective. The maximum Mach number gives a more objective view of solution convergence. To further make this point, a comparison between the two methods is given in Figure 3-12.



Figure 3-12: Solution Convergence Using Residuals and Maximum Mach Number

The picture on the left in the above figure shows how slowly the residual drops for a given case. Even on a log scale, there is no definite solution convergence. The picture on the right, however, clearly shows that the maximum mach number converges to one particular value.

## 3.2.3 BACT Uncertainty Estimation

Before the development of the aeroelastic and aeroservoelastic models are developed, one must consider the experimental uncertainty present in the BACT model. As with any experimental measurement, we expect to see a certain amount of experimental uncertainty. These experimental uncertainties, unfortunately, were not quantified for the BACT model. In an effort to determine estimates for these uncertainties, communication with Mr. Robert C. Scott and Mr. Martin R. Waszak of the NASA Langley Research Center, provided valuable insight into the uncertainty of the measurement techniques.

Since the BACT wing is considered rigid, all of the stiffness terms arrive from the use of the pitch-and-plunge-apparatus (PAPA) [Farmer, 1982]. The wing is reportedly mounted on the PAPA such that the elastic axis is coincident with the geometric center of

the PAPA mount. In the next few paragraphs, estimates in uncertainty are given for the determination of structural mass, stiffness, and damping characteristics, the location of the center of gravity relative to the elastic axis, and determination of dynamic pressure at flutter.

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First, estimates in the uncertainty involved in the determination of structural stiffness and damping is covered. For a two-degree-of-freedom model, the stiffness terms of primary concern are the plunge and pitch stiffness. To measure the plunge stiffness, weights were attached at a location corresponding to the wing's mid-chord. Stiffness was then determined simply by dividing the additional weight by the resulting deflection. Similarly for the pitch stiffness, a known torque was applied about the wing's mid-chord. This known torque was divided by the resulting angular displacement in order to determine the pitch stiffness. Structural damping was determined by exciting the structure in either pitch or plunge and measuring the decay in the free-response.

Generalized mass of the pitch and plunge modes was determined from the resonant in-vacuo natural frequencies. The resonant frequencies were determined by exciting the structure in either pitch or plunge and measuring the number of cycles in a fixed time. Knowing that the natural frequency, stiffness, and mass are related by, (3-4), one can calculate the generalized mass from the measured stiffness and natural frequency. The resulting measurements from the above tests are summarized in Table 3-3. Literature only reports those values in test # 3, the author appreciates the additional data from Mr. Waszak.

$$\omega_n = \sqrt{\frac{k}{m}} \Longrightarrow m = \frac{k}{\omega_n^2}$$
(3-4)

Test #	K <sub>h</sub> (lb/ft)	K <sub>α</sub> (ft·lb/rad)	gh	gα	ω <sub>h</sub> (Hz)	ω <sub>α</sub> (Hz)	M (Slug)	$I_{\alpha}$ (Slug:ft <sup>2</sup> )
1	2659	2897	0.0015	0.0016	3.364	5.257	6.01	2.75
2	2637	2964	0.0015	0.0018	3.360	5.302	6.03	2.70
3	2686	3000	0.0014	0.0010	3.344	5.208	6.08	2.80

Table 3-3: Experimental Measurements in Structural Parameters

Recall that the Benchmark Models Program at NASA Langley involved tests on both a NACA 0012 wing as well as the BACT wing, both tested and mounted on the PAPA with the wing's mid-chord nearly coincident with the elastic axis. The two wings had the same chord, span, airfoil cross-sections, and experimental instrumentation layout. The only external differences that exist are small geometric defects, and the presence of three control surfaces. Internally, a portion of the material had to be removed for the installation of actuators etc. Despite the material removed to add the actuators and spoilers and separate the trailing edge control surface, structural characteristics are very similar between the two. Rivera and others report the values shown in Table 3-4 for the structural properties of the NACA 0012 wing and PAPA mount [Rivera, et al. 1991 & 1992].

K<sub>h</sub> Kα Μ Test ω<sub>h</sub> ωα Iα gh **g**α (lb/ft) (ft·lb/rad) (Hz) (Hz) (Slug) (Slug·ft<sup>2</sup>) 3/92 2659 2897 0.0024 0.0024 3.36 5.20 5.966 2.714 7/91 2697.2 2854.6 0.0034 0.0016 3.40 5.18 5.910 2.7695

Table 3-4: Experimental Measurements in Structural Parameters

Recall that values shown in Table 3-3 were obtained from the BACT wing and PAPA mount. Comparing these values, we see that the tables are very similar. This would seem to indicate that the physical differences between the model should be essentially negligible.

Next, experimental uncertainty in the determination of the center of gravity (CG) relative to the elastic axis (EA) proves to have a *very* significant effect on the prediction of the flutter boundary. In the literature, the CG's location relative to the elastic axis was reported, at best, to be nearly coincident with the mid-chord of the wing. Waszak reports the value of the inertial coupling between the pitch and plunge modes ( $S_{h,\alpha}$ ) as being 0.0142 slug·ft. Using (3-5) below, we can estimate the relative location of the CG to the EA.

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$$S_{\alpha} = m \cdot x_{cg} \tag{3-5}$$

Using the value of  $S_{\alpha}$  reported by Waszak (1996), and the mass, we calculate that the distance from the EA to the CG is 0.028 inches. After communication with Mr. Waszak, he stated that his reported value of 0.0142, which was well within experimental uncertainty, had to be used to account for the slight difference between his computational model and experimental data.

The presumption that the CG and EA are coincident comes from qualitative observations made during testing at the NASA Langley Research Center. When measuring the plunge stiffness, weight was applied at the mid-chord of the wing. During these tests, there was no reported difference in the displacements of the leading and trailing edges indicating the absence of static coupling. Similarly, during measurement of the pitch stiffness, no static coupling was observed. In order to excite the pitch and plunge frequencies, the BACT wing and PAPA mount were excited by an initial deformation that was suddenly removed to allow the structure to vibrate freely. This was done in a manner similar to the static loading, at the mid-chord for plunge and about the mid-chord for pitch. The free vibration of the model excited in this way showed very little pitch motion when excited in plunge in very little plunge motion when excited in pitch. This, of course, implies that the CG must be very close, if not coincident with the mid-chord. As an approximation, the relative location of the CG and the EA was estimated to be no more than 0.1 inches, or 0.625% of the chord.

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From the above data, it is possible to construct a simple model from which we could quickly evaluate the importance of some of the above parameters. Using a simplified aerodynamic model and solving the equations of motion using the p-method, we can quickly solve for the divergence speed. Since the flutter speed can be solved for explicitly in the p-method, parametric studies can be done very quickly. Shown below in Figure 3-13 we see the effect of three different parameters on the flutter prediction.



Figure 3-13: Effect of  $K_h$ ,  $K_a$ , and  $x_{cg}$  Location on Flutter Prediciton

In the above figure, the x axis represents small deviations from nominal values for plunge and pitch stiffness,  $K_h$  and  $K_{\alpha}$ , and  $x_{cg}$ , which is a measure of the distance from the elastic axis to the center of gravity, measured positive aft. As is shown, small changes in both plunge and pitch stiffness effect little change in the flutter prediction,  $\sim \pm 2.5\%$ . Small changes in  $x_{cg}$ , however, influence the flutter prediction significantly. Using the above model, changes in  $x_{cg}$  on the order of 1% can change the flutter prediction by over 20%.

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Now, having the BACT's CG location specified as *nearly coincident* with the elastic axis introduces a slight difficulty in flutter prediction using STARS. For comparison with experimental data, small variations in each of these parameters can add up to large differences in flutter prediction. In addition to all of these differences, there is still the matter of determining the actual flutter point. Looking at time traces of experimental data, it is often difficult to tell exactly when the system is going unstable. Mr. Waszak estimated that the dynamic pressures that defined the flutter boundary were measured to within  $\pm 2$  lb/ft<sup>2</sup>.

Knowledge of these and other uncertainties is fundamental to appreciating the degree to which the computational model can approximate the experimental data. When developing an aeroelastic model, we must assume that the wing is exactly rectangular, perfectly symmetric, its cross-section exactly matches that of a NACA 0012 airfoil, its mass, damping, and stiffness, and the coupling between each, is known precisely, etc. One can quickly appreciate the amount of *tolerance buildup* that is present in the experimental data. These small, relatively unknown, differences translate into a lot of *fine-tuning* of the computational model. In work presented by Waszak, flutter prediction within 7% of experimental data was considered "...pretty good..." [Waszak, 1998].
## 3.2.4 BACT Aeroelastic/Aeroservoelastic Development

From 3.2.1, 3.2.2, and 3.2.3, we now have a solids model with three specified mode shapes, a CFD model, and an appreciation of the experimental uncertainty involved in the aeroelastic data. As developed previously, aeroelasticity is the coupled response of the two aforementioned models. From section 3.2.2 we have the capability of producing a steady CFD solution from which to begin an unsteady simulation. Next, the mode shapes specified in the SOLIDS module for the finite element structural mesh must be interpolated to the CFD mesh. Using the orthogonal property of the natural mode shapes, a superposition of these natural mode shapes can be used to represent an arbitrary structural deformation.

As mentioned previously, if the natural frequencies, mode shapes and other structural properties are known beforehand, they may be entered manually into STARS. Before the interpolation begins, STARS must know which surfaces represent moving boundaries. This is done with information contained inside the file BACT.SCALARS, given in Appendix B-5. This file contains a variety of other parameters of interest to the unsteady solution, but those are not of particular interest and will not be covered. When the interpolation from the SOLIDS mesh to the CFD mesh occurs it creates an *ARRAYS* file. This file contains information regarding the natural frequencies for each mode shape, the generalized mass, stiffness, and damping matrices and nodal displacements for each CFD node which represent nodal displacements on surfaces in the CFD mesh for each mode shape. The BACT case has 3 modes: plunge, pitch, and a control mode that represents the moving control surface. The mass, stiffness, and damping matrices are therefore 3x3 matrices. There are three sets of nodal displacement, or AERO vectors,

one for each mode that specify the generalized displacement of each CFD node for each mode shape. Only the top portion of the BACT.ARRAYS file is given in Appendix B-6 because the file is over 26,000 lines long.

In STARS, the mass, damping and stiffness matrices were manually entered into the BACT.ARRAYS file such that they matched those reported in test #3 for the BACT wing. Since geometric data was entered into stars in units of inches, units of mass are in slinches as opposed to slugs. Where a slug has dimensions of  $lbf \cdot s^2/ft$ , a slinch has dimensions of  $lbf \cdot s^2/in$ . The conversion is, therefore, 1 slinch = 12 slug. Observing the plunge equation we encounter no dimensional conflict within STARS. Noting the moment equation, (3-6)-(3-13), we see the possibility for a slight discrepancy. Beginning with the general equation for the moment in (3-6) we see the following.

$$I\ddot{\alpha} + \beta\dot{\alpha} + K\alpha = M \tag{3-6}$$

The moment is simply the integral of The moment is simply the integral of the pressure times the mode shape, so substituting this into (3-6) we arrive at (3-7).

$$I\ddot{\alpha} + \beta\dot{\alpha} + K\alpha = \int p\phi dx \tag{3.7}$$

In STARS, however, we have the following definition, shown in (3-8).

$$\int p\phi dx = M\alpha_0 = \alpha_0 \int p\phi dx \tag{3.8}$$

Where  $\alpha_0$ , is the generalized pitch displacement of 1°. Rearranging the equations, we get STARS definition of the pitch moment in (3-9).

$$\alpha_0 I \ddot{\alpha} + \alpha_0 \beta \dot{\alpha} + \alpha_0 K \alpha = \int p \phi dx \tag{3.9}$$

Solution of (3-9) assumes  $\alpha$  in units of radians, so using (3-10) we must convert the angular displacements and velocities displacements into dimensional form consistent with the generalized displacement.

$$\alpha = \frac{\pi}{180}q = \alpha_0 q \tag{3.10}$$

We can now substitute this relation back into (3-9) and obtain (3-11).

$$\alpha_0 I\left(\frac{\pi}{180}\ddot{\alpha}\right) + \alpha_0 \beta\left(\frac{\pi}{180}\dot{\alpha}\right) + \alpha_0 K\left(\frac{\pi}{180}\alpha\right) = \int p\phi dx \qquad (3-11)$$

Now, units are consistent on both the left and right-hand sides and can be arranged into a more convenient form, shown in (3-12).

$$\left(\alpha_0 \frac{\pi}{180}I\right) \ddot{\alpha} + \left(\alpha_0 \frac{\pi}{180}\beta\right) \dot{\alpha} + \left(\alpha_0 \frac{\pi}{180}K\right) \alpha = \int p \phi dx \qquad (3-12)$$

Remembering that the generalized pitch displacement was 1° or  $\pi/180$  radians we can go ahead and multiply the generalized displacement by the  $\pi/180$  factor and obtain (3-13).

$$\left(\frac{\pi^2}{180^2}I\right)\ddot{\alpha} + \left(\frac{\pi^2}{180^2}\beta\right)\dot{\alpha} + \left(\frac{\pi^2}{180^2}K\right)\alpha = \int p\phi dx \qquad (3-13)$$

Since generalized displacements for the wing and flap are specified as 1°, parameter entry into the system matrices within STARS requires a pre-multiplication by  $\pi^2/180^2$ . Note that this problem was not encountered for the plunge degree of freedom since both the generalized displacement and mode-shape are in inches.

Shown below in (3-14) is the mass matrix that is entered into the *BACT.ARRAYS* file. Notice that rows 2 and 3 are pre-multiplied by the  $\pi^2/180^2$  scaling factor.

$$\begin{bmatrix} m & S_{h,\alpha} & S_{h,\delta} \\ \frac{\pi^2}{180^2} S_a & \frac{\pi^2}{180^2} I_a & \frac{\pi^2}{180^2} S_{\alpha,\delta} \\ \frac{\pi^2}{180^2} S_{h,\delta} & \frac{\pi^2}{180^2} S_{\alpha,\delta} & \frac{\pi^2}{180^2} I_{\delta} \end{bmatrix}$$
(3-14)

Where: m — Generalized Mass (Plunge)

 $I_{\alpha}$  — Generalized Mass (Pitch)

 $I_{\delta}$  — Generalized Mass (Control Surface)

 $S_{h,\alpha}$  — Plunge-Pitch Inertial Coupling Term

 $S_{h,\delta}$  — Plunge-Control Surface Inertial Coupling Term

 $S_{\alpha,\delta}$  — Pitch-Control Surface Inertial Coupling Term

Similarly, the damping matrix is shown in (3-15):

$$\begin{bmatrix} g_h & 0 & 0 \\ 0 & \frac{\pi^2}{180^2} g_\alpha & 0 \\ 0 & 0 & \frac{\pi^2}{180^2} g_\delta \end{bmatrix}$$
(3-15)

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Where  $g_h$  — Generalized Plunge Damping

 $g_{\alpha}$  — Generalized Pitch Damping

 $g_{\delta}$  — Generalized Control Surface Damping

In the above relationships, g is defined to be  $M \cdot 2 \cdot \zeta \cdot \omega_n$ , where M,  $\zeta$ , and  $\omega_n$  are the appropriate generalized mass, damping, and natural frequency.

$$\begin{bmatrix} k_{h} & 0 & 0 \\ 0 & \frac{\pi^{2}}{180^{2}}k_{\alpha} & 0 \\ 0 & 0 & \frac{\pi^{2}}{180^{2}}k_{\delta} \end{bmatrix}$$
(3-16)

As mentioned earlier, the uncertainty present in the BACT affects the values that are entered into (3-14) to (3-16). From the sensitivity study, we saw that the most sensitive uncertainty exists in the specification of the pitch-plunge coupling term  $S_{\alpha}$  since this related directly to  $x_{cg}$  as discussed in the previous section. Final system matrices were obtained after *fine-tuning* the parameters and are given in Table 3-5.

Table 3-5: BACT Model Parameters in STARS

Generalized Mass Matrix		
0.50667	0.0506667	0.00288
0.154339×10 <sup>-4</sup>	0.0102350	0.57390×10 <sup>-5</sup>
0.877298×10 <sup>-5</sup>	0.57390×10 <sup>-5</sup>	0.40134×10 <sup>-1</sup>

Generalized Damping Matrix		
0.029819	0.0	0.0
0.0	0.66985×10 <sup>-3</sup>	0.0
0.0	0.0	0.0

Generalized Stiffness Matrix

0.223833×10 <sup>3</sup>	0.0	0.0
0.0	0.109500×10 <sup>2</sup>	0.0
0.0	0.0	0.1096623×10 <sup>4</sup>

#### 3.2.4.1 Time-Step Definition in STARS

The time-step used in STARS is computed using (3-17) where the parameters *freq* and *nstpe* are defined in the *CONU* file, *M* is the free-stream Mach number and *a* is the sonic velocity.

$$dt = \frac{2\pi}{freq \cdot nstpe \cdot (M \cdot a)}$$
(3-17)

Until recently, there has been no prescribed method of determining the time-step. A generally accepted rule-of-thumb was to make certain that at a single period of oscillation at the highest frequency was made up of at least 30-40 time-steps. For supersonic cases,

this seems to work just fine. In subsonic flow, however, wake effects are propagated throughout the entire computational domain. More recently, *freq*, is defined to be similar to the highest natural frequency in the SOLIDS model. The parameter *nstpe* can then be thought of as the number of time steps per period of oscillation. One can also look at this another way. In STARS, the default value of *nstpe* is 1. Instead of letting *freq* represent the highest frequency, it may be arbitrarily set such that one obtains an equivalent timestep within STARS. Either method works equally well, but letting *freq* represent a true frequency and increasing the number of steps per period (*nstpe*), makes more intuitive sense.

For proper flow dynamics, the user is concerned with the number of *inner* CFD iterations per time step (*ncycl*), and the length of the time-step. A recent investigation in STARS with a simple NACA 0012 airfoil provided valuable insight into the relative importance of *ncycl* and *dt*. The study was done using the problem of a suddenly accelerated wing in subsonic flow (Wagner Problem) where the lift and drag are time-evolving parameters. While changing the parameters *ncycl* and *dt*, plots of the changing lift were obtained and plotted vs. a non-dimensional time parameter. Each of the following plots were obtained for an impulsively started NACA 0012 airfoil at Mach 0.3 at  $\alpha$ =5°.

As Figure 3-14 demonstrates, for a given value of *ncycl* the time varying lift is highly dependent on the size of the time-step. The disadvantage of going with a small time step is, of course, the fact that it will require additional computational time to run an equivalent job which incorporates the larger time step.

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Another option is to keep the time-step the same, but let the CFD solver perform more iterations at each time-step. This case is demonstrated in Figure 3-15 where we see the effect of time step on differing values of *ncycl*. Shown here is, again, a high degree of sensitivity to the size of the time-step for a given value of *ncycl*. For the time-step of 0.1 in the upper plot, changing the value of *ncycl* shows a definite effect. The lower plot shows that for a much smaller time step, 0.025, the plots of Cl vs. t\* are virtually identical despite the fact that values of *ncycl* differ by a factor of 4. The conclusion, therefore, is that the importance of a *small* time-step outweighs the importance of increasing the number of CFD iterations per time-step.



Figure 3-14: Effect of Time-Step at Two Different Values of *ncycl* on the Lift Evolution for an Impulsively Started NACA 0012 Airfoil at Mach 0.3,  $\alpha$ =5°



Figure 3-15: Effect of *ncycl* with at Two Different Time-Steps on the Lift Evolution for an Impulsively Started NACA 0012 Airfoil at Mach 0.3,  $\alpha$ =5°

To begin the ASE simulation, we must have first generated the *ARRAYS* file and completed a steady state CFD solution at the reference Mach number. Once the parameters are set in the *SCALARS* file, and the *CONU* file is configured properly, an ASE solution may be started. The length of the solution is determined primarily by parameters in the *CONU* file. There are a lot of parameters set in this file, but for the

ASE simulation, we are primarily concerned with the values of *nstep* and *ncycl*. The total number of time-steps is specified with *nstep*. The number of inner CFD iterations per time step is specified with *ncycl*. For instance, with *nstep* = 500, and *ncycl* = 40, the ASE simulation would last for a total of 500 *outer* time steps. At each *inner* time-step, 40 CFD iterations are allowed for the computation of the new aerodynamic forces. All together, these parameters specify that  $500 \times 40$  CFD iterations.

#### 3.2.4.2 Modal Identification Technique

With each CFD iteration taking on the order of 30 seconds, we quickly see how time-consuming these ASE simulations are. For the BACT, the *nstep* and *ncycl* were generally 5000 and 40. Assuming 30 seconds per CFD step and doing the math, we estimate that an EULER solution for a single transient may take on the order of 69 days on an IBM RS6000 3BT. The general procedure required that the solution be monitored and when the time-histories *looked* to be going unstable, assume that is the flutter point and kill the solution. The nature of the BACT system makes this method impractical. Observe the following figure which is a portion of an actual time-history obtained from STARS.



Figure 3-16: Abbreviated Time-History of BACT Wing in STARS

From Figure 3-16, it appears that the solution is going unstable. Typically, that would have been considered *good enough* but allow the solution to continue for the full 5000 time-steps and we obtain the following time-history.



Figure 3-17: Complete 5000-Step Time-History of BACT Wing in STARS

Allowing the solution to continue for the full 5000 steps, Figure 3-17 shows that mode 1 exhibits a slight amount of damped-beating while mode 2 is lightly damped, therefore not

yet at the flutter point. Beyond visual interpretation, a modal identification technique provides damping characteristics for each structural mode [Eckhart, 1998]. Given a timehistory from STARS, this tool provides the user with both a damping frequency and damping factor.

## 3.2.4.3 System Identification Technique

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For each flutter point, one must generally take a trial-and-error approach in the determination of the flutter point. Trials are made until dynamic pressures on each side of the flutter point are obtained. This is, of course, very time consuming. The determination of a complete flutter boundary for a problem of this type could easily take several months. Recent work by Cowan, allows the use of a system identification procedure to model the coupled structural/CFD system. [Cowan, 1998]. This has the significant benefit of accelerating the time required for a full ASE simulation. Essentially eliminating the CFD solver, which makes up the vast majority of time during a coupled simulation, and replacing it with an algebraic transfer function reduces ASE run-times from days and months to minutes. For the same 5000 step solution described previously, an ASE simulation is obtained in about 5 minutes, as opposed to 69 days.

This system identification procedure is currently implemented into the STARS and provides a very accurate prediction of the full Euler solution. To model the system, each mode is displaced from an initially steady-state CFD solution through a known input referred to as a multi-step. Forcing the CFD model with these known modal inputs during an Euler solution allows STARS to compute the aerodynamic forces due to these known inputs. The system identification procedure then constructs an ARMA model based on the known inputs and resulting outputs. Once the system is modeled, the Euler aerodynamic solver is essentially "replaced" with a much faster system of algebraic equations.

The multi-step sequence used on the BACT wing is given in Figure 3-18 and specified with parameters in the *SCALARS* file. The duration of the multi-step is determined by the following equation: 5 + isize(4nr + 3), where *isize* is the magnitude of the multi-step and *nr* are the number of modes to be excited. For the BACT, *isize* and *nr* were generally set as 10 and 3, respectively resulting in a duration of 155 time-steps. The actual CFD solution extended to 240 time-steps to insure that all of the aerodynamics have enough time to come to steady-state values.



Figure 3-18: Multi-Step Sequence for the BACT Wing (3-Modes)

Notice that each mode is forced to undergo a displacement resulting from a specified velocity. These displacements and velocities, through the transpiration method, are implemented as unsteady boundary conditions in the CFD flow solver. The resulting aerodynamic forces and moments resulting from this sequence of events are then modeled. The extent to which these models actually fit the data is described in more detail in Chapter 4, but Figure 3-19 shows a comparison of the actual and modeled response to the multi-step shown previously.

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Figure 3-19: Modeled and Actual Response to Multi-Step Input

Similar results are obtained for all other Mach numbers under consideration and are given in Chapter 4. Further validation and references are found in the original work by Cowan.

## 3.2.4.4 Control Law Development

The final objective of the current work is to use the trailing edge control surface on the BACT wing as a means of flutter suppression. In a paper by Waszak, the BACT wing is modeled at Mach 0.77 in a MATLAB program [Waszak, 1996-97]. The program developed essentially provides the user with a state-space representation of the BACT/PAPA system at a user-defined q at Mach 0.77. Using only a portion of the program, models of the BACT/PAPA system were obtained at three different dynamic pressures: a little below, close to, and beyond the flutter point. The resulting state-space system was then condensed down into a single *group* in SIMULINK. Shown in Figure 3-20 is the complete model developed with its core element being the q-dependant statespace model obtained from the MATLAB program.



Figure 3-20: MATLAB/SIMULINK<sup>®</sup> Model of BACT with Control

While looking complicated, this is a relatively simple block diagram of the entire system. The entire diagram basically consists of four parts: state inputs and outputs, disturbance inputs, controllable and control surface inputs, and a means of viewing the output. In the center of the diagram is the BACT/PAPA system with its associated inputs and outputs. In the upper right are the disturbance inputs from which one may *disturb* pitch, plunge, and a host of other parameters. The upper left of the figure is essentially the control portion of the diagram, where the deflection of the control surface is controlled through simple P, PI, PD, or PID control based on pitch and/or plunge rates or displacements. Left of center are separate control surface inputs. If control is turned off, arbitrary control surface displacements, sine waves etc., can be input into the system. The lower right-hand-side of the figure contains blocks that display pitch, plunge, and control surface deflection as a function of time. This tool was used to gain an understanding of the effectiveness of different control laws before their implementation into STARS.

Shown below in (3-18) and (3-19) are the equations for lift and moment of the BACT/PAPA system employed in the model shown above.

$$L = qSC_L = qS\left[C_{L_0} + C_{L_a}\alpha + C_{L_b}\delta + \frac{\overline{c}}{2U_0}\left(C_{L_a}\dot{\alpha} + C_{L_b}\dot{\theta} + C_{L_b}\dot{\delta}\right)\right]$$
(3-18)

$$M = qS\overline{c}C_{M} = qS\overline{c}\left[C_{M_{u}} + C_{M_{a}}\alpha + C_{M_{b}}\delta + \frac{\overline{c}}{2U_{0}}\left(C_{M_{a}}\dot{\alpha} + C_{M_{q}}\dot{\theta} + C_{M_{b}}\dot{\delta}\right)\right] \quad (3-19)$$

Static aerodynamic parameters were obtained from experimental data and previous windtunnel experiments, force and moment data at various angles of attack and control surface positions were used to compute most of the stability and control derivatives, while dynamic derivatives were obtained from computational analysis. Parameters unknown or unavailable were assumed to be zero. Though simplified through modeling assumptions, the model proved to be a very useful tool in obtaining quick qualitative data regarding flutter suppression using the trailing edge control surface. Despite the quality of this data, the majority of ASE simulation was conducted in STARS since the modeling simplifications are not a limiting factor. Of particular interest are the additional aerodynamic mass and damping terms that result from the plunging motion of the wing and the effect on lift and moment due to the rate at which the control surface deflects.

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In general, any control law will have as its output a desired flap position. Waszak reports the control surface actuator's transfer function as (3-20) where k (1.02 deg/deg) is the actuator gain,  $\zeta$  (.56) is the damping ratio,  $\omega$  (rad/sec) is the natural frequency,  $\delta_s$  is the desired control surface deflection, and  $\delta$  is the actual resulting deflection.

$$\frac{\delta}{\delta_s} = \frac{k\omega}{s^2 + 2\varsigma\omega s + \omega^2}$$
(3-20)

For our purpose, however, it is more convenient to move from the frequency domain back to the time domain. The corresponding differential equation is shown in (3-21).

$$\ddot{\delta} + 2\varsigma\omega\dot{\delta} + \omega^2\delta = k\omega^2\delta_s \tag{3-21}$$

To begin putting the above equation into state-space format, we'll make the following substitutions:  $x_1 = \delta$  and  $x_2 = \dot{\delta} = \dot{x}_1$ . Taking derivatives of these equations results in the following:  $\dot{x}_1 = \dot{\delta} = x_2$  and  $\dot{x}_2 = \ddot{\delta} = \ddot{x}_1$ . Using these relationships, we re-write (3-21) in the following form:  $\dot{x}_2 + 2\varsigma \omega x_2 + \omega^2 x_1 = k\omega^2 \delta_x$ . We now have two first-order differential equations which we can write in state-space format, see (3-22).

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -\omega^2 & -2\varsigma\omega \end{bmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} + \begin{pmatrix} 0 \\ k\omega^2 \delta_s \end{pmatrix}$$
(3-22)

To actually implement these equations into STARS, the time-derivatives are replaced by the following relationships shown in (3-23) and (3-24) where *n* is the current value, and *n-1* represents past values.

$$\frac{x_1^n - x_1^{n-1}}{\Delta t} = x_2^{n-1}$$
(3-23)

$$\frac{x_2'' - x_2''^{-1}}{\Delta t} = k\omega^2 \delta_s - 2\varsigma \alpha x_2''^{-1} - \omega^2 x_1''^{-1}$$
(3-24)

Solving each for the current values of  $x_1$  and  $x_2$  yields (3-25) and (3-26).

$$x_1^n = x_1^{n-1} + x_2^{n-1} \Delta t \tag{3-25}$$

$$x_{2}^{n} = \left(k\omega^{2}\delta_{s} - 2\varsigma\omega x_{2}^{n-1} - \omega^{2}x_{1}^{n-1}\right)\Delta t + x_{2}^{n-1}$$
(3-26)

Up till this point, the desired control surface position has been arbitrary. For our purpose, the desired flap angle will be a function of plunge displacement and velocity, and angular displacement and velocity. The resulting control law is shown in (3-27), where the gains  $K_i$  are not necessarily absolute. Given the range of Mach numbers, it is assumed that some sort of gain-scheduling, based on both Mach number and dynamic pressure, is needed.

$$\delta_s = K_1 h + K_2 \dot{h} + K_3 \theta + K_4 \dot{\theta} \tag{3-27}$$

The resulting gains and time-histories for a variety of Mach numbers are described further in Chapter 4.

#### **CHAPTER 4**

#### RESULTS

It is the intent of the current effort to demonstrate the effectiveness of the transpiration method in its application to steady and unsteady flow conditions. Based on these results, the implementation of a discrete-time control law within STARS is discussed in regard to active flutter-suppression for the BACT wing. In a logical series of steps, this chapter will present results starting with steady-flow simulations, which include the effects of a deflected control surface, eventually leading up to both the open and closed-loop aeroservoelastic response. Where available, comparisons are made to experimental data.

## 4.1 Steady Results Without Control Surface Deflections

The starting point of all unsteady cases in STARS, the steady state solution, must be fully converged before starting an unsteady job. For the final CFD mesh on the BACT wing, the steady solution was run for 3000 steps to assure that the solution had, in fact, converged to a steady state value. Convergence was assured using the maximum Mach number criterion discussed in section 3.2.2.5. Experimental data are available for the majority of test cases discussed in this section.

Remembering that the BACT CFD model is actually the CFD model for both the NACA 0012 wing as well as the BACT wing, the differences between the two should be

noted here. With an undeflected control surface, there should be no difference between the two models since they are geometrically similar. Aside from slight manufacturing differences, however, the two models were tested in a different fluid medium. The NACA 0012 wing was tested in air ( $\gamma$ =1.4) and the BACT wing was tested in R-12 ( $\gamma$ =1.148). As far as the calculation of the pressure coefficient is concerned, the value of the ratio of specific heats,  $\gamma$ , acts only as a scaling factor in steady simulations. Experimental steady data presented here comes from pressure transducers located at the NACA 0012 wing's 60% span [Rivera, et al, 1992]. More significant later, this 60% span location corresponds to a distance of 19.2 inches from the wings root which, for the BACT wing, corresponds to the mid-span of the control surface.

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The next six figures, Figure 4-1 to Figure 4-6, show steady pressure data obtained at Mach numbers of 0.51, 0.67, 0.71, 0.77, 0.80, and 0.82, respectively. Each figure shows pressure data at an angle of attack of 0°, with a control surface deflection of 0°. As each of the figures shows, agreement between predicted and experimental data is very good, even at the higher transonic Mach numbers. Typically, as was briefly mentioned in Chapter 2, Euler flow solvers over-predict both the location and strength of transonic shocks. One common factor in each of the figures seems to be the fact that STARS tends to predict a slightly higher suction peak, though still within the upper range of the experimental scatter.

The BACT wing's critical Mach number appears to be  $\sim 0.77$  which coincides with that of a NACA 0012 airfoil. At this point, flow accelerates from the free-stream Mach number of 0.77 to just sonic on the surface of the wing. Cases run at Mach numbers greater than 0.77 clearly show the existence of these transonic shocks.



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Figure 4-1: Steady Chordwise Pressure at Mach 0.51,  $\alpha=0^{\circ}$ ,  $\delta=0^{\circ}$ , 60% Span



Figure 4-2: Steady Chordwise Pressure at Mach 0.67,  $\alpha=0^{\circ}$ ,  $\delta=0^{\circ}$ , 60% Span



Figure 4-3: Steady Chordwise Pressure at Mach 0.71,  $\alpha=0^{\circ}$ ,  $\delta=0^{\circ}$ , 60% Span



Figure 4-4: Steady Chordwise Pressure at Mach 0.77,  $\alpha=0^{\circ}$ ,  $\delta=0^{\circ}$ , 60% Span



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Figure 4-5: Steady Chordwise Pressure at Mach 0.80,  $\alpha=0^{\circ}$ ,  $\delta=0^{\circ}$ , 60% Span



Figure 4-6: Steady Chordwise Pressure at Mach 0.82,  $\alpha=0^{\circ}$ ,  $\delta=0^{\circ}$ , 60% Span

Also accounting for the slight difference between predicted and experimental data is a transition strip running approximately one inch from the leading edge of the wing. There were no quantified uncertainties presented for these data, but judging from the scatter in the pressure data, STARS predicts pressures that lie well within the experimental scatter over the entire range of Mach numbers. Scatter is particularly evident in Figure 4-5.

Solutions in the vicinity of Mach 0.77 took the most time to converge. At, and slightly beyond, Mach 0.77 when shocks first begin to appear, solution convergence is hampered as STARS resolves the location of the transonic shock. For lack of a better term, the location of the shock seems to *dance* around a narrow portion of the wing's surface. Though not a problem for the steady case, per-se, a lack of resolution in the shock locations could pose a problem with the unsteady flow solution. Addressed later, the solution to this obstacle is to make sure that plenty of iterations are allowed for the solution to completely converge at each solution time-step.

## 4.2 Steady Results With Control Surface Deflections

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The steady results presented above did not have to make use of the transpiration boundary condition. For the case of a steady control surface deflection, there will be the first actual application of the transpiration method thus far in this study. To show the effectiveness of the transpiration method, a couple of different comparisons must be made independent of one another. First, pressure distributions and contours are compared for the case of a physical and transpired control surface deflection. Second, resulting pressure data for a simulated control surface deflection is compared to experimental data from the BACT wing.

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# 4.2.1 Steady Solutions for Transpired and Actual Control Surface Deflections

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Recall that a CFD model for an actual control surface deflection was constructed in addition to the standard CFD mesh for the wing. For purposes of comparison, a 10° control surface deflection is compared to that of a simulated 10° deflection angle. The 10° deflection angle was used to illustrate the effectiveness of the transpiration method for relatively large surface deflections. Shown below in Figure 4-7 is a comparison between the deflected and un-deflected CFD grids.



Figure 4-7: Comparison of Actual and Simulated 10° Control Surface Deflections

In the above figure, one can clearly see the extent of the flap deflection An Euler solver would not be expected to detect or account for the likely separation and boundary layershock interaction for such a large control surface deflection. The comparison with this large control surface deflection is, therefore, used to demonstrate that the transpiration method is as accurate as the limitations imposed by the inviscid flow assumption.

The first comparison of an actual and simulated control surface deflection is at Mach 0.77, 0° angle of attack, and 10° (downward) flap deflection. A qualitative comparison of the pictures in Figure 4-8 shows very good agreement between an actual and simulated control surface deflection. A more quantitative comparison can be made

with a comparison of the steady pressure distributions at the 60% span location, which corresponds to the  $\frac{1}{2}$  span of the control surface.

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Figure 4-8: Surface Pressure Contours at Mach 0.77, 10° Control Surface Deflection



Figure 4-9: Comparison of Predicted Pressure Distributions for an Actual and Simulated  $10^{\circ}$  Control Surface Deflection at Mach 0.77,  $0^{\circ} \alpha$ 

Figure 4-9 shows the excellent quantitative agreement between the predicted pressure distribution for the actual and simulated control surface deflection. With only

the slight discrepancy located at the x/c location which corresponds to the wing/control surface interface. The rest of the data points essentially lie directly on top of one-another. The resulting differences in lift and moment predictions will also be small enough to be considered insignificant.

At a slightly higher Mach number, Mach 0.82, similar results are presented. From Figure 4-10 we again good qualitative agreement is seen between the pressure contours not only on the wing, but out to the wall as well. Except for the fact that one can actually see a physical deflection in the picture on the left, there is essentially no visual difference. Quantitative agreement is again evaluated with the comparison of pressure distributions at the 60% span location, see Figure 4-11. As was seen at Mach 0.77, the only noticeable discrepancy between the pressure distributions is again at the same location, the wing/control surface interface. One also notes the significant three dimensional effects that are captured as well.



10° Actual Deflection10° Simulated DeflectionFigure 4-10: Pressure Contours at Mach 0.82, 10° Control Surface Deflection

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Figure 4-11: Comparison of Predicted Pressure Distributions for an Actual and Simulated 10° Control Surface Deflection at Mach 0.82,  $0^{\circ} \alpha$ 

The point as been made that the pressure distributions match well across the chord, but what about the significant three-dimensionality of the flow at the trailing edge. With a control surface deflection, one would expect to see counter-rotating vortices generated at the control surface edges, such as the vortices at the wing tip. Similar to the way pressure data is obtained, STARS can also look at velocity vectors through a *slice* in the computational domain. Shown in Figure 4-12 are velocity contours as seen looking at the trailing edge towards the leading edge. The difference between the two pictures comes after close inspection of the trailing edge in the region of the control surface. In the top picture, one can see a physical discontinuity where the trailing edge of the control surface has actually separated from the rest of the wing. These figures clearly show that the transpiration method does an excellent job of capturing all of the flow physics.



Figure 4-12: Cross-Flow Velocity Vectors at the Trailing Edge of the BACT Wing With an Actual and Simulated 10° Control Surface Deflection

What has been shown thus far are results confirming that STARS provides an accurate prediction of steady pressures on an undeformed wing. This is verified with a comparison to experimental results. Next, the pressures obtained from a simulated control surface were shown to be at least as accurate, within engineering accuracy, as those obtained from an actual control surface deflection. Next, we'll see the extent to

which the simulated flap deflection matches experimental data. The fact that all of the following experimental data is compared to a simulated flap deflection using the transpiration method in STARS must be reiterated. Once the solution converged, the scalar multiple of the generalized control surface deflection was changed and another simulation started almost immediately.

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# 4.2.2 Steady Solutions for Transpired Control Surface Deflections Compared With Experimental Data

Beginning at Mach 0.77 comparison with experimental data is shown for control surface deflections of 2°, 5°, and 10°. Figure 4-13-Figure 4-15 again show chordwise pressure distributions at the 60% span location. One again observes very good agreement for both the 2° and 5° control surface deflections. Minor differences in peak suction are observed, but again not far from the experimental scatter. Slight differences can also be accounted for due to small deviations from nominal values of Mach number, angle of attack, and control surface deflection angle. Table 4-1-Table 4-3 show comparisons of nominal values used in STARS with actual experimental values.

	STARS	Experiment
Mach #	0.77	0.771
Angle of Attack (°)	0.0	0.0304
Control Surface Angle (°)	2.0	1.9594

Table 4-1: Nominal and Actual Parameters for Mach 0.77,  $\alpha=0^{\circ}$ ,  $\delta=2^{\circ}$ 

Table 4-2: Nominal and Actual Parameters for Mach 0.77,  $\alpha=0^{\circ}$ ,  $\delta=5^{\circ}$ 

	STARS	Experiment
Mach #	0.77	0.768
Angle of Attack (°)	0.0	0.0306
Control Surface Angle (°)	5.0	4.9647

	STARS	Experiment
Mach #	0.77	0.767
Angle of Attack (°)	0.0	0.0311
Control Surface Angle (°)	10.0	9.9534

Table 4-3: Nominal and Actual Parameters for Mach 0.77,  $\alpha=0^{\circ}$ ,  $\delta=10^{\circ}$ 

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For the 10° deflection we see, for the first time, pressure data that agrees poorly in the region of the control surface. As was expected with the utilization of an Euler code, the obvious viscous effects due to boundary layer and shock interactions cannot be accounted for. The 10° case has been used primarily to show comparison between actual and simulated control surface deflections within STARS. A realistic prediction can be expected for control surface deflections of ~7° or 8°, which would still be considered large for control applications. As mentioned previously, this is a limitation of the inviscid flow solver, *not* the transpiration method.



Figure 4-13: Comparison of Predicted and Experimental Chordwise Pressure Distributions at Mach 0.77,  $\alpha=0^{\circ}$ ,  $\delta=2^{\circ}$ 



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Figure 4-14: Comparison of Predicted and Experimental Chordwise Pressure Distributions at Mach 0.77,  $\alpha = 0^{\circ}$ ,  $\delta = 5^{\circ}$ 



Figure 4-15: Comparison of Predicted and Experimental Chordwise Pressure Distributions at Mach 0.77,  $\alpha=0^{\circ}$ ,  $\delta=10^{\circ}$ 

Similar to the results presented above for Mach 0.77, chordwise pressure distributions at Mach 0.82 for control surface deflections of 2°, 5°, and 10° are presented in Figure 4-16-Figure 4-18. As before, differences exist between nominal values of Mach number, angle of attack and control surface deflection. Table 4-4-Table 4-6 again show a comparison between the nominal values used in STARS and those actually seen in experiment. The tables also serve to show that differences between nominal and desired parameters as well as small geometric anomalies account for a portion of the variations seen between computational predictions and experimental data.

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Table 4-4: Nominal and Actual Parameters for Mach 0.82,  $\alpha=0^{\circ}$ ,  $\delta=2^{\circ}$ 

	STARS	Experiment
Mach #	0.82	0.81753
Angle of Attack (°)	0.0	0.0288
Control Surface Angle (°)	2.0	1.7017

Table 4-5: Nominal and Actual Parameters for Mach 0.82,  $\alpha=0^{\circ}$ ,  $\delta=5^{\circ}$ 

	STARS	Experiment
Mach #	0.82	0.81993
Angle of Attack (°)	0.0	0.0291
Control Surface Angle (°)	5.0	4.7044

Table 4-6: Nominal and Actual Parameters for Mach 0.82,  $\alpha=0^{\circ}$ ,  $\delta=10^{\circ}$ 

	STARS	Experiment
Mach #	0.82	0.81824
Angle of Attack (°)	0.0	0.03
Control Surface Angle (°)	10.0	9.6813

As is characteristic for Euler solvers in this particular range of Mach numbers, the transonic shock is predicted slightly aft of the position shown experimentally. As with Mach 0.77, the 2° and 5° control surface deflection angles are in reasonable agreement

with experiment. Again, the 10° deflection angle induces boundary layer-shock interactions that cannot be resolved within the inviscid flow assumption.

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Figure 4-16: Comparison of Predicted and Experimental Chordwise Pressure Distributions at Mach 0.82, α=0°, δ=2°

One would expect similar results for other Mach numbers. Mach 0.77 and Mach 0.82 were chosen due to the unique complexities present with each. Mach 0.77 was shown to be the approximate critical Mach number, and Mach 0.82 highlights the significant three-dimensional effects introduced with a control surface deflection. Results would be expected to be as good, if not better, than those shown above for Mach numbers lower than 0.77 due to the limited existence of transonic shocks.



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Figure 4-17: Comparison of Predicted and Experimental Chordwise Pressure Distributions at Mach 0.82,  $\alpha = 0^{\circ}$ ,  $\delta = 5^{\circ}$ 



Figure 4-18: Comparison of Predicted and Experimental Chordwise Pressure Distributions at Mach 0.82,  $\alpha=0^{\circ}$ ,  $\delta=10^{\circ}$ 

#### 4.3 Aeroelastic Results

Up to this point, results have focused on the comparison of steady data obtained in STARS compared with experimental data. Steady cases, with no control surface deflections showed good agreement at all Mach numbers, and simulated control surface deflections of 2° and 5° at both Mach 0.77 and 0.82 agreed reasonably well with experimental data. The next logical step is to investigate the flutter prediction as obtained using STARS compared to that predicted experimentally.

4.3.1 Unsteady Data for the BACT and NACA 0012 Wings Tested at Langley

Shown in Figure 4-19 is a comparison of the experimental flutter boundaries obtained for both the NACA 0012 wing tested in air, and the BACT wing tested in R-12.



Figure 4-19: Flutter Boundary Comparison Between 2 Geometrically Similar Wings: NACA 0012 Wing (Air) & BACT Wing (R-12)

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Except for Mach numbers in the narrow range of 0.77-0.80, there exists small differences in the flutter boundary predictions.

Differences could exist for several reasons. First, the models were tested in a different fluids, air and R-12. R-12 is often used in transonic and supersonic tunnels as a means of obtaining higher Reynolds and Mach numbers. For similar power input, the Mach number can be increased by a factor of 2.5 while the Reynolds number can be increased by a factor of 3.6 [Pope, 1954]. As was described in 3.2.3, the relative location of the center of gravity and elastic axis plays a significant role in the flutter characteristics. Any slight difference in the way these models were mounted would most likely be amplified here.

## 4.3.2 System Identification Parameters and Effectiveness

As was discussed in Chapter 3, STARS flutter prediction was accelerated using a system identification procedure. Good agreement, as one would imagine, is directly a function of how well the model matched the Euler prediction given the same multi-step input. The parameters, *Na* and *Nb* are specified at the end of the *SCALARS* file. Once the Euler multi-step is complete, the *Na* and *Nb* parameters specify the order of the ARMA model used in the system identification procedure. As suggested by Cowan, a general rule of thumb is that *Nb* should always be greater than *Na* to ensure a stable model. Summarized in Table 4-7 are the model parameters, *Na* and *Nb*, and the scaled RMS errors that indicate the degree to which the model successfully duplicated the full Euler solution.

Mach	Na	Nb	Scaled RMS Error						
			(1)	(2)	(3)				
0.51	4	11	0.457E-2	0.678E-2	0114E-1				
0.67	4	10	0.686E-3	0.122E-2	0.605E-3				
0.71	4	13	0.727E-3	0.170E-2	0.119E-2				
0.77	3	11	0.551E-4	0.433E-4	0.117E-2 0.217E-4				
0.80	4	12	0.637E-3	0.318E-2	0.189E-2				
0.82	4	12	0.709E-3	0152E-2	0.240E-2				

Table 4-7: Model Orders and Associated RMS Errors at Various Mach Numbers

To more fully appreciate the ability to model the actual system, Figure 4-20 to Figure 4-25 show a superposition of the model and Euler solution obtained using the multi-step sequence. This multi-step sequence is used to *train* the system model based on the generalized forces resulting from a known input. Plotted are generalized forces vs. dimensional time where *GF1*, *GF2*, and *GF3* are measures of the lift, pitch moment, and control surface hinge moment, respectively. For a fixed control surface position ( $\delta$ =0°), generalized force 3 does not actually get used in the model for determining the conventional flutter boundary since the control surface is held stationary during the aeroelastic case. The following section, however, makes use of the control surface as a means of flutter suppression.

What the aforementioned figures demonstrate is the ability of a system model to correctly predict generalized forces during a controlled input. The complete effectiveness must ultimately be measured by the extent to which the model predicts generalized forces, displacements, and velocities during the general flutter case where modal displacements and velocities are those resulting from the unsteady response. As mentioned previously, the amount of time it would take to validate every system model would take over one year to complete on current hardware. Presented in Figure 4-26 to Figure 4-29 is a portion of a single validation at Mach 0.82. Notice that for both

generalized displacement and velocity, the system model is virtually indistinguishable from the Euler prediction. The Euler validation extends over a small portion of the model due to the amount of time it takes to generate solutions. The small number of cycles shown took on the order of 10 days to complete. As demonstrated by Cowan, once the model correctly predicts a couple of Euler CFD cycles, the rest of the time-history will continue in a similar manner. Cowan provides numerous test-cases with Euler validations for a variety of cases including the AGARD 445.6 wing, a supersonic panel case, a generic hypersonic vehicle, and others [Cowan, 1998]. Based on the effectiveness of the system identification procedure, further validation is deemed unnecessary at this point.



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Figure 4-20: Training Data at Mach 0.51, q=141.8 psf



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Figure 4-21: Training Data at Mach 0.67, q=146.5 psf



Figure 4-22: Training Data at Mach 0.71, q=146.9 psf



Figure 4-23: Training Data at Mach 0.77, q=144.2 psf



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Figure 4-24: Training Data at Mach 0.80, q=147.2 psf



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Figure 4-25: Training Data at Mach 0.82, q=159.9 psf



Figure 4-26: Model Validation for STARS CFD/ASE: Model at Mach 0.82 for Plunge Displacement (in)



Figure 4-27: Model Validation for STARS CFD/ASE: Model at Mach 0.82 for Pitch Displacement (deg)



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Figure 4-28: Model Validation for STARS CFD/ASE: Model at Mach 0.82 for Plunge Velocity (in/sec)



Figure 4-29: Model Validation for STARS CFD/ASE: Model at Mach 0.82 for Pitch Velocity (deg/sec)

### 4.3.3 Flutter Prediction Using STARS

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As a culmination of all of the above efforts, let's turn to the predicted flutter boundary using STARS. As was demonstrated in Chapter 3, there is a significant sensitivity to the location of the center of gravity relative to the elastic axis ( $S_{h,\alpha}$ ). For simplicity, the *p*-method was used for quick parametric studies of plunge and pitch stiffness as well as  $S_{h,\alpha}$ . The fully 3-D, nonlinear STARS model also showed this same sort of sensitivity as is seen in Figure 4-30.



Figure 4-30: Flutter Boundary Prediction for Different  $x_{cg}$  Locations

In the above figure, we see three different flutter boundary predictions for slight changes in CG location relative to the elastic axis. As one would expect, as  $x_{cg}$  moves aft of mid chord, the predicted flutter point drops. This is perhaps the most effective demonstration thus-far of the sensitivity that exists with this particular choice of CG location. Table 4-8 quantifies the data given in the previous figure.

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Mach	Dynamic Pressure @ Flutter (psf) for:							
	x <sub>cg</sub> =0.028"	$x_{cg} = 0.08$ "	x <sub>cp</sub> =0.10"					
0.51	182.5	146.0	1297					
0.67	176.5	148.3	136.9					
0.71	176.9	151.8	141.6					
0.77	159.2	147.0	139.9					
0.80	173.2	160.5	154.9					
0.82	215.9	206.2	201.3					

Table 4-8: Sensitivity to  $x_{cg}$  for the NACA 0012 & BACT Wings in STARS

Shown in Table 4-9 are the resulting changes in flutter prediction across the entire Mach number range for less than a 1% change in  $x_{cg}$ . As was quickly demonstrated using the *p*-method with simplified linear aerodynamics, a 1% change can very significantly alter the flutter prediction. It is interesting that the apparent sensitivity to  $x_{cg}$  seems to diminish with increasing Mach number.

Mach	% Change in q <sub>flutter</sub>						
0.51	-28.9%						
0.67	-22.4%						
0.71	-20.0%						
0.77	-12.2%						
0.80	-10.6%						
0.82	-6.8%						

Table 4-9: Percent Change in  $q_{flutter}$  for a 0.9% Shift in  $x_{cg}$  (8.028"  $\Rightarrow$  8.10")

This  $x_{cg}$  shift results from moving the cg's location, relative to the elastic axis, aft from 8.028" to 8.10", where the wing's mid-chord is at 8.0". Through personal contact with Mr. Waszak, experimental results show that a shift in  $x_{cg}$  from 8.0 to 8.1 at Mach 0.77 resulted in a change in  $q_{flutter}$  from 169 psf to 148 psf [Waszak, 1998]. For this similar

shift in  $x_{cg}$ , the resulting 12% drop if  $q_{flutter}$  compares well to the change noticed in STARS.

As seen in Figure 4-31, STARS flutter prediction, in general, compared well with experimental data. Error in the estimates in the flutter boundary were minimized through the use of the modal identification technique described previously. At each Mach number, the model was ran in small increments of dynamic pressure, at which mode 1 and 2 damping values were recorded. Once the mode 2 (Pitch) damping went from a positive to a negative number, a linear interpolation between the two points provided an estimate for the flutter point.



Figure 4-31: STARS Flutter Prediction Compared with Experimental Results from the NACA 0012 Wing and the BACT Wing

From Mach 0.51 to 0.77, predicted values of  $q_{flutter}$  were less than 4% different than experiment. As was noticed in the experimental data, the predicted flutter boundary increased sharply past the transonic dip. Though slightly higher than observed through

experiment, predicted results compared reasonably well considering the fact that differences in flutter prediction past the transonic dip appear exaggerated due to the very good agreement prior to the dip.

## 4.4 Aeroservoelastic Results

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The natural extension of work done to this point is to use the control surface on the BACT wing to suppress flutter. The actual design of the control law, as was mentioned in Chapter 3, was assisted through the use of a computational MATLAB<sup>®</sup> model developed by Waszak. The MATLAB<sup>®</sup> model allowed very quick studies on the effectiveness of different control laws for the BACT wind-tunnel model at Mach 0.77. Shown in the following figure is an example plot obtained from the investigation using the MATLAB<sup>®</sup> model. Initially control is off and the system oscillates towards flutter. At *t*=0.8 sec, control is activated and the entire response plotted. The plot on the left shows plunge and pitch positions in inches and degrees, respectfully. The plot on the right shows control surface position. The plots were kept separate to allow better visualization of the system dynamics.

Figure 4-32 shows a representative flutter suppression example using the MATLAB model. Control laws for the such models were kept relatively simple to facilitate their implementation into STARS.



Figure 4-32: MATLAB<sup>®</sup> Flutter Suppression Example

#### 4.4.1 Control Law Development

In deciding on a control law, it was noted that the lift was much more affected through a change in pitch angle than in control surface deflection. With  $C_{L_a} = 4.584$  and  $C_{L_s} = 0.63$ , we see that the effect of  $\alpha$  on lift is more than 7 times greater than the effect of  $\delta$ . Additionally, with  $C_{M_a} = 1.490$  and  $C_{M_s} = -0.0246$ , we see that the effect of  $\alpha$  on moment is more than 60 times that of  $\delta$ . Since the data was unavailable, the trailing edge rate effects were ignored in the MATLAB model. These effects, after analyzing a stepinput to the control surface in STARS, showed to be of significant value. Since this research effort focuses on the feasibility of simulating control surface deflections during flutter using the transpiration boundary condition, effort given to the development of a control algorithm was for the purpose of demonstrating the feasibility of ASE control of the BACT wing within STARS.

#### 4.4.2 Control Implementation into STARS

With the simulation acceleration provided through the system identification technique, changes in control laws and control gains could be seen relatively quickly. A study of this type using the Euler solver would be very impractical if one had to wait for several weeks to see if a control algorithm worked. For example, using the estimated solution duration developed in section 3.2.4.2, a single 5000 step time history requires approximately 70 days to complete. Now, consider trying numerous control algorithms, or even simple gain changes where each parameter change requires another 60 or 70 days to complete. Again, these numbers illustrate this impracticality since a single control law, at a single Mach number and dynamic pressure could easily take several years to complete. In this effort, control is demonstrated at Mach 0.51, 0.77, and 0.82. As with the case of the flutter boundaries, validation is given at a single Mach number, 0.77, due to time restrictions.

For the actual implementation into STARS, the following block diagram illustrates the control algorithm desired. Since the position and velocity are already updated and calculated at each time step within STARS, the feed back control law is based upon proportional feedback of plunge and pitch magnitude, as well as plunge and pitch rates.



Figure 4-33: Block Diagram of Control Implemented into STARS

Typically,  $q_r$ , the vector of desired modal displacements and velocities, will be zero. The control law simply calculates a desired control surface position,  $\delta_s$ , based on the specified gains. The actual control surface deflection,  $\delta$ , is subject to the actuator model introduced in section 3.2.4.4. From the actuator model, a new displacement and velocity is calculated and enforced at each discrete time step.

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Shown below is a portion of the code modified in *CFDASE* to input control surface deflections and velocities into STARS. These control surface deflections follow the adapted actuator model originally developed by Waszak.

```
elseif ( ibcx .eq. 2 ) then
                                               ibcx=2 Specifies ASE Control to be Used
CHS
       Define Controls Parameters
                                               Actuator Model Parameters
        k = 1.02
        zeta = .56
        omega = 165.3
CHS
       Delay Control For a While...
                                               Delays control for 50 steps
        if (istep .gt. 50 ) then
CHS
       Define New C.S. Position
          xn1(3) = DELT*xn16old+xn13old
                                               Compute New Desired C.S. Angle
CHS
      Limit C.S. Deflection Amount
                                               Limits C.S. Deflection to \pm 15^{\circ}
            if (xn1(3) .GT. 15.0) then
             xn1(3) = 15.0
            elseif (xn1(3) .LT. -15.0) then
             xn1(3) = -15.0
            end if
      Define New C.S. Velocity
CHS
                                               Compute New Desired C.S. Ang. Vel.
          xn1(6) = DELT*( -10.0*rbcx*xn1(1)-0.5*rbcx*xn(4)-
     δc
                           2.0*rbcx*xn1(5) )*k*omega*omega-
                    DELT*2*zeta*omega*xn16old-
     &
     &
                    DELT*omega*omega*xn13old+
     &
                    xn16old
          else
                                               C.S. Held Steady While Control is Off
          xn1(3) = 0.0
          xn1(6) = 0.0
          end if
:
```

In the section of the code above, the parameters *ibcx* and *rbcx* are defined in the *SCALARS* file. For purposes of control, *ibcx* tells the code that control is desired after the  $50^{\text{th}}$  time step. The 50 step delay simply allows the BACT system to work past any flow transients due to the impulsive force before control is activated. The proportional gain is set with the *rbcx* parameter. The variables xnl(1), xnl(2), xnl(3), xnl(4), xnl(5), and xnl(6) are the mode 1,2, and 3 generalized displacements and velocities, respectively.

## 4.4.3 Flutter Suppression for the BACT Wing Using STARS

Implementing these modifications in an aeroservoelastic application lacks only a control algorithm. Since the research is more focused upon the feasibility of control, control laws are not optimized for performance, but rather demonstrate the ability for STARS to be applied to this sort of problem.

During the implementation process, it was discovered that the typical multi-step sequence did not convey enough information to completely model the control surface. The effects of plunging and pitching the wing had much greater effects on the generalized forces than did the *small* control surface deflections. This can be seen from the multi-step training data shown in Figure 4-20 through Figure 4-25. The solution was to simply allow the multi-step corresponding to the control surface deflection to have a higher magnitude than that of the plunge and pitch degrees of freedom. Figure 4-34 shows the new multi-step sequence adapted for the ASE portion of the study. The figure clearly shows the additional magnitude present in both the displacement and velocity inputs for mode 3. In this case, increasing the magnitude by a factor of three worked sufficiently well.



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Figure 4-34: Modified Multi-Step Sequence Used for ASE

As was with the previous cases, the extent to which the system model predicted the Euler solution is first judged by a solution comparison using the multi-step. Figure 4-35 shows the resulting generalized forces resulting from the new multi step. For this case, at Mach 0.77, one can see a much more defined response, as compared to Figure 4-23, in modes 1 and 2 due to the deflection of the control surface. This additional data significantly improved the system models ability to predict the Euler solution.



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Figure 4-35: Multi-Step Response for Model and Euler Solutions

Figure 4-36, Figure 4-37, and Figure 4-39 show the resulting time histories with the trailing edge control surface effectively damping out a response that would otherwise tend towards flutter. Control of this single-input, multi-output system actually proved to be slightly illusive. Choosing a control law based on a trial and error approach for a system as highly coupled as this was not a simple task.

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Many combinations of control algorithms and gains were tested and the final control law used results more from empirical observations of many time-histories. The control method that seemed to work the best was one that quickly damped out the pitch motion. This makes sense since it is typically the pitch degree-of-freedom driving the system towards instability. Control on pitch alone did not work quite as desired so a contribution due to the plunge position was eventually added. Each of the following figures shows that the control law worked as it was supposed to. In each case, pitch motion is initially more highly damped than plunge motion, with both pitch and plunge eventually tending towards zero displacement.



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Figure 4-36: Aeroservoelastic Response at Mach 0.51



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Plunge (--) and Pitch (--) Figure 4-38: MATLAB<sup>®</sup> Model Comparison Using a Similar Control Law at Mach 0.77

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Figure 4-38 shows a similar control law implemented at Mach 0.77 in the MATLAB model. Comparing with Figure 4-37, we see that both models agree reasonably well and show pitch motion is eliminated first, with plunge motion following.

The Mach 0.82 case had an interesting occurrence. In order to control the plunge and pitch motions, the sign of the plunge gain had to be changed. With the critical Mach number for the BACT wing being approximately 0.77, a very definite transonic shock exists at Mach 0.82. With the center of pressure moved further back on the wing due to the presence of the shock, the control law used in the two previous cases was no longer valid.

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Figure 4-40: Euler Validation of the Modeled Aeroservoelastic Response at Mach 0.77

Shown in Figure 4-40 is the Euler validation of the system model for Mach 0.77. Moreso than was seen with the previous validation case, we see more significant differences between the system model and the Euler solution. These differences exhibit one of the limitations within the system model. The system model assumes that in a small region of the steady state solution, perterbations are essentially linear. Typically this is true, but remember that Mach 0.77 is the apparent critical Mach number for the BACT wing. With no deflected control surface, there are no shocks on the surface of the wing but as one can see, control surface deflections approach 10° during the control sequence. With a significant control surface deflection, however, shocks begin to form in the region of the deflection. The presence of these shocks introduce nonlinearities into the solution that were not present during the multi-step solution which is used to train the model. From the above figure, we observe is a loss of predicted control surface effectiveness, but the general trend is in agreement with that predicted by the model.

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There is no comparison with experimental data presented for this case, but, as was seen for the case of a steady flap deflection, reasonal results could be expected as long as the control surface deflection during control is not greater than 7° or 8°, or in cases where significant viscous effects are present.

#### **CHAPTER 5**

#### CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

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The objective of the research conducted was to demonstrate the effectiveness of the transpiration method when applied to: steady control surface deflections, unsteady aeroelastic applications, and unsteady aeroservoelastic control. Previously, the transpiration method was demonstrated to be effective on continuous geometric deflections in cases such as the AGARD 445.6 and the 2×1 Plate. The current effort successfully applied the transpiration method, through STARS, on a problem involving the additional complexities associated with discontinuous deformations. Additionally, research focused on the implementation of a discrete-time control algorithm into STARS and was demonstrated to be effective for flutter suppression at a variety of Mach numbers.

The primary test cases for this effort were the NACA 0012 wing and the BACT wind-tunnel model, both developed and tested at the NASA Langley Research Center under the Benchmark Models Program. At all Mach numbers investigated, steady pressure distributions without a control surface deflection matched very well, even for the cases involving transonic shocks.

When compared to a mesh with a physical 10° control surface deflection, simulated 10° deflections at both Mach 0.77 and 0.82 matched the Euler prediction from

STARS very well. These results indicated that the transpiration method was at least as accurate as the Euler prediction. When compared to experimental data at Mach 0.77 and Mach 0.82 with control surface deflections of 2°, 5° and 10°, pressure distributions using simulated control surface deflections of 2° and 5° matched well. With a 10° deflection, however, it appeared that the significant viscous effects present with such a large deflection made the flow physics intractable for the use of an Euler flow solver.

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Experimental results were often subject to slight differences from nominal experimental parameters. Flutter prediction was demonstrated to be highly sensitive to the location of the center of gravity relative to the elastic axis  $(x_{cg})$ . Changes in  $x_{cg}$  of less than 1% were also shown to affect flutter prediction differently across the range of Mach numbers tested. Also mentioned was the difficulty in the determination of the exact dynamic pressure at the onset of flutter. The determination of the actual flutter point is often a subjective judgement. STARS used a modal identification procedure to alleviate the subjectivity in this judgement.

Prediction of the flutter boundary also compared well with experimental data from both the NACA 0012 wing tested in air and the BACT wing tested in R-12. For Mach numbers ranging from 0.51 to 0.77, differences from experimental data were less than 4%. Past the transonic dip at Mach 0.77, computational results, compared to experimental data, show a more aggressive increase in dynamic pressure at flutter  $(q_f)$  at both Mach 0.80 and 0.82.

For the first time, aeroservoelastic control of a body using the transpiration method was implemented into STARS. For control based on plunge position and pitch-rate, time-histories at Mach 051, 0.77, and 0.82 show that the transpiration boundary

condition can successfully be employed during a full ASE simulation. An Euler validation for control at Mach 0.77 showed good agreement between the actual Euler solution and that predicted by the system model.

#### 5.2 Recommendations

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Validation of the system-identification technique showed that the system model adequately modeled the actual coupled structural/aerodynamic problem. Due to significant time constraints, however, validation of each flutter point could take a great deal of computational time to complete. However accurate the model, an Euler validation is the only way to truly validate all of the computational data presented in this paper. As was demonstrated in the ASE simulation, significant nonlinear effects can be introduced during control which introduce slight discrepancies between the Euler and model solutions, and therefore must be accounted for.

Finally, it is still possible that a more efficient/effective control algorithm exists. The robustness of the current control law was not fully investigated, specifically the effect of dynamic pressure. For the purpose of demonstrating the aeroservoelastic capability in STARS, however, the control law adopted is adequate.

For future work, a method of extracting stability and control derivatives from the system model could prove very useful. One could then combine the structural and aerodynamic state space equations with an arbitrary control law in a program such as MATLAB. With a complete model in MATLAB, a much more sophisticated control analysis would be possible allowing the controller to be designed in MATLAB and validated through its implementation into STARS.

Additionally, an ASE simulation could be expanded beyond that of a simple wing/flap geometry. As a feasibility study, the BACT wing provided valuable insight into ASE implementation into STARS. For the general ASE simulation, one could expand the current problem to include rigid body modes and model an entire aircraft. Modeling the entire aircraft would allow a more general prediction of the complete flight dynamics during an ASE simulation.

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I

# APPENDIX A-1

# STARS-SOLIDS Data File (NOPAPA.DAT)

BACT Wing With Flap, No PAPA Mount												
404, 354, 5, 6, 3, 3, 0, 0, 0, 0												
0,	0, 0, 0	), 0, 0,	0, 0,	0								
1,	1, 0, (	), 0, 0,	0, 0									
2,	0, 0, (	), 0, 0,	0, 1,	0,	0							
1, 3, 0, 1000E+04, 0000E+00.0000E+00												
\$NODAL DATA												
13	.0000	.0000	0000 0	0	0	0	0	0	0	0	0	
14	2.0000	.0000	.0000 0	) ()	0	0	0	0	0	0	0	
52	4.0000	.0000	.0000 (	) ()	0	0	0	0	0	0	0	
53	6.0000	.0000	.0000 (	) ()	0	0	0	0	0	0	0	
54	8.0000	.0000	.0000 (	) ()	0	0	0	0	0	0	0	
55	10.0000	.0000	.0000	0 0	) (	) (	0	0	0	0	0	)
56	12.0000	.0000	.0000	0 0	) (	) (	0	0	0	0	0	)
90	14.0000	.0000	.0000	0 0	) (	) (	0	0	0	0	0	)
91	16.0000	.0000	.0000	0 0	) (	) (	0	0	0	0	0	)
300	16.0000	14.4000	.0000	0	0	0	0	0	0	0	0	0
301	16.0000	15.0400	.0000	0	0	0	0	0	0	0	0	0
302	16.0000	15.6800	.0000	0	0	0	0	0	0	0	0	0
303	16.0000	16.3200	.0000	0	0	0	0	0	0	0	0	0
304	16.0000	16.9600	.0000	0	0	0	0	0	0	0	0	0
305	16.0000	17.6000	.0000	0	0	0	0	0	0	0	0	0
306	16.0000	18.2400	.0000	0	0	0	0	0	0	0	0	0
307	16.0000	18.8800	.0000	0	0	0	0	0	0	0	0	0
308	16.0000	19.5200	.0000	0	0	0	0	0	0	0	0	0
309	16.0000	20.1600	.0000	0	0	0	0	0	0	0	0	0
310	16.0000	20.8000	.0000	0	0	0	0	0	0	0	0	0
311	16.0000	21.4400	.0000	0	0	0	0	0	0	0	0	0
312	16.0000	22.0800	.0000	0	0	0	0	0	0	0	0	0
313	16.0000	22.7200	.0000	0	0	0	0	0	0	0	0	0
314	16.0000	23.3600	.0000	0	0	0	0	0	0	0	0	0
315	16.0000	24.0000	.0000	0	0	0	0	0	0	0	0	0
316	15.6667	14.4000	.0000	0	0	0	0	0	0	0	0	0
317	15.6667	15.0400	.0000	0	0	0	0	0	0	0	0	0
318	15.6667	15.6800	.0000	0	0	0	0	0	0	0	0	0
319	15.6667	16.3200	.0000	0	0	0	0	0	0	0	0	0
320	15.6667	16.9600	.0000	0	0	0	0	0	0	0	0	0
321	15.6667	17.6000	.0000	0	0	0	0	0	0	0	0	0
322	15.6667	18.2400	.0000	0	0	0	0	0	0	0	0	0
323	15.6667	18.8800	.0000	0	0	0	0	0	0	0	0	0
324	15.6667	19.5200	.0000	0	0	0	0	0	0	0	0	0
325	15.6667	20.1600	.0000	0	0	0	0	0	0	0	0	0
326	15.6667	20.8000	.0000	0	0	0	0	0	0	0	0	0
327	15.6667	21.4400	.0000	0	0	0	0	0	0	0	0	0
328	15.6667	22.0800	.0000	0	0	0	0	0	0	0	0	0
329	15.6667	22.7200	.0000	0	0	0	0	0	0	0	0	0
330	15.6667	23.3600	.0000	0	0	0	0	0	0	0	0	0
331	15.6667	24.0000	.0000	0	0	0	0	0	0	0	0	0
332	15.3333	14.4000	.0000	0	0	0	0	0	0	0	0	0
333	15.3333	15.0400	.0000	0	0	0	0	0	0	0	0	0
334	15.3333	15.6800	.0000	0	0	0	0	0	0	0	0	0
335	15.3333	16.3200	.0000	0	0	0	0	0	0	0	0	0
336	15.3333	16.9600	.0000	0	0	0	0	0	0	0	0	0

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337 15.3333	17.6000	.0000	0	0	0	0	0	0	0	0	0
338 15.3333	18.2400	.0000	0	0	0	0	0	0	0	0	0
339 15.3333	18.8800	.0000	0	0	0	0	0	0	0	0	0
340 15.3333	19.5200	.0000	0	0	0	0	0	0	0	0	0
341 15.3333	20.1600	.0000	0	0	0	0	0	0	0	0	0
342 15.3333	20.8000	.0000	0	0	Ó	0	0	0	Ō	Ō	0
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617	2.000	0 176000	0000	ň	ň	ň	ň	ň	ň	ň	ň	ň
(10	2.000	0 17.0000	.0000	0	0	0	0	0	0	0	0	0
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650	10.000	0 29.3333	.0000	0	0	0	0	0	0	0	0	0
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658	8.0000	32.0000	.0000	0	0	0	0	0	0	0	0	0
659	6.0000	25.3333	.0000	0	0	0	0	0	0	0	0	0
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661	6,0000	28,0000	0000	ň	ň	Ň	ň	~	5	Ň	Ň	<u>0</u>
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002	0.0000	29.3333	.0000	U	0	0	0	0	U	0	0	0
663	6.0000	30.6667	.0000	0	0	0	0	0	0	0	0	0
664	6.0000	32.0000	.0000	0	0	0	0	0	0	0	0	0
665	4 0000	25 2222	0000	ň	ň	ň	Ň	ň	~	ň	ň	2
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667	4.0000	28.0000	.0000	0	0	0	0	0	0	0	0	0
668	4.0000	29.3333	.0000	0	0	0	0	0	0	0	0	0
660	4.0000	30 6667	0000	ň	ň	Ň	ň	ň	ň	ň	ň	Ň
470	4,0000	22,000/		0	0	0	0	0	0	0	0	0
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671	2.0000	25.3333	.0000	0	0	0	0	0	0	0	0	0
672	2.0000	26.6667	.0000	0	0	0	0	0	0	0	0	0
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2 300 300 301 317 316	0	0	0	0	5	3	0	0	0	0	
2 301 301 302 318 317	0	0	0	0	5	3	0	0	0	0	
2 302 302 303 319 318	0	0	0	0	5	3	0	0	0	0	
2 303 303 304 320 319	0	0	0	0	5	3	0	0	0	0	
2 305 305 306 322 321	0	0	0	0	5	3	0	0	0	0	
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2 307 307 308 324 323	0	0	0	0	5	3	0	0	0	0	
2 308 308 309 325 324	0	0	0	0	5	3	0	0	0	0	
2 309 309 310 326 325	0	0	0	0	5	3	0	0	0	0	
2 310 310 311 327 328	0	0	0	0	5 5	2	0	0	0	0	
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2 314 314 315 331 330	0	0	0	0	5	3	0	0	0	0	
2 315 316 317 333 332	0	0	0	0	5	3	0	0	0	0	
2 310 317 318 334 333	0	0	0	0	5	3	0	0	0	0	
2 318 319 320 336 335	0	0	ŏ	ŏ	5	3	0	0	0	ŏ	
2 319 320 321 337 336	0	0	0	0	5	3	0	0	0	0	
2 320 321 322 338 337	0	0	0	0	5	3	0	0	0	0	
2 321 322 323 339 338	0	0	0	0	5	3	0	0	0	0	
2 322 323 324 340 339	0	0	0	0	5	3	0	0	0	0	
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2 325 326 327 343 342	0	0	0	0	5	3	0	0	0	0	
2 326 327 328 344 343	0	0	0	0	5	3	0	0	0	0	
2 327 328 329 345 344	0	0	0	0	5	3	0	0	0	0	
2 328 329 330 346 345	0	0	0	0	5	3	0	0	0	0	
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2 332 334 335 351 350	0	0	0	0	5	3	0	0	0	0	
2 333 335 336 352 351	0	0	0	0	5	3	0	0	0	0	
2 334 330 337 353 352	0	0	0	0	5	3	0	0	0	0	
2 336 338 339 355 354	0	0	0	0	5 5	2	0	0	0	0	
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2 338 340 341 357 356	0	0	0	0	5	3	0	0	0	0	
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2 340 342 343 359 358	0	0	0	0	5	3	0	0	0	0	
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2 344 346 347 363 362	0	0	0	Δ	5	3	Δ	n	0	Ω
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2 350 353 354 370 369	0	0	0	0	5	3	0	0	0	0
2 351 354 355 371 370	0	0	0	0	5	3	0	0	0	0
2 252 255 256 272 271	ň	ň	ŏ	Ň	~	2	Ň	~	Ň	0
2 332 333 330 372 371	U	U	U	0	Э	3	U	U	0	0
2 353 356 357 373 372	0	0	0	0	-5	3	0	0	0	0
2 354 357 358 374 373	Ó	۰.	n.	Ā	5	2	õ	ñ	ň	Ň
2 334 337 338 314 313	v	0	U	U	2	2	U	U	U	U
2 355 358 359 375 374	0	0	0	0	- 5	- 3	0	0	0	0
2 356 359 360 376 375	0	Ω	0	0	5	3	0	Δ	0	Δ
2 250 259 260 278 275	~	Ň	~	~	-	-	~	~	0	Ŷ
2 35/ 300 361 3// 3/6	0	0	0	0	5	3	0	0	0	0
2 358 361 362 378 377	0	0	0	0	5	3	0	0	0	0
2 250 262 262 270 279	Ā	Ā	Ň	ň		ñ	ň	Ň	Ň	Ň
2 339 302 303 319 318	U	v	U	U	3	3	U	U	U	U
2 360 364 365 381 380	0	0	0	0	5	3	0	0	0	0
2 361 365 366 382 381	Δ	۵	Δ	٥	5	2	Δ	Δ	Â	Ň
2 301 303 300 302 301				0	5	5	v	v	v	v
2 362 366 367 383 382	0	0	0	0	5	3	0	0	0	0
2 363 367 368 384 383	0	0	0	0	5	3	Ω	0	Ω	Ω
2 2(4 2(8 2(0 205 204	~	~	Ň	Ň	-	2	~	~	Š	0
2 304 308 309 385 384	0	U	0	0	5	3	0	0	0	0
2 365 369 370 386 385	0	0	0	0	-5	3	0	0	0	0
2 366 370 371 387 386	ñ	Ā	ñ	Ň	5	ž	ň	ň	ň	ň
2 300 370 371 387 380	U	v	U	U	3	د	U	U	U	U
2 367 371 372 388 387	0	0	0	0	5	3	0	0	0	0
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2 369 373 374 390 389	0	0	0	0	5	3	0	0	0	0
2 370 374 375 391 390	0	0	0	0	5	3	0	Ω	Ω	Δ
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2 3/1 3/5 3/6 392 391	0	U	0	U	2	3	0	0	0	0
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2 313 311 318 394 393	U	U	U	U	Э	3	U	0	0	0
2 374 378 379 395 394	0	0	0	0	5	3	0	0	0	0
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2 373 380 381 397 390				v	2	2	v	v	U	U
2 376 381 382 398 397	0	0	0	0	5	3	0	0	0	0
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2 406 413 414 430 429	0	0	0	0	5	3	0	0	0	0
2 407 414 415 431 430	0	0	0	0	5	3	0	Û	0	n
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2 409 416 417 433 432	0	0	0	0	5	3	0	0	0	0
2 410 417 418 424 422	n.	ñ	ñ	n.	¢	2	ñ	ň	ñ	ň
2 710 71/ 410 434 433	U	0	v	v	2	3	U	v	U	U
2 411 418 419 435 434	0	0	0	0	5	3	0	0	0	0
2 412 419 420 436 435	0	0	0	0	5	3	0	٥	0	0
2 412 420 421 420 433	0	0	~	v	5	2	0	0	v	v o
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2 4 14 4 21 4 22 4 38 4 37 0 0 0 0 5 3 0 0 0 0	2 484 512 513 521 520 0 0 0 0 5 3 0 0 0 0
2 415 422 423 439 438 0 0 0 0 5 3 0 0 0 0	2 485 513 514 522 521 0 0 0 0 5 3 0 0 0 0
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2 418 425 426 442 441 0 0 0 0 5 3 0 0 0 0	2 488 90 517 526 56 0 0 0 0 5 3 0 0 0 0
2 419 426 427 443 442 0 0 0 0 5 3 0 0 0 0	2 489 517 518 527 526 0 0 0 0 5 3 0 0 0 0
2 420 428 429 445 444 0 0 0 0 5 3 0 0 0 0	2 400 518 510 578 577 0 0 0 0 5 3 0 0 0 0
2 421 429 430 446 445 0 0 0 0 5 3 0 0 0 0	2 491 519 520 529 528 0 0 0 0 5 3 0 0 0 0
2 422 430 431 447 446 0 0 0 0 5 3 0 0 0 0	2 492 520 521 530 529 0 0 0 0 5 3 0 0 0 0
2 423 431 432 448 447 0 0 0 0 5 3 0 0 0 0	2 493 521 522 531 530 0 0 0 0 5 3 0 0 0 0
2 424 432 433 449 448 0 0 0 0 3 3 0 0 0 0	2 494 522 523 532 531 0 0 0 0 5 3 0 0 0 0
2 425 433 434 450 449 0 0 0 0 5 3 0 0 0 0	2 495 523 692 691 532 0 0 0 0 5 3 0 0 0 0
2 426 434 435 451 450 0 0 0 0 5 3 0 0 0 0	2 496 56 526 534 55 0 0 0 0 5 3 0 0 0 0
2 427 435 436 452 451 0 0 0 5 3 0 0 0 0	2 407 526 527 525 524 0 0 0 0 5 2 0 0 0 0
	2 497 320 327 333 334 0 0 0 0 3 3 0 0 0 0
2 428 436 437 453 452 0 0 0 0 5 3 0 0 0 0	2 498 527 528 536 535 0 0 0 0 5 3 0 0 0 0
2 429 437 438 454 453 0 0 0 0 5 3 0 0 0 0	2 499 528 529 537 536 0 0 0 0 5 3 0 0 0 0
2 430 438 439 455 454 0 0 0 0 5 3 0 0 0 0	2 500 529 530 538 537 0 0 0 0 5 3 0 0 0 0
2 431 439 440 436 435 0 0 0 0 3 5 0 0 0 0	2 301 330 331 339 338 0 0 0 0 5 3 0 0 0 0
2 432 440 441 457 456 0 0 0 0 5 3 0 0 0 0	2 502 531 532 540 539 0 0 0 0 5 3 0 0 0 0
2 433 441 442 458 457 0 0 0 0 5 3 0 0 0 0	2 503 532 691 690 540 0 0 0 0 5 3 0 0 0
2 131 112 113 159 158 0 0 0 0 5 3 0 0 0 0	2 504 55 524 542 54 0 0 0 0 5 2 0 0 0 0
	2 304 33 334 343 34 0 0 0 0 3 3 0 0 0 0
2 435 444 445 461 460 0 0 0 0 5 3 0 0 0 0	2 505 534 535 544 543 0 0 0 0 5 3 0 0 0 0
2 436 445 446 462 461 0 0 0 0 5 3 0 0 0 0	2 506 535 536 545 544 0 0 0 0 5 3 0 0 0
2 437 446 447 463 462 0 0 0 0 5 3 0 0 0 0	2 507 536 537 546 545 0 0 0 0 5 3 0 0 0
2 / 38 / 47 / 48 /64 /62 0 0 0 0 5 2 0 0 0 0	2 500 527 520 547 546 0 0 0 0 5 3 0 0 0 0
2 439 448 449 465 464 0 0 0 0 5 3 0 0 0 0	2 509 538 539 548 547 0 0 0 0 5 3 0 0 0 0
2 440 449 450 466 465 0 0 0 0 5 3 0 0 0 0	2 510 539 540 549 548 0 0 0 0 5 3 0 0 0
2 441 450 451 467 466 0 0 0 0 5 3 0 0 0 0	2 511 540 600 690 540 0 0 0 0 5 3 0 0 0 0
2 442 451 452 468 467 0 0 0 0 5 3 0 0 0 0	2 512 54 543 552 53 0 0 0 0 5 3 0 0 0 0
2 443 452 453 469 468 0 0 0 0 5 3 0 0 0 0	2 513 543 544 553 552 0 0 0 0 5 3 0 0 0 0
2 444 453 454 470 469 0 0 0 0 5 3 0 0 0 0	2 514 544 545 554 553 0 0 0 0 5 3 0 0 0 0
2 445 454 455 471 470 0 0 0 0 5 2 0 0 0	2 515 545 546 555 554 0 0 0 0 5 2 0 0 0 0
	2 313 343 340 333 334 0 0 0 0 3 3 0 0 0 0
2 446 455 456 472 471 0 0 0 0 5 3 0 0 0 0	2 516 546 547 556 555 0 0 0 0 5 3 0 0 0 0
2 447 456 457 473 472 0 0 0 0 5 3 0 0 0 0	2 517 547 548 557 556 0 0 0 0 5 3 0 0 0 0
2 448 457 458 474 473 0 0 0 0 5 3 0 0 0 0	2 518 548 549 558 557 0 0 0 0 5 3 0 0 0 0
2 440 459 450 475 474 0 0 0 0 5 2 0 0 0 0	
2 449 458 459 475 474 0 0 0 0 5 3 0 0 0 0	2 519 549 689 688 558 0 0 0 0 5 3 0 0 0 0
2 450 460 461 477 476 0 0 0 0 5 3 0 0 0 0	2 520 53 552 561 52 0 0 0 0 5 3 0 0 0 0
2 451 461 462 478 477 0 0 0 0 5 3 0 0 0 0	2 521 552 553 562 561 0 0 0 0 5 3 0 0 0
2 452 462 463 479 478 0 0 0 0 5 3 0 0 0 0	2 522 553 554 563 562 0 0 0 0 5 3 0 0 0
2 452 402 400 479 478 0 0 0 0 5 3 0 0 0 0	
2 453 463 464 480 479 0 0 0 0 5 3 0 0 0 0	2 523 554 555 564 563 0 0 0 0 5 3 0 0 0 0
2 454 464 465 481 480 0 0 0 0 5 3 0 0 0 0	2 524 555 556 565 564 0 0 0 0 5 3 0 0 0 0
2 455 465 466 482 481 0 0 0 0 5 3 0 0 0 0	2 525 556 557 566 565 0 0 0 0 5 3 0 0 0 0
2 456 466 467 483 482 0 0 0 0 5 3 0 0 0 0	2 526 557 559 567 566 0 0 0 0 5 3 0 0 0 0
	2 520 537 538 507 508 0 0 0 0 5 5 0 0 0 0
245/46/4684844830000530000	2 527 558 688 687 567 0 0 0 0 5 3 0 0 0 0
2 458 468 469 485 484 0 0 0 0 5 3 0 0 0 0	2 528 52 561 570 14 0 0 0 0 5 3 0 0 0 0
2 459 469 470 486 485 0 0 0 0 5 3 0 0 0 0	2 529 561 562 571 570 0 0 0 0 5 3 0 0 0 0
2 460 470 471 497 496 0 0 0 5 3 0 0 0 0	2 52 56 562 571 570 0 0 0 0 5 3 0 0 0 0
2 461 471 472 488 487 0 0 0 0 5 3 0 0 0 0	2 531 563 564 573 572 0 0 0 0 5 3 0 0 0 0
2 462 472 473 489 488 0 0 0 0 5 3 0 0 0 0	2 532 564 565 574 573 0 0 0 0 5 3 0 0 0 0
2 463 473 474 490 489 0 0 0 0 5 3 0 0 0 0	2 533 565 566 575 574 0 0 0 0 5 3 0 0 0 0
2 464 474 475 491 490 0 0 0 5 3 0 0 0 0	2 534 566 567 576 575 0 0 0 0 5 3 0 0 0 0
2 404 474 473 491 490 0 0 0 0 3 3 0 0 0 0	
2 405 4/6 4/7 493 492 0 0 0 0 5 3 0 0 0 0	2 535 567 687 686 576 0 0 0 0 5 3 0 0 0 0
2 466 477 478 494 493 0 0 0 0 5 3 0 0 0 0	2 536 14 570 579 13 0 0 0 0 5 3 0 0 0 0
2 467 478 479 495 494 0 0 0 0 5 3 0 0 0 0	2 537 570 571 580 579 0 0 0 0 5 3 0 0 0 0
2 161 110 119 195 191 0 0 0 0 5 3 0 0 0 0	2 531 570 571 570 581 580 0 0 0 0 5 3 0 0 0 0
2 408 479 480 490 495 0 0 0 0 5 3 0 0 0 0	2 338 3/1 3/2 381 380 0 0 0 0 5 3 0 0 0 0
2 469 480 481 497 496 0 0 0 0 5 3 0 0 0 0	2 539 572 573 582 581 0 0 0 0 5 3 0 0 0 0
2 470 481 482 498 497 0 0 0 0 5 3 0 0 0 0	2 540 573 574 583 582 0 0 0 0 5 3 0 0 0
2 471 482 483 400 408 0 0 0 0 5 3 0 0 0 0	2 541 574 575 594 592 0 0 0 0 5 2 0 0 0 0
2 4 12 483 484 500 499 0 0 0 0 5 3 0 0 0 0	2 542 575 576 585 584 0 0 0 0 5 3 0 0 0 0
2 473 484 485 501 500 0 0 0 0 5 3 0 0 0 0	2 543 576 686 685 585 0 0 0 0 5 3 0 0 0 0
2 474 485 486 502 501 0 0 0 0 5 3 0 0 0	2 544 492 587 704 703 0 0 0 0 5 3 0 0 0
2 475 496 497 502 500 0 0 0 0 5 2 0 0 0 0	
	2 343 387 497 103 104 0 0 0 0 5 3 0 0 0 0
2 476 487 488 504 503 0 0 0 0 5 3 0 0 0 0	2 546 497 589 706 705 0 0 0 0 5 3 0 0 0 0
2 477 488 489 505 504 0 0 0 0 5 3 0 0 0 0	2 547 589 502 707 706 0 0 0 0 5 3 0 0 0 0
2 478 489 490 506 505 0 0 0 0 5 3 0 0 0 0	2 548 502 591 708 707 0 0 0 0 5 2 0 0 0
2 4/9 490 491 50/ 506 0 0 0 0 5 3 0 0 0 0	2 549 591 507 709 708 0 0 0 0 5 3 0 0 0 0
2 480 91 509 517 90 0 0 0 0 5 3 0 0 0 0	2 550 541 592 598 550 0 0 0 0 5 3 0 0 0 0
2 481 509 510 518 517 0 0 0 0 5 3 0 0 0 0	2 551 592 593 599 598 0 0 0 0 5 3 0 0 0
2 482 510 511 510 518 0 0 0 0 5 2 0 0 0 0	
2 482 510 511 519 518 0 0 0 0 5 3 0 0 0 0	2 32 393 394 000 399 0 0 0 0 5 3 0 0 0 0
2 483 511 512 520 519 0 0 0 0 5 3 0 0 0 0	2 553 594 595 601 600 0 0 0 0 5 3 0 0 0 0
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2 554 595 596 602 601 0 0 0 0 5 3 0 0 0 0	2 624 672 673 679 678 0 0 0 5 3 0 0 0 0
2 555 596 597 603 602 0 0 0 0 5 3 0 0 0 0	
	2 625 673 674 680 679 0 0 0 0 5 3 0 0 0 0
2 556 550 598 604 559 0 0 0 0 5 3 0 0 0 0	2 626 674 675 681 680 0 0 0 0 5 3 0 0 0 0
2 557 598 599 605 604 0 0 0 0 5 3 0 0 0 0	2 627 675 676 682 681 0 0 0 0 5 3 0 0 0 0
2 558 599 600 606 605 0 0 0 0 5 3 0 0 0 0	2 628 627 621 605 601 0 0 0 5 2 0 0 0 0
	2 6 29 6 21 615 696 695 0 0 0 0 5 3 0 0 0 0
2 560 601 602 608 607 0 0 0 0 5 3 0 0 0 0	2 630 615 609 697 696 0 0 0 0 5 3 0 0 0 0
2 561 602 603 609 608 0 0 0 0 5 3 0 0 0 0	2 631 609 603 698 697 0 0 0 0 5 3 0 0 0
	2 0 3 2 0 0 3 5 9 / 0 9 9 0 9 8 0 0 0 0 5 3 0 0 0 0
2 563 604 605 611 610 0 0 0 0 5 3 0 0 0 0	3 633 709 700 699 0 0 0 0 0 5 3 0 0 0 0
2 564 605 606 612 611 0 0 0 0 5 3 0 0 0 0	2 634 507 411 701 700 0 0 0 0 5 3 0 0 0 0
2 565 606 607 613 612 0 0 0 0 5 3 0 0 0 0	
	2 033 411 313 /02 /01 0 0 0 0 5 3 0 0 0 0
2 566 607 608 614 613 0 0 0 0 5 3 0 0 0 0	2 636 685 686 577 586 0 0 0 0 5 3 0 0 0 0
2 567 608 609 615 614 0 0 0 0 5 3 0 0 0 0	2 637 686 687 568 577 0 0 0 0 5 3 0 0 0 0
2 568 568 610 616 577 0 0 0 0 5 3 0 0 0 0	2 639 697 699 550 569 0 0 0 0 5 2 0 0 0 0
2 309 610 611 617 616 0 0 0 0 5 3 0 0 0 0	2 639 688 689 550 559 0 0 0 0 5 3 0 0 0 0
2 570 611 612 618 617 0 0 0 0 5 3 0 0 0 0	2 640 689 690 541 550 0 0 0 0 5 3 0 0 0 0
2 571 612 613 619 618 0 0 0 0 5 3 0 0 0 0	3 641 690 691 703 0 0 0 0 0 5 3 0 0 0 0
2 577 613 614 620 610 0 0 0 5 2 0 0 0 0	
	2 042 091 092 390 492 0 0 0 0 5 3 0 0 0 0
2 573 614 615 621 620 0 0 0 0 5 3 0 0 0 0	2 643 692 693 300 396 0 0 0 0 5 3 0 0 0 0
2 574 577 616 622 586 0 0 0 0 5 3 0 0 0 0	3 644 703 541 690 0 0 0 0 0 5 3 0 0 0 0
2 575 616 617 623 622 0 0 0 0 5 3 0 0 0 0	3 645 400 703 601 0 0 0 0 0 5 2 0 0 0 0
2 5/0 01/ 018 024 023 0 0 0 0 5 3 0 0 0 0	3 646 709 699 597 0 0 0 0 0 5 3 0 0 0 0
2 577 618 619 625 624 0 0 0 0 5 3 0 0 0 0	364770950770000000530000
2 578 619 620 626 625 0 0 0 0 5 3 0 0 0 0	2 648 703 704 592 541 0 0 0 6 5 2 0 0 0 0
2 570 630 631 637 636 0 0 0 0 5 5 0 0 0 0	
	2 049 /04 /05 593 592 0 0 0 0 5 3 0 0 0 0
2 580 702 628 635 701 0 0 0 0 5 3 0 0 0 0	2 650 705 706 594 593 0 0 0 0 5 3 0 0 0 0
2 581 628 629 636 635 0 0 0 0 5 3 0 0 0 0	2 651 706 707 595 594 0 0 0 0 5 3 0 0 0
2 582 629 630 637 636 0 0 0 0 5 3 0 0 0 0	<b>7 657 707 708 506 505 0 0 0 0 5 5 0 0 0 0</b>
2 383 630 631 638 657 0 0 0 0 5 3 0 0 0 0	2 653 708 709 597 596 0 0 0 0 5 3 0 0 0 0
2 584 631 632 639 638 0 0 0 0 5 3 0 0 0 0	\$ LINE ELEMENT BASIC PROPERTIES
2 585 632 633 640 639 0 0 0 0 5 3 0 0 0 0	1 3058F-01 1488F-00 7442E-00 7442E-00 1100E-01 1100E-0
	2 2000 00 200 1400 00 200 00 10 100 100 100 100 100 100
2 380 /01 033 041 /00 0 0 0 0 3 3 0 0 0 0	2./SUUE+00.5664E-01.3906E-02.5625E+00.1000E+01.1000E+
2 587 635 636 642 641 0 0 0 0 5 3 0 0 0 0	3.3058E+00.1488E-01.7442E-02.7442E-02.1100E+01.1100E+0
2 588 636 637 643 642 0 0 0 0 5 3 0 0 0 0	SHELL FLEMENT THICKNESSES
2 589 637 638 644 643 0 0 0 0 5 2 0 0 0 0	
	1.1.00ETUI.0000ETUU.0000ETUU
2 390 638 639 643 644 0 0 0 0 5 3 0 0 0 0	2.1500E+01.0000E+00.0000E+00
2 591 639 640 646 645 0 0 0 0 5 3 0 0 0 0	3.2500E+00.0000E+00.0000E+00
2 592 700 641 647 699 0 0 0 0 5 3 0 0 0	SMATERIAL PROPERTIES
	1 1
2 594 642 643 649 648 0 0 0 0 5 3 0 0 0 0	.1000E+08.3000E+00.0000E+00.2539E-03.0000E+00.0000E+00
2 595 643 644 650 649 0 0 0 0 5 3 0 0 0 0 l	2 1
2 596 644 645 651 650 0 0 0 0 5 2 0 0 0 0	
	.1000ET00 .2000ET00 .0000ET00 .2393E-03 .0000E+00 .0000E+00
2 39/ 643 646 652 651 0 0 0 0 5 3 0 0 0 0	3 1
2 598 699 647 653 698 0 0 0 0 5 3 0 0 0 0	3000E+08_3000E+00_0000E+00_7306E-03_0000E+00_0000E+00
2 599 647 648 654 653 0 0 0 0 5 3 0 0 0 0	
	7 1 20000100 200000100 000000100 00 00000000
	JUNE+08 JUNE+00 .0000E+00 .7306E-03 .0000E+00 .0000E+00
2 601 649 650 656 655 0 0 0 0 5 3 0 0 0 0	5 1
2 602 650 651 657 656 0 0 0 0 5 3 0 0 0 0	.1030E+12.3000E+00.0000E+00.2539E-08.0000E+00.0000E+00
2 603 651 652 658 657 0 0 0 0 5 3 0 0 0 0	
2 004 098 033 039 09/ 0 0 0 0 5 3 0 0 0 0	
2 605 653 654 660 659 0 0 0 0 5 3 0 0 0 0	
2 606 654 655 661 660 0 0 0 0 5 3 0 0 0 0	
2 607 655 656 662 641 0 0 0 0 5 2 0 0 0 0	
2 608 656 657 663 662 0 0 0 0 5 3 0 0 0 0	
2 609 657 658 664 663 0 0 0 0 5 3 0 0 0 0	
2 611 659 660 666 665 0 0 0 0 5 3 0 0 0 0	
2 612 660 661 667 666 0 0 0 0 5 3 0 0 0 0	
2 613 661 662 668 667 0 0 0 0 5 2 0 0 0 0	
2 614 662 663 669 668 0 0 0 0 5 3 0 0 0 0	,
2 615 663 664 670 669 0 0 0 0 5 3 0 0 0 0 1	
2 616 696 665 671 695 0 0 0 0 5 3 0 0 0 0	
2 01/003 000 0/2 0/1 0 0 0 5 3 0 0 0 0	
2 618 666 667 673 672 0 0 0 0 5 3 0 0 0 0	
2 619 667 668 674 673 0 0 0 0 5 3 0 0 0 0	
2 020 008 009 0/3 0/4 0 0 0 0 5 3 0 0 0 0	
2 621 669 670 676 675 0 0 0 0 5 3 0 0 0 0	
2 622 695 671 677 694 0 0 0 0 5 3 0 0 0 0	
2 673 671 677 678 677 0 0 0 0 5 2 0 0 0 0	

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## APPENDIX A-2

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# STARS-SOLIDS Generalized Mode 1 Displacement Definition (Plunge)

	Original XY	Z Location		New XYZ	w XYZ Location No			lodal Displacement			
Node	X	Y	Z	X	Y'	Z'	ΔΧ	Δγ	ΔZ		
13	0	0	0	0	1	0	0	1	0		
14	2	0	0	2	1	0	0	1	0		
52	4	0	0	4	1	0	0	1	0		
55	6	0	0	6	1	0	0	1	0		
54	8	0	0	8	1	0	0	1	0		
55 57	10	0	0	10	1	0	0	1	0		
20	12	0	0	12	1	0	0	1	0		
90	14	0	0	14	1	0	0	1	0		
200	16	14.4	0	16	1	0	0	1	0		
201	10	14.4	0	16	15.4	U	0	1	0		
201	10	15.04	0	16	16.04	0	0	1	0		
302	10	15.68	0	16	16.68	0	0	1	0		
202	10	16.32	0	16	17.32	0	0	1	0		
304	10	10.90	0	16	17.96	0	0	1	0		
205	10	17.0	0	16	18.6	U	0	1	0		
200	10	18.24	0	16	19.24	0	0	1	0		
307	10	10.00	0	16	19.88	0	0	1	0		
200	10	19.52	0	16	20.52	0	0	1	0		
210	10	20.10	0	16	21.16	0	0	1	0		
211	10	20.8	0	10	21.8	0	0	1	0		
212	10	21.44	0	10	22.44	0	0	1	0		
212	10	22.08	0	10	23.08	0	0	1	0		
214	10	22.72	0	16	23.72	0	0	I	0		
215	10	23.30	0	10	24.30	0	0	l	0		
216	10	24	0		25	0	0	1	0		
217	15.6667	14.4	0	15.0007	15.4	0	0	1	0		
318	15.6667	15.04	0	15.000/	16.04	0	0	1	0		
310	15.6667	16.32	0	15.0007	10.08	0	0	1	0		
320	15 6667	16.96	0	15.6667	17.52	0	0	1	0		
321	15.6667	17.6	0	15.6667	19.6	0	0	1	0		
322	15.6667	18 24	ñ	15.6667	10.74	0	0	1	0		
323	15.6667	18.88	õ	15.6667	10.88	0	0	1	0		
324	15.6667	19.52	õ	15.6667	20.52	Ő	0	1	0		
325	15 6667	20.16	õ	15.6667	21.16	Ő	0	1	0		
326	15 6667	20.8	õ	15.6667	21.10	Ŏ	0	1	0		
327	15.6667	21.44	õ	15.6667	22.44	õ	0	1	0		
328	15.6667	22.08	õ	15 6667	23.08	õ	0	1	0		
329	15.6667	22.72	Ő	15 6667	23.00	ŏ	0	1	0		
330	15.6667	23.36	Ő	15 6667	24 36	õ	Ő	1	0		
331	15.6667	24	Ō	15.6667	25	õ	õ	1	Ő		
332	15.3333	14.4	Ō	15.3333	15.4	õ	õ	1	Ő		
333	15.3333	15.04	0	15.3333	16.04	Õ	ŏ	i	õ		
334	15.3333	15.68	0	15.3333	16.68	õ	ŏ	i	õ		
335	15.3333	16.32	0	15.3333	17.32	0	Õ	i	ŏ		
336	15.3333	16.96	0	15.3333	17.96	0	Ō	1	õ		
337	15.3333	17.6	0	15.3333	18.6	0	0	ł	Ō		
338	15.3333	18.24	0	15.3333	19.24	0	0	ī	Õ		
339	15.3333	18.88	0	15.3333	19.88	0	0	1	Ō		
340	15.3333	19.52	0	15.3333	20.52	0	0	l	Ō		
341	15.3333	20.16	0	15.3333	21.16	0	0	1	0		
342	15.3333	20.8	0	15.3333	21.8	0	0	1	0		

343	15.3333	21.44	0	15.3333	22.44	0	0	1	0
344	15.3333	22.08	0	15 3333	23.08	õ	õ	1	ň
345	15 3333	22.00	õ	15 2222	23.00	ŏ	0	1	0
246	15.3333	22.72	0	15.3333	23.12	0	U	1	0
340	15.3333	23.36	0	15.3333	24.36	0	0	1	0
347	15.3333	24	0	15.3333	25	0	0	1	0
348	15	14.4	0	15	15.4	0	0	1	0
349	15	15.04	0	15	16.04	0	Ō	i	õ
350	15	15.68	Ň	15	16.61	õ	0	1	0
251	15	16.00	0	15	10.08	0	0	1	0
331	15	16.32	0	15	17.32	0	0	1	0
352	15	16.96	0	15	17.96	0	0	1	0
353	15	17.6	0	15	18.6	0	0	1	Ó
354	15	18 24	0	15	19 24	Ő.	ñ	1	0
355	15	19.99	Ň	15	10.99	ŏ	0	1	0
255	15	10.00	0	15	19.00	0	U	1	0
330	15	19.52	0	15	20.52	0	0	1	0
357	15	20.16	0	15	21.16	0	0	1	0
358	15	20.8	0	15	21.8	0	0	1	0
359	15	21.44	0	15	22 44	0	Ô	1	Ő
360	15	22.08	ň	15	22.09	0	õ	:	0
200	15	22.00	0	15	23.08	U	U	1	0
301	15	22.12	0	15	23.72	0	0	1	0
362	15	23.36	0	15	24.36	0	0	1	0
363	15	24	0	15	25	0	0	1	0
364	14 6667	14 4	Ó	14 6667	15.4	ň	ň	1	õ
265	14 6667	15.04	õ	14.6667	16.04	0	0	1	U O
200	14.0007	15.04	0	14.0007	10.04	0	U	I	0
366	14.6667	15.68	0	14.6667	16.68	0	0	1	0
367	14.6667	16.32	0	14.6667	17.32	0	0	1	0
368	14.6667	16.96	0	14.6667	17.96	0	0	1	Ó
369	14 6667	17.6	Ó	14 6667	18.6	õ	õ	1	ŏ
270	14 6667	19.24	ŏ	14.0007	10.0	0	0	1	0
270	14.0007	10.24	0	14.0007	19.24	0	U	1	0
3/1	14.0007	18.88	0	14.6667	19.88	0	0	1	0
372	14.6667	19.52	0	14.6667	20.52	0	0	1	0
373	14.6667	20.16	0	14.6667	21.16	0	0	1	Ô
374	14 6667	20.8	õ	14 6667	21.8	õ	0	1	0
275	14 6667	20.0	0	14.0007	21.0	0	0	1	0
373	14.0007	21.44	Ű	14.0007	22.44	0	0	I	0
376	14.6667	22.08	0	14.6667	23.08	0	0	1	0
377	14.6667	22.72	0	14.6667	23.72	0	0	1	0
378	14.6667	23.36	0	14 6667	24 36	0	0	1	Ō
379	14 6667	24	Ō	14 6667	25	õ	Ň	1	ŏ
200	1'4 2222	14.4	0	14.0007	23	0	0	1	0
200	14.3333	14.4	U O	14.3333	15.4	0	0	1	0
381	14.3333	15.04	0	14.3333	16.04	0	0	1	0
382	14.3333	15.68	0	14.3333	16.68	0	0	1	0
383	14.3333	16.32	0	14.3333	17.32	0	0	1	Ó
384	14 3333	16.96	Ô	14 3333	17.96	Ň	ň	i	õ
295	14 2222	174	õ	14.3333	10.0	0	0	1	0
202	14.3333	17.0	0	14.3333	18.0	U	0	I	0
380	14.3333	18.24	0	14.3333	19.24	0	0	1	0
387	14.3333	18.88	0	14.3333	19.88	0	0	1	0
388	14.3333	19.52	0	14.3333	20.52	0	0	1	0
389	14.3333	20.16	0	14 3333	21.16	õ	Ň		õ
300	14 3333	20.8	õ	14 2222	21.10	0	0	1	0
201	14 3232	20.0	0	14.3333	21.0	0	0	1	U
391	14.3333	21.44	0	14.3333	22.44	0	0	1	0
392	14.3333	22.08	0	14.3333	23.08	0	0	1	0
393	14.3333	22.72	0	14.3333	23.72	0	0	1	0
394	14.3333	23.36	0	14.3333	24.36	0	0	1	0
395	14 3333	24	0	14 3333	25	Ō	Ō	1	õ
306	14	14.4	õ	14	15 4	õ	0	1	0
207	14	15.04	0	14	13.4	0	0	1	0
391	14	15.04	0	14	16.04	0	0	1	0
398	14	15.68	0	14	16.68	0	0	1	0
399	14	16.32	0	14	17.32	0	0	1	0
400	14	16.96	0	14	17.96	Ô	0	1	ŏ
401	14	17.6	Ō	14	18.6	õ	õ		ŏ
402	14	19.34	õ	14	10.0	0	U O		0
402	14	10.24	0	14	19.24	U	0	1	0
403	14	18.88	0	14	19.88	0	0	1	0
404	14	19.52	0	14	20.52	0	0	I	0
405	14	20.16	0	14	21.16	0	0	1	0
406	14	20.8	0	14	21.8	0	n N	i	ň
407	14	21 44	ň	14	21.0	0	Ň		0
100	14	21.77	~	14	22.44	U A	U A	l	U
408	14	22.08	v	14	23.08	U	U	1	0
409	14	22.72	0	14	23.72	0	0	1	0
410	14	23.36	0	14	24.36	0	0	1	0
411	14	24	0	14	25	0	0	i	ñ
412	13 6667	14 4	0	13 6667	154	õ	ň		ň
412	13 6667	15.04	ň	12 4447	16.04	0	0	1	U O
-TLJ A1A	12 (((7	15.04	U C	13.000/	10.04	U	U	l	0
414	13.6667	15.68	U	13.6667	16.68	0	0	1	0

415	13 6667	16 22	0	12 4447	17 22	0	•		_
415	13.0007	10.52	U	13.0007	17.32	0	U	1	0
416	13.6667	16.96	0	13.6667	17.96	0	0	1	0
417	13.6667	17.6	0	13 6667	18.6	0	ñ	ī	ň
418	13 6667	18.24	Ň	12 6667	10.0	, ,	0	1	0
410	13.0007	10.24	U	13.0007	19.24	0	0	1	0
419	13.6667	18.88	0	13.6667	19.88	0	0	1	0
420	13.6667	19.52	0	13 6667	20.52	Ô	Ň		Å
421	12 6667	20.10	õ	13.0007	20.52	0	U	1	0
421	15.0007	20.10	U	13.6667	21.16	0	0	1	0
422	13.6667	20.8	0	13.6667	21.8	0	0	1	0
423	13 6667	21 44	0	12 6667	22.44	ő	õ		0
424	12.0007	22.00	0	13.0007	22.44	U	U	I	0
424	13.6667	22.08	0	13.6667	23.08	0	0	1	0
425	13.6667	22.72	0	13.6667	23 72	Δ	0	1	ò
426	13 6667	22.26	Ā	12 (((7	24.26	0	0	1	0
420	13.0007	23.50	0	13.0007	24.30	0	0	1	0
427	13.6667	24	0	13.6667	25	0	0	1	0
428	13.3333	14.4	0	13 3333	154	0	0	1	Ň
420	12 2222	15.04	ő	10.0000	10.4	0	0	1	U
429	15.5555	15.04	0	13.3333	16.04	0	0	1	0
430	13.3333	15.68	0	13.3333	16.68	0	0	I I	0
431	13 3333	16.32	0	13 3333	17 22	ň	Å		ő
422	10.0000	16.52	0	13.3333	17.52	U	U	I	0
432	13.3333	10.90	0	13.3333	17.96	0	0	1	0
433	13.3333	17.6	0	13 3333	18.6	٥	0	1	Ō
131	12 2222	19.34	- -	12 2222	10.04	ő	0	1	0
434	13.3333	10.24	U	15.5555	19.24	U	0	1	0
435	13.3333	18.88	0	13.3333	19.88	0	0	1	0
436	13.3333	19.52	0	13 3333	20.52	0	0	1	Ň
137	12 2222	20.16	Å	12 2222	21.16	0	0	1	0
437	13.3333	20.10	U	13.3333	21.10	0	0	]	0
438	13.3333	20.8	0	13.3333	21.8	0	0	1	0
439	13 3333	21 44	0	13 3333	22.44	ň	Å		0
440	13.3333	22.11	0	15.5555	22.44	U	U	1	0
440	13.3333	22.08	0	13.3333	23.08	0	0	1	0
441	13.3333	22.72	0	13 3333	23 72	0	Δ	1	Ó
447	13 3333	22.26	0	12 2222	24.26	0	0	1	0
442	12.3333	23.50	U	15.5555	24.30	U	0	I	0
443	13.3333	24	0	13.3333	25	0	0	1	0
444	13	144	0	13	15.4	٥	0	1	Ň
445	12	15.04	õ	10	13.4	0	U O	1	U
445	13	15.04	0	13	16.04	0	0	1	0
446	13	15.68	0	13	16.68	0	0	1	0
447	13	16 32	Δ	12	17 32	Ō	Å	1	Ň
110	12	16.06	0	13	17.52	0	0	1	U
448	12	10.90	0	13	17.96	0	0	1	0
449	13	17.6	0	13	18.6	0	0	1	۵
450	13	18 24	٥	12	10.24	ő	õ		
451	15	10.24	0	15	19.24	U	U	1	0
451	13	18.88	0	13	19.88	0	0	1	0
452	13	19.52	0	13	20.52	0	0	1	Ā
453	13	20.16	Ň	12	21.14	0	0	1	0
433	15	20.10	U	13	21.10	0	0	I	0
454	13	20.8	0	13	21.8	0	0	1	0
455	13	21 44	0	13	22 44	Ō	Ň	1	Ň
156	12	22.00	õ	15	22.77	0	0	1	U
430	13	22.08	0	13	23.08	0	0	1	0
457	13	22.72	0	13	23.72	0	0	1	٥
458	13	23.36	0	12	24.26	õ	õ		~
450	10	25.50	0	15	24.30	U	U	1	0
459	13	24	0	13	25	0	0	1	0
460	12.6667	14.4	0	12.6667	15.4	0	0	1	Δ
461	12 6667	15.04	0	12 6667	16.04	õ	õ		0
4(2)	12.0007	15.04	0	12.0007	10.04	U	0	1	0
462	12.6667	15.68	0	12.6667	16.68	0	0	1	0
463	12.6667	16.32	0	12.6667	17 32	0	0	1	٥
464	12 6667	16.06	0	12 667	17.00	õ			U
446	12.0007	10.90	0	12.0007	17.90	U	U	I	0
465	12.6667	17.6	0	12.6667	18.6	0	0	1	0
466	12.6667	18.24	0	12.6667	19 24	0	0	1	Ō
467	12 6667	18.88	Ā	13 4447	10.99	0	0	1	0
4/0	12.0007	10.00	0	12.0007	19.00	U	0	1	0
468	12.6667	19.52	0	12.6667	20.52	0	0	1	0
469	12.6667	20.16	0	12 6667	21.16	0	٥	1	Ô
470	12 6667	20.8	0	12 (((7	31.0	0	0	1	0
470	12.0007	20.8	v	12.0007	21.8	0	U	1	0
471	12.6667	21.44	0	12.6667	22.44	0	0	1	0
472	12.6667	22.08	0	12.6667	23.08	0	0	1	Ō
473	12 6667	22.22	0	17 4447	22.00	0	0	1	0
	12.0007	22.12	U	12.0007	23.12	0	0	1	0
4/4	12.6667	23.36	0	12.6667	24.36	0	0	1	0
475	12.6667	24	0	12.6667	25	0	Ó	1	ň
476	12 2222	14.4	õ	12 2222	15 4	0	0		v
110	12.3333	14.4	U	12.3555	15.4	U	U	1	0
477	12.3333	15.04	0	12.3333	16.04	0	0	1	0
478	12.3333	15.68	0	12 3333	16.68	Ω	n.	1	ň
470	12 2222	16.00	Č	12.3333	10.00	0	U C	1	U
417	12.3333	10.32	U	12.3333	17.32	0	0	1	0
480	12.3333	16.96	0	12.3333	17.96	0	0	1	n
481	12 3333	17.6	Ω	17 2222	19.6	Ň	Ň	•	~
107	12.0000	10.04	0	12.0000	10.0	v	U	1	0
402	12.3335	18.24	U	12.3333	19.24	0	0	I	0
483	12.3333	18.88	0	12.3333	19.88	0	0	1	0
484	12 3333	19 52	n	12 2222	20.52	ñ	ň	:	0
105	12.0000	20.14	v	12.3333	20.32	U	U	I	0
480	12.3333	20.16	U	12.3333	21.16	0	0	1	0
486	12.3333	20.8	0	12 3333	21.8	0	0	i	ň
			-			•	v	1	v

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	487	12.3333	21.44	0	12 3333	22 44	0	0	1	0
	488	12 3333	22.08	õ	12.3333	22.14	0	0	1	0
	400	12.3333	22.00	0	12.3333	23.08	U	U	1	U
	489	12.3333	22.12	0	12.3333	23.72	0	0	1	0
	<b>49</b> 0	12.3333	23.36	0	12.3333	24.36	0	0	1	0
	491	12 3333	24	0	12 3333	25	Ň	õ	1	õ
	402	12	14.4	Å	12.5555	15 4	ő	0	1	0
	472	12	14.4	U	12	15.4	U	0	I	0
	493	12	15.04	0	12	16.04	0	0	1	0
	494	12	15.68	0	12	16.68	0	0	1	0
	495	12	16.32	0	12	17 32	Ň	õ	;	ŏ
	406	12	16.06	0	12	17.52	U O	0	1	Ű
	490	12	10.90	U	12	17.96	0	0	1	0
	497	12	17.6	0	12	18.6	0	0	1	0
	498	12	18.24	0	12	19.24	0	0	1	0
	400	12	18 88	0	12	10.99	ő	0	;	0
	500	12	10.00	0	12	19.00	0	U	1	U
	500	12	19.52	0	12	20.52	0	0	1	0
	501	12	20.16	0	12	21.16	0	0	1	0
	502	12	20.8	0	12	21.8	0	Ó	1	Ō
	503	12	21.44	õ	10	21.0	ů	0		0
	505	12	21.44	0	12	22.44	0	U	1	0
	504	12	22.08	0	12	23.08	0	0	1	0
	505	12	22.72	0	12	23.72	0	0	1	0
	506	12	23 36	0	12	24.36	ñ	Ň	i	ŏ
	500	12	23.50	0	12	24.50	0	0		U
	307	12	24	0	12	25	0	0	1	0
	509	16	1.8	0	16	2.8	0	0	1	0
	510	16	3.6	0	16	4.6	0	Ω	1	0
	511	16	5.4	ñ	16	6.4	õ	0	1	0
	511	10	5.4	U	10	0.4	0	U	1	0
	512	16	7.2	0	16	8.2	0	0	1	0
	513	16	9	0	16	10	0	0	1	0
	514	16	10.8	Ó	16	11.9	õ	ň	÷	ŏ
•	515	10	10.0	0	10	11.0	0	U	1	U
	515	10	12.0	0	16	13.6	0	0	1	0
	517	14	1.8	0	14	2.8	0	0	1	0
	518	14	3.6	0	14	46	0	Ó	1	Ō
	510	14	5 4	ň	14	6.4	õ	0	,	0
	519	14	3.4	U O	14	0.4	U	U	1	0
	520	14	7.2	0	14	8.2	0	0	1	0
	521	14	9	0	14	10	0	0	1	0
	522	14	10.8	0	14	118	Ó	ů.	ī	Ň
	572	14	10.0	õ	14	12.6	0	0	1	0
	323	14	12.0	U	14	13.0	0	0	1	0
	526	12	1.8	0	12	2.8	0	0	1	0
	527	12	3.6	0	12	46	0	0	1	Ó
	528	12	5.4	Å	12	6.4	ő	õ	1	0
	520	12	3.4	0	12	0.4	0	0	1	U
	529	12	1.2	0	12	8.2	0	0	1	0
	530	12	9	0	12	10	0	0	1	0
	531	12	10.8	0	12	11.8	Ō	0	1	ň
	522	12	10.0	Å	12	12.0	0	0	1	0
	552	12	12.0	0	12	13.0	0	0	1	0
	534	10	1.8	0	10	2.8	0	0	1	0
	535	10	3.6	0	10	4.6	0	0	1	0
	536	10	5 1	Ō	10	6.4	õ	õ	;	0
	550	10	5.4	0	10	0.4	U	0	1	0
	537	10	1.2	0	10	8.2	0	0	1	0
	538	10	9	0	10	10	0	0	1	0
	539	10	10.8	0	10	11.8	0	0	1	0
	540	10	174	ů ů	10	11.0	0	0		0
	540	10	12.0	v	10	13.0	U	U	1	0
	541	10	14.4	0	10	15.4	0	0	1	0
	543	8	1.8	0	8	2.8	0	0	1	0
	544	8	3.6	0	8	4.6	ò	Ň	ī	ň
	545	ě	5 1	ň	0	6.4	~	0 A	4	~
	545	0	J.4	U O	0	0.4	U	U	I	U
	546	8	1.2	U	8	8.2	0	0	1	0
	547	8	9	0	8	10	0	0	1	0
	548	8	10.8	0	8	11.8	Ô	Õ	i	Ň
	540	0	10.0	0	0	11.0	0	0	1	U
	349	8	12.0	0	ð	13.0	0	0	I	0
	550	8	14.4	0	8	15.4	0	0	1	0
	552	6	1.8	0	6	2.8	0	0	1	0
	553	6	36	Λ	6	16	Ň	Ň	1	ő
	555	2	5.0	0	J	<b>T</b> .0	v v	U	1	U
	334	D	5.4	U	0	0.4	U	U	1	0
	555	6	7.2	0	6	8.2	0	0	1	0
	556	6	9	0	6	10	0	0	1	Ň
	557	6	10.9	ň	4	11 0	õ	č	1	~
	551	U C	10.0	U C	U Ú	11.0	U	U	1	U
	228	0	12.6	U	6	13.6	0	0	1	0
	559	6	14.4	0	6	15.4	0	0	1	0
	561	4	1.8	0	4	2.8	n	Ô	1	ň
	567	4	3.6	õ		2.0 A 6	õ	0	1	0
	502	-	J.U 2 4	~	4	4.0	U	V	1	U
	203	4	5.4	U	4	6.4	0	0	1	0
	564	4	7.2	0	4	8.2	0	0	1	0
	565	4	9	0	4	10	ñ	ñ	1	ň
	564		10.0	~	-	10	0	U C	1	U
	200	4	10.8	U	4	11.8	U	0	1	0

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567	4	12.6	0	4	13.6	0	0	1	0
568	4	14.4	0	4	15.4	õ	ŏ	1	ŏ
570	2	1.8	0	2	2.8	Ő	õ	1	ň
571	2	3.6	õ	2	4.6	Ň	Ő	1	0
572	2	5.4	ŏ	2	4.0	0	0	1	0
573	2		0	2	0.4	0	0	1	0
575	2	7.2	0	2	8.2	0	0	1	0
574	2	9	U	2	10	0	0	1	0
575	2	10.8	0	2	11.8	0	0	1	0
576	2	12.6	0	2	13.6	0	0	1	0
577	2	14.4	0	2	15.4	0	0	1	0
579	0	1.8	0	0	2.8	0	0	1	Ó
580	0	3.6	0	0	4.6	Ō	õ	i	ň
581	0	54	õ	ŏ	6.4	ň	Õ	1	0
582	Ň	7 2	Õ	õ	87	ő	0	1	0
583	õ	0	ő	0	0.2	0	0	1	0
501	0	7	0	Ů,	10	0	0	1	0
504	0	10.8	0	0	11.8	0	0	1	0
282	0	12.6	0	0	13.6	0	0	1	0
586	0	14.4	0	0	15.4	0	0	1	0
587	12	16	0	12	17	0	0	1	0
589	12	19.2	0	12	20.2	0	0	1	0
591	12	22.4	0	12	23.4	0	0	1	0
592	10	16	0	10	17	0	Ő	i	ň
593	10	17.6	ň	10	18.6	õ	0	1	0
504	10	10.7	Ő	10	10.0	0	0	1	0
505	10	19.2	0	10	20.2	U	0	1	0
393	10	20.8	0	10	21.8	0	0	1	0
596	10	22.4	0	10	23.4	0	0	1	0
597	10	24	0	10	25	0	0	1	0
598	8	16	0	8	17	0	0	1	0
599	8	17.6	0	8	18.6	0	0	1	0
600	8	19.2	0	8	20.2	0	õ	1	Ň
601	8	20.8	ñ	Ř	21.8	õ	õ	1	Ő
602	8	22.0	ñ	e e	21.0	0	0	1	0
603	8	22.4	õ	0 0	23.4	0	0	1	0
404	0 4	14	0	0	25	0	0	1	0
004	0	10	0	Ó	17	0	0	I	0
603	0	17.6	0	6	18.6	0	0	1	0
606	6	19.2	0	6	20.2	0	0	1	0
607	6	20.8	0	6	21.8	0	0	1	0
608	6	22.4	0	6	23.4	0	0	1	0
609	6	24	0	6	25	0	0	1	0
610	4	16	0	4	17	0	0	i	Ň
611	4	17.6	õ	4	18.6	Ň	õ	i	ň
612	4	19.2	ñ	Å	20.2	ő	Ő	1	0
613	4	20.8	Ő	4	20.2	0	0	1	0
614	4	20.8	0	4	21.0	0	0	1	0
(15	4	22.4	0	4	23.4	0	0	1	0
010	4	24	0	4	25	0	0	1	0
616	2	16	0	2	17	0	0	1	0
617	2	17.6	0	2	18.6	0	0	1	0
618	2	19.2	0	2	20.2	0	0	1	0
619	2	20.8	0	2	21.8	0	0	1	0
620	2	22.4	0	2	23.4	0	0	1	0
621	2	24	0	2	25	0	0	1	Ō
622	0	16	0	0	17	0	õ	i	Ň
623	0	17.6	Ō	õ	18.6	õ	0	1	0
624	ñ	19.2	õ	õ	20.2	Ň	0	1	0
625	ň	20.9	0	0	20.2	0	0	1	U
625	0	20.0	0	0	21.0	0	0	l	0
020	0	22.4	0	U	23.4	0	0	I	0
027	U	24	0	0	25	0	0	1	0
628	16	25.3333	0	16	26.3333	0	0	1	0
629	16	26.6667	0	16	27.6667	0	0	1	0
630	16	28	0	16	29	0	0	1	0
631	16	29.3333	0	16	30.3333	0	0	1	0
632	16	30.6667	0	16	31.6667	0	0	1	ñ
633	16	32	0	16	33	Ô	Ō	1	ň
635	14	25,3333	Ő	14	26 3333	õ	ň	1	Ň
636	14	26.5555	ň	14	20.3333	Ň	0	1	U A
627	14	20.000/	N N	14	27.0007	U	U	1	0
420	14	20	0	14	29	U	U	1	0
(20	14	29.3333	U	14	30.3333	0	U	1	0
639	14	30.6667	U	14	31.6667	0	0	1	0
640	14	32	0	14	33	0	0	1	0
641	12	25.3333	0	12	26.3333	0	0	1	0
642	12	26.6667	0	12	27.6667	0	0	1	0
643	12	28	0	12	29	0	0	1	Ō
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644	12	29.3333	0	12	30.3333	0	0	1	0
645	12	30.6667	0	12	31,6667	õ	ů	i	Ň
646	12	32	0	12	33	õ	0	i	ň
647	10	25 3333	õ	10	26 3333	ŏ	0	1	0
648	10	26 6667	õ	10	20.5555	Ő	0	1	0
649	10	20.000,	õ	10	27.0007	0	0	1	0
650	10	20	0	10	29	0	0	1	0
651	10	27.3333	0	10	30.3333	0	0	1	0
653	10	30.0007	0	10	31.0007	0	0	1	0
652	10	52	0	10	33	0	0	1	0
033	8	25.3333	0	8	26.3333	0	0	1	0
034	8	26.6667	0	8	27.6667	0	0	1	0
633	8	28	0	8	29	0	0	1	0
656	8	29.3333	0	8	30.3333	0	0	1	0
657	8	30.6667	0	8	31.6667	0	0	1	0
658	8	32	0	8	33	0	0	1	0
659	6	25.3333	0	6	26.3333	0	0	1	0
660	6	26.6667	0	6	27.6667	0	0	1	0
661	6	28	0	6	29	0	0	1	Ō
662	6	29.3333	0	6	30.3333	Ó	Ō	1	Ň
663	6	30.6667	0	6	31 6667	Ō	õ	1	ň
664	6	32	ō	Ğ	33	õ	Õ	1	0
665	4	25 3333	õ	4	26 3333	ŏ	õ	1	0
666	4	25.5555	ŏ	4	20.3333	0	0	1	0
667	4	20.0007	0	4	27.0007	0	0	1	0
607	4	20 2222	0	4	29	0	0	1	0
600	4	29.3333	U	4	30.3333	U	0	1	0
009	4	30.6667	0	4	31.6667	0	0	ł	0
670	4	32	0	4	33	0	0	1	0
671	2	25.3333	0	2	26.3333	0	0	1	0
672	2	26.6667	0	2	27.6667	0	0	1	0
673	2	28	0	2	29	0	0	1	0
674	2	29.3333	0	2	30.3333	0	0	1	Ő
675	2	30.6667	0	2	31.6667	0	0	1	Ō
676	2	32	0	2	33	0	Ő	i	õ
677	0	25.3333	0	ō	26 3333	ŏ	ñ	i	Ň
678	Ō	26 6667	õ	õ	27 6667	õ	ů	1	0
679	õ	20.0001	Ň	õ	20,0007	ő	0	1	0
680	Õ	20 3333	Ő	õ	30 3333	0	0	1	0
681	Õ	30 6667	ů	õ	21 6667	0	0	1	0
692	õ	20.0007	0	0	21.0007	0	0	1	U
695	0	32	0	0	33	0	U	1	0
000	2	14.5	0	0	15.3	U Q	0	I	0
080	2	14.3	0	2	15.3	0	0	1	0
08/	4	14.3	0	4	15.3	0	0	1	0
688	6	14.3	0	6	15.3	0	0	1	0
689	8	14.3	0	8	15.3	0	0	1	0
690	10	14.3	0	10	15.3	0	0	1	0
691	12	14.3	0	12	15.3	0	0	1	0
692	14	14.3	0	14	15.3	0	0	1	0
693	16	14.3	0	16	15.3	0	0	1	0
694	0	24.1	0	0	25.1	0	0	1	0
695	2	24.1	0	2	25.1	0	Ō	i	Ő
696	4	24.1	0	4	25.1	Ō	Ō	i	ő
697	6	24.1	0	6	25.1	õ	õ	i	ň
698	8	24.1	õ	Ř	25.1	ŏ	Ň	;	Ň
699	10	24.1	õ	10	25.1	õ	Ň	1	0
700	12	24.1	õ	12	25.1	õ	õ	1	0
701	14	24.1	õ	14	25.1	0	0	1	0
702	14	27.1	0	14	23.1	0	U	1	0
702	10	24.1	U	10	25.1	U	U	L	0
703	11.4	14.4	U	11.4	15.4	0	0	1	0
/04	11.9	16	0	11.9	17	0	0	1	0
705	11.9	17.6	0	11.9	18.6	0	0	1	0
706	11.9	19.2	0	11.9	20.2	0	0	I	0
707	11.9	20.8	0	11.9	21.8	0	0	l	0
708	11.9	22.4	0	11.9	23.4	0	0	1	0
709	11.4	24	0	11.4	25	0	0	1	0

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## APPENDIX A-3

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## STARS-SOLIDS Generalized Mode 2 Displacement Definition (Pitch)

	Original XY	Z Location		New XYZ	Location		Nodal Dis	placement	
Node	X	Y	Z	X	Y'	Z	ΔΧ	Δv	ΔZ
13	0	0	0	0.001218	0	0.139619	0.001218	0	0.139619
14	2	0	0	2.000914	0	0.104714	0.000914	0	0.104714
52	4	0	0	4.000609	0	0.06981	0.000609	0	0.06981
53	6	0	0	6.000305	0	0.034905	0.000305	0	0.034905
54	8	0	0	8	0	0	0	0	0
55	10	0	0	9.999695	0	-0.0349	-0.0003	0	-0.0349
56	12	0	0	11.99939	0	-0.06981	-0.00061	0	-0.06981
90	14	0	0	13.99909	0	-0.10471	-0.00091	0	-0.10471
91	16	0	0	15.99878	0	-0.13962	-0.00122	0	-0.13962
300	16	14.4	0	15.99878	14.4	-0.13962	-0.00122	0	-0.13962
301	16	15.04	0	15.99878	15.04	-0.13962	-0.00122	0	-0.13962
302	16	15.68	0	15.99878	15.68	-0.13962	-0.00122	0	-0.13962
303	16	16.32	0	15.99878	16.32	-0.13962	-0.00122	0	-0.13962
304	16	16.96	0	15.99878	16.96	-0.13962	-0.00122	0	-0.13962
305	16	17.6	0	15.99878	17.6	-0.13962	-0.00122	0	-0.13962
306	16	18.24	0	15.99878	18.24	-0.13962	-0.00122	0	-0.13962
307	16	18.88	0	15.99878	18.88	-0.13962	-0.00122	0	-0.13962
308	16	19.52	0	15.99878	19.52	-0.13962	-0.00122	0	-0.13962
309	16	20.16	0	15.99878	20.16	-0.13962	-0.00122	0	-0.13962
310	16	20.8	0	15.99878	20.8	-0.13962	-0.00122	0	-0.13962
311	16	21.44	0	15. <b>99878</b>	21.44	-0.13962	-0.00122	0	-0.13962
312	16	22.08	0	15.99878	22.08	-0.13962	-0.00122	0	-0.13962
313	16	22.72	0	15.99878	22.72	-0.13962	-0.00122	0	-0.13962
314	16	23.36	0	15.99878	23.36	-0.13962	-0.00122	0	-0.13962
315	16	24	0	15.99878	24	-0.13962	-0.00122	0	-0.13962
316	15.6667	14.4	0	15.66553	14.4	-0.1338	-0.00117	0	-0.1338
317	15.6667	15.04	0	15.66553	15.04	-0.1338	-0.00117	0	-0.1338
318	15.6667	15.68	0	15.66553	15.68	-0.1338	-0.00117	0	-0.1338
319	15.6667	16.32	0	15.66553	16.32	-0.1338	-0.00117	0	-0.1338
320	15.6667	16.96	0	15.66553	16.96	-0.1338	-0.00117	0	-0.1338
321	15.6667	17.6	0	15.66553	17.6	-0.1338	-0.00117	0	-0.1338
322	15.6667	18.24	0	15.66553	18.24	-0.1338	-0.00117	0	-0.1338
323	15.6667	18.88	0	15.66553	18.88	-0.1338	-0.00117	0	-0.1338
324	15.6667	19.52	0	15.66553	19.52	-0.1338	-0.00117	0	-0.1338
325	15.6667	20.16	0	15.66553	20.16	-0.1338	-0.00117	0	-0.1338
326	15.6667	20.8	0	15.66553	20.8	-0.1338	-0.00117	0	-0.1338
327	15.6667	21.44	0	15.66553	21.44	-0.1338	-0.00117	0	-0.1338
328	15.6667	22.08	0	15.66553	22.08	-0.1338	-0.00117	0	-0.1338
329	15.6667	22.72	0	15.66553	22.72	-0.1338	-0.00117	0	-0.1338
330	15.6667	23.36	0	15.66553	23.36	-0.1338	-0.00117	0	-0.1338
331	15.6667	24	0	15.66553	24	-0.1338	-0.00117	0	-0.1338
332	15.3333	14.4	0	15.33218	14.4	-0.12798	-0.00112	0	-0.12798
333	15.3333	15.04	0	15.33218	15.04	-0.12798	-0.00112	0	-0.12798
334	15.3333	15.68	0	15.33218	15.68	-0.12798	-0.00112	0	-0.12798
335	15.3333	16.32	0	15.33218	16.32	-0.12798	-0.00112	0	-0.12798
336	15.3333	16.96	0	15.33218	16.96	-0.12798	-0.00112	0	-0.12798
337	15.3333	17.6	0	15.33218	17.6	-0.12798	-0.00112	0	-0.12798
338	15.3333	18.24	0	15.33218	18.24	-0.12798	-0.00112	0	-0.12798
339	15.3333	18.88	0	15.33218	18.88	-0.12798	-0.00112	0	-0.12798
340	15.3333	19.52	0	15.33218	19.52	-0.12798	-0.00112	0	-0.12798
341	15.3333	20.16	0	15.33218	20.16	-0.12798	-0.00112	0	-0.12798
342	15.3333	20.8	0	15.33218	20.8	-0.12798	-0.00112	0	-0.12798

343	15.3333	21.44	0	15.33218	21.44	-0.12798	-0.00112	0	-0.12798
344	15.3333	22.08	0	15.33218	22.08	-0.12798	-0.00112	0	-0 12798
345	15,3333	22 72	0	15 33218	22 72	-0 12798	-0.00112	ñ	0 12708
346	15 2222	22.72	õ	15 22210	22.72	0.12790	-0.00112	0	-0.12798
240	15.5555	23.30	v	15.33218	23.30	-0.12/98	-0.00112	0	-0.12798
347	15.3333	24	0	15.33218	24	-0.12798	-0.00112	0	-0.12798
348	15	14.4	0	14.99893	14.4	-0.12217	-0.00107	0	-0.12217
349	15	15.04	0	14.99893	15.04	-0 12217	-0.00107	Ô	-0 12217
350	15	15.68	ñ	14 00802	15.69	0.12217	0.00107	0	-0.12217
251	15	16.00	0	14.77073	15.00	-0.12217	-0.00107	U	-0.12217
351	15	16.32	0	14.99893	16.32	-0.12217	-0.00107	0	-0.12217
352	15	16.96	0	14.99893	16.96	-0.12217	-0.00107	0	-0.12217
353	15	17.6	0	14.99893	17.6	-0 12217	-0.00107	0	-0 12217
354	15	18 24	Õ	14 00803	18 74	0 12217	0.00107	õ	0.12217
255	15	10.24	ŏ	14.00000	10.24	-0.12217	-0.00107	0	-0.12217
333	15	10.00	0	14.99893	18.88	-0.12217	-0.00107	0	-0.12217
356	15	19.52	0	14.99893	19.52	-0.12217	-0.00107	0	-0.12217
357	15	20.16	0	14.99893	20.16	-0.12217	-0.00107	0	-0.12217
358	15	20.8	0	14 99893	20.8	-0 12217	-0.00107	Ō	-0 12217
250	15	21.44	Ő	14.00002	21.44	0.12217	-0.00107	0	-0.12217
339	15	21.44	0	14.99893	21.44	-0.12217	-0.00107	0	-0.12217
360	15	22.08	0	14.99893	22.08	-0.12217	-0.00107	0	-0.12217
361	15	22.72	0	14.99893	22.72	-0.12217	-0.00107	0	-0.12217
362	15	23.36	0	14 99893	23 36	-0 12217	-0.00107	Ó	-0 12217
363	15	24	Ň	14 00903	21	0.12217	0.00107	0	0.12217
205	14 (((7	144	0	14.33033	24	-0.12217	-0.00107	U	-0.12217
304	14.0007	14.4	U	14.66568	14.4	-0.11635	-0.00102	0	-0.11635
365	14.6667	15.04	0	14.66568	15.04	-0.11635	-0.00102	0	-0.11635
366	14.6667	15.68	0	14.66568	15.68	-0.11635	-0.00102	0	-0.11635
367	14 6667	16 32	0	14 66568	16 32	-0 11635	-0.00102	ò	0 11625
368	14 6667	16.06	ŏ	14.00500	16.06	0.11635	-0.00102	0	-0.11033
308	14.0007	10.90	0	14.00308	10.90	-0.11035	-0.00102	U	-0.11635
369	14.0007	17.6	0	14.66568	17.6	-0.11635	-0.00102	0	-0.11635
370	14.6667	18.24	0	14.66568	18.24	-0.11635	-0.00102	0	-0.11635
371	14.6667	18.88	0	14 66568	18 88	-0 11635	-0.00102	0	-0 11635
377	14 6667	10.52	0	14 66569	10.50	0.11635	0.00102	0	-0.11035
272	14.0007	17.52	0	14.00308	19.52	-0.11033	-0.00102	U	-0.11035
3/3	14.000/	20.16	0	14.66568	20.16	-0.11635	-0.00102	0	-0.11635
374	14.6667	20.8	0	14.66568	20.8	-0.11635	-0.00102	0	-0.11635
375	14.6667	21.44	0	14.66568	21.44	-0.11635	-0.00102	0	-0.11635
376	14 6667	22.08	Ô	14 66568	22.08	-0 11635	-0.00102	õ	0.11635
277	14 6667	22.00	Ň	14.00500	22.00	-0.11035	-0.00102	0	-0.11033
277	14.0007	22.12	0	14.00308	22.12	-0.11035	-0.00102	0	-0.11635
378	14.6667	23.36	0	14.66568	23.36	-0.11635	-0.00102	0	-0.11635
379	14.6667	24	0	14.66568	24	-0.11635	-0.00102	0	-0.11635
380	14.3333	14.4	0	14.33234	14 4	-0.11053	-0.00096	Ó	-0 11053
381	14 3333	15.04	Ň	14 22224	15.04	0.11053	0.00070	0	-0.11055
201	14.3333	15.04	U O	14.33234	13.04	-0.11055	-0.00090	0	-0.11053
382	14.3333	15.68	0	14.33234	15.68	-0.11053	-0.00096	0	-0.11053
383	14.3333	16.32	0	14.33234	16.32	-0.11053	-0.00096	0	-0.11053
384	14.3333	16.96	0	14.33234	16.96	-0.11053	-0.00096	0	-0 11053
385	14 3333	17.6	Ō	14 33334	17.6	0 11052	0.00004	Ő	0.11055
202	14.3333	19.04	0	14.33234	17.0	-0.11055	-0.00090	U	-0.11055
300	14.3333	10.24	0	14.33234	18.24	-0.11053	-0.00096	0	-0.11053
387	14.3333	18.88	0	14.33234	18.88	-0.11053	-0.00096	0	-0.11053
388	14.3333	19.52	0	14.33234	19.52	-0.11053	-0.00096	0	-0.11053
389	14.3333	20.16	0	14 33234	20.16	-0.11053	-0.00096	0	-0 11053
390	14 3333	20.8	õ	14 33234	20.10	-0.11053	0.00006	0	0.11055
201	14.3333	20.0	0	14.33234	20.8	-0.11033	-0.00090	0	-0.11055
391	14.3333	21.44	U	14.33234	21.44	-0.11053	-0.00096	0	-0.11053
392	14.3333	22.08	0	14.33234	22.08	-0.11053	-0.00096	0	-0.11053
393	14.3333	22.72	0	14.33234	22.72	-0.11053	-0.00096	0	-0.11053
394	14.3333	23.36	0	14.33234	23.36	-0.11053	-0 00096	ñ	-0 11052
305	14 3333	24	õ	14 22224	24	0.11052	0.00006	õ	0.11055
204	14	14.4	0	12 00000	27	-0.11033	-0.00090	0	-0.11053
390	14	14.4	0	13.99909	14.4	-0.10471	-0.00091	0	-0.10471
397	14	15.04	0	13.99909	15.04	-0.10471	-0.00091	0	-0.10471
398	14	15.68	0	13.99909	15.68	-0.10471	-0.00091	0	-0.10471
399	14	16.32	0	13 99909	16 32	-0 10471	-0.00091	Ô	-0 10471
400	14	16.06	ñ	13,00000	14.04	0.10471	0.00001	0	-0.10471
400	14	10.90	0	13.77709	10.90	-0.10471	-0.00091	0	-0.10471
401	14	17.6	0	13.99909	17.6	-0.10471	-0.00091	0	-0.10471
402	14	18.24	0	13.99909	18.24	-0.10471	-0.00091	0	-0.10471
403	14	18.88	0	13.99909	18.88	-0.10471	-0.00091	0	-0.10471
404	14	19.52	0	13 99909	19 52	-0 10471	0 00001	õ	-0 10471
405	14	20.14	ň	12 00000	20.14	0.10471	0.00071	~	-0.10471
405	14	20.10	U	13.99909	20.10	-0.104/1	-0.00091	U	-0.10471
406	14	20.8	0	13.99909	20.8	-0.10471	-0.00091	0	-0.10471
407	14	21.44	0	13.99909	21.44	-0.10471	-0.00091	0	-0.10471
408	14	22.08	0	13,99909	22.08	-0.10471	-0.00091	ò	-0 10471
409	14	22 72	Ň	13 00000	22.00	-0 10471	-0.00001	ň	0.10471
410	14	22.72	0	13.77707	22.12	-0.104/1	-0.00091	U C	-0.10471
410	14	23.30	U	13.99909	23.36	-0.10471	-0.00091	0	-0.10471
411	14	24	0	13.99909	24	-0.10471	-0.00091	0	-0.10471
412	13.6667	14.4	0	13.66584	14.4	-0.0989	-0.00086	0	-0.0989
413	13.6667	15.04	0	13.66584	15.04	-0.0989	-0.00086	Ō	-0.0080
414	13 6667	15 69	ň	12 66504	15.04	-0.0202	0.00000	~	-0.0707
717	13.0007	13.00	v	13.00384	13.08	-0.0787	-0.00080	U	-0.0989

415	13.6667	16.32	0	13.66584	16 32	-0.0989	-0.00086	0	0.0090
416	13.6667	16.96	0	13 66584	16.06	.0.0080	0.00000	0	-0.0787
417	13 6667	17.6	0	12 44694	10.50	-0.0767	-0.00086	0	-0.0989
419	12 6667	19.34	0	13.00384	17.0	-0.0989	-0.00086	0	-0.0989
410	13.0007	18.24	0	13.66584	18.24	-0.0989	-0.00086	0	-0.0989
419	13.6667	18.88	0	13.66584	18.88	-0.0989	-0.00086	0	-0.0989
420	13.6667	19.52	0	13.66584	19.52	-0.0989	-0.00086	0	-0.0989
421	13.6667	20.16	0	13.66584	20.16	-0.0989	-0.00086	Ó	-0.0989
422	13.6667	20.8	0	13.66584	20.8	-0.0989	-0.00086	õ	0.0000
423	13 6667	21 44	õ	13 66584	21.44	0.0080	-0.00080	0	-0.0989
474	13 6667	22.09	ő	13.00384	21.44	-0.0989	-0.00080	0	-0.0989
425	13.0007	22.00	U O	13.00384	22.08	-0.0989	-0.00086	0	-0.0989
425	13.000/	22.72	0	13.66584	22.72	-0.0989	-0.00086	0	-0.0989
426	13.6667	23.36	0	13.66584	23.36	-0.0989	-0.00086	0	-0.0989
427	13.6667	24	0	13.66584	24	-0.0989	-0.00086	Ō	-0.0080
428	13.3333	14.4	0	13 33249	144	-0.00308	-0.00001	ŏ	0.0000
429	13 3333	15.04	õ	13 33240	15.04	0.00300	-0.00081	0	-0.09308
120	12 2222	15.04	0	13.33249	13.04	-0.09308	-0.00081	0	-0.09308
430	13.3333	15.08	U	13.33249	15.68	-0.09308	-0.00081	0	-0.09308
431	13.3333	16.32	0	13.33249	16.32	-0.09308	-0.00081	0	-0.09308
432	13.3333	16.96	0	13.33249	16.96	-0.09308	-0.00081	0	-0.09308
433	13.3333	17.6	0	13.33249	17.6	-0.09308	-0.00081	Ó	-0.00308
434	13.3333	18.24	0	13 33249	18 24	-0.00308	-0.00081	Ő	-0.07508
435	13 3333	18.88	Ō	13 33240	10.00	0.00000	0.00081	0	-0.09308
136	12 2222	10.00	0	13.33249	10.00	-0.09308	-0.00081	0	-0.09308
427	13.3333	19.32	0	13.33249	19.52	-0.09308	-0.00081	0	-0.09308
437	13.3333	20.16	0	13.33249	20.16	-0.09308	-0.00081	0	-0.09308
438	13.3333	20.8	0	13.33249	20.8	-0.09308	-0.00081	0	-0.09308
439	13.3333	21.44	0	13.33249	21.44	-0.09308	-0.00081	0	-0.09308
440	13.3333	22.08	0	13.33249	22.08	-0.09308	-0.00081	Ň	0.00208
441	13 3333	22 72	0	13 33240	22.00	0.00208	0.00001	0	-0.09308
442	13 3333	72.26	õ	12.2249	22.12	-0.09308	-0.00081	0	-0.09308
442	12.2222	23.30	0	13.33249	23.30	-0.09308	-0.00081	0	-0.09308
443	13.3333	24	0	13.33249	24	-0.09308	-0.00081	0	-0.09308
444	13	14.4	0	12.99924	14.4	-0.08726	-0.00076	0	-0.08726
445	13	15.04	0	12.99924	15.04	-0.08726	-0.00076	0	-0.08726
446	13	15.68	0	12.99924	15.68	-0.08726	-0.00076	Ő	0.00726
447	13	16.32	Ô	12 00024	16 32	0.08726	0.00076	0	-0.08720
449	12	16.04	Ň	12.77724	16.32	-0.08720	-0.00076	0	-0.08/26
440	13	10.90	0	12.99924	16.96	-0.08726	-0.00076	0	-0.08726
449	13	17.6	0	12.99924	17.6	-0.08726	-0.00076	0	-0.08726
450	13	18.24	0	12.99924	18.24	-0.08726	-0.00076	0	-0.08726
451	13	18.88	0	12.99924	18.88	-0.08726	-0.00076	0	-0.08726
452	· 13	19.52	0	12.99924	19.52	-0.08726	-0.00076	Ō	-0.08726
453	13	20.16	Ō	12 99924	20.16	-0.08726	0.00076	0	-0.08720
454	13	20.10	ň	12.00024	20.10	-0.08720	-0.00076	0	-0.08/20
455	13	20.8	0	12.99924	20.8	-0.08/26	-0.00076	0	-0.08726
435	15	21.44	0	12.99924	21.44	-0.08726	-0.00076	0	-0.08726
456	13	22.08	0	12.99924	22.08	-0.08726	-0.00076	0	-0.08726
457	13	22.72	0	12.99924	22.72	-0.08726	-0.00076	0	-0.08726
458	13	23.36	0	12.99924	23.36	-0.08726	-0.00076	Ô	-0.08726
459	13	24	0	12 99924	24	-0.08726	-0.00076	õ	0.00720
460	12 6667	14.4	Ō	12 66500	14.4	0.00146	-0.00070	0	-0.08/20
461	12.0007	15.04	0	12.00399	14.4	-0.08145	-0.00071	0	-0.08145
401	12.0007	15.04	0	12.00399	15.04	-0.08145	-0.00071	0	-0.08145
402	12.0007	15.68	0	12.66599	15.68	-0.08145	-0.00071	0	-0.08145
463	12.6667	16.32	0	12.66599	16.32	-0.08145	-0.00071	0	-0.08145
464	12.6667	16.96	0	12.66599	16.96	-0.08145	-0.00071	0	-0.08145
465	12.6667	17.6	0	12,66599	176	-0.08145	-0.00071	ň	_0.09144
466	12 6667	18 24	0	12 66500	18.24	0.00145	0.00071	0	-0.08143
467	12 6667	19.99	õ	12.00577	10.27	-0.08145	-0.00071	0	-0.08145
469	12.0007	10.00	0	12.00399	10.00	-0.08145	-0.00071	0	-0.08145
408	12.0007	19.52	0	12.66599	19.52	-0.08145	-0.00071	0	-0.08145
469	12.6667	20.16	0	12.66599	20.16	-0.08145	-0.00071	0	-0.08145
470	12.6667	20.8	0	12.66599	20.8	-0.08145	-0.00071	0	-0.08145
471	12.6667	21.44	0	12.66599	21.44	-0.08145	-0.00071	Ō	-0.08145
472	12.6667	22.08	0	12 66599	22.08	-0.08145	-0.00071	Ő	0.00145
473	12 6667	22 72	Ň	12 66500	22.00	0.00145	-0.00071	0	-0.08143
474	12.6667	72.72	0	12.00377	22.72	-0.08143	-0.00071	0	-0.08145
	12.0007	23.30	U A	12.00399	23.30	-0.08145	-0.00071	0	-0.08145
4/3	12.0007	24	0	12.66599	24	-0.08145	-0.00071	0	-0.08145
476	12.3333	14.4	0	12.33264	14.4	-0.07563	-0.00066	0	-0.07563
477	12.3333	15.04	0	12.33264	15.04	-0.07563	-0.00066	Ó	-0.07562
478	12 3333	15.68	Ô	12 33264	15.69	-0.07542	-0.00000	Ň	0.07503
470	12 3232	16 22	õ	12.33204	16 22	-0.07505	-0.00000	U C	-0.07563
417 AQA	10 2222	16.04	U A	12.33204	10.32	-0.07563	-0.00066	U	-0.07563
400	12.3333	10.90	U	12.33264	16.96	-0.07563	-0.00066	0	-0.07563
481	12.3333	17.6	U	12.33264	17.6	-0.07563	-0.00066	0	-0.07563
482	12.3333	18.24	0	12.33264	18.24	-0.07563	-0.00066	0	-0.07563
483	12.3333	18.88	0	12.33264	18.88	-0.07563	-0.00066	ň	-0 07562
484	12.3333	19.52	0	12.33264	19.52	-0 07563	-0.000064	ň	-0.07505
485	12.3333	20.16	õ	12 33264	20.16	-0.07505	0.00000	0	-0.0/303
486	12 3222	20.10	õ	12.33204	20.10	-0.07303	-0.00000	U	-0.07563
-00	12.3333	20.8	v	12.33204	20.8	-0.07563	-0.00066	Û	-0.07563

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487	12 3333	21 44	Δ	12 22264	21 44	0.07562	0.00044	0	0.07662
400	12.5555	21.77	0	12.55204	21.44	-0.07505	-0.00000	U	-0.07303
488	12.3333	22.08	0	12.33264	22.08	-0.07563	-0.00066	0	-0.07563
489	12.3333	22.72	0	12.33264	22.72	-0.07563	-0.00066	0	-0.07563
490	12 3333	23.36	Ō	12 22264	22.26	0.07562	0.00066	õ	0.07503
490	12.5555	23.50	0	12.33204	23.30	-0.07505	-0.00066	0	-0.07563
491	12.3333	24	0	12.33264	24	-0.07563	-0.00066	0	-0.07563
492	12	14.4	0	11.99939	14.4	-0.06981	-0.00061	0	-0.06981
401	12	15.04	Ā	11.00020	15.04	0.04091	0.00061	õ	0.00701
404	12	15.04	0	11.77737	13.04	-0.00981	-0.00001	0	-0.00981
494	12	15.68	0	11.99939	15.68	-0.06981	-0.00061	0	-0.06981
495	12	16.32	0	11.99939	16.32	-0.06981	-0.00061	0	-0.06981
406	12	16.06	Ň	11.00020	16.06	0.06091	0.00041	Å	0.00001
490	12	10.90	v	11.99939	10.90	-0.00981	-0.00061	U	-0.06981
49/	12	17.6	0	11.99939	17.6	-0.06981	-0.00061	0	-0.06981
498	12	18.24	0	11.99939	18.24	-0.06981	-0.00061	0	-0.06981
100	12	10 00	0	11,00020	10.00	0.060901	0.00061	õ	0.00001
477	12	10.00	U	11.99939	10.00	-0.00981	-0.00061	0	-0.06981
500	12	19.52	0	11.99939	19.52	-0.06981	-0.00061	0	-0.06981
501	12	20.16	0	11.99939	20.16	-0.06981	-0.00061	0	-0.06981
502	12	20.8	Å	11.00030	20.0	0.0609.01	0.00061	ů	0.00701
502	12	20.8	0	11.99939	20.0	-0.00981	-0.00001	U	-0.00981
503	12	21.44	0	11.99939	21.44	-0.06981	-0.00061	0	-0.06981
504	12	22.08	0	11 999 39	22.08	-0.06981	-0.00061	0	-0.06981
505	12	22.72	õ	11,00020	22.00	0.060901	0.00001	0	0.00001
505	12	22.72	U	11.99939	22.12	-0.00981	-0.00061	0	-0.06981
506	12	23.36	0	11.99939	23.36	-0.06981	-0.00061	0	-0.06981
507	12	24	0	11.99939	24	-0.06981	-0.00061	0	-0.06981
500	16	1.9	ů.	15 00979	1.0	0 12042	0.00100	õ	0.120/2
509	10	1.0	0	13.99070	1.0	-0.13902	-0.00122	U	-0.13962
510	16	3.6	0	15.99878	3.6	-0.13962	-0.00122	0	-0.13962
511	16	5.4	0	15.99878	5.4	-0.13962	-0.00122	0	-0 13962
512	16	7 2	Λ	15 00979	7 7	0 12062	0.00122	õ	0 12042
512	10	1.2	0	13.770/0	1.2	-0.13962	-0.00122	0	-0.13962
513	16	9	0	15.99878	9	-0.13962	-0.00122	0	-0.13962
514	16	10.8	0	15.99878	10.8	-0.13962	-0.00122	0	-0 13962
515	16	12.6	Ó	15 00979	12.6	0.12062	0.00122	õ	0.120(2
515	10	12.0	U O	13.990/0	12.0	-0.13902	-0.00122	U	-0.13902
517	14	1.8	0	13.99909	1.8	-0.10471	-0.00091	0	-0.10471
518	14	3.6	0	13.99909	3.6	-0.10471	-0.00091	0	-0 10471
510	14	5.4	Ō	12.00000	5 4	0 10471	0.00001	õ	0.10471
515	14	5.4	0	13.99909	5.4	-0.10471	-0.00091	U	-0.10471
520	14	1.2	0	13.99909	7.2	-0.10471	-0.00091	0	-0.10471
521	14	9	0	13.99909	9	-0.10471	-0.00091	0	-0 10471
522	14	10.8	Ô	12 00000	10.9	0 10471	0.00001	Å	0.10471
522	14	10.6	0	13.77709	10.6	-0.10471	-0.00091	U	-0.104/1
523	14	12.6	0	13.99909	12.6	-0.10471	-0.00091	0	-0.10471
526	12	1.8	0	11.99939	1.8	-0.06981	-0.00061	0	-0.06981
527	12	36	0	11 00030	36	-0.06081	-0.00061	0	0.06091
520	12	5.0	0	11.77737	5.0	-0.00901	-0.00001	0	-0.00981
528	12	5.4	0	11.99939	5.4	-0.06981	-0.00061	0	-0.06981
529	12	7.2	0	11.99939	7.2	-0.06981	-0.00061	0	-0.06981
530	12	0	Ó	11 00020	0	0.06091	0.00041	ő	0.00001
550	12	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	0	11.77737	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	-0.00981	-0.00001	U	-0.00981
531	12	10.8	0	11.99939	10.8	-0.06981	-0.00061	0	-0.06981
532	12	12.6	0	11.99939	12.6	-0.06981	-0.00061	0	-0.06981
534	10	1.9	Ó	0.000605	1.9	0.0240	0.0002	õ	0.0240
535	10	2.6	0	3.333033	1.0	-0.0349	-0.0003	U U	-0.0349
232	10	3.6	0	9.999695	3.6	-0.0349	-0.0003	0	-0.0349
536	10	5.4	0	9.999695	5.4	-0.0349	-0.0003	0	-0.0349
537	10	72	0	0 000605	7 7	-0.0340	-0.0003	Ō	0.0240
530	10	7. <u>4</u>	0	9.999090	1.4	-0.0349	-0.0003	0	-0.0349
228	10	9	0	9.999695	9	-0.0349	-0.0003	0	-0.0349
539	10	10.8	0	9.999695	10.8	-0.0349	-0.0003	0	-0.0349
540	10	12.6	0	9 999695	12.6	-0 0349	-0.0003	0	-0.0340
5 41	10	14.4	0	0.000(05	12.0	-0.0349	-0.0003	0	-0.0349
341	10	14.4	U	9.999093	14.4	-0.0349	-0.0003	0	-0.0349
543	8	1.8	0	8	1.8	0	0	0	0
544	8	3.6	0	8	36	0	0	0	0
545	ě	5 1	ň	õ	£ A	ň	~	0 0	~
575	0	5.4	v	0	3.4	U	U	U	U
546	8	7.2	0	8	7.2	0	0	0	0
547	8	9	0	8	9	0	0	0	0
548	8	10.8	Ā	0	10.0	Ň	õ	ů	ő
540	0	10.6	0	0	10.6	0	0	U	0
549	ð	12.6	0	8	12.6	0	0	0	0
550	8	14.4	0	8	14.4	0	0	0	0
552	6	18	0	6.000305	18	0.034905	0.000305	0	0.034005
557	é.	3.6	ň	6 000205	24	0.024005	0.000305	č	0.034005
555	0	0.0	U .	0.000303	3.0	0.034903	0.000305	U	0.034905
554	6	5.4	0	6.000305	5.4	0.034905	0.000305	0	0.034905
555	6	7.2	0	6.000305	7.2	0.034905	0.000305	0	0.034905
556	6	0	Ň	6 000205	0	0.024005	0.000204	ň	0.024005
550	U	7	v	0.000303	7	0.034903	0.000305	V	0.034905
557	6	10.8	0	6.000305	10.8	0.034905	0.000305	0	0.034905
558	6	12.6	0	6.000305	12.6	0.034905	0.000305	0	0.034905
550	6	14 4	ñ	6 000205	14.4	0.024006	0.000206	ň	0.024000
507	•	1.41.44	v	0.000303	14.4	0.034903	0.000303	U	0.034905
201	4	1.8	0	4.000609	1.8	0.06981	0.000609	0	0.06981
562	4	3.6	0	4.000609	3.6	0.06981	0.000609	0	0.06981
563	4	54	Ō	4 000600	5 4	0.06091	0.000400	ň	0.00701
565		J. <del>1</del>	0	1.000009	J.4	0.00961	0.000009	v	0.00981
304	4	1.2	U	4.000609	7.2	0.06981	0.000609	0	0.06981
565	4	9	0	4.000609	9	0.06981	0.000609	0	0.06981
566	4	108	0	4.000609	10.8	0.06981	0.000600	n	0.06081
	•		5			0.00701	0.000007		0.00701

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567	4	12.6	0	4.000609	12.6	0.06981	0.000609	0	0.06981
568	4	14.4	0	4.000609	14.4	0.06981	0.000609	0	0.06981
570	2	1.8	0	2.000914	1.8	0.104714	0.000914	0	0.104714
571	2	3.6	0	2.000914	3.6	0.104714	0.000914	0	0 104714
572	2	54	Ó	2 000914	54	0 104714	0.000914	ň	0.104714
573	2	7 2	ň	2.000914	7 2	0.104714	0.000014	0	0.104714
575	2	,.2	0	2.000914	1.2	0.104714	0.000914	0	0.104714
574	2	9	0	2.000914	9	0.104714	0.000914	0	0.104714
575	2	10.8	0	2.000914	10.8	0.104714	0.000914	0	0.104714
576	2	12.6	0	2.000914	12.6	0.104714	0.000914	0	0.104714
577	2	14.4	0	2.000914	14.4	0 104714	0.000914	Ô	0 104714
570	ō	1.8	Ň	0.001218	1.9	0.120410	0.000714	ő	0.104714
590	0	2.6	0	0.001218	1.0	0.139019	0.001218	0	0.139019
580	0	3.0	U	0.001218	3.6	0.139619	0.001218	0	0.139619
581	0	5.4	0	0.001218	5.4	0.139619	0.001218	0	0.139619
582	0	7.2	0	0.001218	7.2	0.139619	0.001218	0	0.139619
583	0	9	0	0.001218	9	0.139619	0.001218	0	0 139619
584	0	10.8	0	0.001218	10.8	0 139619	0.001218	õ	0 130610
585	ň	12.6	õ	0.001219	12.6	0.130610	0.001218	0	0.139019
585	0	12.0	0	0.001218	12.0	0.139019	0.001218	0	0.139619
080	0	14.4	0	0.001218	14.4	0.139619	0.001218	0	0.139619
587	12	16	0	11.99939	16	-0.06981	-0.00061	0	-0.06981
589	12	19.2	0	11.99939	19.2	-0.06981	-0.00061	0	-0.06981
591	12	22.4	0	11.99939	22.4	-0.06981	-0.00061	0	-0.06981
502	10	16	õ	0 000605	16	-0.0340	0.00001	0	0.00701
502	10	17.6	0	7.777075	10	-0.0349	-0.0003	U	-0.0349
393	10	17.0	0	9.999695	17.0	-0.0349	-0.0003	0	-0.0349
594	10	19.2	0	9.999695	19.2	-0.0349	-0.0003	0	-0.0349
595	10	20.8	0	9.999695	20.8	-0.0349	-0.0003	0	-0.0349
596	10	22.4	0	9.999695	22.4	-0.0349	-0.0003	0	-0 0349
597	10	24	Ó	9 999695	24	-0 0349	-0.0003	ň	-0.0340
508		16	õ	0	14	-0.03+9	-0.0005	0	-0.0349
500	0	10	0	0	10	U	0	U	0
599	8	17.0	U	8	17.6	U	0	0	0
600	8	19.2	0	8	19.2	0	0	0	0
601	8	20.8	0	8	20.8	0	0	0	0
602	8	22.4	0	8	22.4	0	0	0	Ó
603	8	24	Ň	ğ	74	õ	Ň	ŏ	Ő
603	0 4	14	0	0	24	0 00 0000	0 000005	U O	0 00000
004	o	10	U	6.000305	10	0.034905	0.000305	0	0.034905
605	6	17.6	0	6.000305	17.6	0.034905	0.000305	0	0.034905
606	6	19.2	0	6.000305	19.2	0.034905	0.000305	0	0.034905
607	6	20.8	0	6.000305	20.8	0.034905	0.000305	0	0.034905
608	6	22.4	0	6 000305	22.4	0.034905	0.000305	Ô	0.034905
600	6	24	Ň	6 000205	24	0.024005	0.000305	õ	0.034005
610	4	14	0	4.000505	24	0.034903	0.000303	0	0.034903
010	4	10	0	4.000609	10	0.06981	0.000609	0	0.06981
611	4	17.6	0	4.000609	17.6	0.06981	0.000609	0	0.06981
612	4	19.2	0	4.000609	19.2	0.06981	0.000609	0	0.06981
613	4	20.8	0	4.000609	20.8	0.06981	0.000609	0	0.06981
614	4	22.4	0	4 000609	22.4	0.06981	0.000609	õ	0.06081
615		24	õ	1.000000	22.4	0.00701	0.000000	0	0.00981
015	-	24	0	4.000009	24	0.00981	0.000609	0	0.06981
616	2	16	0	2.000914	16	0.104714	0.000914	0	0.104714
617	2	17.6	0	2.000914	17.6	0.104714	0.000914	0	0.104714
618	2	19.2	0	2.000914	19.2	0.104714	0.000914	0	0.104714
619	2	20.8	0	2.000914	20.8	0.104714	0.000914	0	0 104714
620	2	22.4	Ō	2 000914	22.4	0 104714	0.000014	õ	0.104714
621	5	24	ň	2.000014	22.7	0.104714	0.000914	0	0.104714
(22	2	24	U O	2.000914	24	0.104/14	0.000914	0	0.104/14
622	0	16	0	0.001218	16	0.139619	0.001218	0	0.139619
623	0	17.6	0	0.001218	17.6	0.139619	0.001218	0	0.139619
624	0	19.2	0	0.001218	19.2	0.139619	0.001218	0	0.139619
625	0	20.8	0	0.001218	20.8	0 139619	0.001218	Ο	0 139619
626	õ	22.0	ň	0.001210	20.0	0.120610	0.001210	õ	0.130610
(27	0	22.4	0	0.001218	22.4	0.139019	0.001218	U O	0.139019
027	U	24	U	0.001218	24	0.139619	0.001218	0	0.139619
628	16	25.3333	0	15.99878	25.3333	-0.13962	-0.00122	0	-0.13962
629	16	26.6667	0	15.99878	26.6667	-0.13962	-0.00122	0	-0.13962
630	16	28	0	15.99878	28	-0.13962	-0.00122	0	-0.13962
631	16	20 3333	Ō	15 00878	20 3333	-0 13062	-0.00122	õ	0 12062
637	16	30 6667	ň	15 00979	20 6667	0.12062	0.00122	0	0.13902
632	10	20.000/	U C	13.998/8	30.0007	-0.13962	-0.00122	U	-0.13962
033	16	32	U	15.99878	32	-0.13962	-0.00122	0	-0.13962
635	14	25.3333	0	13.99909	25.3333	-0.10471	-0.00091	0	-0.10471
636	14	26.6667	0	13.99909	26.6667	-0.10471	-0.00091	0	-0.10471
637	14	28	0	13.99909	28	-0.10471	-0.00091	Ô	-0 10471
638	14	29 3333	Ó	13 00000	20 2222	0 10471	-0.00001	ň	_0 10471
630	14	20 6667	n n	12,00000	20.6667	0.10471	-0.00071	0	-0.104/1
960	14	1000.00	v	13.99909	1000.00	-0.10471	-0.00091	U	-0.10471
640	14	32	0	13.99909	32	-0.10471	-0.00091	0	-0.10471
641	12	25.3333	0	11.99939	25.3333	-0.06981	-0.00061	0	-0.06981
642	12	26.6667	0	11.99939	26.6667	-0.06981	-0.00061	0	-0.06981
643	12	28	0	11 99939	28	-0.06981	-0.00061	ň	-0.06081
· · ·			~			0.00701	0.00001	v	-0.00701

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644	12	29.3333	0	11.99939	29.3333	-0.06981	-0.00061	0	-0.06981
645	12	30.6667	0	11.99939	30.6667	-0.06981	-0.00061	0	-0.06981
646	12	32	0	11.99939	32	-0.06981	-0.00061	Ō	-0.06981
647	10	25.3333	0	9,999695	25.3333	-0.0349	-0.0003	õ	-0 0349
648	10	26.6667	0	9,999695	26.6667	-0.0349	-0.0003	õ	-0 0349
649	10	28	0	9,999695	28	-0 0349	-0.0003	ň	-0.0340
650	10	29 3333	ŏ	9 999695	20 2222	-0.0349	-0.0003	õ	-0.0349
651	10	30 6667	õ	0.000605	29.5555	-0.0349	-0.0003	0	-0.0349
652	10	30.0007	Ŏ	0.000405	30.0007	-0.0349	-0.0003	0	-0.0349
652	10	32	0	9.999093	32	-0.0349	-0.0003	0	-0.0349
654	0	23.3333	0	8	25.3333	0	0	0	0
034	8	20.0007	U	8	26.6667	0	0	0	0
000	8	28	0	8	28	0	0	0	0
636	8	29.3333	0	8	29.3333	0	0	0	0
657	8	30.6667	0	8	30.6667	0	0	0	0
658	8	32	0	8	32	0	0	0	0
659	6	25.3333	0	6.000305	25.3333	0.034905	0.000305	0	0.034905
660	6	26.6667	0	6.000305	26.6667	0.034905	0.000305	0	0.034905
661	6	28	0	6.000305	28	0.034905	0.000305	0	0.034905
662	6	29.3333	0	6.000305	29.3333	0.034905	0.000305	ò	0.034905
663	6	30.6667	0	6.000305	30,6667	0.034905	0.000305	ň	0.034905
664	6	32	0	6 000305	32	0.034905	0.000305	õ	0.034905
665	4	25 3333	õ	4 000600	25 2222	0.054905	0.000505	0	0.034903
666	4	26.6667	Ő	4.000009	25.5555	0.00981	0.000009	0	0.00981
667	4	20.0007	0	4.000009	20.0007	0.00961	0.000609	0	0.06981
440	4	20	0	4.000609	28	0.06981	0.000609	0	0.06981
660	4	29.3333	0	4.000609	29.3333	0.06981	0.000609	0	0.06981
009	4	30.0007	0	4.000609	30.6667	0.06981	0.000609	0	0.06981
670	4	32	0	4.000609	32	0.06981	0.000609	0	0.06981
671	2	25.3333	0	2.000914	25.3333	0.104714	0.000914	0	0.104714
672	2	26.6667	0	2.000914	26.6667	0.104714	0.000914	0	0.104714
673	2	28	0	2.000914	28	0.104714	0.000914	0	0.104714
674	2	29.3333	0	2.000914	29.3333	0.104714	0.000914	0	0.104714
675	2	30.6667	0	2.000914	30.6667	0.104714	0.000914	0	0.104714
676	2	32	0	2.000914	32	0.104714	0.000914	0	0.104714
677	0	25.3333	0	0.001218	25.3333	0.139619	0.001218	ō	0 139619
678	0	26.6667	0	0.001218	26.6667	0.139619	0.001218	ŏ	0 139619
679	0	28	0	0.001218	28	0 139619	0.001218	Ő	0.130610
680	0	29.3333	õ	0.001218	29 3333	0 139619	0.001218	0	0.139619
681	õ	30 6667	õ	0.001218	30 6667	0.139610	0.001218	0	0.139019
682	ŏ	32	õ	0.001218	30.0007	0.139019	0.001218	0	0.139019
685	ů	14 3	ň	0.001218	14.3	0.139019	0.001218	0	0.139019
686	Š	14.5	Ő	2.0001218	14.3	0.139019	0.001218	0	0.139019
497	2	14.5	0	2.000914	14.5	0.104/14	0.000914	0	0.104/14
200	4	14.5	U	4.000609	14.3	0.06981	0.000609	0	0.06981
000	0	14.3	0	0.000305	14.3	0.034905	0.000305	0	0.034905
089	8	14.3	0	8	14.3	0	0	0	0
690	10	14.3	0	9.999695	14.3	-0.0349	-0.0003	0	-0.0349
691	12	14.3	0	11.99939	14.3	-0.06981	-0.00061	0	-0.06981
692	14	14.3	0	13.99909	14.3	-0.10471	-0.00091	0	-0.10471
693	16	14.3	0	15.99878	14.3	-0.13962	-0.00122	0	-0.13962
694	0	24.1	0	0.001218	24.1	0.139619	0.001218	0	0.139619
695	2	24.1	0	2.000914	24.1	0.104714	0.000914	0	0.104714
696	4	24.1	0	4.000609	24.1	0.06981	0.000609	Ō	0.06981
697	6	24.1	0	6.000305	24 1	0.034905	0.000305	õ	0.034905
698	8	24.1	0	8	24.1	0	0	ŏ	0.054705
699	10	24.1	Ô	9 999695	24.1	-0 0349	-0 0003	ŏ	0 0340
700	12	24.1	ñ	11 00030	24.1	-0.06081	-0.0005	0	-0.0347
701	14	24.1	0	12 00000	24.1	-0.00981	+0.00001	0	-0.00981
707	14	27.1	0	13.77707	24.1	-0.104/1	-0.00091	U	-0.10471
702	10	24.1	U C	13.998/8	24.1	-0.13962	-0.00122	U	-0.13962
703	11.4	14.4	U	11.39948	14.4	-0.05934	-0.00052	0	-0.05934
704	11.9	10	0	11.89941	16	-0.06806	-0.00059	0	-0.06806
705	11.9	17.6	U	11.89941	17.6	-0.06806	-0.00059	0	-0.06806
706	11.9	19.2	0	11.89941	19.2	-0.06806	-0.00059	0	-0.06806
707	11.9	20.8	0	11.89941	20.8	-0.06806	-0.00059	0	-0.06806
708	11.9	22.4	0	11.89941	22.4	-0.06806	-0.00059	0	-0.06806
709	11.4	24	0	11.39948	24	-0.05934	-0.00052	0	-0.05934

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### **APPENDIX A-4**

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# STARS-SOLIDS Generalized Mode 3 Displacement Definition (Control Mode)

	Original XY	Z Location		New XYZ	Location		Nodal Di	splacement	
Node	X	Y	Z	X'	Y'	<u>Z'</u>	ΔΧ	Δv	ΔZ
13	0	0	0	0	0	0	0	0	0
14	2	U	0	2	0	0	0	0	0
52	4	U	0	4	0	0	0	0	0
53	6	U	0	6	0	0	0	0	0
54	8	U	0	8	0	0	0	0	0
55	10	0	0	10	0	0	0	0	0
56	12	U	0	12	0	0	0	0	0
90	14	0	0	14	0	0	0	0	0
91	16	0	0	16	0	0	0	0	0
300	16	14.4	0	16.0692	14.4	0.06981	0.0692	0	0.06981
301	16	15.04	0	16.0692	15.04	0.06981	0.0692	0	0.06981
302	16	15.68	0	16.0692	15.68	0.06981	0.0692	0	0.06981
303	16	16.32	0	16.0692	16.32	0.06981	0.0692	0	0.06981
304 205	16	16.96	0	16.0692	16.96	0.06981	0.0692	0	0.06981
305	16	17.6	0	16.0692	17.6	0.06981	0.0692	0	0.06981
306	16	18.24	0	16.0692	18.24	0.06981	0.0692	0	0.06981
307	16	18.88	0	16.0692	18.88	0.06981	0.0692	0	0.06981
308	16	19.52	0	16.0692	19.52	0.06981	0.0692	0	0.06981
309	16	20.16	0	16.0692	20.16	0.06981	0.0692	0	0.06981
310	16	20.8	0	16.0692	20.8	0.06981	0.0692	0	0.06981
311	16	21.44	0	16.0692	21.44	0.06981	0.0692	0	0.06981
312	16	22.08	0	16.0692	22.08	0.06981	0.0692	0	0.06981
313	16	22.72	0	16.0692	22.72	0.06981	0.0692	0	0.06981
314	16	23.36	0	16.0692	23.36	0.06981	0.0692	0	0.06981
315	16	24	0	16.0692	24	0.06981	0.0692	0	0.06981
316	15.6667	14.4	0	15.73013	14.4	0.063993	0.063434	0	0.063993
317	15.6667	15.04	0	15.73013	15.04	0.063993	0.063434	0	0.063993
318	15.6667	15.68	0	15.73013	15.68	0.063993	0.063434	0	0.063993
319	15.6667	16.32	0	15.73013	16.32	0.063993	0.063434	0	0.063993
320	15.6667	16.96	0	15.73013	16.96	0.063993	0.063434	0	0.063993
321	15.6667	17.6	U	15.73013	17.6	0.063993	0.063434	0	0.063993
322	15.6667	18.24	U	15.73013	18.24	0.063993	0.063434	0	0.063993
323	15.6667	18.88	0	15.73013	18.88	0.063993	0.063434	0	0.063993
324	15.6667	19.52	0	15.73013	19.52	0.063993	0.063434	0	0.063993
325	15.6667	20.16	0	15.73013	20.16	0.063993	0.063434	0	0.063993
326	15.6667	20.8	0	15.73013	20.8	0.063993	0.063434	0	0.063993
327	15.6667	21.44	0	15.73013	21.44	0.063993	0.063434	0	0.063993
328	15.6667	22.08	0	15.73013	22.08	0.063993	0.063434	0	0.063993
329	15.6667	22.72	0	15.73013	22.72	0.063993	0.063434	0	0.063993
066	15.6667	23.36	0	15.73013	23.36	0.063993	0.063434	0	0.063993
155	15.6667	24	U	15.73013	24	0.063993	0.063434	0	0.063993
332	15.3333	14.4	U	15.39097	14.4	0.058174	0.057666	0	0.058174
555	15.3333	15.04	U	15.39097	15.04	0.058174	0.057666	0	0.058174
334	15.3333	15.68	0	15.39097	15.68	0.058174	0.057666	0	0.058174
333	15.3333	16.32	U	15.39097	16.32	0.058174	0.057666	0	0.058174
330	15.3333	10.90	U	15.39097	16.96	0.058174	0.057666	0	0.058174
331	15.3333	1/.6	U	15.39097	17.6	0.058174	0.057666	0	0.058174
338	15.5553	18.24	0	15.39097	18.24	0.058174	0.057666	0	0.058174
339	15.3333	18.88	0	15.39097	18.88	0.058174	0.057666	0	0.058174
340	15.3333	19.52	U	15.39097	19.52	0.058174	0.057666	0	0.058174
341	15.3333	20.16	U	15.39097	20.16	0.058174	0.057666	0	0.058174
342	15.5555	20.8	0	15.39097	20.8	0.058174	0.057666	0	0.058174

242	15 2222	21.44	0	16 20007	01.44	0.000.00	0.000	•	
545	13.3333	21.44	0	15.39097	21.44	0.058174	0.057666	0	0.058174
344	15.3333	22.08	0	15.39097	22.08	0.058174	0.057666	0	0.058174
345	15 3333	22 72	0	15 30007	22 22	0.058174	0.057666	Ō	0.059174
216	15 2222	12.24	ň	16 20007	22.72	0.050174	0.057000	, v	0.038174
340	15.5555	23.30	U	15.39097	23.30	0.058174	0.05/666	0	0.058174
347	15.3333	24	0	15.39097	24	0.058174	0.057666	0	0.058174
348	15	14.4	0	15 0519	14 4	0.052357	0.0510	<u>n</u>	0.052257
3/0	15	15.04	Ň	16.0610	16.04	0.052357	0.0517	0	0.052557
349	15	15.04	U	15.0519	15.04	0.052357	0.0519	0	0.052357
350	15	15.68	0	15.0519	15.68	0.052357	0.0519	0	0.052357
351	15	16 32	٥	15.0510	16 32	0.052357	0.0510	Ā	0.053257
252	15	16.06	õ	15.0510	16.52	0.052357	0.0519	0	0.032337
352	15	10.90	U	15.0519	16.96	0.052357	0.0519	0	0.052357
353	15	17.6	0	15.0519	17.6	0.052357	0.0519	0	0.052357
354	15	18 24	0	15.0510	18 74	0.052357	0.0510	Ň	0.053367
755	15	10.00	0	15.0519	10.24	0.052357	0.0319	U	0.032337
333	15	10.00	U	15.0519	18.88	0.052357	0.0519	0	0.052357
356	15	19.52	0	15.0519	19.52	0.052357	0.0519	0	0.052357
357	15	20.16	0	15.0519	20.16	0.052357	0.0510	Ō	0.052257
250	15	20.10	õ	15.0515	20.10	0.052357	0.0319	U O	0.052557
330	15	20.8	U	12.0218	20.8	0.052357	0.0519	0	0.052357
359	15	21.44	0	15.0519	21.44	0.052357	0.0519	0	0.052357
360	15	22.08	0	15.0519	22.08	0.052357	0.0510	ñ	0.052257
241	15	22.00	Å	15.0510	22.00	0.052557	0.0519	0	0.052557
201	15	22.12	U	15.0519	22.12	0.052357	0.0519	0	0.052357
362	15	23.36	0	15.0519	23.36	0.052357	0.0519	0	0.052357
363	15	24	0	15.0519	24	0.052357	0.0510	ñ	0.052257
264	14 (((7	14.4	Å	14 71000	24	0.032337	0.0519	0	0.052357
304	14.0007	14.4	0	14./1285	14.4	0.04654	0.046134	0	0.04654
365	14.6667	15.04	0	14.71283	15.04	0.04654	0.046134	0	0.04654
366	14 6667	15.68	0	14 71283	15.68	0.04654	0.046134	Ô	0.04654
247	14 4447	16.00	õ	14 71202	16.00	0.04054	0.040134	0	0.04034
307	14.0007	10.32	U	14.71283	10.32	0.04654	0.046134	0	0.04654
368	14.6667	16.96	0	14.71283	16.96	0.04654	0.046134	0	0.04654
369	14.6667	176	0	14 71283	17.6	0.04654	0.046134	Ô	0.04654
270	14 4447	10 74	õ	14 71202	10.04	0.04054	0.040134	0	0.04034
370	14.0007	10.24	U	14./1283	18.24	0.04654	0.046134	0	0.04654
371	14.6667	18.88	0	14.71283	18.88	0.04654	0.046134	0	0.04654
372	14.6667	19.52	0	14 71283	19.52	0.04654	0.046134	Ô	0.04654
272	14 6667	20.14	Ň	14 71202	20.10	0.04054	0.040134	, v	0.04034
313	14.0007	20.10	U	14./1283	20.16	0.04654	0.046134	0	0.04654
374	14.6667	20.8	0	14.71283	20.8	0.04654	0.046134	0	0.04654
375	14.6667	21.44	0	14 71283	21 44	0.04654	0.046134	Ó	0.04654
276	14 6667	22.00	Å	14 71202	22.00	0.04054	0.040134	0	0.04034
370	14.0007	22.00	U	14.71283	22.08	0.04654	0.046134	0	0.04654
377	14.6667	22.72	0	14.71283	22.72	0.04654	0.046134	0	0.04654
378	14.6667	23 36	0	14 71283	23 36	0.04654	0.046134	0	0.04654
370	14 6667	24	Å	14 71303	23.50	0.04054	0.040134	0	0.04054
2/9	14.0007	24	0	14./1285	24	0.04654	0.046134	0	0.04654
380	14.3333	14.4	0	14.37367	14.4	0.040722	0.040366	0	0.040722
381	14.3333	15.04	0	14 37367	15.04	0.040722	0.040366	0	0.040722
202	14 2222	15.69	Ň	14 27267	15.01	0.040722	0.040300	0	0.040722
362	14.3333	13.00	0	14.37307	12.08	0.040722	0.040366	0	0.040722
383	14.3333	16.32	0	14.37367	16.32	0.040722	0.040366	0	0.040722
384	14.3333	16.96	0	14 37367	16.96	0.040722	0.040366	0	0.040722
295	14 2222	17.6	õ	14.27267	17.0	0.040722	0.040300	0	0.040722
303	14.5555	17.0	U	14.3/30/	17.0	0.040722	0.040366	0	0.040722
386	14.3333	18.24	0	14.37367	18.24	0.040722	0.040366	0	0.040722
387	14.3333	18.88	0	14 37367	18.88	0.040722	0.040366	0	0.040722
200	14 2222	10.52	Ň	14 27267	10.50	0.040722	0.040300	0	0.040722
300	14.3333	19.52	0	14.3/30/	19.52	0.040722	0.040366	U	0.040722
389	14.3333	20.16	0	14.37367	20.16	0.040722	0.040366	0	0.040722
390	14.3333	20.8	0	14.37367	20.8	0.040722	0.040366	0	0.040722
301	14 3333	21.44	ñ	14 27267	21.44	0.040722	0.040300	Ň	0.040722
200	14.3333	21.44	0	14.57507	21.44	0.040722	0.040300	U	0.040722
392	14.3333	22.08	0	14.37367	22.08	0.040722	0.040366	0	0.040722
393	14.3333	22.72	0	14.37367	22.72	0.040722	0.040366	0	0.040722
394	14 3333	23.36	0	14 37367	22.36	0.040722	0.040366	ō	0.040722
205	14 2222	23.50	ő	14.37307	23.50	0.040722	0.040300	0	0.040722
393	14.5555	24	0	14.3/36/	24	0.040722	0.040366	0	0.040722
396	14	14.4	0	14.0346	14.4	0.034905	0.0346	0	0.034905
397	14	15.04	0	14 0346	15.04	0.034005	0.0346	Ő.	0.024005
200	14	15 60	ő	14.0346	15.04	0.034005	0.0340	0	0.034903
390	14	13.08	0	14.0340	15.68	0.034905	0.0346	0	0.034905
399	14	16.32	0	14.0346	16.32	0.034905	0.0346	0	0.034905
400	14	16.96	0	14 0346	16.96	0.034905	0.0346	0	0.034005
401	14	176	ŏ	14.0246	17.6	0.034005	0.0340	0	0.034905
402	1-4	17.0	ý	14.0340	1/.0	0.034905	0.0346	U	0.034905
402	14	18.24	0	14.0346	18.24	0.034905	0.0346	0	0.034905
403	14	18.88	0	14.0346	18.88	0.034905	0.0346	0	0.034905
404	14	19 57	ò	14 0246	10 52	0.034005	0.0244	õ	0.034005
404	1.4	20.14	~	14.0340	17.34	0.034903	0.0340	v	0.034903
405	14	20.16	0	14.0346	20.16	0.034905	0.0346	0	0.034905
406	14	20.8	0	14.0346	20.8	0.034905	0.0346	0	0.034905
407	14	21 44	Ô	14 0246	21 44	0.024005	0.0244	õ	0.034005
400	1-7	41. <del>77</del>	0	14.0340	21.44	0.034903	0.0340	U	0.034905
408	14	22.08	U	14.0346	22.08	0.034905	0.0346	0	0.034905
409	14	22.72	0	14.0346	22.72	0.034905	0.0346	0	0.034905
410	14	23 36	, 0	14 0246	73.26	0.024005	0.0244	õ	0.034005
411	1-7	00.02	0	14.0340	23.30	0.034903	0.0340	U	0.034905
411	14	24	0	14.0346	24	0.034905	0.0346	0	0.034905
412	13.6667	14.4	0	13.69553	14.4	0.029088	0.028834	0	0.029088
413	13 6667	15.04	0	13 60553	15.04	0.020088	0.028934	ň	0.000000
414	13 22/7	16.00	0	13.07333	10.04	0.027088	0.020034	U	0.029088
414	13.0007	10.08	U	13.09333	15.68	0.029088	0.028834	0	0.029088

415	13.6667	16.32	0	13 69553	16 32	0.029088	0.028834	Ω	0.020088
416	13 6667	16.96	0	13 69553	16.96	0.029088	0.028834	õ	0.020088
417	13.6667	17.6	0	13.69555	17.6	0.029088	0.020034	0	0.029088
410	13.0007	17.0	0	13.09333	17.0	0.029088	0.028834	U	0.029088
418	13.000/	18.24	0	13.69553	18.24	0.029088	0.028834	0	0.029088
419	13.6667	18.88	0	13.69553	18.88	0.029088	0.028834	0	0.029088
420	13.6667	19.52	0	13.69553	19.52	0.029088	0.028834	0	0.029088
421	13.6667	20.16	0	13 69553	20.16	0.029088	0.028834	Ō	0.029088
422	13 6667	20.8	Ň	13 60553	20.10	0.020000	0.020004	õ	0.020000
422	12 4447	20.0	0	13.09333	20.8	0.029088	0.020034	0	0.029088
423	13.0007	21.44	U	13.09553	21.44	0.029088	0.028834	0	0.029088
424	13.6667	22.08	0	13.69553	22.08	0.029088	0.028834	0	0.029088
425	13.6667	22.72	0	13.69553	22.72	0.029088	0.028834	0	0.029088
426	13.6667	23.36	0	13.69553	23.36	0.029088	0.028834	0	0.029088
427	13 6667	24	0	13 69553	24	0.029088	0.028834	Ň	0.020088
128	12 2222	14.4	õ	12 25627	14.4	0.027000	0.020034	0	0.023068
420	13.3333	14.4	0	13.33037	14.4	0.023269	0.023066	0	0.023269
429	13.3333	15.04	0	13.35637	15.04	0.023269	0.023066	0	0.023269
430	13.3333	15.68	0	13.35637	15.68	0.023269	0.023066	0	0.023269
431	13.3333	16.32	0	13.35637	16.32	0.023269	0.023066	0	0.023269
432	13.3333	16 96	0	13 35637	16.96	0.023269	0.023066	0	0.023260
433	13 3333	17.6	ň	12 25627	17.6	0.023260	0.023066	0	0.023207
424	13.3333	10.04	0	13.33037	17.0	0.023209	0.023066	0	0.023269
434	13.3333	18.24	U	13.33037	18.24	0.023269	0.023066	0	0.023269
435	13.3333	18.88	0	13.35637	18.88	0.023269	0.023066	0	0.023269
436	13.3333	19.52	0	13.35637	19.52	0.023269	0.023066	0	0.023269
437	13.3333	20.16	0	13.35637	20.16	0.023269	0.023066	0	0.023269
438	13 3333	20.8	Ô	13 35637	20.8	0.023269	0.023066	ñ	0.023260
120	12 2222	21.44	õ	12 25427	21.44	0.023207	0.023000	0	0.023209
437	13.3333	21.44	0	13.33037	21.44	0.023269	0.023066	0	0.023269
440	13.3333	22.08	0	13.35637	22.08	0.023269	0.023066	0	0.023269
44]	13.3333	22.72	0	13.35637	22.72	0.023269	0.023066	0	0.023269
442	13.3333	23.36	0	13.35637	23.36	0.023269	0.023066	0	0.023269
443	13 3333	24	0	13 35637	24	0.023269	0.023066	ň	0.023269
111	13.5555	14.4	ŏ	12 0172	14.4	0.025207	0.023000	0	0.023203
445	13	14.4	0	13.0173	14.4	0.017452	0.0173	0	0.017452
445	13	15.04	U	13.0173	15.04	0.017452	0.0173	0	0.017452
446	13	15.68	0	13.0173	15.68	0.017452	0.0173	0	0.017452
447	13	16.32	0	13.0173	16.32	0.017452	0.0173	0	0.017452
448	13	16.96	0	13.0173	16.96	0.017452	0.0173	0	0.017452
449	13	17.6	Ō	13 0173	17.6	0.017452	0.0173	õ	0.017452
450	12	19.24	Ő	12 0172	10.24	0.017452	0.0173	0	0.017432
450	15	10.24	0	13.0173	18.24	0.017452	0.0173	0	0.017452
451	13	18.88	0	13.0173	18.88	0.017452	0.0173	0	0.017452
452	13	19.52	0	13.0173	19.52	0.017452	0.0173	0	0.017452
453	13	20.16	0	13.0173	20.16	0.017452	0.0173	0	0.017452
454	13	20.8	0	13 0173	20.8	0.017452	0.0173	õ	0.017452
455	13	21 44	Õ	12 0172	21.44	0.017452	0.0173	0	0.017452
455	13	21.44	0	13.0173	21.44	0.017432	0.0173	0	0.017452
430	13	22.08	0	13.0173	22.08	0.01/452	0.0173	0	0.017452
457	13	22.72	0	13.0173	22.72	0.017452	0.0173	0	0.017452
458	13	23.36	0	13.0173	23.36	0.017452	0.0173	0	0.017452
459	13	24	0	13 0173	24	0.017452	0.0173	0	0.017452
460	12 6667	14.4	Ô	12 67823	14 4	0.011636	0.011534	ŏ	0.011636
460	12.0007	15.04	0	12.07823	14.4	0.011030	0.011534	0	0.011030
401	12.0007	15.04	0	12.07823	15.04	0.011030	0.011534	U	0.011636
462	12.6667	15.68	0	12.67823	15.68	0.011636	0.011534	0	0.011636
463	12.6667	16.32	0	12.67823	16.32	0.011636	0.011534	0	0.011636
464	12.6667	16.96	0	12.67823	16.96	0.011636	0.011534	0	0.011636
465	12,6667	17.6	0	12.67823	17.6	0.011636	0.011534	ñ	0.011636
466	12 6667	18.24	ň	12.67822	19.24	0.011636	0.011534	0	0.011030
460	12.0007	10.24	0	12.07823	10.24	0.011030	0.011534	0	0.011030
407	12.0007	18.88	0	12.67823	18.88	0.011636	0.011534	0	0.011636
468	12.6667	19.52	0	12.67823	19.52	0.011636	0.011534	0	0.011636
469	12.6667	20.16	0	12.67823	20.16	0.011636	0.011534	0	0.011636
470	12.6667	20.8	0	12.67823	20.8	0.011636	0.011534	0	0.011636
471	12 6667	21.44	0	12 67823	21 44	0.011636	0.011534	Ň	0.011636
172	12.0007	22.09	ů N	12.07023	21.77	0.011636	0.011534	0	0.011030
472	12.0007	22.00	0	12.07823	22.08	0.011030	0.011534	U	0.011636
473	12.0007	22.12	0	12.67823	22.72	0.011636	0.011534	0	0.011636
474	12.6667	23.36	0	12.67823	23.36	0.011636	0.011534	0	0.011636
475	12.6667	24	0	12.67823	24	0.011636	0.011534	0	0.011636
476	12.3333	14.4	0	12.33907	144	0.005817	0.005766	ñ	0.005817
477	12 3333	15.04	ň	12 22007	15.04	0.005917	0.005700	Å	0.000017
470	12.2000	15.49	0	12.33707	15.04	0.003017	0.003/00	U	0.003817
4/8	12.3333	15.68	Û	12.33907	15.68	0.005817	0.005766	0	0.005817
479	12.3333	16.32	0	12.33907	16.32	0.005817	0.005766	0	0.005817
<b>48</b> 0	12.3333	16.96	0	12.33907	16.96	0.005817	0.005766	0	0.005817
481	12.3333	17.6	0	12.33907	17.6	0.005817	0.005766	0	0.005817
482	12 3333	18 74	ñ	12 33907	18 74	0.005817	0.005766	ñ	0.005017
492	17 2222	19.99	ň	12.33907	10.27	0.003017	0.005700	0	0.003017
403	12.3333	10.00	U	12.3390/	10.00	0.005817	0.005766	U	0.005817
484	12.3333	19.52	Û	12.33907	19.52	0.005817	0.005766	0	0.005817
485	12.3333	20.16	0	12.33907	20.16	0.005817	0.005766	0	0.005817
486	12.3333	20.8	0	12.33907	20.8	0.005817	0.005766	0	0.005817

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487	12.3333	21.44	0	12.33907	21.44	0.005817	0.005766	0	0.005817
488	12.3333	22.08	0	12.33907	22.08	0.005817	0.005766	0	0.005817
489	12.3333	22.72	0	12.33907	22.72	0.005817	0.005766	0	0.005817
490	12.3333	23.36	0	12.33907	23.36	0.005817	0.005766	0	0.005817
491	12.3333	24	0	12.33907	24	0.005817	0.005766	0	0.005817
492	12	14.4	0	12	14.4	0	0	0	0
493	12	15.04	0	12	15.04	0	0	0	0
494	12	15.68	0	12	15.68	0	0	0	Ó
495	12	16.32	0	12	16.32	Ō	Ō	Ō	Ō
496	12	16.96	Õ	12	16.96	õ	õ	ň	õ
497	12	17.6	ŏ	12	17.6	õ	õ	ŏ	Ő
408	12	18 24	õ	12	18 74	ů Ú	0	õ	0
400	12	10.24	Ő	12	10.27	ő	0	0	0
477	12	10.00	0	12	10.00	0	0	0	0
500	12	19.32	0	12	19.52	0	0	0	0
501	12	20.10	Ŭ,	12	20.16	0	U	U	0
502	12	20.8	0	12	20.8	0	0	0	0
503	12	21.44	0	12	21.44	0	0	0	0
504	12	22.08	0	12	22.08	0	0	0	0
505	12	22.72	0	12	22.72	0	0	0	0
506	12	23.36	0	12	23.36	0	0	0	0
507	12	24	0	12	24	0	0	0	0
509	16	1.8	0	16	1.8	0	0	0	0
510	16	3.6	0	16	3.6	0	0	0	0
511	16	5.4	0	16	5.4	0	0	0	0
512	16	7.2	0	16	7.2	0	0	0	0
513	16	9	0	16	9	0	0	0	Ō
514	16	10.8	Ō	16	10.8	Ō	Ō	õ	õ
515	16	12.6	õ	16	12.6	õ	õ	õ	Õ
517	14	1.8	õ	14	1.8	õ	õ	õ	ů 0
518	14	3.6	Õ	14	3.6	Ő	Õ	ŏ	0
510	14	5.0	õ	14	5.0	0	Ő	0	0
520	14		0	14	7.7	0	0	ŏ	0
520	14	7.2	0	14	1.4	0	0	0	0
521	14	10.0	0	14	10.0	0	0	0	0
522	14	10.8	0	14	10.8	U	0	0	0
523	14	12.6	U	14	12.6	0	0	0	0
526	12	1.8	U	12	1.8	0	0	0	0
527	12	3.6	0	12	3.6	0	0	0	0
528	12	5.4	0	12	5.4	0	0	0	0
529	12	7.2	0	12	7.2	0	0	0	0
530	12	9	0	12	9	0	0	0	0
531	12	10.8	0	12	10.8	0	0	0	0
532	12	12.6	0	12	12.6	0	0	0	0
534	10	1.8	0	10	1.8	0	0	0	0
535	10	3.6	0	10	3.6	0	0	0	0
536	10	5.4	0	10	5.4	0	0	0	0
537	10	7.2	0	10	7.2	0	0	0	0
538	10	9	0	10	9	0	0	0	0
539	10	10.8	0	10	10.8	0	0	Ō	Ō
540	10	12.6	0	10	12.6	Ō	õ	õ	ō
541	10	14.4	õ	10	14.4	ň	õ	õ	õ
543	8	1.8	õ	8	1.8	õ	õ	Ő	õ
544	8	3.6	õ	8	3.6	Ő	õ	Ő	ů N
545	8	5.0	õ	8	5.0	Ő	. 0	0	0
546	8	7.7	Ő	8	77	0	Ő	0	0
540	0 9	0	0	8	0	0	0	0	0
549	0	10.9	0	0	10.9	0	0	0	0
540	0	10.6	0	0	10.6	0	0	0	0
549	0	12.0	0	8	12.0	0	0	0	0
550	8	14.4	U	8	14.4	U	0	0	0
552	6	1.8	U	6	1.8	0	0	0	0
553	6	3.6	0	6	3.6	0	0	0	0
554	6	5.4	0	6	5.4	0	0	0	0
555	6	7.2	0	6	7.2	0	0	0	0
556	6	9	0	6	9	0	0	0	0
557	6	10.8	0	6	10.8	0	0	0	0
558	6	12.6	0	6	12.6	0	0	0	0
559	6	14.4	0	6	14.4	0	0	0	0
561	4	1.8	0	4	1.8	0	0	0	0
562	4	3.6	0	4	3.6	0	0	0	0
563	4	5.4	0	4	5.4	0	0	0	0
564	4	7.2	0	4	7.2	0	0	0	0
565	4	9	0	4	9	0	0	0	Ō
566	4	10.8	0	4	10.8	0	0	0	0

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567	4	12.6	U	4	12.6	0	0	0	0
568	4	14.4	0	4	14.4	0	0	0	0
570	2	1.8	0	2	1.8	0	0	0	0
571	2	3.6	õ	2	3.6	õ	õ	Õ	Ň
571	2	5.0	0	ź	5.0	0	0	0	0
572	2	5.4	0	2	5.4	0	0	0	0
573	2	7.2	0	2	7.2	0	0	0	0
574	2	9	0	2	9	0	0	0	0
575	2	10.8	0	2	10.8	0	0	0	0
576	2	12.6	Ő	2	12.6	Ô	0	0	Ô
577	2	14.4	õ	ñ	14.4	õ	Ő	ŏ	Ő
577	2	14.4	0	2	14.4	0	0	0	0
5/9	U	1.8	U	0	1.8	0	U	0	U
580	0	3.6	0	0	3.6	0	0	0	0
581	0	5.4	0	0	5.4	0	0	0	0
582	0	7.2	0	0	7.2	0	0	0	0
583	õ	0	Ô	Ô	Q	Ō	Ň	Ô	Ô
503	õ	10.0	ő	õ	10.9	õ	Ő	0	ő
504	ů,	10.6	0	0	10.0	0	0	0	0
282	U	12.0	0	U	12.0	U	0	U	U
5 <b>8</b> 6	0	14.4	0	0	14.4	0	0	0	0
587	12	16	0	12	16	0	0	0	0
589	12	19.2	0	12	19.2	0	0	0	0
591	12	22.4	0	12	22.4	0	0	0	0
502	10	16	Ō	10	16	Ō	Ō	0	Ō
502	10	17.6	õ	10	17.6	õ	õ	0	0
393	10	17.0	0	10	17.0	0	0	0	0
594	10	19.2	0	10	19.2	0	0	0	0
595	10	20.8	0	10	20.8	0	0	0	0
596	10	22.4	0	10	22.4	0	0	0	0
597	10	24	0	10	24	0	0	0	0
508	8	16	Ň	8	16	ň	ñ	Ő	ň
500	0	17.6	õ	0	17.6	õ	ŏ	Ő	Ô
399	8	17.0	0	8	17.0	0	0	0	0
600	8	19.2	0	8	19.2	0	0	0	0
601	8	20.8	0	8	20.8	0	0	0	0
602	8	22.4	0	8	22.4	0	0	0	0
603	8	24	0	8	24	0	0	0	0
604	Ğ	16	0	6	16	Ō	Ő	0	Ô
604	4	17.6	0	6	17.6	õ	Ő	õ	0
603	0	17.0	0	0	17.0	0	0	0	0
606	6	19.2	U	6	19.2	0	U	0	0
607	6	20.8	0	6	20.8	0	0	0	0
608	6	22.4	0	6	22.4	0	0	0	0
609	6	24	0	6	24	0	0	0	0
610	Å	16	Ň	4	16	ñ	Ň	0	0
610	4	17.6	ő	4	17.6	õ	Ő	Ň	ň
011	4	17.0	0	4	17.0	0	0	0	0
612	4	19.2	0	4	19.2	0	0	0	0
613	4	20.8	0	4	20.8	0	0	0	0
614	4	22.4	0	4	22.4	0	0	0	0
615	4	24	0	4	24	0	0	0	0
616	2	16	0	2	16	0	0	0	0
617	2	176	Ň	2	17.6	õ	õ	Ō	ň
617	2	10.2	õ	ว้	10.2	0	0	õ	Ň
018	2	19.2	0	2	19.2	0	0	0	0
619	2	20.8	0	2	20.8	0	0	0	0
620	2	22.4	0	2	22.4	0	0	0	0
621	2	24	0	2	24	0	0	0	0
622	0	16	0	0	16	0	0	0	0
623	Ó	17.6	0	0	17.6	0	0	0	0
624	õ	10.2	õ	Õ	10.2	õ	õ	ň	ñ
(25	0	20.9	0	0	20.0	0	0	0	ő
025	U	20.8	0	0	20.6	0	0	0	0
626	0	22.4	0	0	22.4	0	0	0	0
627	0	24	0	0	24	0	0	0	0
628	16	25.3333	0	16	25.3333	0	0	0	0
629	16	26.6667	0	16	26.6667	0	0	0	0
630	16	28	Ô	16	28	0	0	0	0
(2)	16	20	0	16	20 2222	0	õ	0	ň
031	10	29.3333	0	10	29.3333	0	0	U	0
632	16	30.6667	0	16	30.6667	U	0	0	U
633	16	32	0	16	32	0	0	0	0
635	14	25.3333	0	14	25.3333	0	0	0	0
636	14	26.6667	0	14	26.6667	0	0	0	0
~~~	• •	20.0007	õ	14	28	Ó	õ	Ō	Õ
637	14	/ 🖌	v	4 7			Y.		
637 638	14	28 20 2222	Ô.	14	70 1111	Δ (1)	0	Λ	n
637 638	14 14	29.3333	0	14	29.3333	0	0	0	0
637 638 639	14 14 14	28 29.3333 30.6667	0	14 14	29.3333 30.6667	0	0	0	0
637 638 639 640	14 14 14 14	28 29.3333 30.6667 32	0 0 0	14 14 14	29.3333 30.6667 32	0 0 0	0 0 0	0 0 0	0 0 0
637 638 639 640 641	14 14 14 14 12	29.3333 30.6667 32 25.3333	0 0 0 0	14 14 14 12	29.3333 30.6667 32 25.3333	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
637 638 639 640 641 642	14 14 14 12 12	29.3333 30.6667 32 25.3333 26.6667	0 0 0 0 0	14 14 14 12 12	29.3333 30.6667 32 25.3333 26.6667	0 0 0 0	0 0 0 0	0 0 0 0 0	0 0 0 0

,

644	12	29.3333	0	12	29.3333	0	0	0	0
645	12	30.6667	0	12	30.6667	0	0	0	0
646	12	32	0	12	32	0	0	0	0
647	10	25.3333	0	10	25.3333	0	0	0	0
648	10	26.6667	0	10	26.6667	0	0	0	0
649	10	28	0	10	28	0	0	0	0
650	10	29.3333	0	10	29.3333	0	0	0	0
651	10	30.6667	0	10	30.6667	0	0	0	0
652	10	32	0	10	32	0	0	0	0
653	8	25.3333	0	8	25.3333	0	0	0	0
654	8	26.6667	0	8	26.6667	0	0	0	0
655	8	28	0	8	28	0	0	0	0
656	8	29.3333	0	8	29.3333	0	0	0	0
657	8	30.6667	0	8	30.6667	0	0	0	0
638	8	32	0	8	32	0	0	U	0
659	6	25.3333	0	6	25.3333	0	0	0	0
000	6	20.0007	0	0	20.000/	0	0	0	0
001	6	28	0	0	28	0	0	0	0
002 662	0	29.3333	0	0	29.3333	0	0	0	0
003	0	30.0007	0	0	30.0007	0	0	0	0
004	0	26 2222	0	0	32	0	0	0	0
003	4	23.3333	0	4	23.3333	0	0	0	0
600	4	20.000/	0	4	20.000/	0	0	0	0
669	4	20	0	4	20	0	0	0	0
660	4	29.3333	0	4	29.3333	0	0	0	0
670	4	30.0007	0	4	30.0007	0	0	Õ	0
671	2	25 2222	Õ	2	25 3333	0	0	Ŏ	ő
672	2	26.6667	Ň	2	25.5555	ŏ	0	õ	Ň
673	2	28	ŏ	2	20.0007	Ő	õ	ŏ	Ő
674	2	29 3333	õ	2	29 3333	Ő	Ő	Õ	õ
675	2	30 6667	õ	2	30 6667	õ	õ	Ő	ň
676	2	32	Õ	2	32	ŏ	Ő	õ	ŏ
677	ō	25.3333	õ	ō	25.3333	ŏ	ŏ	õ	Ő
678	Ō	26.6667	Õ	Õ	26.6667	ŏ	õ	õ	ŏ
679	0	28	Ō	Ō	28	õ	ō	Ō	Õ
680	0	29.3333	0	0	29.3333	0	0	0	0
681	0	30.6667	0	0	30.6667	0	0	0	0
682	0	32	0	0	32	0	0	0	0
685	0	14.3	0	0	14.3	0	0	0	0
686	2	14.3	0	2	14.3	0	0	0	0
687	4	14.3	0	4	14.3	0	0	0	0
688	6	14.3	0	6	14.3	0	0	0	0
689	8	14.3	0	8	14.3	0	0	0	0
<b>69</b> 0	10	14.3	0	10	14.3	0	0	0	0
691	12	14.3	0	12	14.3	0	0	0	0
692	14	14.3	0	14	14.3	0	0	0	0
693	16	14.3	0	16	14.3	0	0	0	0
694	0	24.1	0	0	24.1	0	0	0	0
695	2	24.1	0	2	24.1	0	0	0	0
696	4	24.1	0	4	24.1	0	0	0	0
697	6	24.1	0	6	24.1	0	0	0	0
698	8	24.1	0	8	24.1	0	0	0	0
700	10	24.1	0	10	24.1	0	0	0	0
700	12	24.1	0	12	24.1	0	0	0	0
701	14	24.1	0	14	24.1	0	0	0	0
702	10	24.I 14.4	0	10	24.1 14.4	0	U	U	0
703	11.4	14.4	0	11.4	14,4	0	0	U	0
704	11.9	10	0	11.9	10	0	0	0	0
705	11.7	10.7	0	11.9	10.0	0	0	0	0
707	11.7	20.8	0 0	11.7	20.8	0 0	0	0	0
708	11.9	22.4	õ	11.9	22.4	õ	õ	õ	ñ
709	11.4	24	ŏ	11.4	24	ŏ	õ	ŏ	ŏ
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#### **APPENDIX A-5**

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#### Program to Write Nodal Displacement Data into STARS-SOLIDS Format

```
program new_out2.f
C Reads in a file named: 3modes.txt and writes to 3 files
C formatted as *.out.2 should be.
       implicit none
       integer i, j, k, dof, node, zero, nmodes, nm1, nm2, nm3, nd1, nd2, nd3
       real node data(10000,7,3),disp
       open(unit=10,file='3modes.txt')
       zero≃0
C Read in header data
       read(10,*) nmodes
       read(10,*) nml,ndl
       read(10,*) nm2,nd2
       read(10,*) nm3,nd3
C Read in nodal dof and disp data
       do i=1, (nml*nd1)
         read(10,*) node,dof,disp
            if(dof .eq. 1) then
               node data(node,1,1)=disp
            else if (dof .eq. 2) then
               node data(node,2,1)=disp
            else if (dof .eq. 3) then
               node_data(node,3,1)=disp
            else if (dof .eq. 4) then
               node data(node,4,1)=disp
            else if (dof .eq. 5) then
               node data(node, 5, 1) = disp
            else
               node data(node, 6, 1) = disp
            end if
           node_data(node,7,1) =node
       end do
       do i=1, (nm2*nd2)
         read(10,*) node,dof,disp
            if (dof .eq. 1) then
               node data(node,1,2)=disp
            else if (dof .eq. 2) then
               node_data(node,2,2)=disp
            else if (dof .eq. 3) then
               node_data(node,3,2) =disp
            else if (dof .eq. 4) then
               node data(node, 4, 2) = disp
            else if (dof .eq. 5) then
               node data(node, 5, 2) = disp
```

```
else
                node_data(node, 6, 2) = disp
             end if
           node_data(node,7,2)=node
       end do
       do i=1, (nm3*nd3)
         read(10,*) node,dof,disp
             if(dof .eq. 1) then
                node data(node,1,3)=disp
             else if (dof .eq. 2) then
                node data(node,2,3)=disp
             else if (dof .eq. 3) then
                node_data(node,3,3)=disp
             else if (dof .eq. 4) then
                node data(node,4,3)=disp
             else if (dof .eq. 5) then
                node data(node, 5, 3) = disp
            else
               node data(node, 6, 3) = disp
            end if
           node_data(node,7,3)=node
       end do
       close(10)
C Write to 3 files
       do k=1,3
        j=1
        if (k .eq. 1) open(unit=15,file='out1.dat')
        if (k .eq. 2) then
         close(15)
         open(unit=15,file='out2.dat')
        end if
        if (k .eq. 3) then
         close(15)
         open(unit=15, file='out3.dat')
        end if
         write(15,1000)
         write(15,1001)
         do i = 1,10000
            if (node_data(i,7,k) .eq. i) then
               write(15,1002) i,j,
     δ.
               node_data(i,1,k), node_data(i,2,k),
     δα
               node_data(i,3,k),node_data(i,4,k),
               node data(i,5,k),node data(i,6,k)
     &
              j=j+1
            end if
         end do
       end do
1000
        format(7x, 'NODE')
1001
        format(5x, 'EXT', 3x, 'INT', 6x, 'X-DISPL.', 6x, 'Y-DISPL.',
     &
             6x, 'Z-DISPL.', 6x, 'X-ROTN.', 7x, 'Y-ROTN.', 7x,
     &
              'Z-ROTN.'/)
1002
        format(5x, i3, 3x, i3, 4x, E12.6, 2x, E12.6, 2x, E12.6, 2x, E12.6,
             2x,E12.6,2x,E12.6)
     &
       stop
```

```
end
```

### **APPENDIX B-1**

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## STARS-CFD Geometry Data File (BACT.DAT)

BACTNACA 0012 Wing & Flap	0.000000 (	0	0.000000	3.954741	0	0.948188
32 15	0.001542 (	0	0.027865	4.091030	0	0951432
Curve Components	0.006168 (	0	0.055494	4.228826	0	0.954057
1 1	0.013875 (	0	0.082883	4.368076	0	0.956067
2	0.024661 (	0	0.110027	4.508726	0	0957468
-160 0 -100	0.038522 (	0	0.136923	4.650722	0	0.958266
-160 0 100	0.055452 (	0	0.163563	4.794009	0	0.958466
2 1	0.075445 (	0	0.189942	4.938533	0	0.958077
2	0.098493 (	)	0216053	5.084236	0	0.957106
-160 0 100	0.124587 (	)	0241889	5231064	0	0955562
160 0 100	0.153718 (	)	0267440	5378959	0	0953453
3 1	0.185873 (	)	0292700	5.527864	0	0.950789
2	0.221041 (	)	0.317658	5.677723	0	0.947580
160 0 100	0.259207 (	)	0.342306	5.828476	0	0.943836
160 0 -100	0.300358 (	)	0.366632	5.980067	0	0.939569
4 1	0344477 (	)	0.390628	6.132437	0	0.934789
2	0.391548 (	)	0.414281	6.285527	0	0.929508
160 0 -100	0.441552 (	)	0.437581	6439277	Ō	0.923739
-160 0 -100	0.494469 (	)	0.460516	6.593630	0	0.917493
5 1	0.550281 (	)	0.483075	6.748524	Õ	0.910783
2	0.608964 (	)	0.505246	6.903901	õ	0903623
-160 0 -100	0.670496 (	)	0.527017	7.059701	Ő	0.896025
-160 160 -100	0.734855 (	)	0.548375	7.215863	0	0.888002
6 1	0.802014 (	)	0.569308	7.372327	0	0.879569
2	0.871948 0	)	0.589805	7.529034	0	0.870739
-160 0 100	0.944630 0	)	0.609852	7.685921	0	0.861525
-160 160 100	1.020032 0	)	0.629438	7.842930	0	0.851942
7 1	1.098125 0	)	0.648550	8.000000	0	0.842004
2	1.178879 0	)	0.667177	8.157070	0	0.831724
160 0 100	1.262262 0	)	0.685306	8314079	0	0.821117
160 160 100	1.348243 (	)	0.702927	8.470966	0	0.810197
8 1	1.436788 0	)	0.720029	8.627673	0	0.798978
2	1.527864 0	)	0.736599	8.784137	0	0.787473
160 0 -100	1.621435 0	)	0.752628	8.940299	0	0.775697
160 160 -100	1.717465 0	)	0.768107	9.096099	0	0.763664
9 1	1.815916 0	)	0.783024	9251476	0	0.751388
2	1.916752 0	)	0.797372	9.406370	0	0.738882
-160 160 -100	2.019933 C	)	0.811141	9.560723	0	0.726159
-160 160 100	2.125420 0	)	0.824323	9.714473	0	0.713235
10 1	2.233171 0	)	0.836912	9.867563	0	0.700121
2	2.343146 0	)	0.848899	10.019933	0	0.686832
-160 160 100	2.455301 0	)	0.860280	10.171524	0	0.673381
160 160 100	2.569594 0	)	0.871048	10322277	0	0.659780
11 1	2.685980 0	)	0.881199	10.472136	0	0.646042
2	2.804416 0	)	0.890728	10.621041	0	0.632181
160 160 100	2.924854 0	)	0.899632	10.768936	0	0.618209
160 160 -100	3.047248 0	)	0.907908	10.915764	0	0.604139
12 1	3.171552 0	)	0.915554	11.061467	0	0.589983
2	3.297718 0	)	0.922570	11.205991	0	0.575753
160 160 -100	3.425696 0	)	0.928953	11.349278	0	0.561462
-160 160 -100	3.555438 0	)	0.934706	11.491274	0	0.547121
13 1	3.686893 0	)	0.939828	11.631924	0	0.532743
161	3.820011 0	)	0.944321	11.771174	0	0.518340

11.908970 0 0.503922	0.259207 0 -0.342306	8.470966 0 -0.810197
12.045259 0 0.489503	0.300358 0 -0.366632	8.627673 0 -0.798978
12.179989 0 0.475093	0.344477 0 -0.390628	8784137 0 -0787473
12.313107 0 0.460704	0391548 0 -0414281	8940299 0 -0775697
12,444562 0 0,446347	0441552 0 -0437581	9096099 0 0763664
12.574304 0 0.432034	0494469 0 -0460516	9251476 0 -0751388
12 702282 0 0417776	0550281 0 -0483075	9406370 0 0738882
12 828448 0 0.403585	0.608964 0 -0.505246	9560773 0 -0726159
12 952752 0 0 389470	0.670496 0 -0.527017	9714473 0 0713235
13.075146 0 0.375445	0.734855 0 .0.548375	9867563 0 -0.700121
13.195584 0 0.361518	0.802014 0 -0.560308	10010033 0 -0.686833
13 314020 0 0347703	0.871948 0 -0.580805	10.171574 0 .0672281
13/20/06 0 0.33/000	0.014620 0 0.600952	10.171324 0 -0.073381
13.544690 0 0.320447	1.020032 0 -0.629438	10.322277 0 -0.039780
13 656954 0 0.207020	1.020032 0 -0.025436	10.472130 0 -0.040042
13.766829 0 0.202765	1.078123 0 -0.048330	10.021041 0 -0.002181
13,700629 0 0293703	1.176879 0 -0.007177	10.706950 0 -0.016209
13.090067 0 0.260000	1202202 0 -0.080500	10.913704 0 -0.004139
13/30007 0 0/20/745	1.340243 0 40.702927	11.001407 0 -0.365963
14.194094 0 0.20000	1507864 0 0726500	11203991 0 -0.373733
14.104004 0 0.242400	1.527804 0 -0.750579	11.349278 0 -0.301402
14272555 0 0230134	1.717465 0 0.769107	114912/4 0 40.04/121
14.576505 0 0.216021	1.717403 0 -0.708107	11.031924 0 -0.332743
14,472130 0 0.200130	1.01(75) 0 0.700024	11.771174 0 -0.518340
14,503212 0 0.194469	1.910/32 0 -0.19/372	11.908970 0 -0.303922
14.051757 0 0.183092	2019933 0 -0.811141	12.045259 0 -0.489503
14.737738 0 0.171955	2.125420 0 -0.824323	12.179989 0 -0.475093
14.821121 0 0.101087	2233171 0 -0.830912	12.313107 0 -0.460704
14/901875 0 0.120498	2.343140 0 -0.848899	12.444302 0 -0.440347
14.979908 0 0.140198	2455501 0 -0.800280	125/4304 0 -0.452034
15.055370 0 0.130190	2.309394 0 -0.871048	12./02282 0 -0.41///6
15.128052 0 0.120502	2.00.7900 0 40.001179	12.626996 0 -0.403565
15.197980 0 0.111120	2.004910 0 -0.890728	12952752 0 -0.389470
15205145 0 0.102075	2.924634 0 40.899032	13.073140 0 -0.373443
15.329304 0 0.0933300	3.047246 0 40.907908	13.193384 0 -0.301318
15.391030 0 0.004908	3.171332 0 -0.913334	13.314020 0 -0.347703
15.449/19 0 0.0/090/	3.297718 0 -0.922370	13.430406 0 -0.334009
15 559449 0 0062012	3.423090 0 -0.920933	13.544099 0 40.320447
15.536446 0 0.002015	3,333436 0 -0.934700	13.030834 0 -0.30/029
15,555572 0 0,049559	3.000093 0 -0.939626	13./00829 0 -0.293/03
15,005323 0 0,049410	3.020011 0 -0.344321	13.6/4300 0 -0.260000
15.099042 0 0.042410	3/394/41 0 40340100 4/001030 0 0.0051/32	13.960007 0 40.207743
15.740795 0 0.050057	4.091030 0 40931432	14.083248 0 -0.233000
15 814127 0 0005350	4228820 0 -0.994037	14.104004 0 40.242400
15.846382 0 0.021826	4508776 0 -0.057468	14202050 0 4020004
15.875413 0 0.017710	4650772 0 .0958266	14.378303 0 -0218021
15.01507 0 0.014015	4.000722 0 -0.950200	14 562212 0 0 104490
15924555 0 0010745	4038533 0 .0058077	14.51757 0 0.192000
15 944548 0 0007903	5084236 0 -0.057106	14.031737 0 -0.180092
15961478 0 0.005494	5231064 0 -0955562	14.821121 0 -0.161087
15975339 0 0003519	5378959 0 -0953453	14 901 875 0 -0.150408
15986125 0 0001981	5 527864 0 -0950789	14.979968 0 -0.140198
15993832 0 0000881	5677723 0 -0947580	15055370 0 -0.130196
15 998458 0 0,000220	5.828476 0 -0.943836	15128052 0 -0.120502
1600000 0 000000	5980067 0 -0939569	15197986 0 -0111126
14 1	6132437 0 -0934789	15265145 0 -0.102075
161	6285527 0 -0929508	15 329504 0 -0.093360
0000000 0 0000000	6439277 0 0923739	15 391036 0 .0.084988
0001542 0 -0027865	6593630 0 -0917493	15449719 0 -0076967
0006168 0 -0.055494	6748524 0 -0910783	15.505531 0 -0.069306
0013875 0 -0082883	6903901 0 -0903623	15 558448 0 -0062013
0024661 0 -0110027	7.059701 0 -0.896025	15.608452 0 -0.055094
0038522 0 -0136923	7215863 0 -0.888002	15655523 0 -0.048558
0055452 0 -0163563	7.372327 0 -0.879569	15.699642 0 -0.042410
0.075445 0 -0.189942	7.529034 0 -0.870739	15.740793 0 -0.036657
0.098493 0 -0.216053	7.685921 0 -0.861525	15.778959 0 -0.031305
0.124587 0 -0.241889	7.842930 0 -0.851942	15814127 0 -0026359
0.153718 0 -0.267440	8,00000 0 -0.842004	15,846282 0 -0.021826
0.185873 0 -0.292700	8.157070 0 -0.831724	15.875413 0 -0017710
0221041 0 -0.317658	8314079 0 -0.821117	15.901507 0 -0.014015

15924555 0	-0.010745	4.938533 32 0.958077	14.651757 32 0.183092
15.944548 0	-0.007903	5.084236 32 0.957106	14.737738 32 0.171955
15.961478 0	-0.005494	5.231064 32 0.955562	14.821121 32 0.161087
15.975339 0	-0.003519	5378959 32 0.953453	14.901875 32 0.150498
15986125 0	-0.001981	5.527864 32 0.950789	14.979968 32 0.140198
15.009459 0	-0.000881	5,6/7/23 32 0,947580	15.055370 32 0.130196
15556458 0	0,000220	5.826470 52 0.943830	15.128052 32 0.120502
15 1	0.00000	5.560007 52 0.959507 6.139437 32 0.034780	15.197960 32 0.111120
161		6285527 32 0929508	15320504 32 0.003360
0.000000 32	0.000000	6439277 32 0.923739	15391036 32 0.084988
0.001542 32	0.027865	6.593630 32 0.917493	15,449719 32 0,076967
0.006168 32	0.055494	6.748524 32 0.910783	15.505531 32 0.069306
0.013875 32	0.082883	6.903901 32 0.903623	15.558448 32 0.062013
0.024661 32	0.110027	7.059701 32 0.896025	15.608452 32 0.055094
0.038522 32	0.136923	7.215863 32 0.888002	15.655523 32 0.048558
0.055452 32	0.163563	7372327 32 0.879569	15.699642 32 0.042410
0.075445 32	0.189942	/.529034 32 0.8/0/39	15.740793 32 0.036657
0.098493 32	0.210053	7.080921 32 0.801020	15.778959 32 0.031305
0.124387 32	0241009	8,000000 32 0,821942	15.814127 32 0.020339
0.135718 32	0.292700	8157070 32 0.831724	15,846282 32 0.021820
0221041 32	0317658	8314079 32 0.821117	15901507 32 0.014015
0.259207 32	0.342306	8470966 32 0.810197	15924555 32 0010745
0.300358 32	0.366632	8.627673 32 0.798978	15.944548 32 0.007903
0.344477 32	0.390628	8.784137 32 0.787473	15.961478 32 0.005494
0.391548 32	0.414281	8.940299 32 0.775697	15975339 32 0.003519
0.441552 32	0.437581	9.096099 32 0.763664	15986125 32 0.001981
0.494469 32	0.460516	9251476 32 0.751388	15993832 32 0.000881
0.550281 32	0.483075	9.406370 32 0.738882	15.998458 32 0.000220
0.608964 32	0.505246	9.560723 32 0.726159	16.000000 32 0.000000
0.6/0496 32	0.527017	9.714473 32 0.713235	16 1
0.734855 32	0.548375	9.80/203 32 0.700121	101
0.802014 32	0.589805	10.171524 32 0.673381	0.00000 32 0.00000
0.944630 32	0.609852	103222777 32 0659780	0.001.342 32 -0.027803
1.020032 32	0.629438	10472136 32 0646042	0.013875 32 -0.082883
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1.262262 32	0.685306	10915764 32 0.604139	0.055452 32 -0.163563
1.348243 32	0.702927	11.061467 32 0.589983	0.075445 32 -0.189942
1.436788 32	0.720029	11205991 32 0.575753	0.098493 32 -0.216053
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1.015910 32	0.787377	11.771174 32 0316340	0.221041 32 -0.317038
2019933 32	0811141	12 04 5 2 5 0 5 0 5 2 0 5 0 5 2 2 1 2 0 4 8 9 5 0 3	0300358 37 .0366637
2.125420 32	0.824323	12.179989 32 0.475093	0.344477 32 -0.390628
2.233171 32	0.836912	12.313107 32 0.460704	0.391548 32 -0.414281
2343146 32	0.848899	12.444562 32 0.446347	0.441552 32 -0.437581
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2.804416 32	0.890728	12952752 32 0.389470	0.670496 32 -0.527017
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3 171552 32	0.915554	13 314020 32 0 347703	0.802014 52 -0.509506
3297718 32	0.922570	13,430406 32 0,334009	0944630 32 -0.00000
3.425696 32	0.928953	13.544699 32 0.320447	1.020032 32 -0.629438
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3.820011 32	0.944321	13.874580 32 0.280666	1.262262 32 -0.685306
3.954741 32	0.948188	13980067 32 0267743	1.348243 32 -0.702927
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2.019933 32 -0.811141	12.045259 32 -0.489503	21 1
2.125420 32 -0.824323	12.179989 32 -0.475093	55
2233171 32 -0.836912	12.313107 32 -0.460704	12.00000 14.4 0.494308997
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2455301 32 -0.860280	125/4304 32 -0.432034	12.179989 14.4 0.475093031
2,505594 52 -0.871048	12.702282 32 -0.4177/6	12313107 14.4 0.460704012
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3297718 32 -0.922570	13430406 32 -0334009	13075146 144 0375444624
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8.157070 32 -0.831724	15.875413 32 -0.017710	15.778959 14.4 0.031304631
8.514079 52 40.621117 8.470066 33 -0.810107	15901507 32 40,014015	15.814127 14.4 0.026359429
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9.714473 32 -0.713235 9.867563 32 -0.700121 10.019933 32 -0.686832	15998458 32 -0.000220 16.000000 32 0.000000 17 1 2 0 0 0	15.975339         14.4         0.003519031           15.986125         14.4         0.001980723           15.993832         14.4         0.000880725           15.998458         14.4         0.000220242           16.00000         14.4         0.00000
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9.714473 32 -0.713235 9.867563 32 -0.700121 10.019933 32 -0.686832 10.171524 32 -0.673381 10.322277 32 -0.659780 10.472136 32 -0.646042 10.621041 32 -0.632181 10.768936 32 -0.618209 10.915764 32 -0.64139 11.061467 32 -0.589983 11.205991 32 -0.575753 11.349278 32 -0.561462 11.491274 32 -0.561462	15998458       32       -0.000220         16.000000       32       0.000000         17       1         2       0       0         0       0       0         18       1         2       16       0         16       14.4       0         19       1       2         16       14.4       0         19       1       2         16       14.4       0         16       24       0         20       1       1	15.975339         14.4         0.003519031           15.986125         14.4         0.001980723           15.993832         14.4         0.000880725           15.993832         14.4         0.000220242           16.00000         14.4         0.000220242           16.00000         14.4         0.00000           22         1         2           12         14.4         0.494308997           12         24         0.494308997           23         1           55         12.00000         24         0.494308997           12.045259         24         0.489503001           12.179989         24         0.475093031           12.145259         24         0.489703031           12.13107         24         0.46070013
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9.714473 32 -0.713235 9.867563 32 -0.700121 10.019933 32 -0.686832 10.171524 32 -0.673381 10.322277 32 -0.659780 10.472136 32 -0.646042 10.621041 32 -0.632181 10.768936 32 -0.618209 10.915764 32 -0.604139 11.061467 32 -0.589983 11.205991 32 -0.575753 11.349278 32 -0.561462 11.491274 32 -0.561462 11.491274 32 -0.518340	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	15.975339         14.4         0.003519031           15.986125         14.4         0.001980723           15.993832         14.4         0.000880725           15.993832         14.4         0.000220242           16.00000         14.4         0.000220242           16.00000         14.4         0.00000           22         1         2           12         14.4         0.494308997           12         24         0.494308997           12         24         0.494308997           12         14         0.494308997           12         24         0.494308997           12.045259         24         0.494308997           12.045259         24         0.49503001           12.179989         24         0.475093031           12.313107         24         0.446704012           12.444562         24         0.446347363           12.574304         24         0.446347363
9.714473 32 -0.713235 9.867563 32 -0.700121 10.019933 32 -0.686832 10.171524 32 -0.673381 10.322277 32 -0.659780 10.472136 32 -0.646042 10.621041 32 -0.632181 10.768936 32 -0.618209 10.915764 32 -0.604139 11.061467 32 -0.589983 11.205991 32 -0.575753 11.349278 32 -0.561462 11.491274 32 -0.561462 11.491274 32 -0.518340 11.908970 32 -0.503922	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	15.975339         14.4         0.003519031           15.986125         14.4         0.001980723           15.993832         14.4         0.000880725           15.993832         14.4         0.000880725           15.998458         14.4         0.000220242           16.00000         14.4         0.000020242           12         1         2           12         14.4         0.494308997           12         24         0.494308997           12         24         0.494308997           12.045259         24         0.494308997           12.045259         24         0.494308997           12.045259         24         0.49503001           12.179989         24         0.475093031           12.313107         24         0.460704012           12.444562         24         0.446347363           12.574304         24         0.432034431           12.702282         24         0.417776497

12828448       24       0403584782       14282535       14.4       -0230134       15.055370       2         12952752       24       0389470453       14.378565       14.4       -0218021       15.128052       2         13.075146       24       0.375444624       14.472136       14.4       -0206136       15.197986       2         13.195584       24       0.361518361       14.563212       14.4       -0.194489       15.265145       2         13.314020       24       0.347702684       14.651757       14.4       -0.183092       15.329504       2         13.430406       24       0.334008569       14.737738       14.4       -0.171955       15.391036       2         13.544699       24       0.320446949       14.821121       14.4       -0.161087       15.449719       2         13.656854       24       0.307028714       14.901875       14.4       -0.150498       15.505531       2         13.766829       24       0.293764709       14.9901875       14.4       -0.140198       15.558448       15.558448         13.8765829       24       0.293764709       14.99086       14.4       -0.140198       15.558448       15.558448       15.955270	24 -0.130196 24 -0.120502 24 -0.111126 24 -0.102075 24 -0.093360 24 -0.084988 24 -0.075607
12952752       24       0.389470453       14.378565       14.4       -0.218021       15.128052       2         13.075146       24       0.375444624       14.472136       14.4       -0.206136       15.197986       2         13.195584       24       0.361518361       14.563212       14.4       -0.194489       15.265145       2         13.195584       24       0.347702684       14.651757       14.4       -0.183092       15.329504       2         13.314020       24       0.347702684       14.651757       14.4       -0.183092       15.329504       2         13.340406       24       0.334008569       14.737738       14.4       -0.171955       15.391036       2         13.544699       24       0.320446949       14.821121       14.4       -0.161087       15.449719       2         13.656854       24       0.307028714       14.901875       14.4       -0.150498       15.505531       2         13.766829       24       0.293764709       14.9901875       14.4       -0.140198       15.558448       2         13.874580       24       0.39764709       14.99086       14.4       -0.140198       15.558448       14.901875       14.4 <t< td=""><td>24 -0.120502 24 -0.111126 24 -0.102075 24 -0.093360 24 -0.084988 24 -0.0756067</td></t<>	24 -0.120502 24 -0.111126 24 -0.102075 24 -0.093360 24 -0.084988 24 -0.0756067
13075146       24       0.375444624       14.472136       14.4       -0.206136       15.197986       1         13.195584       24       0.361518361       14.563212       14.4       -0.194489       15.265145       1         13.314020       24       0.347702684       14.651757       14.4       -0.194489       15.2265145       1         13.314020       24       0.347702684       14.651757       14.4       -0.183092       15.329504       1         13.430406       24       0.334008569       14.737738       14.4       -0.171955       15.391036       2         13.544699       24       0.320446949       14.821121       14.4       -0.161087       15.449719       2         13.656854       24       0.307028714       14.901875       14.4       -0.150498       15.505531       2         13.766829       24       0.293764709       14.979986       14.4       -0.140198       15.558448       2         13.8765829       24       0.39764709       14.979786       14.4       -0.140198       15.558448       2         13.8765829       24       0.398645774       14.901875       14.4       -0.140198       15.558448       2	24 -0.1120502 24 -0.111126 24 -0.102075 24 -0.093360 24 -0.084988 24 -0.075667
13.075146       24       0375444624       14.472136       14.4       -0.206136       15.197986       1         13.195584       24       0361518361       14563212       14.4       -0.194489       15265145       1         13.195584       24       0.347702684       14.651757       14.4       -0.183092       15329504       2         13.430406       24       0.334008569       14.737738       14.4       -0.171955       15391036       2         13.544699       24       0.320446949       14.821121       14.4       -0.161087       15.449719       2         13.656854       24       0.307028714       14.901875       14.4       -0.161087       15.505531       2         13.766829       24       0.293764709       14.9901875       14.4       -0.140198       15.558448       2         13.8765829       24       0.307028714       14.901875       14.4       -0.140198       15.558448       2         13.874589       24       0.392645774       14.9058774       14.4       -0.140198       15.558448	24 -0.111126 24 -0.102075 24 -0.093360 24 -0.084988 24 -0.084988
13.195584       24       0.361518361       14.563212       14.4       -0.194489       15.265145       2         13.314020       24       0.347702684       14.651757       14.4       -0.183092       15.329504       2         13.430406       24       0.334008569       14.737738       14.4       -0.171955       15.391036       2         13.544699       24       0.320446949       14.821121       14.4       -0.161087       15.449719       2         13.656854       24       0.307028714       14.901875       14.4       -0.16098       15.505531       2         13.766829       24       0.293764709       14.9918968       14.4       -0.140198       15.558448       2         13.8765829       24       0.390567774       14.9018968       14.4       -0.140198       15.558448       2	24 -0.102075 24 -0.093360 24 -0.084988
13314020       24       0.347702684       14.651757       14.4       -0.183092       15.329504         13.430406       24       0.334008569       14.737738       14.4       -0.171955       15.391036       2         13.544699       24       0.320446949       14.821121       14.4       -0.161087       15.449719       2         13.656854       24       0.307028714       14.901875       14.4       -0.150498       15.505531       2         13.766829       24       0.293764709       14.9901875       14.4       -0.140198       15.558448       2         13.8766829       24       0.39705274       14.99586       14.4       -0.140198       15.558448       2	24 -0.093360 24 -0.084988 24 0.074067
1351443       24       03470404       1440173       144       0.16092       132504       132504         13430406       24       0334008569       14.737738       14.4       0.171955       15391036       2         13544699       24       0320446949       14821121       14.4       -0.161087       15449719       2         13.656854       24       0307028714       14901875       14.4       -0.16098       15505531       2         13.766829       24       0293764709       14.979968       14.4       -0.140198       15558448       2         13.8765829       24       0293764709       14.979968       14.4       -0.140198       15558448       2	24 -0.093360 24 -0.084988
13430406       24       0334008569       14.737/38       14.4       -0171955       15.391036       2         13544699       24       0.320446949       14.821121       14.4       -0.161087       15.449719       2         13.656854       24       0.307028714       14.901875       14.4       -0.150498       15.505531       2         13.766829       24       0.293764709       14.979968       14.4       -0.140198       15.558448       2         13.8765829       24       0.39065774       14.955720       14.4       -0.140198       15.558448       2	24 -0.084988
13.544699       24       0.320446949       14.821121       14.4       -0.161087       15.449719       2         13.656854       24       0.307028714       14.901875       14.4       -0.150498       15.505531       2         13.766829       24       0.293764709       14.9901875       14.4       -0.140198       15.558448       2         13.8765829       24       0.39265774       14.99058       14.4       -0.140198       15.558448       2	34 0.076067
13.656854         24         0.307028714         14.901875         14.4         -0.150498         15.505531         2           13.766829         24         0.293764709         14.979968         14.4         -0.140198         15.558448         2           13.766829         24         0.293764709         14.979968         14.4         -0.140198         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.558448         15.55848         15.5584	24 UU/050/
13500674 24 050702714 14507875 144 0.150958 1550531 2 13.766829 24 0293764709 14979968 144 0.140198 15558448 2 13.974590 24 0.09065774 15.055170 14.010107	21 0.070707
13.766829 24 0293764709 14.979968 14.4 -0.140198 15.558448 2	24 -0.009300
12 974590 24 0 290665724 15 055270 144 0 120100 15 000452 2	24 -0.062013
12/0/19/00/29/02/00/03/29/11/02/02/02/02/02/02/02/02/02/02/02/02/02/	24 .0.055004
	24 -0.0000000
13980007 24 0267742339 13.128052 14.4 -0.120502 15.655523 2	24 -0.048558
14.083248 24 0.255005822 15.197986 14.4 -0.111126 15.699642 2	24 -0.042410
14 184084 24 0 242466224 15 265145 14.4 -0 102075 15 7407293 2	74 .0036657
	24 -0.00007
14.282335 24 0.230134319 15.32504 14.4 -0.093360 15.778959 2	24 -0.031305
14.378565 24 0.218020612 15.391036 14.4 -0.084988 15.814127 2	24 -0.026359
14 472136 24 0.20613553 15 440710 14 4 -0.076967 15 846282 7	74 0001904
	24 -0.021620
14563212 24 0.19448941 15505531 14.4 -0.069306 152675413 2	24 -0.017710
14.651757 24 0.183092492 15.558448 144 -0.062013 15.901507 2	24 -0014015
14 727738 24 0 171054005 15 608452 14 4 0.055004 15 004555 7	34 0.010746
14,13/136 24 0.171534500 13,000432 14,4 4,0,03044 13,524353 2	24 -0.010/45
14.821121 24 0.161086662 15.655523 14.4 -0.048558 15.944548 2	24 -0.007903
14901875 24 0.150497635 15699642 144 -0.042410 15961478 2	24 -0.005494
	24 0.000 510
14.979906 24 0.140197535 15.740795 14.4 40.030657 15.975339 2	24 -0.003519
15.055370 24 0.130195989 15.778959 14.4 -0.031305 15.986125 2	24 -0.001981
15 128052 24 012050233 15 814127 14.4 -0.026359 15 903832 2	24 .0000881
	24 -0.000001
15.197986 24 0.111125777 15.846282 14.4 -0.021826 15.998458 2	24 -0.000220
15265145 24 0.102075327 15.875413 14.4 -0.017710 16.00000 2	24 0.000000
15329504 24 0.093359749 15901507 14.4 -0.014015 27 1	
1525307 24 0.05555747 15301307 144 0.014015 27 1	
15.391036 24 0.08498/577 15.924555 14.4 -0.010745 108	
15,449719 24 0.076967086 15,944548 14.4 -0.007903 0,000000 14	44 000000
	4.4 0.0000000
15305351 24 0.009500222 15361478 14.4 -0.005494 0.001542 14	4.4 0.027865
15.558448 24 0.062012879 15.975339 14.4 -0.003519 0.006168 14	4.4 0.055494
15608452 24 0.055094287 15986125 144 -0.001981 0.013875 14	44 0.082883
	4.4 0.1100007
13.03325 24 0.048337594 13.995832 14.4 0.000881 0.024661 14	4.4 0.110027
15.699642 24 0.04240955 15.998458 14.4 -0.000220 0.038522 14	4.4 0.136923
15 740702 04 0.00((\$(\$5)	44 0163563
12/40/91 /4 000000000 1000000000000000000000000	1.4 0.100000
15.740793 24 003050553 16.00000 14.4 000000 005552 14	4.4 0.1000.40
15.778959 24 0.031304631 25 1 0.005452 14	4.4 0.189942
15.7407/3       24       0.036656533       16.00000       14.4       0.00000       0.055452       14         15.778959       24       0.031304631       25       1       0.075445       14         15.814127       24       0.026359429       2       0.098493       14	4.4 0.189942 4.4 0.216053
15./40/93         24         0.0050553         16.00000         14.4         0.00000         0.015542         14           15.778959         24         0.031304631         25         1         0.075445         14           15.814127         24         0.026359429         2         0.098493         14           15.866282         24         0.021826198         12         14.4         -0.494308997         0.124827         14	4.4     0.189942       4.4     0.216053       4.4     0.241889
15.740793       24       0.00505533       16.00000       14.4       0.00000       0.055452       14         15.778959       24       0.031304631       25       1       0.075445       14         15.814127       24       0.02639429       2       0.098493       14         15.846282       24       0.021826198       12       14.4       -0.494308997       0.124587       14         15.846282       24       0.017507275       12       24.4       0.41200277       0.124587       14	<ul> <li>4.4 0.189942</li> <li>4.4 0.216053</li> <li>4.4 0.241889</li> </ul>
15.740793       24       0.036365533       16.00000       14.4       0.00000       0.055452       14         15.778959       24       0.031304631       25       1       0.075445       14         15.814127       24       0.026359429       2       0.098493       14         15.846282       24       0.021826198       12       14.4       -0.494308997       0.124587       14         15.875413       24       0.017709775       12       24       -0.494308997       0.153718       14	4.40.1899424.40.2160534.40.2418894.40.267440
15.740793       24       0.00505533       1600000       14.4       0.00000       0.055452       14         15.778959       24       0.031304631       25       1       0.075445       14         15.814127       24       0.026359429       2       0.098493       14         15.846282       24       0.021826198       12       14.4       -0.494308997       0.124587       14         15.875413       24       0.01709775       12       24       -0.494308997       0.153718       14         15.901507       24       0.014014579       26       1       0.185873       14	4.4       0.189942         4.4       0.216053         4.4       0.241889         4.4       0.267440         4.4       0.292700
15.740795       24       0.00505555       16.00000       14.4       0.00000       0.055452       14         15.778959       24       0.031304631       25       1       0.075445       14         15.814127       24       0.026359429       2       0.098493       14         15.846282       24       0.021826198       12       14.4       -0.494308997       0.124587       14         15.875413       24       0.017709775       12       24       -0.494308997       0.153718       14         15.901507       24       0.0104014579       26       1       0.185873       14         15.9204555       24       0.010744594       55       0.010744594       55       0.221011       14	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           1.4         0.21755
15.740793       24       0.03636533       16.00000       14.4       0.00000       0.055452       14         15.778959       24       0.031304631       25       1       0.075445       14         15.814127       24       0.026359429       2       0.098493       14         15.846282       24       0.021826198       12       14.4       -0.494308997       0.124587       14         15.875413       24       0.017709775       12       24       -0.494308997       0.153718       14         15.901507       24       0.01014579       26       1       0.185873       14         15.924555       24       0.010744594       55       0.221041       14         15.924556       24       0.007703750       12.0070700       24.0494308977       0.153718	4.40.1899424.40.2160534.40.2418894.40.2674404.40.2927004.40.317658
15.740793       24       0.00505533       1600000       14.4       0.00000       0.05542       14         15.778959       24       0.031304631       25       1       0.075445       14         15.814127       24       0.026359429       2       0.098493       14         15.84628       24       0.021826198       12       14.4       -0.494308997       0.124587       14         15.875413       24       0.017709775       12       24       -0.494308997       0.153718       14         15.901507       24       0.010744579       26       1       0.185873       14         15.924555       24       0.010744594       55       0.221041       14         15.944548       24       0.007903359       12.000000       24       -0.494309       0.259207       14	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306
15.740795       24       0.00505553       16.00000       14.4       0.00000       0.055452       14         15.778959       24       0.031304631       25       1       0.075445       14         15.814127       24       0.026359429       2       0.098493       14         15.846282       24       0.021826198       12       14.4       -0.494308997       0.124587       14         15.875413       24       0.01709775       12       24       -0.494308997       0.153718       14         15.901507       24       0.0104414579       26       1       0.185873       14         15.924555       24       0.010744594       55       0.221041       14         15.961478       24       0.007903359       12.000000       24       -0.494309       0.259207       14         15.961478       24       0.005493962       12.045259       24       -0.489503       0.300358       14	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           1.4         0.342306           1.4         0.366632
15.740795       24       0.00505553       16.00000       14.4       0.00000       0.0155452       14         15.778959       24       0.031304631       25       1       0.075445       14         15.814127       24       0.026359429       2       0.098493       14         15.846282       24       0.021826198       12       14.4       -0.494308997       0.124587       14         15.875413       24       0.017709775       12       24       -0.494308997       0.153718       14         15.901507       24       0.010744594       26       1       0.185873       14         15.924555       24       0.010744594       55       0.221041       14         15.924555       24       0.007903359       12.000000       24       -0.494309       0.259207       14         15.951478       24       0.005493962       12.045259       24       -0.489503       0.300358       14         15.951379       24       0.005493962       12.179989       24       -0.45903       0.304377       14	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           1.4         0.342306           1.4         0.36632           1.4         0.390638
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.414281
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.44281           4.4         0.437581
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.437581           4.4         0.437581
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.414281           4.4         0.437581           4.4         0.460516
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.414281           1.4         0.437581           4.4         0.460516           1.4         0.483075
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.414281           4.4         0.437581           4.4         0.436516           4.4         0.505246
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.437581           4.4         0.437581           4.4         0.460516           4.4         0.505246           4.4         0.505246           4.4         0.527017
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.414281           4.4         0.437581           4.4         0.460516           1.4         0.505246           1.4         0.527017
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.414281           4.4         0.437581           4.4         0.460516           1.4         0.4505246           1.4         0.5527017           1.4         0.548375
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.43090628           4.4         0.414281           4.4         0.437581           4.4         0.460516           4.4         0.505246           4.4         0.505246           4.4         0.548375           1.4         0.548375           1.4         0.569308
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.414281           4.4         0.437581           4.4         0.505246           4.4         0.527017           1.4         0.548375           1.4         0.548375           1.4         0.548375           1.4         0.548375           1.4         0.548375           1.4         0.548375           1.4         0.548375           1.4         0.569308           1.4         0.569308
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390632           4.4         0.414281           4.4         0.437581           4.4         0.505246           4.4         0.5527017           1.4         0.548375           1.4         0.589308           1.4         0.589908           1.4         0.589905
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.342306           4.4         0.346632           4.4         0.4300628           4.4         0.414281           4.4         0.437581           4.4         0.460516           4.4         0.505246           1.4         0.505246           1.4         0.505246           1.4         0.548375           1.4         0.569308           1.4         0.569308           1.4         0.569308           1.4         0.609852
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.390628           4.4         0.390628           4.4         0.414281           4.4         0.437581           4.4         0.437581           4.4         0.505246           4.4         0.552308           4.4         0.569308           4.4         0.569308           4.4         0.609852           4.4         0.629438
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.390622           4.4         0.390622           4.4         0.414281           4.4         0.460516           4.4         0.460516           4.4         0.505246           4.4         0.5527017           4.4         0.569308           1.4         0.589805           1.4         0.589805           1.4         0.629438           1.4         0.629438           1.4         0.648550
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.346632           4.4         0.3406632           4.4         0.3406632           4.4         0.44281           4.4         0.437581           4.4         0.437581           4.4         0.505246           4.4         0.5527017           4.4         0.5527017           4.4         0.569308           1.4         0.659852           1.4         0.609852           1.4         0.6048550           1.4         0.648550           1.4         0.648516
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.346632           4.4         0.342306           4.4         0.342306           4.4         0.390628           4.4         0.44281           4.4         0.437581           4.4         0.43075           4.4         0.55246           4.4         0.55246           4.4         0.569308           4.4         0.569308           4.4         0.569308           4.4         0.669852           4.4         0.629438           4.4         0.667177           4.4         0.667177
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.390622           4.4         0.390622           4.4         0.414281           4.4         0.437581           4.4         0.437581           4.4         0.505246           4.4         0.505246           4.4         0.569308           1.4         0.569308           1.4         0.569308           1.4         0.629438           1.4         0.629438           1.4         0.648550           1.4         0.648550           1.4         0.648550           1.4         0.648550           1.4         0.6485306
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.317658           4.4         0.342306           4.4         0.390632           4.4         0.390632           4.4         0.414281           4.4         0.437581           4.4         0.460516           4.4         0.505246           4.4         0.5527017           4.4         0.589805           1.4         0.659308           1.4         0.609852           1.4         0.6648550           1.4         0.6648530           1.4         0.668530           1.4         0.668530           1.4         0.668530           1.4         0.668530           1.4         0.668530           1.4         0.6685306           1.4         0.6685306           1.4         0.605306           1.4         0.605306           1.4         0.702927
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.390628           4.4         0.390628           4.4         0.442306           4.4         0.390628           4.4         0.437581           4.4         0.437581           4.4         0.43075           4.4         0.55246           4.4         0.552361           4.4         0.569308           4.4         0.569308           4.4         0.659308           1.4         0.629438           1.4         0.667177           1.4         0.667177           1.4         0.683306           1.4         0.702927           1.4         0.702927
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.36632           4.4         0.390628           4.4         0.44281           4.4         0.437581           4.4         0.437581           4.4         0.505246           4.4         0.505246           4.4         0.569308           4.4         0.569308           4.4         0.569308           4.4         0.669852           1.4         0.648550           1.4         0.648550           1.4         0.629438           1.4         0.629438           1.4         0.629438           1.4         0.629438           1.4         0.720227           1.4         0.720227           1.4         0.720227
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390632           4.4         0.414281           4.4         0.437581           4.4         0.460516           4.4         0.505246           4.4         0.5527017           4.4         0.5527017           4.4         0.569308           4.4         0.569308           4.4         0.669852           4.4         0.669855           4.4         0.667177           1.4         0.648550           1.4         0.667177           1.4         0.6675306           1.4         0.720227           1.4         0.736599
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.4342305           4.4         0.4342316           4.4         0.4342315           4.4         0.437581           4.4         0.43075           4.4         0.552466           4.4         0.559008           4.4         0.569308           4.4         0.659308           4.4         0.667177           4.4         0.629438           1.4         0.628520           1.4         0.720292           1.4         0.736599           1.4         0.736599 </td
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.442306           4.4         0.390628           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.505246           4.4         0.505246           4.4         0.569308           4.4         0.569308           4.4         0.569308           4.4         0.669852           4.4         0.669852           4.4         0.6685306           4.4         0.720297           4.4         0.720297           4.4         0.752029           4.4         0.7569107
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.366632           4.4         0.366632           4.4         0.414281           4.4         0.437581           4.4         0.460516           4.4         0.505246           4.4         0.5527017           4.4         0.5527017           4.4         0.569308           4.4         0.669852           4.4         0.669855           4.4         0.667177           1.4         0.648550           1.4         0.667177           1.4         0.720297           1.4         0.736599           1.4         0.736599           1.4         0.768107
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.4342316           4.4         0.4342316           4.4         0.4343075           4.4         0.43075           4.4         0.5527017           4.4         0.569308           4.4         0.569308           4.4         0.569308           4.4         0.629438           4.4         0.629438           4.4         0.629438           4.4         0.629438           4.4         0.72029 </td
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.44281           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.505246           4.4         0.569308           4.4         0.569308           4.4         0.569308           4.4         0.669852           4.4         0.669852           4.4         0.629438           4.4         0.629438           4.4         0.72029           4.4         0.72029           4.4         0.756509           4.4         0.768107           4.4         0.768107           4.4         0.768107           4.4         0.783024           4.4         0.783024           4.4         0.783024           4.4         0.783024  <
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.317658           4.4         0.317658           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.434231           4.4         0.436532           4.4         0.437581           4.4         0.437581           4.4         0.43075           4.4         0.5527017           4.4         0.5569308           4.4         0.569308           4.4         0.66852           4.4         0.66852           4.4         0.6685306           4.4         0.6685306           4.4         0.72029           4.4         0.736599           4.4         0.78024           4.4         0.78024           4.4         0.783024
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.390628           4.4         0.390628           4.4         0.442306           4.4         0.390628           4.4         0.432306           4.4         0.432306           4.4         0.432306           4.4         0.432306           4.4         0.432306           4.4         0.432306           4.4         0.432306           4.4         0.432306           4.4         0.432306           4.4         0.43275           4.4         0.55246           4.4         0.569308           4.4         0.569308           4.4         0.659308           4.4         0.667177           4.4         0.667177           4.4         0.7202927           4.4         0.7202927           4.4         0.736599           4.4         0.768107
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.366632           4.4         0.390628           4.4         0.414281           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.505246           4.4         0.569308           4.4         0.569308           4.4         0.569308           4.4         0.569308           4.4         0.669852           4.4         0.669852           4.4         0.6629438           4.4         0.72029           4.4         0.72029           4.4         0.756509           4.4         0.768107           4.4         0.768107           4.4         0.783024           4.4         0.783024           4.4         0.824323
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.342306           4.4         0.342306           4.4         0.366632           4.4         0.366632           4.4         0.432306           4.4         0.432305           4.4         0.432305           4.4         0.432305           4.4         0.432305           4.4         0.432581           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.527017           4.4         0.569308           4.4         0.629438           4.4         0.668520           4.4         0.6685306           4.4         0.6685306           4.4         0.72029           4.4         0.72029           4.4         0.72029           4.4         0.72628
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.317658           4.4         0.342306           4.4         0.390628           4.4         0.390628           4.4         0.44281           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.505246           4.4         0.559308           4.4         0.569308           4.4         0.569308           4.4         0.629438           4.4         0.629438           4.4         0.629438           4.4         0.629438           4.4         0.667177           4.4         0.7202927           4.4         0.7202927           4.4         0.726528           1.4         0.752628           1.4         0.783024           1.4         0.783024
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	4.4         0.189942           4.4         0.216053           4.4         0.241889           4.4         0.267440           4.4         0.292700           4.4         0.342306           4.4         0.342306           4.4         0.390628           4.4         0.390628           4.4         0.390628           4.4         0.414281           4.4         0.437581           4.4         0.437581           4.4         0.437581           4.4         0.505246           4.4         0.569308           4.4         0.569308           4.4         0.569308           4.4         0.669852           4.4         0.669852           4.4         0.669852           4.4         0.72029           4.4         0.72029           4.4         0.72628           4.4         0.72628           4.4         0.783024           4.4         0.783024           4.4         0.848899           4.4         0.848891           4.4         0.848891           4.4         0.848891

2 569594 14.4 0.871048	0.006168 14.4 .0.055494	6748524 144 0010782
2685090 144 0891100	0.012975 144 0.092992	(0000) 144 000(00)
2.06.3960 14.4 0.661199	0.013875 14.4 -0.082883	6.903901 14.4 -0.903623
2.804416 14.4 0.890728	0.024661 14.4 -0.110027	7.059701 14.4 -0.896025
2.924854 14.4 0.899632	0.038522 14.4 -0.136923	7.215863 14.4 -0.888002
3 047248 14.4 0 907908	0.055452 144 -0.163563	7 377377 144 0870560
2171552 144 0016654	0.005452 14.4 0.100000	7572527 14.4 -0.879309
5.171552 14.4 0.915554	0.0/5445 14.4 -0.189942	7529034 14.4 -0.870739
3297718 14.4 0.922570	0.098493 14.4 -0.216053	7.685921 14.4 -0.861525
3425696 144 0928953	0124587 144 0241889	7842030 144 0851042
3 555429 14.4 0024706	0.152710 144 02(7440	
3,3,3,4,36 14,4 0,9,54,700	0.153718 14.4 -0.207440	8.00000 14.4 -0.842004
3.686893 14.4 0.939828	0.185873 14.4 -0.292700	8.157070 14.4 -0.831724
3.820011 14.4 0.944321	0221041 144 -0.317658	8314079 144 -0821117
3 054741 14.4 0 048188	0.250707 14.4 0.242206	8470066 144 0810107
5.554741 1444 0.540100	0239207 14.4 40.342300	8.470900 14.4 -0.810197
4.091030 14.4 0.951432	0.300358 14.4 -0.366632	8.627673 14.4 -0.798978
4.228826 14.4 0.954057	0.344477 14.4 -0.390628	8.784137 14.4 -0.787473
4368076 144 0.956067	0391548 144 -0414281	8040000 144 0775607
4508770 14.4 0.057469		8.740277 14.4 40.773077
4.308720 14.4 0.937408	0.441552 14.4 -0.437581	9.096099 14.4 -0.763664
4.650722 14.4 0.958266	0.494469 14.4 -0.460516	9.251476 14.4 -0.751388
4794009 144 0.958466	0.550281 14.4 -0.483075	9406370 144 .0738882
4029522 144 0059077	0.608064 144 0.605346	
4.936.333 14.4 0.936077	0.008904 14.4 -0.505240	9.560/23 14.4 -0./26159
5.084236 14.4 0.957106	0.670496 14.4 -0.527017	9.714473 14.4 -0.713235
5.231064 14.4 0.955562	0.734855 14.4 -0.548375	9867563 144 -0.700121
5 379050 144 0053453	0.900014 144 0.560209	10010022 144 0(8(822
5,578957 14.4 0.559955	0.802014 14.4 -0.509508	10.019933 14.4 -0.080832
5.527864 14.4 0.950789	0.871948 14.4 -0.589805	10.171524 14.4 -0.673381
5.677723 14.4 0.947580	0.944630 14.4 -0.609852	10.322277 14.4 -0.659780
5 828476 14.4 0943836	1 020032 14.4 .0.620438	10472136 144 0646042
5 090067 14 4 0.020560	1.000105 14.4 0.020405	10.472130 14.4 -0.040042
5.980067 14.4 0.939569	1.098125 14.4 -0.648550	10.621041 14.4 -0.632181
6.132437 14.4 0.934789	1.178879 14.4 -0.667177	10.768936 14.4 -0.618209
6.285527 14.4 0.929508	1 262262 14.4 -0.685306	10915764 144 .0604130
6420077 144 0002720	1249242 14.4 0.202022	
0.439277 14.4 0.923739	1.348243 14.4 -0.702927	11.051467 14.4 -0.589983
6.593630 14.4 0.917493	1.436788 14.4 -0.720029	11.205991 14.4 -0.575753
6.748524 14.4 0.910783	1.527864 144 -0.736599	11 349278 14.4 -0 561462
6003001 144 0003633	1631425 144 0.753639	11.401074 14.4 0.547101
	1.021433 14.4 40.732026	11.4912/4 14.4 -0.54/121
7.059701 14.4 0.896025	1.717465 14.4 -0.768107	11.631924 14.4 -0.532743
7.215863 14.4 0.888002	1.815916 14.4 -0.783024	11.771174 14.4 -0.518340
7.372327 144 0.879569	1916752 144 -0.797372	11 908970 144 -0 503922
7 520034 14.4 0.870739	2010032 144 0.911141	12000000 14.4 0.404200
7.022004 14.4 0.0010737		12.00000 14.4 -0.494309
7.685921 14.4 0.861525	2.125420 14.4 -0.824323	29 1
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8000000 144 0.842004	2 343146 144 -0 848899	0.000000 24 0.000000
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6.137070 14.4 0.831724	2.455501 14.4 -0.860280	0.001542 24 0.027865
8.314079 14.4 0.821117	2.569594 14.4 -0.871048	0.006168 24 0.055494
8470966 14.4 0.810197	2685980 144 -0.881199	0.013875 24 0.082883
8 6 7 6 7 3 14 4 0 709078	2904416 144 0.900729	0.004661 24 0.110007
0.02/0/3 14.4 0.703/70	2.604410 14.4 -0.690726	0.024001 24 0.110027
8.784137 14.4 0.787473	2.924854 14.4 -0.899632	0.038522 24 0.136023
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0.770 <i>4.7</i> 7 14.4 U.//JU7/	3.047248 14.4 -0.907908	0.055452 24 0.163563
9.096099 144 0.763664	3.047248 14.4 -0.907908 3.171552 14.4 -0.915554	0.055452 24 0.163563
9.096099 14.4 0.763664 0.251476 14.4 0.763664	3.047248 14.4 -0.907908 3.171552 14.4 -0.915554	0.055452 24 0.163563 0.075445 24 0.189942
9.056099 14.4 0.7(3)57 9.251476 14.4 0.7513664 9.251476 14.4 0.751388	3.047248         14.4         -0.907908           3.171552         14.4         -0.915554           3.297718         14.4         -0.922570	0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053
9.096099 14.4 0.763664 9.251476 14.4 0.751388 9.406370 14.4 0.738882	3.047248         14.4         -0.907908           3.171552         14.4         -0.915554           3.297718         14.4         -0.922570           3.425696         14.4         -0.928953	0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889
9.056099 14.4 0.763664 9.251476 14.4 0.751388 9.406370 14.4 0.738882 9.560723 14.4 0.726159	3.047248         14.4         -0.907908           3.171552         14.4         -0.915554           3.297718         14.4         -0.922570           3.425696         14.4         -0.928953           3.555438         14.4         -0.934706	0.055452 24 0.163563 0.075445 24 0.189942 0.098493 24 0.216053 0.124587 24 0.241889 0.153718 24 0.267440
9.096099 14.4 0.763664 9251476 14.4 0.751388 9.406370 14.4 0.726159 9.560723 14.4 0.726159 9.714473 14.4 0.713235	3.047248         14.4         -0.907908           3.171552         14.4         -0.915554           3.297718         14.4         -0.922570           3.425696         14.4         -0.928953           3.555438         14.4         -0.928953           3.686693         14.4         -0.930878	0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.267440
0.776272       14.4       0.7763664         9251476       14.4       0.751388         9.406370       14.4       0.751388         9.506723       14.4       0.726159         9.714473       14.4       0.713235	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.934706         3.686893       14.4       -0.939828         202001       14.4       -0.939828	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700
9.056099 14.4 0.763664 9251476 14.4 0.751388 9.406370 14.4 0.738882 9.560723 14.4 0.726159 9.714473 14.4 0.713235 9.867563 14.4 0.700121	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.934706         3.686893       14.4       -0.939828         3.820011       14.4       -0.944321	0.055452         24         0.163563           0.075445         24         0.183942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658
0.776272       14.4       0.7763674         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.726159         9.50723       14.4       0.713235         9.867563       14.4       0.700121         10.019933       14.4       0.686832	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.934706         3.686693       14.4       -0.939828         3.820011       14.4       -0.944321         3.954741       14.4       -0.948188	0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306
0.776272       14.4       0.763664         9251476       14.4       0.751388         9.406370       14.4       0.751388         9.560723       14.4       0.713235         9.867563       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.668832         10.171524       14.4       0.673381	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.928953         3.686893       14.4       -0.939828         3.820011       14.4       -0.948188         4.091030       14.4       -0.948188	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.267440           0.185873         24         0.27000           0.221041         24         0.317658           0.259207         24         0.342306           0.300368         24         0.346632
0.70277       14.4       0.713077         9.096099       14.4       0.763664         9251476       14.4       0.751388         9.406370       14.4       0.738882         9.560723       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.934706         3.686893       14.4       -0.939828         3.820011       14.4       -0.944321         3.954741       14.4       -0.951432         4.091030       14.4       -0.951432	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.304358         24         0.266632
0.776272       14.4       0.763664         9.096099       14.4       0.751388         9.406370       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.700121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.3222777       14.4       0.659780	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0938028         3.820011       14.4       -0939828         3.820011       14.4       -0944321         3.954741       14.4       -0944132         4.091030       14.4       -0951432         4.228826       14.4       -0954057	0.055452         24         0.163563           0.075445         24         0.183563           0.078493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.344477         24         0.390628
0.776272       14.4       0.775057         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.726159         9.560723       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10322277       14.4       0.659780         10.472136       14.4       0.646042	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.455646       14.4       -0.928953         3.555438       14.4       -0.934706         3.686893       14.4       -0.934828         3.820011       14.4       -0.948188         4.091030       14.4       -0.954132         4.228826       14.4       -0.954057         4.368076       14.4       -0.956067	0.055452         24         0.163523           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.30358         24         0.36632           0.344477         24         0.390628           0.391548         24         0.414281
0.76277       14.4       0.763664         9.096099       14.4       0.763664         9.251476       14.4       0.75388         9.406370       14.4       0.738882         9.560723       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.700121         10.019933       14.4       0.686832         10.322277       14.4       0.673381         10.322277       14.4       0.66042         10.621041       14.4       0.632181	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.928953         3.656483       14.4       -0.934706         3.686893       14.4       -0.939828         3.820011       14.4       -0.944321         3.954741       14.4       -0.944188         4.091030       14.4       -0.951432         4.228826       14.4       -0.956067         4.508726       14.4       -0.957468	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.300358         24         0.346632           0.304477         24         0.390628           0.391548         24         0.41281           0.4317581         24         0.437581
0.776272       14.4       0.763664         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.73882         9.560723       14.4       0.713235         9.567563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.66042         10.621041       14.4       0.6622181         100768936       14.4       0.618009	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0939828         3.820011       14.4       -0939828         3.820011       14.4       -0934121         3.954741       14.4       -0948188         4.091030       14.4       -0951432         4.228826       14.4       -0954057         4.368076       14.4       -0954067         4.508726       14.4       -0954067	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.344477         24         0.390628           0.391548         24         0.414281           0.4414552         24         0.445516
0.776272       14.4       0.763664         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.700121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.64042         10.658936       14.4       0.618209         10.768936       14.4       0.618209	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.939828         3.686893       14.4       -0.939828         3.820011       14.4       -0.944321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.954057         4.368076       14.4       -0.954067         4.508726       14.4       -0.957468         4.650772       14.4       -0.957468	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.183942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.344477         24         0.390628           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516
0.776272       14.4       0.775057         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.726159         9.560723       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.700121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.646042         10.621041       14.4       0.632181         10.768936       14.4       0.618209         10.915764       14.4       0.604139	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.928953         3.686893       14.4       -0.928953         3.820011       14.4       -0.939828         3.820011       14.4       -0.948188         4.091030       14.4       -0.948188         4.091030       14.4       -0.954157         4.368076       14.4       -0.956067         4.508726       14.4       -0.957468         4.650772       14.4       -0.958266         4.794009       14.4       -0.958266	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.300358         24         0.36632           0.300358         24         0.36632           0.344477         24         0.390628           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.483075
0.776277       14.4       0.763664         9.096099       14.4       0.753664         9.251476       14.4       0.753882         9.406370       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10322277       14.4       0.659780         10472136       14.4       0.6659780         10.420246       14.4       0.662181         10.768936       14.4       0.618209         10.915764       14.4       0.658983         11.061467       14.4       0.589983	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.928953         3.686893       14.4       -0.939828         3.820011       14.4       -0.939828         3.820011       14.4       -0.944321         3.954741       14.4       -0.948188         4.091030       14.4       -0.951432         4.228826       14.4       -0.956057         4.508726       14.4       -0.957468         4.6507722       14.4       -0.957868         4.6507722       14.4       -0.958266         4.794009       14.4       -0.958466         4.938533       14.4       -0.958077	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.304477         24         0.390628           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.48075           0.608964         24         0.505246
0.776272       14.4       0.763664         9.096099       14.4       0.751388         9.406370       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.664042         10.621041       14.4       0.632181         10.768936       14.4       0.618209         10.915764       14.4       0.618209         10.915764       14.4       0.578983         11.061467       14.4       0.589983	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0939828         3.820011       14.4       -0939828         3.820011       14.4       -0944321         3.954741       14.4       -09441321         3.954741       14.4       -0948188         4.091030       14.4       -0954057         4.368076       14.4       -0954057         4.368076       14.4       -0954067         4.508726       14.4       -0957468         4.650722       14.4       -0958266         4.794009       14.4       -0958266         4.938533       14.4       -0958166         4.938533       14.4       -0958106	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.344477         24         0.390628           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.50246           0.608964         24         0.50246           0.60496         24         0.50246
0.776272       14.4       0.763664         9251476       14.4       0.751388         9.406370       14.4       0.751388         9.406370       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.700121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.646042         10621041       14.4       0.632181         10.768936       14.4       0.604139         11.061467       14.4       0.589983         11.205991       14.4       0.551462	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425666       14.4       -0.928953         3.555438       14.4       -0.934706         3.686893       14.4       -0.934828         3.820011       14.4       -0.948188         4.091030       14.4       -0.948188         4.091030       14.4       -0.948188         4.091030       14.4       -0.948188         4.091030       14.4       -0.948188         4.091030       14.4       -0.954057         4.368076       14.4       -0.954067         4.508726       14.4       -0.957468         4.650722       14.4       -0.958266         4.794009       14.4       -0.958077         5.084236       14.4       -0.957106         5.731064       14.4       -0.955552	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.259207         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.304477         24         0.390528           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.527017           0.608964         24         0.527017           0.74485         24         0.527017
0.70277       14.4       0.713071         9.096099       14.4       0.763664         9.251476       14.4       0.75388         9.406370       14.4       0.738882         9.560723       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.659780         10.472136       14.4       0.659780         10.621041       14.4       0.632181         10.768936       14.4       0.618209         10.915764       14.4       0.658983         11.205991       14.4       0.575753         11.349278       14.4       0.561462	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0928953         3.686893       14.4       -0939828         3.820011       14.4       -0948188         4.091030       14.4       -0948188         4.091030       14.4       -0954057         4.368076       14.4       -0956067         4.508726       14.4       -0954057         4.368076       14.4       -0954057         4.368076       14.4       -0954057         4.368076       14.4       -0954057         4.368076       14.4       -0954057         4.368076       14.4       -0954057         4.368076       14.4       -0958266         4.794009       14.4       -0958077         5.084236       14.4       -0957106         5.231064       14.4       -0955462	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.300358         24         0.346632           0.300358         24         0.366632           0.304477         24         0.390628           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.55246           0.670496         24         0.527017           0.734855         24         0.548375
0.70272       14.4       0.713037         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.666042         10.621041       14.4       0.664042         10.621041       14.4       0.6604139         11.061467       14.4       0.575753         11.205991       14.4       0.575753         11.349278       14.4       0.54142	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0938028         3.820011       14.4       -0939828         3.820011       14.4       -0934121         3.954741       14.4       -0944321         3.954741       14.4       -09441321         3.954741       14.4       -09441321         3.954741       14.4       -09441321         3.954741       14.4       -0954057         4.368076       14.4       -0954067         4.508726       14.4       -0954066         4.794009       14.4       -0958466         4.938533       14.4       -0958106         5.084236       14.4       -0957106         5.231064       14.4       -095562         5.378959       14.4       -0953453	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.18563           0.078493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.300358         24         0.366632           0.344477         24         0.390628           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.505246           0.608964         24         0.527017           0.734855         24         0.548375           0.802014         24         0.569308
0.776272       14.4       0.7763674         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.738882         9.50723       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.700121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.646042         10.621041       14.4       0.659780         10.975763       14.4       0.618209         10.915764       14.4       0.618209         10.915764       14.4       0.589983         11.205991       14.4       0.561462         11.491274       14.4       0.54142         11.491274       14.4       0.54142	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425666       14.4       -0.928953         3.555438       14.4       -0.939828         3.686893       14.4       -0.939828         3.820011       14.4       -0.943121         3.954741       14.4       -0.948188         4.091030       14.4       -0.954057         4.368076       14.4       -0.954057         4.368076       14.4       -0.954057         4.368076       14.4       -0.954057         4.368076       14.4       -0.954057         4.368076       14.4       -0.954067         4.508726       14.4       -0.958266         4.794009       14.4       -0.958266         4.938533       14.4       -0.957106         5.231064       14.4       -0.957105         5.231064       14.4       -0.953453         5.27864       14.4       -0.950789	0.055452         24         0.163523           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.21041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.304477         24         0.390628           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.55246           0.608964         24         0.55246           0.670496         24         0.527017           0.734855         24         0.548375           0.802014         24         0.569308           0.871948         24         0.589805
0.706272       14.4       0.713037         9.096099       14.4       0.753664         9.251476       14.4       0.75388         9.406370       14.4       0.738882         9.560723       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.659780         10.472136       14.4       0.659780         10.472136       14.4       0.659780         10.621041       14.4       0.652181         10.768936       14.4       0.618209         10.915764       14.4       0.6582983         11.205991       14.4       0.575753         11.392278       14.4       0.561462         11.491274       14.4       0.552743         11.771174       14.4       0.518240	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425646       14.4       -0.928953         3.555438       14.4       -0.934706         3.686893       14.4       -0.939828         3.820011       14.4       -0.939828         3.820011       14.4       -0.948188         4.091030       14.4       -0.948188         4.091030       14.4       -0.954132         4.228826       14.4       -0.954057         4.368076       14.4       -0.954057         4.368076       14.4       -0.954057         4.368076       14.4       -0.95468         4.650722       14.4       -0.95468         4.650722       14.4       -0.958266         4.794009       14.4       -0.958266         4.794009       14.4       -0.9581453         5.231064       14.4       -0.955562         5.378959       14.4       -0.950789         5.677723       14.4       -0.927580	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.300358         24         0.366632           0.300358         24         0.366632           0.30358         24         0.366632           0.30358         24         0.366632           0.304477         24         0.390528           0.391548         24         0.414281           0.441552         24         0.437581           0.441552         24         0.460516           0.550281         24         0.450526           0.50286         24         0.505246           0.608964         24         0.527017           0.734855         24         0.548375           0.8071948         24         0.569308           0.871948         24         0.569308           0.871948         <
0.70679       14.4       0.763664         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.72882         9.560723       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.66042         10.42136       14.4       0.6618209         10.915764       14.4       0.6518209         10.915764       14.4       0.575753         11.205991       14.4       0.561462         11.61467       14.4       0.561462         11.491274       14.4       0.52743         11.771174       14.4       0.518340	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0939828         3.820011       14.4       -0939828         3.820011       14.4       -0944321         3.954741       14.4       -0948188         4.091030       14.4       -0954057         4.368076       14.4       -0954057         4.368076       14.4       -0954067         4.560722       14.4       -0958266         4.79409       14.4       -0958466         4.938533       14.4       -0958177         5.084236       14.4       -0958165         5.378959       14.4       -0958165         5.378959       14.4       -0958077         5.677723       14.4       -0958165         5.677723       14.4       -0958078         5.677723       14.4       -0950789         5.677723       14.4       -0950789	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.18363           0.075445         24         0.183563           0.075445         24         0.183563           0.078493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.304477         24         0.390628           0.391548         24         0.414281           0.4414552         24         0.460516           0.550281         24         0.460516           0.550281         24         0.460516           0.550281         24         0.505246           0.670496         24         0.505246           0.670496         24         0.569308           0.871948         24         0.569308           0.871948         24         0.508805           0.944630
0.776272       14.4       0.763664         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.646042         10.621041       14.4       0.632181         10.768936       14.4       0.618209         10.915764       14.4       0.6518209         10.915764       14.4       0.65828         11.061467       14.4       0.561820         11.205991       14.4       0.55753         11.349278       14.4       0.561462         11.491274       14.4       0.52743         11.771174       14.4       0.503922         11.908970       14.4       0.503922	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425696       14.4       -0.928953         3.555438       14.4       -0.939828         3.686893       14.4       -0.939828         3.820011       14.4       -0.944321         3.954741       14.4       -0.944321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.9441321         3.954741       14.4       -0.954057         4.28826       14.4       -0.954057         4.368076       14.4       -0.955826         4.794009       14.4       -0.958166         4.938533       14.4       -0.957106         5.231064       14.4       -0.955562         5.378959       14.4       -0.950789         5.527864       14.4       -0.950789         5.627723       14.4       -0.950789         5.627723       14.4       -0.950789 <t< td=""><td>0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.36632           0.30358         24         0.36632           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.36632           0.30358         24         0.342306           0.30358         24         0.460516           0.550281         24         0.460516           0.550281         24         0.567266           0.670496         24         0.567308           0.670496         24         0.569308           0.802014         24         0.569308           0.871948         24         0.569308           0.944630         24<!--</td--></td></t<>	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.36632           0.30358         24         0.36632           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.36632           0.30358         24         0.342306           0.30358         24         0.460516           0.550281         24         0.460516           0.550281         24         0.567266           0.670496         24         0.567308           0.670496         24         0.569308           0.802014         24         0.569308           0.871948         24         0.569308           0.944630         24 </td
0.76277       14.4       0.713037         9.096099       14.4       0.753664         9.251476       14.4       0.753882         9.406370       14.4       0.738882         9.560723       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.669780         10.472136       14.4       0.646042         10.621041       14.4       0.632181         10.768936       14.4       0.618209         10.915764       14.4       0.658780         11.061467       14.4       0.575753         11.349278       14.4       0.575753         11.349278       14.4       0.561462         11.491274       14.4       0.512743         11.771174       14.4       0.518340         11.908970       14.4       0.503922         12.000000       14.4       0.503922	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425666       14.4       -0.928953         3.555438       14.4       -0.934706         3.686893       14.4       -0.934828         3.820011       14.4       -0.948188         4.091030       14.4       -0.948188         4.091030       14.4       -0.954057         4.368076       14.4       -0.954057         4.368076       14.4       -0.956067         4.508726       14.4       -0.957468         4.650722       14.4       -0.95786         4.650722       14.4       -0.958266         4.794009       14.4       -0.958266         4.794009       14.4       -0.958166         5.231064       14.4       -0.958165         5.237864       14.4       -0.957106         5.237895       14.4       -0.950789         5.677723       14.4       -0.950789         5.677723       14.4       -0.947580         5.828476       14.4       -0.943836         5.980067       14.4       -0.939569	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.21041         24         0.317658           0.300358         24         0.342306           0.300358         24         0.366632           0.300358         24         0.342306           0.30358         24         0.366632           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.414281           0.441552         24         0.460516           0.550281         24         0.527017           0.734855         24         0.527017           0.5802014         24<
0.76277       14.4       0.763664         9251476       14.4       0.75388         9406370       14.4       0.751388         9406370       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10472136       14.4       0.659780         10472136       14.4       0.659780         10472136       14.4       0.618209         10915764       14.4       0.618209         10915764       14.4       0.518209         10915764       14.4       0.518209         10915764       14.4       0.518209         10915764       14.4       0.518209         10915764       14.4       0.518209         11.061467       14.4       0.518209         11.05147       14.4       0.51462         11.491274       14.4       0.51321         11.771174       14.4       0.518340         11.908970       14.4       0.503922         12.000000	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0939828         3.820011       14.4       -0939828         3.820011       14.4       -0944321         3.954741       14.4       -0948188         4.091030       14.4       -0954057         4.368076       14.4       -0954057         4.368076       14.4       -0954067         4.560722       14.4       -0954067         4.560722       14.4       -0958266         4.794009       14.4       -09581453         5.084236       14.4       -0955162         5.378959       14.4       -0958077         5.084236       14.4       -0958078         5.527864       14.4       -0950789         5.677723       14.4       -0950789         5.677723       14.4       -0947580         5.828476       14.4       -0934789         6.132437       14.4       -0934789	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.300358         24         0.366632           0.300358         24         0.346632           0.300358         24         0.346632           0.30358         24         0.346632           0.30358         24         0.34628           0.30358         24         0.41281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.4505246           0.670496         24         0.55246           0.670496         24         0.569308           0.871948         24         0.569308           0.871948         24         0.569308           0.871948         24         0.69852           1.020032         2
0.776272       14.4       0.713037         9.096099       14.4       0.763664         9.251476       14.4       0.751388         9.406370       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.666042         10.621041       14.4       0.660412         10.621041       14.4       0.6604139         11.061467       14.4       0.575753         11.349278       14.4       0.561462         11.491274       14.4       0.547121         11.631924       14.4       0.52743         11.771174       14.4       0.518340         11.908970       14.4       0.503922         12.000000       14.4       0.494309         28       1       108	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0939828         3.820011       14.4       -0939828         3.820011       14.4       -0944321         3.954741       14.4       -09441321         3.954741       14.4       -09441321         3.954741       14.4       -09441321         3.954741       14.4       -09441321         3.954741       14.4       -0954057         4.368076       14.4       -0954057         4.368076       14.4       -0954067         4.508726       14.4       -0957468         4.650722       14.4       -0957106         5.084236       14.4       -0957106         5.231064       14.4       -0950789         5.677723       14.4       -0950789         5.677723       14.4       -0950789         5.828476       14.4       -0950789         5.828476       14.4       -0950789         5.828476       14.4       -0930789         5.828476 </td <td>0.055452         24         0.163523           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.267440           0.185873         24         0.27010           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.346632           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30391548         24         0.414281           0.441552         24         0.460516           0.502081         24         0.562308           0.670496         24         0.569308           0.670496         24         0.569308           0.871948         24         0.589805           0.944630         <td< td=""></td<></td>	0.055452         24         0.163523           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.267440           0.185873         24         0.27010           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.346632           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30358         24         0.342306           0.30391548         24         0.414281           0.441552         24         0.460516           0.502081         24         0.562308           0.670496         24         0.569308           0.670496         24         0.569308           0.871948         24         0.589805           0.944630 <td< td=""></td<>
0.70272       14.4       0.713037         9096099       14.4       0.763664         9251476       14.4       0.751388         9406370       14.4       0.726159         9.50723       14.4       0.726159         9.714473       14.4       0.713235         9.867563       14.4       0.70121         10.019933       14.4       0.686832         10.171524       14.4       0.673381         10.322277       14.4       0.659780         10.472136       14.4       0.668432         10.472136       14.4       0.618209         10.472136       14.4       0.618209         10.915764       14.4       0.618209         10.915764       14.4       0.518209         10.915764       14.4       0.561462         11.205991       14.4       0.551753         11.349278       14.4       0.551462         11.491274       14.4       0.518340         11.908970       14.4       0.503922         12.000000       14.4       0.503922         12.000000       14.4       0.494309         28       1         108       0000000 </td <td>3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425666       14.4       -0.928953         3.555438       14.4       -0.939828         3.686893       14.4       -0.939828         3.820011       14.4       -0.943121         3.954741       14.4       -0.948188         4.091030       14.4       -0.954057         4.368076       14.4       -0.956067         4.508726       14.4       -0.957468         4.650722       14.4       -0.958266         4.794009       14.4       -0.958266         4.794009       14.4       -0.958266         4.794009       14.4       -0.958266         4.794009       14.4       -0.958266         5.231064       14.4       -0.951453         5.527864       14.4       -0.951453         5.527864       14.4       -0.950789         5.677723       14.4       -0.950789         5.677723       14.4       -0.939569         6.132437       14.4       -0.929508         6.282527       14.4       -0.929508   &lt;</td> <td>0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.21041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.344477         24         0.390528           0.344477         24         0.390528           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.548375           0.608964         24         0.527017           0.734855         24         0.548375           0.802014         24         0.569308           0.871948         24         0.569308           0.871948         24         0.60852           1.020032         24         0.629438           1.098125         &lt;</td>	3.047248       14.4       -0.907908         3.171552       14.4       -0.915554         3.297718       14.4       -0.922570         3.425666       14.4       -0.928953         3.555438       14.4       -0.939828         3.686893       14.4       -0.939828         3.820011       14.4       -0.943121         3.954741       14.4       -0.948188         4.091030       14.4       -0.954057         4.368076       14.4       -0.956067         4.508726       14.4       -0.957468         4.650722       14.4       -0.958266         4.794009       14.4       -0.958266         4.794009       14.4       -0.958266         4.794009       14.4       -0.958266         4.794009       14.4       -0.958266         5.231064       14.4       -0.951453         5.527864       14.4       -0.951453         5.527864       14.4       -0.950789         5.677723       14.4       -0.950789         5.677723       14.4       -0.939569         6.132437       14.4       -0.929508         6.282527       14.4       -0.929508   <	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.21041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.344477         24         0.390528           0.344477         24         0.390528           0.391548         24         0.414281           0.441552         24         0.437581           0.494469         24         0.460516           0.550281         24         0.548375           0.608964         24         0.527017           0.734855         24         0.548375           0.802014         24         0.569308           0.871948         24         0.569308           0.871948         24         0.60852           1.020032         24         0.629438           1.098125         <
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0939828         3.820011       14.4       -0939828         3.820011       14.4       -093428         3.820011       14.4       -0934828         3.820011       14.4       -0934828         3.820011       14.4       -0944321         3.954741       14.4       -0948188         4.091030       14.4       -0954057         4.368076       14.4       -0954067         4.568726       14.4       -0957468         4.650722       14.4       -0958066         4.794009       14.4       -0958077         5.084236       14.4       -09581453         5.527864       14.4       -095807         5.828476       14.4       -0957106         5.2378059       14.4       -0950789         5.677723       14.4       -0947580         5.828476       14.4       -0947580         5.828476       14.4       -0934789         6.132437	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.189942           0.098493         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.300358         24         0.366632           0.300358         24         0.366632           0.300358         24         0.366632           0.30358         24         0.366632           0.30358         24         0.366632           0.30358         24         0.44236           0.391548         24         0.437581           0.441552         24         0.460516           0.550281         24         0.460516           0.550281         24         0.505246           0.608964         24         0.527017           0.734855         24         0.548375           0.802014         24         0.569308           0.871948         24         0.629438           1.02032
0.76272 $14.4$ $0.763664$ $9.096099$ $14.4$ $0.763664$ $9.251476$ $14.4$ $0.751388$ $9.406370$ $14.4$ $0.726159$ $9.714473$ $14.4$ $0.713235$ $9.867563$ $14.4$ $0.701121$ $10.019933$ $14.4$ $0.686832$ $10.171524$ $14.4$ $0.673381$ $10.22277$ $14.4$ $0.659780$ $10.472136$ $14.4$ $0.6646042$ $10.621041$ $14.4$ $0.6640139$ $10.768936$ $14.4$ $0.604139$ $11.061467$ $14.4$ $0.557753$ $11.349278$ $14.4$ $0.561462$ $11.491274$ $14.4$ $0.518340$ $11.908970$ $14.4$ $0.503922$ $12.000000$ $14.4$ $0.000000$ $0.001542$ $14.4$ $0.000000$	3.047248       14.4       -0907908         3.171552       14.4       -0915554         3.297718       14.4       -0922570         3.425696       14.4       -0928953         3.555438       14.4       -0938028         3.820011       14.4       -0939828         3.820011       14.4       -093420         3.820011       14.4       -093428         3.820011       14.4       -093428         3.820011       14.4       -0944321         3.954741       14.4       -0944132         3.954741       14.4       -0944132         4.28826       14.4       -0954057         4.368076       14.4       -0954057         4.508726       14.4       -0954067         4.508726       14.4       -0958266         4.794009       14.4       -0958266         4.794009       14.4       -0958163         5.084236       14.4       -0958165         5.231064       14.4       -0958163         5.527864       14.4       -0950789         5.677723       14.4       -0934789         5.828476       14.4       -0934789         5.980067	0.055452         24         0.163563           0.055452         24         0.163563           0.075445         24         0.18363           0.075445         24         0.216053           0.124587         24         0.241889           0.153718         24         0.267440           0.185873         24         0.292700           0.221041         24         0.317658           0.259207         24         0.342306           0.300358         24         0.366632           0.304477         24         0.390628           0.391548         24         0.414281           0.4414552         24         0.460516           0.550281         24         0.450526           0.608964         24         0.505246           0.670496         24         0.569308           0.871948         24         0.569308           0.871948         24         0.569308           0.871948         24         0.69852           1.02032         24         0.69852           1.02032         24         0.648550           1.178879         24         0.67177           1.262262

1.527864 24 0.736599	11.349278 24 0.561462	5231064 24 -0.955562
1.621435 24 0.752628	11.491274 24 0.547121	5378959 24 -0.953453
1.717465 24 0.768107	11.631924 24 0.532743	5.527864 24 -0.950789
1.815916 24 0.783024	11.771174 24 0.518340	5.677723 24 -0.947580
1.916752 24 0.797372	11.908970 24 0.503922	5.828476 24 -0.943836
2.019933 24 0.811141	12.000000 24 0.494309	5.980067 24 -0.939569
2.125420 24 0.824323	30 1	6.132437 24 -0.934789
2.233171 24 0.836912	108	6.285527 24 -0.929508
2.343146 24 0.848899	0.000000 24 0.000000	6.439277 24 -0.923739
2.455301 24 0.860280	0.001542 24 -0.027865	6.593630 24 -0.917493
2.569594 24 0.871048	0.006168 24 -0.055494	6.748524 24 -0.910783
2.685980 24 0.881199	0.013875 24 -0.082883	6.903901 24 -0.903623
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2.924854 24 0.899632	0.038522 24 -0.136923	7.215863 24 -0.888002
3.047248 24 0.907908	0.055452 24 -0.163563	7.372327 24 -0.879569
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3.425696 24 0.928953	0.124587 24 -0.241889	7.842930 24 -0.851942
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3.820011 24 0.944321	0.221041 24 -0.317658	8.314079 24 -0.821117
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4.091030 24 0.901432	0.300358 24 -0.366632	8.627673 24 -0.798978
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4.508070 24 0.950007 4.508726 24 0.057468	0.391546 24 -0.414281	8.940299 24 40.775697
4.508720 24 0.557408	0.441532 24 40.457561	9.090099 24 -0.703004
4794009 24 0.958466	0.550081 24 0.400510	92014/0 24 40./01088
4938533 24 0.958077	0.5.5.2231 24 -0.465075	9.400370 24 40.736662
5084236 24 0957106	0670496 24 -0527017	9.300723 24 -0.720139
5.231064 24 0.955562	0.734855 24 -0.548375	9867563 24 -0.713233
5.378959 24 0.953453	0.802014 24 -0.569308	10019933 24 -0.686832
5.527864 24 0.950789	0.871948 24 -0.589805	10171524 24 -0673381
5.677723 24 0.947580	0.944630 24 -0.609852	10.322277 24 -0.659780
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6.439277 24 0.923739	1.348243 24 -0.702927	11.061467 24 -0.589983
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6.748524 24 0.910783	1.527864 24 -0.736599	11349278 24 -0.561462
0.903901 24 0.903023	1.621435 24 -0.752628	11.491274 24 -0.547121
7.0.57/01 24 0.690023	1.717403 24 -0.708107	11.631924 24 -0.532743
7377377 24 0.888002	1.81.5910 24 40.763024	11.//11/4 24 -0.518340
7 570034 24 0.87909	2010022 24 -0.797572	11.906970 24 -0.503922
7685921 24 0.861525	2 125420 24 -0.824323	12.00000 24 -0.494309
7.842930 24 0.851942	2233171 24 -0836912	2
8.000000 24 0.842004	2.343146 24 -0.848899	0 144 0
8.157070 24 0.831724	2,455301 24 -0.860280	0 24 0
8.314079 24 0.821117	2.569594 24 -0.871048	32 1
8.470966 24 0.810197	2.685980 24 -0.881199	2
8.627673 24 0.798978	2.804416 24 -0.890728	0 24 0
8.784137 24 0.787473	2.924854 24 -0.899632	0 32 0
8.940299 24 0.775697	3.047248 24 -0.907908	Surface Components
9.096099 24 0.763664	3.171552 24 -0.915554	1 1
9.251476 24 0.751388	3.297718 24 -0.922570	2 2
9.406370 24 0.738882	3.425696 24 -0.928953	-160 0 -100
9.560723 24 0.726159	3.555438 24 -0.934706	160 0 -100
9.714473 24 0.713235	3.686893 24 -0.939828	-160 0 100
9.80/203 24 0.700121	3.820011 24 -0.944321	160 0 100
10.017753 24 0.080632	3.554/41 24 -0.548188 4.001020 24 0.051422	2 1
10.171324 24 0.073361	4.071030 24 -0.551452	2 Z 160 160 100
10472136 24 0.646042	4368076 24 -0.554057	-160 160 100
10621041 24 0.632181	4.508726 24 -0.957468	160 160 100
10.768936 24 0.618209	4.650722 24 -0.958266	-160 160 -100
10.915764 24 0.604139	4.794009 24 -0.958466	3 1
11.061467 24 0.589983	4.938533 24 -0.958077	2 2
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0.024661	0	0.136923
0.055452	0	0.163563
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0.124587	0	0216053
0.153718	Ő	0267440
0.185873	0	0292700
0.221041	0	0317658
0.300358	Õ	0.366632
0.344477	0	0.390628
0.391548	0	0.414281 0.437581
0.494469	0	0.460516
0.550281	0	0.483075
0.608964	0	0.505246
0.734855	ŏ	0.548375
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1.527864	0	0.736599
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1.815916	0	0.783024
1.916752	0	0.797372
2.019933	0	0.811141
2.233171	õ	0.836912
2.343146	0	0.848899
2.455301 2.569594	0	0.860280
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2.929854 3.047748	0	0.899632
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3.171552	0	0.915554
3297718	0	0922570
3.425696	0	0.928953
3.000438	0	0.934706
3 820011	0	0.939828
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4.228826	0	0.954057
4.368076	0	0.956067
4.508/25	0	0.059766
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5.084236	0	0.957106
5.231064	0	0.955562
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5.52/864	0	0.950789
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6.132437	Ō	0.934789
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6.593630	0	0.917493
6.748524	0	0910/83
7 059701	0	0.896025
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7.372327	0	0.879569
7.529034	0	0.870739
7.685921	0	0.861525
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8.470966	ŏ	0.810197
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11.908970	0	0.503922
12.045259	0	0.489503
12.1/9989	0	0.475093
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12.702282	0	0.417776
12.828448	0	0.403585
12952752	0	0.389470
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13.430406	0	0.334009
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13980067	0 0	0260000
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14.184084	Ő	0242466
14.282535	Õ	0230134
14378565	Ō	0.218021
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14.563212	0	0.194489
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14.737738	0	0.171955
14.821121	0	0.161087
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15 778959	ñ	0.031305
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0.098493	14.4	0216053
0.124587	14.4	0.241889
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0.185873	14.4	0.292700
0.221041	14.4	0.317658
0.259207	14.4	0.342306
0.300358	14.4	0.366632
0.344477	14.4	0.390628
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0.608964	14.4	0.505246
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1.098125 14.4 0.648550	10.621041 14.4 0.632181	0.024661 14.4 -0.110027
1.178879 14.4 0.667177	10.768936 14.4 0.618209	0.038522 14.4 -0.136923
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1.348243 14.4 0.702927	11.061467 14.4 0.589983	0.075445 14.4 -0.189942
1.436788 14.4 0.720029	11.205991 14.4 0.575753	0.098493 14.4 -0.216053
1.527864 14.4 0.736599	11.349278 14.4 0.561462	0.124587 14.4 -0.241889
1.621435 14.4 0.752628	11.491274 14.4 0.547121	0.153718 14.4 -0.267440
1.717465 14.4 0.768107	11.631924 14.4 0.532743	0.185873 14.4 -0.292700
1.815916 14.4 0.783024	11.771174 14.4 0.518340	0.221041 14.4 -0.317658
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2.019933 14.4 0.811141	12.045259 14.4 0.489503	0.300358 14.4 -0.366632
2.125420 14.4 0.824323	12.179989 14.4 0.475093	0.344477 14.4 -0.390628
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2.343140 14.4 0.848899	12444562 14.4 0.446.54/	0.441552 14.4 -0.437581
2.455501 14.4 0.800280	12574304 14.4 0.432034	0.494469 14.4 -0.460516
2,009094 14.4 0.871046	12.702282 14.4 0.417776	0.550281 14.4 -0.4830/5
2.06.7%0/ 14.4 0.661179	12.828448 14.4 0.403383	0.608964 14.4 -0.505246
2.004410 14.4 0.090/20	12952752 14.4 0.389470	0.570496 14.4 -0.527017
2.5240.54 14.4 0.0550.52 3.047548 14.4 0.007508	13.075140 14.4 0.375445	0.734855 14.4 -0.548375
3 171557 144 0015554	13,153,364 14,4 0,301318	0.802014 14.4 -0.509508
3 207718 144 0972570	13,430,405 14,4 0,324,000	0.0/1/946 14.4 -0.589805
3425606 144 0.022570	13 544600 14 4 0 30407	1,000020 14.4 0,6004002
3 555438 14.4 0934706	13656854 144 0307079	1.020032 14.4 -0.029438
3 68 68 93 14.4 0.93 98 28	13.766829 14.4 0.293765	1178970 144 064330
3820011 144 0944321	13.874580 144 0290666	1.176877 14.4 -0.685306
3.954741 14.4 0.948188	13980067 144 0.267743	1348243 144 -0.702927
4.091030 14.4 0.951432	14,083248 14,4 0,255006	1436788 144 -0720029
4.228826 14.4 0.954057	14.184084 14.4 0.242466	1.527864 14.4 -0.736599
4.368076 14.4 0.956067	14282535 14.4 0.230134	1.621435 14.4 -0.752628
4.508726 14.4 0.957468	14.378565 14.4 0.218021	1.717465 14.4 -0.768107
4.650722 14.4 0.958266	14.472136 14.4 0.206136	1.815916 14.4 -0.783024
4.794009 14.4 0.958466	14.563212 14.4 0.194489	1.916752 14.4 -0.797372
4.938533 14.4 0.958077	14.651757 14.4 0.183092	2.019933 14.4 -0.811141
5.084236 14.4 0.957106	14.737738 14.4 0.171955	2.125420 14.4 -0.824323
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7.059701 14.4 0.896025	15.608452 14.4 0.055094	3.686893 14.4 -0.939828
7215863 14.4 0.888002	15.655523 14.4 0.048558	3.820011 14.4 -0.944321
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7.529034 14.4 0.870739	15.740793 14.4 0.036657	4.091030 14.4 -0.951432
7.685921 14.4 0.861525	15.778959 14.4 0.031305	4228826 14.4 -0.954057
/.842930 14.4 0.851942	15.814127 14.4 0.026359	4.368076 14.4 -0.956067
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9.867563 14.4 0.700121	161 2	6.285527 14.4 -0.929508
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10.522277 14.4 0.659780	0.006168 14.4 -0.055494	6.748524 14.4 -0.910783

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	15.558448 14.4 -0.062013	3.820011 0 -0.944321
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12045759 144 -0.489503	0391548 0 .0414281	8.784137 0 -0.787473 9.040300 0 0.775607
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12.444.302 14.4 40.440.047		7.4UUU/V V 47.7.30002
12.574304 14.4 -0.432034	0.608964 0 -0.505246	9.560723 0 -0.726159
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12.574304 14.4 -0.432034 12.5702282 14.4 -0.417776 12.828448 14.4 -0.403585	0.608964 0 -0.505246 0.670496 0 -0.527017 0.734855 0 -0.548375	9.560723 0 -0.726159 9.714473 0 -0.713235 9.867563 0 -0.700121
12.574304 14.4 -0.432034 12.574304 14.4 -0.432034 12.702282 14.4 -0.417776 12.828448 14.4 -0.403585 12.952752 14.4 -0.389470	0.608964 0 -0.505246 0.670496 0 -0.527017 0.734855 0 -0.548375 0.802014 0 -0.569308	9.560723         0         -0.726159         9.714473         0         -0.713235         9.867563         0         -0.700121         10.019933         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         0         -0.686832         -0.686832         -0.686832         -0.686832         -0.686832         -0.686832         -0.686832         -0.686832         -0.686832
12:474:302       14:4       -0.432034         12:574304       14:4       -0.432034         12:702282       14:4       -0.417776         12:828448       14:4       -0.403585         12:952752       14:4       -0.389470         13:075146       14:4       -0.375445	0.608964 0 -0.505246 0.670496 0 -0.527017 0.734855 0 -0.548375 0.802014 0 -0.569308 0.871948 0 -0.589805	9.560723 0 -0.726159 9.714473 0 -0.713235 9.867563 0 -0.700121 10.019933 0 -0.686832 10.171524 0 -0.673381
12.574304 14.4 -0.432034 12.702282 14.4 -0.417776 12.828448 14.4 -0.403585 12.952752 14.4 -0.389470 13.075146 14.4 -0.375445 13.195584 14.4 -0.361518	0.608964         0         -0.505246           0.670496         0         -0.527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -6.609852	9.560723 0 -0.726159 9.714473 0 -0.713235 9.867563 0 -0.701121 10.019933 0 -0.686832 10.171524 0 -0.673381 10.322277 0 -0.655780
12:574304       14:4       -0.432034         12:702282       14:4       -0.417776         12:828448       14:4       -0.403585         12:952752       14:4       -0.389470         13:075146       14:4       -0.375445         13:195584       14:4       -0.361518         13:314020       14:4       -0.347703	0.608964         0         -0.505246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -6.60852           1.020132         0         -0.629438	9.560723 0 -0.726159 9.714473 0 -0.713235 9.867563 0 -0.701121 10.019933 0 -0.686832 10.171524 0 -0.673381 10.322277 0 -0.659780 10.472136 0 -0.646042
12.574304       14.4       -0.432034         12.70228       14.4       -0.417776         12.828448       14.4       -0.403585         12.952752       14.4       -0.389470         13.075146       14.4       -0.375445         13.195584       14.4       -0.361518         13.195584       14.4       -0.347703         13.430406       14.4       -0.334009         13.544659       14.4       -0.33047	0.608964         0         -0.505246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.60852           1.020032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177	9.560723 0 -0.726159 9.560723 0 -0.726159 9.714473 0 -0.713235 9.867563 0 -0.700121 10.019933 0 -0.686832 10.171524 0 -0.673381 10.322277 0 -0.659780 10.472136 0 -0.646042 10.621041 0 -0.632181
12.574304       14.4       -0.432034         12.702282       14.4       -0.417776         12.828448       14.4       -0.403585         12.952752       14.4       -0.389470         13.075146       14.4       -0.375445         13.195584       14.4       -0.361518         13.430406       14.4       -0.334009         13.5446699       14.4       -0.320447         13.656854       14.4       -0.320147	0.608964         0         -0.505246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.02032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1262762         0         -0.685306	9.560723 0 -0.726159 9.560723 0 -0.726159 9.714473 0 -0.713235 9.867563 0 -0.700121 10.019933 0 -0.686832 10.171524 0 -0.673381 10.322277 0 -0.659780 10.472136 0 -0.646042 10.621041 0 -0.632181 10.768936 0 -0.618209
12.574304       14.4       -0.432034         12.702282       14.4       -0.41776         12.828448       14.4       -0.403585         12.952752       14.4       -0.389470         13.075146       14.4       -0.375445         13.195584       14.4       -0.361518         13.195584       14.4       -0.347703         13.430406       14.4       -0.334009         13.5446699       14.4       -0.320447         13.656854       14.4       -0.23765	0.608964         0         -0.505246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.02032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1.262262         0         -0.685306           1.348243         0         -0.702927	9.560723 0 -0.726159 9.560723 0 -0.726159 9.867563 0 -0.713235 9.867563 0 -0.701121 10.019933 0 -0.686832 10.171524 0 -0.673381 10.322277 0 -0.659780 10.472136 0 -0.646042 10.621041 0 -0.632181 10.768936 0 -0.618209 10.915764 0 -0.689883
$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$	0.608964         0         -0.505246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.02032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1.262262         0         -0.685306           1.348243         0         -0.702927           1.436788         0         -0.720029	9.5607723         0         -0.726159           9.560723         0         -0.721529           9.867563         0         -0.713235           9.867563         0         -0.701121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.638983           11.061467         0         -0.589983           11205991         0         -0.575753
$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$	0.608964         0         -0.505246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1262262         0         -0.685306           1.348243         0         -0.702927           1.436788         0         -0.736599	9.5607723         0         -0.726159           9.5607723         0         -0.721529           9.714473         0         -0.713235           9.867563         0         -0.701121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.644139           11.061467         0         -5785753           11.349278         0         -0.571553
$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$	0.608964         0         -0.505246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1262262         0         -0.685306           1.348243         0         -0.702927           1.436788         0         -0.736599           1.621435         0         -0.752628	9.5607723         0         -0.726159           9.5607723         0         -0.721529           9.714473         0         -0.713225           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           11.061467         0         -575753           11.349278         0         -0.571753           11.349274         0         -0.547121
$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$	0.608964         0         -0.505246           0.670496         0         -0.55246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1.262262         0         -0.685306           1.348243         0         -0.702927           1.436788         0         -0.720029           1.527864         0         -0.752628           1.717465         0         -0.768107	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.644139           11.61467         0         -0.589983           11.205991         0         -0.57753           11.349278         0         -0.561462           11.491274         0         -0.547121           11.631924         0         -0.532743
12.574304       14.4       -0.432034         12.70282       14.4       -0.432034         12.70282       14.4       -0.403585         12.952752       14.4       -0.403585         12.952752       14.4       -0.375445         13.075146       14.4       -0.375445         13.195584       14.4       -0.361518         13.314020       14.4       -0.34009         13.544699       14.4       -0.30407         13.656854       14.4       -0.307029         13.766829       14.4       -0.230765         13.874580       14.4       -0.293765         13.890067       14.4       -0.25006         14.184084       14.4       -0.25006         14.184084       14.4       -0.25006	0.608964         0         -0.505246           0.670496         0         -0.55246           0.670496         0         -0.55246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.667177           1262262         0         -0.685306           1.348243         0         -0.702927           1.436788         0         -0.720029           1.527864         0         -0.752628           1.717465         0         -0.783024	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           11.61467         0         -0.57533           11.349278         0         -0.5715442           11.491274         0         -0.547121           11.631924         0         -0.532743           11.771174         0         -0.518340
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0.608964         0         -0.505246           0.670496         0         -0.55246           0.670496         0         -0.55246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.667177           1262262         0         -0.685306           1.348243         0         -0.702927           1.436788         0         -0.72029           1.527864         0         -0.752628           1.717465         0         -0.783024           1.916752         0         -0.797372	9.5607723         0         -0.726159           9.5607723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           11.61467         0         -0.57533           11.349278         0         -0.561462           11.491274         0         -0.547121           11.631924         0         -0.51840           11.771174         0         -0.518340
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0.608964         0         -0.505246           0.670496         0         -0.55246           0.670496         0         -0.55246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1262262         0         -0.685306           1.348243         0         -0.72029           1.527864         0         -0.752628           1.717465         0         -0.768107           1.815916         0         -0.783024           1.916752         0         -0.9797372           2.019933         0         -0.811141	9.5607723         0         -0.726159           9.5607723         0         -0.72159           9.714473         0         -0.713225           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           11.61467         0         -0.57533           11.349278         0         -0.561462           11.491274         0         -0.51840           11.771174         0         -0.518340           11.908970         0         -0.503922           12.045259         0         -0.489503
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0.608964         0         -0.505246           0.670496         0         -0.55246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1262262         0         -0.685306           1.348243         0         -0.702927           1.436788         0         -0.720129           1.527864         0         -0.75628           1.717465         0         -0.783024           1.916752         0         -0.7811141           2.125420         0         -0.824323           2.733171         0         -0.824612	9.5607723         0         -0.726159           9.5607723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           11.061467         0         -0.589983           11.205991         0         -0.57753           11.349278         0         -0.547121           11.631924         0         -0.51840           11.771174         0         -0.518340           11.908970         0         -0.503922           12.045259         0         -0.489503           12.179989         0         -0.475093
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0.608964       0       -0.505246         0.670496       0       -0.55246         0.670496       0       -0.5527017         0.734855       0       -0.548375         0.802014       0       -0.569308         0.871948       0       -0.589805         0.944630       0       -0.609852         1.020032       0       -0.629438         1.098125       0       -0.667177         1.262262       0       -0.685306         1.348243       0       -0.702927         1.436788       0       -0.72029         1.527864       0       -0.752628         1.717465       0       -0.768107         1.815916       0       -0.783024         1.916752       0       -0.824323         2.019933       0       -0.811141         2.125420       0       -0.824323         2.233171       0       -0.836912	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.6547139           11.061467         0         -0.551753           11.349278         0         -0.5547121           11.631924         0         -0.51840           11.908970         0         -0.51840           11.908970         0         -0.503922           12.045259         0         -0.489503           12.179989         0         -0.475093           12.313107         0         -0.460704           2.444552         0         -0.445247
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	0.608964         0         -0.505246           0.670496         0         -0.55246           0.670496         0         -0.5527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1262262         0         -0.685306           1.348243         0         -0.72029           1.527864         0         -0.752628           1.717465         0         -0.768107           1.815916         0         -0.783024           1.916752         0         -0.824323           2.233171         0         -0.824323           2.233171         0         -0.846092           2.455301         0         -0.9460280	9.5607723         0         -0.726159           9.5607723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           11.061467         0         -0.589983           11.205991         0         -0.57753           11.349278         0         -0.541462           11.491274         0         -0.51840           11.908970         0         -0.532743           11.771174         0         -0.518340           11.908970         0         -0.503922           12.045259         0         -0.489503           12.179989         0         -0.475093           12.313107         0         -0.460744           12.444562         0         -0.443074
12.574304 $14.4$ $-0.432034$ $12.574304$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.403585$ $12.952752$ $14.4$ $-0.389470$ $13.075146$ $14.4$ $-0.375445$ $13.195584$ $14.4$ $-0.34703$ $13.430406$ $14.4$ $-0.334009$ $13.544699$ $14.4$ $-0.307029$ $13.656854$ $14.4$ $-0.230765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.980067$ $14.4$ $-0.255006$ $14.184084$ $14.4$ $-0.255006$ $14.184084$ $14.4$ $-0.220134$ $14.378565$ $14.4$ $-0.230134$ $14.378565$ $14.4$ $-0.218021$ $14.472136$ $14.4$ $-0.218021$ $14.477138$ $14.4$ $-0.194489$ $14.551757$ $14.4$ $-0.183092$ $14.2712121$ $14.4$ $-0.161087$ $14.291875$ $14.4$ $-0.150498$	0.608964       0       -0.505246         0.670496       0       -0.55246         0.670496       0       -0.5527017         0.734855       0       -0.548375         0.802014       0       -0.589805         0.944630       0       -0.609852         1.020032       0       -0.629438         1.020120       0       -0.648550         1.178879       0       -0.667177         1.262262       0       -0.685306         1.348243       0       -0.72029         1.527864       0       -0.752628         1.717465       0       -0.768107         1.815916       0       -0.783024         1.916752       0       -0.824323         2.233171       0       -0.824323         2.343146       0       -0.848899         2.455301       0       -0.846280	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           11.061467         0         -0.589983           11.205991         0         -0.57753           11.349278         0         -0.541462           11.491274         0         -0.51840           11.908970         0         -0.532743           11.771174         0         -0.518340           11.908970         0         -0.503922           12.045259         0         -0.489503           12.179989         0         -0.475093           12.313107         0         -0.480503           12.479304         0         -0.432034           12.702
12.574304 $14.4$ $-0.432034$ $12.574304$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.403585$ $12.952752$ $14.4$ $-0.389470$ $13.075146$ $14.4$ $-0.375445$ $13.195584$ $14.4$ $-0.361518$ $13.314020$ $14.4$ $-0.34703$ $13.546699$ $14.4$ $-0.307029$ $13.566854$ $14.4$ $-0.230765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.260666$ $13.980067$ $14.4$ $-0.255006$ $14.184084$ $14.4$ $-0.255006$ $14.184084$ $14.4$ $-0.220134$ $14.378565$ $14.4$ $-0.230134$ $14.571757$ $14.4$ $-0.183092$ $14.571757$ $14.4$ $-0.194489$ $14.501757$ $14.4$ $-0.161087$ $14.901875$ $14.4$ $-0.150498$ $14.901875$ $14.4$ $-0.160198$	0.608964       0       -0.505246         0.670496       0       -0.55246         0.670496       0       -0.5527017         0.734855       0       -0.548375         0.802014       0       -0.569308         0.871948       0       -0.589805         0.944630       0       -0.609852         1.020032       0       -0.629438         1.020120       0       -0.648550         1.178879       0       -0.667177         1.262262       0       -0.685306         1.348243       0       -0.702927         1.436788       0       -0.720129         1.527864       0       -0.75628         1.717465       0       -0.768107         1.815916       0       -0.783024         1.916752       0       -0.824323         2.233171       0       -0.824323         2.233171       0       -0.848899         2.455301       0       -0.848290         2.4559301       0       -0.841148         2.6685980       0       -0.881199	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           11.061467         0         -0.589983           11.205991         0         -0.57753           11.349278         0         -0.561462           11.491274         0         -0.518340           11.908970         0         -0.532743           11.771174         0         -0.518340           11.908970         0         -0.503922           12.045259         0         -0.489503           12.179989         0         -0.475093           12.313107         0         -0.460704           12.454304         0         -0.432034           12.70
12.574304 $14.4$ $-0.432034$ $12.574304$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.828448$ $14.4$ $-0.403585$ $12.952752$ $14.4$ $-0.389470$ $13.075146$ $14.4$ $-0.375445$ $13.195584$ $14.4$ $-0.361518$ $13.314020$ $14.4$ $-0.34703$ $13.546699$ $14.4$ $-0.30409$ $13.546699$ $14.4$ $-0.307029$ $13.766829$ $14.4$ $-0.230765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.280666$ $13.980067$ $14.4$ $-0.280666$ $14.184084$ $14.4$ $-0.255006$ $14.184084$ $14.4$ $-0.220134$ $14.378565$ $14.4$ $-0.220134$ $14.378565$ $14.4$ $-0.218021$ $14.472136$ $14.4$ $-0.218021$ $14.477138$ $14.4$ $-0.183092$ $14.571773$ $14.4$ $-0.183092$ $14.52157$ $14.4$ $-0.150498$ $14.978956$ $14.4$ $-0.150498$ $14.979968$ $14.4$ $-0.130196$	0.608964       0       -0.505246         0.670496       0       -0.55246         0.670496       0       -0.527017         0.734855       0       -0.548375         0.802014       0       -0.589805         0.944630       0       -0.609852         1.020032       0       -0.629438         1.020132       0       -0.648550         1.178879       0       -0.667177         1.262262       0       -0.685306         1.348243       0       -0.72029         1.527864       0       -0.752628         1.717465       0       -0.768107         1.815916       0       -0.783024         1.916752       0       -0.824323         2.233171       0       -0.824323         2.233171       0       -0.84899         2.455301       0       -0.846280         2.569594       0       -0.871048         2.685980       0       -0.881199         2.804416       0       -0.890728	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           10.61467         0         -0.57533           11.349278         0         -0.561462           11.491274         0         -0.518340           11.908970         0         -0.518340           11.908970         0         -0.5322743           11.771174         0         -0.518340           11.908970         0         -0.460704           12.445529         0         -0.446347           12.574304         0         -0.43234           12.702282         0         -0.41776           12.828448         0         -0.403585           12.9527
12.574304 $14.4$ $-0.432034$ $12.574304$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.43585$ $12.952752$ $14.4$ $-0.389470$ $13.075146$ $14.4$ $-0.375445$ $13.195584$ $14.4$ $-0.361518$ $13.314020$ $14.4$ $-0.34703$ $13.44699$ $14.4$ $-0.30409$ $13.546699$ $14.4$ $-0.307029$ $13.766829$ $14.4$ $-0.230765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.280666$ $13.980067$ $14.4$ $-0.280666$ $14.184084$ $14.4$ $-0.255006$ $14.184084$ $14.4$ $-0.220134$ $14.378565$ $14.4$ $-0.220134$ $14.378565$ $14.4$ $-0.218021$ $14.472136$ $14.4$ $-0.218121$ $14.4$ $-0.183092$ $14.737738$ $14.4$ $-0.183092$ $14.737738$ $14.4$ $-0.161087$ $14.901875$ $14.4$ $-0.160188$ $14.979968$ $14.4$ $-0.120502$	0.608964         0         -0.505246           0.670496         0         -0.55246           0.670496         0         -0.55246           0.670496         0         -0.55246           0.670496         0         -0.55246           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.020132         0         -0.629438           1.020132         0         -0.667177           1.262262         0         -0.685306           1.348243         0         -0.720129           1.527864         0         -0.752628           1.717465         0         -0.783024           1.916752         0         -0.783024           1.916752         0         -0.797372           2.019933         0         -0.811141           2.125420         0         -0.824323           2.233171         0         -0.826012           2.343146         0         -0.848899           2.455501         0         -0.881199           2.804416 <td< td=""><td>9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           10.915764         0         -0.547121           11.61467         0         -0.547121           11.631924         0         -0.547121           11.631924         0         -0.51840           11.908970         0         -0.518340           11.908970         0         -0.5322743           11.771174         0         -0.518340           11.908970         0         -0.460704           12.44562         0         -0.446347           12.574304         0         -0.43234           12.702282         0         -0.41776           2.828448</td></td<>	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           10.915764         0         -0.547121           11.61467         0         -0.547121           11.631924         0         -0.547121           11.631924         0         -0.51840           11.908970         0         -0.518340           11.908970         0         -0.5322743           11.771174         0         -0.518340           11.908970         0         -0.460704           12.44562         0         -0.446347           12.574304         0         -0.43234           12.702282         0         -0.41776           2.828448
12.574304 $14.4$ $-0.432034$ $12.574304$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.828448$ $14.4$ $-0.403585$ $12.952752$ $14.4$ $-0.389470$ $13.075146$ $14.4$ $-0.375445$ $13.195584$ $14.4$ $-0.34703$ $13.430406$ $14.4$ $-0.34703$ $13.546699$ $14.4$ $-0.304029$ $13.546699$ $14.4$ $-0.307029$ $13.766829$ $14.4$ $-0.230765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.280666$ $13.980067$ $14.4$ $-0.255006$ $14.184084$ $14.4$ $-0.220134$ $14.822535$ $14.4$ $-0.20134$ $14.378565$ $14.4$ $-0.20134$ $14.378565$ $14.4$ $-0.18021$ $14.472136$ $14.4$ $-0.18092$ $14.577738$ $14.4$ $-0.18092$ $14.737738$ $14.4$ $-0.161087$ $14.901875$ $14.4$ $-0.130196$ $15.128052$ $14.4$ $-0.120502$ $15.197986$ $14.4$ $-0.111126$	0.608964       0       -0.505246         0.670496       0       -0.55246         0.670496       0       -0.527017         0.734855       0       -0.548375         0.802014       0       -0.589805         0.944630       0       -0.609852         1.020032       0       -0.629438         1.020132       0       -0.648550         1.178879       0       -0.667177         1.262262       0       -0.685306         1.348243       0       -0.72029         1.527864       0       -0.752628         1.717465       0       -0.768107         1.815916       0       -0.783024         1.916752       0       -0.824323         2.233171       0       -0.824323         2.233171       0       -0.848899         2.455301       0       -0.846280         2.569594       0       -0.871048         2.6859800       0       -0.881199         2.804416       0       -0.899632         3.047248       0       -0.907798	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646139           10.61467         0         -0.547121           11.61467         0         -0.547121           11.631924         0         -0.547121           11.631924         0         -0.51840           11.908970         0         -0.503922           12.045259         0         -0.489503           12.179989         0         -0.475093           12.179989         0         -0.43034           12.70282         0         -0.43034           12.70282         0         -0.43234           12.70282         0         -0.432344           12.822448
12.574304 $14.4$ $-0.432034$ $12.574304$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.43585$ $12.952752$ $14.4$ $-0.389470$ $13.075146$ $14.4$ $-0.375445$ $13.075146$ $14.4$ $-0.361518$ $13.3195584$ $14.4$ $-0.34703$ $13.454699$ $14.4$ $-0.370029$ $13.566854$ $14.4$ $-0.207029$ $13.766829$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293134$ $14.083248$ $14.4$ $-0.220134$ $14.378565$ $14.4$ $-0.206136$ $14.53212$ $14.4$ $-0.18092$ $14.53212$ $14.4$ $-0.18092$ $14.53215$ $14.4$ $-0.180198$ $14.979968$ $14.4$ $-0.120502$ $15.128052$ $14.4$ $-0.120502$ $15.197986$ $14.4$ $-0.12075$	0.608964       0       -0.505246         0.670496       0       -0.55246         0.670496       0       -0.527017         0.734855       0       -0.548375         0.802014       0       -0.589805         0.944630       0       -0.609852         1.020032       0       -0.629438         1.020032       0       -0.648550         1.178879       0       -0.667177         1.262262       0       -0.685306         1.348243       0       -0.72029         1.527864       0       -0.752628         1.717465       0       -0.768107         1.815916       0       -0.783024         1.916752       0       -0.783024         1.916752       0       -0.824323         2.233171       0       -0.824323         2.233171       0       -0.848899         2.455301       0       -0.846280         2.569584       0       -0.871048         2.6859800       0       -0.881199         2.804416       0       -0.899728         2.924854       0       -0.997908         3.171552       0       -0.915554     <	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713225           9.867563         0         -0.700121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.654753           11.205991         0         -0.57533           11.349278         0         -0.547121           11.631924         0         -0.547121           11.631924         0         -0.51840           11.908970         0         -0.503922           12.045259         0         -0.489503           12.179989         0         -0.475093           12.313107         0         -0.460704           12.44562         0         -0.443234           12.70282         0         -0.432344           12.70282         0         -0.432934           12.95752<
12.574304 $14.4$ $-0.432034$ $12.574304$ $14.4$ $-0.432034$ $12.70232$ $14.4$ $-0.432034$ $12.70232$ $14.4$ $-0.432034$ $12.70232$ $14.4$ $-0.432034$ $12.822448$ $14.4$ $-0.403585$ $12.952752$ $14.4$ $-0.389470$ $13.075146$ $14.4$ $-0.375445$ $13.195584$ $14.4$ $-0.361518$ $13.314020$ $14.4$ $-0.34703$ $13.454699$ $14.4$ $-0.307029$ $13.566854$ $14.4$ $-0.230765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293144$ $14.083248$ $14.4$ $-0.220134$ $14.378565$ $14.4$ $-0.18092$ $14.571757$ $14.4$ $-0.18092$ $14.571757$ $14.4$ $-0.18092$ $14.571757$ $14.4$ $-0.180198$ $14.978955$ $14.4$ $-0.120502$ $15.128052$ $14.4$ $-0.120502$ $15.1297986$ $14.4$ $-0.102075$ $15.329504$ $14.4$ $-0.092360$	0.608964       0       -0.505246         0.670496       0       -0.55246         0.670496       0       -0.527017         0.734855       0       -0.548375         0.802014       0       -0.589805         0.944630       0       -0.609852         1.020032       0       -0.629438         1.020132       0       -0.648550         1.178879       0       -0.667177         1.262262       0       -0.685306         1.348243       0       -0.72029         1.527864       0       -0.752628         1.717465       0       -0.768107         1.815916       0       -0.783024         1.916752       0       -0.783024         1.916752       0       -0.824323         2.233171       0       -0.824323         2.233171       0       -0.848299         2.455001       0       -0.846280         2.569594       0       -0.871048         2.6859800       0       -0.881199         2.804416       0       -0.990728         2.924854       0       -0.990728         2.924854       0       -0.990752     <	9.560723         0         0.726159           9.560723         0         0.70121           10.019933         0         -0.701121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.646042           10.621041         0         -0.532181           10.768936         0         -0.618209           10.915764         0         -0.547121           11.61467         0         -0.547121           11.631924         0         -0.547121           11.631924         0         -0.547334           11.908970         0         -0.503922           12.045259         0         -0.4489503           12.179989         0         -0.475093           12.313107         0         -0.460704           12.454304         0         -0.432344           12.70282         0         -0.417776           12.82
12.574304 $14.4$ $-0.432034$ $12.574304$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.828448$ $14.4$ $-0.403585$ $12.952752$ $14.4$ $-0.389470$ $13.075146$ $14.4$ $-0.375445$ $13.195584$ $14.4$ $-0.361518$ $13.314020$ $14.4$ $-0.34703$ $13.430406$ $14.4$ $-0.334009$ $13.546699$ $14.4$ $-0.307029$ $13.766829$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $14.4822535$ $14.4$ $-0.293134$ $14.8378565$ $14.4$ $-0.218021$ $14.472136$ $14.4$ $-0.206136$ $14.52121$ $14.4$ $-0.161087$ $14.52121$ $14.4$ $-0.161087$ $14.979968$ $14.4$ $-0.160187$ $14.979986$ $14.4$ $-0.120502$ <td>0.608964         0         -0.505246           0.670496         0         -0.505246           0.670496         0         -0.527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1.262262         0         -0.685306           1.348243         0         -0.720297           1.436788         0         -0.72029           1.527864         0         -0.752628           1.717465         0         -0.783024           1.916752         0         -0.79372           2.019933         0         -0.811141           2.125420         0         -0.826323           2.233171         0         -0.860280           2.569544         0         -0.81199           2.804416         0         -0.89728           2.924854         0         -0.907908           3.171552         <td< td=""><td>9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.701121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.604139           11.061467         0         -0.518340           10.915764         0         -0.51462           11.491274         0         -0.518340           11.908970         0         -0.518340           11.908970         0         -0.518340           11.908970         0         -0.518340           12.045259         0         -0.4460704           12.444562         0         -0.446377           12.574304         0         -0.432034           12.79989         0         -0.47776           12.828448         0         -0.304470           13.075</td></td<></td>	0.608964         0         -0.505246           0.670496         0         -0.505246           0.670496         0         -0.527017           0.734855         0         -0.548375           0.802014         0         -0.569308           0.871948         0         -0.589805           0.944630         0         -0.609852           1.020032         0         -0.629438           1.098125         0         -0.648550           1.178879         0         -0.667177           1.262262         0         -0.685306           1.348243         0         -0.720297           1.436788         0         -0.72029           1.527864         0         -0.752628           1.717465         0         -0.783024           1.916752         0         -0.79372           2.019933         0         -0.811141           2.125420         0         -0.826323           2.233171         0         -0.860280           2.569544         0         -0.81199           2.804416         0         -0.89728           2.924854         0         -0.907908           3.171552 <td< td=""><td>9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.701121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.604139           11.061467         0         -0.518340           10.915764         0         -0.51462           11.491274         0         -0.518340           11.908970         0         -0.518340           11.908970         0         -0.518340           11.908970         0         -0.518340           12.045259         0         -0.4460704           12.444562         0         -0.446377           12.574304         0         -0.432034           12.79989         0         -0.47776           12.828448         0         -0.304470           13.075</td></td<>	9.560723         0         -0.726159           9.560723         0         -0.72159           9.714473         0         -0.713235           9.867563         0         -0.701121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.604139           11.061467         0         -0.518340           10.915764         0         -0.51462           11.491274         0         -0.518340           11.908970         0         -0.518340           11.908970         0         -0.518340           11.908970         0         -0.518340           12.045259         0         -0.4460704           12.444562         0         -0.446377           12.574304         0         -0.432034           12.79989         0         -0.47776           12.828448         0         -0.304470           13.075
12.574304 $14.4$ $-0.432034$ $12.574304$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.432034$ $12.70282$ $14.4$ $-0.403585$ $12.952752$ $14.4$ $-0.389470$ $13.075146$ $14.4$ $-0.375445$ $13.195584$ $14.4$ $-0.361518$ $13.314020$ $14.4$ $-0.34703$ $13.430406$ $14.4$ $-0.334009$ $13.546699$ $14.4$ $-0.37029$ $13.766829$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.293765$ $13.874580$ $14.4$ $-0.267743$ $14.083248$ $14.4$ $-0.255006$ $14.184084$ $14.4$ $-0.255006$ $14.184084$ $14.4$ $-0.226136$ $14.282535$ $14.4$ $-0.20134$ $14.378565$ $14.4$ $-0.20134$ $14.378565$ $14.4$ $-0.20134$ $14.563212$ $14.4$ $-0.18092$ $14.737738$ $14.4$ $-0.18092$ $14.737738$ $14.4$ $-0.161087$ $14.991875$ $14.4$ $-0.161087$ $14.99285$ $14.4$ $-0.120502$ $15.1928052$ $14.4$ $-0.120502$ $15.197986$ $14.4$ $-0.102075$ $15.329504$ $14.4$ $-0.084988$ $15.449719$ $14.4$ $-0.064967$ $15.91036$ $14.4$ $-0.064967$	0.608964       0       -0.505246         0.670496       0       -0.5527017         0.734855       0       -0.569308         0.802014       0       -0.569308         0.871948       0       -0.589805         0.944630       0       -0.609852         1.020032       0       -0.629438         1.098125       0       -0.667177         1.262262       0       -0.685306         1.348243       0       -0.72029         1.527864       0       -0.736599         1.621435       0       -0.72029         1.527864       0       -0.783024         1.916752       0       -0.78102         1.815916       0       -0.783024         1.916752       0       -0.783024         1.916752       0       -0.797372         2.019933       0       -0.811141         2.125420       0       -0.826323         2.233171       0       -0.860280         2.565954       0       -0.81199         2.804416       0       -0.890728         2.924854       0       -0.997908         3.171552       0       -0.915554 <td>9.560723         0         -0.726159           9.560723         0         -0.72159           9.560723         0         -0.713235           9.867563         0         -0.701121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.604139           11.061467         0         -0.518209           10.915764         0         -0.51462           11.491274         0         -0.517573           11.349278         0         -0.518340           11.908970         0         -0.518340           11.908970         0         -0.475093           12.179989         0         -0.475033           12.179989         0         -0.475033           12.179989         0         -0.475033           12.179989         0         -0.475033           12.702282         0         -0.417776           12.82</td>	9.560723         0         -0.726159           9.560723         0         -0.72159           9.560723         0         -0.713235           9.867563         0         -0.701121           10.019933         0         -0.686832           10.171524         0         -0.673381           10.322277         0         -0.659780           10.472136         0         -0.646042           10.621041         0         -0.632181           10.768936         0         -0.618209           10.915764         0         -0.604139           11.061467         0         -0.518209           10.915764         0         -0.51462           11.491274         0         -0.517573           11.349278         0         -0.518340           11.908970         0         -0.518340           11.908970         0         -0.475093           12.179989         0         -0.475033           12.179989         0         -0.475033           12.179989         0         -0.475033           12.179989         0         -0.475033           12.702282         0         -0.417776           12.82

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13.874580 0 -0.280666	1262262 14.4 0.685306	10915764 14.4 0.604139
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15.505331 0 -0.069300	3.423090 14.4 0.928953	0.185873 24 0.292700
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15.005325 0 -0.040338	3.820011 14.4 0.944321	0.300358 24 0.366632
15.099042 0 40.042410	3.954/41 14.4 0.948188	0.344477 24 0.390628
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15901307 0 -0.014013	4.794009 14.4 0.908400	0.670496 24 0.527017
15.924555 0 40.010745	4.938033 14.4 0.9580//	0.734855 24 0.548375
13944948 0 40.007903 15061478 0 0.006404	5,084230 14.4 0.957106	0.802014 24 0.569308
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15975559 0 -0.005519	5.57844 14.4 0.953453	0.944630 24 0.609852
15960123 0 -0.001981	5.52/804 14.4 0.950/89	1.020032 24 0.629438
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0.038522 14.4 0.136923	7215863 14.4 0.888002	2019933 24 0811141
0.055452 14.4 0.163563	7.372327 14.4 0.879569	2.125420 24 0.824323
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0.550281 14.4 0.483075	9.406370 14.4 0.738882	3.686893 24 0.939828
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5.084236 24 0.957106	0.670496 24 -0.527017	9.714473 24 -0.713235
5231064 24 0.955562	0.734855 24 -0.548375	9.867563 24 -0.700121
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8.940299 24 0.775697	3.047248 24 -0.907908	0.098493 14.4 -0.216053
9.096099 24 0.763664	3.171552 24 -0.915554	0.124587 14.4 -0.241889
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0.024661 24 -0.110027	7.059701 24 -0.896025	1916752 14.4 -0.797372
0.038522 24 -0.136923	7.215863 24 -0.888002	2.019933 14.4 -0.811141
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7.685921 32 -0.861525	15778959 32 -0.031305	4.508776	24 24	-0.550007
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12,179989 32 -0,475093	0441552 24 -0437581	0,004000	27 74	-0.113091
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9251476 24 -0.751388	15.993832 24 -0.000881	13.195584	24	0361518
9.406370 24 -0.738882	15.998458 24 -0.000220	13.314020	24	0.347703
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11,001407 24 40,069960	12.828448 14.4 0.403085	14.4/2130	24	0.2061.36
11200991 24 -05/5/55	12952/52 14.4 0.3894/0	14.303212	24	0.194489
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12.179989 24 -0.475093	13.766829 14.4 0.293765	15.128052	24	0.120502
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12.444562 24 -0.446347	13.980067 14.4 0.267743	15265145	24	0.102075
12.574304 24 -0.432034	14.083248 14.4 0.255006	15.329504	24	0.093360
12.702282 24 -0.417776	14.184084 14.4 0.242466	15.391036	24	0.084988
12.828448 24 -0.403585	14282535 14.4 0230134	15.449719	24	0.076967
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13.075146 24 -0.375445	14.472136 14.4 0.206136	15,558448	24	0.062013
13.195584 24 -0.361518	14.563212 144 0.194489	15608452	24	0.055094
13 314020 24 -0 347703	14651757 144 0183092	15655573	24	0.035054
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15.055370 24 -0.130196	15.778959 14.4 0.031305	12.000000	24	-0.494309
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14.00212	24	-0.194489	15.608452 14.4 -0.055094	3.686893	32	-0939828
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12/075146	1/1.1	0275445	0.070490 52 -0.521017	0.00750	22	0.713233
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14 083248	14.4	.0255006	1436789 32 0.700000	11:001407	22	0,57570
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4070069	14.4	-0.140198	2455301 32 -0.960390	12:771.332	_ <u>5</u> ∠	0.42202
17.7700	14.4	0.120104	2.533301 32 30.000200	12.3/4304	32 ~~	-0.432034
13.0003/0	14.4	-0.130190	2.309394 32 -0.8/1048	12.702282	32	-0.417776
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5 505521	14.4	-0.069306	3475696 37 _0078052	12 644400	-3∠ m	0.22044
\$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	14.4	-0.65012	2 555/29 22 0.02/1702	13,544099	<u>2</u> د	-0.32044
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13 766820 32 .0.202765	1 249242 22 15(41( 0 (05204	
13.700023 32 -0.233703	1.346243 32.130410 -0.083304	11.061467 32.131284 -0.575191
13.874380 32 -0.280606	1.436788 32.160221 -0.701976	11.205991 32.128117 -0.561318
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14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.26514539 15.26514539 15.32950366 15.39103626 15.39103626 15.39103626 15.5844837 15.605552269 15.569564189 15.74079274	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.0120774499           32.08285676         0.018911515           32.07503736         0.017126788           32.0645809         0.013799164           32.05371296         0.012259632           32.04734015         0.010805081           32.0473405         0.009437013           32.0357375         0.00815685           32.0351976         0.009465936
14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.26514539 15.26514539 15.32950366 15.39103626 15.39103626 15.39103626 15.5844837 15.60845213 15.65552269 15.69964189 15.74079274 15.77895936 15.7895936	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.0120774499           32.08285676         0.018911515           32.07503736         0.017126788           32.06756863         0.015422099           32.0645809         0.013799164           32.04734015         0.00805081           32.04734015         0.00845681           32.04734015         0.00845681           32.04734015         0.00845685           32.0353715         0.00845685           32.0351976         0.005665936           32.03509854         0.005865525
14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.26514539 15.26514539 15.32950366 15.39103626 15.39103626 15.39103626 15.5844837 15.605552269 15.69564189 15.74079274 15.77895936 15.71895936	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.0120774499           32.08285676         0.018911515           32.07503736         0.017126788           32.06756863         0.015422099           32.0645809         0.013799164           32.04734015         0.00805081           32.04734015         0.00815685           32.0357375         0.00815685           32.03051976         0.00565936           32.03269854         0.005865525           32.02127897         0.004856786
14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.26514539 15.26514539 15.26514539 15.26514539 15.26514539 15.26514539 15.2653069 15.55844837 15.60845213 15.6054129 15.74079274 15.74079274 15.77895936	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.0120774499           32.08285676         0.018911515           32.07508736         0.017126788           32.06756863         0.015422099           32.0645809         0.013799164           32.05731296         0.012259632           32.04734015         0.00805081           32.0473405         0.00845681           32.0353715         0.00815685           32.0351976         0.006965936           32.02569854         0.005865525           32.02127897         0.004856786           32.021278575         0.003940796
14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.26514539 15.32950366 15.39103626 15.39103626 15.39103626 15.55844837 15.669564189 15.74079274 15.77895936 15.81412705 15.84628224 15.87541254 15.90150672	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.09101903         0.0120774499           32.08285676         0.018911515           32.07503736         0.017126788           32.0645809         0.013799164           32.05371296         0.012259632           32.04734015         0.00805081           32.04734015         0.00815685           32.0351976         0.008465936           32.0351976         0.005865525           32.02127897         0.004856786           32.01726575         0.003940796           32.0136522         0.003118537
14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.26514539 15.26514539 15.26514539 15.26514539 15.26514539 15.26514539 15.2653069 15.55844837 15.60845213 15.6054129 15.74079274 15.77895936 15.81412705 15.84628224 15.78079274 15.7895936	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.0120774499           32.08285676         0.018911515           32.07508736         0.017126788           32.06756863         0.015422099           32.0645809         0.013799164           32.0371296         0.012259632           32.04734015         0.00805081           32.04734015         0.00815685           32.0351375         0.00815685           32.0351976         0.006965936           32.0256854         0.005865525           32.02127897         0.004856786           32.01726575         0.003940796           32.0136632         0.003118537           32.014726575         0.003290897
14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.26514539 15.26514539 15.32950366 15.39103626 15.39103626 15.39103626 15.39103626 15.5844837 15.66845213 15.66954189 15.74079274 15.77895936 15.81412705 15.84628224 15.77895936 15.81412705 15.84628224 15.9741254 15.90150672 15.92455472	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.15704788         0.03845154           32.14672435         0.03488874           32.1269317         0.028971333           32.11748108         0.026814291           32.0833962         0.024727812           32.09951609         0.022713897           32.09101903         0.0120774499           32.08285676         0.018911515           32.07503736         0.017126788           32.06756863         0.015422099           32.0645809         0.013799164           32.05371296         0.012259632           32.04734015         0.00805081           32.0353715         0.00815685           32.0351976         0.006965936           32.02569854         0.003865525           32.02127897         0.004856786           32.01726575         0.003940796           32.01726575         0.003940796           32.01726572         0.001758663           32.01770521         0.001758663
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14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.26514539 15.26514539 15.26514539 15.26514539 15.26514539 15.32950366 15.39103626 15.39103626 15.44971948 15.50553069 15.55844837 15.60845213 15.60964189 15.74079274 15.74079274 15.741254 15.79150672 15.84628224 15.97541254 15.90150672 15.92455472 15.92455476 15.96147781 15.97533867	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.012774499           32.08285676         0.018911515           32.07508736         0.017126788           32.06756863         0.015422099           32.0645809         0.013799164           32.0371296         0.012259632           32.04734015         0.00805081           32.04734015         0.00815685           32.0351976         0.006965936           32.025755         0.003940796           32.0127897         0.004856786           32.01726575         0.003118537           32.01770521         0.01758663           32.00735622         0.00122552           32.0073552         32.00770521           32.00736362         0.00778058           32.0177551         0.001758663           32.00736522         0.001725
14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.12805219 15.12805219 15.26514539 15.32950366 15.39103626 15.39103626 15.39103626 15.39103626 15.55824837 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.60845213 15.874628224 15.9745472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.9245572 15.9245572 15.9245572 15.9245572 15.9245572 15.9245572 15.9245572 15.9245572 15.9245572 15.9245572 15.9245572 15.9245572 15.9245	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.022717499           32.0951609         0.022717499           32.0951609         0.0120774499           32.0951639         0.0120774499           32.08285676         0.018911515           32.07503736         0.017126788           32.06756863         0.015422099           32.0645809         0.013799164           32.05371296         0.010805081           32.04734015         0.000815685           32.0351976         0.006965936           32.02569854         0.005865525           32.001726575         0.003118537           32.0127897         0.004856786           32.01726575         0.003290897           32.00173622         0.001758663           32.00173521         0.001788663           32.001336622         <
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14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.12805219 15.12805219 15.26514539 15.32950366 15.39103626 15.39103626 15.39103626 15.5944837 15.55824837 15.56845213 15.60545213 15.60545213 15.60545213 15.60545213 15.60545213 15.60545224 15.77895936 15.8142785 15.84628224 15.90150672 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.94454766 15.9612488 15.99383229 15.99845792	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.022713897           32.08285676         0.018911515           32.07508736         0.017126788           32.06756863         0.018911515           32.06756863         0.018911515           32.04734015         0.010805081           32.04734015         0.010805081           32.04134625         0.009437013           32.02569854         0.005865525           32.001726575         0.003118537           32.01726575         0.003940796           32.01726575         0.00178663           32.002390897         32.00770521           32.00335622         0.001722522           32.0034308         0.000783058           32.00193106         0.000440752           32.0021472         4.90084E-05           915E-17
14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.12805219 15.12805219 15.26514539 15.32950366 15.39103626 15.49971948 15.50645213 15.60545213 15.60545213 15.60545213 15.60545213 15.60545213 15.60545213 15.60545213 15.60545213 15.60545214 15.777895936 15.8142705 15.84628224 15.90150672 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.9612488 15.99383229 15.99845792 16.32 - 5.92 0.32 0	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.022717499           32.0951609         0.022717499           32.0951609         0.0120774499           32.06756863         0.018911515           32.07503736         0.017126788           32.06756863         0.018911515           32.06756863         0.018911515           32.04734015         0.010805081           32.04734015         0.010805081           32.04734015         0.010805081           32.04734015         0.000865525           32.0051976         0.006965525           32.0127897         0.004856786           32.01726575         0.003118537           32.0104752         0.0012290897           32.00736522         0.00172522           32.0034308         0.000783058           32.00193106
14.6517569 14.73773787 14.82112131 14.90187509 14.97996806 15.05537011 15.12805219 15.12805219 15.26514539 15.32950366 15.39103626 15.39103626 15.449771948 15.50544837 15.60845213 15.60845213 15.60845213 15.60845213 15.60964189 15.74079274 15.77895936 15.81412705 15.84628224 15.87541254 15.90150672 15.92455472 15.92455472 15.92455472 15.92455472 15.92455472 15.94454766 15.9612488 15.99338229 15.998612488 15.99383229 15.998612488	32.17850198         0.040741912           32.16764364         0.038263566           32.15704788         0.035845154           32.14672435         0.033488874           32.13668251         0.031196891           32.1269317         0.028971333           32.11748108         0.026814291           32.10833962         0.024727812           32.0951609         0.022713897           32.0951609         0.020774499           32.08285676         0.018911515           32.07508736         0.017126788           32.06756863         0.015422099           32.0645809         0.013799164           32.05371296         0.012259632           32.04734015         0.010805081           32.04734015         0.010805081           32.04134625         0.009437013           32.0259854         0.005865525           32.021726575         0.003118537           32.01726575         0.003940796           32.0035622         0.00122522           32.0034308         0.000783058           32.00193106         0.000440752           32.0021472         4.90084E-05           915E-17         32.02510559         0.012090215

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Į	2.019933385	32.73081246	0.35194073
	2.125419925	32.74268947	0.357660398
	2.233171226	32.75403132	0.363122346
	2.343145751	32.76483185	0.368323607
	2.4553011 3.	2.77508547 0	37326149
	2.569594036	32.78478718	0.377933588
	2.083980497	32.7939320	0.382337791
ļ	2.00+13013	32.80231796	0.3004/2291
	3.047248406	32.81799679	0.797976493
I	3.171552464	32.82488596	0.397244141
	3.297717982	32.83120656	0.400287983
	3.425696318	32.83695813	0.403057794
	3.555438136	32.84214088	0.405553672
	3.686893417	32.84675567	0.407776037
	3.820011482	32.85080403	0.409725629
	3.754/41013	32,83428818	0.411403506
I	4228826105	32,85957587	0.413040071
	4.368076002	32.86138702	0.414822126
	4.508726075	32.86264916	0.415429939
	4.6507221 32	2.86336762 0.	415775934
1	4.794009335	32.86354834	0.415862963
I	4.938532541	32.8631978	0.41569415
	5.084236001	32.862.32302	0.415272882
	5 278058564	32 85002152	0.414002797
I	5.527864045	32,85663136	0.412531077
l	5.677722582	32.8537401	).411139565
I	5.828476401	32.85036714	0.409515233
I	5.980067384	32.84652229	0.407663648
	6.132437089	32.84221572	0.405589712
I	6.285526775	32.83745795	0.403298494
	6.439277424	32.83225984	0.400795216
I	0.393029761	32.82003252	0.398085239

6.74852428	32,82058738	0.395174053
6.903901267	32.81413606	0.392067263
7.05970082	32.80729042	0.388770575
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7.372327234	32,79246444	0.381630762
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7.685921474	32,7762075	0.37380183
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8 32,75861	942 0365331	858
8.15706954	32,74935772	0360871656
8.314078526	32,73980112	0356269441
8470966429	32,7299623	0351531315
8 6 2 7 6 7 2 7 6 6	32 71985392	0346663377
8,784137123	32,70948862	0341671713
8.94029918	32,698879 0	33656239
9.096098733	32,6880376	0.331341447
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12.82844754	32.36361732	0.175108874
12.95275159	32.35090075	0.168984896
13.07514627	32 33826302	
12 10559/20	Jan J.	0.162899317
12.12220422	32.32571679	0.162899317 0.156856938
13.3140195	32.32571679 32.31326929	0.162899317 0.156856938 0.150862541
13.3140195 13.43040596	32.32571679 32.31326929 32.30093132	0.162899317 0.156856938 0.150862541 0.144920887
13.3140195 13.43040596 13.5446989	32.32571679 32.31326929 32.30093132 32.28871272	0.162899317 0.156856938 0.150862541 0.144920887 0.13903672
13.19556459 13.3140195 13.43040596 13.5446989 13.65685425	32.32571679 32.31326929 32.30093132 32.28871272 32.27662331	0.162899317 0.156856938 0.150862541 0.144920887 0.13903672 0.133214766
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13.19338439 13.3140195 13.43040596 13.5446989 13.65685425 13.76682877 13.87458008 13.98006661 14.08324772	32.32571679 32.31326929 32.30093132 32.208971272 32.27662331 32.26467286 32.25287109 32.24122769 32.22975231	0.162899317 0.156856938 0.150862541 0.144920887 0.13903672 0.133214766 0.12745973 0.121776298 0.116169134 0.11064288
13.19338439 13.3140195 13.43040596 13.5446989 13.65685425 13.76682877 13.87458008 13.98006661 14.08324772 14.18408363	32,32571679 32,31326929 32,30093132 32,228871272 32,27662331 32,26467286 32,25287109 32,24122769 32,22975231 32,21845452	0.162899317 0.156856938 0.150862541 0.144920887 0.13903672 0.133214766 0.12745973 0.121776298 0.116169134 0.11064288 0.105202152
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0.802013728 32 0.569308434	10.01993262 32 0.686832308	Curve Segments
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# STARS-CFD Background Mesh Data File (BACT.BAC)

Background mesh — NACA 0012 w/Flap					
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	0	1	0	10	
	0	0	1	10	
2	-1000	-1000	-1000		
	1	0	0	10	
	0	1	0	10	
	0	0	1	10	
3	-1000	1000	-1000		
	1	0	0	10	
	0	1	0	10	
	0	0	1	10	
4	8	80	1000		
	1	0	0	10	
	0	1	0	10	
	0	0	1	10	
1	1	2	3	4	
*	Point So	ources			
*	Line So	urces			
Leading	g Edge				
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0	32	0	.30	.50	1.00
Trailing Edge 1					
16	0	0	.65	2.00	10.00
16	14.4	0	.65	2.00	10.00
Flap Trailing Edge					
16	14.4	0	.65	2.00	10.00
16	24	0	.65	2.00	10.00
Trailing Edge 3					
16	24	0	.65	2.00	10.00
16	32	0	.65	2.00	10.00
Airfoil ]	Гір 1				
0	32	0	.35	.50	1.00

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4	33	0	.35	.50	1.00		
Airfoil	Tip 2						
4	33	0	.35	.50	1.00		
12	32.5	0	.35	.50	1.00		
Airfoil	Tip 3						
12	32.5	0	.25	.50	1.00		
16	32	0	.25	.50	1.00		
Top Be	ginning	of Flap					
12	14.4	0.49430	)9	.40	0.50	1.00	
12	24	0.49430	)9	.40	0.50	1.00	
Bottom	Beginni	ng of Fla	p				
12	14.4	-0.4943	09	.40	0.50	1.00	
12	24	-0.4943	09	.40	0.50	1.00	
*	Triangle	e Sources	s				
Airfoil	Surface 1						
0	0	0	0.65	2.0	10.0		
16	0	0	0.65	2.0	10.0		
16	32	0	0.65	2.0	10.0		
Airfoil	Surface 2	2					
16	32	0	0.65	2.0	10.0		
0	32	0	0.65	2.0	10.0		
0	0	0	0.65	2.0	10.0		
Flap To	p Surfac	e 1					
12		14.4	.49430	9	0.40	0.5	1.0
12		24	.49430	9	0.40	0.5	1.0
16.0		24	0		0.40	0.5	1.0
Flap To	p Surfac	e2					
12		14.4	.49430	9	0.40	0.5	1.0
16		14.4	0		0.40	0.5	1.0
16		24	0		0.40	0.5	1.0
Flap Bo	ottom Sur	face 1					
12		14.4	49430	19	0.40	0.5	1.0
12		24	49430	19	0.40	0.5	1.0
16		24	0		0.40	0.5	1.0
Flap Bo	ottom Sur	face 2					
12		14.4	49430	19	0.40	0.5	1.0
16		14.4	0		0.40	0.5	1.0
16		24	0		0.40	0.5	1.0

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# STARS-CFD Boundary Condition File (BACT.BCO)

Boundary Condition File NACA 0012 "BACT" with Flap	24 4
15 32	25 0
Surface Regions	26 4
1 1	27 0
2 3	28 0
3 3	29 0
4 3	30 0
5 3	31 0
6 3	32 0
7 1	
8 1	
9 1	
10 1	
13 1	
14 1	
15 1	
Curve Segments	
1 0	
2 0	
3 0	
4 0	
5 0	
6 0	
7 0	
8 0	
9 0	
10 0	
11 0	
12 0	
13 4	
14 4	
15 4	
16 4	
17 0	
18 I	
19 1	
20 1	
21 4	
22 0	
23 4	

## STARS-CFD Parameter Control File (BACT.CONU)

&control nstep = 240, nout = 6000, ncycl = 40, ncyci = 40, nstage = 5, cfl 0.7, = nsmth = 2, smofc = 0.2, diss1 = 3.5, diss2 = 3.5, relax = 1.0, mach = 0.77, alpha = 0.0, beta = 0.0, restart = 1, nlimit = 2, lg = 1, nite0 = 1, nite 1 = 1, nite2 = 0, tlr = 0.00001, debug = .false., meshc = 1, mesh f = 1, low = .false., cbt(1) = 1.0, cbt(2) = 0.5, cbt(3) = 0.0, cbt(4) = 0.0, wux = 0.0,wuy = 0.0, wuz = 1.0, amplitude= 2.0, freq = 1.0, trans = .true., bulkvis = .false., pistonn\_sol= .false., model\_sol= .true., 1

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# STARS-Unsteady Scalars File (BACT.SCALARS)

\$ aeroelastic scalars data file nr, ibc (0=full modes, 1=q(1) = 0.01, 2=q(nr+1)=0.01)3, 2, 0.5, 10 10, 1, 7, 8, 9, 10, 11, 12, 13, 14, 15 \$ iread, iprint 2, 1 \$ dimensional parameters; mach-inf, rho-inf(slin/in^3), a-inf(in/s), gamma, pinf 0.77 1.8924E-08 13165.2 1.4 0.0 \$ shift factor and gravity constant 1.0 1.0 \$ flag, ffi, ns, ne 2, 35.0, 5, 20 \$ cfa, cfi 1, 1 \$ nterms, nsteps 20, 2 \$ na, nb 4, 11

#### Portion of STARS-Unsteady Arrays File (BACT.ARRAYS)

**\$ ARRAYS FILE FOR RUNNING UNSTEADY** \$ nna, nela 8814 17624 \$ Frequency (hz) 3.344 5.207 26.261 **\$ COMPLETE GENERALIZED STIFFNESS MATRIX** .223833E+03 .000000E+00 .000000E+00 .000000E+00 .109500E+02 .000000E+00 .000000E+00 .000000E+00 .109663E+04 **\$ COMPLETE GENERALIZED MASS MATRIX** .506670E+00 .405333E-01 .002880E+00 .123472E-04 .102350E-01 .573900E-05 .877300E-06 .573900E-05 .402803E-01 **\$ COMPLETE GENERALIZED DAMPING MATRIX** .298190E-01 .000000E+00 .000000E+00 .000000E+00 .669850E-03 .000000E+00 .000000E+00 .000000E+00 .000000E+00 **\$ AERO VECTORS** 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.0000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 :

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